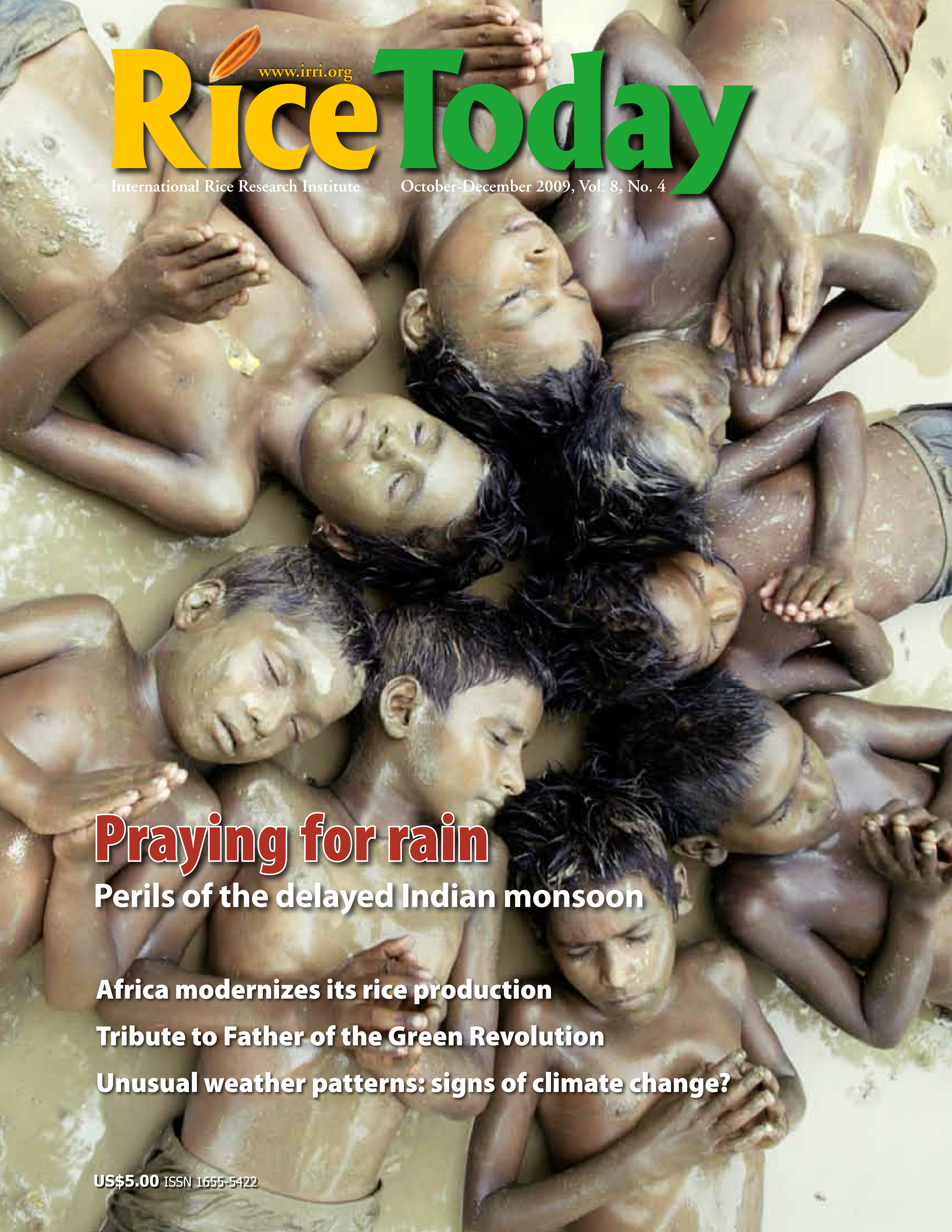


www.irri.org

Rice Today

International Rice Research Institute October-December 2009, Vol. 8, No. 4

Praying for rain

Perils of the delayed Indian monsoon

Africa modernizes its rice production

Tribute to Father of the Green Revolution

Unusual weather patterns: signs of climate change?

US$5.00 ISSN 1655-5422

contents

RiceToday
Vol. 8, No. 4

On the cover:
Delayed monsoon in India has caused a 15–20% reduction in the country's rice production. This has subsequently taken out 4% of the world's rice supply according to USDA estimates. As almost half of the nation's states declare drought conditions and a possible food shortage looms before the country, children in Nari, Bari, lie in mud and pray for rain to come and shower their parched land.

While India reels from drought conditions, other countries experience deluges that drown their crops. This issue features the many faces of climate change.

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

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

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

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

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

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

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

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

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

cover photo © **Rajesh Kumar Singh,** Associated Press

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

On the shoulders of GIANTS

This edition of *Rice Today* helps launch the 50th anniversary of the International Rice Research Institute (IRRI).

Right at the beginning, our rice breeders, notably Peter Jennings and Hank Beachell, who can be seen in this issue's centerfold (pages 30-31), developed high-yielding shorter-stemmed rice varieties that helped boost rice production across Asia from the mid-1960s until today. This helped prevent famine and saved millions of hectares of natural ecosystems from being converted to farmland.

Despite their own successes, I suspect that our esteemed predecessors would have never imagined the nature of the future scientific successes that have been built on their hard work. I say this with some trepidation. Peter was an important mentor for me and I know how he hates to have words or thoughts attributed to him!

In 2005, rice was the first crop to have its genome sequenced. Since then, technology has progressed rapidly, opening more possibilities to decode thousands more rice genomes. This would allow us to unlock the genetic diversity of rice and make it more widely available in breeding new, resilient, and high-yielding rice varieties.

It is this kind of foresight that has helped IRRI scientists deliver a whole range of innovative research solutions to farmers over the past 50 years. More than 860 rice varieties developed from IRRI breeding lines have been released, including the recent submergence- and drought-tolerant rice. There has also been a research-driven shift to ecologically based pest management and integrated nutrient management that has helped reduce pesticide use and rationalize fertilizer applications. The potential of other technologies, such as hybrid rice, are yet to be fully realized.

Asia, as the producer and consumer of more than 90% of the world's rice, has been one of the biggest beneficiaries of rice research. But, as we have seen in the recent issues of *Rice Today*, rice production is now gaining ground in Africa. This issue looks at how Africa is modernizing its rice production by improving its farming equipment. The recent meeting among the member countries of the Africa Rice Center concluded with a set of plans to make the region more self-sufficient.

Quite significantly, IRRI's research scope continues to broaden in terms of geography and also in networks. Our strong partnerships with other institutions have helped multiply our impact worldwide. By fostering new private-sector partnerships, we see another avenue opening to add value to our research and provide new ways to deliver it—helping us help poor rice farmers and consumers.

Tomorrow holds ongoing challenges for rice science. We need an additional 8–10 million tons of rice each year for the next 20 years to meet anticipated demand. But, climate change looms as a particular threat to rice production. Hence, this issue looks at how we can conserve water and reduce greenhouse gas emissions to help minimize the effects of rice production on climate change. We also pay particular attention to the delayed Indian monsoon that has significantly reduced crop production in India.

As we look to the future and celebrate our past achievements, I would like to take the opportunity to honor the passing of a true giant in our field, Dr. Norman Borlaug. The legacy Norm leaves with us is his enduring compassion for people, commitment to overcome poverty, and his insatiable curiosity to find solutions to help feed millions of people not only during his time but in the coming generations. May these qualities live on in us and be fostered in all new scientists, the next giants in agriculture.

Robert S. Zeigler

Dr. Robert S. Zeigler
Director General
International Rice Research Institute

Hidden Treasure

The International Rice Research Institute's (IRRI) 50th anniversary is approaching soon. As I ponder the history that makes this event significant, two key words come to mind—travel and change. We have also successfully concluded The Rice Trader Americas 2009 conference (and, on a very personal level, I have witnessed my daughter's first birthday).

Travel

How much have we physically or mentally traveled in the years that have passed just to get to where we are? More challenges lie on the road ahead. Every hurdle we overcome may seem like mere passing moments, but these successes add to the stature of the Institute that is so deeply rooted in its resolve to support sustainable global food production. Think of the many scientists from around the world who pass through the gates of IRRI to arm themselves with the knowledge that saves lives. These journeys are often amazing.

In fact, I was struck by a story I read some time ago about Mr. John D. Rockefeller's determination to make it to the grand opening of the Institute after being stranded first in Singapore because of aircraft problems, and then again in Hong Kong, after flying there as a solution to the earlier problem. As we all now know, IRRI's founder did make it to the opening of IRRI, but only by making the sacrifice of procuring an airplane of his own. Thankfully, his kindness and ingenuity over the years have helped the world in many ways.

Business travel has always been a mixed blessing. It is especially necessary for people who are part of the international rice trade or the global scientific arena. We can all learn from these trips, yet, the time spent traveling can also be viewed as a sacrifice. Last month, I had a long trip in which I drove many miles from California to the Midwest. Apart from that, I also found time to fly to Asia to attend the Thailand Rice Convention 2009. I was honored to deliver an address during the event and also to network with a global audience of rice professionals that included Rice Today's very own Mr. Duncan Macintosh (associate publisher) and Mr. V. Subramanian (managing editor). Highlighting the future of the world's largest rice exporter (Thailand), the event was an opportunity for the leaders in rice trade to air their views and make a mid-year review of the current situation and the road ahead—a road made even more bumpy by the 2008 food crisis and the supply-demand dynamics that continue to shape markets.

After more than a month on the road, it is nice to finally be home. Sacrifices and the costs associated are best appreciated when the moment has passed, when the benefits can be savored.

Travel also offers a chance to think. The most profound thought I had during the trip was a look back at our ancestral family farm's wheat crop, while sitting peacefully in a quiet hotel lobby.

Change

It struck me even here that the place I left long ago had changed. The look of the farm had changed; so did the varieties in the fields. Soybeans were being planted here for the very first time, and it was only then that I realized how the same observation of change could be made for IRRI and the science behind the rice plant. IRRI has grown in both size and influence over the past 50 years—an important change that recognizes the larger role the Institute has in feeding an ever-increasing population. One could say that dealing with change is a difficult but necessary part of evolution and the backbone of success. Change, in this case, could only be described as a great blessing.

To end my quarterly thoughts, I want to wholeheartedly thank the hardworking scientists, benefactors, and especially the founders who have made IRRI possible. Their efforts gave birth to the Green Revolution. Now, their work continues to save countless lives. Specifically, I want to thank the Philippines for playing host to IRRI for the past 50 years and for the country's role in co-hosting the upcoming "The Rice Trader–World Rice Conference." My thanks go especially to Secretary of Agriculture Arthur Yap.

Jeremy Zwinger

Jeremy Zwinger
Publisher

Learning from the plants

It was around 5:30 on an April morning in 1988 in Ciudad Obregón, Mexico, when I heard a knock on my hotel room door. I opened it a crack and there stood Nobel Peace Prize Laureate Norman Borlaug. "Come on, let's go," he razzed me with a sly wink and a smile. "The plants are up early around here."

The evening before, after dinner, he had asked me if I could accompany him the next morning to the nearby sprawling experiment station of the Centro de Investigaciones Agrícolas del Noroeste (CIANO) located just a few kilometers down the road. He wanted me to take some "portrait" photos of wheat plants against the backdrop of the early-morning azure sky that this part of the fertile Yaqui Valley is famous for. When he said "early" I didn't think he meant predawn. But, I should have known better!

"Just a second," I said, with a voice that I hoped implied I had been waiting for him. I don't think I had ever moved so fast. I quickly tied my shoes and grabbed my Nikon camera. In any event, we were soon speeding down the local highway, named in his honor, as the dawn approached.

We were both in this prosperous agricultural region of northwestern Mexico with most of the Wheat Program staff of the International Maize and Wheat Improvement Center (CIMMYT). The staff was on its annual spring-time sojourn at CIANO to nurture and study the new wheat lines being advanced for farmers in developing countries. I was there as the Program's science writer/editor to document the latest research achievements. Norm, on the other hand, was there officially as a CIMMYT "consultant." He was asked to assist with running the latest batch of 25 or so young wheat research trainees from all over the world through the rigors of field work associated with wheat breeding such as pulling plants and selecting seed.

As the sun rose, the lighting was perfect and the sky was as blue as I'd ever seen. No one else was around. It was just the two of us walking among the bread and durum wheat plots in which the plants—nearly ready for harvest—reflected a golden luster. As Norm selected plants for me to frame against the sky with my camera, he told me that he learned a lot from the plants during his daily early-morning hikes, observing, for example, how the ripening heads might quake in a sudden gust of wind. He felt that the bread wheats and durums all had their distinct "personalities."

That morning, Norm was particularly interested in getting a good portrait of triticale, a man-made cereal derived from crossing a wheat "mother" with a rye "father." He hoped to come up with a cover shot for a book (*Triticale: a promising addition to the world's cereal grains*; see http://snipurl.com/rzrsf) about the research progress with this grain that can combine some of wheat's qualities for producing noodles, pastries, and some breads with rye's disease resistance, drought tolerance, hardiness, and adaptability to difficult soils. This book was to be produced soon by the U.S. National Research Council. He thought that the ripe triticale plants were the most photogenic of all at this growth stage and I agreed, using up the remainder of my film, taking shots from a variety of angles, until the sun was already quite high in the sky and it was time for breakfast.

I'll always remember that particular morning in northwestern Mexico. When I moved on to work at the International Rice Research Institute (IRRI) in 1995, I unfortunately didn't have many opportunities to touch base with Norm any more. The last time was when the global agricultural diplomat swung by the Philippines in late April 1999 and made a brief stop at IRRI to confer with researchers here.

Norm left the stage last 12 September at age 95. If only all of us could live such a long, passionate, persistent, and persuasive life, as former IRRI economist Robert Herdt heralds in his tribute to Norm, beginning on page 32.

All of us—and the plants—will miss Norm.

Gene Hettel

Gene Hettel
Contributing editor and head of IRRI's Communication and Publications Services

Syngenta and IRRI collaborate to benefit Asia's rice farmers

Another lane on the research highway between the nonprofit and private sector opens today to help deliver technology-driven solutions to rice farmers and the rice industry in the face of climate change and global food security challenges.

SYNGENTA

A Memorandum of Understanding (MOU) signed in Singapore between the International Rice Research Institute (IRRI) and Syngenta sets out a commitment between the two organizations to closely collaborate in undertaking rice research, to build scientific capacity, and to establish a Scientific Know-How Exchange Program (SKEP).

The SKEP will allow Syngenta and IRRI to pool their expertise and resources and focus on a number of areas such as characterizing the genetic diversity of rice, marker-assisted breeding applications, and dealing with constraints to rice productivity.

"Syngenta has significant expertise in rice research, in the use of marker technology, and in the development of holistic approaches to crop production and performance," says Dr. Robert Zeigler, director general of IRRI.

"This complements the strengths of IRRI, which include conserving the world's largest collection of rice and making it widely available, numerous breeding programs that produce new breeding lines and varieties of rice that are made available to farmers worldwide, and expertise on all aspects of sustainable and environment-friendly management for the key rice production systems," he explains.

"We will work together on disseminating new crop management and postharvest technologies in key rice-growing regions, including water-saving irrigation and site-specific nutrient management," adds Dr. Zeigler.

Future areas of research collaboration on the agenda may include insect resistance monitoring and management, newly emerging diseases, grain quality, weed management in dry-seeded rice, water quality and ecosystem services, and alternative forms of irrigation.

Public awareness events on rice and scholarships for educating a new generation of rice scientists are also scheduled to be part of the SKEP agreement.

The MOU and the anticipated SKEP will also ensure that IRRI, a nonprofit organization, can continue to widely deliver its research, including the seed of new rice varieties, to its partners. Neither the MOU nor the SKEP will include any agreements on exclusive access to IRRI's research or research outcomes.

"Our collaboration with IRRI, including the SKEP, is an important next step in our close working relationship," says Mr. Peter Pickering, Syngenta's head of Seeds for the Asia Pacific Region. "It is entirely consistent with Syngenta's very strong commitment to rice in the region and to improving outcomes for rice farmers."

On hand to witness the signing was Syngenta Chairman Mr. Martin Taylor, who was in the region visiting several of Syngenta's rice and research facilities.

In 2010, IRRI celebrates its 50th anniversary. Since its establishment, IRRI has fostered many partnerships with the private sector and others that have increased IRRI's capacity to deliver on its mission to improve the welfare of rice farmers and consumers, particularly through higher rice yields.

Announced in Singapore—an emerging hub for IRRI where it will raise awareness about rice research and build alliances in the region—the MOU and subsequent SKEP are part of the latest generation of IRRI's collaboration with private-sector partners to increase the scope and impact of rice research.

Global team develops tools to unravel diversity of rice

By looking at what different types of rice have in common, a team of international scientists is unlocking rice's genetic diversity to help conserve it and find valuable rice genes to help improve rice production.

Understanding rice's valuable genetic diversity and using it to breed new rice varieties will provide the foundation for improving rice production and securing global food supplies.

Recently published online in the *Proceedings of the National Academy of Sciences* (PNAS) are the findings of the research team, which scrutinized the genomes of 20 different types of genetically diverse rice used in international breeding.

"We are hunting for snippets of DNA, called single nucleotide polymorphisms, or SNPs, that distinguish this rice," says Dr. Ken McNally from the International Rice Research Institute (IRRI). "The collection of SNPs that we have found is the most extensive in rice to date.

"If the rice types share a favorable trait, such as drought tolerance, high yield, or even desirable cooking quality characteristics, they probably share similar SNPs contributing to that trait," he added.

Rice contains tens of thousands of genes, so finding a successful way to hunt through them all is a major breakthrough. IRRI maintains the International Rice Gene Bank containing more than 109,000 types of rice, yet relatively few have been used in breeding programs.

IRRI Director General Dr. Robert Zeigler says, "If breeders know more about the genetic makeup of rice, they can use it more effectively. As we face more erratic changes in climate, we will increasingly rely on using the untapped diversity of rice to develop new and improved rice varieties."

This study represents a significant international collaboration attracting researchers from Asia, North America, and Europe who are interested in both basic and applied science from evolution and crop domestication to practical breeding.

BRIEFLY

G8 issues statement on global food security

Leaders of 40 states and international organizations approved the L'Aquila Food Security Initiative (AFSI) at the 2009 G8 Summit held in L'Aquila, Italy. Their objective is to invest 20 billion dollars over 3 years to encourage rural development of poor countries. Initially invested funds amounted to 15 million dollars.

The Initiative promotes the development of a global partnership focused on agriculture and food security with the objective of prioritizing the importance of agriculture on the international agenda, launching new investments, and improving the efficiency of aid programs and regional coordination by involving all the partners.

The Consultative Group on International Agricultural Research (CGIAR) endorsed the Initiative with Bioversity International's Emile Frison, who was involved in the G8 expert meetings to develop the AFSI, representing the CGIAR in the G8 Development Ministers' Meeting.

The Initiative also mentions the CGIAR, among other international agricultural bodies, as one of its partners in its aims toward better global governance, acknowledging the fundamental reform processes under way.
Source: www.g8italia2009.it

Hillary Clinton visits India rice scene

U.S. Secretary of State Hillary Clinton named agriculture as a major part of renewed U.S.-India collaboration, and pledged assistance from the Obama administration that may be in part monetary. She announced this during her visit to the Indian Agricultural Research Institute (IARI) in July 2009. She noted that, although India has 3% of the world's crop land, it feeds almost a fifth of the world's population.

Clinton went to IARI to learn more

USRPA

about its programs and the work of the Consultative Group on International Agricultural Research (CGIAR) centers. The U.S. Embassy requested the presence of a number of CGIAR partners from the Cereal Systems Initiative for South Asia (CSISA) and the International Rice Research Institute (IRRI).

Improved gene to tackle rice blast fungus

Having a blast is no fun for farmers. The rice blast fungus *Magnaporthe oryzae* can wipe out hectares at a time. It is "a devastating problem," says Robert Zeigler, a plant pathologist and director general of the International Rice Research Institute (IRRI).

IRRI estimates that blast outbreaks can cut yields up to 85%. Fungicides are widely used in developed countries, but in the developing world they "are not a viable economic or logistical option for most farmers," Dr. Zeigler says.

Breeders have found genes that provide resistance against rice blast. But plants equipped with these genes produce lower-quality rice, and the fungus has quickly evolved to overcome resistance in as little as 2 years. At last, however, scientists appear to have found a winner. *Science*, in its 21 August 2009 edition, reports that a team led by plant molecular biologist Shuichi Fukuoka of Japan's National Institute of Agrobiological Sciences in Tsukuba describes a novel type of gene that promises lasting resistance without degrading grain taste.
Source: Science, www.sciencemag.org

"No-cook" rice developed

If Indian scientists are correct, hundreds of millions of people across the subcontinent could benefit from rice that "cooks" simply by being soaked in water.

Experts at the Central Rice Research Institute (CRRI) in Orissa who have developed the rice were inspired by so-called soft rice, or *komal saul*, that grows in the northeast Indian state of Assam. Traditional recipes call for such rice to be soaked overnight in water, then eaten with mustard oil and onions.

Until now, these low-yielding grains have not grown outside the northeast, but the scientists at CRRI have managed to develop a hybrid of a traditional soft rice with a high-yielding variety of regular rice. The result has been called Aghunibora.

The institute's director, Dr. T.P. Adhya, said that field trials of Aghunibora were already positive, suggesting that it could be grown in different climates across India. "This is the first time soft rice has been grown anywhere else," he said.

The aim, he said, was to produce a grain that would allow people across the country to prepare rice "simply by putting it in water."
Source: The Independent, www.independent.co.uk

Awards and recognition

IRRI's ***Rice Database***, maintained by the IRRI Library, received the Association of College and Research Libraries (ACRL) Science and Technology Section 2009 Oberly Award for bibliography in the agricultural or natural sciences. The award is given every 2 years to "the best English-language bibliography in the field of agriculture or any related science."

Keeping up with IRRI staff

Development Director **Duncan Macintosh** has been named acting executive director of IRRI Fund Singapore (IFS) following the Fund's establishment in June. Director General **Robert Zeigler** is IFS Board chair.

Bill Hardy is now IRRI's senior science editor.

Alexis Faulkner joins IRRI as consultant for the Institute's Golden Jubilee. She will serve as the point person for all information pertaining to IRRI's 50th-year celebrations.

Gurdev Khush, former principal plant breeder at IRRI, has been appointed eminent professor from 2008 to 2013 at the Graduate School of Biotechnology of Kyung-Hee University (KHU) in Suwon, South Korea. He will work on the project *Development of an Ecofriendly High-Yield New Plant Type Rice* with a KHU professor.

Thomas Metz, former interim head of the Crop Research Informatics Laboratory (CRIL), continues as head of CRIL-IRRI. **Guy Davenport** will head CRIL-CIMMYT.

Richard Bruskiewich, formerly bioinformatics specialist, is now computational/systems biologist and deputy leader of the C_4 Rice project. **Noel Magor**, head of the Training Center, is now interim leader for IRRI's Program 6 (Information and Communication). **Thelma Paris**, gender specialist, has been appointed deputy head of the Social Sciences Division. **Sushil Pandey** continues his work as leader for Program 7 (Rice Policy Support and Impact Assessment).

Glenn Gregorio is back at IRRI headquarters as plant breeder for abiotic stresses (salinity and zinc deficiency) after a successful 3.5-year stint in Nigeria. He will continue the work of R.K. Singh in these two areas as **R.K. Singh** becomes senior scientist and regional plant breeding coordinator for East and southern Africa. He has moved to Dar es Salaam, Tanzania, where he joins the new IRRI–Africa Rice Center office.

Paul Quick has joined IRRI as principal scientist and head of the applied photosynthesis and systems modeling team for C_4 Rice.

