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International Rice Research Institute

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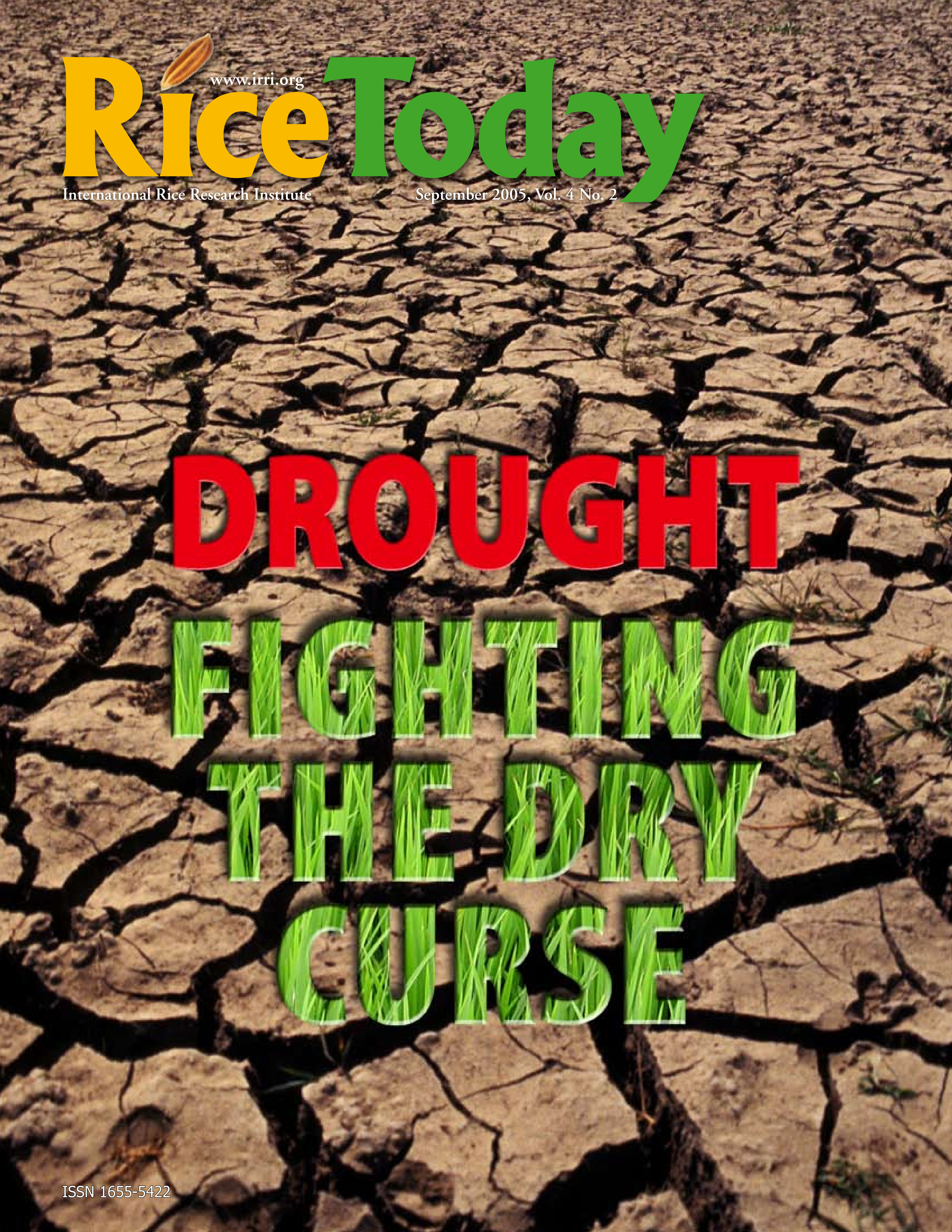

DROUGHT

FIGHTING THE DRY CURSE

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contents

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cover design **George Reyes, Juan Lazaro IV**

publisher **Duncan Macintosh**
editor **Adam Barclay**
art director **Juan Lazaro IV**
designer and production supervisor **George Reyes**
deputy editor **Leharne Fountain**
contributing editors **Gene Hettel, Bill Hardy**
news editor **Juanito Goloyugo**
photographer **Ariel Javellana**
circulation **Chrisanto Quintana**
printer **Primex Printers, Inc.**

International Rice Research Institute
DAPO Box 7777, Metro Manila, Philippines
Web (IRRI): www.irri.org
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: a.barclay@cgiar.org

Rice Today is published by the International Rice Research Institute (IRRI), the world's leading international rice research and training center. Based in the Philippines and with offices in 11 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. IRRI is one of 15 centers funded through the Consultative Group on International Agricultural Research (CGIAR), an association of public and private donor agencies. For more information, visit the CGIAR Web site (www.cgiar.org).

A TIME OF REVOLUTION

The last revolution in rice research and production is close to 40 years old. The now-famous Green Revolution began in the 1960s with the release in Asia of the first modern high-yielding rice variety, developed at the Philippines-based International Rice Research Institute (IRRI). This advance, and the regional food security it guaranteed, laid the foundations for the economic revolution that transformed Asia in the 1980s and 1990s. Never have more people been lifted out of poverty in such a short period of time.

Now, the international rice industry stands on the threshold of not one but multiple revolutions in rice production and consumption. First and foremost is the gene revolution sparked by the recent sequencing of the rice genome — meaning that scientists, for the first time ever, have the chance to truly unmask the genetic secrets that dwell inside the rice plant and determine how it grows and produces its grains. Most exciting of all, this new knowledge is only the beginning; intertwined with this looms a revolution in rice nutrition. Researchers are on the cusp of developing rice that is rich in essential nutrients such as vitamin A, iron and zinc, and which has the potential to improve the lives of millions of malnourished poor across the globe.

Next is a global upheaval in rice consumption. As economic growth and development in Asia lead to more diverse diets, consumption patterns are changing. But, as population growth continues, so demand will grow. Meanwhile, the crop's popularity in other parts of the world — particularly Africa — is steadily increasing.

And that's not all. Rice production in Asia faces challenges not seen since the population explosion in the 1950s brought about the first Green Revolution. The region is staring at the prospect of massive land and water shortages as increasing urbanization and industry compete for dwindling resources. And as rice farmers put down their tools to look for better lives in the cities, there may soon be too few farmers to grow enough rice for people to eat. Hovering behind these problems is climate change. Its effect on rice production is yet to be seen, but the signs are ominous.

Finally, there is an ongoing revolution in intellectual property and plant variety rights. Ten years ago, few countries had laws to protect their unique rice varieties; now, almost every nation in Asia has introduced such legislation and some are already firmly enforcing it.

This is a time of enormous change for rice — the food that helps feed almost half the world each and every day. In the face of these formidable challenges and an ever-growing avalanche of information, how can anyone hope to stay informed?

As the pace of change accelerates, it is our hope that *Rice Today* will help its many readers stay in touch with the rice revolutions that are already transforming the world's most important food supply.

Duncan Macintosh
Publisher

PS: *Rice Today* welcomes letters and articles from its readers, but makes no commitment for their return or publication. Please send correspondence to Adam Barclay.

Email: a.barclay@cgiar.org
Airmail: International Rice Research Institute (IRRI)
DAPO Box 7777, Metro Manila, Philippines
Fax: (632) 580-5699

The web of rice

Search for "rice" on the Internet and you'll get around 40 million results. Among this multitude of Web pages, there are plenty on the staple grain that feeds over 3 billion people. But to find them, you'll have to navigate around pages discussing U.S. Secretary of State Condoleezza Rice's latest foreign policy comments, the research coming out of Rice University, and tribute pages to author Anne Rice, among many others. So how can you find the best resources about rice on the Web? In short, how do you separate the rice from the chaff? Checking out the Web pages featured here is a good start.

Learn about rice

The U.S. Rice Producers Association has created Rice Romp (www.riceromp.com; pictured at right) for teachers and students. Although it focuses on rice production in the USA, it also contains more widely relevant information. The site offers games and learning modules, and students can select their school level from kindergarten through to final-year high school. There is a choice of study areas covering mathematics, science, health and social studies. After completing all the study areas for a given school level, students are ready to play Rice Rampage, a rice trivia game. The site also contains teaching resources for each study area, across all school grades.

Rice collaborations

The Internet is a natural place for scientists to collaborate in rice research by sharing resources and information and making their research available to others. The Rice Rise Information System (http://rise.genomics.org.cn/rice/), hosted by the Beijing Genomics Institute, houses up-to-date, integrated information resources for rice genomes. Other sites offering researchers similar analytical tools and data include TIGR Rice Genome Annotation (www.tigr.org/tdb/e2k1/osa1), hosted by the Institute for Genomic Research, and the Korea Rice Genome Database (http://bioserver.myongji.ac.kr/ricemac.html).

Rice industries

For the latest news on rice prices, market conditions and the world rice industry, check out Oryza.com (www.oryza.com). The site provides daily market information and instant news updates, and has features to help industry participants connect with the world rice community. There are forums on a range of topics from trends in the rice milling industry to new technologies and research in farm management. Other features include an industry calendar, statistics and an extensive glossary of rice terminology. Another industry site, Rice Online (www.riceonline.com) contains information on rice prices, industry news and a searchable industry directory.

Rice industry sites from a range of countries offer information about the environments and conditions of rice production around the world. These include the USA Rice Federation (www.usarice.com), California Rice Research Board (www.carrb.com), and the Australian Rice Growers Association (www.rga.org.au). Rice Farming magazine (www.ricefarming.com) provides articles about research and industry news relevant to rice farmers in the USA.

Rice and development

The Association of South East Asian Nations (ASEAN) plus China, Japan and Korea has formed the East Asia Emergency Rice Reserve (www.eaerr.org) to provide food aid for assistance in disaster areas and to alleviate poverty. The United Nations Convention on Trade and Development hosts a Web site that houses economic information about a number of commodities and crops, including rice. The site offers a synopsis of international market and rice policies of the main rice exporters and importers at http://r0.unctad.org/infocomm/anglais/rice/ecopolicies.htm.

And of course — don't forget the International Rice Research Institute's own site, www.irri.org. Also see www.irri.org/science/links.asp for links to the Web sites featured here plus many more.

Long live the International Year of Rice

The International Year of Rice 2004 (IYR) saw an explosion of Web-based resources centered on rice. Although IYR has passed, its message is as relevant as ever. The Food and Agriculture Organization of the United Nations, official home to IYR, continues to host its IYR Web site at www.fao.org/rice2004. The site covers information on culture, nutrition, livelihood, economics, science and gender. There are interesting facts about rice for kids, rice recipes from around the world and stunning photos from the IYR global photography contest: "Rice is Life."

The Global Education Web site (www.globaleducation.edna.edu.au) provides teaching resources on a number of global issues, including rice. Follow the homepage link to "Rice" for information about IYR plus a range of teaching modules. Teachers on the Web host an IYR site (www.teachers.ash.org.au/jmresources/rice/year.html) that contains links to pages on growing rice, history of rice, nutrition and rice around the world, as well as lesson plans, quizzes and games. Australia's EdNA online houses an IYR page (www.edna.edu.au/edna/page2394.html) that has links to numerous IYR and general rice Web sites.

Milestones in rice research


Blast-affected rice plants

NANCY CASTILLA (2)

It's been an extraordinary few months for rice research as scientists continue to unravel some of the secrets of the staple that feeds half the world. The finalized sequence of the complete rice genome was scheduled to be published just after *Rice Today* went to press in August, helping to further open the door to improved rice varieties that can better help the poor and hungry. Other significant advances include a new version of Golden Rice with much more beta-carotene — the building block of vitamin A — and the sequencing of the rice blast genome.

Five years ago, many hailed the discovery of the original strain of golden rice as a breakthrough for the estimated 500,000 children around the world who go blind each year because of vitamin A deficiency. However, the rice contained insufficient beta-carotene to meet children's vitamin A requirements.

The April 2005 issue of *Nature Biotechnology* reported that Syngenta scientists have now developed a new strain of Golden Rice that contains around 20 times more beta-carotene. The achievement came through replacing the daffodil gene originally added to Golden Rice with a counterpart gene found in maize. Syngenta is making the technology freely available to public research institutions in developing countries.

Despite strong enthusiasm from many quarters, concerns about biotechnology and genetically modified foods continue to be raised. A report by BBC environment correspondent Richard Black stated that, "Not everyone believes golden rice is the best answer to Vitamin A deficiency. Some agricultural experts and environmental groups say aiming for a balanced diet across the board would be a better solution."

But the Golden Rice Humanitarian Board, which oversees developments in the plant's technology, emphasized that the crop was never intended to be the sole solution to vitamin A deficiency and that Golden Rice could contribute to a better overall diet.

Researchers now have invaluable new information in the battle against the rice fungal disease known as rice blast (*Magnaporthe grisea*) following the sequencing of its genome by a team of scientists led by Ralph Dean of North Carolina State University, heading the International Rice Blast Genome Consortium. Rice blast, considered one of the most destructive diseases of rice, can completely wipe out young seedlings and destroy grain in older plants.

Soap opera wins World Bank prize


CGIAR

A radio-based environmental education program has been awarded one of 31 World Bank Development Marketplace Awards for 2005. Developers of the Environmental Radio Soap Opera for Rural Vietnam project, IRRI's K.L. Heong and Monina Escalada (pictured *above* receiving the award from then World Bank President James Wolfensohn), along with Nguyen Huu Huan of the Vietnam Ministry of Agriculture and Rural Development, and Vu Huu Ky Ba of the Voice of Ho Chi Minh, were awarded the prize at a May 25 ceremony in Washington D.C.

The new environmental radio program will build on the success of earlier IRRI-led radio projects (see www.irri.org/radio) and will promote environmental sustainability in rice ecosystems using entertainment-education principles. More than 100 new episodes will feature environmental health in rice ecosystems, including soil health, crop residue management, natural biological control conservation and reduction of farm chemicals. The project team will join social scientists, ecologists and creative writers to create an informative, entertaining and motivational radio soap opera. The program's messages will be reinforced through activities such as local competitions, printed materials and video, ultimately expanding the radio audience to 10 million farm households.

"This project will establish a unique platform for partnerships between and among scientists, creative writers and extension staff to develop stories that will motivate farmers to use environmental best practices," said project leader Dr. Heong.

The prize includes US$131,800 to support project implementation. The win was also reported in the 9 June issue of *Nature* in a story titled "Soap opera reaps prize for its clean message."

Research offers drought hope

LEHARNE FOUNTAIN

New research funded by the Rockefeller Foundation and conducted by IRRI on the impact of drought in rural India is one of the first major efforts to fully understand the economic consequences of drought in Asia, especially in relation to rice. The research results, detailed in the report *Economic costs of drought and rainfed rice farmers' coping mechanisms in eastern India*, coincided with severe drought in several Asian countries.

IRRI Director General Robert Zeigler noted that despite drought's devastating economic and social costs, drought-alleviation research is relatively underfunded. He points out that, despite this, public rice research in Asia is developing a range of new technologies and strategies to help poor farmers combat drought.

"What we need to do now is make sure these technologies get fully developed and reach the farmers who need them so they will have a better chance of avoiding the poverty and hardship drought can so easily cause," said Dr. Zeigler.

Drought-fighting approaches include new rice varieties that are better adapted to dry conditions and new irrigation water, soil fertility and weed management strategies. For more on drought, see *Dreams beyond drought* on pages 14-21.

Tsunami damage less than expected

Lands inundated with salt after last December's Indian Ocean tsunami are recovering faster than expected, according to a recent study by the United Nations Food and Agriculture Organization (FAO). Despite fears that the salt-logged lands would remain unsuitable for most types of cultivation in the long term, the FAO survey shows that 81% of the 47,000 hectares of agricultural land damaged by tsunami waves in Indonesia, Sri Lanka, Maldives, India and Thailand can be used for cultivation this year.

But Daniel Renault, FAO coordinator for agriculture in tsunami-affected countries, warns that other problems still threaten farmers' livelihoods. An Associated Press report quotes him as saying that, "Many fields have been covered by soil sediment and trash and have been damaged by massive soil erosion. In addition, there is a shortage of labor for cleaning and cultivating fields. Many farmers also lack capital and tools to resume production."

Meanwhile, the tsunami prompted the International Crops Research Institute for the Semi-Arid Tropics and the M.S. Swaminathan Research Foundation to join forces. The institutes are screening crop varieties for salt tolerance, selecting varieties through community participation, establishing local seed banks, and rehabilitating tsunami-affected soil and water systems. IRRI has also provided seeds of salt-tolerant rice varieties that have been held in the institute's International Rice Genebank.

MARK BELL

Tsunami-affected land in Sri Lanka

Drought inflicts a heavy toll

Media reports earlier this year brought news of drought-stricken countries across Asia. Several news agencies, including Bloomberg and Agence France Press, reported that half a million people in Cambodia are struggling with food shortages due to prolonged drought. An April report by Indian online news service Kerala Next quoted Ta Mom, chief of Paing Lovea village in one of the kingdom's hardest hit provinces, as saying that, "The drought is so bad these last months that we have lost our entire harvest. It's a disaster."

