CM202, CM205, CM206, A670, B57, B73, B79, B84, BS13, FR13A, FR619, FR632, FR670, FRVa26, H96, H98, H99, H100, H101, Mo17, MSP1, Tuxpeno, Suwan 1 and Populations 24, 26, 31 and 36. Commercial hybrids like Paras, Parkash, JH3459, Sheetal and Buland have been developed using the inbred lines derived from these heterotic pools.

The efforts on introduction of maize germplasm have been focused on CIMMYT. Other sources need to be tapped, such as heterotic pools developed in other parts of the world; physiologically efficient, input responsive, high plant density and inbreeding stress tolerant germplasm in the US Cornbelt and Europe; high oil and protein germplasm in the USA; high protein and cold tolerant germplasm in Germany; cold tolerant germplasm in Canada, northern Europe and New Zealand; downy mildew resistant germplasm in South-east Asia besides known genetic stocks having genes for nutritional, stress resistance/tolerance and other traits. Trait specific germplasm developed by CIMMYT, such as resistance/ tolerance to downy mildews, maize streak virus, drought, acid-soils and other abiotic stresses needs more rigorous efforts on introduction and utilization. Further, germplasm adapted to Indian agro-climatic conditions have been obtained in abundance from CIMMYT, which should not be expected in case of germplasm introduced from other sources. Many times exotic germplasm would be required to be subjected to adaptive mass selection, and early generation recycling would need to be incorporated in inbreeding. The utilization of exotic germplasm has to be a stepwise approach.

The germplasm from different geographical areas have different useful traits. For example, the tropical germplasm are tall, late and large biomass producers. Therefore, these are good for fodder maize. The US Corn Belt germplasm have high harvest index, standability, responsiveness to inputs and tolerance to high plant density (relatively light canopy and erect leaves). Highland germplasm have cold tolerance, rapid seedling emergence, long roots, purple pigmentation on stem and leaf, and pubescent leaf. In India major germplasm introduction has been of tropical and sub-tropical germplasm whereas temperate germplasm did not get required focus. The genetic base of specialty maize (quality protein, high oil, special starch types, sweet corn, pop corn etc.) and fodder maize germplasm available with Indian maize breeders is very narrow which needs to be urgently widened. Introduction of germplasm of teosinte and *Tripsacum*, particularly that of the former, is also required. The importance of maize as feed and industrial crop is bound to increase. Maize cultivation during winter may expand with expected climate change. To meet these challenges, an increased need for expanding genetic base of maize in India is foreseen, for which highly diverse germplasm would have to be introduced, evaluated, adapted and utilized.

Sorghum and Millets Introduction: Achievements and Opportunities in India

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The origin and domestication of *Sorghum bicolor* (L.) Moench has taken place in Africa about 5000–8000 years ago. Indian subcontinent is the secondary centre of origin of Sorghum. The evidence for its cultivation was discovered at Saurastra dating back to about 4500 years. Sorghum was probably brought to India from eastern Africa during the first millennium BC. It is reported to have existed there around 1000 BC. The sorghums of India are related to those of northeastern Africa and the coast between Cape Guardafui and Mozambique. *Pennisetum glaucum* (L.) R. Br. is important millet in India, second to sorghum. It is considered to have been introduced to India from Africa. A large number of related species are found wild in Africa. The small millets indigenous to India are little millet (*Panicum sumentranse* Roth), kodo millet (*Paspalum scrobiculatum* L.) and Indian barnyard millet (*Echinochloa frumentacea* Link). On the contrary, three other small millets *viz*., finger millet (*Eleusine coracana* (L.) Gaertn), foxtail millet (*Setaria italica* (L.) P. Beaurv) and common/ proso millet (*Panicum miliaceum* L.) have originated elsewhere but reached India long ago. Finger millet originated in highlands of Africa and foxtail and common millet in Eurasia. The long history of cultivation of these three introduced crop species accompanied with human selection has resulted in generation of large variability especially in finger millet, giving India, a status of secondary centre of diversity.

The first major effort in the assembly of a World Collection of sorghum germplasm was in the 1960s by the Rockefeller Foundation's Agricultural Research Programme in India. A total of 22,701 exotic germplasm have been introduced into India from different countries of the world for various sources of important traits. The major contribution is from the Ethiopia, Sudan, Nigeria, Uganda, Zimbabwe, Cameroon, and USA. Ethiopia, Uganda, and Sudan in East Africa, Nigeria, Mali, and Burkina Faso (Upper Volta) in West Africa are the best sources of alleles for several agronomic attributes. Resistance to several diseases is found in the *conspicuum* of Nigeria. Alleles for high productivity with prospects for increased yield due to nodal tillering appear to be in combinations of *caudatum*, *durra*, and *caffrorums* from both West and East African regions. The Ethiopian *durras* are an excellent source for the staygreen (non-senescence) trait related to post-flowering drought tolerance trait. There are several examples of pearl millet introductions that have proved to be of direct commercial significance. The introduction of cytoplasmic-nuclear male-sterile line (Tift 23A) from the Coastal Plain Experiment Station, Tifton, Georgia, USA, which led to the development and release in India of the first commercial hybrid HB 1 is a landmark in direct commercial utilization of an introduction. Finger millet is presumed to have been introduced first to peninsular India at least 5000 years ago. The antiquity of foxtail millet cultivation although not very clear might have come from China and cultivation gradually extended to different parts of Indian sub-continent. The proso millet, which originated in Manchuria was possibly introduced from China, first to Himalayas and gradually spread to other parts of the country.