Martin Gummert is now senior scientist (postharvest specialist). **Guoyou Ye** has also come on board as senior scientist (breeding informatics specialist). He will lead the development and deployment of germplasm information management systems and will contribute to related activities across the Institute.

Mark Boru Douthwaite joins IRRI as guest scientist and innovation and impact director for the Challenge Program on Water and Food.

New scientists are **David Raitzer**, who will do impact assessment and priority setting for rice research as it relates to food security, poverty reduction, rural livelihoods, human health and nutrition, and environmental sustainability; **M.S. Ramesha**, who will develop high-yielding rice varieties adapted to water-scarce conditions and suitable for direct-seeding and alternate wetting and drying systems; **Deepinder Grewal**, who will help develop elite breeding lines with high iron and zinc contents in polished rice grains; and **Fiona Hay**, who will lead new areas of research to improve the operations of the Genebank at IRRI and its coordination with other rice genebanks.

M. Srinivas Rao is now the chief executive officer of the Cereal Systems Initiative for South Asia (CSISA) project. CSISA brings together public- and private-sector organizations to develop and deliver integrated technology solutions for sustainable intensification of major intensive cereal production systems in India, Pakistan, Bangladesh, and Nepal.

New postdoctoral fellows are **Alexis Ndayiragije**, who is with the IRRI-Africa program; **Shanta Karki** and **Jolly Chatterjee** for applied photosynthesis and systems modeling in C4 rice; **Yuko Nakano** joins under the Bill & Melinda Gates Foundation project on stress-tolerant rice; and **Junghyun Shim** works with the Plant Breeding, Genetics, and Biotechnology Division.

IRRI bids farewell to **Robert Hijmans**, senior scientist (GIS specialist); **Terry Jacobsen**, head of the Facilities Management Unit; and **Hari Bhagat Gurung**, international research fellow.

Obituaries

Mike Gale, former IRRI Board of Trustees member (2001-03), passed away on 18 July while attending a music festival with his wife, Sue. Mike was a highly distinguished scientist and has been honored internationally for his contributions to cereal genetics and the genetic improvement of crops. His work and collaborations with cereal-mapping groups worldwide founded the new science of comparative genomics.

A Thai colleague, **Yothin Konboon**, died of unknown causes on 27 August while attending a workshop at IRRI. Yothin was a soil scientist at the Ubon Ratchathani Rice Research Center and was a long-standing collaborator of the Consortium for Unfavorable Rice Environments.

Nobel Laureate **Norman Borlaug**, known as the "Father of the Green Revolution," died of complications from cancer on 12 September. The Nobel committee honored Borlaug in 1970 for his contributions to high-yield crop varieties and for bringing other agricultural innovations to the developing world. Many experts credit the Green Revolution with averting global famine during the second half of the 20th century, which perhaps saved 1 billion lives.

TRAINING COURSES AT IRRI

Upland Rice Variety Selection Techniques (for African countries)

IRRI Training Center, Los Baños, Philippines, 9-13 November 2009 (targeted participants

This is a one-week course for researchers and extension officers from African countries who work in upland rice. The main objective is for participants to learn selection techniques for upland rice to enable them to develop rice variety selection plans and promote upland rice cultivation in Africa. The course will cover the theories and practices of cultivation and management techniques of upland rice. After the course, participants should be able to evaluate upland rice varieties that are suitable in African countries, and also be knowledgeable of the maintenance and multiplication of breeders' and quality paddy seed.

This course is supported by the government of Japan through the Japan International Cooperation Agency.

Leadership for Asian Women in Agricultural R&D and Extension

IRRI Training Center, Los Baños, Philippines, 23 November-3 December 2009

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

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

Top 5 downloaded IRRI books on Google™

1. **Principles and practices of rice production** (http://snipurl.com/scytg)
   By Surajit K. De Datta
2. **Small farm equipment for developing countries** (http://snipurl.com/scyvu)
   By United States Agency for International Development, International Rice Research Institute
3. **Rice is life** (http://snipurl.com/scyx9)
   Edited by K Toriyama, K L Heong, B Hardy, World Rice Research Conference, International Rice Research Institute
4. **The rice economy of Asia** (http://snipurl.com/scyxt)
   By Randolph Barker, Robert W. Herdt, Beth Rose
5. **Technical handbook for the paddy rice postharvest industry in developing countries** (http://snipurl.com/scyzk)
   By James E. Wimberly, International Rice Research Institute

Top 10 PDF downloading countries

1. India
2. United States
3. Philippines
4. Vietnam
5. Thailand
6. Malaysia
7. China
8. Indonesia
9. Iran
10. Japan

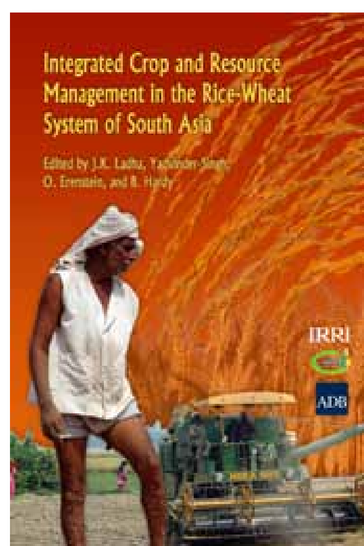
NEW BOOK www.irri.org/publications

Integrated Crop and Resource Management in the Rice-Wheat System of South Asia

Edited by J.K. Ladha, Yadvinder-Singh, O. Erenstein, and B. Hardy.

This book covers the history of the Rice-Wheat Consortium and explains the importance of resource-conserving technologies developed for this system, such as laser land leveling, zero-till and reduced-till drill-seeded wheat, direct seeding of rice, and a leaf color chart for nitrogen management.

Through integrated crop and resource management, farmers can combine their practices with these new technologies. This 395-page book presents the outputs of the Asian Development Bank project titled "Enhancing Farmers' Income and Livelihood through Integrated Crop and Resource Management in the Rice-Wheat System in South Asia." The goal is to produce more food at less cost (by improving yield per unit area) and improve water productivity. This is necessary because there will be an additional 20 million people per year in this area to feed. This book helps explain how this can be done.



RiceToday around the world

1. *RICE TODAY* Managing Editor V. Subramanian (*center*) takes the magazine to Myanmar. From *left to right:* Tin Aung Latt, Tin Aung Lay, Yan Kyaw, and Htun Than.

2. THE RICE Trader Happy Hour is never without the latest issue of *Rice Today*. From *left to right:* R. Sundar, N. Mohan, Raza Taqi, Sedat Andic, Jimmy Soh, Andrew Tan, and Edmund Siua.

3. INFORMATION and Communications Unit (ICU) staff of the International Center for Soil Fertility (IFDC) reads every issue of *Rice Today*. In the front row (*left to right*) are IFDC editors Lisa Thigpen and Courtney White. Standing at the back (*right*) are Cheryl Bennet, IFDC librarian; and Tom Hargrove (*left*), recently retired ICU coordinator. Hargrove, who reads the *IFDC Corporate Report* in this photo, was editor, then head, of the IRRI Communication and Publications Department from 1973 through 1992.

4. HONEYMOON READ. IRRI newly wed staff Ruth Panela (*left)* and husband, Red, take *Rice Today* with them to Hong Kong.

Odd seasons

Is it time to re-define our growing seasons?

by **R. Wassmann, G. Centeno,** and **S.B. Peng**

Unusual dry seasons in 2008 and 2009 cast suspicion on climate change

Climate change has often been blamed for unusual weather phenomena, especially the extreme cases. But then again, climate has never been a "fixed" condition. It constantly changes. So, any detection of genuine signs of climate change has to filter out the new but normal climate patterns that occur at the same time. In the Philippines, variations in climate are largely influenced by El Niño, which is an irregular climatic occurrence. It generally arrives every 3 to 5 years.

Rice is grown in the Philippines during two distinct seasons—the dry and the wet season. The dry season, from January to April, tends to produce higher yields than the wet season, from July to October. Climatic changes within these seasons can significantly affect rice production. Thus, farmers and researchers alike grew concerned when they experienced very wet conditions during the first months of 2008 and 2009. Those in Los Baños, Laguna, where the International Rice Research Institute (IRRI) is situated, wondered whether the weather was undergoing some fundamental changes. Given such occurrence, should we start re-defining our growing seasons?

IRRI's Climate Unit thus studied this occurrence to assess the potential changes in the supposedly dry season of Los Baños.

Needed sunshine

More sunshine translates into more energy to convert atmospheric carbon dioxide and water into carbohydrates that subsequently result in higher rice yields. If the sun becomes covered by clouds, especially heavy dark clouds that bring rains, rice plants find it harder to work. Their photosynthetic process slows down, so the plants produce lower yields. Because of this, potential yield in the dry season is normally higher. When farmers plant rice in early January, the crop's flowering and grain-filling stages fall right on time during April, when the month's bright sunny days bring enough solar radiation to achieve maximum plant photosynthesis.

Oddly, however, almost all the days of the 2008 and 2009 dry season received low radiation (see Fig. 1). The

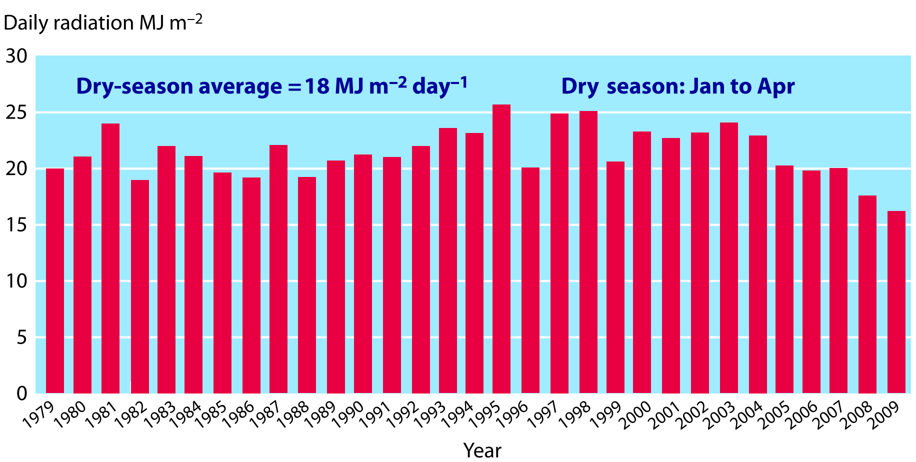


Fig. 1. Average daily radiation in the dry season at the IRRI farm.
Data source: IRRI Climate Unit.

MS. CENTENO, IRRI associate scientist, monitors the weather at the wetland agromet station.

CHRISANTO QUINTANO

average daily radiation from January to April was 14.9 and 15.1 megajoules per square meter per day in 2008 and 2009, respectively. Significantly, these values are the lowest since 1979, when IRRI's weather station started recording data. Moreover, these values are about 20% below the 30-year average dry-season value. They are even lower than the 30-year average wet-season value, which is 16.5 megajoules per square meter per day (from June to September of 1979-2009).

Too much rain

The wettest dry season in the past 30 years occurred in 2009 (see Fig. 2). This year also had the highest daily rainfall amount ever recorded in a dry season. To note, rainfall on 21 April (104.1 mm) was extremely high compared with the average rainfall of 152 mm over the entire dry season.

El Niño effect

The interannual variability of the climate in the Philippines—as well as in all of Southeast Asia—is also largely determined by El Niño. El Niño corresponds to the wet years. Its counterpart, La Niña, is more associated with high rainfall. La Niña conditions prevailed from early 2007 to early 2009. Its occurrence in 2007-08 was the strongest within the past 20 years. Over the past few months, however, La Niña has transitioned to El Niño. According to the World Meteorological Organization, during June and July 2009, the ocean surface in the central and eastern equatorial Pacific has been substantially warmer than normal, supporting the development of El Niño through the remainder of 2009 and probably into the first quarter of 2010. In all likelihood, the next dry season will not be as wet as the preceding ones.

Unusual dry seasons

Following these observations, it can be said that the dry seasons of 2008 and 2009 were more like a wet season for the rice crop. Is this evidence of climate change? Should we indeed start re-defining our growing seasons? At this point, it is still premature to describe this as a symptom of a persistent trend. Scattered over the past decades were years with unusually high rainfall, but none of which had a discernible trend as 2008 and 2009 did. We will remember the dry season of 2009, but we have yet to see whether this extreme case will occur again soon.

Two years of study are simply not enough to detect any statistically significant amount of climate change. We do, however, need to carefully watch future development in terms of seasonal shifts. If wet dry seasons occur more frequently, breeding programs and crop management recommendations will have to be adjusted quickly to help farms continue to yield more rice despite poor radiation and more rainfall.

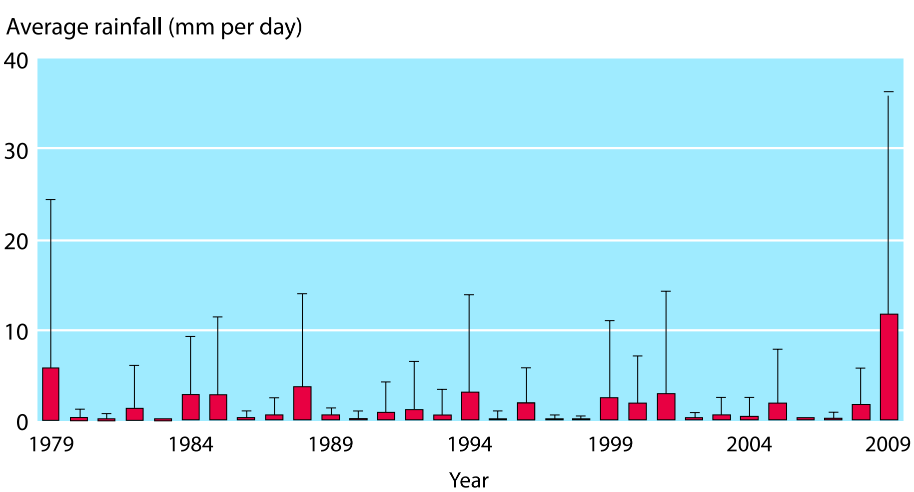


Fig. 2. Average daily rainfall during the dry season recorded at the IRRI Wetland Agromet Station, 1979 to 2009.
Data source: IRRI Climate Unit.

Dr. Wassmann is the coordinator of the Rice and Climate Change Consortium, Ms. Centeno is an associate scientist in the Climate Change Unit at IRRI, and Dr. Peng is a senior crop physiologist in the Crop and Environmental Sciences Division at IRRI.

A clearer picture

by **G. Centeno, K. Sumfleth,** and **R. Wassmann**

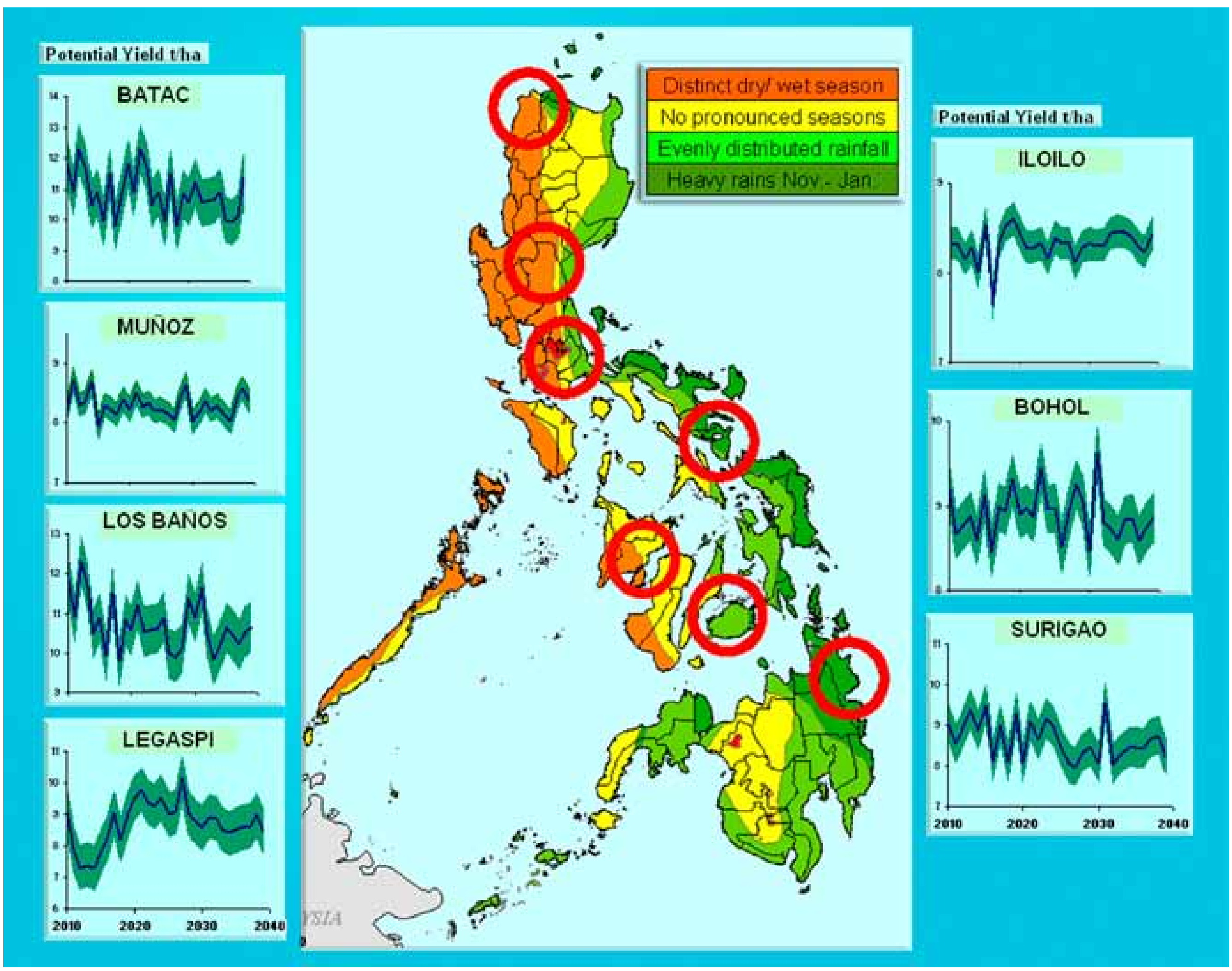
Forecasting changes in climate has always been a complex task. However, with the development of new regional downscaling tools, such as PRECIS, studying the causes and patterns of climate change has at last become less difficult.

PRECIS, or Providing Regional Climates for Impact Studies, was developed by the Hadley Centre of the UK Meteorological Office for impact studies in developing countries. Previously, climatologists mainly used General Circulation Models (GCM) that operate at a global scale and can generate illustrations with a resolution ranging from 150 × 150 km to 300 × 300 km. In studying more regional scopes, however, these resolutions tend to fall short of providing a clearer picture. Although for now GCM cannot provide finer resolution, regional downscaling tools have been developed to complement GCM. One of these tools is PRECIS, which can produce high-resolution climate change scenarios for a selected target region.

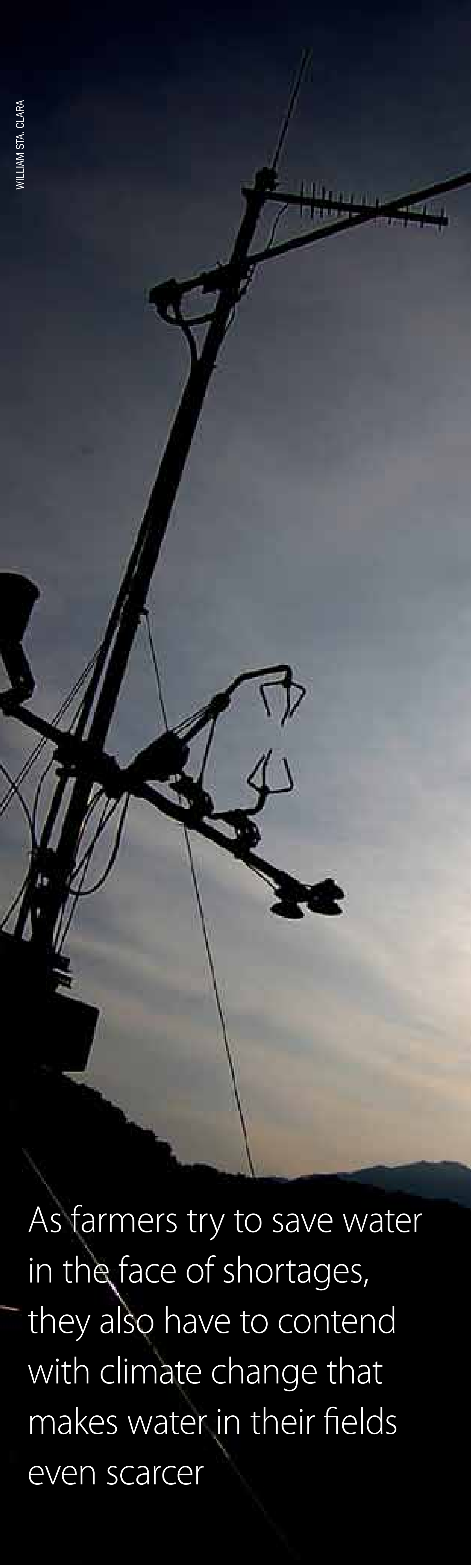
Understanding the advantages of this tool, the International Rice Research Institute's (IRRI) Climate Unit has now adopted PRECIS in its studies of climate change in relation to rice growing. In its first study done in 2009 in the Philippines, it was able to assess potential rice production output in seven provinces by analyzing the type of climate each area has and by identifying hot spots of high vulnerability, that is, rice production areas that are especially vulnerable to expected climate change (see figure). The report hoped to help the government and other stakeholders in their long-term planning and policy development to improve rice production.

With the success of this initial research, IRRI will also do similar assessments in other rice-growing countries in the next few years. In fact, the IRRI office in India has already started doing a study on northern India.

Dr. Sumfleth is a visiting research fellow at IRRI.



Note: The authors would like to thank the Bilateral Programme Budget of the British Embassy for partially funding this project, and also the Information and Technology Services staff of IRRI for their technical assistance in operating the climate server.



WILLIAM STA. CLARA

As farmers try to save water in the face of shortages, they also have to contend with climate change that makes water in their fields even scarcer

Finding a balance

by **M. Alberto, Y. Hosen,** and **R. Wassmann**

Rice thrives in a flooded ecosystem. These conditions enrich the nutrients available for the crop's growth, allowing farmers to reap abundant harvests. The downside, however, is that this flooded ecosystem emits large amounts of methane—a major greenhouse gas (GHG)—that contribute to global climate change.

One of the effects of climate change is drought, which now occurs more frequently in some regions. This aggravates water shortages, which thus threaten rice production even more. Hence, water-saving techniques have been developed, particularly by the International Rice Research Institute (IRRI), such as alternate wetting and drying (AWD) and the growing of aerobic rice in well-drained, nonpuddled, and nonsaturated soils (see *The big squeeze* on pages 26-31 of *Rice Today* Vol. 7, No. 2, and *High and dry* on pages 28-31 of *Rice Today* Vol. 6, No. 4).

In this bid to conserve water, however, the environmental impacts of these methods have yet to be established.

Needless to say, the two water-saving techniques have advantages and disadvantages. AWD, for one, maintains the basic features of flooded rice fields and keeps the potential for high production intact. However, although this practice reduces methane emissions, it can potentially increase the release of nitrous oxide—another GHG. Aerobic rice systems similarly entail drastic changes in carbon and nitrogen emissions and canopy temperature that contribute to global warming and aggravate heat stress for the rice plants, respectively. Although the consequences for the sustainability of rice fields remain unknown, it is worthwhile to thoroughly assess the use of aerobic rice, and AWD, as an option to mitigate the dire effects of climate change and, at the same time, reduce emissions.

