Millets with regard to food and nutritional security of India- A Review

SARBAJOYA GOSWAMI[1]* AND P. BANDOPADHYAY[2]

Visva-Bharati, PalliShikshaBhavana, Department of Agronomy, Sriniketan, Bolpur,Birbhum, West Bengal.731236

ABSTRACT

Millets are traditional food for 59 crore people in Africa, Latin America and Asia. They are grown in 131 countries with an area of 71.2 m ha and production is around 86.3 m t. India produces 80% of Asia's millets and 20% of World millets. In 1965-70, millets contributed 20% of total food grain basketof India but now it comes down to 6%. Millets are considered as 'super food' because they provide not only major nutrients like protein, carbohydrates, fats etc. but also provide ample *amounts*of vitamins and minerals. It has also been reported that millet proteins are good sources of essential amino acids except lysine and threonine but are relatively high in methionine. Millets are also rich sources of minerals and dietary fibers when compared to rice or wheat and contains 9-14% protein and 70-80% carbohydrates. These are rich sources of phytochemicals and micronutrients. The quality of protein is mainly a function of its essential amino acids. Finger millet contains 44.7% essential amino acids of the total amino acids. Among the millets, pearl millet (Bajra) has the highest content of macronutrients and iron, zinc, Mg, P, folic acid and riboflavin. Finger millet records the highest amount of sulphur containing amino acids like methionine and cycteine besides containing the highest amount of Ca when compared to conventional cereals. In India, millets possess immense potential in our battles against climate change and poverty, and provide food, nutrition, fodder and livelihood security. The Government of India started the POSHAN Mission Abhiyanand laid emphasis on the nutritional significance of millets.

Key words: *Millets, super food, nutrition, livelihood security and poshan mission abhiyan*

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*[1]Ph. D Scholar, *E-mail: sabajoyagoswami98@gmail.com*

[2]*Professor, Bidhan Chandra KrishiViswavidyalaya, Department of Agronomy, Mohanpur, Nadia, West Bengal 741252E-mail:pintobckv@gmail.com*

1 INTRODUCTION

Millets are small grained cereals belonging to Gramineae family which include major millets like sorghum and pearl millet (which are tall growing and fairly drought tolerant) and minor millets with short slender culm and small grains possessing remarkable drought tolerance (ICRISAT and FAO, 1996).Small millets are a group of six crops comprising of finger millet, kodo millet, little millet, foxtail millet, barnyard millet and proso millet. They are considered as nutri- cereals and are source of food, feed and fodder (Sujata*et al.,* 2018).

(a) Genera and species: The term "millet' is often used loosely to refer to several types of small seeded annual grasses. Millets share a set of characteristics which make them unique amongst cereals. They belong to five genera, namely *Panicum, Setaria, Echinochola, Pennisetum, Paspalum,* and*Eleusine*. The genus *Pennisetum* includes about 140 species, some of which are domesticated and some grow in the wild. Most of the genera are widely distributed throughout the tropics and subtropics of the world (De Wet *et al*, 1984). Millets can be a valuable source of forage because of their rapid growth, high nutritive value and ability to survive stressful conditions such as drought.

(b) Important millet species:According to Hulse*et al.* (1980), the most important cultivated millet species are pearl millet (*Pennisetumtyphoides*), also known as bulrush millet; proso millet (*Panicummiliaceum*), also known as common millet; foxtail millet (*Setariaitalica*); Japanese barnyard millet (*Echinochloa* crus- gallivar or *E. colona*); finger millet (*Eleusinecoracana*), also known as birds foot millet or African millet and kodo millet (Paspalumscorbiculatum). Other millets include little millet (*Panicumsumatrense*), tef millet (*Eargrostistef*) and fonio millet *Digitariaexilis* and *D. iburua*) (Dogget, 1989).

(c) Millets grownin India

- The three major millet crops currently growing in India are jowar (sorghum), bajra (pearl millet) andragi (finger millet).
- Along with that, India grows a rich array of bio-genetically diverse and indigenous varieties of"small millets" like kodo, kutki, chenna and sanwa.
- Major producers include Rajasthan, Andhra Pradesh, Telangana, Karnataka, Tamil Nadu, Maharashtra,Gujarat and Haryana.

