Drought-proof rice for African farmers

by **Savitri Mohapatra**

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

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

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

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

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

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

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

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

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

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

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

Now, WARDA scientists and their partners are investigating these gene pools. They are

integrating phenotypic screening (physical characteristics) with molecular analysis (genetic composition) to unravel the secrets of drought tolerance.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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