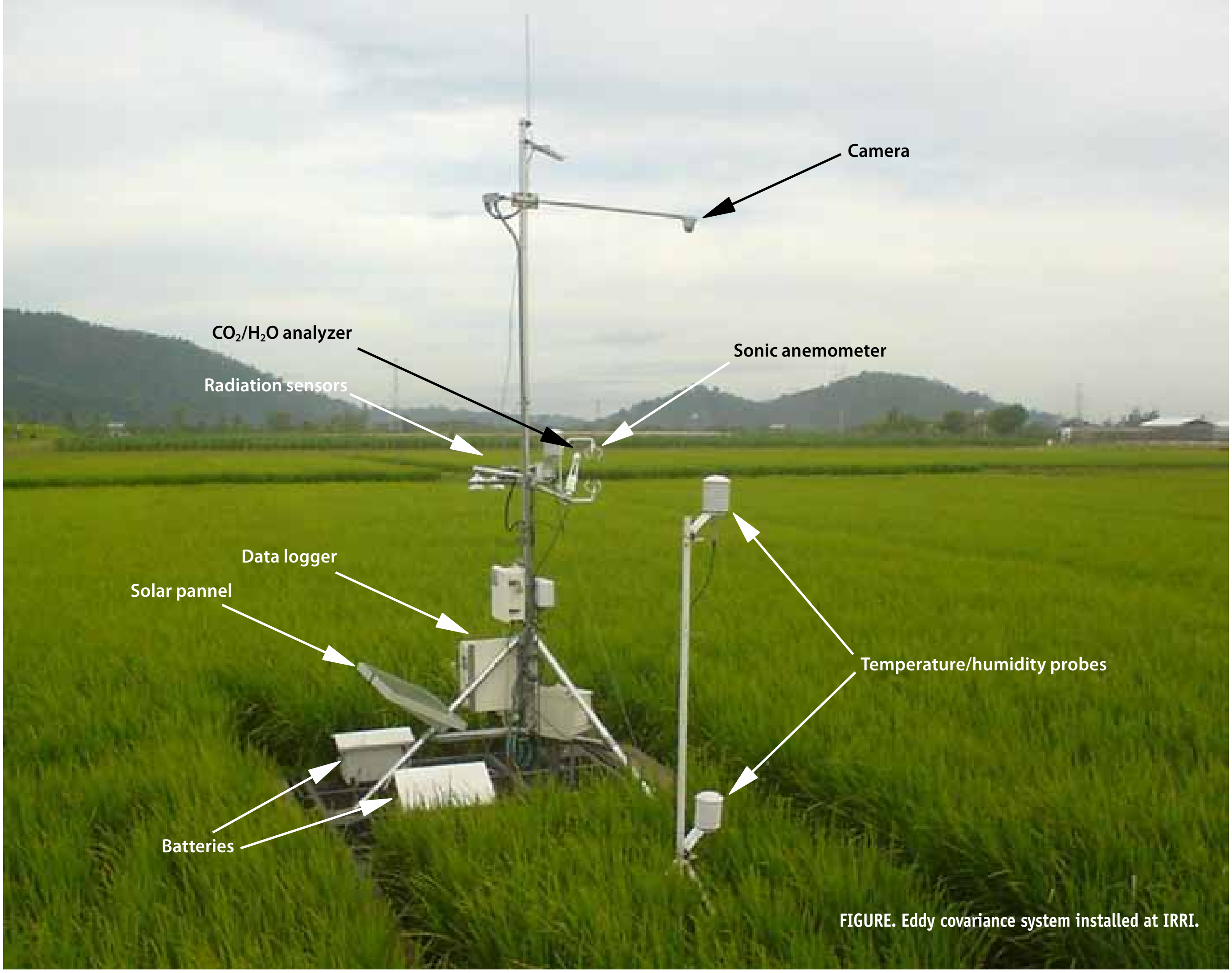
Hence, in response to these concerns, IRRI conducted two distinct field measurements to determine just how much AWD and aerobic rice growing contribute to climate change (see *Goodbye gas* on page 14 of *Rice Today* Vol. 6, No. 3).

One goes down, another goes up

Methane emissions from rice fields are mainly determined by the application of water and organic inputs. Again, the more flooded the field is, the more methane is released. The emission of this particular GHG is also influenced by the type of soil, weather, tillage management, residue, fertilizer, and rice cultivar. Recent assessments of irrigated rice cultivation estimate that, in 2000, its global emissions were equivalent to 625 million metric tons of carbon dioxide.

Since flooding the soil sustains methane emissions, shifting to a more conservative way of applying water in rice fields appears to be the best solution to reduce the amount of methane released into the atmosphere. To note, AWD effectively lessens the water used in irrigation by 15–30%.

The first experiment IRRI did in 2006 covered eight crop seasons and measured GHG emissions captured in chambers installed in AWD fields. This study confirmed that water-



M. ALBERTO

FIGURE. Eddy covariance system installed at IRRI.

saving techniques are indeed effective in mitigating the net global warming potential (GWP) of rice fields.

These methods, however, raise the risk of increasing nitrous oxide emissions when a high amount of nitrogen fertilizer is applied. This can offset or even supersede any GWP savings made by lowered methane emissions. These findings can be used to explain conflicting reports on the net GWP water-saving techniques had in earlier studies conducted in different regions and under different N management practices. There seems to be a growing consensus that water-saving techniques can still keep nitrous oxide emissions relatively low if nitrogen is applied in appropriate doses. Thus, the aim should be to combine techniques of (1) water saving and (2) efficient N-use management as a means to reduce GHG emissions.

The warmer field

IRRI conducted its second study in 2008 during the wet and dry seasons to compare the seasonal changes in heat, water vapor, and carbon dioxide in a lowland (flooded) and aerobic rice environment using the eddy covariance (EC) method (*see* Figure).

EC is the standard micrometeorological method that directly measures CO_2 and heat exchange over a larger area. Unlike the chambers used in the study described above that cover an area of only 1 square meter per chamber, the EC's minimum scope is a 100-meter radius corresponding to a field size of 4 hectares when the system is located in the center. The EC system at IRRI is actually the first in the Philippines. Powered by a solar panel, the system consists of a sonic anemometer that senses wind coming from all directions to record its gas composition, an open-path CO_2/H_2O infrared analyzer, as well as sensors for radiation, temperature, and humidity. All these sensors can generate 10 data records per second. These data are then stored in a data logger.

Based on the 2008 findings, lowland rice fields sequester more carbon from the atmosphere than aerobic rice fields. This is attributed to lowland rice's higher photosynthetic capacity to convert carbon into organic compounds and to the slow organic matter decomposition in flooded soils. In turn, the conversion from a flooded to an aerobic system entails net emissions from soil organic carbon that have to be taken into account to compute the net GWP of these systems.

Moreover, IRRI found out that the temperature and water vapor profiles in rice canopies of these two different environments vary significantly. The difference was particularly observed in the records of what is scientifically called “sensible heat flux” and “latent heat flux.” Sensible heat is the energy that warms the surrounding air, whereas latent heat is the energy stored as water vapor. IRRI learned that, on an annual basis, aerobic rice fields had 58% more sensible heat flux and flooded fields had 18% more latent heat flux. This distinction has implications for the heat stress the rice plant is exposed to

WILLIAM STA. CLARA

RUTH AGBISIT, assistant scientist at IRRI, collects a gas sample from a field chamber through a manual gas collection system.

in either system. Heat stress caused by high temperatures is aggravated by high humidity. The distinct microclimates in the canopy result in more temperature-related stress in nonflooded rice fields and more vapor-related stress in flooded fields.

Facing climate change

As much as growing rice and saving water are important, their effects on climate change mean more challenges ahead. This demonstrates how complex the world can be, as we try to plug one hole and another one bursts open that equally needs attention. Nevertheless, this only goes to show how the world needs to find a balance. Aside from saving water, it is also important to consider the overall effect of these water-saving technologies on climate change, while at the same time ensuring food security.

Ms. Alberto, assistant scientist, and Dr. Hosen, soil scientist, are working with the Rice and Climate Change Consortium at IRRI.

Food vs. gas

by **Reiner Wassmann**

IRRI finds a way to ensure food security and mitigate greenhouse gas emissions

The International Rice Research Institute's (IRRI) work has demonstrated the potential to reduce greenhouse gas (GHG) emissions in rice production with relatively low opportunity costs and, in some cases, with increased productivity. Adapting technologies to local conditions is necessary, and this involves local farmers, extension agents, and research institutions in technology design and dissemination.

Technically, methane reduction from irrigated rice could be a promising strategy to mitigate GHG emissions in line with the idea of Certified Emission Reductions (CERs) introduced in the Kyoto Protocol (http://unfccc.int/resource/docs/convkp/kpeng.pdf). According to this regulation, farmers can receive payments from a private or public institution in an industrialized country for reducing GHG emissions. In the next step, a designated panel of the United Nations Framework Convention on Climate Change (http://cdm.unfccc.int/index.html) can approve CERs that can be used by the purchasing institution as part of its required contingent of emission savings.

Now, however, there is no CER project in rice production. One obstacle is the reluctance of the UNFCCC panel to accept projects in the land-use sector. Even if this changes in the near future, the existing regulations for CERs obstruct funding of GHG mitigation through water-saving projects. Water-saving techniques can reduce GHG emissions in a given area of rice land, but, in most cases, the saved water will then be used to irrigate more rice land or new crops in future seasons. Subsequently, reduced emissions caused by these techniques are offset by emissions created in newly irrigated land. Ironically, if the saved water were channeled to other users, for example, in residential areas, one could rightfully claim CERs because of a net reduction in global warming potential (GWP) caused by the mitigation project.

Increasing food production is an absolute necessity for the human population, and improved resource-use efficiencies are imperative to achieving this goal. As an agricultural research institution devoted to increasing food production, IRRI proposes specific provisions for CER allocations in the land-use sector to converge the legitimate goals of food security and GHG mitigation in a Copenhagen agreement. Our suggestion is to compute net GWP savings based on food production targets. As long as saved resources, namely, water and fertilizer, are used to increase food production in a resource-efficient manner, it seems unreasonable to account for new emissions as offsets in or leakages from a mitigation project.

IRRI technician collects a soil solution sample in an AWD field.

WILLIAM STA. CLARA

MYANMAR

One year after a devastating cyclone, a bitter harvest

by **Richard Stone**

Myanmar weathered Cyclone Nargis better than expected, but the global financial crisis has jeopardized the country's fragile food security

During the night of 2 May 2008, Cyclone Nargis barreled across Myanmar's Ayeyarwady delta, flattening homes and sweeping away people, draft animals, and stores of rice. On a visit to the region 4 months later, plant physiologist Abdelbagi Ismail saw vestiges of the storm's fury, including tidal-surge watermarks more than 2.5 meters high on the few trees left standing. He witnessed the lingering anguish of survivors who lost entire families among the 140,000 people dead or missing. "The scene was shocking, and the stories we heard from farmers were horrific," says Ismail, who with four colleagues from the International Rice Research Institute (IRRI) in Los Baños, Philippines, went to Myanmar (formerly Burma) to advise local scientists on how to restore rice yields after the cyclone.

DAVID JOHNSON/IRRI

RESILIENCE. Nargis survivors transplanting rice last August in the Ayeyarwady delta.

A year after one of the deadliest cyclones in modern history, Myanmar's food security teeters on a knife's edge. Emergency food relief averted starvation among the 2.4 million survivors in the delta, and rice production countrywide has largely rebounded thanks to favorable weather and the use of high-yield varieties. But Nargis paved the way for another crisis—the global financial meltdown—to push Myanmar to the brink of catastrophe. Credit has evaporated, paddy farmers are going broke, and household rice stores are dwindling. "The country's rural economy has virtually collapsed," an official with International Development Enterprises, a nonprofit operating in Myanmar, said to a gathering of food security experts in Yangon in March. "The current conditions are unprecedented in living memory."

To help Myanmar cope, the European Commission, Australia, the U.K.'s Department for International Development (DFID), and other donors are establishing LIFT, a $100 million, 5-year fund for livelihoods and food security. Priorities of the U.N.-managed fund are expected to include microcredit schemes, agricultural policy reform, small business development, and R&D to boost agricultural productivity.

Nargis meted out a major blow to fragile farm communities. With gusts topping 200 kilometers an hour, the cyclone cut a swath of devastation 150 kilometers wide as it churned northeast across the Ayeyarwady delta and over Yangon (formerly Rangoon), Myanmar's capital and biggest city. The tidal surge swamped an estimated 783,000 hectares of paddy fields, destroying a third of the crop in the delta, the country's rice bowl. Local rice varieties are tall and blow down easily, says Ismail, and they succumb readily when fields are flooded or salty. Nargis also ruined much of the delta's rice seeds, which had been stored in bamboo containers that were easily water-logged. "Nargis made a bad food-security situation worse," says Zoe Hensby, livelihoods adviser at DFID.

At first, Burmese scientists feared that delta paddies would remain too saline to grow rice for months. "From the beginning, our advice was not to worry about it," says Ismail. According to observations after the December

2004 tsunami and Cyclone Sidr, which slammed Bangladesh in November 2007, salt intrusions were washed out the following rainy season. Nargis came at the end of Myanmar's dry season, just before cleansing rains. By the time the IRRI team arrived in the middle of the monsoon season in August, salinity was back to normal in fields they inspected and farmers had managed to replant 80% of disaster-hit paddies. "They bounced back and had a crop in the ground," says IRRI's Grant Singleton. "They showed tremendous resilience."

Such perseverance helped Myanmar last year to export nearly half a million tons of rice, according to a report last January for the United Nations Food and Agriculture Organization (FAO) and the U.N. World Food Programme. "The paddies are recovering," says Cheng Fang, an economist at FAO's Global Information and Early Warning System on Food and Agriculture in Rome. His team had rare permission from Myanmar authorities to travel to all areas of the tightly controlled country for a month last autumn.

Robust rice yields were about the only piece of good news that Fang's team uncovered. In addition to the appalling human toll, Nargis drowned 122,000 water buffalo and robbed survivors of farm implements and fishing boats and gear. "Many families lost everything: their homes, property, and job opportunities," says Fang.

The U.N. team also noted that Nargis coincided with a grave pest infestation in Chin, Myanmar's poorest state. In a phenomenon that recurs every half-century or so, bamboo flowered en masse in Chin in 2007. The sudden fecundity fueled an explosion in the rat population. "When this happens, it is invariably a major traumatic event," says Singleton, a zoologist who specializes in rodents. Last year, rats decimated Chin's corn and rice harvests, "leading to acute food insecurity in many villages," according to the U.N. report, which forecasts that the situation will remain critical until July.

In the meantime, the global financial downturn has exposed and aggravated the frailties of Myanmar's agricultural system. "Many households are facing unprecedented levels of hardship," says Hensby.

To mitigate the impact of future cyclones, IRRI has sent submergence- and salt-tolerant rice varieties to Myanmar for testing. IRRI's Irrigated Rice Research Consortium is also working with Burmese universities to incorporate cutting-edge technologies and knowledge into curricula to better train future agricultural scientists and extension officers. Myanmar may have weathered Nargis better than expected, but the country's food security is more vulnerable than ever.

Reprinted with permission from Science *magazine. Mr. Stone is the Asia editor of* Science.

Rice in California

It was a delight getting the various interested parties together in California to highlight this region's advancements in rice research and production. Like many rice-growing areas in the world, California is not exempt from the challenges facing rice production such as water scarcity. Nevertheless, this region never fails to strive to achieve sustainability. In fact, it is a great pleasure to live in the California rice valley and work with these different players every day.

The successive articles in this section feature the diverse regulatory, research, political, and economic needs of the California rice industry, as the authors all aim to give a glimpse of rice in California.

by **Jeremy Zwinger**

Japonica update

Since many of our readers are very interested in this subsection of the market, I felt compelled to do a special overview of the risk areas in this region. For those who do not work or trade in this market, this could be a good eye opener on the effects of supply shortage and the critical nature of water reserves.

There are only four main exporters of japonica rice—China, Australia, Egypt, and the United States. A review of these exporters is the best way to summarize this particular rice's exportable supply. It is also a good way to predict price direction, given the growing overall demand for japonica. Basically, there has not been any substantial change in the market in recent years. The system remains rather tight because, among the japonica rice exporters, the U.S. is the only one left exporting. This is especially the case in the higher quality markets.

One of the key variables to watch in the global japonica market is the weather that has affected the key producing regions. The drought in Australia, for example, has brought the country's crop production to nearly zero, and has significantly reduced the global supply of japonica rice (*see graph on page 22*). This problem is also shown in Australia's coming 2010 crop, which is estimated to produce a total of only 75,000 tons. Consequently, this means another year of no supplies for the export market, as the country's domestic annual consumption is approximately 350,000 tons. There is a huge hole in the exportable supply then, as the year progresses, and as customers wait for the crop from the Northern Hemisphere to arrive.

Following the weather problem, perhaps the next question is, When will Egypt lift its export ban on japonica rice?

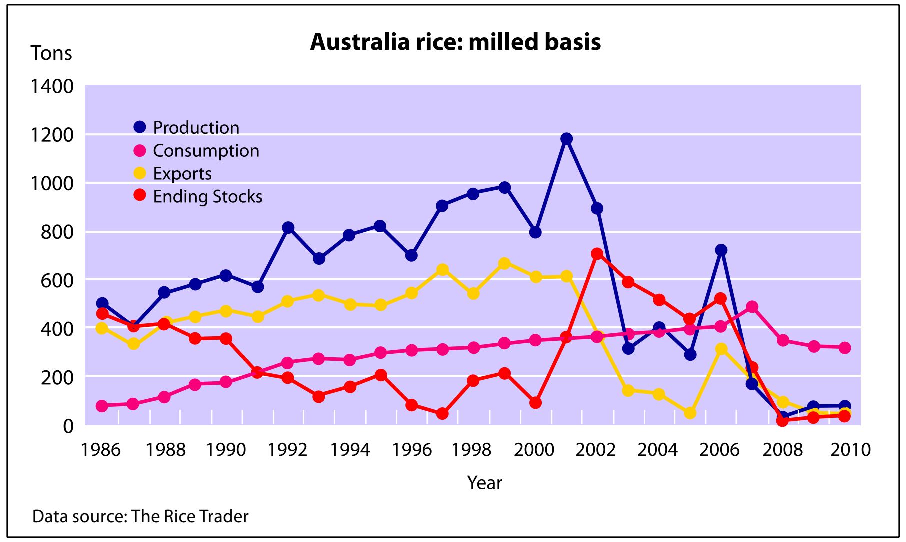
Egypt imposed the export ban primarily to protect its domestic market from excessive price shocks. With the Indian monsoon largely affecting global production this year, I believe that Egypt will likely regard national food security as its top priority and keep the ban in place until October 2009, at least. Similar to what happened in 2008, this restriction would result in rising prices.

Prior to these problems, Egypt used to export 1 million metric tons of rice

annually. In 2008, however, the country exported just 300,000 to 400,000 metric tons. A majority of the export contracts included special terms and restrictions, as the government tried to minimize price impacts on the local market. Because of the tight supply situation worldwide, Egypt might play the same cards again this year. Egypt will most likely continue to minimize its exports to protect domestic prices. I believe this is an accurate analysis of the situation. Note, however, that this is always questionable because the Egyptian government could change its mind at any time.

The drought in Australia and the limited exports from Egypt, when combined with the very little carryout in the California market, will probably keep prices up for some time. One must watch the market dynamics very closely as the year progresses. An increase in the number of players in the U.S., specifically in the California market, has also spurred competition for paddy buying, which has thus resulted in a higher cost of raw product. This can especially be noted from the intense amount of cash trade that replaced the old pool system, which is an odd type of private cooperative, and also from Australia's move to buy a mill in California to fulfill contracts and demand. The Australian businesses continue to work to fill their markets in the Middle East and the Pacific. High-quality material will then be short of supply.

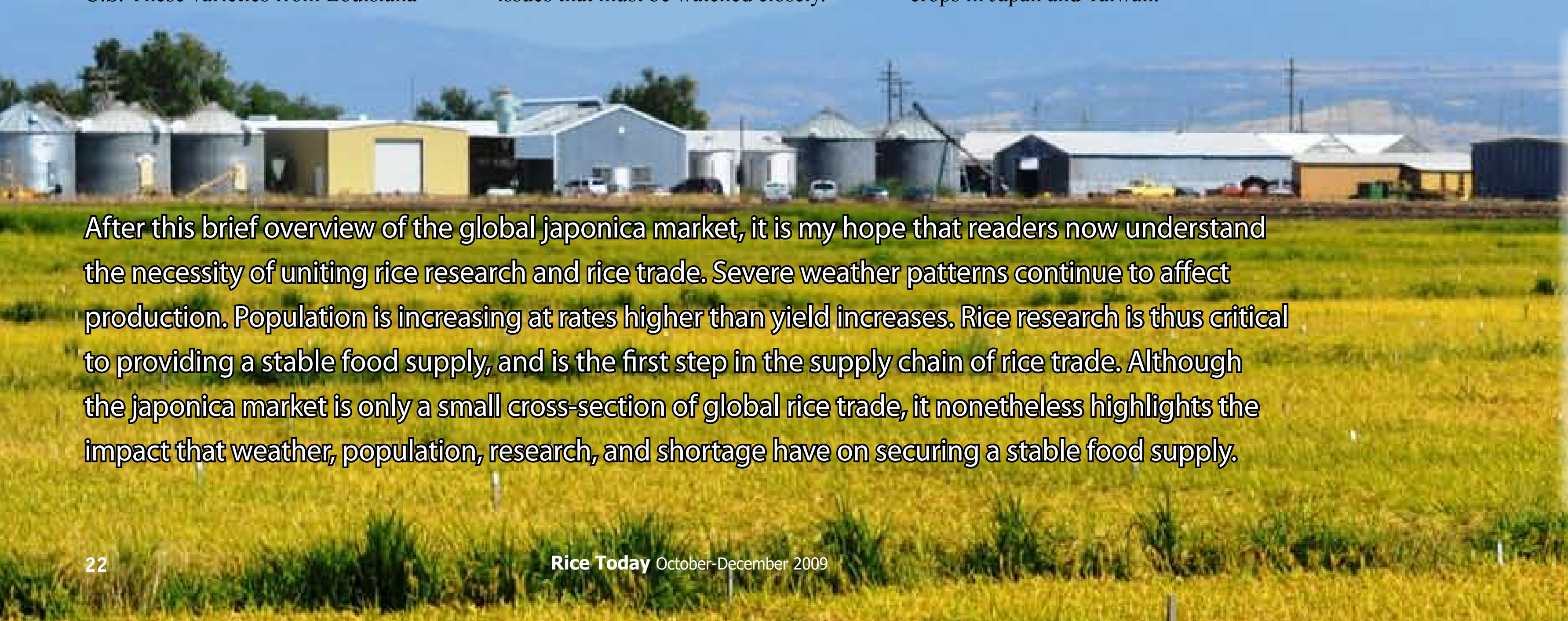
It is also important to watch the introduction of new medium-grain rice varieties in the southern states of the U.S. These varieties from Louisiana



State University have the potential to compete with the varieties grown in California. Jupiter was the first variety introduced. But, now, there is an even better one called Neptune. This event will greatly affect the overall supply and demand equation as the South must now equate the production of indica (long-grain) varieties against the new japonica (medium-grain) varieties. This situation reminds us of the old adage that too much of a good thing can turn into something bad. In this case, it has induced competition. The 2010 crop will likely be firm proof of this fact, as southern U.S. growers gain the ability to choose between indica and japonica varieties. This can potentially shift the competitive balance of equations.

Like Australia, California also experienced a great deal of weather issues that must be watched closely. After 3 years of drought, California's water reservoirs have gone down to very risky levels. This could greatly reduce production unless the next year brings more rain.

