

**Generation Challenge Programme**  
**April 2010**

**Project Title: Improving rice productivity in lowland ecosystems of Burkina Faso, Mali and Nigeria through marker-assisted recurrent selection for drought tolerance and yield potential**

**Targeted Challenge Initiative:** Drought-tolerant rice for Africa

**Targeted Subprogramme:**

Principal Investigator and Lead Institution: Marie-Noëlle Ndjiondjop (AfricaRice)

**Specific Target Countries:** Burkina Faso, Mali, Nigeria

Collaborating Institutions and Scientists:

- Africa Rice Center, Benin: Marie-Noëlle Ndjiondjop
- Institut de l'environnement et des recherches agricoles, Burkina Faso: Drissa Hema
- Institut d'économie rurale, Mali: Fousseyni Cisse
- National Cereals Reserch Institute, Nigeria: Alhassan Maji
- International Rice Research Institute, Philippines: Rachid Serraj
- Institut de recherche pour le développement, France: Alain Ghesquiere
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**Executive Summary**

World paddy production is reached a new record level of 666 million tonnes in 2008. However, in Africa, rice production has not increased at the same rate and has not been able to keep pace with increasing demand. Only 54% of the Sub-Saharan Africa rice consumption is supplied locally. In 2009, rice imports in Africa were forecast to approach 9.3 million tonnes. Among the various abiotic and biotic factors reducing rice yield in West Africa, drought is considered the most important. Rice yield is affected by drought in rainfed lowland ecosystems in around 80% of the total rice area in Mali, 67% in Burkina Faso and 48% in Nigeria, as a result of erratic rainfall and poor water control. Three drought-related risks can be distinguished in rainfed lowlands: (1) early drought, especially in direct-seeded, poorly managed systems; (2) mid-season drought spells alternating with flooding; and (3) terminal drought. Rice breeders have developed improved varieties for rainfed lowland ecosystems, but the complex nature of rainfed lowlands makes it difficult to delineate clearly the target domains of these varieties. Developing drought-tolerant cultivars that have a high yield potential in normal years and provide a good yield under drought and other major stresses for each target environment will help sustain rice production in the large rainfed lowland ecosystem across Africa.

The project will focus on the rainfed lowland ecosystems of Sudanean and Guinean savannah areas in Burkina Faso, Mali and Nigeria. Within 4 years, it will establish (i) the drought profiles of the target population of environments (TPE) in inland valley lowlands; (ii) the identification of traits of interest for targeted environments, using novel phenotyping methodologies enabling an efficient separation of genetic (G) and environmental (E) effects; and (iii) the integration of the information on drought profiles with novel phenotyping

methodologies in a marker-assisted recurrent selection (MARS) scheme to develop better adapted germplasm for each major target environment.

The MARS approach consists of concentrating breeding investments in a few crosses of high potential, and fully exploiting this potential. Quantitative trait loci (QTL) for target traits are detected within the population from each cross and are then 'pyramided' by crossing lines within the population using marker information at each generation. The approach is widely used by private companies to improve breeding efficiency for quantitative traits. The MARS populations developed under this project will be phenotyped under controlled drought conditions, mimicking the drought profiles of the target environments, and under well characterised field conditions. The QTLs involved in conferring drought tolerance or in increasing yield potential in the target environment will be mapped within each cross, and the QTL x environment interactions will be elucidated. Recurrent recombination of specific individuals of the population carrying the favourable allele of the detected QTLs will lead to the creation of adapted lines bearing the favourable QTLs/alleles for drought tolerance and for other important traits.

The combined results of TPE characterisation and the adapted lines developed will facilitate the up-scaling of research results to non-project countries, will increase the adoption rate of the improved varieties and, finally, increase the contribution of rainfed lowland rice in the total rice production of Sub-Saharan Africa.

The project will introduce a new approach – MARS – into NARS and AfricaRice breeding programs through building capacity for modern plant breeding and establishing the systematic use of molecular tools in breeding for quantitative traits. This 4-years project will aim to build a proof concept that the application of MARS in rice, with a focus on drought as target trait, can contribute to increased yield and to change the way breeders involved in this project work. Consequently, the project should put in place a flow of long-term capacity-building with the objective of establishing a modern breeding program for complex traits such as drought in West Africa.