Also quoted was World Food Program Country Director, Thomas Keusters. Expressing concern over the drought's long-term consequences, Keusters reportedly said that "...more people die of hunger than of AIDS, T.B. and malaria combined. So there is no doubt that if the people are in a poor nutritional status, they are much more vulnerable to all sorts of illnesses."

Vietnam's Thanh Nien News reports that rice crop area in the country's Mekong Delta is set to be reduced by more than 130,000 hectares due to drought. Deputy Agriculture Minister Bui Ba Bong is quoted as saying that, "the coming summer-autumn crop in the Mekong Delta is very important, much more than in previous years."

A story from news agency Reuters quoted a report on drought in the *China Daily*. "Vast stretches of cropland are desperately parched due to inadequate irrigation from dry rivers and reservoirs," said the newspaper. Drought in China has reportedly left more than 9 million people facing drinking-water shortages.

Meanwhile, the Associated Press brought news of a less conventional attempt to tackle drought. Female rice farmers in southwestern Nepal are reportedly plowing their fields at night in the nude to please the rain god. A 35-year-old farmer, Ambika Tharu, was quoted by the *Himalayan Times* newspaper as saying, "My mother-in-law said the god would be pleased and make rainfall if women till the land naked."

ICAR

MANGALA RAI (*left*) and Robert Zeigler, directors general of, respectively, ICAR and IRRI, sign the new workplan agreement in June.

IRRI-India workplan

The Indian Council of Agricultural Research (ICAR) has entered into a new workplan agreement with IRRI to support and facilitate its national rice research efforts over the next 3 years. The agreement focuses on genetic enhancement or the development of improved rice varieties, natural resource management focusing on environmental sustainability, and training and technology transfer. The agreement aims to make the latest technologies and ideas easily available to India's rice farmers and ensure that other rice-producing countries benefit from the best Indian research.

Some of the new technologies that IRRI has been working on with ICAR and other partners in Asia include the development of a submergence-tolerant version of the popular Indian rice variety Swarna; the development of rice varieties with improved levels of nutrition, including rice with higher levels of vitamin A; new fertilizer strategies for farmers; and the continuing development of the Indian version of the Rice Knowledge Bank, the world's first digital extension service for farmers and extension workers.

Climate change pessimism

A study presented at the UK's Royal Society in April painted a gloomy picture for the effect of climate change on food production. The paper, presented by a team from the University of Illinois Departments of Plant Biology and Crop Sciences, states that "current projections of global food security under the global atmospheric change anticipated for the second half of this century are likely over-optimistic."

Newly developed technology allowed the researchers to test the effect of global warming and elevated carbon dioxide (CO_2) levels on open-air crop areas much larger than had previously been possible using contained chamber studies. Chamber studies, which are known to be unreliable, had predicted that the yield-boosting effects of more CO_2 would to some extent offset the yield-reducing effects of higher temperatures. However, the study results showed that for the world's major staples — rice, maize, wheat and soybean — the yield increase due to CO_2 was only half as great as earlier chamber studies had shown.

Team member Steve Long was reported by *New Scientist* as saying that, "We need to seriously re-examine our predictions of future global food production," adding that crop output is "likely to be far lower than previously estimated."

Long road to genetically modified rice commercialization

Commercialization of genetically modified (GM) rice in China has again featured prominently in recent news reports, with the country field-trialing three types of GM rice that are candidates for commercialization.

Although no varieties have been given the commercial go-ahead, the *South China Morning Post* (*SCMP*) reported on 9 July that "mainland farmers are continuing to grow GM rice against both Chinese law and the advice of concerned critics."

The *SCMP* quoted farmer Tian Zihai of Hubei province, who claims he grows about 0.7 hectares of GM rice a year, selling some and saving the rest for his family to eat. "I have eaten it for 4 years with no problem at all," he reportedly said.

The article recalled a December 2004 *Newsweek* report that quoted Zhang Qifa of the Chinese Academy of Agricultural Sciences and Central China's Huazhong Agricultural University, who conducted China's largest field trials on GM rice. Professor Zhang reportedly said that farmers living near the GM test areas in Hubei grew and ate such rice without any side effects and that a local company sold GM rice seed to local farmers. This prompted Greenpeace to launch an investigation, collecting rice samples and sending them to Germany's GeneScan laboratory for testing. According to Greenpeace, the tests proved the rice was identical to the rice researched by Professor Zhang.

The article went on to say that the Chinese Ministry of Agriculture refused to accept the test results. Its biosafety office vice director, Fang Xiangdong, reportedly called for extreme caution, emphasizing that legal action would be taken in the face of "concrete evidence."

Meanwhile, the *New York Times* reported on 16 April the concerns of some Chinese growers and foreign specialists over the selling of GM rice on the open market in China's Wuhan region and in small villages in Hubei province. The paper quoted a Greenpeace spokesperson as saying, "If biotech rice has found its way into the food system here, China has become the first place in the world where a major crop, in this instance rice, is being directly consumed by humans — and without regulatory approval."

Chinese rice consumption

China is tapping its state reserves to address its rice supply shortfall during the 2005-06 marketing year. In its June rice market monitoring report, the Ministry of Agriculture indicated that the demand for rice outstripped supply despite a recovery in production in the previous marketing year. The ministry is optimistic that China's 2005 rice acreage will increase as farmers are expected to step up their rice planting due to a minimum purchase price policy.

Early China boosted by rice?

Archaeological evidence uncovered in northern China suggests rice and maize — not only millet, as earlier thought — were important sources of food in early China. The discovery was made by anthropologists from the University of Toronto, who believe the successful cropping combination was the likely stimulus for rapid growth in the earliest cities in northern China, starting as far back as 2400-2000 B.C. Lead anthropologist Gary Crawford claimed that the early rice production, in combination with millet and wheat, could help explain the foundation of China's current huge population.

ALLIANCE GETS ROLLING: Three initiatives will pave the way forward for the new Alliance between IRRI and the International Maize and Wheat Improvement Center. The initiatives are: a new joint program for intensive farming systems in Asia; a single unified crop information system for rice, wheat and maize — a new integrated cereal informatics center; and an integrated cereal systems knowledge-sharing portal for extension workers and national programs. Each activity reflects a continuum from basic research to practical applications. The Alliance also emphasizes the complementarities of maize, rice and wheat in profitability, nutrition, genomics and farming systems. Participants at an Alliance meeting at IRRI in April are pictured at *right*.

BOGGS PANALIGAN

Accolades for hybrid pioneer

Recently retired IRRI principal scientist and plant breeder Sant Virmani is widely recognized for his role in the development and dissemination of hybrid rice technology throughout tropical Asia. In recognition of this, he has been awarded the 2005 Monsanto Crop Science Distinguished Career Award from the Crop Science Society of America, to be presented in September.

Dr. Virmani was also recognized by the Government of India during the 40th Rice Research Group Meeting on 6-8 April in Bangalore and by the Indian Seeds Industry Association and Seedsmen Association at a 13 April ceremony held at the Acharya N. G. Ranga Agricultural University in Hyderabad.

At the 3rd national Workshop on Hybrid Rice, held on 7 June in Manila, the Philippine Department of Agriculture gave Dr. Virmani a plaque of gratitude for more than 25 years spent developing hybrid rice technologies suited to the Philippines.

Following his retirement, Dr. Virmani planned to continue at IRRI as a consultant under the project "Sustaining Food Security in Asia through the Development of Hybrid Rice Technology," from 6 July to 31 August. To learn more about his distinguished career and discover the ups and downs that mark the history of hybrid rice in the tropics, see *A hybrid prioneer* on pages 28-31.

Hybrid happenings

Agricultural policymakers, researchers and scientists from 13 countries, plus representatives from the Asian Development Bank (ADB), the Food and Agriculture Organization of the United Nations, IRRI, nongovernment organizations and the private sector converged at the ADB headquarters on 6-8 June for the "Regional Workshop for Development and Dissemination of Hybrid Rice Technology."

Workshop participants discussed key results achieved so far and the challenges faced by hybrid rice programs in improving food security in Asia. Also considered were the roles of government policies, public-private sector partnerships and promotion of hybrid rice technology.

The 3rd Philippine National Workshop on Hybrid Rice was held in Manila on 7-9 June. Focusing on the theme *Harnessing Hybrid Rice Technology through Policy Advocacy*, the workshop determined policy directions in sustaining the use of hybrid rice in the Philippines.

Hybrid rice is already grown on more than half a million hectares across five states in India. The area is this year expected to rise to 0.8 million hectares, according to a report on the rice industry Web site Oryza.com. Hybrid rice seed production generates an estimated $118 million in annual revenue and yields obtained from hybrid varieties are 1-1.5 tons per hectare higher than nonhybrid varieties.

New digital chlorophyll meter to help optimize fertilizer

Kwang-Ho Park of the Korea National Agricultural College in Seoul has developed a new digital chlorophyll meter (*pictured*) that will allow researchers, extension workers and farmers to precisely measure a rice field's total nitrogen content and recommend the amount of urea to be applied. Excess application of nitrogen can cause plants to lodge (fall over) and can lead to environmental pollution and pest infestation. The new device can also be applied to vegetables and fruits.

SHAOBING PENG


IRRI

Former IRRI director general passes away

Robert D. "Bob" Havener, IRRI interim director general in 1998, passed away on 3 August at his California home, aged 75. Although his 8-month stay at IRRI was only brief, he had a big impact, steering the institute through a difficult period and winning the hearts of its staff. Mr. Havener (pictured *above right* in 1998 with, *from left*, then Head of Public Awareness Robert Huggan, Head of Communication and Publications Services Gene Hettel and then Deputy Director General for Research Ken Fischer) was a champion of international agricultural research, having devoted more than 50 years of his life to agriculture for development. He also worked as interim director general of the International Center for Tropical Agriculture in 1994-95 during a time of crisis. In 1978-85, he was director general of the International Maize and Wheat Improvement Center, which, under his leadership, became recognized as the leading center in its field.

At a memorial service on 8 August at IRRI, Director General Robert Zeigler gave a moving tribute, noting that one of the many things Mr. Havener will be remembered for is his effort in establishing the International Center for Agricultural Research in the Dry Areas (ICARDA) in the 1970s.

"He is seen as the founding father of ICARDA," said Dr. Zeigler, "and revered throughout the Middle East as someone with great compassion and commitment to the region, and someone who has made a great contribution."

BRIEFLY

Sturdier rice plants

Scientists in Japan and China have developed a rice plant that better resists lodging (falling over) in bad weather. Motoyuki Ashikari of Nagoya University and Hitoshi Sakakibara of the Plant Science Center in Yokohama discovered that plants containing a gene that expressed low levels of a particular enzyme produced 23-34% more grains per plant than control plants. More seeds, however, can make plants top-heavy and susceptible to lodging. The scientists combined plants that produced more grains with those that had a gene favoring shorter plant height. The paper, published in the 24 June issue of *Science*, also explains that the scientists' genome-scanning approach could be used to identify genes for disease resistance and stress tolerance.

Successful project shines on

Bangladeshi nongovernment organization AID-Comilla has secured funding from the US Agency for International Development's Integrated Pest Management Collaborative Research Support Project to continue the work of the IRRI-led Livelihood Improvement Through Ecology (LITE) project. LITE showed that applying insecticide to rice fields was essentially a waste of time and money and led to thousands of Bangladeshi rice farmers eliminating insecticide use and reducing their fertilizer applications to optimal levels. Unsprayed crops had the same or greater yields than sprayed crops, and farmers saved money and reduced harm to their health and the environment (see *Reason to cheer* on pages 12-17 of *Rice Today* Vol. 3, No. 4).

Environmental Agenda on the web

IRRI has launched the BETA version of its Environmental Agenda Web site, GreenRice.net, which will provide a wide range of communication tools and access to information about rice and the environment. Users can register to receive updates and can send comments to the site development team. The site also showcases the IRRI Environmental Agenda's seven key areas of concern: poverty and environment, farm chemicals and residues, land use and degradation, water use and quality, biodiversity, climate change, and use of biotechnology. Visit the site at www.greenrice.net.

New CGIAR donor

Malaysia has become the newest donor to the CGIAR, starting this year with an initial contribution of US$300,000 to the International Plant Genetic Resources Institute, the WorldFish Center and IRRI. Malaysia's funding to IRRI will help support research activities in crop improvement and the environmental sustainability of rice production systems.

Environment and livelihood

More than 150 people from 20 countries attended an international conference on Environment and Livelihoods in Coastal Zones on 1-3 March in Bac Lieu, Vietnam. IRRI, the International Water Management Institute (IWMI), the WorldFish Center, Can Tho University, and the People's Committee

Keeping up with IRRI staff

The China Jillian University in Hangzhou has appointed IRRI entomologist **K.L. Heong** as visiting professor to the University's School of Life Sciences. Dr. Heong will work with the School's Dean, Professor Yu Xiaoping, to develop new curricula and research themes that will focus on environment and sustainable development.

Philippe Herve recently joined the Plant Breeding, Genetics and Biotechnology (PBGB) Division. He comes to IRRI from Crop Design, in Belgium, where he worked as a plant and cell biotechnology project leader.

Rakish Kumar Singh has joined PBGB as an international research fellow to work on the salinity project and research funded by the Challenge Program on Water and Food.

Grant Singleton of Australia's Commonwealth Scientific and Industrial Research Organisation has been selected as the new Irrigated Rice Research Consortium coordinator. He was scheduled to begin work at IRRI in September.

Nobuya Kobayashi has joined PBGB to take on responsibility for the IRRI-Japan Collaborative Research Project.

Economist **Deborah Templeton**, who previously worked at the Australian Centre for International Agricultural Research, has joined the Social Sciences Division along with **Kumi Yasunobu**, who comes to IRRI from Japan.

Recently joining IRRI as postdoctoral fellows are **Xuemei Ji** (PBGB), **Bert Collard** (PBGB) and **Chitra Raghavan** (Entomology and Plant Pathology Division).

Entomologist **Gary Jahn** has moved to Laos to serve as IRRI's new project manager for the Swiss Agency for Development Cooperation-funded Lao-IRRI Rice Research and Training Project. He will also act as IRRI representative and coordinator for the Greater Mekong Subregion and has taken over management of the Asian Development Bank-funded Linking Extension and Research Needs with Information Technology (LEARN-IT) Project, which will build electronic linkages between regional research and extension agencies.

International Research Fellow **M. Zainul Abedin** (SSD) is now based in Ethiopia as a farming systems specialist.

International Programs Management Office and the Training Center Head **Mark Bell** has left for Davis, California, along with spouse **Renee Lafitte,** crop physiologist in the Crop, Soil and Water Sciences (CSWS) Division. Dr. Lafitte has taken up a job in the private sector after 8 years working on drought research at IRRI. Dr. Bell, who continues to act as a consultant to IRRI's Rice Knowledge Bank, also received on April 20 a Gratitude Plate from the Rural Development Administration of Korea for his outstanding contributions to the Training Workshop on Rice Technology Transfer Systems in Asia.

Swapan and **Karabi Datta** (PBGB) depart having both advanced rice biotechnology during their time at IRRI.

Matthias Wissuwa, international research fellow in CSWS has moved to Tsukuba, Japan, to work at the Japan International Research Center for Agricultural Science. Dr. Wissuwa made invaluable contributions to the understanding of the molecular and physiological bases of nutrient deficiency tolerance in rice.

Departing postdoctoral fellows are **Devendra Dwivedi** (PBGB) and **Humnath Bandari** (SSD). Dr. Bhandari has since returned to SSD as a visiting research fellow.

Martin Kropff, IRRI agronomist and crop modeler in 1990-94, has been appointed rector of Wageningen University, the Netherlands. Prior to his appointment, which was scheduled to begin in September, Dr. Kropff was chair of the Crop and Weed Ecology Group and director general of the University's Plant Sciences Group.

Also...

Modadugu Gupta, Assistant Director General (International Relations and Partnerships) of the WorldFish Center in 2003-04, is the winner of the 2005 World Food Prize. WorldFish is, along with IRRI, one of the 15 centers that make up the Consultative Group on International Agricultural Research.

of Bac Lieu cosponsored the conference, which focused on the management of inland coastal zones affected by salinity intrusion, with emphasis on conflicting resource uses. About half the world's population depends on coastal resources for industry, trade, recreation and their livelihood. Participants also recognized the importance of protecting coastal zones from shock events like the December 2004 Indian Ocean tsunami.

Managing rice landscapes

Participants from India, Laos, Nepal and Vietnam met with representatives from the International Fund for Agricultural Development (IFAD) and IRRI on 18-20 April for the inception and planning workshop on the IFAD-supported project on "Managing rice landscapes in marginal uplands for household food security and environmental sustainability." The project aims to improve the livelihood of upland farmers while conserving fragile natural resources through identifying, validating and disseminating improved rice-based agricultural technologies suited to upland farmers' diverse livelihood strategies.