Moreover, the Japanese market must also be watched, as the recent change in the government—the first change in parties since the government was set up after World War II—could alter the buying structure (the World Trade Organization–based tender buying with restriction on commercial imports). Japan now buys more than 50% of the U.S. medium-grain exports. Therefore, Japanese demand is critical in providing direction in the market. Japan's very poor growing season caused by the excessive wet and cloudy weather could affect production as well. Typhoon Morakot aggravated the situation by damaging crops in Japan and Taiwan.



After this brief overview of the global japonica market, it is my hope that readers now understand the necessity of uniting rice research and rice trade. Severe weather patterns continue to affect production. Population is increasing at rates higher than yield increases. Rice research is thus critical to providing a stable food supply, and is the first step in the supply chain of rice trade. Although the japonica market is only a small cross-section of global rice trade, it nonetheless highlights the impact that weather, population, research, and shortage have on securing a stable food supply.

California breeding

by **Kent McKenzie**

New and improved rice varieties sweep across America's rice bowl through the hard work of the Rice Experiment Station and support from the California rice industry.

The first successful plantings of California rice occurred a century ago, some 60 miles (96 km) north of Sacramento.

Recognizing the clear need for research, the Sacramento Valley Grain Association, United States Department of Agriculture (USDA), and the University of California (UC) established the Rice Experiment Station (RES) near Biggs in 1912.

This visionary concept of bringing growers, researchers, and other rice industry players together to address and support California's rice production continues to be a successful model. In 1969, it was used to set up the California Rice Research Board that funds the RES Rice Breeding Program and UC Rice Research Projects. Likewise, the founding of the California Rice Commission in 1999 made use of funding from rice farmers and milling and marketing organizations.

The California Cooperative Rice Research Foundation (CCRRF) is a grower-funded, private, nonprofit research foundation that owns and operates RES. The 478-acre (191 hectares) RES facility supports breeding and genetics research, agronomic research, and seed production. Since its inception, the RES has provided many improved varieties that have benefited the California rice industry.

From 1918 to the 1950s, California primarily grew only two tall, japonica short-grain varieties, Caloro and Colusa. Both were originally from Japan and China. In 1947, RES produced the medium-grain Calrose—a product of a backcrossing program for Caloro. After its release, Calrose became the main variety grown throughout the 1970s.

RES initiated a grower-funded accelerated breeding program in 1969. It hired three rice breeders and expanded the program. In one of its projects, RES incorporated the semidwarf trait into Calrose. Then, it added the earlier maturity trait by cross-breeding the variety with induced mutants and a tropical indica variety (IR8). Large-scale crossing, effective selection screening, and yield testing proved to be very effective in coming up with new and better varieties. In fact, the recently developed medium grains have significantly improved yield, kernel size, and whole-kernel milling yield.

So, by 1992, more than 95% of California's rice area was planted with improved semidwarf rice. Average yields rose to 3.6 tons per acre (9 tons per hectare). Together with improved short and long grains, the program also released varieties considered as "specialty market types."

The RES Breeding Program continues to improve varieties. During the Rice Field Day held in September 2009, Dr. Jacob Lage reported that, under the medium-grain project, the stability of milling yield has been recovered in some very early maturing varieties of the Calrose line. They are now in advanced testing and seed increase stage. Dr. Jodari, the long-grain project leader, expressed his enthusiasm about the cooking quality of the conventional varieties and several specialty-type long-grain varieties that are being developed. Dr. Virgilio Andaya, on the other hand, shared his work that uses marker-assisted selection as a new tool for his premium-quality short-grain breeding project. Moreover, the annual event also showcased RES's improved facilities, namely, the new DNA marker laboratory, greenhouses, and the enhanced cold-tolerance screening facilities. Funding used for these capital improvements came from donations made by various rice industry players to support California's rice research.

Dr. McKenzie is the director of the California Rice Experiment Station. He is also a plant breeder at RES.

All in it together

by **Tim Johnson**

California rice growers work together to tackle the tough problems concerning their crops

Research

Four decades ago, California's rice farmers joined together to fund research, specifically to advance varietal development and agronomics for the state's producers. Coming from this geographically isolated region that produces japonica rice, growers realized that advancing production in the state would require a commitment to new varieties and new production techniques.

Using a state law that allows growers to levy a special tax on themselves, the industry formed the California Rice Research Board (CRRB) in 1969. The Research Board spends US$1.5–2 million a year to fund the public breeding program at the California Cooperative Rice Research Station. In addition, important pest and disease research is funded through the University of California (UC) and other research centers across the nation—all specifically for the benefit of California producers.

This initiative paved the way for the development of short-stature japonica varieties, specifically suited to the state's Mediterranean climate. The modern-day Calrose varieties, as well as the premium medium-grain and short-grain varieties, have all been developed through the grower-funded breeding. Yield advancements and improvements in quality over the past 40 years have allowed California to realize some of the highest single-crop yields in the world.

The state also pioneered production systems that included water-seeded rice. Specific methods for controlling watergrass, broadleaf weeds, and rice water weevil are especially important to growers who have few chemical controls, as the use of pesticides is strictly controlled by state and federal regulations.

Regulation

Following the successful model for research, the industry formed the California Rice Commission (CRC) 10 years ago to address the unique regulatory and public policy challenges faced by the state's rice farmers and handlers. With some of the most stringent state regulatory requirements in the world, rice farmers in California are expected to comply with the exacting air, water, and pesticide policies.

CRC implements extensive surface-water quality programs that monitor agricultural drains and streams for pesticides, and also the nutrients and metals associated with rice production. The assessments are paid by farmers and rice handlers. Working closely with UC and CRRB, the Commission also develops management practices to reduce the amount of these constituents that leave the rice fields.

Improving air quality is also important in a state that is largely urban. Twenty years ago, the industry came under close public scrutiny for the age-old practice of burning rice straw at the end of every harvest. Although the practice is a widely accepted method to reduce disease and weed pressure in the following year, the impact on air in the region was unacceptable. Working with regulators and lawmakers, the industry gradually phased out this practice, while it developed alternatives to burning. The farmers were able to work out a practice of re-flooding the fields and incorporating water to the straw to aid in decomposition.

Mr. Johnson is the president and CEO of the California Rice Commission that represents the entire California rice industry.

On their toes by Jim Hill

Researchers in California keep up with the changing times and find solutions to problems affecting rice production

Following the International Rice Research Institute's (IRRI) release of variety IR8, California growers approved in 1969 a self-assessed funding to speed up the lagging effort in rice breeding. The farmers in California wanted to catch up with the programs at IRRI and in other parts of the world. Hence, the Rice Experiment Station (RES) focused on plant breeding, the United States Department of Agriculture (USDA) concentrated on breeding methodology and genetics, while the University of California (UC) zoomed in on plant production, protection, agricultural engineering, and other aspects of rice productivity. The California Rice Research Board (RRB) provided the funding for UC and USDA research. Since the RRB was established, it has given a cumulative total funding of US$20 million (current value).

One of the RRB's early decisions that proved to be remarkably foresighted was the incorporation of the California rice variety testing program into the UC's extension service. This allowed advanced lines from the RES to be given out to local extension advisors in a coordinated statewide effort to test the developed varieties under different environments.

Ten years after the release of IR8, California farmers had their first semidwarf variety, Calrose 76, which was developed by USDA through induced mutation.

Next, RES breeders came out with semidwarf varieties produced in cooperation with the USDA and UC. This event ushered in California's "green revolution" in rice.

A number of important early contributions to rice productivity, however, came from UC Davis's research projects that were funded by the RRB. The research test on the impact of using water as a heat sink against cold night-time temperatures resulted in the practice of raising water levels in the field from 10 to 20 centimeters before flowering to protect the crop from cold temperature–induced floret sterility. Next, studies on the life cycle of rice water weevils demonstrated that egg-laying adults have limited flying ability; thus, only the perimeter of the rice field basins needs to be treated with insecticides. UC Davis research was also able to identify zinc deficiency as the cause of the so-called "alkali disease."

Furthermore, the RRB has also funded far-reaching programs in environmental toxicology, believing that it is always better to participate in the regulation (and de-regulation) of crop protection chemicals than to take a passive role. Thus, in the past 30 years, rice production and research in California have been fully integrated with environmental research. One good example is how the study on rice pesticides in the early 1980s led to improved water management that helped reduce herbicide content in the Sacramento River by 98%.

Over the years, UC and RES research has focused increasingly on rice diseases caused by exotic pests. This has helped solve the problem of blast disease (which was previously not a problem in California) and bakanae disease.

But, perhaps the most pressing issue concerning current production is the persistent growth of herbicide-resistant weeds. University researchers are now studying alternative systems such as minimum tillage and intermittent water management to shift weed recruitment to more vulnerable species. However, such shifts also change fertility, and water and pest management. This must be further studied by an interdisciplinary team.

Forty years after the first referendum for grower-supported research was passed, one thing is abundantly clear—nature abhors a vacuum. For every problem solved, a new one emerges, underscoring the need to be always vigilant in matters of rice productivity and food supply.

Dr. Hill is a professor and extension specialist in the Department of Plant Sciences of the University of California, Davis. He also serves as the associate dean for International Programs in the university's College of Agricultural and Environmental Sciences.

SGS NORTH AMERICA, SEED & CROP SERVICES (3)

RESPONSE of nontolerant seedlings to glyphosate herbicide.

The right seed

by **Amanda Patin**

Choosing seeds carefully can help farmers reap bountiful harvests and good profits

Rice is grown throughout the southern United States, particularly in Arkansas, Louisiana, Mississippi, Missouri, Texas, Florida, and California. The U.S. ranks 11th in world rice production. Interestingly, according to the U.S. Department of Agriculture (USDA), the southern states have increased their rice area except for California. Arkansas and Missouri, in particular, have expanded their planted rice area by 12%, leading to an expected 4% increase in rice exports. In fact, USDA projects the total rice supply for the 2009-10 season will be 268.2 million cwt (13.41 million tons), which is 7% higher than the 2008-09 output. About 3.7 million cwt of the last season's harvest was used as seed rice for 2009-10.

In growing rice, the field's environment and the conditions during growth and harvest affect the quality of rice produced. So, farmers need to make sure that they begin the season right, starting with what type of seed to plant.

Determining the type of seed to plant can be a daunting task. Over the years, technological advancements through conventional breeding and genetic modification have significantly expanded the array of seeds for selection. However, one cannot simply choose seeds randomly. The need to meet the growing demand for food and the increase in plantings on marginal lands have placed great emphasis on seed quality. Seed quality and purity play a critical role in the crop's success.

Because of this, testing methods have been developed to help evaluate seeds.

Standard germination methods for testing rice seed for both Association of Official Seed Analysts (AOSA) and International Seed Testing Association (ISTA) rules are similar and produce similar results. The AOSA seed testing methods are mainly used in the U.S. and are considered the basis for standard germination methods listed in the Federal Seed Act and placed on the seed label. ISTA testing methods, on the other hand, apply internationally and facilitate seed movement across borders. Standard germination places the seed in ideal growing conditions to determine the maximum germination potential of the seed. The acceptable growing medium is sand or a paper-based product. The incubation period is 14 days, and the temperature can be adjusted from 20 to 30 °C or kept constant at 25 °C (AOSA 2008). ISTA specifies some pretreatments to the seed to assist in breaking seed dormancy. These can be a 50 °C preheat period or a 24-hour presoak in water or potassium nitrate (ISTA 2009).

Rice vigor tests are used to help rank the seeds' potential performance under less-than-ideal conditions. Typically, the seed is subjected to a heat or cold stress. The accelerated aging test uses a measured quantity of seed on a screen, suspended above water in a plastic box. The sealed box is placed into a water-jacketed incubator preheated to 42 °C. The seed ages for 96 hours and reaches a seed moisture of 30% (± 2%). Following heat stress, the seed is planted on top of moistened blotters, covered with sand and germinated for 7 days at temperatures alternating between 20 and 30 °C. In the cold test, the seed is planted on blotters saturated with water at 5 °C, and covered with a layer of prechilled sand. The seed stays in this condition for 7 days and is then transferred to a 30 °C incubation chamber for 5 days. Following the prescribed germination period, normal seedlings are evaluated.

Seed genetic purity can be evaluated using the Clearfield™ herbicide bioassay test or isoelectric focusing (IEF). The Clearfield rice herbicide test was developed to detect expression of a herbicide trait in a variety or hybrid to assure an acceptable level of trait purity. This test is a substrate imbibitions test with herbicide solution incorporated into the germination media. Seedlings are grown out and visually evaluated for tolerance of the herbicide. The herbicide concentration allows the nontrait seedling to grow and to express nontrait symptoms. A nontrait rice seedling reveals bent, shortened protective sheaths, blunted primary root, as well as spidery, blunted secondary roots.

IEF tests rice hybrid seed lots and individual seeds for varietal purity. It is an inexpensive and accurate separation method that splits proteins on the basis of their isoelectric points in a pH gradient. Known control samples, individual seeds, and parent control samples are evaluated to determine variety, female selfs, male selfs, and hybrid off-types. The rice seed is crushed and its proteins are extracted with 2% glycine solution. (Glycine extracts glutelins, which are structural proteins soluble in diluted alkali or acid solutions.) The extracted proteins are placed onto an agarose gel with a 4–5 pH range. The proteins are then pulled across the gel at an average of 50 watts for 80 minutes. The gel is stained with phosphohexose isomerase (PHI) enzyme. Different molecular components of the protein are detected according to their position in the gel. Banding patterns between varieties of rice differ greatly.

With each new development in rice, whether it be by traditional breeding methods or by genetic modification, a test method is necessary to evaluate the quality and purity of the seed. Methods to evaluate the purity of new products, such as nutrient enhancement products and new herbicide-tolerant varieties, are developed as the advancements approach the prelaunch stage of commercialization.

Various novel and standard seed amendment products applied to rice seed for protection from pests can affect seed quality. Rice seed treatment application, safety, and storage studies are performed to evaluate how chemicals affect seed physiology through time, using germination and vigor testing. Verification of appropriate treatment levels is also performed using two replicate subsamples from the submitted sample, which are extracted in an appropriate solvent by shaking or by applying sound energy. The amount of chemical treatment is determined by comparing the extracted sample to analytical standards using high-performance liquid chromatography (HPLC). A wide range of treatments from leading manufacturers are available for analysis. More are being developed.

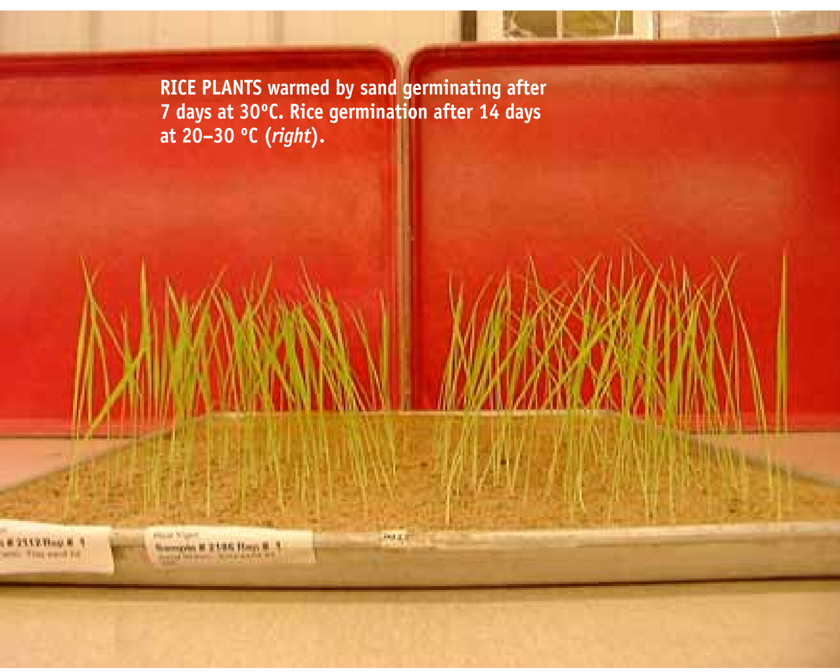
Evaluating seed quality will help ensure that planted seeds grow well and provide good returns to farmers.

References

AOSA. 2008. Rules for testing seeds. Association of Official Seed Analysts, Las Cruces, NM.

ISTA. 2009. International Rules for Seed Testing, Zurich, Switzerland.

Ms. Patin works with the Seed and Crop Services of SGS North America (www.seedservices.sgs.com).



RICE PLANTS warmed by sand germinating after 7 days at 30°C. Rice germination after 14 days at 20–30 °C (*right*).

THE NEW FRONTIER

by **Lanie C. Reyes** and **Charmaine Chin**

Scientists converge to discuss advances in rice genetic research and how they can contribute to food security following the gene revolution that changed the world of rice

The human population and demand for food are projected to increase in the next 40 years. With changes in land use, less agricultural land needs to produce more food—especially rice, the basic food of half of the world's population. Beyond these challenges are climate change and the looming water scarcity, which, if not overcome, will adversely affect rice production.

The historic sequencing of the rice genome completed in 2005 radically changed how scientists approach challenges in rice science. Published in the journal *Nature*, the final sequence of the rice genome was the product of a global collaboration coordinated by the International Rice Genome Sequencing Project (IRGSP). It has been called a "gene revolution"—a milestone for rice improvement programs and a revolutionary landmark in rice science (see *The gene revolution*, pages 15-18 of *Rice Today* Vol. 5, No. 1). Having a high-quality reference sequence of rice has sparked many gene discoveries that promise to improve the efficiency of rice breeding.

Precision breeding

Over the years, traditional plant breeding has evolved. From just selecting the best-performing plants in the field for the next generation, new tools have evolved that enable scientists to rapidly deliver varieties tailored to the needs of farmers. One of these tools is marker-assisted selection (MAS), a new "precision breeding" method (see *On your mark, get set, select* on pages 28-29 of *Rice Today* Vol. 3, No. 3). This shortens the breeding process by precisely moving specific traits from one variety into another through the use of molecular markers—DNA landmarks along the rice chromosomes. In this way, parts of the rice genome (the plant's genetic makeup) that control characteristics (e.g., submergence tolerance, drought tolerance, disease resistance) can readily be identified and the undesirable ones can be avoided during the selection process.

Through marker-assisted selection, the *SUB1* gene, which confers flood tolerance, was transferred into Swarna, a popular variety grown on millions of hectares in India, while still retaining Swarna's good traits such as high yield, high grain quality, and pest and disease resistance. The rapid improvements in marker technology underscore the value

DR. KEN McNally, IRRI molecular biologist, shows the 20 rice varieties whose DNA will be sequenced.

CHRISANTO QUINTANA

RICE LEAF samples in extraction buffer, after the intermittent shaking step of a DNA isolation procedure.

JOSE RAYMOND PANALIGAN (2)

that gene discovery has for developing and delivering new varieties. The mega-varieties with the *SUB1* gene are a good example of how farmers can rapidly benefit from genetic advances (see *Scuba rice, stemming the tide in flood-prone South Asia* on pages 26-31 of *Rice Today* Vol. 8, No. 2).

IRRI scientists continue to work on gene discovery and marker-assisted selection for other important traits. Important work that is poised for revolutionary developments involves genes for salt and drought tolerance, and genes for tolerance of phosphorus deficiency and resistance to pests such as brown planthopper and diseases such as blast, bacterial blight, and tungro virus.

Sequencing of diverse rice varieties

Although having a complete sequence of the rice genome was an essential beginning, the fact is that only a single genome of rice cultivar Nipponbare was sequenced out of thousands of diverse rice varieties grown around the world. More research is urgently needed to further explore DNA sequence variation across other important rice varieties. IRRI's OryzaSNP project, a collaborative effort with other international scientists, aims to discover genetic variation in *Oryza sativa*, cultivated Asian rice. Researchers examined the fine-scaled differences among 20 genetically diverse rice varieties by studying their single nucleotide polymorphisms or SNPs (pronounced as "snips"). SNPs are the genetic variation between a pair of DNA nucleotides in different varieties. Mapping these differences among varieties could help reveal and pinpoint the genetic basis behind rice's diverse traits, including stress tolerance, early maturity, high-quality grains, and increased yield, among others. These traits are essential ingredients for breeding new improved varieties. The OryzaSNP data set, the largest collection of SNP data for rice, is now being used by many researchers worldwide.

New advances in next-generation sequencing methods also promise to accelerate the decoding of many more rice genomes in the future. "In other words, we will have the DNA sequence of thousands of rice varieties, eventually encompassing the entire gene bank of rice," says Dr. David Mackill, IRRI plant breeder. "This would allow us to find all the forms of the genes available and how these affect the traits of the rice plant."

This will provide a pool of SNPs that will enable rapid genotyping of diverse rice germplasm. The availability of low-cost SNP markers will then enable rice breeders to take advantage of more efficient MAS techniques for rapid variety development.

The gathering of experts

More than 700 top scientists and researchers from around the world are expected to attend the 6th International Rice Genetics Symposium (RG6), which will be held on 16-19 November 2009 at the Manila Hotel, Philippines.

RG6 will also be held in conjunction with the 7th International Symposium on Rice Functional Genomics and the Rice Annotation Project 6 Workshop (RAP6), a project led by Japan on analyzing rice genome data. Her Royal Highness Princess Maha Chakri Sirindhorn of Thailand will officially open this event.

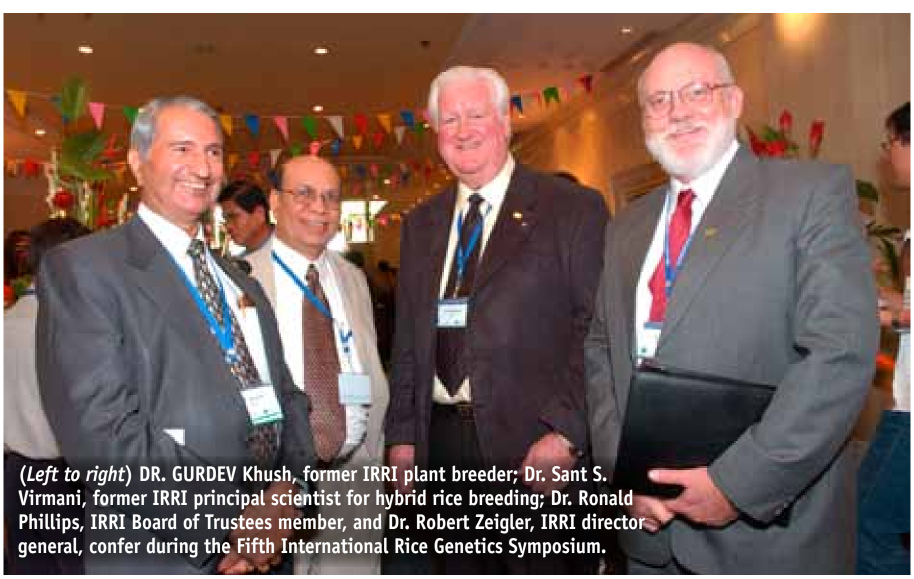
Kick-starting IRRI's 50th anniversary, this event aims to provide an avenue for the participants to exchange new research results from rice genetics and to apply the new knowledge to overcome the problems facing global food security.

RG6 will cover the latest developments in evolutionary studies of rice, breeding research, mapping of genes and quantitative trait loci, identification and cloning of genes for biotic and abiotic stresses, gene expression, genomic databases, and mutant induction for functional genomics.

"The symposium is a timely event that builds on the excitement generated by rapid advances in rice genomics and its potential benefits to food security and the international rice industry," says Dr. Robert Zeigler, IRRI director general.

Simply put, this significant occasion will bring together renowned scientists and rice researchers who share a common goal of improving rice production for humans.

Ms. Chin is marketing manager of Special Events Group, IIR Exhibitions Pte. Ltd. in Singapore.



