

**MILLETS: THE MIRACLE GRAINS****N. SWAMINAIDU^{1&2}, S.K.GHOSH¹ AND K. MALLIKARJUNA^{2*}**

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ABSTRACT

The origin of millet is diverse with varieties coming from both Africa and Asia. Millets are consumed as staple food, feed and drinks. Millets are nutritionally equivalent or superior to most cereals and contains high levels of methionine, cystine, and other vital amino acids for human health. These are rich in micronutrients, particularly iron, calcium, magnesium, phosphorous, zinc and potassium. Millets are often termed as nutria-cereals / nutraceuticals realizing their nutritional value. Millets are very hardy crop grown in very harsh climate, less water, poor or nutrient deficient soils without any fertilizer and pesticides. This can turn out to be a tremendous national gain especially in the ensuing decades of erratic climate, global warming and reduced water availability. Millets can become the crop of security as it can provide securities for food, fodder, health, nutrition, livelihood and ecology. In marginal areas millets are the best available alternative for farmers to get reliable harvest, food and nutrition. If the development issues that confound or influence the importance and status of millets as miracle grains are addressed, the farmers would surely promote the cultivation of millets.

KEYWORDS: millets, nutraceuticals, micronutrients, nutritional security, climate change, drought tolerant, coarse grains

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INTRODUCTION

After 67 years of Independence, malnutrition continues to be one of the biggest challenges in India. A vast segment of resource-poor people suffer from malnutrition particularly micronutrient deficiencies (hidden hunger) and the other section of people are suffering with the growing incidence of obesity and chronic diseases like diabetes, cardiovascular problems, cancer etc. These are the two extremes of our society and this situation aroused partly due to changing food habits and possibly the loss of millets from our diet is one of them. Millets offer unique advantages for health being rich in micronutrients, particularly iron, calcium, magnesium, phosphorous, zinc and potassium. Millets are often termed as coarse grains, however realizing their nutritional value, these are now being referred as 'nutriamillets / nutria-cereals / nutraceuticals'. These phytochemicals have been shown to mitigate above mentioned chronic diseases. Millets can withstand environmental stress being resistant to drought and heat. Currently, they sustain the livelihood of over 60% of small and marginal farmers. Time trends show marked reduction in area under millet cultivation due to many reasons.

1.1 MILLETS: HISTORY

It is acknowledged that during the Stone Age, the Millet plant was grown by the lake inhabitants of Switzerland. History reveals that since the Neolithic Era, millet, a prehistoric seed was cultivated in the dry climates of Africa and northern China. Interestingly it was millets and not rice that was a staple food in Indian, Chinese Neolithic and Korean civilizations. The origin of millet is diverse with varieties coming from both Africa and Asia. Pearl millet originated from West Africa and finger millet from Uganda. Finger millet was taken to India from African highlands about 3,000 years ago and to Europe at the

beginning of the Christian era. Later, the crop was widely distributed in many African countries as well as in the Indian subcontinent. The oldest historical roots of millet are to be found in China, where it was considered a sacred crop. One of the earliest recorded writings dates from 2800 BC giving directions for the growing and storing of the grain. During prehistoric times, people of Northern India were also cultivating millet. Millet's travel continued throughout the Middle East and Northern Africa where it became a staple. They have been a part of the human food system from time immemorial. Many types of millet have been found in Harrapan & Mohenjadaro archaeological sites. In Africa, the Mayans, Incas & Aztecs were known to use millets in their myriad culinary courses.

1.2 MILLETS: AREA, PRODUCTION AND PRODUCTIVITY

Production of millets is still by small and marginal farmers (0.3-5.0 ha farm size) and consumed as staple food and drink in most areas. These millet production areas coincide very well with areas where most of the poor lives and climate is not favorable for cultivation of any other crops. In these marginal areas, millets are the best available alternative for farmers to get reliable harvest, food and nutrition as the environments are very erratic and gets scanty rainfall as well as the soil fertility levels are low. Millets are produced in 18.50 million ha by 28 countries covering 30% of the continent. There are nine species which form major sources of energy and protein for about 130 million people. Millets are consumed as a staple food (78%), drinks and other uses (20%), and feed use (2%). As food, they are nutritionally equivalent or superior to most cereals and contain high levels of methionine, cystine, and other vital amino acids for human health. Millets are also a unique sources of pro-vitamin A (yellow pearl millets) and micronutrients (Zn, Fe and Cu) which are especially high in finger millet.

