Khady Nani Dramé

'The rice farmer need no longer sustain heavy losses in times of drought'

Although the degree of drought tolerance varies from one rice variety to another, most studies have so far been confined to Asian rice, *Oryza sativa*. In the first of a series of interviews commemorating the 10th anniversary of the L'ORÉAL–UNESCO Awards for Women in Science, we talk to Khady Nani Dramé, who is devoting her L'ORÉAL–UNESCO Fellowship obtained in February 2007 to the study of the genetic basis for drought tolerance not in *O. sativa* but in another species, *O. glaberrima* or African rice, grown exclusively in West Africa.

Born in Senegal 28 years ago, Khady Nani Dramé holds a PhD in molecular ecophysiology from the University of Paris XII (France), where she focused on the drought tolerance of the peanut. In West Africa, drought is one of the primary constraints for both rainfed and artificially irrigated rice production, owing to poor water management. With rice being a staple food for both urban and rural populations and with domestic production unable to keep pace with demand, most African countries import large quantities of the high-yielding *O. sativa*. Through her research, Khady Nani Dramé hopes to reduce this dependence on rice imports.

What distinguishes a drought-tolerant rice variety from other varieties?

From an agronomic point of view, a drought-tolerant variety is one capable of maintaining good yields in times of drought when other varieties, in the same conditions, produce little or nothing. From a physiological point of view however, a drought-tolerant variety is not necessarily the most productive. Rather, it is the one best-equipped to survive – and for the longest – a lack of water in its cells. It is also the most adept at resuming normal development once water again becomes available. It does this by triggering specific adaptation mechanisms to keep its cellular functions intact when there is a water-deficit.

How do you go about identifying highly drought-tolerant *O. glaberrima* varieties?

We set up field and pot trials, during which several *O. glaberrima* varieties at different stages of development are subjected to drought by suspending watering. Various traits are evaluated to identify which varieties adapt best to a lack of water without heavy losses in terms of yield. These traits include the closure of the stomata – those minute pores on the leaf through which gaseous exchanges and transpiration take place –, leaf-rolling, the water potential, total biomass and yield.

This is only the first stage?

Yes. Afterwards, we shall attempt to cross those African rice varieties we have identified as being best-suited to drought with some Asian rice varieties. The rice farmer who is able to count on these durably drought-resistant seeds need no longer sustain heavy losses in times of drought, enabling him or her to break even.

African rice shows good adaptability to abiotic and biotic stresses, including drought, but yields poorly because of lodging and seed-shattering. Asian rice on the other hand may be ill-suited to the environmental rigours of sub-Saharan Africa but it is very productive (*see photo overleaf*).

Hence the idea of combining the tolerance traits of *O. glaberrima* with the high-yield potential of *O. sativa* to obtain rice varieties that are both tolerant to environmental rigours and highly productive. However, the two species (*O. glaberrima* and *O. sativa*) are separated by considerable reproductive barriers which cause sterility in first-generation (F_1) hybrid offspring. My host institution, the Africa Rice Center (WARDA[5]) in Cotonou, Benin, has developed breeding techniques based on backcrosses and anther culture – anthers being the male organs containing the pollen grains – to get around these barriers. Thanks to this, WARDA has obtained interspecific lines that produce good varieties known as NERICA, the acronym for New Rice for Africa. It was Dr Monty Jones by the way, a WARDA researcher, who was the first African to be awarded the World Food Prize in 2004 for developing the NERICA varieties.

Where are you now with your research?

Via field and greenhouse screening, we have now identified seven varieties of African rice that perform well in drought conditions.

In order to transfer these traits, two of the seven *O. glaberrima* varieties have been selected and crossed with a drought-sensitive variety in order to improve trait segregation. The sensitive parent selected was an Asian rice variety performing well agronomically, with a high yield and a good-quality grain.

Crossing these individuals – a drought-tolerant male parent and a drought-sensitive female parent but who has good agronomic characteristics – will make it possible to obtain a population that segregates for the trait of interest, in order to identify QTLs[6] (or genes) associated with drought tolerance and perhaps to obtain offspring combining the drought tolerance and good agronomic performance inherited from each of the two parents.

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Rainfed Oryza glaberrima *grown by farmers in Guinea Bissau.* O. glaberrima *is derived from the wild annual* Oryza barthii, *which probably grew abundantly in lakes in what is now the Sahara 10 000–6000 BP. Whereas it depends solely on rain and surface run-off from Senegal to northern Cameroon,* O. glaberrima *depends more on river water than on rainfall in much drier climates, like those of Mali and Niger. Although it prefers fertile alluvial soils,* O. glaberrima *tolerates low soil fertility. In most of West Africa, at least in commercial farming, African rice has been replaced by Asian rice, which is more productive, shatters less easily and has a softer grain that is easier to mill. Small-scale farmers in West Africa often still prefer to grow African rice, however, for its taste and culinary properties, its ability to withstand flooding and its resistance to several diseases and pests (Adapted from: http://database.prota.org)*

It will take at least two or three generations to develop the population before we obtain drought-tolerant material through introgression of the tolerance gene(s) identified in popular varieties from Senegal.

Over this phase corresponding to the first 12 months of my fellowship, we have managed to identify some drought-tolerance donors and to initiate interspecific crossings between *O. sativa* and *O. glaberrima*, in order to transfer this trait.

How do you plan to commercialize the new high-yielding, drought-tolerant varieties of rice?

WARDA is a non-profit centre. The seeds of these drought-tolerant, high-yielding varieties will be distributed to the national agricultural research systems of the countries concerned for wider distribution to farmers.

Several African countries are members of WARDA, which used to be an association for the development of rice in West Africa before joining the Consultative Group on International Agricultural Research (CGIAR). These include Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger and Senegal as well as newcomers Central African Republic and Uganda from Central Africa. WARDA always works in partnership with the national agricultural research systems of these countries, with which it exchanges the new promising varieties.

Above all, I hope these varieties will be adopted widely in order to improve and stabilize rice production in Africa. It is a massive challenge which goes beyond purely scientific considerations. According to FAO, rice imports in Africa currently stand at around 9.6 million tonnes a year at an annual cost to the currency-strapped countries of sub-Saharan Africa of over US$2 billion. Better local production, in terms of quantity and quality, will increase farmers' earnings and reduce imports, thus lessening dependence on foreign markets and contributing to overall development of the region.

What would you say to anyone suggesting that sorghum might be better-suited to semi-arid countries than rice, even of African origin?

Growing sorghum instead of rice in semi-arid countries? In Africa, we are lucky enough to have various types of grain, among them sorghum, fonio, maize and millet. In practically all sub-Saharan African countries, and particularly in the Sahel where most countries have a semi-arid climate, more rice is consumed than any other grain in both urban and rural areas. This is because rice cooks quickly and is easy to prepare, unlike fonio and sorghum, as well as more readily available on the market.

Selecting drought-tolerant rice varieties doesn't mean supplanting other cereals, as we must preserve our diversity, but it will enable us to offer farmers and rice-growers varieties that are better-suited to their environment, particularly given the changes we are seeing in climate, and to cater to their eating habits with local rather than imported rice.

Interview by Susan Schneegans

5. *The Africa Rice Center: www.warda.org*

6. *A locus is a precise and invariable position on a chromosome. A quantitative trait locus (QTL) is a locus where the variation of the alleles is associated with the variation of a quantitative characteristic (heredity trait). An allele is a given variant of a gene in a species*