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Millets for Ensuring Nutritional Security

K. Hariprasanna*, Sunil Gomashe, K. N. Ganapathy and J. V. Patil

Directorate of Sorghum Research, Rajendranagar, Hyderabad – 500 030

***Email of corresponding author: hari@sorghum.res.in**

Millets are small-grained cereal grasses and provide food as well as fodder. Millet cultivation is the mainstay of rainfed farming which provide livelihood to nearly 50% of the total rural workforce and sustain 60% of cattle population in India. Millet grains contain higher protein, fibre, calcium and minerals than the widely consumed fine cereals, and can ensure nutritional security to the poor people who cannot afford a variety of food items in their diet. In spite of nutritional benefits and capability of millet farming system, cultivation of millets is on the decline. Immediate policy and market support, value addition and promotional activities are necessary for reviving millets. Improving productivity and enhancing demand should be the twin approaches. Development of health foods and their commercialization should receive focused attention to promote the millets among the urban population apart from traditional rural consumers.

Introduction

Crops like maize, barley and millets are collectively termed as 'coarse cereals' in agriculture. The name 'Millet' is used to describe a number of different small-grained cereal grasses. Millets are one of the oldest cultivated foods known to humans and have been a staple in Northern Africa for thousands of years, and was a staple in China and India prior to the popularity of fine cereals like rice. Millets are important drought-resistant and hardy crops, and quite adaptable to a variety of agro-climatic adversities. Because of their better adaptability they play an important role in marginal agriculture followed in the semi-arid tropical regions and hilly terrains. Millets are C4 plants and hence have a very efficient photosynthetic system than the less efficient C3 plants like rice and wheat. A majority of millet grains contain higher protein, fibre, calcium and minerals than the widely consumed rice and wheat, and hence now often being regarded as "Nutri-cereals".

Millets in Indian Agriculture

The important millet crops in India are sorghum or jowar (*Sorghum bicolor*), pearl millet or bajra (*Pennisetum glaucum*) and a group of six small millets, which have traditionally been the main components of the food basket of the poor people in India. The group of small millets is represented by finger millet or ragi (*Eleusine coracana*), little millet (*Panicum miliare*), kodo millet (*Paspalum scrobiculatum*), foxtail or italian millet (*Setaria italica*), barnyard millet (*Echinochloa frumentacea*) and proso millet (*Panicum miliaceum*). These crops are an important component of dry farming system in India. Unfortunately, in spite of the superior nutritional qualities of millets and capabilities of millet farming systems, the area under millet production has been on the decline

since green revolution. The period between 1961 and 2009 saw a dramatic decrease in cultivated area under millets, more so in case of small millets (80% for small millets other than finger millet, 46% for finger millet, 59% for sorghum and 23% for pearl millet) (Anonymous, 2012). Between 1966 and 2006, 44% of millet cultivation areas were occupied by other crops signifying an extraordinary loss to India's food and farming systems. The area under all small millets other than finger millet has declined drastically in all states and the total production of small millets has declined by more than 75% (Table 1). Declining government support has significantly contributed to this fall of millets in Indian agriculture.

In major millets like jowar the production levels are almost maintained due to increased productivity over the years due to crop improvement and agro-technology, while in case of bajra the production has jumped by more than four times. The productivity of small millets (other than ragi) remained almost stagnant while in ragi very high genetic gains have been observed (Table 1).

Table 1. All India area, production and productivity of millets

Year/ Crop	Element	1951-52	1961-62	1971-72	1981-82	1991-92	2001-02	2011-12	2012-13*
Jowar	Area	15.94	18.25	16.78	16.60	12.36	9.80	6.25	6.18
	Prodn.	6.08	8.03	7.72	12.06	8.10	7.56	5.98	5.33
	Yield	381	440	460	727	655	771	957	862
Bajra	Area	9.52	11.28	11.77	11.78	10.03	9.53	8.78	7.20
	Prodn.	2.35	3.65	5.32	5.54	4.67	8.28	10.28	8.74
	Yield	246	323	452	470	465	869	1171	1214
Ragi	Area	2.19	2.51	2.43	2.61	2.13	1.65	1.18	1.18
	Prodn.	1.31	2.03	2.21	2.96	2.58	2.37	1.93	1.78
	Yield	599	808	911	1134	1212	1442	1641	1514
Small millets	Area	4.76	4.87	4.48	3.79	2.09	1.31	0.80	0.69
	Prodn.	1.92	2.05	1.67	1.64	0.88	0.58	0.45	0.40
	Yield	402	421	373	433	423	440	565	581
Total millets	Area	32.41	36.91	35.44	34.78	26.61	22.28	17.01	15.25
	Prodn.	11.64	15.76	16.92	22.20	16.23	18.80	18.64	13.25
	Yield	359	427	491	638	610	844	1096	869

(Area: million ha; Prodn: million tonnes; Yield: kg/ha; # As per 2nd Advance Estimates released on 08.02.2013; Source: DMD, GoI and Agricultural Statistics at a glance 2013)

Geographic Distribution

Though millets are grown in almost every state/region, the distribution of individual millet is not uniform. Jowar is predominantly grown in the sates of Maharashtra, Karnataka, Madhya Pradesh and Telangana. Maharashtra (45%) and Karnataka (20%) grow a large proportion of jowar compared to Madhya Pradesh (10%), Andhra Pradesh (undivided) (7%) and other states like Rajasthan, Tamil Nadu, Uttar Pradesh and Gujarat (Anonymous, 2013). Bajra is grown in the dry tracts from Jammu & Kashmir to Tamil Nadu. However, states of Rajasthan (45%), Uttar Pradesh (16%), Gujarat (12%) and Haryana (11%) together contribute more than 80% of the all India production (Anonymous, 2013).

