Mobilizing Regional Diversity for Creating new Potentials for Pearl Millet and Sorghum Farmers in West and Central Africa

Definition of heterosis and the concept of heterotic grouping

The phenomenon of heterosis was first detected in maize. Shull defined heterosis in 1914 as, “The increased vigour, speed of development, resistance to disease and insect pests, or to climatic rigours of any kind, manifested by crossbred organisms as compared with corresponding inbreds as the specific result of unlikeness in the constitutions of the uniting parental gametes.”

Heterosis is due to a high degree of heterozygosity in the genome, that is, the presence of different alleles at many gene-loci in the homologous chromosomes. Heterozygosity can be increased by crossing genetically distinct parental materials, i.e. materials belonging to distinct heterotic groups. So heterotic grouping means identifying germplasm groups that are genetically distinct from each other and that produce superior hybrids when crossed. Heterotic pools, once detected, need to be maintained separately to ensure they remain unrelated by descent. Crossing representatives of different heterotic pools will maximise heterozygosity, hybrid vigour and yield stability of the new cultivars. The enhanced yield stability is due to enhanced capacity for individual buffering in heterozygous genotypes.

In the project ‘Mobilizing Regional Diversity’, heterotic groups are being identified for pearl millet and sorghum.
landraces from West and Central Africa (WCA). This is being achieved through the study of agro-morphological differentiation and the characterisation of genetic diversity at the DNA level via molecular markers. The project is working in tandem with the molecular marker laboratory in ICRISAT-India.

Heterotic groups identified via diversity analysis are validated through multi-location evaluation of intra-pool and inter-pool crosses. This enables identification of the optimal genetic distance among parental materials for attaining maximal hybrid vigour. At the same time, superior crosses can be directly employed as new experimental cultivars and then tested on farms.

In the allogamous (outcrossing) pearl millet, the detection and use of heterotic pools provides a basis for sustainable breeding of both open-pollinated and hybrid cultivars, as both types profit from heterozygosity and hybrid vigour. Results from the project are being employed in the development of highly heterozygous open-pollinated population varieties by crossing representatives of the heterotic pools. Such variety structures have wider potential for adoption at the moment in the absence of viable seed systems. The way is also being cleared for hybrid breeding. In the predominantly autogamous (self-pollinating) sorghum, the heterotic groups will be directly implemented in the development of new hybrids based on available male-sterile lines.

Photo: Heterosis for panicle length in sorghum: contrasting, genetically distinct parental lines are presented on the left and the right, and their resulting hybrid in the middle (Picture from H. Fred Weltzien-Rattunde).

Enhancing heterozygosity of pearl millet and sorghum cultivars through the exploitation of heterotic pools will improve both adaptation and yield stability under the low-input conditions of small farmers in WCA. It will also open up the possibility for intensifying production in the face of declining land availability.

Contact: Bettina HAUSSMANN, ICRISAT, b.i.g.haussmann@cgiar.org