(*Left to right*) DR. GURDEV Khush, former IRRI plant breeder; Dr. Sant S. Virmani, former IRRI principal scientist for hybrid rice breeding; Dr. Ronald Phillips, IRRI Board of Trustees member, and Dr. Robert Zeigler, IRRI director general, confer during the Fifth International Rice Genetics Symposium.

URBITO ONGLEO

THE INTERNATIONAL RICE RESEARCH INSTITUTE
1960

IRRI
50
1960-2010
Rice Science for a Better World

During a visit to IRRI on 26 October 1966, U.S. President Lyndon B. Johnson (*kneeling, right*) contemplates the importance of IR8, soon to spearhead the Green Revolution in rice across South and Southeast Asia.

At center, Robert F. Chandler, IRRI's first director general, explains to Philippine President Ferdinand E. Marcos the significance of IR8's semidwarf trait.

At left are IRRI's first two rice breeders, Peter Jennings, who selected the parents and made the IR8 cross (*standing*), and Hank Beachell, who identified and selected the segregating line, IR8-288-3, which ultimately reached farmers' fields as IR8.

A few minutes after this photo was taken, President Johnson made an impassioned speech to IRRI staff and visitors during which he said, "If we are to win our war against poverty, and against disease, and against ignorance, and against illiteracy, and against hungry stomachs, then we have got to succeed in projects like this, and you are pointing the way for all of Asia to follow." (Watch on YouTube: http://snipurl.com/s286z)

SANJAYA RAJARAM

A TRIBUTE TO NORMAN BORLAUG (1914-2009)

passion, persistence, and persuasion

by **Robert W. Herdt**

This article was adapted from a University of Minnesota Legacy Day presentation on 18 September 2007, which later appeared in The Aurora Sporealis, *the Alumni News Magazine of the Department of Plant Pathology, University of Minnesota, 2007: pp. 24-29. Excerpts are reprinted here by* Rice Today *with permission to, in a small way, recognize Norman Borlaug, a true giant of his time who passed away at age 95 on 12 September 2009. The author is a former economist at the International Rice Research Institute (IRRI), 1973-83, and head of the IRRI Economics Department, 1978-83; later director, agricultural sciences, and vice president, The Rockefeller Foundation; and currently adjunct international professor of applied economics and management, Cornell University. To read the entire article and additional notes, go to www.irri.org/publications/today/borlaug.asp.*

Norman Borlaug received the Nobel Peace Prize in 1970, about 25 years after he began working to increase food production in Mexico. He received the Prize at the midpoint of his career. Before then and since then, he has endured much and accomplished much, and he continues, working every day, traveling around the world, pursuing his mission, inspiring each of us by his very presence.

His life is a story of hard work, determination, persuasion, persistence, and passionate dedication to help farmers produce more abundant food for others and provide better lives for themselves. As *Newsweek* recently reported (20 July 2007), only five people have been awarded the Nobel Peace Prize, the Presidential Medal of Freedom, and the Congressional Gold Medal—Mother Theresa, Nelson Mandela, Martin Luther King, Jr., Elie Wiesel, and Norman Borlaug. Norm shares many characteristics with the other four: self-sacrifice, dedication, patience, vision, and compassion.

Early years

Born at the beginning of the First World War, Norm learned his early lessons at a one-room school in Howard County, Iowa. Growing up on the family farm, he came to know the value of hard work and clear goals. More importantly, in his own words, he came "to know right from wrong from his parents, grandparents, and neighbors."

Norm was a teenager during the Great Depression in the U.S., and one can only imagine the courage and determination it took for him to leave the farm during the depths of that depression and come here to the University of Minnesota, where he would earn his bachelor's, master's, and doctoral degrees.

It must have been during his formative years at the University that he came to recognize the power of science to address the practical problems of farmers. After a brief time with the Forest Service, he decided to continue his education as a graduate student under one of the giants in plant pathology, Professor E.C. Stakman. The influence Stakman had on Norm is hard to overstate. Especially memorable was a 1938 lecture where Stakman characterized wheat rust as "a shifty, changing, constantly evolving enemy." That view of wheat rust has stayed with Borlaug to this day.

After obtaining his doctoral degree with Professor Stakman, Norm took a job as a microbiologist with DuPont. But, after a few years, he had the opportunity to join one of the first international agricultural development assistance programs—The Rockefeller Foundation Program in Mexico.

With the encouragement of U.S. Vice-President Henry Wallace, in 1940, the Foundation entered discussions with the Mexican government and sent three distinguished professionals to review their agricultural situation. Professor Stakman, with Professors Richard Bradfield of Cornell University and Paul Manglesdorf of Harvard, spent more than 2 months roaming over thousands of miles of highways and byways in 16 of Mexico's 33 states, seeking to understand the situation and how the Foundation might help. The essence of their recommendation was that the Foundation should send a team of scientists who would work with the Mexican agricultural ministry to breed better plant varieties, improve soil and crop management, and increase livestock productivity. J. George Harrar, another University of Minnesota plant pathologist, who later became the Foundation's president [and a co-founder of IRRI], was selected to head the team. Norm was invited to join him.

Thus, Norm began the first phase of his life's work.

A lifetime of service

The years 1944 through 1960 were dedicated to helping Mexico increase its food production. The first years were spent on learning by doing. Norm was the team's pathologist and so had responsibility for all the diseases attacking all the crops—with emphasis on dry beans and corn. But, in reality, Norm did whatever needed doing—insect control, plot layout, planting, and recruiting helpers.

Norm recalled, “We were to help Mexico solve its own food problems. In other words, alongside our own work, we were to train local scientists and ease them into our jobs. Moreover, we were to be neither consultants nor advisors, but working scientists getting our hands and boots dirty, and demonstrating by our own field results what could be done.”

But, in the process, Norm had to fight some aspects of Mexican culture, particularly the conviction that scientists were above hand labor or getting dirty. He was told by one of his colleagues in the early days, “Dr. Borlaug, we don't do these things in Mexico. That's why we have peons. All you've got to do is draw up the plans and take them to the foreman and let them do it.”

Norm lost his temper (it wasn't the last time). He yelled back, “That's why the farmers disrespect you. If you don't know how to do something yourself, how can you possibly advise them? If the peons give you false information, you wouldn't even know. No, this has to change. Until we master our own efforts, we will go nowhere in this project.”

In 1944, wheat was Mexico's second most important food crop, and half of it was being imported, at an annual cost of US$21 million. Average yields were 11 bushels to the acre, about half the U.S. level, but subject to enormous fluctuations caused by epidemics of wheat rust. This was an obvious target for the Harrar team, and George himself organized the first year's work on wheat.

GENE HETTEL (2)

DR. BORLAUG lit a spark in the minds of many young scholars in different parts of the world—like these wheat research trainees studying in the field and in the seed quality selection breezeway at the experiment station of the Centro de Investigaciones Agrícolas del Noroeste (CIANO) in northwestern Mexico during the early 1990s—in the conviction that this spark would develop into a flame that would motivate the young people's efforts to improve the standard of living and make life a little more tolerable for the less fortunate. That is the culmination of his life and work. Go to http://snipurl.com/s6c98 to view a 5:16 clip on YouTube of him inspiring these trainees in the field.

In Borlaug's boyhood, the Iowa home farm had never grown wheat, and his doctoral thesis had been on flax. So, when George asked Norm to take over the wheat program after the first year, he had little background to draw on. But, that didn't stop him from taking up the challenge. And so, he began his life-long, persistent attack on wheat rust—that shifty, ever-changing enemy fingered by Professor Stakman.

Norm and his small team began by making crosses among five established Mexican varieties and several imported ones. The resulting 38 combinations, by some stroke of luck, gave promising results from the beginning. Four selections were later released as varieties, resulting in notable increases in Mexico's wheat production by the late 1940s.

But, the potential for disaster remained always in Borlaug's mind. That constantly changing enemy—wheat rust—was at bay but not defeated. In the years to come, he was to make two innovations that had tremendous payoff. Most plant breeders made a few crosses or a few dozen crosses each season. Each of the many individual plants that resulted were observed throughout the growing season and seeds from the best individuals were harvested and planted the next year, with more selections made, and so forth for 8 to 10 years.

Recognizing that each individual plant was potentially valuable, the general practice was to keep most and advance their progeny to the next generation. But, the number of individuals rapidly increases and the work of observation can become overwhelming. As Norm says, “This hit-or-miss process is time-consuming and mind-warpingly tedious. There's only one chance in thousands of ever finding what you want, and actually no guarantee of success at all.”

Success in breeding wheat means keeping ahead of the ever-evolving rust organism. Failure means disaster for farmers, nations, and even, in an extreme case, the whole world. Norm became convinced that only by making thousands of crosses from wheat gathered from all around the world would he be able to raise the probability of finding the right combination to a high enough level. So, he began to make many more crosses than any breeder had until that time. That meant a tremendous increase in the fieldwork of examining and scoring the progeny, imposing tougher criteria, and discarding a higher fraction of plants. This approach, high-volume crossing, gave a much higher overall probability of success.

But, it still required 8 to 10 years to get a variety and Norm looked for a way to grow two crops a year in order to cut down on that time. A possible place was the Yaqui Valley in Sonora, 1,200 miles to the north, where irrigated wheat was normally planted in the fall. But, the wheat program, like the other parts of the Foundation's effort, was focused in Toluca, not far from Mexico City, where most farmers were exceedingly poor and the climate was very different from Sonora. Norm proposed establishing an "off-season" facility in Sonora, but that idea didn't sit well with George and so failed to gain his approval. Getting George to change his mind was to test Norm's passion, persistence, *and* powers of persuasion. Even so, it took the good offices of Professor Stakman, who happened to be in Mexico at the time, to get Norm and George to the point where they could agree on the plan to extend the wheat work to Sonora for a second season each year. This was the birth of "shuttle breeding" (read more about this radical technique in the full article).


GENE HETTEL

IN HIS later years, Dr. Borlaug worked tirelessly to start bringing the Green Revolution to Africa. He made many trips to the continent and mingled with researchers and farmers alike. This photo was taken during a 1994 meeting in Wad Medani, Sudan. See the full Robert Herdt article on the *Rice Today* Web site for more on the "Borlaug approach" in Africa.

Student and teacher

Norm's student years may have begun in Iowa in the 1920s, and formally ended with the awarding of his PhD degree from the University of Minnesota in 1942, but he has never ceased being a student. In addition to Professor Stakman at Minnesota, he credits many colleagues, including George Harrar, Ed Wellhausen, John Neiderhauser, and Louis Roberts, with providing insights and challenges that led him to ever-greater efforts.

But, perhaps his greatest teachers were the wheat plants to which he devoted uncounted hours. As he says, he learned "to tell the status of a wheat plant from its look, manner of growth, feel, movement, and level of growth. Wheat itself was becoming a person. Moreover, wheat was the best teacher about wheat." He began to see that different wheats had different "personalities." He could tell them apart at a glance, or "even by the rustle of the wind through their ripening heads." Like many other pioneering plant scientists, including Mendel and McClintock [Barbara McClintock, American cytogeneticist, 1902-1992], Norm's advances were based on careful observations made during hours and hours of devoted work.

The untold story of Norm's life is, however, his career as a teacher. In the very first days of his assignment to The Rockefeller Foundation's program in Mexico, he encouraged young Mexican technicians to learn the secrets of plant breeding—crossing and selection—the critical steps that most plant breeders kept to themselves. Throughout the Mexico period, he gave young people the opportunity and responsibilities to learn.

But, learning from Norm wasn't easy. His classes didn't take place in an air-conditioned room. It involved preparing land, planting seeds, taking observations and making notes, making crosses, making more observations, harvesting, keeping records, and doing analyses. And, after the invention of shuttle breeding, the process was a year-round effort, unlike most plant breeding in the United States, where the winter season is used to analyze results and plan the next year's work.

If learning from Norm was not easy, neither was being his supervisor. In those days, the Annual Report of The Rockefeller Foundation was compiled from the separate reports of its officers, including those in Mexico and elsewhere. With high-volume crossing, shuttle breeding, and training young scientists, Norm had limited time for paperwork. His annual reports were not always produced by the deadline and apparently, one year, he was particularly late. After several reminders from the responsible director and vice president, George, then Foundation president, sent a telegram telling Norm to get his report in. The responding telegram was short but to the point; Norm said: "Do you want paper or do you want wheat?"

Ever the student and ever the teacher, with passion, persistence, and persuasion, a clear focus on worthy goals, and science directed at solving problems, Norm has stressed the need to tackle problems rather than pursue fame, disciplinary knowledge, or preconceived solutions.

To read more about Norman Borlaug—the global agricultural diplomat, prize winner, and philanthropist—and how his initial work in Mexico saved millions from starvation in South Asia, and his later involvement in Africa, go to the full article on the Rice Today *site at* www.irri.org/publications/today/borlaug.asp. *All issues of* Aurora Sporealis *are available in the University of Minnesota Libraries' Digital Conservancy at* http://conservancy.umn.edu/handle/923.

Michael Gale

scientist, mentor, and humanist

His work significantly contributed to the development of rice science as we know it today

by **H. Leung, J. Leach,** and **R. Zeigler**

> "Being a wheat geneticist is not enough. Being a rice geneticist is also not enough. You have to be a cereal geneticist."

On 18 July 2009, we lost our dear friend, Dr. Michael Gale, who passed away in Norwich, England. Even though Mike was a wheat geneticist, he had a long association with rice research as he worked as a strong supporter of the International Rice Research Institute's (IRRI) mission through his various scientific roles and advisory capacity. Each of us came across Mike in different stages of our careers, and so, our memories of him vary based on our personal experiences. Yet, we all treasure his contributions to the world as a scientist, mentor, and humanist.

Mike started his career in wheat genetics, but his work reached far beyond that. He also had a remarkable influence on rice science. His recognition of the grass genomes as colinear specifically laid the foundation of comparative genomics among plant species. His famous "Crop Ring Circle" (the concentric circles of chromosomes of different cereals and grasses) is still used in seminars and classrooms. But, his influence in rice science and among rice researchers did not really begin until the mid-1980s, when he served as the scientific advisor for The Rockefeller Foundation's (RF) Rice Biotechnology Program. Through this program, Mike advised numerous scientists, helped shape research priorities, and generated active debates that all contributed to the creation of the vibrant rice research community that we see today.

Needless to say, Mike carried an in-depth knowledge of all aspects of genetics. We recall how he used to say, "Being a wheat geneticist is not enough. Being a rice geneticist is also not enough. You have to be a cereal geneticist." Hence, many young scientists looked up to him as a good mentor. His rich knowledge of science mixed with great humor made discussion with him interesting and exciting.

Moreover, one of Mike's greatest contributions in this field of study was his advocacy to use advanced science to solve agricultural problems. After serving as the scientific advisor for the RF Rice Biotechnology Program, he worked for the infusion of cutting-edge technology in rice research. In 1997, he became one of the instigators of a working group that met in Singapore to discuss the merits of sequencing the rice genome. This resulted in an unprecedented multicountry collaboration that produced the first sequenced genome of a crop plant.

Mike served as a member of IRRI's Board of Trustees from 2001 to 2003. He then worked for the Science Council of the Consultative Group on International Agricultural Research, in which he offered scientific advice on genetic research involving crops that are more beneficial to the poor. Within a span of 20 years, Mike helped scientists from both developed and developing nations build careers and networks among countries.

Above all, Mike was a world-class scientist and citizen who will always be remembered well for his generosity in sharing his ideas and time to help solve problems that confront the developing world. We, and many scientists at IRRI and around the world, feel privileged to have known Mike in our careers. He will be dearly missed.

Dr. Leung is a senior plant pathologist at IRRI. Dr. Leach is a professor of plant pathology at Colorado State University. Dr. Zeigler is IRRI's director general.

THE IRRI PIONEER INTERVIEWS

Conducted by Gene Hettel

GENE HETTEL (3)

"Rock" and Rice:

The Rockefeller-IRRI biotechnology saga

Next year, 2010, marks not only the International Rice Research Institute's (IRRI) 50th anniversary but also a half century of collaboration between the Institute and its co-founder, the Rockefeller Foundation. This includes an alliance that started a quarter century ago to help create the new discipline of rice biotechnology. When that effort began in 1984, Gary Toenniessen, currently a managing director of the Foundation, led the charge to bring the new developments in molecular and cellular biology to rice. In this interview, he shows what can be accomplished with around US$120 million of funding and a cornucopia of ideas.

A career with the Rockefeller Foundation

After graduating from the State University of New York at Buffalo, I received a fellowship from the U.S. Public Health Service that sent me to the University of North Carolina at Chapel Hill, where I spent 5 years getting my PhD degree in microbiology. When I was looking around for a job at the end of that training period, the Rockefeller Foundation (RF) contacted me about a new type of postdoctoral fellowship they had, for which one worked with the Foundation while also pursuing some research at a nearby research institute. I received one of those fellowships and, within a year, I was made a program officer of the Rockefeller Foundation. So, for almost my entire career, which is now 38 years, I have been a program officer in the New York office of the Rockefeller Foundation.

In my opinion, IRRI is one of the Rockefeller Foundation's great success stories. The whole idea for IRRI came out of the Foundation. It was based on what Nobel Peace Prize Laureate Norman Borlaug had accomplished with wheat. The thinking was, if you could breed for wheat in Mexico and have those varieties adopted over the vast areas of South Asia, maybe you could breed for rice in a single location and have those varieties, or at least those breeding lines, be used across the vast areas of Asia where rice is grown. So, the Rockefeller Foundation convinced the Ford Foundation to partner with it to create IRRI. Within 3 or 4 years, IRRI's first variety, IR8, came out and had a huge impact throughout South Asia and other regions. But, many more fruits were to come from the Rockefeller-IRRI association over the next four and a half decades.

I was trained as a microbiologist and that meant molecular biology as well. So, when the Foundation, in the late 1970s to early 1980s, decided to move into applying the new tools of molecular and cellular biology to crop improvement, I was one of the people on the staff who knew something about molecular biology and I assumed more responsibility for the Foundation's investments in that area. Once the Rice Biotechnology Program began in 1984, I, more or less, ran that program from the New York office. We also had John O'Toole, a former IRRI agronomist and rice physiologist [1974-84], working in the program, initially from India and then from Bangkok; and Tosh Murashige helping in China, Korea, and the Philippines.

In recent years, we are working more in Africa. So, I spend a lot of time on the African Program today. But, I have to say that the most rewarding work I have done with the Foundation was from 1984 to 2002, when we invested about US$120 million in the Rice Biotechnology Program. I worked very closely with IRRI during that whole period.

The RF changes course—from doing to funding

In 1980, Dr. Richard W. Lyman became the president of the Foundation. His feeling was that foundations really should not be operational. They should be organizations that provide funds to others who get the job done. In the case of agriculture, he congratulated us for helping establish IRRI, the International Maize and Wheat Improvement Center (CIMMYT), the International Center

IRRI

IN OCTOBER 1995 on the IRRI farm during the Foundation's Rice Biotechnology Meeting held in conjunction with Rice Genetics III, Dr. Toenniessen (*3rd from left*) confers with (*from left*) Gurdev Khush, IRRI rice breeder and principal scientist, 1967-2001; Ken Fischer, IRRI deputy director general for research, 1991-99; Darshan Brar, IRRI rice breeder and currently head of the Plant Breeding, Genetics, and Biotechnology Division (PBGB); John O'Toole, IRRI agronomist and rice physiologist, 1974-84, and later Foundation associate director; Zhikang Li, IRRI molecular geneticist and currently coordinator of the International Network for Molecular Breeding, Beijing; Robert Herdt, IRRI economist, 1973-83, head, IRRI Economics Department, 1978-83, and later Foundation director, agricultural sciences, and vice president; and Swapan Datta, IRRI senior scientist in PBGB, 1993-2005, and currently deputy director general for crop science, Indian Council of Agricultural Research.

for Tropical Agriculture (CIAT), the International Institute of Tropical Agriculture (IITA), and a number of the other international centers, and also for creating mechanisms, such as the Consultative Group on International Agricultural Research (CGIAR), to fund those centers.

At about that time, a team of external advisors agreed with Dr. Lyman that it was now possible for the Foundation to bring its field operations to a close. In fact, I can remember their report stating that, in many ways, the era in which expatriate scientists go out and actually do research was coming to a close, and what the Foundation should really do is to find ways of supporting international centers and strengthening existing national programs. So, the advisors recommended that the Foundation work in two principal areas. One was to make sure that the new advances that were occurring in cellular and molecular biology were applied to tropical crops important in developing countries and the staple foods of the poor in those countries. Second, the Foundation should develop a strategy for Africa, where the food situation was deteriorating.

Creating rice biotechnology

So, we then moved quite quickly to implement the first recommendation, which was to apply the new developments in molecular and cellular biology to tropical crops. Dr. Alva App, a new RF director of agriculture, came in. Al had actually spent about 6 years [1976-82] at IRRI as a visiting scientist, seconded to IRRI as an employee of the Boyce Thompson Institute for Plant Research to lead the work on the *Azolla* [a tiny nitrogen-fixing fern]–rice combination. So, it's clear to me that, from the time Al arrived, we were going to work on rice because he quite correctly recognized its importance. But, I still conducted a very systematic process of looking at the eight most important crops in determining whether or not the breeding programs were strong enough in those crops to make it reasonable to introduce a biotechnology program and what the impact would be if the Foundation did do that. When we compared all of the results, rice was clearly at the top. We could build on what were already strong breeding programs. IRRI was there, so we had a strong partner to work with and, of course, rice fed more people than any other crop.

First of all, we received approval from our trustees to make a major long-term commitment. So, the initial document that went to the Foundation's trustees in December 1984 informed

them that this was likely to be a 15-year-long program, or longer, and, at that time, we said that the Foundation was likely to commit US$80 million or more. If you actually adjust $80 million for inflation over that period of time, it comes out to about $120 million.

We designed the program to have three major components. The first was to "create" rice biotechnology. Molecular biology was a brand new discipline in the early 1980s and there was nobody in the world except for a few Japanese who were doing serious work on rice molecular biology. IRRI had no biotechnology program. There were no rice molecular biology programs in the United States. So, it was a wide-open opportunity for the Foundation to lead the effort to really create a significant biotechnology research program for the most important food crop in the world.

Creating the technology meant creating a molecular genetic map of rice and then creating the tools that would allow the genetic engineering of rice. It meant understanding the way the rice genome is structured, and understanding at the molecular level the relationship between rice and rice pathogens. There was a lot of investment in those basic tools that make up the set of technologies that we call biotechnology.

Finding relevant traits

The second component was to work on the traits for which one would want to use those tools, once available, to introduce into rice. But, we needed to understand those traits at the molecular level in order to use those tools. We hired Bob Herdt [IRRI economist, 1973-83; head of the IRRI Economics Department, 1978-83; later, director for agricultural sciences at RF and vice president; see his tribute to Norman Borlaug, *passion, persistence, and persuasion,* pages 32-34] as our colleague at that time. Previously, his job at IRRI had been to prioritize traits that IRRI was going to work on so he had already developed the methodology for prioritizing traits. He did the same thing for the Foundation's rice biotechnology program.

It is basically a technique that measures the yield forgone because you do not have that trait. For example, at that particular time, there were no known genes for resistance to the rice tungro virus, which, at that time, was causing a lot of problems in the Philippines and other countries in Southeast Asia. So, that turned out to be very high on his list of priorities. There were reasons to believe that biotechnology would work as a way of addressing the tungro virus. Bob outlined our research priorities for rice biotechnology in the 1991 book Rice Biotechnology, which IRRI breeder Gurdev Khush and I edited [see http://snipurl.com/qv0uh].