Rice technology transfer systems

The Rural Development Administration (RDA) of Korea and IRRI signed a Letter of Agreement on 20 April, formally extending until 2009 the two organizations' existing collaboration in implementing the Training Workshop on Rice Technology Transfer Systems in Asia — the first of its kind in the region. This year's course is scheduled for 4-17 September at the RDA campus in Suweon, Korea. RDA provides funding support for all participating national agricultural research and extension systems while IRRI provides course materials, key resource people and facilitators.

Money for Africa

The IRRI Board of Trustees is allocating up to US$1 million to support the Institute's strategic initiatives in certain key areas and countries, with the first priority being the development of a major program in Africa. IRRI Senior Scientist Vethaiya Balasubramanian will be IRRI's Africa Coordinator.

Future collaboration

IRRI and Australia's Charles Sturt University, signed a Memorandum of Understanding on 25 April. IRRI became an affiliate institute of the university, setting the stage for future collaboration in rice research and training.

Asian labor out-migration

Trends in Asian modernization have found men taking advantage of the growing job market in the rural nonfarm economy. As a result, women are being left behind to manage the farms. This observation surfaced when participants from Australia, Bangladesh, India, Indonesia, Thailand, Vietnam and the Philippines met at a 26-27 April conference at IRRI on "Impact of labor out-migration on rice household economy with emphasis on gender issues". Led by IRRI Gender Specialist Thelma Paris, the conference focused on the prevalence and

Achievements

IRRI Deputy Director General for Partnerships **William Padolina** has been awarded the prestigious 2005 ASEAN Science and Technology Meritorious Service Award. The award, which Dr. Padolina was scheduled to receive on 11 August, recognizes Association of South East Asian Nations (ASEAN) senior officials and administrators for their efforts and significant contributions toward the promotion and development of regional cooperation in the scientific and technological fields and the upgrading of regional, scientific and technological capabilities.

Two entries with IRRI ties won major awards in a "success story" competition sponsored by the Swiss Agency for Development and Cooperation (SDC) for countries in its East Asia Division. *Three Reductions, Three Gains — Program to improve environment and livelihood of millions of rice farmers in Vietnam* received 2nd prize and *Genuinely Lao — the story of the project that revolutionized rice production in Laos* (pictured at *right*) won 3rd prize. You can read them at www.irri.org/media/impact/three1.asp and www.irri.org/media/impact/laos1.asp, respectively.

For his 33 years of outstanding volunteer efforts and service, IRRI Communication and Publications Services Head **Gene Hettel** received the 2005 Service Award of the U.S.-based Association for Communication Excellence in Agriculture, Natural Resources, and Life and Human Sciences during its annual meeting in San Antonio, Texas, in June.

The Philippine Society of Agricultural Engineers (PSAE) named IRRI Associate Scientist **Ruben Lampayan** as 2005 Outstanding Filipino Agricultural Engineer in the field of Irrigation Research and Development during the 55th PSAE Annual National Convention in General Santos City in April.

IRRI Senior Scientist **Thelma Paris** received the Honorary Fellow Award from the Federation of Crop Science Societies of the Philippines (FCSSP) during its 18th Scientific Conference held in Cagayan de Oro City in May. IRRI Assistant Scientist **Marianne Samson** won the conference's best paper competition in the downstream research category. *Benefits of real-time N-fertilizer management during four years in two long-term experiments* was coauthored with E.V. Laureles, W.M. Larazo and R.J. Buresh from IRRI and H.C. Gines from the Philippine Rice Research Institute (PhilRice).

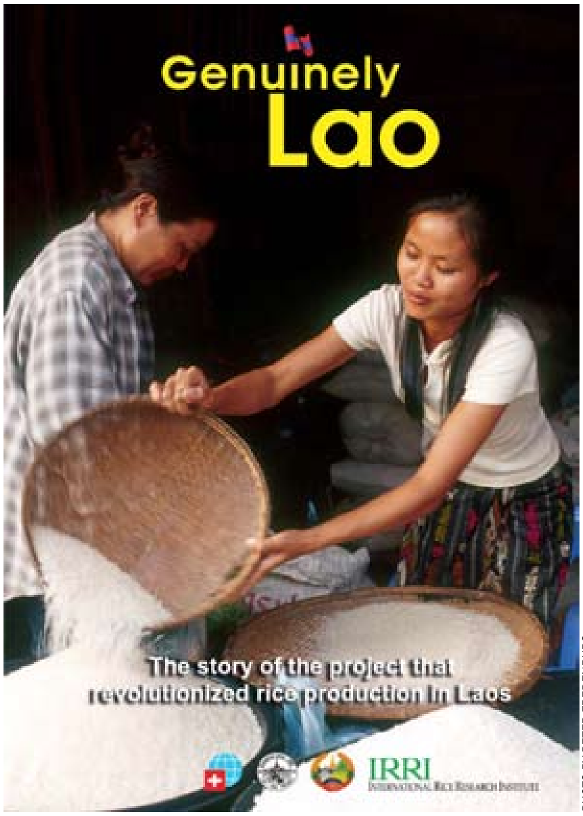

PHOTO BY PETER FREDENBURG

Assistant Scientist **Teodoro Migo** won the Best Paper Award (weed science) at the Pest Management Council of the Philippines Conference at PhilRice, Nueva Ecija, in May. The paper *Response of lowland rice weeds to submergence and the effect of herbicide dose* was co-authored by O.S. Namuco, A.M. Mortimer and D.E. Johnson.

BRIEFLY

patterns of labor out-migration and their impact on livelihood, rice farming efficiency and gender roles.

Sri Lankan rice self-sufficiency

A recent report in Indian newspaper *The Hindu* quoted Sri Lankan Agriculture Minister Anura Kumara Dissanayake's announcement that Sri Lanka has become self-sufficient in rice production. The minister reportedly said that the country's per-hectare productivity had increased from 3.82 to 4.1 tons, thanks to innovative measures such as the revival of an age-old irrigation system, returning abandoned land to cultivation, and supplying quality inputs and subsidized fertilizers to farmers. Sri Lanka previously imported rice from India, Pakistan and Vietnam.

Unfavorable rice environments

Eighty participants from national agricultural research and extension systems (NARES) and IRRI met on Lombok Island, Indonesia, on 24-27 May for the "Fourth Annual Steering Committee Meeting of the Consortium for Unfavorable Rice Environments." The meeting served as the key policy-making and agenda-setting forum for IRRI's research partnership with NARES institutions that are conducting research in the unfavorable rainfed ecosystems. The consortium is engaged in a 3-year program of collaborative research with NARES partners through the Asian Development Bank's Regional Expertise Technical Assistance program.

Private collaboration

IRRI and the India-based Mahyco Research Foundation (MRF) signed a Memorandum of Agreement on 27 June. MRF is a private research and development foundation founded by Maharashtra Hybrid Seeds Company Limited (Mahyco). Established in 1964, Mahyco focuses on plant genetic research and hybrid rice seed production. The memorandum covers collaboration in the areas of functional genomics for brown planthopper resistance, capacity building through human resource development and training for marker-assisted selection, and exchange of germplasm.

Rice policy strategy for West Africa

Experts from Burkina Faso, Mali, Nigeria, Niger, the Economic Community of West African States and the Africa Rice Center (WARDA) have agreed to form a rice policy research and advocacy platform that will help develop policies to promote the region's rice sector as well as develop and implement a common agenda for rice policy research. They will also develop multicountry project proposals based on regional research priorities and jointly source funds to carry out the projects. The experts agreed that local rice would never become competitive unless favorable and consistent policies and effective institutional arrangements are developed and implemented across the region.

Paving the way forward through research

by Katharina Jenny

The driving policy and guiding principles of the Swiss Agency for Development and Cooperation (SDC) aim to help partner countries overcome endemic poverty and to achieve food security and environmental sustainability. To manage this support efficiently, SDC promotes growth among the most disadvantaged groups in society by helping them improve production, manage environmental problems and provide better access to education and basic health care. We recognize that the focus of development today is on achieving community-level impact through better-harmonized programs and procedures, and actively assessing impacts against the aims of the United Nations Millennium Development Goals and World Bank Poverty Reduction Strategies.

SDC's key mandate is to improve the living conditions of the rural poor, who represent 80% of the world's 850 million chronically or acutely malnourished people. This mission involves advancing sustainable agriculture for food security, livelihood improvement and pro-poor growth. The major challenge ahead will be to meet growing food demand with limited land resources, and without sacrificing natural habitats or causing further deforestation and loss of biodiversity.

New approaches to agriculture confront producers in an increasingly liberalized market, in which there is unequal access to assets and limited participation in decision-making. SDC believes research and knowledge can pave the way forward.

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We recognize that the agricultural sector will grow and improve its efficiency only if research delivers appropriate results along with practical and locally adapted solutions.

Within this focus, SDC supports the International Rice Research Institute (IRRI) and other Consultative Group on International Agricultural Research (CGIAR) centers, and has been an active member of the group since its inception. The CGIAR's research is one important link in a chain of knowledge generation for development. SDC's support for agricultural research goes hand-in-hand with building capacity in human resources and strengthening institutions. This support is based not only on the research focus, but also on whether appropriate partnership arrangements and implementation mechanisms exist. And while we do not try to turn research institutions into development agents, we believe the targets of research — the poor and disadvantaged — must always remain in sight. Research for development is about exchanging knowledge and building ownership, and this requires focused, proficient partner institutions that are dedicated to improving life for the poor.

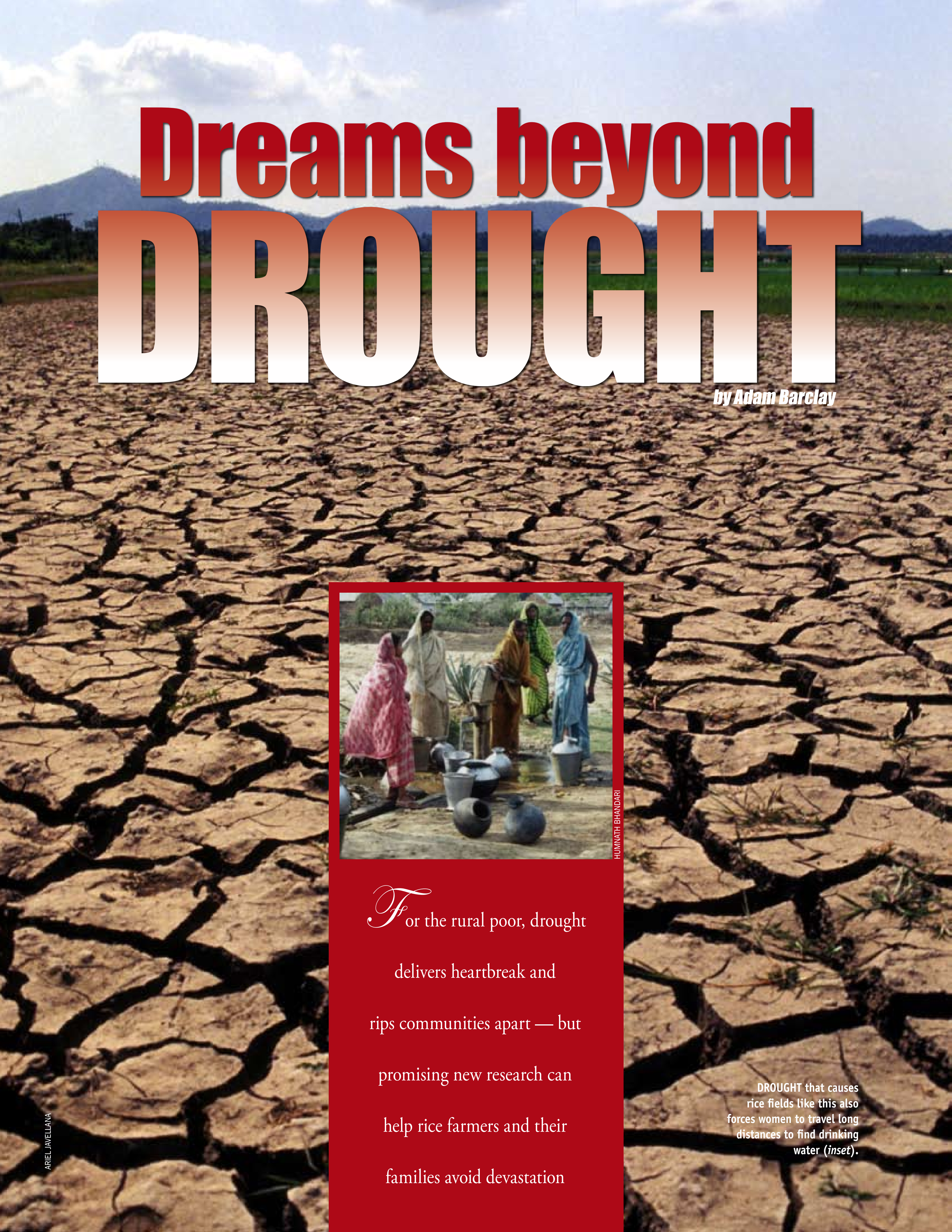
SDC's support for the CGIAR system is threefold. First, unrestricted grants to core center-specific programs and the CGIAR Challenge Programs have remained steady over the past few years at US$10 million per year. Second, projects based in specific target countries receive a similar amount. Third, to maintain a critical mass of expertise in agricultural research for development, SDC helps build networks between Swiss research centers and those of the CGIAR, and provides resources for the Junior Professional Officer Program. In total, SDC's commitment to the CGIAR approaches $20 million annually, making SDC the group's 8th-largest donor.


SDC

Dr. Jenny is senior advisor in the Natural Resources and Environment Division of the Swiss Agency for Development and Cooperation.

IRRI is an important partner of SDC, particularly in Asia. The Lao-IRRI Rice Research and Training Project and the Asia-wide Irrigated Rice Research Consortium (IRRC) are two typical examples of successful partnerships with a concrete impact on food security and livelihoods. Tools developed by the IRRC, for example, are gaining tremendous popularity among Asian rice farmers. In Vietnam, the impact of the *Ba Giam, Ba Tang* ("Three Reductions, Three Gains") campaign is expected to reach and improve the livelihood of more than 12 million rice farmers by decreasing their dependence on insecticides. This, in turn, increases farmers' incomes while reducing unnecessary health hazards and environmental pollution.

Getting technologies into farmers' fields requires researchers to work closely with farmers and involve them in all steps of research, from analyzing their problems through to finding new technologies. The measure of researchers' success should be the adoption rate of appropriate technologies at the farm level, rather than number of publications or scientific rigor alone. In this vein, SDC will continue its support for research that leads to tangible improvements in the lives of the poor.



Dreams beyond DROUGHT

by Adam Barclay

HUMNATH BHANDARI

For the rural poor, drought delivers heartbreak and rips communities apart — but promising new research can help rice farmers and their families avoid devastation

DROUGHT that causes rice fields like this also forces women to travel long distances to find drinking water (*inset*).

ARIEL JAVELLANA

LEHARNE FOUNTAIN

The headlines don't scream at you from the front page. But their effect builds and, if you've followed the news from across Asia this past year or so, you will understand the scale of the problem. Drought doesn't have the immediacy of a tsunami or a flood, but it can kill just as effectively. Its method is slow, insidious and, in the end, more painful, grinding people slowly into the dust that lies where crops once stood.

Essentially, drought is an extended period of substantially lower-than-usual rainfall, leading to a shortage of water for domestic use and agriculture, and ultimately to financial, physical and social hardship. And it happens over and over again in Asia, where around a fifth of all rice area is drought-prone.

The consequences of drought read like a description of the apocalypse: decline in food production, hunger, malnutrition, disease epidemics and other health problems, famine, displacement of people, loss of assets, starvation — the list goes on. Where floods and typhoons inflict instant damage, drought's impact is gradual, so it receives less attention from politicians and policymakers. Nevertheless, prolonged severe drought causes the breakdown of livelihoods and rural economies and the failure of social support systems. The impact is disproportionately high on poor households that are less able to cope because they do not own or have access to the resources they need to escape the worst effects.

The consequences of drought read like a description of the apocalypse

In 2004, widespread severe drought in much of Asia not only resulted in agricultural production losses of hundreds of millions of dollars but also pushed literally millions of people into poverty. In Thailand, drought hit 70 of the country's 76 provinces and affected more than 8 million people. Production loss from major crop failures covering 2 million hectares is estimated at US$326 million, resulting in a 3.9% decline in the 2004 agricultural gross domestic product (GDP). More than half of the rural population of Thailand relies on farm income for their livelihoods. The story is the same all across developing Asia, where well over half the population depends on agriculture.

Reports from numerous countries have a depressing sameness to them. In 2004, the normally lush tropical southern Chinese island of Hainan suffered its worst drought in 50 years, with 12 million hectares of farmland affected. Media reports claimed that more than 9 million Chinese faced drinking-water shortages. Vietnam's eight central highland provinces suffered their worst drought in 28 years, affecting around 1 million people and causing an estimated $80 million worth of crop losses. In March 2005, Cambodian Prime Minister Hun Sen called for international assistance for a national campaign to help farmers who are short of water. Coping with recurrent drought is part of life for millions of Asia's rural poor.

