Extended Summary

Plenary, Evening and Lead Lecture

13th International Conference on Development of Drylands

Converting Dryland Areas from Grey into Green

February 11-14, 2019

Organised by

International Dryland Development Commission

and

Arid Zone Research Association of India

ICAR-Central Arid Zone Research Institute, Jodhpur, INDIA

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Enhancing genetic gains and resilience to climatic stresses in pearl millet

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Pearl millet grown on about 30 m ha in semi-arid and arid ecologies of drylands in Asia and Africa is a valuable staple for humans and its stover is an important component of livestock feed in these marginal ecologies. International Food Policy Research Institutes foresight analysis is quite optimistic indicating increased demand for millets in India and Sub-Sahelian African (SSA) countries by 2040. In a scenario, when pearl millet cultivation is being further pushed to more marginal ecologies across these regions, there is strong need to understand the challenges this crop is facing and then to strategize the approach for enhancing both genetic gains in productivity and resilience to climatic and biotic stresses.

Pearl millet is challenged by downy mildew, low soil fertility and extreme drought conditions in both the continents, while millet head miner, striga weed in West-Central Africa (WCA) and blast in India are the major regional constraints to increase productivity. The production of pearl millet in SSA countries has increased in last 30 years due to increase in area but there has been almost no productivity increase. On the other hand, India witnessed pearl millet productivity increase at an annual rate of 3%, however, rapidly decreasing area is cause of concern.

Indian pearl millet breeding program took a paradigm shift in 1960-70s when hybrids started replacing OPVs leading to rapid increase in productivity, while WCA countries are still waiting for such a change to happen. Indian pearl millet program clearly defined its crop mega-environments and with strong germplasm support from ICRISAT followed environment-adaptation specific breeding strategy in public and private sectors to develop cultivars having high yield potential for different agro-ecologies. Recent investigations evidenced that trait-specific breeding followed in Indian hybrid breeding program led to differentiation of breeding materials into clear cut heterotic pools, separately for seed and restorer parents. Now moving further, highly heterotic B- (seed parent) and R- (restorer parent) heterotic groups have been identified to further elevate genetic gains in pearl millet.

ICRISAT and national programs are continuously restructuring breeding priorities based on farmer- and consumer-driven feedback. Greater emphasis is being laid on high grain yield productivity coupled with disease resistance to enhance cultivar diversity for better endowed environments (with >400 mm rainfall per annum), while screening and breeding approaches are fine- tuned to develop cultivars for highly drought-prone environments (< 400 mm annual rainfall). ICRISAT committed to continuously enhance genetic diversity in pearl millet cultivars recently identified heterotic pools among wide range of African and Asian based pearl millet populations which will go a long way in the development of high yielding cultivars. Recently, Leasyscan system has been standardized at ICRISAT to identify drought tolerant breeding lines/cultivars and validation process is underway to

integrate these new screening systems with breeding programs. Efforts are underway to introgress drought tolerant QTLs in promising genetic backgrounds through forward breeding approaches. ICRISAT in collaboration with advanced ARIs and other research partners has also identified flowering-period heat tolerant sources which have shown high seed set under air temperatures >42°C to enhance cultivar diversity in summer cultivated pearl millet crop in North-Western India, and in several African and Central Asian countries where ambient temperatures are quite high in different crop seasons. Targeted breeding followed by shuttle breeding in target ecology has led to generation of new breeding materials having higher levels of heat tolerance.

Efforts have been made continuously to map downy mildew and blast virulence pathogenicity, to identify disease resistance sources and utilize them in breeding programs to keep breeding programs ahead of pathogen. Multiple disease resistant composites have been developed against downy mildew and blast to provide new gene pools to derive disease resistant breeding lines and efforts are underway to identify blast resistance in wild species.

While working with ICBA, salinity tolerant cultivars were identified and cultivars like "*Hashaki 1*" were released recently for cultivation in salinity affected tracts of central Asian countries. WCA programs are now re-orienting towards strengthening of disease screening systems, initiating hybrid breeding, encouraging stakeholders especially private sector to invest in quality seed production to enhance millet productivity in the region.

The recent availability of pearl millet genome sequence information is helping to map genes of traits of interest. Genomic selection (GS) model has been recently standardized with high predictive ability of breeding value of hybrid parents (with 0.48-0.51for grain yield, and 0.8 to 0.9 for other important traits) and efforts are underway to further strengthen it to enhance the selection efficiency in future breeding programs. Efforts are also in progress towards introducing Rapid Generation Advancement (RGA) coupled with forward breeding for multiple traits, strengthening of screening protocols (diseases, lodging, early generation testing network), digitalization of breeding programs, identification of new germplasm for biotic and abiotic stresses, and introducing hybrid technology for Africa to finally move towards new phase of higher genetic gains and climatic resilience in pearl millet.