

HUMBLE MILLETS CAN AID IN ACHIEVING SUSTAINABLE FOOD SECURITY IN INDIA

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With the growing population, diminishing land and changing climate, we need to explore resilient sustainable crops. Millets are C4 plants which have more photosynthetic efficiency than C3 plants. They are short-duration crops and grow well on acidic to alkaline soil. They are tolerant to high temperature and resistant to drought, most diseases and pests and do not require much care. Millets have immense potential to combat malnutrition. They are rich in macro, micronutrients, phytochemicals and antioxidants. Millets have complex carbohydrates, are gluten free, have low glycaemic index, have good-quality fat and are rich in fibre, protein and essential nutrients. Their consumption can help in prevention of several cardiovascular diseases and good for people with celiac disease or gluten sensitivity. They can be helpful in preventing diseases arising due to bad food habits and also in improving physical and mental well being. Millets have been a staple food for millions of people in India for centuries, specially the rural and tribal population. But after green revolution, their use has declined. Millets are now gaining popularity due to spread of knowledge about their immense health benefits. Due to their nutritional benefits, they need to be an important part of public distribution system (PDS) in India. Global millet market is increasing after the declaration of year 2023 as ‘International Year of Millets’ by the United Nations. We are one of the market leaders with 40% world millet production and amongst top five global exporters of millets. We are looking forward to grab the billions of Dollar of export opportunity by promoting millets and millet-based products. This will not only help farmers but also boost our economy. The present article discusses various aspects of these neglected crops and why they need to be promoted, popularized and accepted by consumers for a sustainable agriculture.

Introduction

The second sustainable developmental goal adopted by United nations in 2015 is zero hunger and food security. United nations declared year 2023 as “International year of Millets”. Millets are small seeded plants belonging to Poaceae or grass family. The term ‘Millet’ originated from the Latin word ‘Milum’ meaning grain. India has a long history of using millets which is mentioned in Yajurveda¹. Millets were a part of Mohenjodaro and Harappa civilization²⁻³. They are considered as poor man’s food because millets have coarse grains and

can be grown on dryland without much care. They can be grown with very less water and require very less fertilizers and pesticides⁴. Our world is facing changing climate due to global warming. Millets being drought resistant are more suitable crops for a changing climate and have the potential to augment global food security. Millets are the food of future, rich in macronutrients, micronutrients and antioxidants. Instead of calling them as “poor man’s food” they should be called as “superfood”. They are truly mentioned as ‘mighty millets which are super-grains of power’ by ICRISAT (Inter-national crops research institute for the semi-arid tropics)³.

Millets are mostly grown in arid and semi-arid regions of India. They are an important source of food and fodder

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for poor farmers. Indian Millets are rich in protein, vitamins and minerals. They are also gluten-free, have low glycaemic index and are nutritionally superior to wheat and rice⁴⁻⁵. They are good for people suffering from diabetes, hyperlipidaemia and other chronic diseases⁴⁻⁵.

Millets can be grown in both *Rabi* and *Kharif* seasons which is an added advantage to farmers and producers. They can be produced in Rajasthan's sand dunes also which confirms that they can tolerate adverse conditions⁴⁻⁵. All these features make them fit to be food for future.

About five decades ago, millets were a major part of diet in India as well as globally⁴⁻⁶. But after green revolution in India, millet cultivation has decreased by 58% for small millets, 64% for sorghum, 49% for finger millet, and 23% for pearl millet since 1956⁴⁻⁶. They are less popular than our staple food crops like wheat and rice⁷. Now, due to initiatives taken by the Government of India, the consumption and use of millets is gaining popularity and people are encouraged for the consumption of healthy and nutritious millets. Millets are drought resistant crops and grown by marginal farmers. Popularising millets and including them in our daily diets can increase the income of our farmers and play a vital role in ecological and economic security of people in rural areas. Chander et al.⁸, George and McKay⁹, Islam & Manaloor¹⁰ have reported that Green Revolution and Public Distribution System (PDS) focussed on staple crops like wheat and rice and were very successful in improving food security in India but not at the desired level. Including millets as a part of PDS in India can ensure food security as well as combat malnutrition and child morbidity¹⁰.