Just over two-thirds of India is susceptible to drought and more than half of Asia's drought-prone rice lands

AS DROUGHT takes its toll, employment for agricultural workers also dries up, forcing them into inactivity or migration to cities in the search for work.

are located in eastern India alone. Drought is one of India's foremost constraints to increased and stable agricultural production. The last century has seen the country rocked by severe droughts in 1918, 1965, 1972, 1979, 1987 and 2002. With agriculture contributing around a quarter of India's GDP, severe drought directly stifles economic growth.

The 2002 drought ranks as one of the most severe in India's recorded history. More than half the country's area and around 300 million people across 18 states felt its impact. The lack of rain caused a 15% drop in total food grains and a 19% drop in rice production — 31 million tons and 17 million tons, respectively — compared with what was expected based on agricultural trends. The Indian Department of Agriculture estimated that the 2002 drought year resulted in a 3.2% decline in agricultural GDP, a $9-billion loss in agricultural income and the loss of a staggering 1.3 billion person-days in rural employment due to shrinkage of agricultural operations.

The 2002 drought ranks as one of the most severe in memory

What do these numbers actually mean, though? First, you have to remember that India is home to more than a sixth of the planet's population — almost 1.1 billion, and rising. So a little economic push here or shove there can affect a *lot* of people. In just three states in eastern India, Chhattisgarh, Jharkhand and Orissa, the 2002 drought slashed farm household income by 40-80% and shoved 13 million people below an already-low poverty line. In short, a lot of people who weren't doing too badly became poor and a lot of poor people became a lot poorer.

Sushil Pandey, a senior agricultural economist at the

HUMNATH BHANDARI

International Rice Research Institute (IRRI), led a recent Rockefeller Foundation-funded study into the impact of drought titled *Economic costs of drought and rainfed rice farmers' coping mechanisms in eastern India*. He points out that the impact at a national level tends to be moderated because a whole country is rarely in drought at once, and areas experiencing a good year will to some extent buffer the hardest hit areas. If you take a look at the effect on localized groups, though, you see a much bleaker picture.

"When you zoom in on specific areas, you see the impact much more," says Dr. Pandey. "It's possible to have very little fluctuation

Community action combats drought

by Leharne Fountain

FARMERS gather in the village of Kapsada, 40 km from the Chhattisgarh capital of Raipur, to share their drill-seeding experiences with scientists from Indira Ghandi Agricultural University.

LEHARNE FOUNTAIN

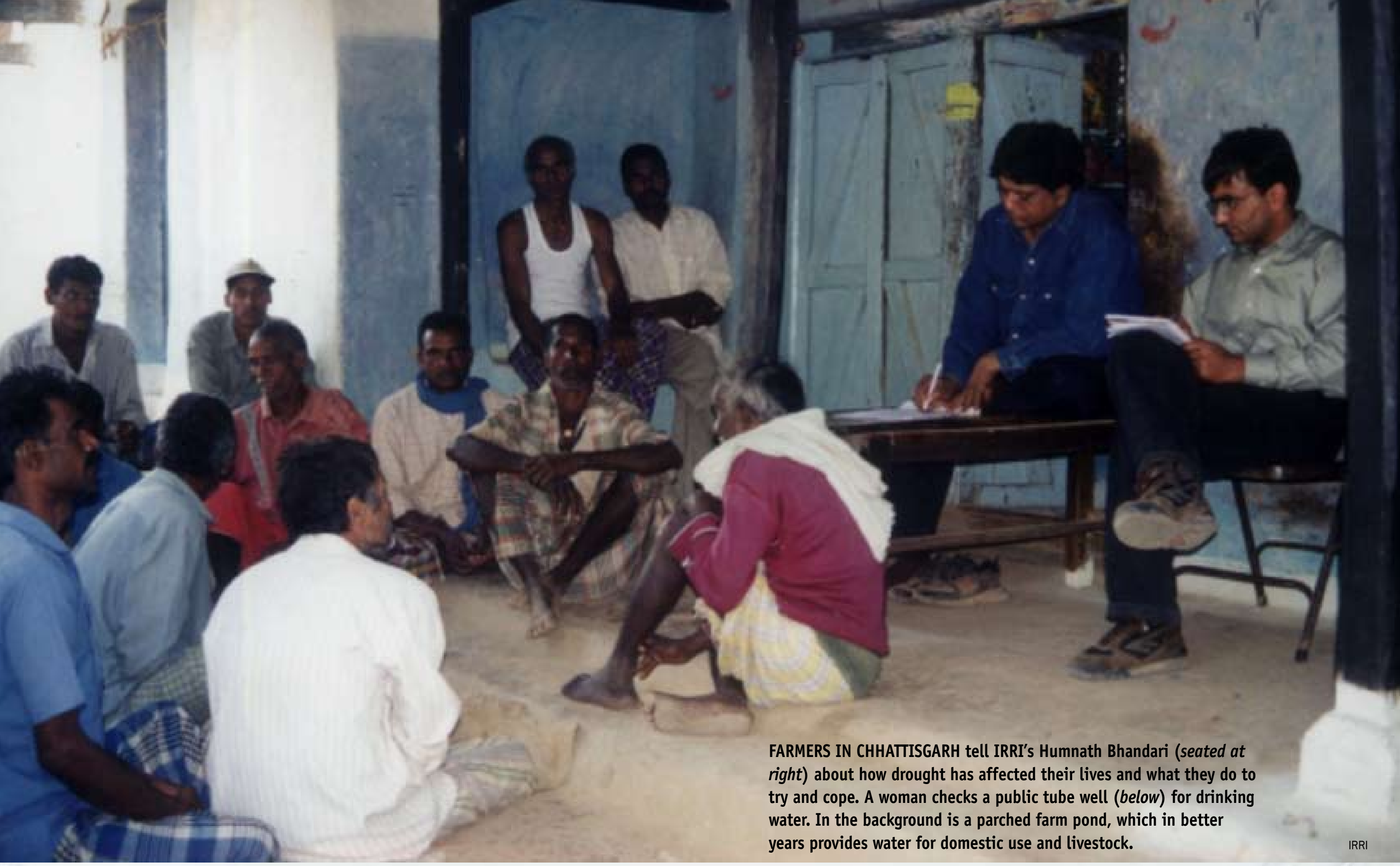
Drought is a major issue for rainfed rice cultivation in eastern India. In Chhattisgarh state in 2002-03, for example, drought led to a halving of rice production, hampering the rural economy and forcing farmers into debt.

Rice cultivation in this region is often performed by direct seeding, rather than transplanting. One drawback of this technique is that weeds can be a big problem. The chief method of weed control in Chhattisgarh is through the traditional practice of *biasi*, which is heavily dependent on adequate and timely rainfall to impound about 10-15 cm of water. Around 30-50 days after sowing, farmers run a narrow plow through the mix of crop and weeds. Although disruptive for the seedlings, the method keeps weeds under control, and allows farmers to redistribute seedlings and fill any gaps. But a lack of enough rainfall can delay or even prevent *biasi*, and weeds soon out-compete the rice, causing severe declines in yield.

One solution is to sow the rice in lines using a seed drill — a device that opens furrows in the soil and drops seeds into them — with different weed management strategies not dependent on impounded water. The technology is not new but, until recently, has not been adopted in Chhattisgarh due largely to a lack of access to seed drills and tractors. Now, IRRI and the Indira Ghandi Agricultural University, with funding from the International Fund for Agricultural Development, are helping remove barriers to adoption by taking a more community-oriented path. The research team recently helped farming communities set up a hiring system and encouraged local entrepreneurs to purchase drills and tractors that could be hired out to other small farmers.

Importantly, line-sown rice matures up to 10 days earlier than *biasi* rice. Previously, farmers grew varieties of different durations, which were harvested relatively late and at different times, prohibiting a second crop under residual soil moisture conditions during the otherwise fallow period. Cropping intensity has increased because the farmers now sow the same early-maturing rice variety, allowing production of a high-yielding variety of chickpea after the rice harvest.

Line sowing is gaining popularity among farmers and helping them to produce higher yields and income. Managing weeds in line-sown crops is easier too, as it isn't dependent on the high rainfall required for *biasi*. Gaining access to line-sowing technology has helped, but it is the cooperation of local communities that has really made the difference.



FARMERS IN CHHATTISGARH tell IRRI's Humnath Bhandari (*seated at right*) about how drought has affected their lives and what they do to try and cope. A woman checks a public tube well (*below*) for drinking water. In the background is a parched farm pond, which in better years provides water for domestic use and livestock.

IRRI

HUMNATH BHANDARI

Tears in the dust

To get a sense of life during an Indian drought, let us examine the case of one farmer. Nandu Bhoi farms a half-hectare block near Datarengi village in the Raipur district of India's Chhattisgarh state. The area's soil retains very little rainwater; crops here depend on consistent, timely rains. It is an unforgiving place to eke out a farm living.

Despite droughts in 1997, 1998 and 2000, Nandu managed to produce a little rice. Then, in the 2002 monsoon season, the rains dried up completely and he neither planted nor harvested a single grain. Six years earlier, he had bought a bullock to help with land preparation and to hire out to other farmers. In the absence of rain, Nandu simply grazed his bullock in his barren rice field, but by 2002 there were not even enough weeds to feed a single draft animal.

With his family becoming hungrier and his bullock fast losing weight, Nandu decided to sell. Many of his fellow farmers in similarly dire circumstances were doing the same thing, so prices for bullocks had hit rock bottom. He received a paltry sum for the sickly beast but at least it was one less thing to worry about. Unable to produce food himself, though, Nandu became more and more desperate, selling his farm tools and some cooking implements.

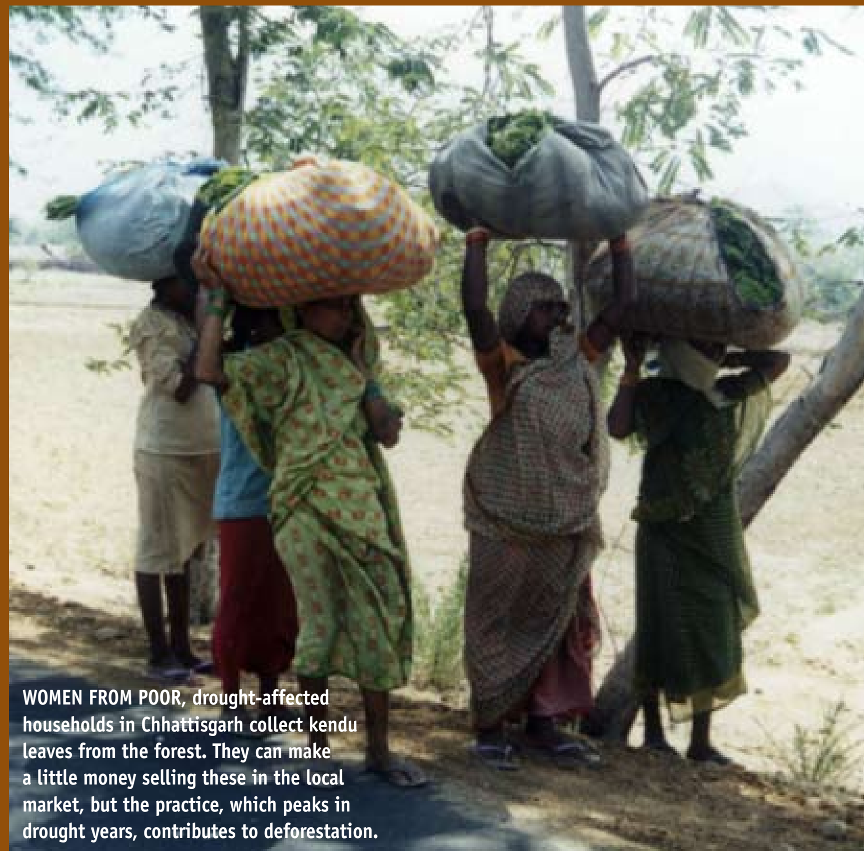
When food is in short supply in this part of India, women are given whatever is left over after the men, the children and the elderly have eaten. Nandu's pregnant wife, Sulochana, had thus become weak, barely able to gather the energy to join the other farm wives foraging in the nearby forest for food. Most days, Sulochana was helped by her 12-year-old-son and 10-year-old daughter. Together, they would spend up to 12 hours each day collecting firewood, timber, medicinal plants and food. Keeping a small portion for themselves, they sold the bulk of it at the market, earning around 50 rupees (US$1.15) per day.

The children no longer attended school and although people harvest forest products in nondrought years, the practice increases sharply during drought, contributing to rapid depletion of useful plants and severe deforestation. Foragers also risk an unreliable market, low prices and exploitation by middlemen.

With his options rapidly dwindling, Nandu moved to Maharashtra, hundreds of kilometers southwest of Raipur, to perform manual labor at a brick-producing kiln. To do this, he borrowed Rs 1000 ($23) from a local money lender, who charged him 40% annual interest. In Maharashtra, he worked a punishing 15-hour day for a paltry Rs 50. Meanwhile, Sulochana gave birth to a 5-week-premature boy who, underweight and underfed, died a week later.

In 2003 the rains finally returned to Raipur and Nandu moved back to Datarengi to re-establish his farm. Already owing money, he had no alternative but to plunge further into debt. Having previously sold his bullock and farm tools, he borrowed enough money to hire what he needed to plant a rice crop. Forced to wait for the equipment until its owners had finished with it, Nandu planted his crop late, resulting in considerable production losses. For the first time in years, though, he was able to provide his family with food that he had grown himself, and so begin the long, hard journey to recovery. But if another drought hits any time soon, Nandu and his family will find themselves rapidly ground into the dust once more.

The story of Nandu Bhoi and his family represents the heartbreaking reality for an enormous number of farm families across India who continue to suffer from recurrent drought. Poverty and debt feed on themselves and, when the rains fail, already-struggling farmers quickly find their circumstances spiraling out of control, unwitting players in a potentially deadly chain reaction.



HUMNATH BHANDARI

WOMEN FROM POOR, drought-affected households in Chhattisgarh collect kendu leaves from the forest. They can make a little money selling these in the local market, but the practice, which peaks in drought years, contributes to deforestation.

and loss of production at the national level at the same time as massive production losses — 60-70% — in the affected areas."

Although the direct impact of drought is production loss and consequent income loss, this is only the start of a farmer's problems.

"The local economy in a rural area depends on agriculture," says Dr. Pandey, "and if the local economy isn't functioning well, the other employment disappears. You have a cumulative effect. The total economic cost of drought is several-fold higher than the value of the production loss, and farmers' coping mechanisms are usually inadequate to prevent a shortfall in consumption, particularly among vulnerable groups. When people are unable to pay off their loans, they go deeper and deeper into debt, ultimately losing their land and whatever else they own, and become completely destitute."

Sukraram Dhuru, from Raipur's Kumarkhan village, sums things by saying "a 1-year drought creates a 5-year problem." Imagine, then, the ruin inflicted by 2, or 3, or 5 consecutive years of poor rains. Some farm families are simply pushed so far down they never make their way back up, condemned to a subsistence of monotonous, unskilled labor, drudgery and malnutrition.

What's more, this sort of tragedy happens again and again. It is both encouraging and sobering to realize

Drought—what is IRRI doing?

IRRI is developing a range of strategies to tackle drought. Read on for a summary of some of the institute's key research.

Breeding for drought tolerance

IRRI researchers have demonstrated that some rice varieties (including some hybrids), are much more tolerant than mainstream high-yielding irrigated varieties to periods of soil drying during the critical flowering and early grain-filling stages. Luckily, this characteristic does not seem to undermine yield under favorable conditions. Rice breeders can find the most drought-tolerant varieties through a screening process wherein plants are deprived of water around the flowering period, and then the best-yielding candidates are selected. Since 2004, IRRI has identified many varieties combining high yield when conditions are good with the ability to produce yields of 2-3 tons per hectare under conditions that are so dry that many popular varieties produce less than 1 ton per hectare. IRRI and collaborators are studying the genetic basis for this tolerance.

Aerobic rice

Rice breeders at IRRI are developing new types of rice that combine the ability of some traditional but low-yielding varieties to grow in dry soils with the fertilizer responsiveness and yield potential of modern high-yielding varieties. The first generation of this so-called aerobic rice has been developed by crossing irrigated high-yielding varieties with some of the traditional types and selecting the progeny under dry soil conditions. Researchers in China and at the Brazilian Agricultural Research Corporation pioneered this breeding strategy. The resulting varieties are direct-seeded into dry soil in nonflooded fields and managed like a high-yielding wheat or maize crop. Irrigation is applied if available and needed, but no standing water is held in the fields.

AEROBIC RICE varieties, like these being trialed at IRRI, can grow in conditions far too dry for commonly grown modern varieties.