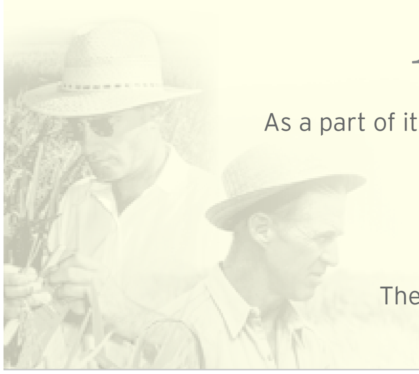
Building molecular biology capacity in Asia

The third component was capacity building in Asian rice research institutions. In countries such as India, China, Thailand, and the Philippines, we tried to link the more fundamental research programs with the rice research institutions within those countries. That involved a lot of training. During that 17- to 18-year period, the Foundation supported about 400 fellowships for Asian scientists. Many went to advanced laboratories in the U.S., Europe, Australia, and Japan, where we were funding the work on tool development. Most of the actual work that led to important discoveries was done by Asian scientists in a laboratory in the U.S. or somewhere else. Since they were really the "inventors" of the tools, they had the real sense of ownership. When they went back home, there was a real sense of pride and desire to use those tools within their home countries and the Foundation supported them when they went home.

Over time, the funds that were going into tool development and into work on the traits shifted from the West—the U.S. and Europe—to Asian countries, particularly China, India, and Thailand, where they began developing real capacity. By about 2000, when we would have meetings of our rice biotechnology network, we had scientists from the major companies working in biotechnology asking to come to those meetings.

We also had scientists from laboratories that we were not supporting around the world asking to come to those meetings because they would learn, not only the most recent results in rice biotechnology but also in biotechnology in general, from some of the Asian programs that we were supporting. That is when we realized that we had achieved our goal, when the Asian scientists were at the forefront of doing the research on tool development and working on the traits. We recognized that we had accomplished our goal of making sure that the new tools on molecular biology would be applied to rice and that has certainly proven to be the case. We see Asian countries continuing to make major advances in the development and application of rice biotechnology. China and India, for example, now have as much capability as Monsanto or Syngenta or any of the major corporations. So, that's an overview of the Foundation's Rice Biotechnology Program.

Go to www.irri.org/publications/today/Toenniessen.asp for the complete transcript with links of Dr. Toenniessen's pioneer interview, in which he tells little-known facts about the fascinating Golden Rice story, the ardent competition among scientists to develop the molecular map for rice, and the challenges that are being encountered to take the Green Revolution to Africa.



DROWNED HARVEST

Story and photography by **Chris Quintana** and **Bill Sta. Clara**

Typhoon Ketsana (Philippine name Ondoy) could not have come at a worse time. On 26 September 2009, Ketsana dumped a record rainfall—1 month's rain in just 6 hours—on Luzon Island in the Philippines, which caused reservoirs, lakes, and waterways to overflow. Rice fields, which would have been harvested in a few more days, were submerged—also drowning farmers' hopes of income for the season.

It certainly looks like climate change at work. The deluge inundated areas that had not flooded in decades, including many parts of Los Baños and Bay towns in Laguna Province (shown in these photos). Many residents of these towns, along the coast of Laguna de Bay and adjacent to the International Rice Research Institute, were forced to leave their submerged homes temporarily and wait out the flood in makeshift shelters, using fishing boats and improvised rafts for transportation.

Five days later, the local social welfare office recorded at least 7,400 affected families in the two towns, where, as in many other areas, floodwaters had not yet substantially subsided. This is but a glimpse of the calamity in 25 Philippine provinces on the island that has affected more than 500,000 families.

To see more photos, go to
http://snipurl.com/sap2q

GRAIN GAINS

by **Mia Aureus**

Experts at the Postharvest Rice Conference and Exhibition identify key solutions to increase yield

At a time when the world food supply continues to be outpaced by a growing population and consumption, boosting grain production has emerged as a top priority among governments. The first Postharvest Rice Conference and Exhibition held last 15 to 17 July in Bangkok, Thailand, was thus very timely in highlighting the importance of postharvest activities in the rice production chain and in achieving food security. Jointly organized by the International Rice Research Institute (IRRI) and AsiaCongress Events Co., Ltd., the conference brought together leading researchers and experts in postharvest. It also featured service providers and equipment suppliers (such as GrainPro, Buhler, Satake, FrigorTec, etc.) that are leading companies in postharvest technological innovations.

Countries did not take real notice of agriculture's importance until the food crisis of 2008. Since then, leaders have put more effort and investments into farming to increase yield, particularly that of rice, the staple food of around half of the world's population. Now, the world produces rice at a 1% annual growth rate. However, Dr. Samarendu Mohanty, head of IRRI's Social Sciences Division, revealed that yield growth must step up to 1.2–1.5% a year if the world intends to keep up with increasing demand. What many fail to consider, though, is that improving yield growth has never really just been about planting the cereal and harvesting it. The postharvest process is just as crucial, as how the grains are handled at this stage makes a lot of difference in the amount of rice that is actually available for consumption.

Lost grains

According to Martin Gummert, IRRI postharvest specialist, 15–20% of rice grains are lost during postharvest. These losses are often caused by delays in the postharvest chain resulting from labor shortage, unsuitable traditional sun-drying practices, pests, moisture absorption in traditional open-storage systems, as well as from outdated and poorly maintained rice mills that yield as low as 60%, and drastically reduce head rice (see *Working together to save grains* on pages 20-21 of *Rice Today* Vol. 8, No. 3). Engr. Carlito Balingbing, an assistant scientist at IRRI, even noted that poor postharvest management operations expose grains to unfavorable environmental conditions that could cause fungal contamination such as mycotoxins, and further losses.

Although research has produced many new postharvest technology concepts, adoption and commercialization have been slow for many reasons. Among them are technologies not matched to users' needs or targeting the wrong users; limited understanding of quality and losses, and how these are affected by postharvest management; lack of market incentives for better quality rice; and limitations in available financing schemes.

A new postharvest value chain approach including all postharvest stakeholders promoting improved postharvest management could speed up the modernization of the sector. Should improved postharvest technologies be adopted by farmers, Engr. Gummert advised that this equipment must be what farmers really need (not what intermediaries perceive that farmers need) and must be user-friendly enough for farmers to easily adapt to it and integrate it into their current rice production practices. Funding is also needed to help raise both knowledge and technology on farms and with other postharvest stakeholders and to sustain the adoption of this technology and improvements for it. Unfortunately, there has been significant disinvestment in public-sector postharvest research and development in the past. Recently, however, we have seen some donors showing renewed interest in reducing postharvest losses. The Asian Development Bank (ADB) and the Swiss Agency for Development and Cooperation (SDC) are currently funding the adaptation and out-scaling of improved postharvest technologies through IRRI and its national partners in Cambodia, Laos, Indonesia, Myanmar, Vietnam, and the Philippines.

Yield of edible rice

More than just losing a significant amount of grains, however, farmers also tend to lose grain quality in the postharvest process. Dr. Melissa Fitzgerald, IRRI grain quality specialist, raised this important question, "What use is high yield if it cannot be eaten or sold?" She said that the two things that determine the value of rice in the domestic and international markets are the proportion of broken grains and the rice's "chalkiness." Improper postharvest activities are one of the key causes of grain breakage. If the grain is densely packed with good-sized starch granules, it is much more likely to withstand postharvest processes.

Chalk, or the white spot on the grain, is caused by air spaces between the starch granules, which make the grain fragile and easy to break. Chalkiness reduces the value of the rice by 25% or more and decreases head rice yield. Dr. Fitzgerald pointed out that an increase in chalkiness decreases the acceptability of the rice, which would consequently spell a marked reduction in financial return to farmers. Chalk is induced by high temperatures; so, rice production faces a further threat with global warming.

IRRI's Grain Quality, Nutrition, and Postharvest Center is trying to develop markers (see *On your mark, get set, select* on pages 28-29 of *Rice Today* Vol. 3, No. 3) in rice's genetic makeup that will enable plant breeders to develop varieties that will be translucent (not chalky) and more resistant to grain breakage. IRRI hopes to go beyond just increasing paddy yield to increasing the "yield of edible rice." Dr. Fitzgerald said that "yield as paddy means nothing to farmers, consumers, or marketers if grains like these (chalky and broken) are beneath the hulls. The Australian Centre for International Agricultural Research is currently funding this work."

Monsoon & Mortgage

The Thai Rice Convention reveals global rice industry concerns: India's monsoon woes and Thailand's restructured rice mortgage scheme dominate.

Story and photos by
V. Subramanian

The Thailand Rice Convention 2009 was the fourth in a series of conferences organized by the Thai government that began in 2001. Built on Thailand's status as the world's largest rice exporter (since 1979), the event gathered more than 500 rice specialists, producers, millers, exporters, buyers, and government officials to discuss all aspects of the global rice industry. Among the invited guest speakers were Samarendu Mohanty, head of the Social Sciences Division of the International Rice Research Institute, and Jeremy Zwinger, publisher of *Rice Today*.

Two concerns that consistently came up during the presentations and discussions were the Thai rice mortgage system that is now being restructured (into a price guarantee scheme) and the delayed monsoon that has affected rice plantings in India. Price outlook, market volatility, and food supply sustainability thus became strong secondary themes on the back of these two events.

Price guarantee scheme

Experts invited to the event scrutinized Thailand's recently approved price guarantee mechanism that will replace the rice mortgage scheme and also the role of politics in rice. Their analysis revealed how the rice mortgage system undermines Thailand's competitiveness in the market. Robert Papanos of Seacor Commodity Trading LLC and Vichai Sriprasert of Riceland International Limited observed that, by creating a system in which guaranteed export availability came at a cost of US$350 per ton of paddy, the scheme has made Thailand the world's most expensive exporter compared with other sizable rice-exporting nations. Mr. Papanos added that Thai exports were simply not made up of generic rice, but of several specialized products such as Hom Mali, parboiled rice, fragrant brokens, and Pathumthani rice. This has allowed Thailand to create a strong brand of rice in the world market, making the country renowned for its high rice quality and consistency. In the process, however, Thailand has struggled in the lower grade segments, where price competitiveness is an integral factor in procurement decisions. Thailand has constantly found itself competing with cheaper exports from Vietnam and Myanmar.

Delayed monsoon

India's monsoon was another hot topic at the conference. According to Dr. Mohanty, at the time of the convention, not more than 19% of the plantings had been completed. The delayed monsoon caused near-drought conditions that destroyed crops. Because of this, India expected to see a lower-than-average production. The delegates agreed that this would keep India out of the market in 2009 and possibly even in 2010, as domestic food security becomes the country's top priority.

Tight balance

The price outlook session featured Mr. Zwinger, Mr. Sridhar Krishnan (Olam International), Mr. Vandara Din (Ascot Commodities), Mr. Rafael Lopez Relimpio (Ebro Puleva), and Mr. Sriprasert. These panelists provided an amalgam of insights concerning the markets of Southeast Asia, the emerging exporters of Cambodia and Myanmar, the current self-sufficiency status of Indonesia, and demand from the ever-growing European Union, Middle East, and, most significantly, Africa. Their views suggested that markets were tightly balanced between supply and demand. Any weather anomaly may affect this tight balance and result in more market volatility. Mr. Zwinger showcased the japonica rice market as a good example of a tight demand and supply situation. Poor crop development in Australia, Egypt, and Japan has made the United States, particularly California (the rice bowl of japonica), the only stable source of japonica rice for exports to key consumers.

The conference, in essence, revealed some very nervous exporters, traders, government officials, and buyers who seek stability in price, rice availability, and the economic environment. The speakers noted how the industry now sits on a razor's edge, given the monsoon, El Niño, and other factors that could significantly affect supply. On the positive side, speakers also pointed to strong production in Thailand and Vietnam as factors that could offset the current production difficulties faced in India. Thailand and Vietnam are sitting on an estimated 7 million tons of stocks, which, together with India's own buffer stock (at an estimated 20 million tons at the time of the convention), could provide hope for a balance between supply and demand.

IRRI

When rats attack

by **Trina Leah Mendoza**

Community members band together to prevent hungry rats from eating their crops

A famine broke out in India's northeastern state of Mizoram in 1958-59. It reportedly took more than 10,000 lives and caused severe sociopolitical conflicts. This led to the Mizoram Uprising in 1966, which was followed by a 20-year armed revolt against the central Indian authority. The struggle ended only in 1986 with the signing of a peace accord.

What started the famine? The answer lies in the startling increase in rodent populations after the rare phenomenon of bamboo flowering occurred.

"Rodents are major pests in agricultural production," says Grant Singleton, IRRI rodent expert and coordinator of the International Rice Research Institute's (IRRI) Irrigated Rice Research Consortium. "In Asia, rodents cause, on average, annual preharvest losses of 5–10% in rice crops. A loss of 6% is substantial, as this is enough rice to feed 225 million people for a year."

However, rare rat population outbreaks can cause severe crop losses, especially in the uplands, where such losses can lead to major food shortages. Since 2005, such cases have been reported in Mizoram (eastern India), Chittagong Hill Tracts (Bangladesh), Chin State (Myanmar), and the provinces of Oudomxay, Luang Namtha, Sayaboury, and Luang Prabang (Lao PDR). These infestations often happen after an expansive bamboo flowering takes place. Also known as *mautam, rattadas*, or *nuu khii*, this rare phenomenon occurs in the Bengal Bay ecoregion (India, Myanmar, Bangladesh), in northern Laos, and in other parts of the world where bamboo grows, including Peru and Argentina in South America.

Damage and disease in the Chittagong Hill Tracts

In November 2008, a team of researchers led by Dr. Steven Belmain, a rodent ecology and management expert from the Natural Resources Institute (NRI), University of Greenwich in the United Kingdom, submitted a scientific assessment report to the United Nations Development Programme on rodent outbreaks following bamboo flowering and their impact in the Chittagong Hill Tracts.

GRANT SINGLETON (2)

RATS CHEWED up most of the rice at the center of the field in Banaue, Philippines.

According to the findings, the dominant bamboo species in the region flower on a 40- to 50-year cycle. Rats devoured large quantities of bamboo seed, fueling their reproductive rate. As soon as they finished eating up the bamboo seed supply, they moved out into the agricultural fields and rural communities and searched for more food.

The damage these rats caused was far more serious than losing a few stored rice sacks. The communities suffered damage 4–5 times greater than that seen in the floodplains of Bangladesh. As if destroying nearly all field crops was not enough, the rats also invaded people's houses, ate stored food, destroyed personal possessions, and even bit people while they slept. Increased dysentery and cases of fever with unknown causes were also reported in the affected areas. Although it has not yet been clinically confirmed, these illnesses were believed to have been caused by rodent-borne diseases.

More rat outbreaks are expected to occur in many parts of the Hill Tracts in 2009 and 2010. To mitigate the damage, the NRI researchers proposed to the Bangladeshi government a strategy that includes community training and capacity building, ecosystem research, and publicity and an awareness campaign.

The worst outbreak in 20 years

The worst rat outbreak in 20 years occurred in April 2008 in northern Laos. Farmers in the uplands lost most of their rice, maize, and other important cash crops. More than 500 villages with 250,000 people possibly affected turned to the World Food Programme (WFP) for assistance. The WFP then conducted an emergency food security assessment in March 2009 to measure the impact of the outbreak and the extent of the damage.

The study learned that nine districts across four provinces lost more than 50% of their expected harvest because of rat outbreaks, and other northern provinces were likely to be severely affected as well. In fact, 100% rice losses were common. Upland farmers in most areas believed that the outbreaks were due to bamboo flowering.

BOY EYES rat meat in Pyay, one of the many markets in Myanmar that sell the rodent as food.

Moreover, rats brought food insecurity to 85,000–140,000 people and caused families to eat only one or two meals a day. The villages that suffered the most were the non-Lao Tai villages that relied mostly on upland farming, were far away from markets, had poor road access, had fewer labor opportunities, and had limited access to natural resources. The rat outbreaks came as an additional shock and an unwanted blow to their already challenged livelihood. According to the WFP's assessment, food insecurity will even intensify when the 2009 rainy season sets in.

Invading Chin State in Myanmar

Chin State is located in western Myanmar, surrounded by the Chittagong Hill Tracts, and Mizoram. Like their neighboring countries, the people of Chin depend on upland rice cultivation for their daily calories. Unfortunately, they also share the problem of rising rat populations after bamboo flowering.

Nyo Me Htwe, a doctoral rodent ecology student and IRRI scholar, studied the impacts of rodent outbreaks throughout Chin State in 2007-08, which were believed to be the most serious in 50 years.

According to Ms. Htwe, rat outbreaks occurred in 30 villages in Paletwa, north of Chin State, in 2007. Caused by the *Rattus rattus* species, outbreaks erupted 2 months after bamboo flowering.

During the outbreak season, the extension staff from the Myanma Agriculture Service (MAS) conducted a rodent control campaign in 28 villages. Farmers used different ways to prevent further rat damage, such as setting local traps, and driving them away with a barrage of noise. "However, the farmers did not do them as a community, as it should be," says Ms. Htwe. "They control rats by using different kinds of local traps only when they see damage in the field, and they rely mainly on rat hunters."

According to MAS, Paletwa regularly imports 6,135 tons of rice from its neighboring district, Rakhine. In 2008, however, they needed to import about 1,200 tons more because of rat damage. The local government also arranged to buy surplus amounts of rice to sell to farmers at the base price, but most farmers did not have money to buy them.

Alarmingly, there were new reports in September 2009 of rodent outbreaks in Palatwa Township, Chin State, and Kyauktaw Township, northern Rakhine State (Arakan). MAS said that rodent damage to upland rice started in August 2009 following massive bamboo flowering, similar to the 2007 and 2008 occurrences.

Working and learning together

Rodent outbreaks are not confined to the upland regions. This year, high crop losses because of rats were also reported in the Philippines and Southeast Sulawesi, Indonesia. These, however, were not related to bamboo flowering but to the asynchrony of rice planting in the irrigated lowlands. Such patchy outbreaks occur too often in the intensive lowland rice agroecosystems. Unfortunately, there is little documentation of the factors leading to these outbreaks, their impacts, and the successes and failures of management action.

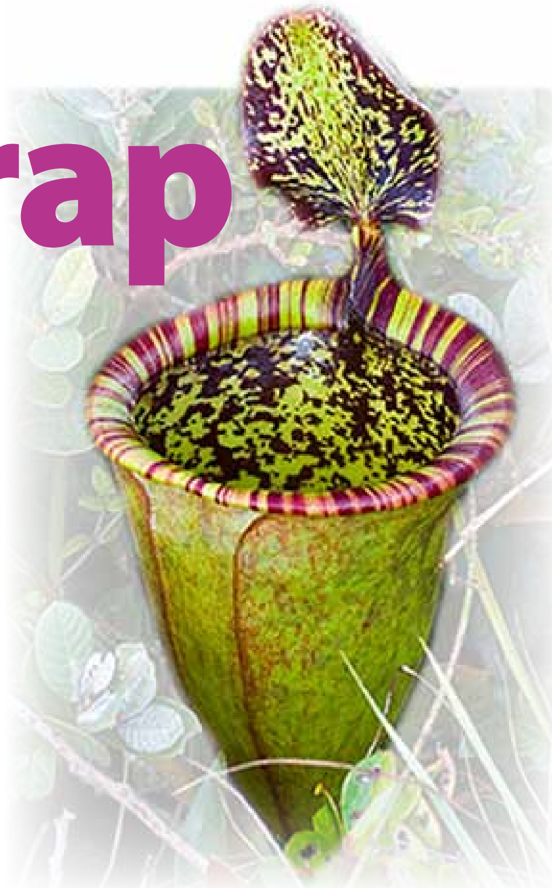
IRRI believes it crucial to conduct an international conference on the impacts of rodent outbreaks on food security in Asia. Scheduled for 26-28 October, the conference will document the evidence and impact of rodent infestations and to develop a framework for research on rodent management in the agricultural systems of Asia. Participants will review the impact of ecologically based rodent management in both lowland and upland rice environments in Southeast Asia and develop follow-up activities that include forging partnerships with the public and private sector (e.g., civil society groups and nongovernment organizations).

Plenary presenters will include Dr. Belmain, Ms. Htwe, Dr. Singleton, Dr. Ken Aplin (Mizoram), Dr. Bounneung Douangboupha (Laos), and Dr. Sudarmaji (Indonesia).

"Historically, there are records dating back to the 1750s of these rodent explosions that have led to devastating food shortages in eastern India, western Myanmar, and southeastern Bangladesh," says Dr. Singleton. "However, there is little information documented about what species are involved, what methods proved effective in holding the hordes of rats at bay, or when these outbreaks will happen. What has surprised the rodent experts is that, over the past 4 years, the outbreaks have been blinking in and blinking out. It is not just one tidal wave of rodents. Instead, it is a gradual wave sweeping through the region. There is so much we need to share and document so that we can be better prepared in the future to fight these waves of starvation."

Rat trap

by **Trina Leah Mendoza**



The tables have been turned. A rat-eating plant has been discovered in Palawan, Philippines. Could this be the solution to rat population control?

In early August, surprising reports of a rat-eating plant discovered in Palawan circulated on the international and local news circuit. According to media reports, a team of botanists led by British experts Stewart McPherson and Alastair Robinson found the plant in 2007 on Mount Victoria in Narra, Palawan, after a 2-month expedition.

The team, which included staff from Palawan State University, received word from two Christian missionaries who found the large, carnivorous pitcher plant in 2000. Their detailed findings were published earlier this year in the *Botanical Journal of the Linnean Society* after a 3-year study of all 120 species of pitcher plant.

According to *GMANews.TV*, the rat-eating plant is among the largest of pitcher plants. Its pitchers measure 30 × 16 centimeters, which are twice the size of pitcher plants commonly found in the area. Named after British nature filmmaker Sir David Attenborough, the *Nepenthes attenboroughii* uses acid-like enzymes to dissolve its prey.

In his interview with *Telegraph.co.uk*, Mr. McPherson said that "the plant produces spectacular traps which catch not only insects but also rodents."

"This is a spectacular discovery," says Grant Singleton, IRRI's expert on rodent management and coordinator of the Irrigated Rice Research Consortium. "We are often told about botanical extracts that are poisonous to rats, but, perhaps, we now have a natural rat trap! Certainly, this newly discovered rat trap is a welcome addition in controlling rats, because rodents are the most abundant and diversified order of living mammals in the world, and can contribute to human disease and threaten public health."

Rodent-borne diseases—a comprehensive review

Dr. Singleton recently co-authored with Drs. Bastian Meerburg and Aize Kijlstra from Wageningen University, the Netherlands, a 50-page review on rodent-borne diseases and their risks to public health. In their article, published in *Critical Reviews in Microbiology*, the scientists stressed that rodents play a significant role in transmitting a large number of diseases to humans, and to animals that provide important sources of protein for humans. Risk levels of infection vary between different pathogens, and it is thus crucial to observe rodent populations more closely to predict future disease occurrences and to be able to identify new rodent-borne diseases.

Models that characterize changes in the demography and population density of rodents are needed to help predict expansion of rodent-borne diseases and thus allow planning, which will improve public health. The authors highlighted that possible effects of human activity and global climate change should be further investigated, because these might lead to rodents having different interaction patterns and habitats, which could then lead to infectious diseases emerging in areas that were previously not affected.

A key message that emerged in the article is the underreporting of rodent zoonoses or disease transmission. "Insufficient attention is paid to the diagnosis of these important diseases," says Dr. Singleton. "In Asia, often common and treatable diseases such as leptospirosis and murine typhus are misdiagnosed. Some cases are simply diagnosed as fevers of unknown origin, while others are misdiagnosed as dengue or malaria. This is a tragedy given that many poor agricultural workers are at high risk of contracting rodent-borne diseases."

The reviewers conclude that more research is needed to develop integrated prevention strategies, and to determine how to interrupt disease transmission cycles that involve rodents. With proper application of ecologically based rodent control methods, it is possible to reduce the dangers of rodent-borne diseases in areas where humans, food animals, and rodents live close to one another.

