

Millets- A Journey to Nutritional Excellence

Suheel Ahmad^{1*}, Nazim Hamid Mir¹, Sheeraz Saleem Bhat¹, Sheikh M Sultan², Susheel K Raina² and Regu Atufa¹

¹ICAR-Indian Grassland and Fodder Research Institute, Regional Research Station, Srinagar-191132

²ICAR-National Bureau of Plant Genetic Resources, Regional Station, Srinagar-191132

*Corresponding Author: suhail114@gmail.com

Millets are among the oldest foods known to humans and likely the first cereal grain used for domestic purposes. For centuries, they have been staple foods for people in the semi-arid tropics of Asia and Africa, where other crops struggle to grow. Historically, millets have been widely consumed in Asia and India. Despite their remarkable qualities, the area dedicated to millet production has been decreasing over the past fifty years, especially since the Green Revolution. These small-grained cereals are gluten-free and rich in vitamins and minerals. Millets are highly nutritious, offering good quality protein, minerals, dietary fiber, phytochemicals, and vitamins. When compared to rice and wheat, millets such as foxtail, proso, and pearl millet have higher protein content, while kodo, little, foxtail, and barnyard millet have higher fiber content. Finger millet, in particular, contains an impressive amount of calcium at 344.00 mg per 100g. Cereal-based food products supplemented with millets are gaining popularity due to their nutritional and economic benefits. Value-added millet products have significant growth potential, as consumers increasingly recognize that millets and millet-based foods contribute to better health.

The Millet Renaissance: A Bounty of Nutrition and Sustainability

Compared to mainstream cereals like maize and barley, millets offer higher protein content, making them essential for a balanced diet. In India, eight millets species (Sorghum, Pearl millet, Finger millet, Foxtail millet, Kodo millet, Proso millet, Barnyard millet and Little millet) are commonly cultivated under rain fed conditions. Further, in each of the millet growing areas at least 4 to 5 species are cultivated either as primary or allied crop in combination with the pulses, oilseeds, spices and condiments. For instance, while pearl millet and sorghum are primary crop and allied crops respectively in the desert regions of Rajasthan, in the eastern parts of Rajasthan and Gujarat it is the opposite. Similarly, sorghum is sown as major crop in the Telangana, Andhra Pradesh, Maharashtra and

parts of Central India, while it is considered as fodder crop in some of the Southern regions.

State-wise Millet Production : 2021-22
(4th adv. estimate)

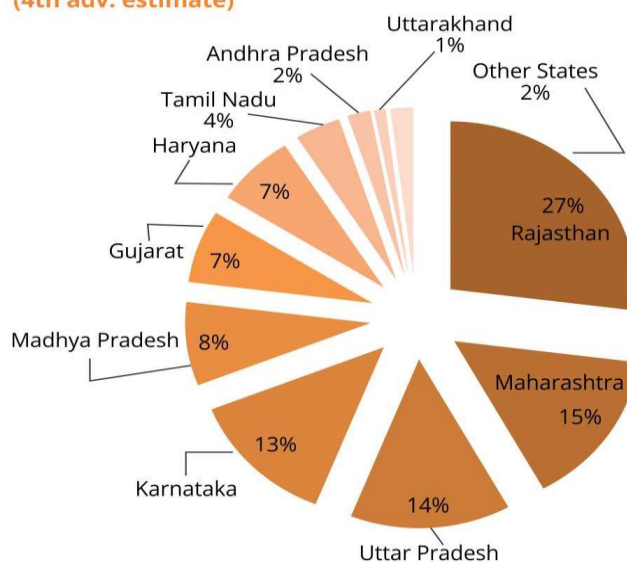


Fig.1. State-wise Millet Production in India (Source: APEDA, 2021)

Table. 1. The origin of millets, their scientific name and common names (Source: Karuppasamy, 2015)