Millet Campaigning and Promotion in India

Millets are primarily cultivated in¹²⁻¹³ different states in our country but they are not as popular as other cereals like wheat and rice. Currently, millets make only 6-7% of our national food basket^{7,11}. India produces 80 per cent of Asia's and 40 per cent of the global production of millet^{7,11}. India is among the top 5 exporters of millets in world⁵. Government of India has prioritized millets and started promoting it since 2018. Millets were rebranded as "Nutri Cereals"¹. The year 2018 was declared as the National Year of Millets¹. Due to immense nutritional benefits millets are called "Shree Anna" by our government, which will open the door to prosperity for poor farmers¹¹. A millets recipe book, titled "Millets (Shree Anna) Recipes - A Healthy Menu for Canteen/Messes" has been developed by Food Safety and Standards Authority of India FSSAI with a compilation of healthy menu options. A postal stamp and

Rs.75 currency coin was released in March 2023 to mark International Year of Millets 11. In mega campaigning for these wonder crops, now Indian army will give the 25% of the cereals in rations for troops as millet flour¹².

Indian Millets and their Advantages

Millets differ in their colour, texture, appearance and grain size. On the basis of the size of the grain, they are classified as **large or major millets** and **small or minor millets**. Some important millets of India are Jowar (*Sorghum vulgare*, Sorghum), Bajra (*Pennisetum typhoides*, Pearl Millet), Ragi (*Eleusine coracana*, Finger Millet), Kagni (*Setaria italica*, Foxtail Millet), and Cheena (*Panicum miliaceum*, Proso millet) which belong to large or major millets. Kodra (*Paspalum scorbulatum*, Kodo Millet), Sama (*Echinochloa esculenta*, Barnyard Millet), Hari Kagni (*Panicum miliare*, Browntop millet), Kutki (*Urochloa ramosa*, Little Millet) belong to small or minor millets.

They are climate resilient crops which can withstand droughts and can survive on 350–400 mm of rain⁴. They can be grown with very low water. Millets can also grow in low fertile soils in a pH range of 4.5 to 8. Pearl millet (*Bajra*) and Proso millet (*Cheena*) require only 20 cm rainfall compared to rice, which requires an average rainfall of 120–140 cm. Millets can be an alternative crop to wheat in acidic soils and rice in saline soils⁴. While rice is very sensitive to saline soils, millets such as Pearl millet (*Bajra*) and finger millet (*Ragi*) can grow in saline soil. Another significant advantage of growing millets is that they have a shorter growth period compared to wheat and rice. Most of the millets mature in 60–90 days after sowing. Barnyard 109 millet (*Sama*) matures in 45–70 days compared to rice (120–140 days). Millets are C4 cereals which have high photosynthetic efficiency and suitable crops for sustainable agriculture. They have the ability to capture carbon dioxide more efficiently than C3 plants in hot and dry conditions. Most of the plant species including our major crops like wheat and rice have C3 photosynthesis. This involves fixation of CO₂ in mesophyll cells of leaves in Calvin cycle with the help of RUBP carboxylase enzyme (RuBisCO). But under hot and dry conditions, C3 crops carry out photorespiration which is a wasteful process. During photorespiration, RuBisCO binds to oxygen instead of CO₂ and releases CO₂ and wastes energy produced during photosynthesis. This reduces the efficiency of C3 plants. On the other hand, C4 crops like millets, maize, sugarcane etc. have an adaptive mechanism to fix CO₂ under hot and dry conditions. They have specialised Kranz anatomy in their leaves and fix CO₂ initially in mesophyll cells and then Calvin cycle takes place in specialized bundle sheath

cells. This adaptation helps in minimizing photorespiration and enhances photosynthetic efficiency under stress conditions. Apart from this advantage, millets can be grown alone, as intercrop or in mixed cropping. They can be grown with minimal requirement of fertilizers and pesticides. The stalk and leaves of plants are utilised as fodder for animals. Millets can be stored for a long period of time and grains can be consumed even after 10-12 years of harvesting and storage⁴. A comparative chart shows the feature of millets and popular cereals Wheat/Rice⁴ (Table 1).