Among small millets, ragi is the most important crop grown in many states of Southern, Central, Eastern, Western and Northern India from sea level in coastal Andhra Pradesh to 8000 feet altitude in Himalayas (Krishne Gowda, 2006). The kodo, little and foxtail millets are grown widely in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Madhya Pradesh and Maharashtra. In Madhya Pradesh, both kodo and little millet are predominant, while foxtail millet is important in Andhra Pradesh and Karnataka. Barnyard millet and proso millet are grown largely in hills of Uttar Pradesh, North-Eastern region and plains of North Bihar and Western Uttar Pradesh and Maharashtra (Krishne Gowda, 2006). The percentage share of major states in area and production of small millets is depicted in Figures 1-2.

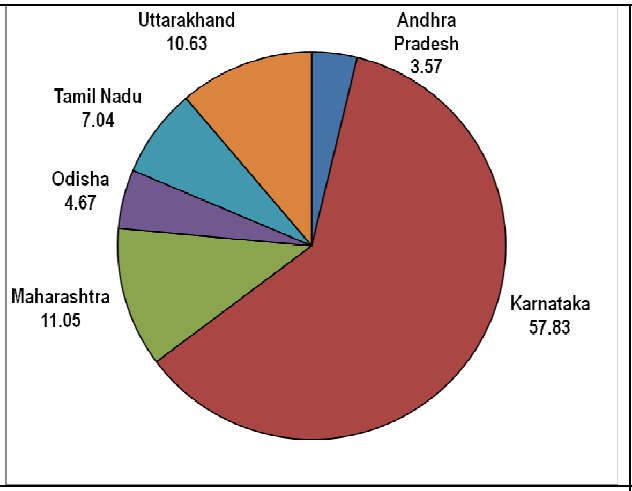

Fig. 1a. Share (%) of major states in ragi area during 2011-12

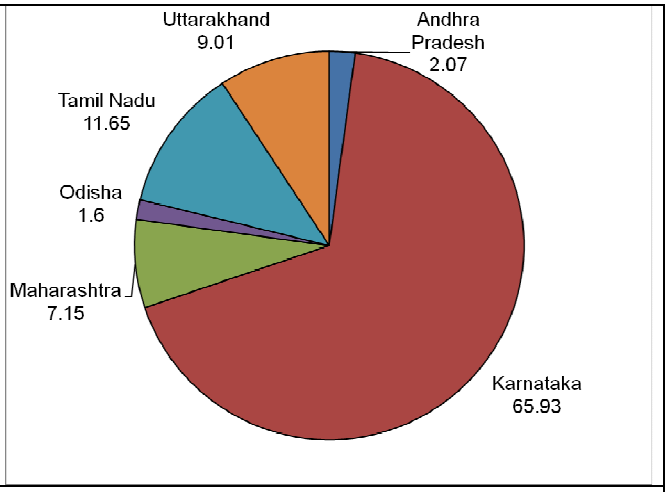

Fig. 1b. Share (%) of major states in ragi production during 2011-12

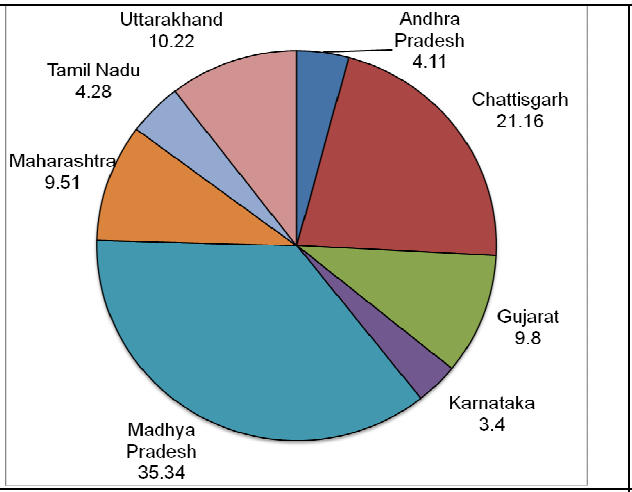

Fig. 2a. Share (%) of major states in area of other small millets (2011-12)