Table 1
World Cereal Market¹

	Year				
	2009-10	2010-11	2011-12	2012-13	2013-14 (estimate)
Production (mt)	2266.1	2257.4	2354.2	2305.4	2525.7
Utilization (mt)	2233.1	2271.7	2327.9	2330.1	2461.3

Table2
Millet production and its growth rate in India
(Department of Agriculture and Co-operation, India)

Year	Production (1000 mt)	Growth Rate
2000	10400	19.82%
2005	10500	-3.14%
2010	13290	51.37%
2011	12800	-3.69%
2012	10760	-15.94%
2013	11520	7.06%
2014	9500	-17.53%

1. MILLETS: DIFFERENT TYPES

Millets are a group of highly variable small-seeded grasses, widely grown around the world as cereal crops other than wheat, rice, maize and barley. These are mostly tiny in size, round in shape and ready for usage as both human food and fodder. It is consumed by humans in the form of pilafs, snacks and cookies too. It has a sweet nutty flavor. Millets are widely grown in Africa and Asia. It has high nutritional values when compared with rice and wheat. Millets are called as miracle grains or wonder grains. Millets is a collective term referring to a number of small-seeded crops belonging to gramineae family. Millets are the most dependable and staple food of the poor and India is the largest producer of many varieties of millets.

The following characteristics of the millets are very important.

- **Hardy crops:** Grows well both in dry zones and rain-fed areas under marginal soil fertility conditions.
- As millets can grow and thrive under difficult conditions, even produces some seeds in years with minimal rainfall. They have become an essential food in areas where the major cereals fail to give sustainable yields².
- **Crop duration:** Millets are very unique due to short growing period and are ready to harvest as early as in 65 days.
- **Keeping quality:** If stored properly the whole millets can be stored well for two years or beyond.

1.1 Classification of millets³.

1.1.1 Major millets

The most widely cultivated species

2.1.1.1 ERAGROSTIDEAE TRIBE

• *Eleusine coracana*

Finger millet (known as *ragi*, *nachani* or *mandwa* in India), fourth most cultivated millet. Finger millet is a short, profusely tillering plant with characteristic finger like terminal inflorescences, bearing small reddish seeds. The crop is extensively grown as a cereal in the dry areas of Southern India. *Ragi* contains high amount of calcium, protein with well-balanced essential amino acids composition along with Vitamin A, Vitamin B and phosphorous. Its high fiber content also checks constipation, high blood cholesterol and intestinal cancer.

2.1.1.2 PANICEAE TRIBE

• *Panicum miliaceum*

Proso millet (common millet, broom corn millet, hog millet or white millet) is the third most cultivated millet and is one of the most nutritious and delicious temperate millet. Proso millet is a short season crop (60-70 days), well suited for many soil types and varied climatic conditions. The grain contains a comparatively high percentage of indigestible fibre. The seeds are enclosed in the hulls and are difficult to remove by conventional milling processes.

- ***Pennisetum glaucum***

Pearl millet (known as *bajra*, *Sajja* in India) is the most cultivated millet and extensively grown in nutrient poor and sandy soils of the desert and dryland areas. This millet is known to possess phytochemicals that lowers cholesterol. It also contains folate, magnesium, copper, zinc, and vitamins E and B complex. It is rich in calcium and unsaturated fats which are good for human health.

- ***Setaria italica***

Foxtail millet the second most cultivated millet (known as *kang* or *rala* in India). Generally grown in semi-arid regions, it has a low water requirement and cropping time is very short (65-70 days). Seeds are borne in a spike-like compressed panicle resembling yellow foxtail or giant foxtail. The grains are gluten free and similar to paddy grain in structure. They contain an outer husk, which needs to be removed in order to be used.

2.1.1.3 ANDROPOGONEAE TRIBE

- ***Sorghum***

is considered as major millets. Sorghum is rich in potassium, phosphorus, zinc, calcium and has small amounts of iron and sodium. Sorghum is recommended as a means to reduce micronutrient malnutrition globally. Sorghum in the meals of a pregnant woman supplies the required minerals and vitamins. It also helps to control heart problems, body weight and arthritis.