Table 1: Comparative profile of Millets compared to Wheat /Rice⁴ in terms of Agricultural Parameters and Nutrient aspects

S.No.	Parameter	Millets	Wheat/Rice
1	Water requirement	20-60cm	120-140cm
2.	Location of growth	Dry zones and rain fed areas	Rain fed areas
3.	Maturation time	Short (45-70days)	Long (120-140 days)
4.	Pest & Disease resistance	High	Low
5.	Pesticide requirement	Low	High
6.	Fertilizer requirement	Low	High
7.	Season of growth	<i>Rabi and Kharif</i>	Either <i>Rabi</i> or <i>Kharif</i>
8.	Climatic resilient	High	Low
9.	High temperature resistance	High	Low
10.	Flood resistance	High	Low
11.	Glycaemic Index	Low	High
12.	Vitamins	High	Low
13.	Minerals	High	Low
14	Proteins	High	Low
15	Good fat	High	Low

Millet Cuisines in India

Millets are called as ‘mota anaaj’ or coarse grain and are less popular than fine grain of wheat and rice which taste better as well as are easier to process and cook. Prior soaking of 6 to 8 hours is required before cooking as these are coarse grains^{1,4}. Despite these limitations, many nutritious and delicious recipes are made with millets in India. They are used to make porridge or used as flour to make chapatis, bread, cakes, cookies, idli and pasta. Dishes such as *bajra khichdi* and *barjra roti* are very popular in Punjab, Haryana and Rajasthan and served as

nutritious recipes in farms and eco villages to tourists^{1,13}. Millet *dosa*, pancakes, waffles are also becoming popular and are also served as breakfast snacks. Millets are more popular when they are blended with other cereals, pulses and legumes. Winter millet like bajra has warming properties, hence very suitable for consumption during winter. On the other hand, summer millets can be used as coolants as they have high water content along with calcium, magnesium and potassium which regulate the body temperature. According to nutritionists, ragi (finger millet), foxtail, barnyard (sama) should be consumed in summers to regulate body temperature¹⁴.

Millets are Immuno-boosters

Millets keep us full for long time^{1,4}. Being rich in macronutrients and micronutrients, they can help combat calcium and iron deficiency and can boost immunity. There are remarkable health benefits of different millets. Finger millet has eight times higher calcium content than wheat. Barnyard millet and pearl millet are the rich source of iron. Foxtail millet has high zinc content. Millets can be used to supplement vitamin and mineral requirements. Millets are also good source of β -carotene and B-vitamins especially riboflavin, niacin and folic acid and can combat Vitamin A deficiency (VAD)⁴.

Millets have low glycaemic index. They are rich in non-starchy polysaccharides and have high fibre content which helps in improving gut health and reducing cholesterol¹. Protein content of millets is equal or more compared to wheat, rice and maize⁴. Millets are rich in antioxidants, polyphenols and other phytochemicals resulting in a slower rate of absorption and slow release of sugars resulting in low glycaemic index and thus reduces the risk of cardiovascular diseases like diabetes and high blood pressure⁴.

Dopamine called ‘happy hormone’, is a neurotransmitter responsible for transmitting signals between the nerve cells in the brain. Dopamine boosts our mood and is a ‘feel-good factor’ in the brain. Millets which have low glycaemic index releases sugar slowly in body helps in increasing the dopamine levels and keeps body and mood happy and energetic throughout day¹⁵. Ragi (Finger Millet, *Eleusine coracana*) is a good for bones as it is rich source of calcium, Kodo millet (Kodra, *Paspalum scrobiculatum*) is rich in iron and reduces high blood pressure and enhances immunity. Little millet (Kutki, *Panicum miliare*) is good for the thyroid. Browntop millet (*Urochloa ramosa*, Hari Kagni) has anti-cancerous properties. Millets are rightly called as nutri-cereals because of their rich nutrient content¹⁶.

