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Genetic Diversity Management in Maize Breeding Programs using Genomic Selection.

There is an increasing awareness that crop breeding programs should balance short and long term objectives by maintaining genetic diversity to cope with future challenges. The advent of high density genotyping opened new avenues to further enhance the efficiency and sustainability of breeding. This involves the evaluation of genetic diversity in elite breeding pools, its efficient conversion into short- and long-term genetic gain and the efficient identification, improvement and introduction of extrinsic variability. Selection of parental crosses that generate superior progeny while maintaining sufficient diversity is a key success factor at short and long term. We derived analytical solutions to predict the joint distribution of a quantitative trait and genetic diversity in the progeny of multiparental crosses (UCPC). We used UCPC to extend the Optimal Cross Selection (OCS) that aims at maximizing the performance in progeny while maintaining diversity. In a simulated maize breeding program, UCPC proved to be more efficient than OCS to convert the genetic diversity into short and long term genetic gains. The narrow genetic base of an elite population might however compromise its long term improvement. An efficient strategy to broaden its genetic base is therefore required. Many genetic resources are accessible to breeders but cannot all be considered. We compared different predictive criteria for selecting genetic resources that best complement elite recipients, based on genomewide marker effects estimated on a collaborative maize diversity panel. We also evaluated the interest of UCPC to improve genetic resources, to bridge these with elite breeding, and to manage recurrent introductions into the breeding population. In a simulated maize breeding program, we demonstrated that recurrent introductions of genetic resources through a bridging population maximize long term genetic gain while maintaining genetic diversity constant, with only limited short term penalty.