(d) History: The vernacular names of millets in India are given in Table 1. India is also the home for the species *Echinocholacolona* (Sawa) under barnyard millet. Many indigenous communities in Asia preferred millets as their grain crop for shifting cultivation. The long history of minor millet cultivation and their spread to different regions of the world, which are notable for extremely harsh farming conditions, had generated considerable genetic variability in these crops.Kodo millet is very hardy and possesses the highest drought resistance with potential to offer a good yield in a growing period between 80-135 days. Barnyard millet could be said to be the second hardiest millet with the ability to give a modest yield in 50-100 days. Finger millet is more widely grown in Africa and Asia, differentiated in to five races and shows wide variability in appearance, adaptability, maturityperiod, yield and quality. Foxtail millet may be ranked fourth in yielding ability. The yield potential of little and proso millets are relatively lower with proso millet being hardier.

Table 1. Vernacular name of different millets grown in different parts of India

English	Botanical	Alternate	Hindi	Kannada	Tamil	Telegu	Malayalam	Marathi
Sorghum	*Sorghum bicolor*	Great Millet/ Milo/Chari	Jowar	Jola	Cholam	Jonnalu	Cholam	Jwari
Pearl millet	*Pennisetumglaucum*	Spiked Millet/ Bullrush	Bajra	Sajje	Kambu	Gantilu/Sazzalu	Kambu	Bajri
Finger millet	*Eleucinecoracana*	Rajika	Mandua/ Madua	Ragi	Kelvargu/kezhvaragu	Ragulu	Muthari	Nachni
Barnyard Millet	*Echinocloafrumantacea*	Japanese Millet/Sawank	Jhangora/Shama	Samai	Kuthiravaali	Odalu/Bonta/ Chamula	-	Shamul
Foxtail Millet	*Setariaitalica*	Moha Millet/Italian Millet	Kangni	Navane/PriyanguThene	Tenai	Korra/Korralu	Thina	Rala
Kodo Millet	*Paspalumscrobiculatum*	Pakodi/Manakodra	Kodra	Harka	Varagu	Arikelu	Varagu	Harik
Proso Millet	*Panicummiliaceum*	French Millet/Common Millet	Barri	Baragu	Panivaragu	Varigulu/varigalu	Panivaragu	Vari
Little Millet	*Panicummiliare*	Goudli/Gondola	Kutki	same	Samai	Sama	Chama	Sava

(e) Importance in dietary need: Millets may have been consumed by humans for 7000 years and potentially had a pivotal role in rise of multi-crop agriculture and settled farming societies. Recently realizing the excellent nutritional composition of these grains, they are now called “nutricious grains” or “nutri cereals”.

2. AREA, DISTRIBUTION AND PRODUCTION

Millets are traditional food for 59 crore people in Asia and Africa. They are grown in 131 countries.

Table2. Millets area and productionscenario over the globe during 2019

Regions	Area (m ha)	Production (m t)
Africa	48.9	42.3
America	5.3	19.3
Asia	16.2	21.5
Europe	0.8	2.0
Australia and New Zealand	0.6	1.2
India	13.8	17.3
World	71.8	86.3

- India produces >1.70 m t (80% of Asia’s & 20% of global production)
- Global average yield: 1229 kg/ha, India (1239 kg/ha)