If this rat-eating pitcher plant can, in some way, help in catching rats, then it is a much-needed contribution to effective rat management and another interesting way of nature to maintain its checks and balances. However, Dr. Singleton explained, "The time it would take a pitcher plant to digest a rat would be sufficient for another generation of rats to be born! So, our quest for an effective method of rodent management continues, with management based on a strong understanding of the ecology and living habits of rodent pests offering the best promise."

Never an empty bowl

by **Savitri Mohapatra**

African countries come together to work toward self-sufficiency

JOSEPH RICKMAN

The Council of Ministers of the 23 member countries of the Africa Rice Center hailed the new harmonized international partnership for rice development in Africa during its 27th Ordinary Session held in Lomé, Togo, 2-3 September 2009. It also greatly appreciated the strong research alignment forged between the Africa Rice Center and the International Rice Research Institute (IRRI).

"By pooling together our resources, our intelligence, and our efforts, we have to generate knowledge and technology that can benefit Africa," commented Africa Rice Center Director General Dr. Papa Abdoulaye Seck. "The advantages of our collaboration can help us have critical mass and very high impact."

On behalf of IRRI, Dr. Achim Dobermann, deputy director general for research, conveyed IRRI's strong commitment to the partnership.

Referring to the ongoing reforms of the Consultative Group on International Agricultural Research (CGIAR), the Council of Ministers called for a mega-program on rice as this cereal is the fastest growing food staple in Africa. Hence, it is regarded as an engine of economic growth and political stability that can affect poverty and hunger.

The mega-program would represent a global rice science partnership providing synergies for research conducted by the three CGIAR-supported centers working on rice (Africa Rice Center, IRRI, and the Centro

Internacional de Agricultura Tropical in Colombia) and other partners, most notably, the national research systems. Also included are other advanced research institutes, in conjunction with development partners.

Recognizing the geographic expansion of the Africa Rice Center, the Council of Ministers made a historic decision to officially change the center's name from the West Africa Rice Development Association (WARDA) to Africa Rice Center (AfricaRice).

"This change reflects the current reality," the Council of Ministers declared. "Today, our center is very different from when it was established in 1971, in view of the increasing number of member countries beyond West Africa and the continent-wide adoption of the public goods generated by it."

The Council underlined that the pan-African ownership of the Center has increased, particularly since 2007, during which six countries from central, eastern, and northern Africa joined the Center. As a result, the number of member countries rose from 17 in 2006 to 23 in 2009. The Council noted that, in fact, the Center's technologies and services greatly benefit 34 African countries, including 11 nonmember countries.

The Council of Ministers Session was inaugurated by the prime minister of the Republic of Togo, Mr. Gilbert Fossoun Houngbo, on behalf of the president. "We salute the prominent role that the Africa Rice Center has been playing in the fight against poverty through the intensification of rice research in Africa," stated the prime minister. He also appreciated the efforts made by the governments of the Center's member countries and the support of the international donor community.

The current session of the Africa Rice Center Council of Ministers, which was chaired by Mr. Kossi Messan Ewovor, minister of agriculture, livestock, and fisheries, Republic of Togo, was held against the backdrop of the recent food crisis, particularly the rice crisis that affected several African countries.

The Council commended the Center for not only assisting the member countries in responding to the rice crisis, but also for alerting them and recommending strategies to effectively manage such crises in the future.

Following the food crisis, several member countries of the Africa Rice Center adopted key policy measures recommended by the Center in 2007 to support the rice sector. According to the Food and Agriculture Organization (FAO) of the United Nations, this contributed to an 18% increase in the region's 2008 rice production compared with that of 2007.

AfricaRice publications are on display at the 27th Ordinary Session of the AfricaRice Council of Ministers.

R. RAMAN (5)

Most notable was the 241% increase in Burkina Faso's rice production in 2008 compared with 2007. Burkina Faso was one of the countries rocked by food riots. FAO attributes this turnaround in Burkina Faso's rice fortunes to government support to farmers. Senegal, the world's eighth-largest rice importer, also increased its rice production by 90% in 2008 through a presidential initiative.

Other African rice-producing countries that have recorded double-digit increases in national rice production in just 1 year are Mali, Benin, Nigeria, Ghana, Côte d'Ivoire, Guinea, and Uganda.

Many African governments have now prioritized local rice production. They strive to create conditions that will enable farmers to begin to use Africa's largely untapped land and water resources to produce affordable rice.

"This is a step in the right direction, but governments still need to do more in order to significantly reduce dependence on rice imports for national food security," says Dr. Papa Seck.

In realization of the critical role played by research in developing technology innovations and solutions required to increase rice production and food security, Africa Rice Center member countries invested ten times more in 2007-08 in rice research through their contribution to the Center than between 2001 and 2006.

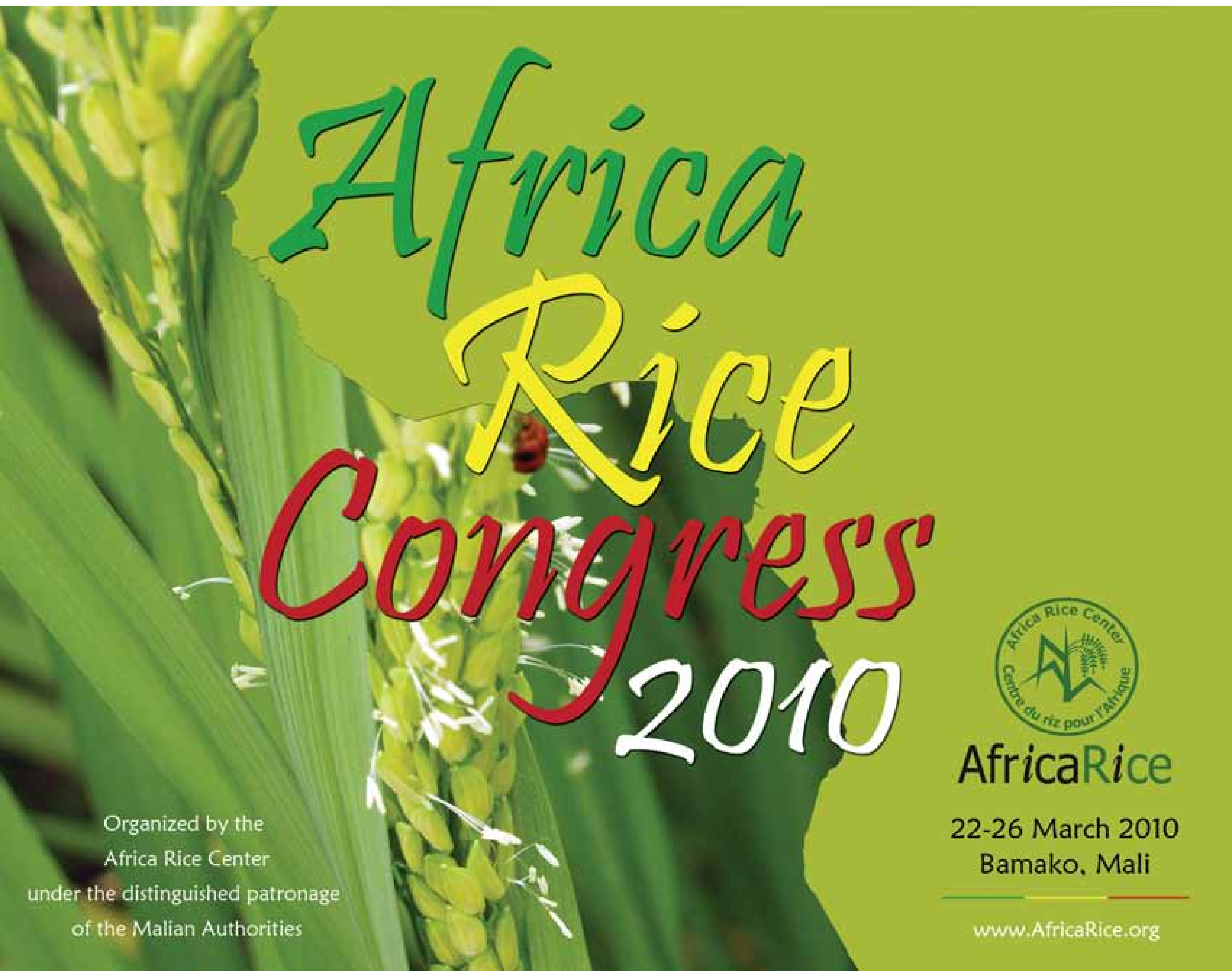
These achievements and the challenges of the African rice sector were discussed by the Council, which concluded by making several key resolutions.

1. INAUGURATION of the 27th Ordinary Session of the AfricaRice Council of Ministers: (*foreground from left to right*) Papa Abdoulaye Seck, director general, AfricaRice; Hon. Florence Chenoweth, minister of agriculture, Liberia; and Gilbert Fossoun Houngbo, prime minister of Togo.

2. AfricaRice-IRRI research alignment hailed by the AfricaRice Council of Ministers: (*from left to right*) Inoussa Akintayo, regional coordinator, African Rice Initiative, AfricaRice; Marco Wopereis, deputy director general for research, AfricaRice; Achim Dobermann, deputy director general for research, IRRI; and Kossi Aboua, scientist, Togo National Program, ITRA.

2. TOGO'S PRIME Minister Gilbert Fossoun Houngbo (*third from left*) inaugurates the 27th Ordinary Session of the AfricaRice Council of Ministers. Sitting with him are Getachew Engida, board chair, AfricaRice (*first from left*); Kossi Messan Ewovor, minister of agriculture, livestock, and fisheries, Togo (*second from left*); Leopold Gninevi, minister of energy, Togo (*fourth from left*); Papa Abdoulaye Seck, director general, AfricaRice (*fifth from left*).

NERICA-based dishes are displayed at the 27th Ordinary Session of the AfricaRice Council of Ministers.



MECHANICAL SELF-SUFFICIENCY

Africa mechanizes its harvest and postharvest resources to achieve food security

Story and photos by **Joseph Rickman**

Rice production in Africa

In sub-Saharan Africa, rice is a very important staple and cash crop. In 2006, the region produced more than 21.6 million metric tons of rice and imported 9.4 million tons. African imports accounted for more than one-third of the internationally traded rice, which cost approximately US$2 billion in foreign exchange.

Over the past 3 years, local rice prices have increased sharply. In Mozambique, during 2008, rice imported from Asia sold for $930 per ton in local stores and markets, which was nearly three times the price in 2007. Even today, in many villages and rural markets, polished rice continues to sell for $0.80–0.90 per kilogram, or $800–900 per ton.

Many African governments now realize that relying on the world market to supply their rice is very risky and expensive, and many consider this an unwise long-term strategy. To avoid severe food insecurity and, in some countries, civil instability, governments are now serious about increasing rice production.

The International Rice Research Institute (IRRI) and the Africa Rice Center (AfricaRice) are working closely with many sub-Saharan governments, nongovernment organizations, and commercial companies to increase rice production across the region.

The potential to increase production

Rice productivity in East and southern Africa is now very low, with yields averaging between 1 and 1.5 tons per hectare. If this region can maximize its fertile lands and acquire ready access to water and other inputs such as fertilizer, Africa can double or even triple its rice production.

Production constraints

At present, however, rice farmers face constraints that constitute a combination of inappropriate and poor management skills, timing of operations, and availability of labor at critical times. These factors are often interrelated and, in many cases, controlled by factors from outside the farm.

Diseases such as HIV/AIDS and tuberculosis, plus the migration of young people to the mines and other urban industries, have reduced the local farm labor pool. When labor is available, productivity is often very low because of poor health and nutrition problems.

Moreover, in many areas, rice crops are not planted on time and yield losses of up to 2 tons per hectare have been recorded on the same farm with plantings 1 month apart. To compensate for this, farmers either plant more seeds or transplant older seedlings. Unleveled and uneven fields also result in higher water requirements, more weeds, poor fertilizer efficiency, and nonuniform crop ripening. Uneven ripening of crops causes delays in harvest and increases losses from shattering, birds, and weather damage. Late-planted crops are also much more susceptible to pest damage, especially leaf diseases. Delays during harvesting, threshing, and drying also cause losses in both grain quantity and quality.

Following the harvest stage, losses during postharvest are also very high, ranging from 15 to 50%. In some instances, all the grains are lost, contaminated by fungus, particularly mycotoxins, or spoiled by rain after harvest. Farmers lose much of their grain because of poor postharvest management, outdated postharvest technology, and poor and unhygienic storage facilities. Since most of the crop is hand-threshed, farmers prefer to harvest crops at lower moisture content—as this makes threshing easier. This often means that the crop is left in the field a month longer than what is necessary. The outcome is less grain and poorer rice quality that later translates into consumers turning away from locally produced rice, thereby reducing farmers' income.

Moreover, potential income is lost as many farmers sell their grain at the point of harvest. If farmers could store their grain safely and have access to transportation—so they are not at the whim of local traders—they could increase the value of their grain by 20–30% within 2–3 months after harvest.

In these circumstances, if postharvest losses in sub-Saharan Africa were reduced by 50%, this would provide another 2 million tons of paddy or 1.6 million tons of milled rice. This is equivalent to nearly 30% of imports and the real value is $700 million per year.

Overcoming the problem

One way to overcome the timeliness problem and improve the efficiency of operations is to add more energy to the system.

Increasing labor is not really an option. But, small machines, such as 2-wheel tractors, grain threshers, and mechanical weeders, can be introduced to boost production.

Where mechanization has been introduced, farmers observed that timeliness of operations improved, as did the efficiency and quality of the end product. Land was much better prepared, weed growth declined, crops were harvested at higher moisture content, and grains were stored safely and much earlier. When 2-wheel tractors are combined with a trailer, many on-farm transportation and market isolation problems are solved. The engine can also be used as an auxiliary power source for pumping water, crop threshing, rice milling, and generating electricity. This combination of equipment helped pave the way for self-sufficiency in many Asian countries and it has the same potential in Africa.

IRRI and the AfricaRice are building on the lessons learned in Asia and are now importing small-scale machines for testing and demonstration in Africa.

IRRI, specifically, is collaborating with the government, machinery manufacturers, and dealers in Tanzania and Mozambique to support the importation, fabrication, and field demonstration of equipment. In 2008, IRRI introduced 2-wheel tractors, threshers (both engine- and pedal-driven), manual cone weeders, and drum seeders into Mozambique. Then, in 2009, another batch of threshers was shipped to Tanzania. A 2-wheel tractor and a pedal- and engine-driven thresher are now on their way to Burundi under the IRRI-CARE project.

The pieces of equipment imported into Mozambique have already proved successful. Hence, the government is now ordering more 2-wheel tractors and threshers from Asia. A local machinery manufacturer has already built and tested the first engine-driven thresher. Cone weeders have also been built locally and a pedal thresher is on the way. The cone weeders proved to be six times faster than hand weeding when tested in southern Mozambique.

In Tanzania, 2-wheel tractors are starting to become very popular. More than 500 machines have been imported, with many going into the rice-growing areas. IRRI is working with the local importer and the Mechanization Section in the Ministry of Agriculture to further support the expansion of 2-wheel tractors and other equipment. Pedal threshers are already being manufactured in Tanzania and an engine-driven thresher will soon follow.

After initial tests, drum seeders are now being fabricated locally in Mozambique and will soon be in Tanzania. The imported plastic Asian version introduced for demonstrations has already succumbed to African rats and rough handling. A metal version is now being built.

Adoption

The adoption and sustainable use of equipment in Africa will take time. IRRI's experience in Asia suggests that it would take 8–10 years for the mechanization program to fully develop—from initial testing to local ownership and wide-scale adoption. And, the key to a sustainable mechanization program is to base it on sound business principles from the beginning. The use of the equipment must show a strong financial benefit, have local ownership and dealer support, have a local champion, have government support, and provide training for all players.

The cost of hiring machinery contractors in Africa is now excessively high. Where large tractors are used, local contractors charge $70–80 per hectare for one pass, and rice millers charge $80–100 per ton for contract milling. In comparison, these costs are nearly three times those of their Asian counterparts. Labor costs in Africa range from $1 to $2 per day, as in Asia.

The cost of importing equipment to East and southern Africa is also very high. A tractor that costs $2,500 in Thailand costs more than $5,000 in Tanzania. One-off fabrication costs are also expensive, but, we hope, these will decline when larger numbers are manufactured locally and more dealers come into the market.

In spite of the high cost of imported equipment, there is a substantial economic benefit in using 2-wheel tractors for land preparation. One 2-wheel tractor can plow 1 hectare a day and uses approximately 20 liters of diesel. Add to this labor, repair, and maintenance, and the total operating cost is approximately $35 per hectare. Obviously, a cost of ownership must be added, so the overall cost will be approximately $50 per hectare. This compares economically very favorably with current manual and large-tractor plowing. Note that the tractor can also be used as a power source for threshing, pumping water, transportation, and generating electricity.

Cooperative ownership appears to be the obvious solution for purchasing equipment in the short term. Many African farmers are already used to working in associations or cooperatives, so this should not be a problem. Local credit organizations have started working with cooperatives and governments now see mechanization as the way forward.

When introducing machines, changes to current farming practices are often required. Several examples have already taken place in Mozambique. Traditional manual threshing requires straw to be left long, whereas mechanical threshing requires short straw. Similarly, the use of mechanical cone weeders requires seedlings to be sown in rows.

IRRI and the AfricaRice have a pivotal role in making mechanization happen. On-farm demonstrations, support for the private sector, and, most important, local training in the use and maintenance of equipment are already taking place. Like in Asia, this will be a long-term transition, but, it is a basic requirement for rice production to increase in Africa.

Mr. Rickman is IRRI's representative for East and southern Africa.

NIR Analyzers for Rice and other whole grains

Near Infrared Analyzers provide rapid, accurate analysis of rice and other grains for moisture, protein, and other constituents. Bruins NIR analyzers are reliable, simple to use, and unsurpassed in their accuracy and reproducibility.

- Accurate analysis of moisture and protein (<0.2%)
- Fast, non-destructive, less than 1 minute per sample
- Calibrations for high and low moisture (dried) rice and polished rice
- Expandable to other constituents including amylose, FFA

Email: Info@bruinsinstruments.com
Web: www.BruinsInstruments.com

Tel: 1.603.898.6527
Fax: 1.978.485.0055

PO Box 1023
Salem, NH 03079 USA

BRUINS INSTRUMENTS
Precision NIR Analyzers for Agriculture
USA

100 years OF RICE RESEARCH

by **Marco van den Berg**

A new technological revolution brings the world together to power research programs

"The world is experiencing three simultaneous revolutions: in molecular biology and genetics, in computational power and storage capacity, and in communications," observes Dr. Robert Zeigler, director general of the International Rice Research Institute (IRRI). "The computational revolution allows scientists around the world to tackle almost unimaginably complex problems as a community, and in real time. Although there are no silver bullets, rice production can be revitalized with the help of new technologies." Agricultural research has recently joined the ranks of scientific disciplines that use intricate computations in their research methods.

GENE HETTEL

Traditionally, supercomputers were associated with research areas that required very large amounts of calculations and huge volumes of complex data such as astrophysics and geophysics. The first generation of supercomputing devices was often purpose-built machines that required specialized care in terms of maintenance. They also needed specific software development skills to optimize the use of the multiprocessor architecture. Now, it is possible to build a device that has more capacity than the early supercomputers using off-the-shelf components. At IRRI, researchers use several number-crunching devices ranging from a specialized high-performance computing (HPC) device to a gaming device modified to run parallelized statistical analyses.

Some complex tasks are daunting even for the largest supercomputing equipment. The Nutritious Rice for the World project, in which IRRI participates, aims to predict the structure of proteins of major strains of rice. The study intends to help farmers breed better rice varieties with higher crop yields, promote greater disease and pest resistance, and use a full range of bioavailable nutrients that can benefit people around the world, especially in regions where hunger is a critical concern (see http://snipurl.com/s8bwy). This project, run by the Computational Biology Research Group at the University of Washington, requires a massive amount of computing time to complete. This is where the World Community Grid comes in (see www.worldcommunitygrid.org).

The World Community Grid offers public research projects an alternative to the large investments required to run such projects on traditional supercomputers by distributing computational tasks over the Internet to volunteers who donate their computers' idle time to this project. Since the World Community Grid was launched on 12 May 2008, the amount of computing time donated to this project at the time of writing was equivalent to a single computer running for 16,687 years. To put this into perspective, a fairly large HPC device with 32 nodes, each having four modern four-core processors, would need to run continuously for more than 32 years to achieve what has been accomplished within a year and a half through the assistance of this unique community of volunteers.

All workstations at IRRI are connected to the institutional network that contributes to the Nutritious Rice for the World project. When a workstation becomes idle for 10 minutes, the Berkeley Open Infrastructure for Network Computing or BOINC (see http://boinc.berkeley.edu) software kicks in and runs tasks associated with the projects on the World Community Grid rather than displaying pretty animated pictures of a screensaver. Note that leaving workstations on at all times is not advisable as this will consume large amounts of electricity. The data obtained at IRRI are the result of idle moments when people have to make a phone call, attend a meeting, visit the washroom, read a newspaper, etc. By the time we celebrate IRRI's 50th anniversary in 2010, the Institute will have donated more than 100 years of computer time to research programs on the World Community Grid.

Anyone who owns a computer that is connected to the Internet can participate in this project. The required BOINC software can be downloaded for computers running different versions of Microsoft Windows and Apple Mac, and for most versions of Linux. Downloads and simple configuration instructions are available from the World Community Grid Web site. And, while you are at it, you may want to join the IRRI team, and we will include your statistics in our team results!

Mr. van den Berg is head of Information Technology Services at IRRI.

The global rice market pauses

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

For the first time since the crisis in late 2007, new uncertainties plague the global rice market. A record global rice crop in 2008 kept the situation under wrap, with rice prices dropping by as much as 60% after peaking in May 2008. Favorable growing conditions in the major rice-producing countries definitely helped the situation, as 10 million tons of rice were added to the global rice inventory at a time when stocks reached a level not seen in the last 30 years. Government interventions in the form of a higher minimum procurement price, along with higher input subsidies, also helped production reach a record.

One of the undesirable outcomes of raising the support level, however, has been the diversion of rice away from the market to government warehouses. This is evident in the more-than-normal spread between Thailand and Vietnam rice prices that has been seen in recent months, when higher Thai intervention prices have kept export prices higher. As Figure 1 shows, the price of Thai rice 5% broken is about $100 higher than its Vietnam counterpart, compared with the normal spread of US$10–20. Similarly, retail rice prices in major Indian markets have also witnessed steep increases in the past months, while government grain bins overflow with rice (see Fig. 2).

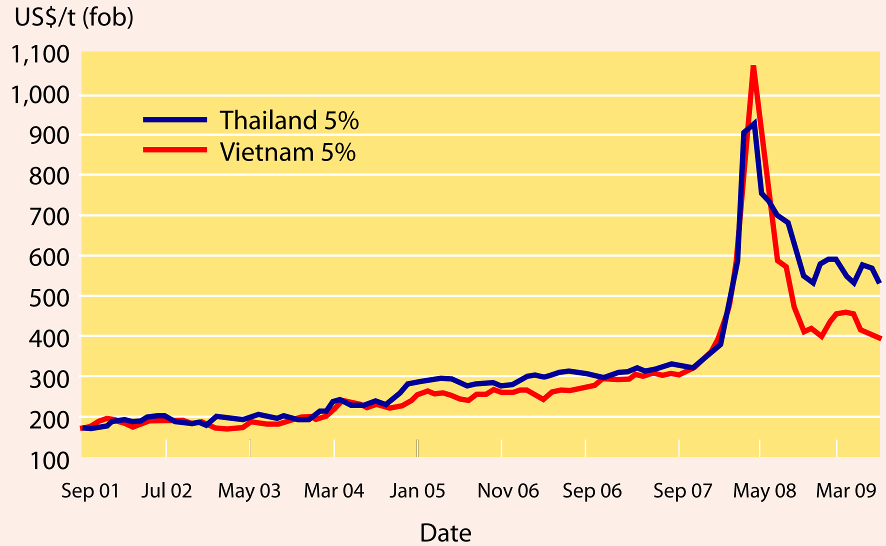


Fig. 1. The rise and fall in global rice prices.
Data sources: World Bank and USDA.

