Bringing Chinese rice technologies to Africa

China is the ancestral home of rice, with a long history of rice cultivation, and remains the largest producer of rice in the world (not surprising when its 1.4 billion population consumes an average of 76.8 kg milled rice per person per year). Thus, the Chinese have had plenty of time to develop advanced cultivars and other technologies to fine-tune its rice production sector.

China has built the world's largest capacity in rice breeding. The 'Green super rice' (GSR) project was launched in 2009 to make Chinese rice varieties accessible to rice researchers and rice farmers in Africa and Asia. This project will take advantage of China's breeding capacity and major scientific advances in plant genomics and molecular breeding for poverty alleviation by developing and adopting GSR hybrid and inbred cultivars in eight countries in Africa, four in Southeast Asia and three in South Asia. GSR cultivars are expected to have good resistance or tolerance to major abiotic and biotic stresses of rice and thus have more stable yield. The project partners are AfricaRice, the Chinese Academy of Agricultural Sciences (CAAS), IRRI and the NARS of the target countries on the two continents. The Gates Foundation funding flows through CAAS to AfricaRice and its partner NARS. The main focus is on cultivar development and dissemination.

The Africa component started in earnest in 2008, with AfricaRice implementing the project in eight countries (Ethiopia, Liberia, Mali, Nigeria, Rwanda, Senegal, Tanzania and Uganda). In the first phase (2008–2011), most of the Chinese cultivars succumbed to African rice gall midge (AfRGM), *Rice yellow mottle virus* (RYMV) and African races of the blast fungus.

"The 'green' in the GSR means environment-friendly," says Kumashiro: "less chemical fertilizers and less chemical pesticides. Thus, it assumes that germplasm provided (developed) by the CAAS carries high yielding capacity under less inputs of fertilizer, plus resistances to biotic stresses. The latter was not achieved in CAAS's initial germplasm in Africa, which succumbed to AfRGM and RYMV. This is natural because both are indigenous to Africa."

Consequently, the second phase of the project (2012–2015) is using African rice germplasm as donors for local adaptation (including resistance to AfRGM, blast and RYMV). In the second phase, AfricaRice is taking the lead in West Africa (Mali, Nigeria and Senegal), while IRRI is coordinating activities in East and Southern Africa (Burundi, Ethiopia, Mozambique, Rwanda, Tanzania and Uganda). Bulk segregating populations from CAAS (comprising F_2, F_3 and BC_1F_2 populations) have been evaluated at sites in Mali, Nigeria and Senegal that are key sites for phenotyping for high yield potential, drought, alkalinity, iron toxicity, bacterial blight, blast, RYMV, AfRGM and salinity. For promising lines, controlled screening for blast resistance is conducted in Benin.

Further down the road of selection, promising pure-breeding lines are nominated to the Africa-wide Rice Breeding Task Force trials, starting with the Multi-Environment Trial for irrigated and rainfed lowland rice-growing environments. Thus, through the breeding task force, GSR lines are made available to all AfricaRice member states and other task-force participant countries beyond the GSR target countries.

By the end of 2014, Mozambique, Rwanda, Tanzania and Uganda had released GSR cultivars, and Mali and Senegal had cultivars in the pipeline for release.

The national partners have developed seed roadmaps and formed partnerships with seed producers in all project countries. Thus, once GSR cultivars are available, seed will be given to the commercial sector to produce Certified Seed for farmers.

The project also has a capacity-building component, with NARS scientists and technicians and seed producers being trained in molecular breeding techniques, and seed production and commercialization. Seed training is conducted for technicians at AfricaRice followed by in-country training by these trainers of seed producers, which has reached more than 100 partners in the eight countries.

"Like STRASA, GSR is also producing good results," says Manneh, who is also coordinator of the African component of GSR, "with adapted varieties outyielding the checks and starting to be released."

STRASA and GSR coordination meeting at the Third Africa Rice Congress, Yaoundé, Cameroon, October 2013

Diffusion and impact of improved varieties in Africa

The 'Diffusion and impact of improved varieties in Africa' (DIIVA) project was funded by the Gates Foundation through Bioversity International. The project was designed to update, widen and deepen an initiative in the late 1990s that estimated the adoption of 'modern varieties' across sub-Saharan Africa (yielding an overall estimate of "about 22% of the growing area of primary food crops"). AfricaRice was one of eight CGIAR centers involved in DIIVA, as the key center for rice.

The DIIVA partners first defined 'modern varieties' "as improved varieties released after 1970 that are available for adoption because of crop improvement efforts in the public or private sectors," says the CGIAR Standing Panel on Impact Assessment (SPIA) brief that summarizes the project results. They "also include 'escapes', products of participatory varietal selection from improved materials, and breeding outputs in countries that do not have a functioning formal release and registry system. Released varieties that are local landraces are not counted as [modern varieties] in their country of origin." Adoption estimates were primarily generated through expert opinion, but DIIVA also drew on its own adoption studies, other adoption studies, inferences from the literature, and seed production and trade figures.

DIIVA calculated that, in 2010, modern varieties covered 35% of the area for 20 primary and secondary food crops across sub-Saharan Africa. About 3500 improved cultivars had been released for these crops since 1970, and more than 1150 improved varieties and hybrids had been adopted by farmers.

The data generated by AfricaRice in 19 of the project's 20 focal countries showed that modern rice varieties covered 2,582,317 ha out of a total rice area of 6,787,043 ha, i.e. a 38% adoption rate.

The study drew a number of conclusions on adoption of modern crop varieties:

- Low investment causes low adoption.
- Countries differ greatly in adoption behavior.
- The CGIAR contribution to adopted modern varieties was in excess of 80%.
- Market forces play a major role in adoption (highlighted by high scores for commercial maize, soybean and wheat).
- There is an absence of widely adapted varieties in Africa (notable exceptions included NERICA 1).

"The results of the DIIVA project show that it is possible to establish a comprehensive benchmark on the diffusion of [modern varieties] in [sub-Saharan Africa] for a relatively small quantity of resources," according to the SPIA brief. "Extrapolating past performance to the future suggests a target of around 50% … adoption by 2020."