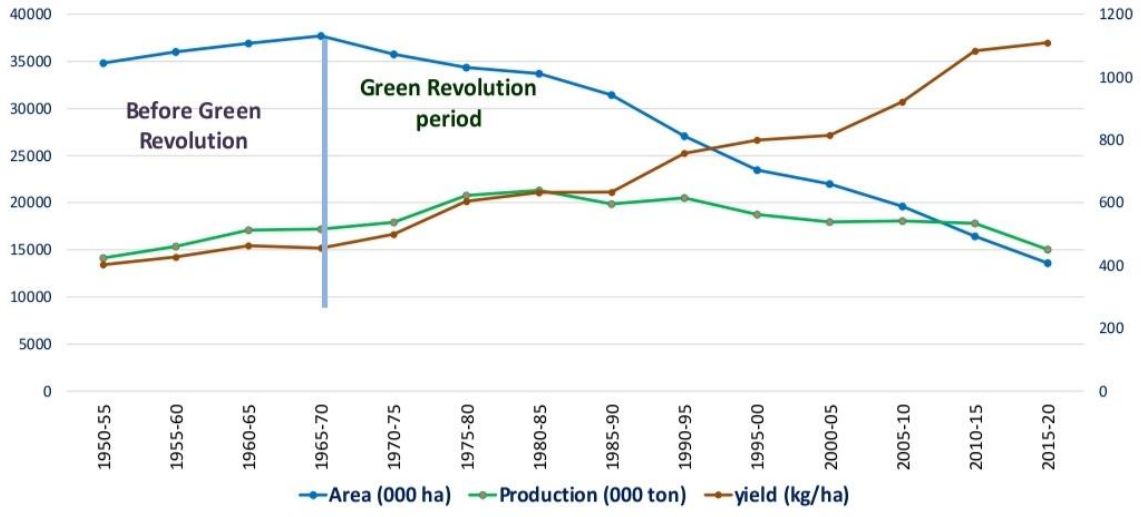


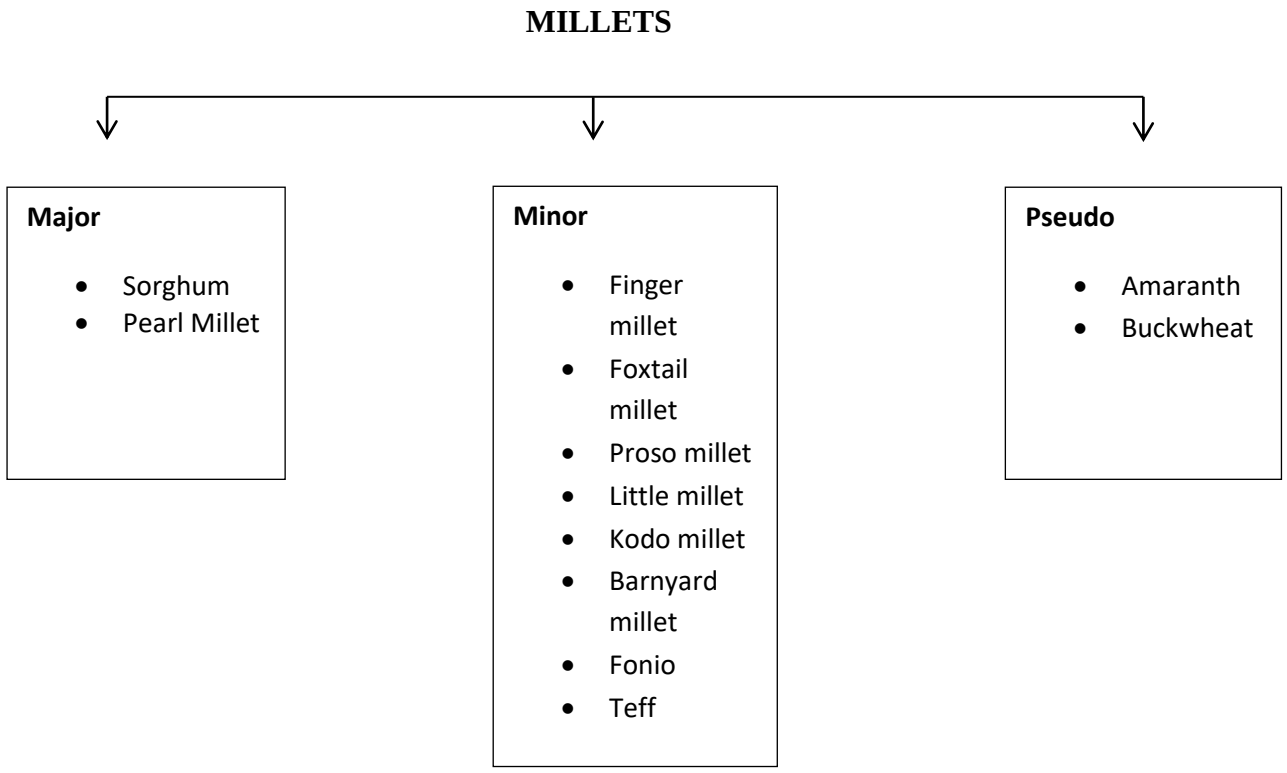
Figure 1. Quinquennial mean area, production and yield of millets in India

- Area decreased (56%), productivity has increased (228%) High adoption of high yielding varieties/ hybrids.
- Up to 1965-70: Millets- 20% of total food grain basket, now only 6% dominated by rice & wheat.