Scientific Name	Common Name	Origin
<i>Sorghum bicolor</i>	Sorghum, great millet, guinea corn, kafir corn, aura, mtama, jowar, cholam, kaoliang, milo, milo-maize	Northeast region of Africa (Ethiopia-Sudan border)
<i>Pennisetum glaucum</i>	Pearl millet, cumbu, spiked millet, bajra, bulrush millet, candle millet, dark millet	Tropical West Africa
<i>Setaria italica</i>	Foxtail millet, Thenai, Italian millet, German millet, Hungarian millet, Siberian millet, Kangni	Eastern Asia (China)
<i>Panicum sumatrense</i>	Little millet, Samai, Kutki	Southeast Asia
<i>Paspalum scrobiculatum</i>	Kodo millet, Varagu, Samai, Kodra	India
<i>Panicum miliaceum</i>	Proso millet, common millet, hog millet, broom-corn millet, Russian millet, brown corn, Panivaragu, Barri	Central and Eastern Asia
<i>Echinochloa crusgalli</i> and <i>Echinochloa coracana</i>	Barnyard millet, sawa millet, Sanwa, Sama, Japanese barnyardmillet, Kudhiraivali	Japan
<i>Eleusine coracana</i>	Finger millet, African millet, koracan, ragi, wimbis, bulo, telebun, Ragi	Uganda or neighbouring region

Likewise, Finger millet is a primary crop in Tamil Nadu and Gujarat, while the same is a minor crop in Telangana. International Year of Millets (IYM 2023): The United Nations General Assembly at its 75th session in March 2021 declared 2023 the International Year of Millets (IYM 2023). #IYM2023 was an opportunity to raise awareness of, and direct policy attention to the nutritional and health benefits of millets and their suitability for cultivation under adverse and changing climatic

conditions. IYM 2023 galvanized interest in millets among various stakeholders like farmers, the youth and civil society and push governments and policy makers to priorities the production and trade in these cereals.

Varieties and Benefits

The small grained cereals of millets have been cultivated for thousands of years and are known for their nutritional benefits being low calorie diet with lot of fiber. The husked grain of millet has a slightly nutty flavor and can be eaten whole after roasting or after cooking like rice. Millet flour is used for making mush, porridge, flat bread or chapatti. Minor millets do not contain gluten, therefore not generally suited for bread making. But due to absence of gluten, these are appropriate food for those with colic disease or other forms of allergies or wheat intolerance.

1. **Sorghum:** Sorghum, known as Jowar in India, has earned its reputation as a superior cereal due to its high nutrient content. It contains a nutrient called policosanols, found in Sorghum wax, which aids in reducing cholesterol levels.
2. **Pearl Millet:** Pearl millet, comparable to wheat and rice, is abundant in fiber, aiding in weight loss and maintaining digestive health aiding in digestion, preventing constipation and helping control diabetes. Its high phosphorous content contributes to robust bone health and respiratory wellness. It is rich in magnesium and iron as well.
3. **Proso Millet:** Rich in fiber, protein, vit. B6 and minerals, Proso millet plays a significant role in maintaining cardiovascular health. Its antioxidant properties make it a potential ally against heart-related diseases and cancer.
4. **Foxtail Millet:** With its high magnesium content, foxtail millet has earned the title of a heart-healthy food. It finds its place in various culinary delights such as porridge, noodles, and alcoholic beverages.
5. **Barnyard Millet:** This millet is a powerhouse of nutrients, including iron, making it an ideal choice for those combating anemia and other lifestyle disorders. Its slow sugar release aids in maintaining stable blood sugar levels. It is a good source of highly digestible protein and is most suitable for people with gluten sensitivity.
6. **Kodo Millet:** Resembling rice, Kodo millet serves as an excellent substitute, aiding in weight loss and providing antioxidants and anti-inflammatory substances for battling lifestyle disorders.

7. **Brown top Millet:** Beneficial for metabolic activities, gut health, and weight loss, browntop millet offers a myriad of health benefits, making it a valuable addition to the diet.

8. **Finger Millet:** It is rich source of carbohydrates and contains lot of fiber helping maintain blood sugar and cholesterol levels. The Finger millet is rich in calcium, vit. D and amino acids and helps in bone health and boosting immune system.

The Path Forward: Overcoming Challenges and Embracing Millets

Efforts to promote millets as 'nutri-cereals' can revolutionize our approach to nutrition, agriculture, and sustainability. The millet now referred as Nutri-cereal instead of coarse grain contains higher proportion of complex carbohydrates, resistant starch and slow releasing sugar. They are high in fibre with soluble fibre content of 3.4 to 6.5 percent. The millets are low in fat content ranging from 1.1 to 5.0 percent and are rich in B vitamins especially niacin, pyridoxine and folic acid.