In sorghum, the introduction and collection of germplasm from other countries was being done through ICRISAT and Rockefeller Foundations in the past. NRCS has introduced 426 accessions from six countries since 2002. The materials are of forage lines (cold tolerant), varieties, popular landraces, and sweet sorghum. It has already evaluated 380 accessions, 18 accessions in the field, 2 accessions to be evaluated and 26 accessions are in the quarantine. Sorghum varietal improvement was achieved by introducing temperate and tropical material. First variety, CSV 1 is a direct introduction of American line IS 3924. By crossing temperate and tropical germplasm, subsequent varieties CSV 2 and CSV 3 were developed. CSV 4, which was used as restorer of three most popular hybrids, CSH 5, CSH 6 and CSH 9, became a very popular variety. The variety is a converted line of an African germplasm line IS 3541, and developed by crossing it with a USA germplasm line, IS 3675. CSV 5, another variety developed from Indian local and US line IS 3687. It has striga resistance. CSV 10, next variety, which became popular for high fodder value was developed from a cross between American elite variety SC 108 and Indian elite variety CS 3541. Another variety which became very popular, SPV 462, (from Coimbatore) developed from multiple cross involving IS 2947 and IS 3687 from USA and IS 1151 and BP 53, locals of Maharashtra and Gujarat in India, respectively. The variety is high yielding for grain and fodder with good grain quality. CSV 13, yet another variety developed from multiple cross having exotic and local genetic base is high grain yielding with medium height. The source for multiple resistance to shoot fly and stem borer are IS 18577, IS 18554 (Nigeria), IS 2312 (the Sudan), IS 18551 (Ethiopia), IS 2122, IS 2134 and IS 2146 (USA).

In pearl millet, an early maturing male-sterile line AKM 2068, developed at Fort Hays Branch Station, Kansas, USA was introduced by ICRISAT in India and distributed as 843A (ICMA 2). Haryana Agricultural University (HAU) succeeded in developing and releasing an extra early maturing hybrid (HHB 67) based on this male sterile line that matures in 60-62 days and is now quite popular with farmers in parts of Haryana and Rajasthan. Similarly, AKM 2021, developed at Fort Hays, was introduced by ICRISAT in India and distributed as 842A (ICMA 3). HAU used this male sterile line to breed an early maturing hybrid (HHB 68) that was released in 1993.

The World Composite, constituted and initially improved for productivity and downy mildew resistance at the Ahmadu Bello University, Samaru, Nigeria was introduced by ICRISAT in India. Evaluation of fullsib progenies from this composite led to the identification of seven promising progenies in a trial at Coimbatore in Tamil Nadu, which were recombined to develop a promising open-pollinated variety WCC 75. This variety was released in 1982 for cultivation in India. A Smut Resistant Composite, based on smut resistant lines selected from the germplasm from western Africa, was constructed at the ICRISAT. An early maturing and large seeded open-pollinated variety, ICTP 8203 was developed by recombining five S2 progenies derived from a landrace from northern Togo. It was released in 1988 for cultivation in Maharashtra and Andhra Pradesh.

The utilization of introduced materials in hybridization programmes has greatly contributed in pearl millet improvement. An outcross of a local strain of Punjab with an African introduction possessing long bristles resulted in the development of an open-pollinated variety S 530 and was released in Punjab. The parents of a promising open-pollinated variety (ICMS 7703), developed at the ICRISAT and released in India in 1985, were derived from crosses involving germplasm from western Africa. Another promising open-pollinated variety ICMV 84400, developed at ICRISAT found to be superior to WCC 75 for both grain and forage yields was developed from the New Elite Composite. This composite derives a great deal of its genetic base from the germplasm from western Africa. A vast array of germplasm from western Africa, the primary centre of genetic diversity for pearl millet has been introduced to India for genetic and cytoplasmic diversification of pearl millet breeding materials. These introductions have provided useful sources of genes for disease resistance, large seed size, dwarfing genes, high panicle volume and cytoplasmic nuclear male sterility and numerous other characters.

In small millets, there are no examples of successful introduction of varieties for direct cultivation in India in any of the small millets. However, introduction of germplasm and selection has contributed a great deal towards development of varieties with superior performance. African finger millet cultivars have been used extensively as donors for improving the Indian varieties. Indo – African crosses were first attempted in early seventies with the identification of donor parents *viz.*, IE 927, IE 929, IE 980-R, IE 910, IE 902, IE 882 and IE 1012 which resulted in the development and release of many popular varieties. The African germplasm has been good source of useful genes for disease resistance, large ear size, higher test weight and grain density besides plant robustness which are lacking in indigenous cultivars.

Finger millet germplasm conserved in the country includes collections from Sri Lanka, Japan, Kenya, Uganda, Malawi, Tanzinia and Zambia. The foxtail millet and proso millet collections include materials from Afghanistan, USSR and Turkey. Two varieties in proso millet-GPUP 8 and GPUP 21 were developed from Indo-Eurasian crosses. Three exotic collections of barnyard millet-PRB 9402, PRB 9403 and PRB 9404 have shown very high degree acclimatization and superior performance in Himalayan region.

In sorghum, germplasm with high yielding, sweet-stalk, specific qualities groups and resistant to biotic and abiotic are important traits that need to be introduced from other countries in future. Search for the resistant gene for shootfly and stemborer and new sweet sorghum lines for industrial uses are very important. The photosensitive lines, core collections, wild and weedy relatives are to be evaluated and maintained.

In small millets, the opportunities are to use the introductions as donors in the hybridization programmes. The exotic collections from Africa, Middle East, and South East Asia are poorly represents in the national collections and efforts are needed to introduce germplasm from the centres of origin.