3. AGRO-CLIMATIC REQUIREMENT

Millets require warm temperatures for germination and development & are sensitive to frost. For these reasons, they are normally planted from mid-June to mid-July month. Optimum soil temperatures for seed germination are between 20°C and 30°C. Proso and foxtail millet are efficient users of water & grow well in areas of low moisture, partly because they are early and thereby avoid periods of drought. Millets are often grown as catch crops where other crops have failed due to unfavorableweather. Millets produce well on well-drained loamy soils. They will not stand water-logged soils or extreme drought. Proso millet does not make good on coarse, sandysoils.

4. CLASSIFICATION



5. SUPER FOOD AND NUTRITIONAL SIGNIFICANCE

Millets are often referred to as Super food and its production can be seen as an approach for sustainable agriculture and a healthy world. Multidimensional benefits associated with millets can address the issues related to nutrition security, food systems security, and farmers' welfare. Further, many unique features linked with millets makes them a suitable crop which is resilient to India's varied agro-climatic conditions. Citing these factors, the year 2018 has already been declared as the National Year of Millets and India has called for declaring 2023 as the "International Year of Millets". However, in spite of acknowledging their significance as a superfood, general perception is that the millets are increasingly seen as "poor person's food". Therefore, it is necessary to re-brand coarse cereals/millets as nutri-cereals and promote their production and consumption.

5.1 Quality food: Nutritional quality of food is a key element in maintaining overall human health. In addition to their cultivating advantages, millets are found to have high nutritive value comparable to that of major cereals such as wheat and rice.

It has also been reported that millet proteins are good sources of essential amino acids except lysine and threonine -but are relatively high in methionine. Millets are also rich sources of phytochemicals and micronutrients (Mal *et al*., 2010;Singh and Raghuvanshi, 2012). Millets are highly nutritious, non-glutinous and non-acid forming foods. Hence they are soothing and easy to digest. They are considered to be the least allergenic and most digestible grains available. Compared to rice (especially polished rice), millets release lesser percentage of glucose.

Finger millet is the richest in calcium, about 10 times that of rice or wheat. Considering the nutrient richness of these grains they are now considered as 'nutri-cereals' and not as 'coarse cereals'. Though millets are generally regarded as "coarse" grains, their potential for augmenting the grain supplies, as also to considerably bridge the protein gap is being increasingly realized. Millet, besides being a rich source of carbohydrates, is very easy to digest; it contains a high amount of lecithin and is excellent for strengthening the nervous system.

Millets are rich in B vitamins, especially niacin, pyridoxine and folic acid, as well as the minerals calcium, iron, potassium, magnesium and zinc. Finger millet carbohydrates comprise of free sugars (1-2%), starch (75-80%) and non-starchy polysaccharides consisting of cellulose and hemicellulose. It is a very good source of dietary fibre, micronutrients and polyphenols.

Among the millets, pearl millet (Bajra) has the highest content of macronutrients and iron, zinc, Mg, P, folic acid and riboflavin. It is significantly rich in resistant starch and soluble and insoluble dietary fibres . Finger millet seed coat is an edible material and contains good proportion of dietary fibre, minerals and phytochemicals. Finger and teff millet are good sources of dietary calcium and magnesium and iron content is significant.

5.1.1 Millets as probiotic and prebiotic: Probiotics are "living microorganisms" which when administered in adequate amounts confer a health benefit on the host . Fermented millet products act as a natural probiotic treatment for diarrhea in young children (Lei *et al*, 2006). In Africa, millet Koko is prepared in the form of fermented millet porridge and drink (Lei and Jacobsen M. 2004). Prebiotics are non digestible food ingredients that beneficially affect the host by selectively stimulating the growth and activity of one or a limited number of bacteria in the colon. Millets whole grain also shows prebiotic activity, which helps to increase the population of bacteria's that plays a key role to promote digestion. Malting reduces important beneficial biochemical changes in the millet grain.

5.1.2 Nutritional significance of millets: Nutritional composition of some of the major cereals including coarse cereals and millets (per 100g) is presented as below. Millets are nutritionally comparable or even superior to major cereals such as wheat and rice, owing to their higher levels of protein with more balanced amino acid profile (good source of methionine, cystine and lysine).