2.1.2 Minor millets

2.1.2.1 Andropogoneae tribe

- ***Coix* spp.** : Job's tears

2.1.2.2 Eragrostideae tribe

- ***Eragrostis tef*** : Teff

2.1.2.3 Paniceae tribe

- ***Digitaria* spp.** : White Fonio, Black Fonio, and Raishan, Polish Millet
- ***Echinochloa* spp.** : Japanese barnyard millet, Indian barnyard millet (syn. : sawa millet) (known as *bhagar* or *varai* in Maharashtra, India), Burgu Millet
- ***Panicum sumatrense*** : Little Millet
- ***Paspalum scrobiculatum*** : Kodo millet
- ***Urochloa* spp.** : Browntop millet, Guinea millet

2. RELEVANCE OF MILLET IN DRY LAND AGRICULTURE

Millets need very less water for their production. The rainfall needed for Sorghum, Pearl Millet and Finger Millet is less than 25% of sugarcane and banana, and 30% that of rice⁴. To grow one kg of rice we use 4000 lt of water, while all millets grow without irrigation. This can turn out to be a tremendous national gain especially in the ensuing decades of erratic climate and millets can become the food of security. Millets are often grown on less than 15 cm deep soil and it never demands rich soil for their survival and growth. Millet cultivation is not dependent on the use of synthetic fertilizers and majority of millet farmers use farmyard manures. The pesticides requirement for millets is close to nil and that's why they are a great boon to the environment. All these qualities of millet cultivation make them the most compliant crops for climate change situation. Climate change forces less rain, more heat and reduced water availability. Millets can withstand these challenges, survive and reproduce. It is important to note that with the projected temperature rise, wheat and rice might disappear (as wheat is an extremely thermos-sensitive crop) and emission of green-house gas from rice fields will be a threat for environment. Wheat and rice provide only food security, whereas millets produce multiple securities (food, fodder, health, nutrition, livelihood and ecological). In spite of all millet cultivation has been shrinking over the last five decades. Since Green Revolution period 44 % millet cultivation area was occupied by other crops signifying an extraordinary loss to India's food and farming systems⁴.

3.1 NEGLIGENCE OF MILLETS AS IMPORTANT CROPS

Increased production and consumption of millets is likely to result in various societal benefits. There are several barriers which have limited and still are limiting the production and consumption of millets is listed.

- Absence of proper production support in terms of input supply and subsidy (seed and nutrients), irrigation support and

marketing support as compared to the support provided for other crops.

- Lack of improved methods of production and improved varieties of small millets.
- Lack of organized seed distribution systems to supply good quality seeds of small millets.
- Lack of appropriate post-harvest processing technologies for small millets.
- Competition and lack of public procurement as compared other market friendly remunerative crops.
- Preference patterns in consumption which resulted in an inadequate appreciation of millets.
- Absence of public or private funded promotion of millets as a nutritious food category.
- Lower cooking quality of millet is one of the major reasons of lower acceptance as a food. If this problem is solved, their high nutritional value can make them highly valuable as food for people⁵.

3.2 IMPROVED CULTIVATION PRACTICES

Even though sorghum, pearl millet and finger millet have seen significant productivity increases still wide productivity gaps present when compared between the state average yield and outputs from frontline demonstrations organized under the Department of Agriculture and Cooperation (DAC). Yield gaps vary between states and between crops. This shows the enormous potential for improvement as well as the great challenge that lies ahead. For pearl millet Reddy et al., (2013) reported some of the low-cost inputs which show the scope for increasing the yield levels in pearl millet as compared to the local practices;

- Application of 20 kg ZnSO₄/ha as basal
- Application of atrazine @ 1.0 kg / ha as pre-emergence spray followed by at least one hand weeding increasing the grain and

fodder yield of pearl millet to increase profitability

- Spray of 0.1% thiourea at tillering and flowering, which helped to mitigate drought stress, reduce loss of crop and increase stability
- Seed treatment with neem oil 5ml/kg seed + spray of 5% NSKE (neem seed kernel extract) at 50% flowering was found to be an effective treatment in controlling pest attack of pearl millet (AICPMIP, 2011).
- Supplementary irrigation increases the yield levels and profitability

The above agronomic practices are profitable both for summer and *kharif* crop. With the adoption of improved cultivars and low-cost improved technology, yields can be increased by 20-30% from the existing levels⁶.

