(A No. 118) Pearl Millet: A Climate-Resilient Cereal for Sustainable Agriculture

Komal Singh[1], Jaipal[2], Pawan[3], Ritul Saharan[3]*
[1]Department of Extension Education & Communication Management, SKRAU, Bikaner
[2]Department of Extension Education, ANDUAT, Ayodhya
[3]Department of Nematology, CCS HAU, Hisar
[*]Email: komals2351@gmail.com

Projections indicate that global climate change may result in a temperature rise of up to 6°C by the close of the 21st century, which is anticipated to substantially impact crop productivity and global food availability. The adverse effects are further exacerbated when elevated temperatures occur in conjunction with diverse biotic and abiotic stress factors. In this context, the identification and promotion of crop species capable of sustaining productivity under suboptimal and stress-prone environments is imperative. Pearl millet represents a suitable candidate in this regard, as it is both nutrient-dense and highly resilient to climatic variability, thereby offering significant potential to enhance farm incomes and to strengthen food and nutritional security in arid and semi-arid regions across the globe.

Scientific projections regarding climate change are increasingly being realized, as evidenced by rising global temperatures, erratic rainfall patterns, recurrent droughts, and pronounced diurnal temperature fluctuations. It is estimated that by the year 2100, global temperatures could rise between 1.5°C and 5.8°C, with crop yields declining by approximately 10% for every 1°C increase in temperature. Such reductions in agricultural productivity pose a serious threat to global food security, particularly when compounded by multiple biotic and abiotic stressors—an issue already affecting nearly 90% of the world's cultivable land. Within this context, millets—especially pearl millet—emerge as highly resilient crops, capable of enduring elevated temperatures and limited water availability throughout their growth cycle, outperforming many major cereals. Pearl millet, commonly known as *bajra* in India, ranks as the sixth most important cereal globally and is predominantly cultivated as a rainfed crop in the arid and semi-arid regions of Asia and Africa. In Asia, India alone accounts for 80% of the pearl millet area, with 7 million hectares under cultivation and an annual production of 8.6 million tonnes. Africa contributes 55% of the world's pearl millet area, with seven countries—Niger, Nigeria, Mali, Burkina Faso, Senegal, Chad, and Sudan—together comprising over 80% of this share. Pearl millet is a multipurpose cereal, valued not only for its grain but also for its stover and green fodder. Nutritionally, it is comparable or even superior to many other cereals, providing about 11% protein, 72% carbohydrates, 4–6% fat, and appreciable quantities of vitamins and minerals, particularly iron and zinc, along with a range of health-promoting phenolic compounds. Unlike most other millet species, which are relatively low in fat, *bajra* is notable for its relatively higher (4–6%) fat

*Image Source- CAZRI, RRS, Bikaner at the time of Natural farming Workshop

content. Pearl millet (bajra) has long been valued as a key energy grain in India's arid western regions. Its exceptionally high fibre content, a defining nutritional feature of millets, is comparable to that of whole wheat flour and oats. It also provides a rich source of iron, far surpassing that of rice—an essential element for maintaining a healthy and productive population. The NIN (ICMR) dietary iron intake report places Gujarat at the top, which correlates strongly with bajra being a dominant staple in the state. Beyond human consumption, the crop also serves as green fodder and stover for livestock and is increasingly being explored as a feedstock for biofuel production.

Climate Resilience and Cultivar Suitability

Pearl millet is widely recognized for its exceptional adaptability to challenging climates, performing well under high temperatures, low soil moisture, and poor soil fertility. It thrives with annual rainfall between 200–500 mm and can withstand temperatures above 30 °C, making it ideal for regions too hot or dry for other staple crops. Consequently, it holds a strategic position in ensuring food security under changing climate scenarios.

In many regions of India and Africa, soil temperatures frequently exceed 45 °C, occasionally touching 60 °C. Roughly one-quarter of India's pearl millet area lies in the arid A1 zone, covering parts of Rajasthan, Gujarat, and Haryana, where rainfall remains below 400 mm and prolonged droughts and heat waves are common. Cultivars bred for this zone typically mature early (around 75 days), produce high tillering, and provide good grain and fodder yields.

Although improved hybrids exist, traditional landraces remain popular in extremely arid and resource-poor areas, as they offer superior quality for local consumption. The OPV CZP 9802—developed from landraces—performs well under both drought and favourable conditions. Moreover, pearl millet tolerates heat stress during the reproductive phase, enduring temperatures up to 42 °C, which allows summer cultivation in regions such as northern Gujarat, eastern Uttar

Pradesh, and parts of Rajasthan. Hybrids like GHB 526, GHB 183, and GHB 558 have proven effective for these summer cropping systems.

Resilience of Pearl Millet to Low Moisture and Poor Soil Fertility

A deep and extensive root system allows pearl millet to withstand prolonged dry spells by maintaining higher leaf water content and promoting efficient nutrient uptake. Its photosynthetic efficiency and capacity for dry matter accumulation enable it to grow in nutrient-poor soils with minimal fertilizer input.

As a C4 plant, it uses water and carbon dioxide more efficiently, making it especially suitable for drought-prone environments. Its leaves are coated with cuticular wax, reducing transpiration losses and reflecting excess solar radiation, which enhances both heat and drought tolerance. Because it provides stable yields in marginal lands, pearl millet remains a preferred choice for farmers in semi-arid and arid zones globally.

Pearl Millet: A Preferred Crop in Salinity Affected Arid Tracts

Soil salinization is rapidly emerging as a major agricultural threat, particularly in regions with low rainfall and high evapotranspiration. Pearl millet has shown a strong ability to tolerate saline soils, and its genes have been successfully incorporated into crops like rice and groundnut to enhance their salinity resistance.

Its low susceptibility to major pests and diseases minimizes the need for chemical control measures, making it an environmentally sustainable crop for salinity-affected landscapes.

Summary

Pearl millet stands among the most robust cereal crops, offering immense promise for climate-resilient farming systems. Its tolerance to heat, drought, salinity, and other abiotic stresses positions it as a strategic alternative to major cereals that may falter under climate change pressures. With growing recognition of its value, breeding programs are actively developing high-yielding varieties and hybrids to meet the diverse agro-ecological requirements of farmers across pearl millet growing zones.