The neutraceutical importance of finger millet lies in its high content of calcium (344mg/100g), protein (6% to14%), dietary fiber (18 %), carbohydrates (65% to 75%), minerals (2.5% to 3.5%), phytates (0.48%), tannins (0.61%), phenolic compounds (0.3 to 3.00%) and trypsin inhibitory factors, and is recognized for its health beneficial effects, such as anti diabetic, anti- tumerogenic, anti- diarrheal, antiulcer, anti-inflammatory, anti-oxidant and anti-microbial properties (Devi *et al.*, 2014; Supriya*et al.*, 1996;ChetanandMalleshi,2007). Finger millet is milled with the testa which is generally rich in dietary fiber and micronutrients to prepare flour and the whole meal is utilized in the preparation of traditional foods, such as roti (unleavened breads), ambali (thin porridge) and mudde (dumplings).

Table 3: Nutrient composition of millets compared to wheat and rice (per 100g)

Food Grain	Protein (g)	Fat (g)	Crude Fibre (g)	Minerals		Sulfur Containing amino acids		Unsaturated Fatty Acids		
				Ca (mg)	Fe (mg)	Methionine (mg)	Cysteine (mg)	Oleic (mg)	Linoleic (mg)	Linolenic (mg)
Finger Millet	7.3	1.3	3.6	344	3.9	210	140	-	-	-
Kodo Millet	8.3	1.4	9.0	27	0.5	-	-	-	-	-
Proso Millet	12.6	1.1	2.2	14	0.8	160		53.80	34.90	
Foxtail Millet	12.3	4.3	8.0	31	2.8	180	100	-	-	-
Little Millet	7.7	4.7	7.6	17	9.3	180	90	-	-	-
Barnyard Millet	6.2	2.2	9.8	20	5.0	180	110	-	-	-
Sorghum	10.4	1.9	1.6	25	4.1	100	90	31.0	49.0	2.70
Bajra	11.6	5.0	1.2	42	8.0	150	110	25.40	46.0	4.10
Wheat(Whole)	11.8	1.5	1.2	41	5.3	90	140	11.50	56.30	3.70
Rice(rawmilled)	6.8	0.5	0.2	10	0.7	150	90	42.5	39.10	1.10

6. SOME POTENTIAL HEALTH BENEFITS OF MILLETS

a) Millets for diabetes: Lower incidences of diabetes have been reported in millet-consuming population. Millet phenolics inhibit like alpha – glucosidase, pancreatic amylase reduce postprandial hyper glycemia by partially inhibiting the enzymatic hydrolysis of complex carbohydrates.Inhibiters like aldose reductase prevents theaccumulation of sorbital and reduce the risk of diabetes induced cateract diseases. Finger millet feeding to the diabetic animals for four weeks, controlled the glucose level and improve the anti oxidant status, which hasten the dermal wound healing

process .Dehulled and heat treated banyard millet has been reported beneficial for Type II diabetes in which low glycemic index for dehulled millet (50.0) and heat treated was recorded.

b) Millets and aging: The chemical reaction between amino group of proteins and the aldehyde group of reducing sugars, termed as non enzymatic glycosylation, is a major factor responsible for the complications of the diabetes and aging. Millets are rich in anti oxidants and phenolics like phytates, phenols and tannins which can contribute to the anti oxidant activity important in health, aging and metabolic syndrome (Hegde*et al.,* 2002).

c) Millets against cancer and celiac disease: Millets are known to be rich in phenolic acids, tannins and phytates that act as "anti nutrients". However these anti nutrients reduce the risk of colon and breast cancer in animals. It is demonstrated that millet phenolics may be effective in the prevention of cancer initiation and progression in vitro The overall growing demand for novel, tasty and "healthy" foods together with the increasing number of people suffering from celiac disease has given birth to a new market consisting of cereal products made from grains other than wheat and rye. In this challenging market, oat, sorghum and millet have gained a special position. Celiac disease is an immune – mediated enteropathy triggered by the ingestion of gluten in genetically susceptible individuals. However, since millets are gluten free, they have considerable potential in foods and beverages that can be suitable for individuals suffering from celiac disease. Therefore millet grains and their functions have the potential to be useful in cancer prevention and for producing food products for celiac people.