3. NUTRITIONAL PROFILE AND MEDICINAL BENEFITS

These are some of the general health benefits of millets when consumed everyday (Source:<http://www.whfoods.com>)

- Millets are generally rich in protein, fibre, calcium, iron and minerals especially magnesium, copper and phosphorous.
- It is gluten free and helps to reduce cholesterol, lowers blood pressure and lowers the risk of Type 2 diabetes especially for women.
- It helps in the development and repair of body cells and tissues.
- It is a great food for people looking for weight loss, diabetic and cardiac patients.
- Its high insoluble fibre helps to prevent gallstones formation.
- Pre-menopausal women eating millets have a reduced breast cancer risk.
- Millets are highly nutritious, non-glutinous, non-acid forming foods thus easy to digest.
- Being gluten free, these are least allergenic and hence well suited for those suffering from celiac disease.

Table 3
Nutrient Content of Various Millets with Comparison to Rice and Wheat ⁷

Crop / Nutrient	Protein (g)	Fiber (g)	Minerals (g)	Iron (mg)	Calcium (mg)
Pearl millet	10.6	1.3	2.3	16.9	38
Finger millet	7.3	3.6	2.7	3.9	344
Foxtail millet	12.3	8	3.3	2.8	31
Proso millet	12.5	2.2	1.9	0.8	14
Kodo millet	8.3	9	2.6	0.5	27
Little millet	7.7	7.6	1.5	9.3	17
Barnyard millet	11.2	10.1	4.4	15.2	11
Rice	6.8	0.2	0.6	0.7	10
Wheat	11.8	1.2	1.5	5.3	41

Compared to rice, especially polished rice, millet ingestion results in a slower release of glucose over a period of time. In other words, millets have low glycaemic index (GI) and low glycaemic load (GL), and thus their habitual intake reduces the risk of *Diabetes mellitus*⁸. However, millets also feature high fiber content and poor digestibility of nutrients, which severely limit their value in nutrition and influence their consumer acceptability (FAO, 1995).

4. MILLETS: THE POTENTIAL

Millets are still the staple food for millions of poor people. Millets are the high-energy nutritious grains can be made useful components of dietary and nutritional balance in foods. Millet is very important food grain for food and nutrition security as they are having good amounts of untapped potential. There is an enormous possibility for yield increases through hybrid development and production, superior yield gains under drought and resource-poor environments.

Research & Development (R&D) should focus on strategies to enhance productivity and increase the demand of millets. The strategies to be adopted as follows:

- 4.1 Increasing the production and productivity to improve the competitiveness of millets as compared to other crops.
- 4.2 Promoting millets for commercialization through improvement of processing and utilization methods and technologies including fermentation, malting, brewing and micro milling.
- 4.3 Diversifying end-use products to include ready-made, non-conventional, better-packaged and more presentable conventional foods.

- 4.4 Expanding the use of pearl millets in livestock feed industry, malting, brewing and by-products industries.
- 4.5 Use of millets in novel food products, novel traits, bio-fortified food products (using their unique qualities of high levels of Copper, Iron, Zinc, Magnesium and Manganese), nutritional convenience and health snack foods.
- 4.6 Developing trade in millets for raw and finished products with improved quality and standards.
- 4.7 Creation of awareness about the healthy nutritional qualities of millets to improve the status of millets among common people.
- 4.8 Closer interactions between stake holders including producers, consumers, processors, traders, distributors and government agencies.

5. CONCLUSION

With regard to Global Hunger Index (GHI), India ranks 64 (among the 81 nations) and in child malnutrition it occupies the second place. This is the scenario despite the Public Distribution System (PDS) being there for nearly five decades, which has helped the poor and marginalized households in meeting their food and nutrition needs. However, the focus of PDS has been only on wheat / rice distribution while the millets have long been disregarded¹⁰. There are important researchable and development issues that confound or influence the importance and status of millets and their potential in commercialization. Adaptation and improvement of local varieties, knowledge and use of nutritional qualities of millets by industries and productivity increase would surely promote the cultivation of millets. With

good productive returns, little management and high nutritional values, small millets are often the crop of choice for impoverished societies where labour is cheap and organized on a small scale. With these advantages, one would expect to find good evidence for millet use in the archaeological record (NABARD). Millets are water saving, drought tolerant crops, therefore millets must be viewed as climate change compliant crops. This is the perspective from which the millet cultivation and its promotion must be regarded. Every

millet farmer of India must be given a climate change bonus, biodiversity bonus, water conservation bonus. Unless this is focused through policy or financial incentives, millets might disappear from the agrarian system of India. This will be a great loss to India's food and farming systems. Therefore, there is an urgent need for Indian policy makers to refocus their attention towards millet farming and make millet as India's food and farming future.

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