Increasing agriculture productivity and resilience in West Africa: Dryland cereals improvement strategies in WA for diversified agricultural models and adaptation to changing environments

Pearl millet and sorghum are dryland cereals that were domesticated in the Sahel area and are well adapted to the arid and low soil fertility conditions found in this region where they play a central role for food security. They are mainly cultivated by smallholder farmers (in Senegal for example about 90% of exploitations are less than 10 ha) and in low input cropping systems. These agricultural systems are very diverse and are threatened by global changes. Indeed, most climatic models predict that changing climatic patterns sub-Saharan Africa will have a huge impact on cereal yields in the area if we keep the current agricultural practices. There is therefore a need to develop sustainable strategies for crop adaptation combining plant breeding and new agricultural practices. Moreover, improving these crops for new food and non-food uses (beer, bioenergy, biomaterials, ...) could contribute to economic and social development in West Africa.

A need for revisiting crop improvement to address more diversity and more complexity

- Plant breeding has been so far more targeted toward specialized systems; partly because the uniformity of these systems simplifies the crop improvement problem thus providing opportunities for greater and faster genetic gains. In order to provide options for the diverse agricultural systems that are existing in West Africa and for the diversity of varietal needs that correspond to them, crop improvement needs to develop diverse and targeted strategies that can take into account the complexity of more generalized systems. In order to achieve this shift, crop improvement programs need to incorporate recent advances of many different disciplines and foster interactions between stakeholders of the crop improvement system.

- Recent genetic-genomic tools and approaches provides now a clear understanding of the genetic diversity of cultivated crops and their wild relatives which form the reservoir of variability for pre-breeding and breeding programs. Positioned in geographic space, crop diversity information can be linked to other layers of social, environmental, and agronomic data and contribute with other approaches to identifying genetic determinants of adaptation and traits of interest to improve breeding accuracy and efficiency.

- Crop modeling is another cornerstone of this general scheme, to identify combinations of traits, management and environmental conditions toward precisely designing plant ideotypes corresponding to traditional agricultural systems or targeting new end uses and value chains.

- Deciphering the complexity of interactions occurring in cropping systems involving associated crop species and their symbionts is a research front toward breeding in an agroecological perspective for sustainable intensification.

- The access and use of genetic resources as well as the diffusion of new cultivars need also to take into account regulation frameworks and to experiment innovative governance mechanisms for crop diversity management.

- Such integration of disciplines, approaches and actors can provide a boost to breeding programs toward a much more diversified portfolio of varietal options addressing the multiplicity of agricultural models and the forthcoming environmental changes.

New partnerships for research and education to foster interdisciplinary approaches

- In order to achieve these goals, we are using a new research and education partnerships model associating European (IRD and Cirad) and West African research institutes and Universities.

- The joint international laboratory on plant and associated microbes adaptation to environmental stresses (LAPSE) based in Senegal brings together researchers from IRD, Cirad, ISRA, UCAD University, Thies University and AlfortOffice to conduct research and capacity building activities on the sustainable intensification of crop production in West Africa.

- The IAVAO (Innovation and plant breeding in West Africa) partnership platform associates national research institutes and universities from Senegal, Mali, Niger, Burkina Faso, CIBAD, IRD and Montpellier SupAgro in France. It fosters regional collaborations to create inter- and interdisciplinary research and training programs in plant breeding. As far as education is concerned, the IAVAO platform is currently building a regional master in plant breeding and associated microbes adaptation to environmental stresses involving associated crop species and their symbionts is a research front toward breeding in an agroecological perspective for sustainable intensification.

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