d) Millets for cardiovascular disease: Obesity, smoking, unhealthy diet and physical inactivity increase the risk of heart attacks and strokes. Most of the world countries face high and increasing rates of cardiovascular disease. It has been demonstrated that rats fed with diet of native and treated starch from barnyard millet had the lowest blood glucose, serum cholesterol and triglycerides compared with rice and other minor millets. Finger millet and proso millet may prevent cardiovascular disease by reducing plasma triglycerides in hyper lipidemic rats (Lee *et al*., 2010). Diversification of food production must be encouraged both at national and household levels in tandem with increasing yields. Providing more healthful and traditional whole-grain and multigrain substitutes for refined carbohydrates can be one important aspect of therapeutic dietary modification and promoting utilization of minor-grain foods (Singh and Raghuvanshi 2012)

7. NEED FOR PROMOTION OF MILLETS

a) **Climate resilient crop**: As millets are resistant to climatic stress, pests and diseases, this makes them a sustainable food source for combating hunger in changing world climate. Further, millets are not water or input-intensive, making them a sustainable strategy for addressing climate change and building resilient agri-food systems.

b) **Nutritional security**: Millets are high in dietary fibre,nutri-cereals are a powerhouse of nutrients including iron, folate, calcium, zinc, magnesium, phosphorus, copper, vitamins and antioxidants. They are not only important for the healthy growth and

development of children but have also been shown to reduce the risk of heart disease and diabetes in adults. Millets, being gluten free and low glycemic index food are good for diabetic persons and can help to combat cardiovascular diseases and nutritional deficiency.

c) **Economic security**: Millets can be grown on dry, low-fertile, mountainous, tribal and rain-fed areas. Moreover, millets are good for the soil, have shorter cultivation cycles and require less costintensive cultivation. Given these features, low investment will be needed for production of millets and thus can prove to be a sustainable income source for farmers.

8. SUBDUED USE OF MILLETS

- **Green Revolution**: With the Green Revolution, the focus was on food security and high-yielding varieties of wheat and rice. An unintended consequence of this policy was the gradual decline in the production of millets. Further, the cost incentives provided via MSPs to wheat and rice, discouraged production of millets.
- **Increased demand for processed food**: In parallel, India saw a jump in consumer demand for ultraprocessed and ready-to-eat products, which are high in sodium, sugar, trans-fats and even some carcinogens. With the intense marketing of processed foods, even the rural population started perceiving mill-processed rice and wheat as more aspirational.
- **Double burden:** This has led us to the double burden of mothers and children suffering from micronutrient deficiencies and the astounding prevalence of diabetes and obesity.

9. STEPS TAKEN BY THE GOVERNMENT

- **Increase in MSP:** The government has hiked the MSP of Millets, which came as a big price incentive for farmers. Further, to provide a steady market for the produce, the government has included millets in the public distribution system.
- **Input support:** The government has introduced provision of seed kits and inputs to farmers, building value chains through Farmer Producer Organisations and supporting the marketability of millets.
- **Integration approach:** The Ministry of Women and Child Development has been working at the intersection of agriculture and nutrition by setting up nutri-gardens, promoting research on the interlinkages between crop diversity and dietary diversity and running a behaviour change campaign to generate consumer demand for nutri-cereals.

10. WAY FORWARD

- **Way forward changing the narrative**: There is a need to change the general perception around consumption and trade point of view associated with millets and to re-brand coarse cereals/millets as nutri-cereals. Further, civil society can begin the mass involvement by taking small steps towards choosing healthier foods, which are good for the environment and bring economic prosperity to our farmers.

- **MSP on lines of wheat and rice:** Government can try on a pilot basis for providing MSP to millets on the lines of wheat and rice (state guarantee of procurement at MSP.).
- **Mission mode initiative**: The government can encourage farmers to align their local cropping patterns to India's diverse 127 agro-climatic zones and promote cultivation of millets with local topography and natural resources. Inter-Ministerial Approach: There is a requirement of a multi-ministerial policy framework that is aimed towards building anself sufficient India and resonates with the global call for self-sufficiency and sustainable development.

CONCLUSION

Millets are easily available and cheap. Millets contain many major and minor nutrients like carbohydrates, protein, fat, dietary fibre, vitamins and minerals as well as antioxidants and phytochemical.This year, the United Nations General Assembly adopted a resolution declaring 2023 the International Year of Millets, as proposed by India to the Food and Agriculture Organization (FAO). Millets possess immense potential in our battles against climate change and poverty, and provide food, nutrition, fodder and livelihood security. Being hardy crops, they can withstand extreme temperatures, floods and droughts**.**

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