Millets offer good amount of calcium, iron, potassium, magnesium and zinc. The nutrient content of millet is better than rice or wheat. Millets contain about 8.0 percent protein and 4.0 percent fat. They are rich source of vitamins and minerals. Millets are especially rich in calcium. The dietary carbohydrates content of millets is also relatively high. Prolamines and glutelins form the major portion of their proteins. The fats from millet contain a higher portion of unsaturated fatty acids and essential fatty acids. Although a considerable portion of nutrients is concentrated in the seed coat, the bioavailability of the nutrients present in the endosperm is higher than the seed coat nutrient. Anti-nutritional factors such as phytate and polyphenols are also present in millets but they are mostly confined to the seed coat and the milled millets are generally free from the anti-nutritional factors. Millets contain higher proportion of unavailable carbohydrate and release of sugar from millet is slow. Millet protein contains amino acids in balanced proportions and is rich in methionine, cysteine and lysine. These are especially beneficial to vegetarians who depend on plant food for their protein nourishment. Important vitamins namely thiamine, riboflavin and niacin are present in high quantities. Millets, thus provide a wide range of nutrients and phytochemicals including dietary fibre, vitamin E, magnesium and folate that optimize health.

Millets as Convenience foods

Value added products from millet have the potential to add value to business and has a large potential for growth as consumers believe that millets and millet-based foods contribute directly to their health. The millet grains offer many opportunities for the development of diversified food products like bakery and puffed products, quick cooking cereals, ready-to-eat snacks, supplementary foods, weaning foods and more importantly quality health foods by adopting appropriate milling and processing techniques.

1. Breakfast foods - Multigrain dosa mix, Millet paniyaram mix, millet pongal mix, millet paniyaram mix, millet adai mix and millet puttu mix
2. Lunch - Multigrain Sambar rice mix, Multigrain Tomato rice mix, Multigrain Bisibele bath mix, Multigrain Biriyan, Pulav, Jeera mix
3. Health Foods - Nutrimalt, Thenai laddu (Nutriball)
4. Nutritious blends - Nutri beverage, Malted products
5. Snacks - Millet Khakhra, Millet murukku, Millet bar, Millet laddu, Millet blended chocolate.

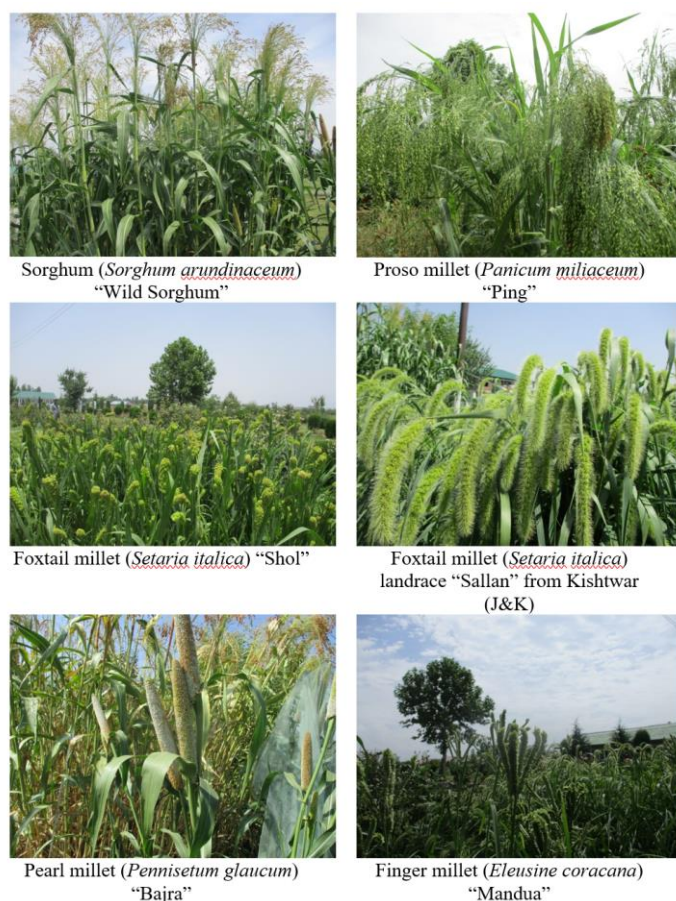


Fig. 2 Millets of North Western Himalayan region

Table 2. Millets grown in Himalayan region (Source: Bhat *et al.*, 2019)