GARY ATLIN

Crop management strategies

IRRI is researching a range of crop management strategies that have the potential to reduce the impact of drought. Dry direct seeding — planting seeds directly into nonflooded fields instead of transplanting seedlings into flooded fields — has the potential to help farmers avoid late season drought, increase rice yield and gain opportunities to grow extra crops. Researchers are also quantifying drought effect on crop development, growth and yield, then using the Oryza2000 crop modeling system (co-developed by IRRI and Wageningen University in The Netherlands) to simulate rice growth under drought conditions. Such modeling has already allowed scientists to analyze yield constraints and explore management options to increase the yield and stability of rainfed lowland rice in Indonesia. Land leveling can help farmers use water more efficiently. Studying how soil and hydrological characteristics vary according to topography — and how this affects soil nutrients, water availability and yield — will help researchers develop improved, site-specific management strategies for drought conditions.

Deletion mutants

Deletion mutants offer an exciting way of exploring the effect of unknown genes on drought tolerance. IRRI scientists have created more than 40,000 deletion mutants where chemicals or radiation were used to "knock out" random segments of the chromosome. The resultant plants — the deletion mutants — are then screened under drought stress in the field, or by applying drought-related plant hormones in the laboratory, to identify drought-tolerant or drought-susceptible mutants. By carefully investigating different physiological characteristics of the tolerant mutants a picture of the mechanisms important for drought tolerance in rice is beginning to emerge. Work is also under way to identify which deleted genes are responsible for this effect.

Physiological, anatomical and molecular bases of drought sensitivity

The reproductive stage of rice is the most sensitive to drought stress. Inadequate rainfall during the flowering and grain-filling stages can lead to large yield losses in many leading rice varieties. One of the reasons for reduced yields is that the panicle (the flowering section of the rice plant) does not fully emerge from the leaf sheath. For the panicle to fully emerge, the plant needs to produce a particular hormone (gibberellin). Under drought stress, however, the plant decreases production of gibberellin and increases production of a different hormone (abscisic acid), which works in opposition to gibberellin. This same phenomenon is responsible for poor pollen release under drought conditions, which also inhibits yield. IRRI scientists are examining the genes that control the production and release of these hormones, as well as the corresponding proteins. Ultimately, researchers hope to develop rice plants that maintain reasonable yields under drought conditions.

Molecular breeding

Although drought-resilient rice varieties do exist, it has proved difficult to combine drought tolerance and high yields. To link these two traits, scientists at IRRI and the Chinese Academy of Agricultural Sciences interbred popular high-yielding varieties with more than 100 varieties from diverse origins. This produced a large number of breeding lines, which were then screened for high yield under drought stress. Researchers identified many lines whose physical appearance and performance were similar to the popular varieties they were derived from, but with improved yield in a range of drought environments. These lines are now being field-tested in drought-prone environments in South and Southeast Asia. This approach has also helped scientists identify many genes and parts of the genome that influence drought tolerance.

The Challenge Program on Water and Food

The Challenge Program on Water and Food is one of several high-impact, collaborative research programs that target major global and regional agricultural issues. The Challenge Programs are an initiative of IRRI's parent organization, the Consultative Group on International Agricultural Research (CGIAR). Ultimately, the Water and Food program will help farmers grow more food with less water. IRRI is leading the program's Crop Water Productivity Improvement theme, which seeks to increase crop water productivity to ensure food security and improve farmers' livelihoods without increasing water used for agriculture over the amount used in the year 2000. Researchers from five CGIAR centers and several additional partners aim to achieve this by developing water-efficient crops, improving farming practices to optimize water use, and promoting policies and institutions to help farmers gain access to new technologies.

HUMNATH BHANDARI (2)

JOBLESS AND APPREHENSIVE, people wait anxiously for relief to arrive, while farmers gather to sell their bullocks at a weekly market in Orissa (*below*). As drought-induced hardship forces more and more farmers to sell their productive assets, such as farm animals, prices drop lower and lower.

that the worst consequences can be avoided. We may not have the ability to prevent drought, but we have the chance to soften its effects and give people who depend on agriculture a fighting chance.

The answer lies in three interconnected areas — research, effective long-term drought-mitigation policies and relief strategies. There is an urgent need for policies that give farmers access to markets and affordable credit. Improved irrigation systems and soil and water conservation, through better approaches to managing natural watersheds, can help ease the effects of drought. Access to improved agricultural technologies that increase productivity will help farmers diversify their income sources, giving them opportunities to earn a living from more than just one type of crop and from viable nonfarm activities.

"Farmers need nonagricultural income so even when there is agricultural failure, they can earn money," explains Humnath Bhandari, a visiting research fellow at IRRI who coauthored the India drought report.

"Effective drought relief, such as emergency food supplies, is crucial," says Dr. Bhandari, "but people only receive assistance when a drought actually happens. Millions of relief dollars are spent but with little impact on long-term mitigation. Unless we focus on long-term strategies, we won't find a solution, but governments are now starting to realize how serious this issue really is."

In research, we find the potential for truly sustainable improvements. IRRI has taken on a suite of different approaches, from breeding rice varieties that are better able to tolerate drought conditions, to improved crop and water management strategies that help conserve and reduce the need for water (see *Drought – what is IRRI doing?*, opposite).

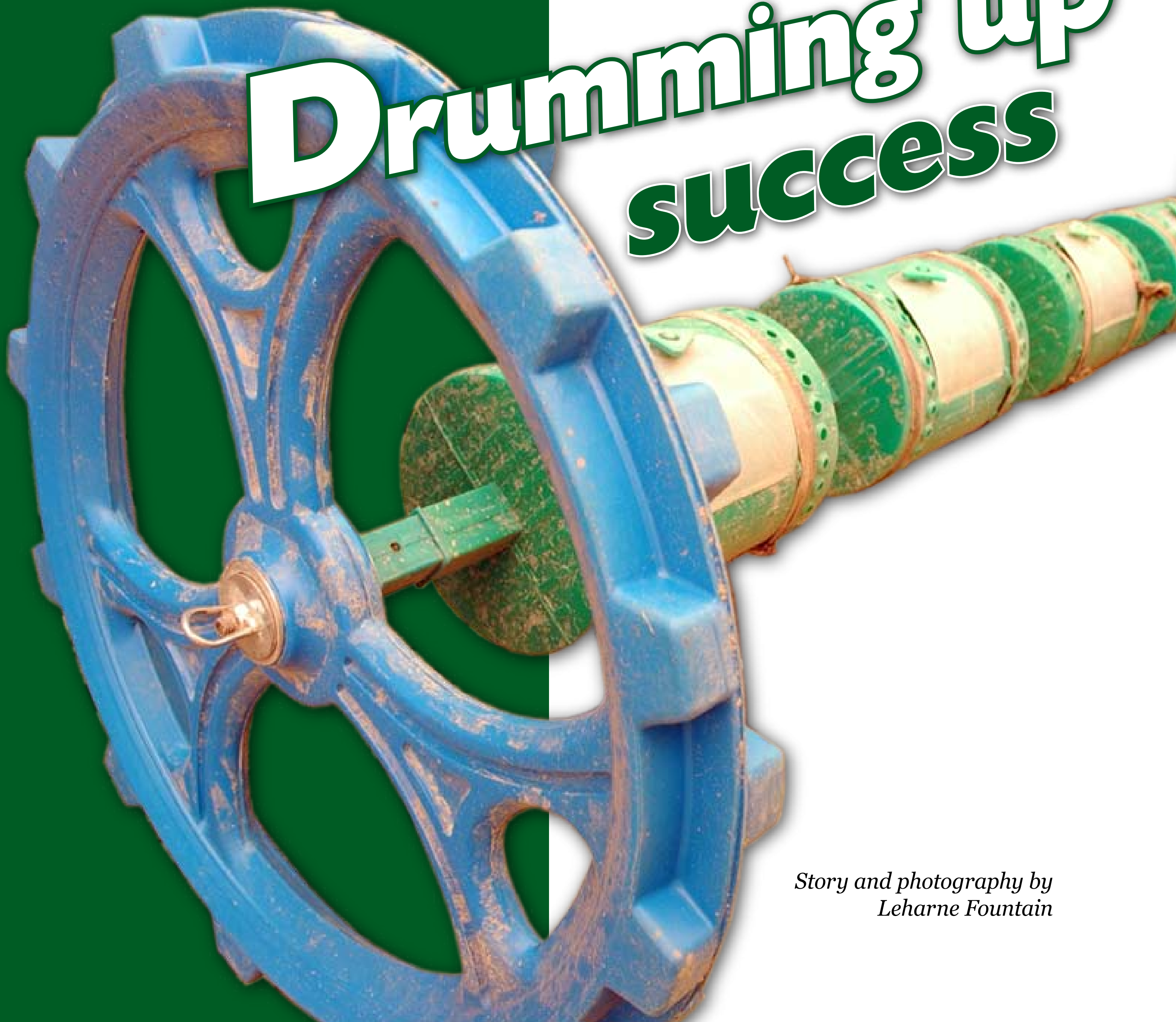
In combination with inadequate coping mechanisms, drought not only perpetuates poverty but also deepens it, forcing more people below the poverty line and dragging those already there deeper down. At the same time, improvements borne by research can have the opposite effect, nudging people back up into better circumstances.

"What would happen," asks Dr. Pandey, "if we could halve the rice yield loss suffered during drought years? This alone would prevent about 4 million people in eastern India from falling into poverty."

Combine that with improved policies, effective relief and better infrastructure, and you give farmers and their families a chance to keep water in their fields, their crops above ground and their heads above water.

An improved way of planting rice is increasing farmers' incomes and strengthening communities in Bangladesh

Drumming up success



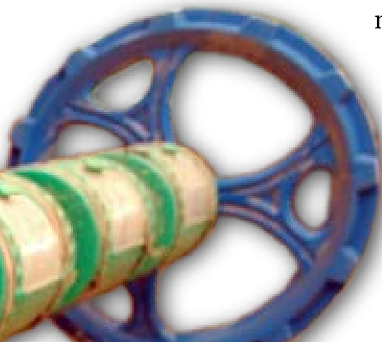
Story and photography by Leharne Fountain

MA. ROMILEE BOOL

A PLASTIC DRUM SEEDER holds six or eight perforated cylindrical drums housing pregerminated seeds that are dropped in rows as the seeder is easily pushed or pulled along by a single person — like Filipino farmer Jimmy Gonzales — at walking pace. M. Zainul Abedin (*below left*), who led the drum-seeding trial, is interviewed about the technology by Bangladesh TV Channel *i* during a field day in Pabna. The media has played a crucial role in raising awareness of drum seeding throughout Bangladesh.

Almost 90% of the 11 million hectares of rice that are planted each season in Bangladesh is transplanted — seedlings are grown in nurseries then moved to the field. It is a heavily labor-intensive process, requiring nearly half-a-billion person-days across the country. In the past, rural laborers abounded, but increasing labor out-migration to city areas and a shift towards alternative rural employment has seen a severe shortage of hands available for transplanting rice.

This scarcity of farm workers is hurting Bangladeshi rice farmers on several fronts. The most obvious impact is an increase in labor costs. Also, the optimal planting periods for the *boro* (dry) and *aman* (wet) seasons are relatively short. A lack of workers means not all farmers can plant their rice on time. Delayed planting leads to late-maturing rice, increasing the risk of crop losses at the tail end of both seasons — due to hailstorms or flooding from rain during the *boro* season and due to drought during the *aman* season. These factors, combined with increasing costs of other inputs and a falling or stagnant market price for rice, are diminishing the economic viability of rice production in Bangladesh.



But a simple, inexpensive piece of equipment has the potential to change the face of rice farming across the country. The drum seeder (see photo, *opposite*) is a lightweight device made from high-density plastic with a cost of around US$40 and a life of 6-8 years. Originally designed by the International Rice Research Institute (IRRI), improvements by researchers and manufacturers in Vietnam have substantially reduced the weight, cost and usability of the device. It consists of six to eight cylindrical drums along a central axis. Each drum is studded with holes through which pre-germinated seeds drop neatly in rows on puddled soils as the drum seeder is pulled along. The drums are supported by a large plastic wheel at each end, allowing the whole system to be easily pulled along by a single user at walking pace. Drum seeding has already had success in Vietnam as a seed-saving strategy, but its capacity to save labor is profound: while it may take up to 50 person-days to transplant 1 hectare of rice, direct wet seeding with a drum seeder takes barely 2 person-days.

Bangladesh's first drum-seeding trial, conducted during the 2003 *aman* season — a collaboration between IRRI and the Bangladesh Rice Research Institute (BRRI), funded by the International Fund for Agricultural Development (IFAD) — was a comprehensive success. In the trial, led by M. Zainul Abedin, Farming Systems Specialist in

IRRI's Social Sciences Division, and implemented by BRRI Chief Scientific Officer Musherraf Husain and participating farmers, drum seeding resulted in an average 18% higher yields and 6% reduced costs compared with transplanting, and drum-seeded crops matured an average 10 days earlier. What's more, drum-seeded rice gave an average gross return 21% higher than for transplanted rice. This translates to more than double the average profit — a boost of around $120-150 per hectare per crop.

All those involved saw the technology as cheaper, requiring less labor, producing higher yields and resulting in better plant growth. The only areas of concern were the potential cost of acquiring a drum seeder, uncertainty over availability, and weed management. More recently, though, a follow-up IFAD-funded project, aiming to accelerate the adoption of the technology, has given IRRI and BRRI, with the assistance of the Bangladesh Department of Agricultural Extension (DAE), the chance to solve some inherent problems and lead the spread of drum seeding in Bangladesh.

Dr. Abedin developed guidelines for technology adoption using a community participatory approach to research and extension. One key to the approach is a pre-adoption analysis that takes into consideration institutional, technical, policy, social and economic factors that may help or hinder adoption. This means understanding an entire farming community, not just individual farmers. Many farmers grow other crops in addition to rice, so the approach must consider how drum seeding will affect their whole farming system. The product of a Bangladeshi farm family himself, Dr. Abedin emphasizes the value of allowing farming communities to make their own decisions, and to recognize they have the ability to experiment, take calculated risks and innovate.

Fifty-six groups across the country decided to try drum seeding during the 2004 *boro* season, in the hope the technology would spread out from these points. Establishing a drum-seeded crop requires earlier irrigation than does transplanting, so owners of tube wells — each of which usually irrigates several rice farms — were the first people contacted in each location.

"It's useless," says Dr. Abedin, "to get the farmers involved if they can't irrigate their crop at the right time, so it was crucial that we included the well owners. Understanding, and working within, the existing community structures is essential."

Extraordinary pace

Now, after just three growing seasons, the popularity of drum seeding is spreading at an extraordinary pace. Some 4,000 Bangladeshi farmers in more than 300 groups are already using the technology, with hundreds more seeking access to drum seeders.

Dr. Abedin attributes the successful adoption of drum seeding in large part to the project's community participatory approach and, critically, the early

establishment of research linkages with development and policy makers, entrepreneurs and the media. Ultimately, though, it comes down to the farmers themselves.

"It was the farmers who experimented with the technology and were confident of success, even in the face of skepticism," he says. "The researchers were continuously learning from farmers and integrating these lessons into the work plan. Farmers also trained other farmers. Working with groups of farmers helps establish ongoing, community-level monitoring and evaluation, and ensures that drum-seeding success stories spread rapidly to neighbors."

The project abounds with stories about farmers like Abdul Aziz, from Gazipur district northeast of the capital, Dhaka. Aziz soldiered on even while neighboring farmers scoffed, believing he wouldn't harvest any rice from his drum-seeded crop. At 55 bigha, or just under 8 hectares (7 bighas equal 1 hectare), Aziz's farm is large by Bangladeshi standards. He started growing drum-seeded rice during the 2004-05 *boro* season. Previously, his entire crop was transplanted, requiring 25 laborers per 5 bigha. For the same area, drum seeding required just a single laborer.

Aziz explains that on top of the labor savings, he increased his yield by 0.5-0.8 tons per hectare, and he harvested 10 days earlier than previously with transplanted rice. He has more money in his pocket and he intends to invest it outside of rice farming, to increase his earning capacity and diversify his income. Many of Aziz's fellow Gazipur farmers are now eager to try drum seeding for themselves, and he is only too happy to share his knowledge and experience — and his drum seeder — with them.

It's a common theme: skeptical neighbors become true believers. Mohammad Ghiasuddin, who owns a very small farm in Mymensingh district north of Dhaka, has already harvested three drum-seeded crops. After just one season, both he and his neighbors, who had originally thought him mad, were convinced of the virtues of drum seeding, and he too has shared the technology with them.

In this way, from farmer to farmer, the technology is spreading.

FARMER Jamal Sheikh (*opposite*) discusses his drum-seeding experiences with Channel *i* director Shykh Seraj during the Pabna field day. Looking on are State Minister Mirza Fakhrul Islam Alamgir (*in white*), BRRI Director of Research Niloofar Karim (*right of minister*) and Dr. Abedin (*left of Seraj*).

TOWEL BUSINESSMAN Haji Shahabuddin (*above*) approached BRRI, eager to try drum seeding on his land, after seeing the technology showcased on the local television program *Soil and man*. Farmer Mohammad Ghiasuddin (*above right*) stands in front of his drum-seeded crop. Filling drum seeders is easy for Filipino farmer Hernando Bambo (*below*) — simply open the hatch in each drum and pour in the pregerminated seeds.

