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Genetic gain in Brassica breeding in India

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Oilseed brassicas are the mainstay of the edible oil economy in India. The country is estimated to have produced more than 12 million metric tonnes of rapeseed and mustard valued at 3.58 billion dollars during FY2020. *B. juncea* (Indian mustard), *B. rapa* (toria and brown sarson), and *B. napus* (oilseed rape) are cultivated in India, with *B. juncea* alone accounting for over 80 percent of the area. *B. rapa* and *B. napus* are grown in localised niches in east, north-east, and north-west India, respectively. These crops are primarily cultivated in stressed ecosystems under low input conditions. Consequently, the average yield levels are low (1.6 t/ha). And the compound annual growth rate (CAGR) has hovered around 1.86 percent since 1995–96. However, the CAGR for mustard yield in Haryana (3.67) and Rajasthan (2.50) states during the same period compares favourably with the CAGR levels witnessed in *B. napus*. Most of the plant breeding efforts are public-funded, and these have led to the development and release of over 150 varieties and hybrids. Of these, 58 varieties were released during the past ten years alone.

OP varieties of mustard, yellow sarson, and oilseed rape have been developed mainly using pedigree and performance-based selection. Yield levels above 3 t/ha have been recorded in the demonstration plots of newly developed varieties of mustard and oilseed rape. However, the recent data from national coordinated breeding trials is suggestive of a slackening response to selection, indicating a narrow gene pool as indicated by genome wide genetic diversity analysis of 459 mustard accessions, including 86 released varieties. The analysis is suggestive of a limited mobilisation of the available genetic diversity to the high-yielding cultivars, possibly due to the tendency of plant breeders to limit their crossing programs to intensively bred genotypes or the repetitive use of elite cultivars.

The availability of cytoplasmic male sterility and fertility restoration sources (moricaandia, ogura, and I-126) has enabled a switch over to the production of single-cross hybrids in mustard. The private sector is very active in breeding mustard hybrids. The level of heterosis is low, requiring the need to create heterotic pools based on current admixed gene pools. Traditional breeding methods have helped achieve incremental increases in oil content through indirect reductions in the thickness of the seed coat or the protein content. Marker-assisted selection for seed quality modifications is now commonly used in mustard. Several "00" varieties and hybrids have been bred in mustard and oilseed rape. It has been difficult to find genetic solutions for susceptibility to many pests and diseases due to a lack of resistance sources, ill-defined genetics, and the propensity of brassica breeders to ignore small effect genes. Identification of simply inherited sources of resistance and associated molecular markers for white rust resistance have resulted in the release of white rust-resistant mustard cultivars. While alien introgression lines have been developed for resistance to aphids, sclerotinia, and *Alternaria* in mustard, introgressed genes are yet to be commercially deployed due to associated linkage drag.