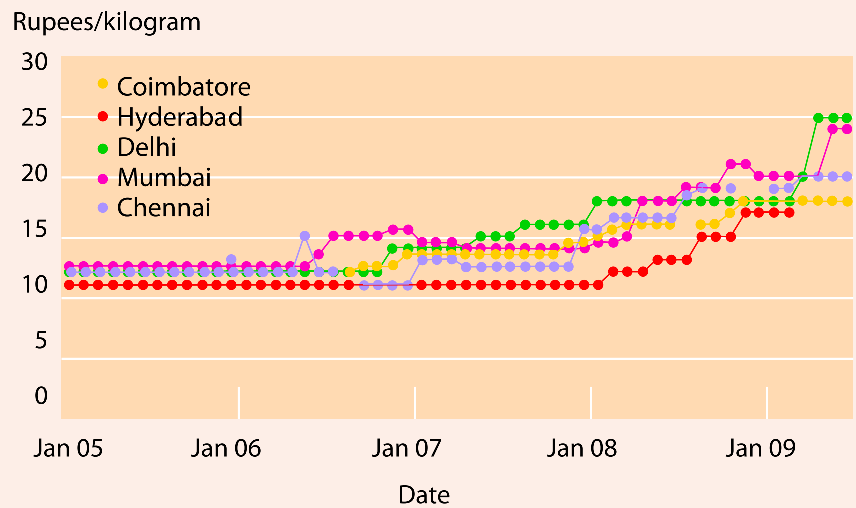


Fig. 2. Rice retail prices in major Indian markets.
Data source: Department of Agriculture and Cooperation, Government of India. US$1 = 48 rupees.

Experts' estimates regarding the amount of rice sitting in government warehouses, particularly in India and Thailand, vary. The estimates range from 20 to 25 million tons for India and 6 to 8 million tons for Thailand. In addition, India also had a banner year in terms of record wheat procurement, pegged somewhere around 30 million tons. From the outside, it appears that India is sitting comfortably with these buffer stocks at its disposal. However, more than half of the procurement stocks need to be channeled through the public distribution system to provide subsidized grain to the 65 million people living below the poverty line. The government has also allocated 17 million tons of grain to those above the poverty line who can buy it at less subsidized prices. The challenge for the government now is to strike a balance between the public and private distribution system to ensure a steady supply of grain in the market and keep prices stable.

The current situation

Despite the comforting stock numbers for India, Thailand, China, and other Asian countries, the global market is waiting and watching because of the number of uncertainties evolving quickly in the market today. First, the erratic behavior of the monsoon in many parts of India and Bangladesh is making other major players re-evaluate their situation. Thailand, which was initially desperate to auction off some of its surplus rice to

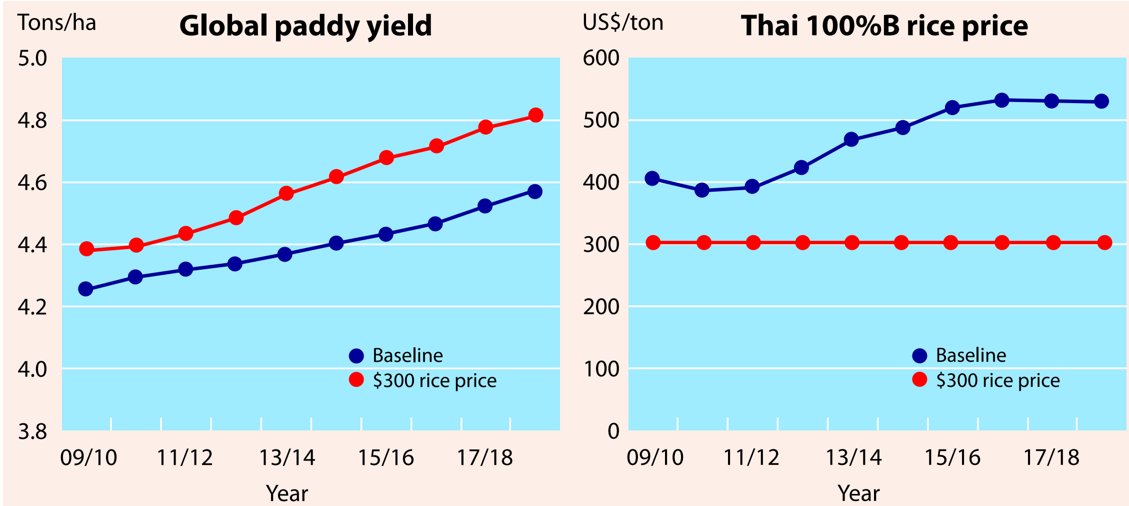


Fig. 3. Yield growth needed to keep the rice price (Thai 100%B) constant at around $300 per ton.
Data source: Global rice model, University of Arkansas.

open up storage space for the new crop, no longer appears to be in such a hurry.

Hence, supply in the global market has suddenly dried up and traders now assess the extent of the Indian drought's damage before they jump into the market. Sources from India say that the kharif (summer crop) rice area is down by as much as 20% compared to the last season, and production is estimated to be 10 million tons lower. These numbers are just preliminary figures, however, and it will take a few more weeks to come up with more concrete estimates of the area and yield of the current kharif crop. The last time the monsoon failed was in 2002. It was just as bad as the current monsoon and Indian production then fell by more than 21 million tons.

Rainfall in recent weeks has definitely helped in expanding rice planting in the lowlands of Uttar Pradesh and Bihar, but many parts of the upland rice area have already been lost this season because of deficient rainfall. Members of the International Rice Research Institute's (IRRI) field visit to eastern Uttar Pradesh and Bihar in the second week of September clearly observed moderate to severe stress on rice plants because of the delayed planting and irregular rainfall throughout August. It is evident that rice production in India will be less than in the previous kharif season because of reduced rice area and yield.

Unlike in India, however, crop conditions in Bangladesh look much better. The delayed arrival of the monsoon initially affected the transplanting process, particularly in the northern parts of the country, but rice planting has picked up in recent weeks, as sufficient rains arrived.

Looking beyond 2009

Irrespective of what happens to the market in the next few months, the fundamental problem for achieving global rice food security, sagging yield growth, has yet to be addressed. Over the past 8 years, nearly half of the production increase has been attributed to area expansion rather than to productivity growth. Current global rice area is at a historic high, but yield growth has fallen below 1%. At the same time, global consumption has been rising at a healthy rate of 1.5% annually. With further area expansion less likely in the future, productivity growth must be ramped up if we want to feed the hundreds of millions of poor people.

To assess the yield growth required to keep rice cheaper, we ran a simulation using the global rice model developed and managed by researchers at the University of Arkansas. Baseline projections for rice supply, demand, trade, and prices were developed under the assumption that the weather is normal, the current policies continue, and present yield growth is still applicable. As Figure 3 shows, baseline paddy yield is projected to grow by 8% in the next 10 years, with the rice price (represented by Thai 100%B on the right side) climbing up to $530 per ton in the next few years and staying there for the last few years of the projection period. To keep the price at around $300 per ton, yield needs to grow at a much faster rate (of around 15%) in the next 10 years.

In addition to revamping yield growth, it is also necessary to achieve a greater degree of price stabilization in the global market. This is particularly true for rice, the primary staple for the poorest of the poor in the region. Uncertainty in production arising out of India's poor monsoon this season will likely happen again in the future in another country and combine with some other problem. Re-building stocks to a level that can assure importing countries of a steady flow of rice to the global market is one way to stabilize the market. Although this sounds like an expensive proposition, it is a realistic solution considering the structure of the global rice market, in which domestic food security is a top priority for four of the top five exporters. The current global rice stocks of 89 million tons[1] are higher than the stocks recorded a couple of years ago, but lower than those seen during the 1990s. The need for a higher buffer may not be essential if rice markets in the region become integrated enough so that any form of trade restriction is not a viable policy option anymore.

[1] United States Department of Agriculture estimate.

South Asia's twist of fate

by **Sonia Asilo, Arnel Rala, Angelo Pacheco,** and **Cornelia Garcia**

Water is essential in rice farming. Proper water control in rice fields helps farmers attain high yield. More often, however, nature takes this control away from farmers. Drought leaves them with little water, while storms ravage their crops. Both circumstances devastate their rice fields.

During the monsoon season, South Asia regularly experiences widespread floods. In 2007, heavy rains inundated Bangladesh, India, and Nepal. The Asian Development Bank reported that floods damaged 13.3 million hectares of crop area in Bihar, India, and 130,000 hectares of arable land in Nepal, and took away 25% of the potential wet-season crop area in Bangladesh.

The National Aeronautics and Space Administration (NASA) in collaboration with the National Space Development Agency of Japan launched on 27 November 1997 the Tropical Rainfall Measuring Mission (TRMM) satellite that gives researchers and scientists access to near-real-time rainfall information on a global scale and maps of potential flooding. TRMM products are available in image and ascii formats. It can be downloaded for free from NASA's Web site using TOVAS. The satellite observations are complemented by ground radar and rain-gauge measurements to validate the satellite rain estimation techniques. Using the script written in the statistical environment, R, TRMM 3B43 v6 ASCII product can be mapped and converted to tiff using the raster package developed at IRRI.

TRMM accumulated rainfall (mm) images were captured during the monsoon season (June-September) in South Asia. In 2007, flood was recorded in South Asia. In Figure 1, the orange to dark red regions show high rainfall accumulation in areas severely affected by flooding. Figure 2 shows the excessive amount of rainfall recorded in 2008. The northern part of Uttar Pradesh in India had the highest rainfall accumulation, not to mention the highest number of casualties as well.

In a sudden twist of fate, however, this year's monsoon season took a different turn. As you will read in this issue's Rice facts, this year, India's summer-season crops were left thirsting for water.

Fig. 1. 2007 rainfall accumulation in South Asia.

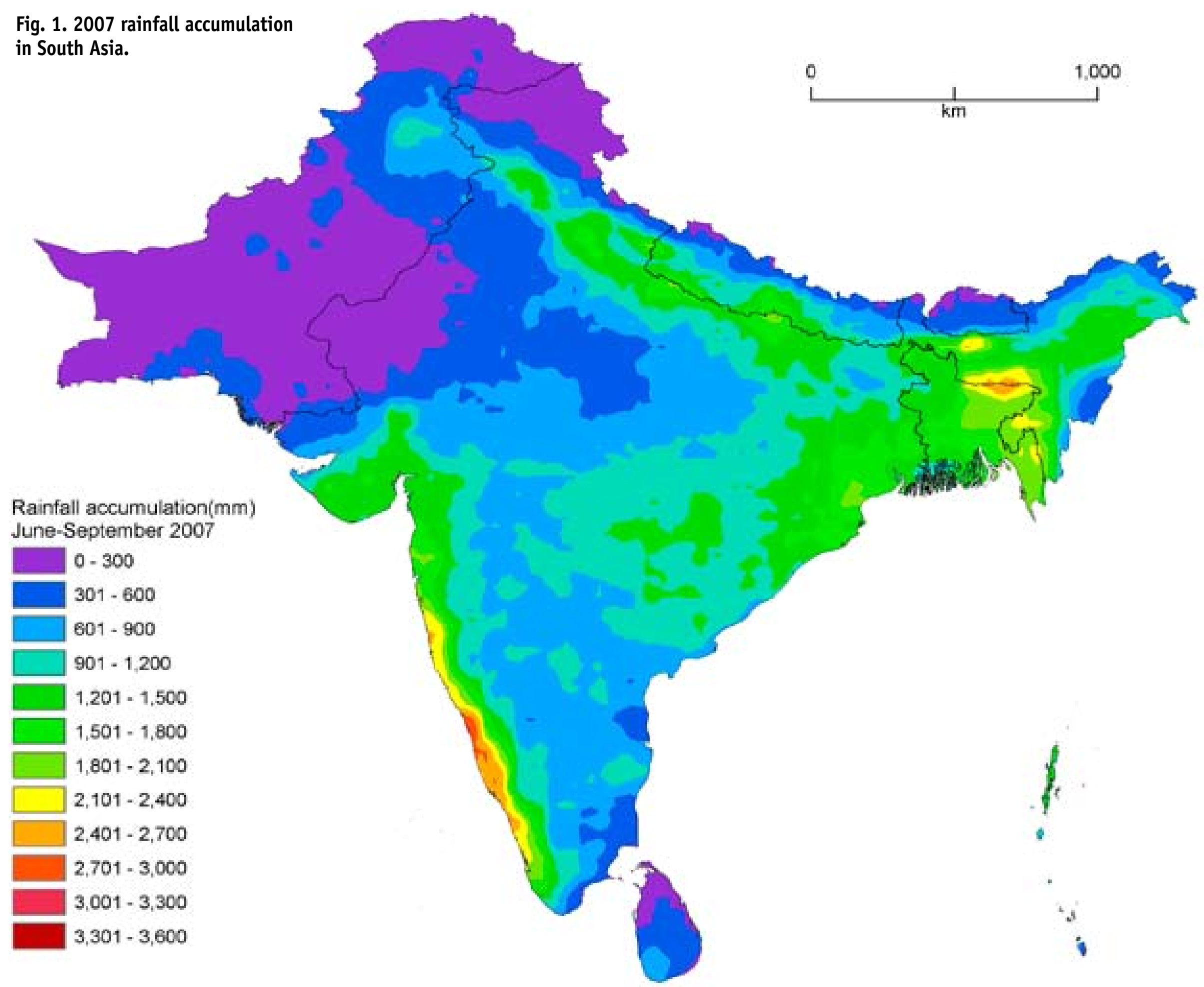
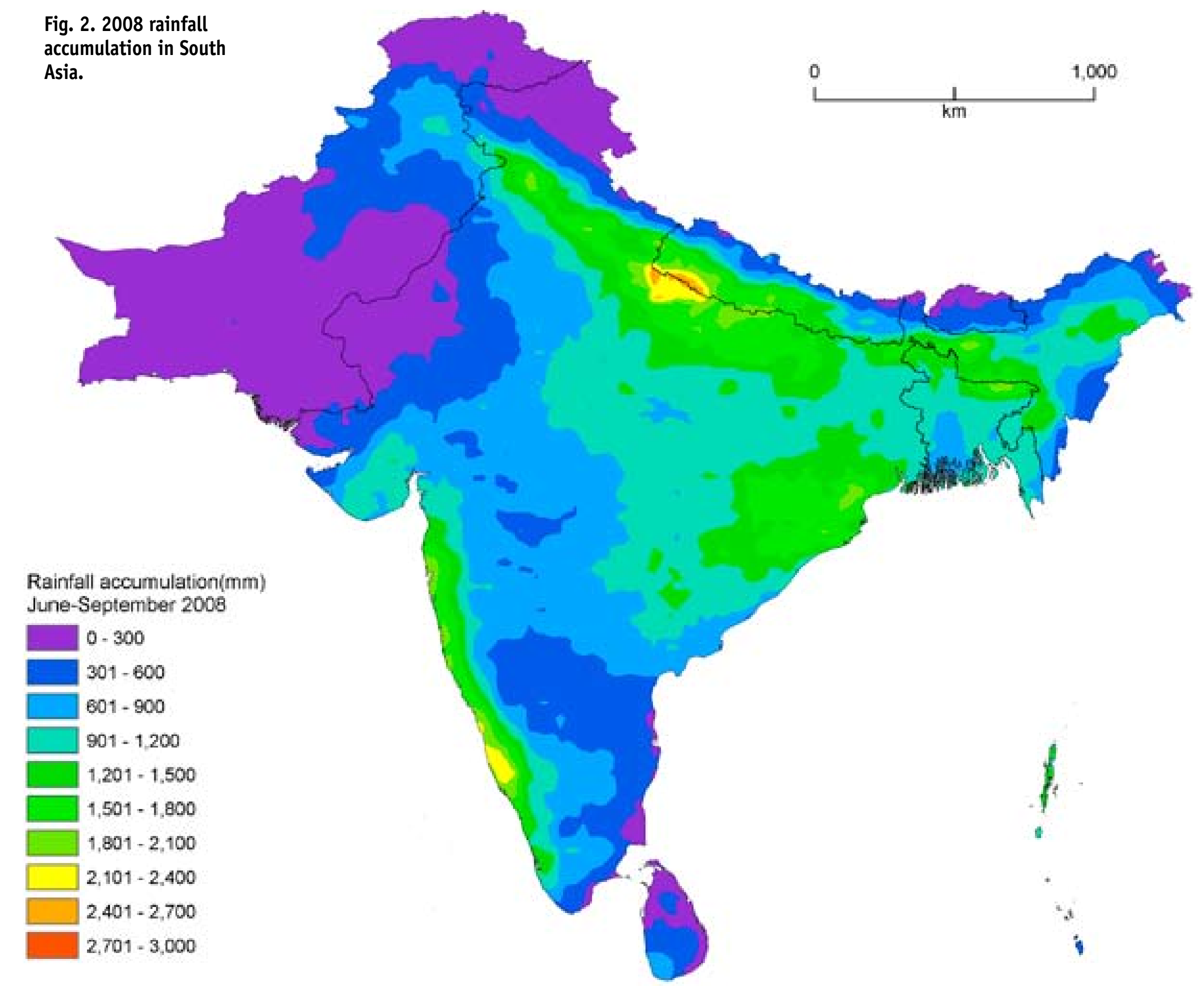


Fig. 2. 2008 rainfall accumulation in South Asia.



Acknowledgment

The images and data used were acquired using the GES-DISC Interactive Online Visualization and Analysis Infrastructure (Giovanni) as part of NASA's Goddard Earth Sciences (GES) Data and Information Services Center (DISC).

References

Majumdar B. 22 August 2008. Food riots as floods swamp South Asia. Environmental News Network. www.enn.com/lifestyle/article/37998.

Gutro R. 10 August 2009. NASA Satellite Sees Severe Flooding Rains from Deadly Typhoon Morakot. NASA/ Goddard Space Flight Center. www.nasa.gov/mission_pages/ hurricanes/archives/2009/h2009_ MorakotNews.html

Hijmans RJ, Van Etten J. 2009. raster: raster data handling for geographic data analysis and modeling. R package version 0.9.7-8. http://r-forge.r-project.org/projects/raster/.

Huke R, Huke E. 1997. Rice area by type of culture: South, Southeast, and East Asia. Los Baños (Philippines): International Rice Research Institute.

NASA. 2009. Introduction to TRMM. http://disc.sci.gsfc.nasa.gov/ precipitation/trmm_intro.shtml#Intro.

Wikipedia. 2009. 2007 South Asian floods. http://en.wikipedia.org/ wiki/2007_South_Asian_floods.

Ms. Asilo is a senior specialist in remote sensing, Mr. Rala is an associate scientist, Ms. Garcia is an associate graphics, and Mr. Pacheco is a programmer. All work at IRRI's Social Science Division.

[1] Tropical Rainfall Measuring Mission Online Visualization and Analysis System (http://disc2.nascom.nasa.gov/Giovanni/tovas/).

Circle irrigation:

a new response to climate change

BY BLAKE ONKEN

Global water scarcity and its implications for rice production have been an area of significant concern and discussion. Water scarcity is a problem of sufficient magnitude, that a "one-size-fits-all" solution is unlikely. Breeding programs aimed at improving drought tolerance in rice, as well as innovative and novel production systems, will be required to adequately address the issue of water scarcity, as it relates to rice production. One topic that has had little discussion, however, is the use of center-pivot irrigation systems to help resolve this problem.

Research is currently underway to evaluate and adapt center-pivot sprinkler systems to rice production. The impetus for this research is threefold: to reduce the water required to produce rice, to expand the geographic area suitable for rice production, and, finally, to reduce the cost of overall production by automating irrigation operations and fertilizer and chemical applications.

Center-pivot sprinkler systems have many advantages over other forms of irrigation. They apply water much more uniformly to fields than do either flood or furrow irrigation; and, since pumping requirements are reduced, water outflows are lessened allowing farmers to save on both water and energy. Moreover, another added benefit is, fertilizers and chemicals can be applied through the center-pivot system with the same high efficiency as the irrigation water. This can significantly reduce labor and application costs. The loss of fertilizers and chemicals to leaching and runoff is minimized, thereby increasing input efficiencies and reducing potential environmental impacts. Furthermore, in-season application of nutrients (particularly nitrogen) through fertigation enables plants to better utilize the nutrients, as the system matches the plant need and uptake.

RICK PROVAZNIK

Center-pivot systems perform well on sloped fields of up to 30 degrees, which eliminate the cost of expensive land leveling operations. Additional cost savings can be realized from reductions in labor and expenses for land repair, heavy tillage, puddling, lateral canal construction, surface smoothing, and check (bund) construction and maintenance. Expansion of rice ground without expensive land development can occur by using center-pivot systems. Areas previously unsuitable for rice production due to topographic or soil type constraints may now be considered for cultivation. Sloped fields, uneven ground, and lighter textured soils could all be put into rice production.

Established rice paddies are suitable only for rice production. To rotate rice with other crops can be difficult or impossible. The use of center-pivot systems would help facilitate crop rotation for healthier crops and soils. It would also make farmers more flexible to respond to changes in markets, weather, and other conditions. Because a field irrigated by a center-pivot system does not require maintaining flood water, puddling operations, which make crop rotation difficult would be eliminated.

From a "green perspective," published estimates place the methane production of rice paddies at between 50 and 100 million tons per year. Greenhouse gas emissions could be reduced by not flooding and water logging rice soils. In addition, reducing the number of flooded fields would reduce breeding areas for mosquitoes.

Research performed in Missouri and Arkansas in the United States and in Brazil has shown that irrigating rice with a center-pivot system reduces water applications from 28 to 50% compared with conventional flood methods, while maintaining or improving rice yields. Reported yields from these studies have been between 6 and 8 tons per hectare.

Because a center-pivot irrigated field is never flooded, early season rains are less likely to drown direct-seeded rice as it germinates. This was documented this season in field trials in Arkansas. While paddy fields had to be replanted due to excessive spring rains, the center-pivot irrigated field sustained very little damage. Plus, center-pivot irrigated fields will dry out more quickly at the end of the growing season allowing harvest equipment into the field sooner. Also, earlier harvesting will reduce yield losses from seed-head shatter, lodging, and pests.

A number of factors do have to be taken into account when considering the use of center-pivot systems for rice irrigation. The use of blast resistant rice varieties is essential as overhead sprinkler systems will regularly wet the rice canopy. Increased dependence on herbicides will also occur without flood water to keep weeds in check. Herbicide and fungicide programs will have to be carefully monitored. The cost of these programs should be offset by reduced production and pumping costs, however.

Center-pivot sprinkler systems may not be applicable to every field and every situation, but the expectation is that, the advantages of center-pivot sprinkler irrigation can be successfully adapted to widespread rice production. More research is required to confirm the sustainability of rice yields in using this technology. Early indications, however, show that center-pivot sprinkler systems will provide the same water, labor, and nutrient savings for rice as for other field crops.

Mr. Onken is the director of Application Engineering and Education for the Lindsay Corporation based in the United States.

Know your Industry. Know your world

Know what your competitors **don't**.

In a world with so many questions, access to information is what separates you from your competitor. Therefore, **information is power**. That is why The Rice Trader is respected as the authoritative voice in the rice industry, and is the only weekly publication dedicated to risk management and trade for the rice industry. Combining years of experience with proven analysis, your company can't afford not to subscribe to The Rice Trader.

Get Informed. Be Confident.

THE RICE TRADER

www.thericetrader.com Phone: +1 (530) 345-4140

The Rice Trader is a member of the International Commodity Institute.