Field days, often attended by hundreds of farmers, give drum-seeding converts the chance to inspire others to try the technology. At a field day in April 2005, three farmers shared their experiences of drum seeding with a crowd of nearly 400 farmers and extension workers from around Pabna, 240 km west of Dhaka. One of the speakers, Jamal Sheikh, described the experiment he and some fellow farmers performed to try and reduce both the need for irrigation and the cost of land preparation by adopting a zero-tillage technique that made use of residual moisture in his field from receding floodwaters — and which, in concert with drum seeding, gained them yields at least 20% higher than for transplanted rice. It is this spirit of innovation and determination that has stirred pride in those already drum seeding and inspired their counterparts.

Involving Bangladeshi policy makers in the adoption process provided a major boost. From an early stage, Dr. Abedin realized government support would be critical (see *Grain of truth* on page 38). The team fostered relations with the Bangladesh Ministry of Agriculture and subsequently secured government funding of 10 million Bangladeshi taka (US$156,000), which was mainly used to buy an extra 2,500 drum seeders. The government also pledged to subsidize the cost of drum seeders for farmers. The media have also been instrumental in increasing awareness of drum seeding. Many people — not only rice farmers — approached BRRI and DAE for information on trying drum seeding after seeing stories about the technology on television or in the newspapers.

But there is still work to be done. Research is still identifying the varieties and areas most suited to drum seeding, particularly taking into account land, soil and existing cropping systems. Weed management is also an issue, as is the availability of the drum seeders, and the possible need for adaptations. And although scarcity of labor is the primary basis for using drum seeding, in some areas the technology has the potential to displace jobs.

"Researchers need to be aware of their social responsibility to see that there is no serious effect on rural employment," cautions Dr. Abedin. "However, the economic boost caused by drum seeding should create jobs elsewhere to absorb displaced labor."

IRRI, BRRI and the DAE are currently in discussions with Bangladeshi entrepreneurs interested in manufacturing drum seeders locally, and two companies have already manufactured prototypes. This sort of enterprise can help the availability of drum seeders meet the rising demand.

Major shift

Drum seeding represents a major shift from transplanting, and there is a need to manage the change and create an environment that allows change nationally. Training farmers and both government and nongovernment extension workers is of paramount importance. An IRRI-led meeting in June 2005, attended by senior government officials and high-level research, extension, nongovernmental, media and business personnel, established a 5-year plan for transferring drum-seeding technology. Following this, the government has given the go ahead


MA. ROMILEE BOOL

RICE FARMER Abdul Ahad stands beside a shallow tube well, which irrigates crops on several farms during the *boro* (dry) season. Because they control irrigation, tube well owners are crucial to the success of drum seeding, which requires earlier irrigation than does transplanting.

to the project team for an additional investment of around 100 million taka ($1.56 million) to continue the work to spread drum-seeding technology across Bangladesh.

Originally, the only planned benefit of drum seeding was the cost saving from reduced labor requirements. It was expected, however, that this would be offset slightly by an increased need for weed management. As it turns out, farmers have also experienced improved plant growth, increased yields and earlier plant maturity, and they have used fewer seeds.

The latest results of drum seeding across the country show yield increases of up to 20% in both *boro* and *aman* seasons, and up to double the net profit, translating to additional income, over transplanted rice, of 7,000-10,000 taka ($110-160) per hectare per season, a significant boost for most Bangladeshi rice farmers. Drum seeding also frees family labor, which has wide-ranging social benefits.

Even with modest projections, Dr. Abedin believes drum seeding can have a profound impact. "If drum seeding works on only 4 million hectares," he explains, "a 15% yield increase equates to 3 million tons of extra rice with very little extra investment. I believe drum seeding has the potential to change the landscape of rice farming in Bangladesh."

Rangpur Dinajpur Rural Service, a participating nongovernmental organization, sees early harvest and increased yield as more than just a way to reduce *monga* (starvation) during the pre-harvest period in October and November. First, early harvesting generates employment for landless laborers, providing them income to buy food. Second, the early harvest and increased production make food available to vulnerable farmers during the *monga* period.

The farmers themselves are overjoyed by the results and are eagerly sharing the technology with other farmers. Dr. Abedin has also witnessed benefits of the technology that run deeper than this — the spirit of innovation and entrepreneurship among farmers and the strengthening of communities through working together are just as significant.

Drum seeding is helping to advance rice farming in Bangladesh. Its success so far confirms that simple and relatively inexpensive technologies can be effective. It goes much further, too. The drum-seeding experience is proving that working with communities in the testing, adaptation and adoption of appropriate technologies, and linking policy makers, entrepreneurs and other stakeholders early on — in other words, engaging from the beginning those who stand to benefit and those who have the power to help — can have a profound and lasting impact.

The father of farmers

In his own words, Ayub Husain is a "father of farmers." Husain was part of the first group of farmers to receive drum-seeding training from BRRI. He then trained others, beginning with five farmers in two locations during the 2003-04 *boro* (dry) season. In the following *aman* (monsoon) season, just two farmers used the drum seeder. The next *boro* season, though, more than 60 farmers sowed 15 hectares by drum seeding, including almost a hectare of Husain's own land. Wanting to spread the word, he joined forces with IRRI and BRRI to hold a farmer field day, which was attended by the State Minister for Agriculture.

Inspired by the results in his own area, Husain set out 500 km across Bangladesh, where he led trials in the hometown of the Finance Minister to raise government awareness of the technology. The trials were not as successful as hoped because of unsuitable conditions, but neither he nor the farmers were discouraged; these same farmers are now testing the seeder in the *aus* (pre-monsoon) season.

What motivates a farmer to go to such lengths? Husain claims his mission is simply to help his fellow Bangladeshi farmers, as most grow enough rice merely to feed themselves and their families, and many struggle to produce even that. By instilling farmers with a spirit of innovation, he believes Bangladeshi society as a whole can move forward. Husain has seen that partnerships between farmers, scientists and researchers can increase productivity, and he wants scientists to help farmers realize that they can take a technological approach to solving problems and improving their farming.

While Husain travels around the country spreading the news about drum seeding and other technologies, his family looks after the farm. It is more important, he feels, to dedicate his time to benefit the entire country. This self-professed father of farmers doesn't expect any payment for his work: parents don't expect to be paid for being parents, he says, For Husain, it is a reward in itself to watch his children — the farmers he has mentored — "growing up."

A HYBRID PIONEER

by Tim Overett

It has been said of pioneers that they rarely get the biggest benefit from that which they have pioneered, and that the people who profit most are those who follow carefully in their footsteps.

This is evident in the history of many new technologies — from computers to medicines, from the motor vehicle to the airplane. Now, after toiling away for more than 3 decades, it is time for a new pioneer to add strength to this adage.

VIRMANI PRIVATE COLLECTION

SANT VIRMANI observes rice crosses (*top*) from IRRI's hybrid rice program. He has come a long way since his days as a PhD student in the Cytogenetic Lab of the Department of Plant Breeding at Punjab Agricultural University, India, in 1966-69.

For almost 30 years, "Sant" Singh Virmani has pioneered the introduction of tropical hybrid rice, not just in Asia but around the world. Seeking impact before accolades and results before fame and fortune, Dr. Virmani dared to go where few had gone before.

He embraced one of the most challenging and controversial technologies in agriculture and delivered it safely and securely to the rice farmers of the world. Like

ARIEL JAVELLANA

so many pioneers before him, he retires this year from the Los Baños, Philippines-based International Rice Research Institute (IRRI) confident that he's made a real difference in the lives of millions — but, financially, he's none the richer for it and it will probably be those who follow in his footsteps that reap the monetary rewards that hybrid rice can offer.

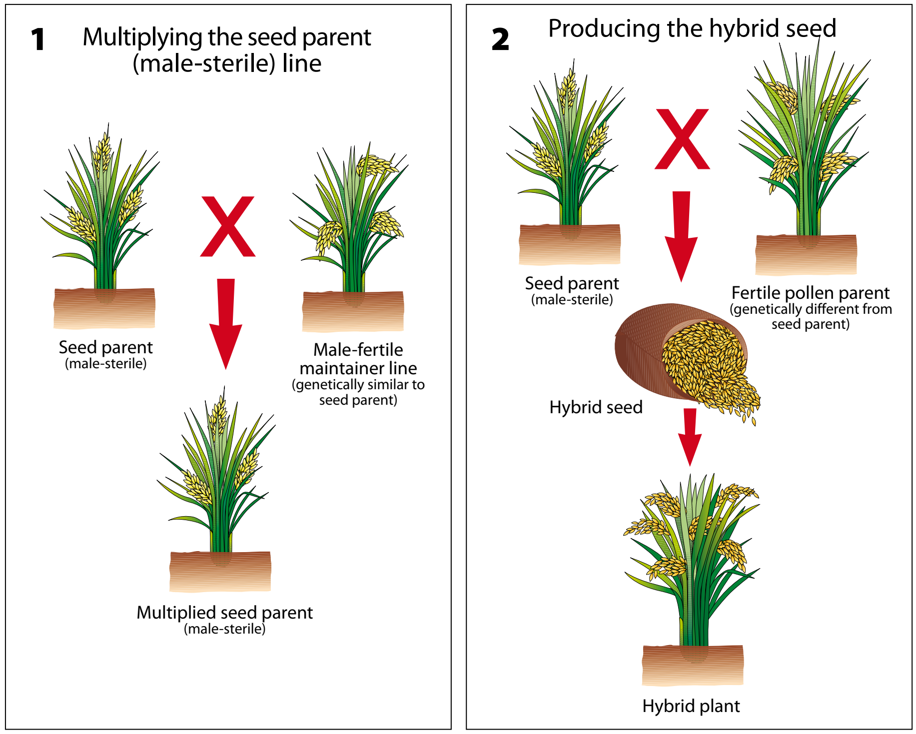
Like the rice plants he has spent most of his life studying and developing, Dr. Virmani is a hybrid of sorts himself — benefiting from the influence of several different cultures.

As a small boy he was a refugee, the only son in a family of five children forced to flee the trouble sparked by the painful partitioning of India and Pakistan in 1947. Having lost his father at age 17, he faced a limited future in the family's logging business.

But his mother intervened, insisting on a higher education. Inspired by her commitment and support, Dr. Virmani excelled academically, studying genetics and plant breeding at Vikram University in India, where in 1963 he earned his Masters degree.

The talents and intelligence he would carry with him all his life propelled him onwards to a PhD in plant breeding at the renowned

Hybrid rice made simple



Producing hybrid rice

Hybrid rice is the first-generation offspring of a cross between two genetically diverse rice plants. These hybrid offspring benefit from a natural phenomenon known as hybrid vigor or heterosis, which is present in all biological systems and has been exploited commercially in many agricultural crops. Rice breeders use heterosis to develop traits important to farmers such as increased yields and resilience to stressful environments.

Hybrid rice seeds must be produced for each new crop; a complex process requiring specific genetic tools. The difficulty stems from the self-fertilizing nature of rice — each plant has both male and female elements in the same flower. So, to cross two genetically different varieties, one of them must be prevented from fertilizing its own seed.

Hybrid breeders first breed a rice line that does not produce viable pollen, termed "male-sterile." But this line can produce seed if pollinated by another line, called a "maintainer," which is fertile but otherwise genetically similar to the male-sterile line. Multiplication of the male-sterile line is achieved by crossing it with the maintainer, which helps to maintain the male-sterile line's sterility.

The multiplied male-sterile plants are then grown alongside a third variety, which is genetically different from the first two, and whose pollen fertilizes the male-sterile plants, and creates a fertile "first-filial-generation" hybrid.

Breeders use a range of parents to create a diversity of hybrids. The different combinations are evaluated for yield, disease resistance, insect resistance and grain quality. The best are selected and their seeds are produced in bulk to supply farmers.

Hybrid varieties must perform better than not only both their parents, but also farmers' inbred varieties. They have a larger total biomass than high-yielding inbred varieties and produce more grains per unit area, resulting in significantly higher yields. But if farmers save and plant the seeds of a hybrid crop, the resulting crop will not be uniform, will show mixed grain types and will have lost its yield advantage — so new hybrid seed must be bought for every crop.

DR. VIRMANI examines his hybrid rice breeding materials in the IRRI Phytotron, a controlled-environment laboratory for growing rice.

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Punjab Agricultural University. Under the guidance of the respected D.S. Athwal, he graduated in 1969.

Dr. Virmani's first job was in 1970 as a postdoctoral fellow at IRRI headquarters, where he relaunched a relationship that would influence the rest of his professional life. By this time, Dr. Athwal — a man who, according to founding IRRI Director General Robert Chandler, "had sound judgment, was an indefatigable worker and was highly regarded by the IRRI staff" — had become IRRI's assistant director. He would once again take the young Dr. Virmani under his wing.

Dr. Virmani presented his early hybrid rice work at IRRI's first rice breeding symposium in 1971. Participants discussed the prospects of hybrid rice, but the majority felt the technology didn't have much practical use. IRRI subsequently discontinued hybrid rice research the next year, and after completing his fellowship, Dr. Virmani returned to the Punjab Agricultural University as a legume geneticist and breeder. The following year, he took up a rice breeder position with the West Africa-based International Institute of Tropical Agriculture. With his young wife, Indu, and their Los Baños-born baby girl, Raminder, he set off for a 6-year stint in Liberia, where their son Jusmeet (Sunny) was born in 1974.

In 1977, China dropped a bombshell onto the world of rice research and production by announcing it had produced the first hybrid rice variety, triggering immense curiosity and interest among the global rice research community. In 1979, Dr. Virmani was offered a chance to return to IRRI on sabbatical leave. He arrived back in Los Baños, intending to stay for just a year, to help IRRI explore the prospects and problems of hybrid rice in the tropics. Shortly after returning, Dr. Virmani traveled to China to observe first-hand its hybrid rice research and industry.

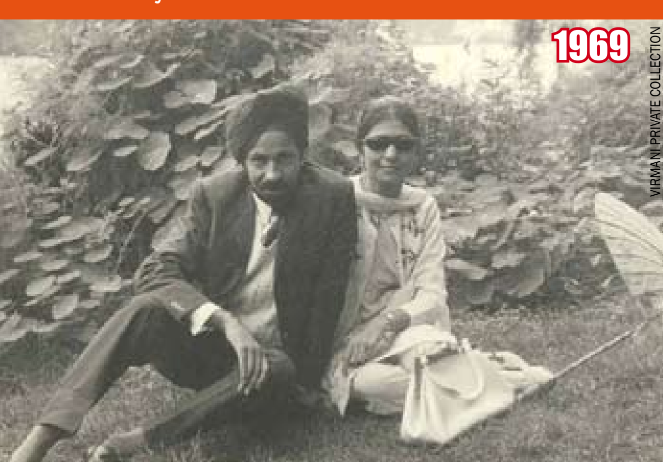
"I had always known hybrid rice was technically possible," he explains, "but seeing its widespread adoption in China in the late 70s convinced me that it was a serious and important option for the rest of the world's rice farmers."

And so began the exhaustive process of studying what had happened in China. In 1980 and 1981, Dr. Virmani joined 20 other rice breeders in month-long tours of China's hybrid rice areas. By the time he returned to IRRI, several others had begun to see and accept the Virmani vision, but with one important caveat.

Unsuited to the tropics, the Chinese varieties would not be viable for farmers across much of tropical Southeast Asia. More work was needed to develop hybrid rice varieties that would thrive in the region's hot, humid climate. Achieving this would take years of breeding, testing and trials, along with a fair share of errors, setbacks and debate.

One of Dr. Virmani's biggest challenges was convincing his own peers in public-sector research of the potential of hybrid rice in the

MOMENTS IN TIME (*from left to right*): Dr Virmani with wife Indu on a North Indian trip; demonstrating his hybrid rice research to former Philippine President Ferdinand Marcos (*left*) and Agriculture Secretary A. Tanco (*extreme left*), with first lady Imelda Marcos (*second from left*) watching on; showing IRRI rice breeding materials to Nobel Laureate Norman Borlaug (*center*) and former IRRI principal plant breeder and World Food Prize Laureate Gurdev Khush (*right*); and receiving the 2005 Pravasi Bharatiya Samman Award for nonresident Indians from Indian President A.P.J. Abdul Kalam in Mumbai.



VIRMANI PRIVATE COLLECTION

IRRI

tropics. A big stumbling block was the inability of farmers to save and re-use hybrid seeds, as is possible with inbred varieties (see *Hybrid rice made simple*, page 29). For this reason, farmers resisted the new technology, and many rice-growing countries did not have an adequate seed industry set up to handle hybrid rice seed production and marketing.

Meanwhile, IRRI still struggled to find him a permanent place among its research staff. It was not until the 1982 arrival of the legendary M.S. Swaminathan — who strongly believed in the prospects of hybrid rice for increasing production in the tropics — as the new IRRI director general in that Dr. Virmani was able to finally settle down and face a secure future.

After this, it took 7 years for Dr. Virmani and his team to develop types of rice suitable for breeding tropical hybrids capable of laying the foundations for a hybrid rice industry in tropical Asia. As it turned out, this major breakthrough marked the beginning of even greater problems — but it wasn't the science itself that stood in Dr. Virmani's way.