Crop name	Climate adaptation	Crop duration (days)	Av.yield (kg/ha)	Adaptation for impacts of climate change
Finger millet	Wide adaptation up to 2300 m	90-130	1226	Moderately resistant to heat, drought and humidity, adapted to wide altitude range
Foxtail millet	Wide adaptation up to 2000m	70-120	565	Adapted to low rainfall, high altitude
Kodo millet	Tropic/ Sub-tropic up to 1800m	120-180	312	Long duration, but very hardy, needs little rainfall, comes up in very poor soils, good response to improved management
Barnyard millet	Wide adaptation up to 2000m	45-60	857	Very short duration, not limited by moisture, high altitude adapted
Little millet	Tropic/ Sub-tropic up to 2100m	70-110	349	Adapted to low rainfall and poor soils; used as famine food; can withstand water logging to some extent
Proso millet	Wide adaptation up to 3500m	60-90	323	Short duration, low rainfall, high altitude adapted

Millets as livestock feed

As per reports, the shortage of green fodder, dry fodder, and concentrates for livestock is about 11%, 23%, and 28%, respectively. Millets forms a crucial component of climate-resilient livestock food systems especially in arid and semiarid regions since

their evolution and diversification were mainly influenced by the exposure to arid environments. By incorporating millets into animal diets, farmers can promote sustainable animal production and reduce the reliance on conventional feed and fodder sources. The nutrient profile of sorghum is similar to corn, a major component used as animal feed and fodder. It is

reported that sorghum silage has about 15% higher neutral detergent fiber (NDF) content.

Therefore, it is more “rumen filling” than corn silage, thereby reducing the total diet intake. Incorporation of sorghum in goat diet has shown to cause weight gain of 66 g/d. Sorghum can replace about 70% of corn in broiler and layer rations without affecting the production. Pearl millet is a promising crop for green fodder supply (up to 40-50 t/ha), even in summer months. On dry matter (DM) basis, pearl millet silage can be included at 50% rate in a lucerne silage/concentrate-based diet or 36% in concentrate-based diet. This can sustain 24-26.3 kg/d milk yield in lactating dairy cows. In dairy cows, pearl millet grain can replace 10-30% of corn silage or maize grain with no deleterious effect on DM intake, milk yield, or milk composition. Finger millet provides excellent hay and is used as green forage for cattle, sheep, and goats. It also contains methionine, that helps dairy cattle digest feed, wean healthier calves, and in milk yield.

Continued research, policy support, and promotion are vital for maximizing the benefits of millets as a sustainable and nutrient-rich livestock feed and fodder resource.

Conclusion: A Millet-Powered Future

In a world grappling with health issues, environmental concerns, and changing agricultural

landscapes, millets emerge as a beacon of hope. They are not just cereals; they are lifelines, offering solutions to malnutrition, climate change, and economic instability. Due to urbanization, increase in health awareness and buying capacity among city dwellers, the demand for processed and convenience foods have increased appreciably. Millets are much cheaper, but they have to be properly processed for further usage. About 50 million Indians suffer from diabetes, 15% of the Indian population are obese and India ranks 128th among all the mal-nutrition countries. Hence, there is a need to educate people about the health and nutritional benefits of millets to increase the consumption of millets and millet-based products to save people from health and malnutrition related issues. Embracing millets is not merely a return to our roots; it is a step towards a healthier, greener, and more sustainable future. Let's celebrate the revival of millets and pave the way for a brighter, healthier tomorrow. Due to unpredictable climate changes and rainfall patterns the entire world is now increasingly witnessing crop failures of main cereal crops of wheat, rice and maize. Millets are often short duration, drought tolerant and low input crops and thus are the ultimate crops which stand up in the present crisis of climate change.

* * * * *