Though there are immense health benefits of millets, there are some disadvantages also and their excessive intake should be avoided. Millets are rich in complex carbohydrates and digest slowly. Phytic acid is present in them which reduces absorption of other nutrients. They should be consumed after soaking in water. Millets contain goitrogens which interfere with the absorption of iodine¹⁶⁻¹⁸.

Millets Needs to be Revived and Popularized

During the recent G-20 summit organized in India, millet dishes were an important part of menu served to the delegates including head of the States of world over countries¹. Now it is our turn that we include them in our daily diet. Revival of millet production in country will generate lot of jobs resulting in sustainable agriculture, economic and ecological security. Efforts are being undertaken to change mind set of people to increase the demand of millets^{1,8}. Smart Food campaign is an initiative in which organisations like Indian Institute of Millet Research (IIMR), National Institute of Nutrition (NIN), MS Swaminathan Research Foundation (MSSRF) and Self Employed Women's Association (SEWA) have been involved in popularizing millets¹⁹.

It may be noted that pseudo-cereals or pseudo-millets are another class of millets which can supplement millets in aiding food security. They are called as pseudo-cereals or pseudo-millets because their seeds resemble cereals. They do not belong to grass family Poaceae but are dicotyledonous plants. The pseudo-cereals are excellent source of fibre, protein and mineral (Ca, Mg, Fe)²⁰⁻²². These have similar nutritional qualities and agricultural requirements like millets. The three best-known pseudo-cereal crops in India are grain amaranth (*Ramdana* or *chaulai*, *Amaranthus caudatus*), quinoa (*Chenopodium quinoa*), and buckwheat (*Kuttu*, *Fagopyrum esculentum*)²⁰.

Market Potential of Millets

In India an average of 3.28 million hectares of land is now used under cultivation of millets. India is a leader in world millet production and produces more than 40% of millets globally and nearly 80% of millet production in Asia. India is amongst the top 5 global exporters of millets and its millet export jumped to US\$ 75.45 million in the year 2022–23 compared to US\$ 62.95 million in 2021–22. By promoting millets and millet-based products we can grab a US\$ 2 billion export opportunity²³. Innovative products of commercial value from millet can include healthy snacks, bakery products, energy bars, beverages etc. These products will also have great acceptability among people

suffering from diabetes & also among other health conscious people looking for alternative source of food. According to the Indian Council of Agricultural Research a thousand of millet based start-ups are in operation since 2023²³.

Conclusion

Millets have been a staple food for rural India for hundreds of years. However, after the advent of green revolution, the use of millets have declined. To combat global warming and wider food security, we need hardy and short duration crops which can survive under water as well as temperature stress. Millets are hardy crops, rich in macro and micronutrients with low maintenance cost. They are good sources of carbohydrates, protein, dietary fibre, good- quality fat, vitamin B complex and minerals like calcium, potassium, magnesium, iron, manganese and zinc. They help in maintaining body mass index (BMI), weight management, reducing high blood pressure, protecting from cardiovascular diseases and preventing diabetes.

Immunity boosting food have gained attention and many new food and crop plants are being explored after the outbreak of COVID-19. The need of the hour is to promote the growth and use of millets for a sustainable agriculture and food security. Policy makers must make action plan to include them in India's food and agricultural policy with multiple goals including nutritional security, elevating economic condition of rural farmers and eco friendly cultivation. Millets should be adopted in public distribution system (PDS) in India and included in government's free food grain scheme. Popularizing, promoting and making people aware of these super crops will help poor farmers. Traditional knowledge and wisdom can be utilised to reap the benefits of these super crops. Increasing awareness about health benefits of millets will help in the promotion of these neglected wonder crops and aid in food security.

Statements and Declarations

Conflict of Interest: Author declares that there is no conflict of Interest. □

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