Having quietly achieved a historic breakthrough in public rice research, Dr. Virmani was hit with a series of unprecedented challenges. Not only did he have to convince government policy makers of the potential of hybrid rice, but he had to lobby for the setting up of hybrid rice seed industries; find ways to encourage the private sector to invest in hybrid rice; and — hardest of all — convince farmers they could make a better income from hybrids despite having to buy new seed each year.

Why did he persist in the face of such challenges? "I was convinced that not only could it work," he says, "but that the improvements were significant enough to make a difference in the lives of farmers."

He was also motivated by the fact that hybrid rice could help assure the food security of his fellow Indians — an ambition perhaps linked to his challenging childhood when so many around him faced famine.

Over his career, Dr. Virmani published almost 200 scientific papers plus several books including *Heterosis and Hybrid Rice Breeding*, which was translated into Chinese. Fittingly, several major awards have come Dr. Virmani's way, not to mention widespread and deserved international recognition and respect. He has been elected Fellow of the National Academy of Agricultural Sciences of India, the American Society of Agronomy, the Crop Science Society of America (CSSA), and the American Association for the Advancement of Science. His awards include the CSSA's 2002 International Crop Science Research Award and 2005 Monsanto Crop Science Distinguished Career Award; the 2005 Pravasi Bharatiya Samman Award for nonresident Indians "for his efforts to assuage India's concerns on food security and related issues;" and the Koshihikari International Rice Prize for his contributions to developing and disseminating hybrid rice technology in countries outside China.

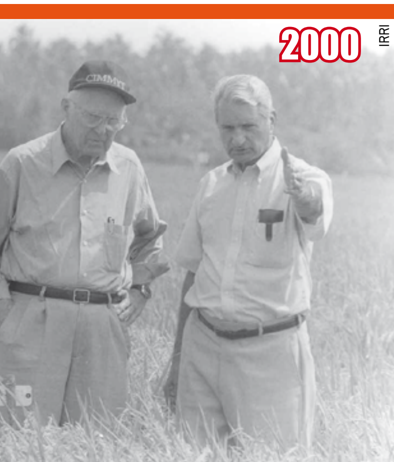
After retiring from IRRI this year, Dr. Virmani's experience and expertise will remain in great demand around the world. It is a testament to his achievements that rice hybrids he has developed are now commercially successful in India, Philippines, Vietnam, Bangladesh, Indonesia and Myanmar. Sri Lanka, Pakistan, Iran and Egypt are also ready to commercialize hybrid rice. And more than 70 seed companies in the public, private and nongovernmental sectors are currently investing significantly in hybrid rice.

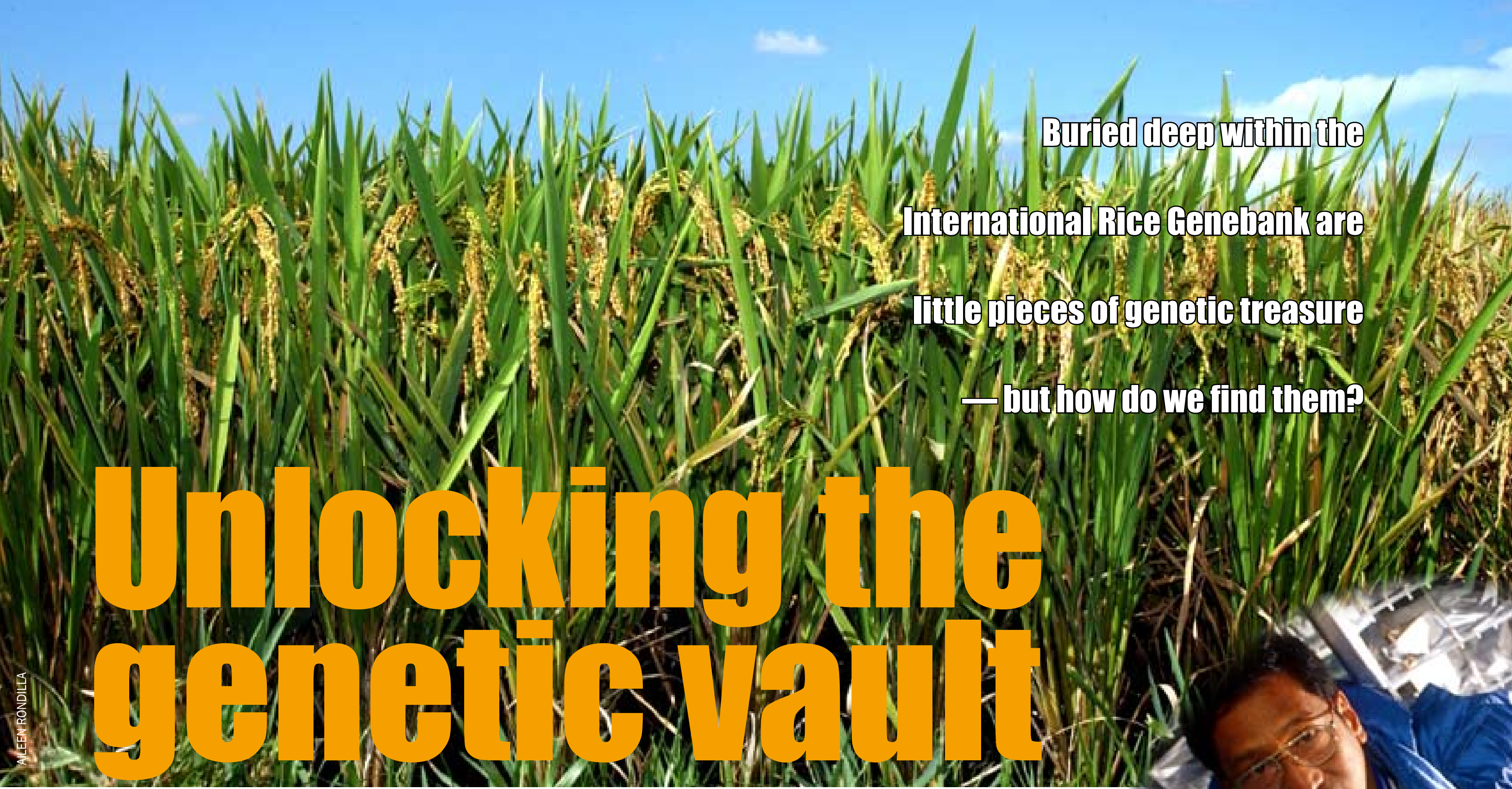
Sant Singh Virmani, hybrid rice pioneer, may be retiring — but he has left a legacy upon which others will build, and his work will continue to help feed the poor and the hungry.

Tim Overett is a career human resources practitioner who also writes about technical and policy matters.

Major dates in the development of hybrid rice

1964	Hybrid rice research commences in China.
1970	Chinese researchers discover a wild male-sterile rice variety and begin experimenting with hybrid rice.
1970	IRRI begins hybrid rice research but discontinues in 1972.
1976	China successfully develops and commercializes hybrid rice technology under the leadership of "the father of hybrid rice," Yuan Long Ping.
1977	China announces it is producing hybrid rice on an economic scale.
1979	IRRI revives work on developing hybrid rice for the tropics.
1986	First International Symposium on Hybrid Rice held in China in collaboration with IRRI.
1993-94	India adopts IRRI hybrid rice in its market economy with the participation of private seed industry.
1996	India has 150,000 hectares under hybrid rice, encouraging several other countries outside China to start working on hybrid technology.
1999	Philippines and Bangladesh begin using hybrid rice from IRRI. China joins the IRRI-sponsored International Hybrid Rice Network involving national agricultural research systems in India, Indonesia, Bangladesh, Philippines, Sri Lanka and Vietnam.
2000	Seed production of hybrid rice becomes commercially viable in India, Philippines, Vietnam and Bangladesh.
2004	Hybrid rice covers 1.5 million hectares in Vietnam, India, Philippines, Bangladesh, Indonesia and Myanmar.





AILEEN RONDILLA

Buried deep within the International Rice Genebank are little pieces of genetic treasure — but how do we find them?

Unlocking the genetic vault

by Ruaraidh Sackville Hamilton and Ken McNally

Imagine the diversity of rice that the International Rice Research Institute (IRRI) conserves in the International Rice Genebank. The Philippines-based repository, responsible for safekeeping all known types of rice, contains more than 100,000 strains and varieties (each is referred to as an “accession”). Many of these comprise a mixture of different genotypes. Each rice genotype — that is, the genetic makeup that defines each type of rice — has an estimated 50,000 genes. Every gene comes in an unknown number of different versions, known as alleles, and each allele may change the way the rice looks or grows or tastes. Consider the incalculable number of different possible combinations of all the different versions, and you begin to comprehend the diversity of rice.

Try a simple calculation, assuming that only two alleles of each gene actually work: write down the number “1” and then write 15,000 zeros after it. Equivalently, say “million” a thousand million times (it’ll take you 12 years without sleeping). Give or take a few thousand zeros, that’s approximately the number of combinations of alleles that might make a recognizable rice plant. Then consider the enormous complexity of interacting biochemical reactions that drive the life of any organism — each allele may have a different effect on any one of the thousands and thousands of biochemical steps. Changing one step produces a series of cumulative effects, altering each subsequent step and, ultimately, the overall biochemical process. The point is that a seemingly small genetic difference can produce significant differences in the end product. Each gene affects many traits and each trait is controlled by many genes.

Rice agriculture depends on this diversity. If a new rice disease appears, researchers can search the genebank for resistant varieties. The alleles required to make rice more tolerant of drought, for example, exist within the varieties contained in the collection. The genebank contains the diversity of alleles we need to respond to changes in climate, consumer expectations, agricultural technologies and government priorities.

The entire genebank collection may contain samples of most working versions of each rice gene. The full value of the collection is being, and will be, realized through plant breeding — combining the best alleles from different genes in different accessions to create superior new combinations of the traits needed by farmers and consumers. In this way, researchers can breed nutritious, high-quality, high-yielding rice varieties that are resistant to pests and diseases and tolerate stresses such as drought, flooding, low or high temperatures and poor soils.

This seems simple enough in principle, but leaves us with some burning questions. How can we identify the best combinations of alleles? How can we identify the “best” allele of each gene? When a new disease appears, how can we know which alleles offer resistance

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RESEARCH TECHNICIAN Bernardo Mercado pulls a sample from IRRI’s International Rice Genebank. The genes contained therein may eventually help to produce healthy, high-yielding rice (*top*).

to that disease? And once we know which alleles, how can we find which of the genebank's more than 100,000 accessions contains them? The challenge is formidable. We are yet to discover the function of most rice genes, or which alleles are possible for most of the genes.

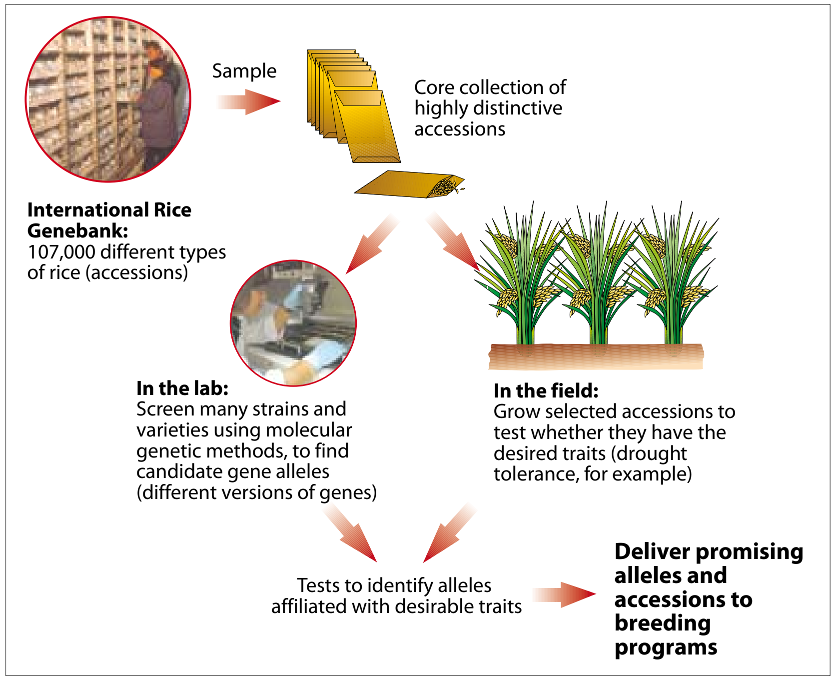
Compounding the difficulty, much of the genetic variation is "hidden" in two ways. First, the effect of an allele depends on the genetic background — the genetic composition of the rest of the genome — and may not be expressed in the accessions that contain it. (The rice genome is the complete set of genetic material contained in, and responsible for, a rice plant.) Second, even where an allele is expressed, it takes a lot of research to tease out its effect from the effects of all other genes in the genome.

Finding the unknown valuable alleles in the collection is called "allele mining." Discovering all there is to know about the genetic diversity of rice is way beyond the capacity of current technologies.

The necessary first step to actually mining for new alleles in the genebank collection is to decide which part of the genome we should explore. Which genes should researchers look at? Discovering the important genes involves an intensive series of genetic analyses of a small, carefully-selected set of genotypes. This area of functional genomics, or gene discovery, allows us to decide which parts of the genome determine agronomic traits of interest. The answer depends on which traits we are interested in — grain quality, nutritional value, disease resistance, tolerance of poor soils and so on. The output of this research is a set of "candidate genes" — genes that we believe may have a certain functional significance.

Having chosen the candidate genes for exploration, we can start the serious business of allele mining — discovering new alleles at the selected genes. This means working through the collection to find all the alleles of these selected genes. Researchers can't just start with the first accession and work through the collection. Such an approach would be inefficient, since the second accession, for example, might be similar to the first at the chosen genes, so analyzing that second accession wouldn't give us much additional information. Instead, we begin by choosing a subset of highly distinctive accessions. This subset is known as a "core collection."

Mining alleles



To choose the best core collection, researchers collect a wide range of evidence on diversity, then sample accessions representative of this diversity. One easy generic factor is geographic origin. Traditional varieties from different parts of the world have had an independent history of domestication for thousands of years, and are therefore likely to show differences across the whole genome. This way, researchers can discover at least the majority of new alleles in a relatively small number of accessions.

However, even a good core collection won't allow us to discover all possible alleles. Plant breeders are familiar with the concept that breeding is a "numbers game." Breeders need to screen large numbers of plants in order to find the rare valuable genotypes. The same applies to allele mining — if a valuable allele is present in only one of the 100,000-plus accessions, we will miss it from a core collection. Ultimately, we may have to screen the whole collection. With allele-mining technologies rapidly becoming cheaper and faster, this will soon be within our grasp.

However, simply discovering the new alleles is not the end of the story. Each time we discover a new allele at a candidate gene, we then have to determine its agronomic significance. Here we go back to a new round of functional genomics research to assess the value of the new allele.

By discovering the full diversity of available alleles and their agronomic significance, we can finally look forward to genebanks achieving their full potential — contributing to sustainable development by enabling us to deploy the right alleles in the right places at the right time.

Dr. Sackville Hamilton is head of IRRI's Genetic Resources Center. Dr. McNally is a molecular geneticist in the Genetic Resources Center.

Building a better rat trap

by Adam Barclay

Amid the spectacular mountains of the northern Philippines, an improved rat trap is helping farmers prevent rodents from devastating precious rice fields

A crafty, cunning creature is the rat. And when it comes to rice crops, some species of rats are truly devastating. Rodents are considered the single most destructive pest of rice crops in Southeast Asia, consuming enough rice every year to feed millions of people. They attack all stages of the rice plant and are extremely difficult to control. Not only do rats reduce yield, they also consume and contaminate stored food and carry diseases such as leptospirosis, rat typhus and plague.

All across the rice-growing world, farmers are crying out for effective ways to control rodents. The situation is no different in the northern Philippine municipalities of Banaue and Hungduan. There, rat damage can cause yield losses of up to 75%.

Now, though, an improved system for trapping rodents is helping rice farmers in these famously scenic areas (Banaue is home to stunning, 2,000-year-old World Heritage–listed rice terraces). The community-based approach builds on the trap barrier system (TBS), which is based on methods developed in the 1980s by Malaysian scientist Lam Yuet Ming. Known as the community trap barrier system (CTBS), it is a chemical-free rodent-management system that helps reduce rat damage, improve hygiene and increase rice yields and farmers' income.

A key to the CTBS is an area of rice known as the trap crop, planted inside a farmer's rice field in advance of the main crop. Tempted by the chance for an early-season

STAFF from the Philippine Rice Research Institute inspect a community trap barrier system (CTBS) in Banaue, Philippines. In another area of Banaue, a CTBS (*taller rice in center of page*) sits in front of a stunning view of the region's famous rice terraces.

GRANT SINGLETON (2)


GRANT SINGLETON (*crouching*) talks to farmers about the impact of rodents in the Banaue rice terraces.

PHILRICE

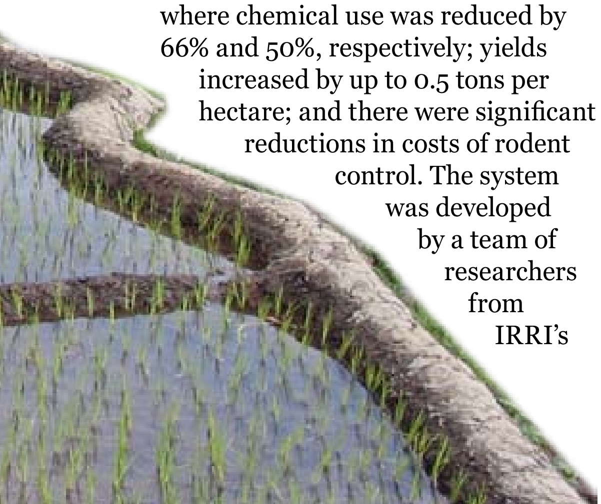
reward, rats are lured into simple, easily-constructed mechanical traps.

"The idea is very interesting," says K.L. Heong, leader of the Rodent Ecology Work Group at the International Rice Research Institute (IRRI), "because it's a trap within a crop. Instead of setting traps outside the rice crop, you set them inside."

Rats can bring destruction because of their ability to multiply extremely quickly. Rice-field rats have a short, 3-week pregnancy and average litters of 11-12 pups, which are ready to breed at only 6 weeks of age. Breeding-age females can become pregnant again within a few days of giving birth, potentially leading to three litters — 30-40 new rats — per first-generation female during the early phase of the crop. In two cropping seasons, a single adult breeding pair of rats can produce 500 descendents.

One benefit of the CTBS is that it doesn't rely on expensive, toxic or environmentally damaging poisons. This is especially important in developing countries, where poor farmers sometimes use cheaper poisons not intended for use against rodents, and which can kill other species, including domesticated farm animals and natural predators of rodents such as birds of prey. The toxins can, of course, also be poisonous to the farmers themselves. Loss of biodiversity — especially among invertebrates at the base of the food chain — can hurt the local ecology through increased damage by insect and rodent pests and a consequent increased reliance on the same inappropriate toxins.

The CTBS has already enjoyed success in Vietnam and Indonesia, where chemical use was reduced by 66% and 50%, respectively; yields increased by up to 0.5 tons per hectare; and there were significant reductions in costs of rodent control. The system was developed by a team of researchers from IRRI's Rodent Ecology Work Group, Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Indonesia's Institute for Rice Research, with funding from the Australian Centre for International Agricultural Research. Ravindra Joshi and his team from the Philippine Rice Research Institute (PhilRice) under the Department of Agriculture, Republic of the Philippines, together with CSIRO's Grant Singleton, have been using comics and posters to promote use of the CTBS in Banaue and Hungduan, where rice farming is the major source of income for the area's indigenous Ifugao people. At the PhilRice Central Experiment Station in Nueva Ecija, the CTBS has become standard practice.



Another key to the CTBS is that first word: "community." When it was merely the TBS, the traps were available to farmers who could afford them. But not all farmers had enough money and, because most rice farms in Asia are small, not all farmers need to use the trap themselves. One system can protect 10-15 hectares of irrigated rice, typically an area covering around 10 farms, allowing farmers to share the costs and benefits. It is much more efficient to have one farmer plant a trap crop 2 to 3 weeks ahead of the surrounding farmers, to trap rats early in their breeding season before they can rapidly multiply. The rats' strong sense of smell leads them to the trap crop, which is contained inside a plastic barrier dotted with openings that let the rodents in but not out.

Dr. Heong points out that the community action is in some ways both a blessing and curse for the CTBS, as organizing a group campaign can be tricky. "Without community action, it doesn't fly," he says. "With it, though, it's very good."

As well as being environmentally friendly, the CTBS allows farmer involvement from the planning stages through to setting the traps and capturing the rodents — a process that helps build a stronger community. The increased income generated from higher rice yields also benefits farmers, their families and ultimately the community as a whole.

"The CTBS is but one tool in an integrated approach to rodent management," notes Dr. Singleton. "Other actions include collecting rodents at key times and in source habitats, and increasing general hygiene around villages. Planting crops within a 2-week period effectively limits the rats' breeding season, which is linked to the development and ripening of the rice seed."

Dr. Singleton adds that while the CTBS has proven successful in irrigated lowland rice-growing systems, it has been less effective in rainfed and upland systems where, consequently, other community actions take on higher importance.

Dr. Singleton's team and the Rodent Ecology Work Group won CSIRO's Partnering Excellence Medal in 2002 for their CTBS research and development. The medal recognized excellence in providing international leadership, scientific expertise and training in ecologically-based management of rodent pests in Australia and Asia, through building quality partnerships.

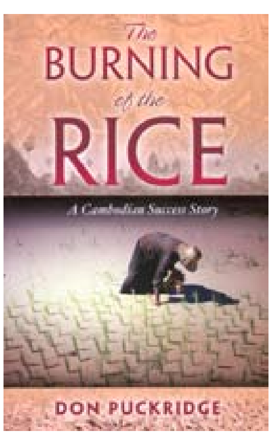
Novel ways to share knowledge

Innovations in Rural Extension – Case Studies from Bangladesh: Paul Van Mele and Noel Magor, Eds; Published by CABI Publishing, UK.

Innovations in Rural Extension describes new and creative ways to share knowledge with farmers. Presenting case studies from Bangladesh during the 5-year Poverty Elimination Through Rice Research Assistance project, the book illustrates the use of innovative methods such as video, songs and women-led extension to share knowledge with farmers on topics including seed production, postharvest technologies and integrated rice-duck farming. The book examines numerous approaches and assesses their potential for replication and growth.

A burning read

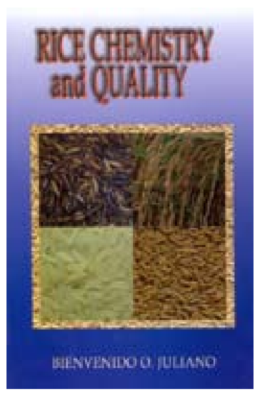
The Burning of the Rice – a Cambodian Success Story: Don Puckridge; Published by Sid Harta Publishers, Australia.



New Agriculturist online has highly recommended *The Burning of the Rice*, praising the writing style of author Don Puckridge as making "this fascinating book accessible far beyond the obvious 'science' audience." The book tells the story of the remarkable recovery of Cambodian agriculture following the devastation wrought by years of Khmer Rouge rule. Dr. Puckridge was part of the IRRI team sent to Cambodia to work with Cambodian scholars and scientists to help re-establish the country's rural economy. To read a short excerpt from the book, see *Rice Today*, Vol. 4 No. 1, page 15.

Valuable reference on rice chemistry

Rice Chemistry and Quality: Bienvenido Juliano; Published by the Philippine Rice Research Institute.



Rice Chemistry and Quality, written by former IRRI cereal chemist Bienvenido Juliano, is a revised and updated version of *Rice Chemistry and Technology*, 2nd edition (1985). In the new book, Dr. Juliano has summarized his accumulated experience over 4 decades of rice research, describing all aspects of rice chemistry and rice grain quality, and citing relevant work by other scientists. A review by the journal *Starch* states that the book is "intended for anyone interested in rice, in particular researchers, teachers and students, and is an informative and valuable reference work."

World Rice Research Conference proceedings

The World Rice Research Conference (WRRC), held 4-7 November 2004 in Tokyo and Tsukuba, Japan, marked the culmination of the International Year of Rice 2004. Nearly 500 papers and posters were presented under the conference theme of "Rice is life: scientific perspectives for the 21st century." Akinori Noguchi, Vice president of the Japan International Research Center for Agricultural Sciences and Chairman of WRRC 2004, described the proceedings as containing "the state of the art in rice science and production that we hope will be useful to rice scientists, extension specialists, development agents and policymakers." Download a free PDF version of the entire proceedings from www.irri.org/publications/catalog/catalog.asp?ref=R#005-971-22-0204-6 or purchase the CD online or at IRRI's Riceworld Bookstore.

Toward a hunger free world

Toward a Hunger-Free World – life and Work of M.S. Swaminathan: Anwar Dil, Compiler and Editor; Published by Intercultural Forum, U.S.A.

Against a background of serious food shortages following World War II, M.S. Swaminathan recognized the potential of harnessing different plant varieties of rice and wheat to advance food production. Over the last 4 decades, his objective has been a hunger-free world. A new compilation by Anwar Dil brings together the writings of Dr. Swaminathan on how to free the world from hunger and poverty, together with perspectives on his life and work. A review in *The Hindu* newspaper regards this publication "a reference book of a rare kind for all engaged in the task of alleviating hunger and poverty, [...] which should serve as a source of inspiration to the younger generation."

Awards for rice insect book

Rice-feeding Insects and Selected Natural Enemies in West Africa, by E.A. Heinrichs and Alberto T. Barrion and edited by G.P. Hettel, has won two major awards from the U.S.-based Association for Communication Excellence (ACE). Published jointly by IRRI and The Africa Rice Center – WARDA, the book won a Gold Award in the Editing Class and a Bronze Award in the Technical Publications Class in the Publishing Category of ACE's Critique and Awards Program. The publication provides the first comprehensive taxonomic keys to West African rice-feeding insects and their natural enemies, describing the presence and abundance of important insects and spiders in the various climatic zones and rice ecosystems of the region. It can be purchased online at www.irri.org/publications/catalog/index.asp.

Does rice research reduce poverty in Asia?

by Mahabub Hossain
Head, IRRI Social Sciences Division

ARIEL JAVELLANA

Over the past 4 decades, rice research has achieved substantial progress in developing genetically improved rice varieties and more efficient management of natural resources and inputs (fertilizer, pesticides, new seeds and labor). These advances have helped farmers increase productivity and decrease production costs, as well as reduce the crop maturity period, thereby releasing land to grow another crop during the year. Rice is the principal agricultural crop in most Asian countries, often accounting for more than half of total cropped area, so improved technologies can have an enormous impact — potentially more than doubling rice yields and farm profits, and reducing the unit cost of production by 25%, compared to traditional rice varieties. But to what extent do such improved technologies really benefit the poor?

In the early 1970s, many social scientists argued that the new technologies, which sparked the Green Revolution, would bypass small-scale farmers who would be unable to afford the necessary irrigation, drainage and inputs. But, inspired by the improved yields and profitability offered by the new technologies, both governments and farmers increased investment in irrigation infrastructure. Larger farmers adopted the new systems first, but small-scale farmers soon caught up.

Access to irrigation and well-drained land are the major determinants for adoption of improved rice varieties. Socioeconomic factors such as farm size and lack of access to institutional credit have not proved to be major constraints. By the 1990s, improved varieties had extended to almost 70% of rice area.

The most important factor limiting the contribution of improved rice technologies to poverty reduction in Asia is scarcity of land and small farm sizes. Over two-thirds of farm households in Asia cultivate less than 1 hectare, which is insufficient to generate an income above poverty level, even with improved technology.

One-third to one-half of rural households in developing Asia are landless and these depend on agricultural labor and nonfarm activities (such as transport operation and construction) for their livelihood. They do not gain directly from improved technologies and better land productivity, but they benefit from consequently cheaper rice — equivalent to a higher real income and purchasing capacity, given that the poorest of the poor spend a large proportion of their money on food in general and, in Asia, rice in particular. And the reduced unit cost of food production means that lower prices don't cut profits for small-scale farmers. Decline in the real (inflation-adjusted) price of rice is the main factor behind the moderate progress in poverty alleviation seen over the past 3 decades.

Improved technologies can have an enormous impact

But technological progress is running out of steam for irrigated rice ecosystems and, with water becoming increasingly scarce, there is little scope for expanding irrigated areas. The potential for sustaining growth in irrigated rice production is limited unless researchers can further increase the yield potential of irrigated varieties or improve water-use such that irrigated area can expand. There is still some scope for increasing production in rainfed environments, where the yield is currently low. Rainfed ecosystems account for just over half of Asia's rice land and scientists are developing new rainfed varieties that can reduce the gap between achieved and potential yields. Keeping rice affordable for the poor — and consequent progress in poverty reduction — therefore depends on technological advances.

Growth in productivity, income and savings catalyzed by technological progress allows rural households to invest in children's education and nonfarm business, thereby spurring growth of the rural nonfarm economy. Ultimately, this process leads to a decline in agriculture's share of the rural and national economies. Such growth must go hand-in-hand with the development of rural infrastructure such as roads and electrification — without this, educated people tend to migrate to urban areas or abroad for better income-earning opportunities, draining rural areas of vital entrepreneurial skills.

Agriculture's role in poverty alleviation depends partly on the state of development of the economy. At low levels of economic development, where food production is a major source of employment and incomes, improved agricultural productivity has a substantial direct effect on poverty reduction, but this declines with economic prosperity. At the middle stage of development, diversification out of staple food and movement into nonfarm economic activities become important sources of rural income growth. But it is the increase in productivity of staple food crops — predominantly rice in Asia — that triggers economic growth and clears the path to prosperity.

Successful technology adoption needs support from both farmers and governments

M. Zainul Abedin
Farming Systems Specialist, IRRI Social Sciences Division

Involving farmers and farming communities in decisions about new agricultural technologies or management practices and allowing them to try a technology form the crux of the participatory approach to research. Not only does this give farming communities a sense of ownership, it also ensures that the technologies are sustainable under the farmers' own management.

But is farmer participation alone enough to ensure that new technologies are successfully adopted? Even if a new technology initially proves acceptable to farmers, it may ultimately be policy support from governments that catalyzes its spread. Attracting such support requires that governments themselves also participate in the technology adoption process.

In Bangladesh, the direct seeding of rice with plastic drum seeders provides a good example. A drum seeder consists of a series of perforated drums supported between two wheels. Seeds are placed in the drums and the device is hand-pulled by one farmer, allowing seeds to fall in rows into the puddled field. This technology offers great potential to save labor and increase yield and income for Bangladeshi farmers.

Beginning in the 2003 *aman* (monsoon) season, an IRRI-led drum-seeding trial had five farmers try the technology in their fields. By the next *boro* (dry) season, the trial had expanded to include farmers in 56 locations across the country. Now, after just three seasons, demand for drum seeders is rising rapidly. Some 4,000 Bangladeshi farmers are currently using the technology, with hundreds more seeking access to it.

In the early stages of the trials, IRRI, the Bangladesh Rice Research Institute and the Bangladesh Department of Agricultural Extension (DAE) supplied drum seeders to participating farmers. This was designed to be a starting point rather than a sustainable approach. In the longer term, IRRI envisioned a local manufacturer producing and selling drum seeders as a business venture, and local farmers purchasing directly or through retailers. But this is not something that IRRI and its research and funding partners can achieve alone — it requires the backing of the Bangladeshi government. Sure enough, encouraging government involvement has been a critical part of ensuring the policy support needed for widespread adoption of drum seeding.

Is farmer participation alone enough to ensure that new technologies are successfully adopted? Even if a new technology proves acceptable to farmers, it may ultimately be policy support that catalyzes its spread.

Through the DAE, the Bangladesh Minister for Agriculture, M.K. Anwar, has already allocated 10 million Bangladeshi taka (US$156,000) to support the project and has pledged to allocate more, as well as subsidize the cost of drum seeders for farmers, with the hope of seeing the technology spread throughout the country in the next 3-5 years. At every turn, the project team has encouraged Mr. Anwar and the State Minister for Agriculture, Mirza Fakhrul Islam Alamgir, to participate in field days and take other opportunities to talk to farmers who have tried the technology. The team now has a strong rapport with the ministers and their offices, and this has been crucial in negotiating further government support. Through their close interest in the technology adoption process, the ministers have become powerful allies and champions of drum-seeding technology.

In West Bengal, India, where drum seeding is in the early stages of trial and adoption, project leaders have already fostered relations with Sukhabilas Barma, the Principal Secretary of the state's Ministry of Agriculture, and the drum seeder is set to be included under a grant program for new innovation and mechanization. IRRI and its Indian partners have also briefed the Secretary of the national Ministry of Agriculture, Radha Singh, who has pledged her support through further grants to the state government. This will see drum seeders available to farmers at a nominal cost, and associated extension and training activities will be provided.

Without such government endorsement, where would the adoption process be? Certainly, there has been no problem in convincing farmers of the benefits of drum seeding. But without financial and policy support from the governments of Bangladesh and West Bengal, the spread of the technology would flounder. Allowing private enterprise to manufacture and distribute drum seeders — IRRI and its partners cannot simply continue to hand them out — also needs trade and investment policy support, areas well beyond the jurisdiction of the technology's researchers and developers.

In short, participation with governments — as well as farmers — in technology adoption ensures a far greater chance of ongoing success.

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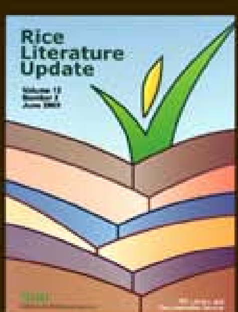

Rice Literature Update, vol. 13, no. 1, June 2005

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