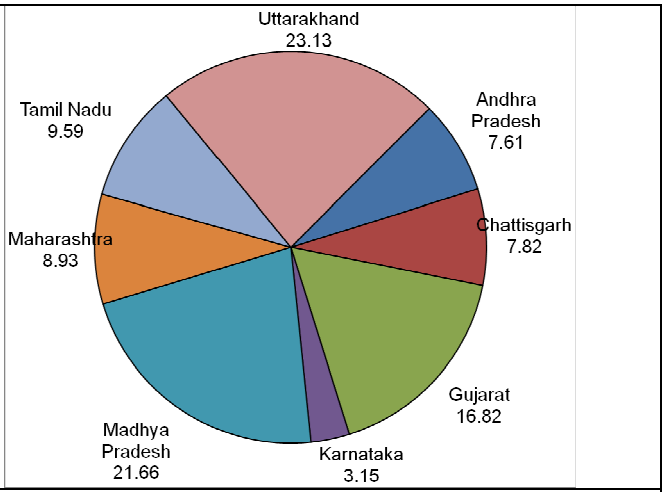

Fig. 2b. Share (%) of major states in production of other small millets (2011-12)

Nutritional Benefits of Millets

Majority of the millets are nutritionally superior compared to fine cereals like rice and wheat. Among the millets, bajra has the highest content of macronutrients, and micronutrients such as iron, zinc, magnesium, phosphorus, folic acid and riboflavin. Jowar is a cheap source of energy, protein, iron and zinc next only to bajra among all cereals and pulses, and grain has a nutritional profile better than that of rice. Small millets are highly nutritious and even superior to rice and wheat in certain constituents. Ragi is the richest source of calcium (300-350 mg/100 g) and other small millets are good source of phosphorous and iron too. The protein content ranges from 7-12% and fat content from 1-5% (Table 2). The millet protein has well balanced amino acid profile and good source of methionine, cystine and lycine (Table 3). These essential amino acids are of special benefit to those who depend on plant food for their protein nourishment. The millet grain contains about 65% carbohydrate, a high proportion of which is in the form of non-starchy polysaccharides and dietary fibre which help in prevention of constipation, lowering of blood cholesterol and slow release of glucose to the blood stream during digestion. Lower incidence of cardiovascular diseases, duodenal ulcer and hyperglycemia (diabetes) are reported among regular millet consumers. Millet grains are also rich in important vitamins *viz*., thiamine, riboflavin, folin and niacin (Table 4). Millets are comparable to rice and wheat or rich in some of the minerals (Table 5) as well as fatty

acids (Table 6). Millets vary largely in composition of carbohydrates as proportion of amylose and amylopectin content vary from 16-28% and 72-84%, respectively (Table 7).

Table 2. Nutrient composition of millets compared to fine cereals (per 100 g)

Food grain	Carbo-hydrates (g)	Protein (g)	Fat (g)	Energy (KCal)	Crude fibre (g)	Mineral matter (g)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Sorghum	72.6	10.4	1.9	349	1.6	1.6	25	222	4.1
Pearl millet	67.5	11.6	5.0	361	1.2	2.3	42	296	8.0
Finger millet	72.0	7.3	1.3	328	3.6	2.7	344	283	3.9
Little millet	67.0	7.7	4.7	341	7.6	1.5	17	220	9.3
Kodo millet	65.9	8.3	1.4	309	9.0	2.6	27	188	0.5
Foxtail millet	60.9	12.3	4.3	331	8.0	3.3	31	290	2.8
Barnyard millet	65.5	6.2	2.2	307	9.8	4.4	20	280	5.0
Proso millet	70.4	12.5	1.1	341	2.2	1.9	14	206	0.8
Wheat (whole)	71.2	11.8	1.5	346	1.2	1.5	41	306	5.3
Rice (raw, milled)	78.2	6.8	0.5	345	0.2	0.6	10	160	0.7

(Source: Nutritive value of Indian foods, NIN, 2007)

Table 3. Essential Amino acid profile of millets (mg/g of N)

Food grain	Arginine	Histidine	Lysine	Tryptophan	Phenyl Alanine	Tyrosine	Methionine	Cystine	Threonine	Leucine	Isoleucine	Valine
Sorghum	240	160	150	70	300	180	100	90	210	880	270	340
Pearl millet	300	140	190	110	290	200	150	110	140	750	260	330
Finger millet	300	130	220	100	310	220	210	140	240	690	400	480
Little millet	250	120	110	60	330	-	180	90	190	760	370	350
Foxtail millet	220	130	140	60	420	-	180	100	190	1040	480	430
Barnyard millet	270	120	150	50	430	-	180	110	200	650	360	410
Proso millet	290	110	190	50	310	-	160	-	150	760	410	410
Rice	480	130	230	80	280	290	150	90	230	500	300	380
Wheat	290	130	170	70	280	180	90	140	180	410	220	280

(Source: Nutritive value of Indian foods, NIN, 2007)

Table 4. Vitamin profile of millets

Food grain	Thiamin (mg)	Niacin (mg)	Riboflavin	Vit A (carotene) (µg/100g)	Vit B6 (mg/100g)	Folic Acid (mg/100g)	Vit B5 (mg/100g)	Vit E (mg/100g)
Sorghum	0.38	4.3	0.15	47	0.21	20.0	1.25	12.0
Pearl millet	0.38	2.8	0.21	132	-	45.5	1.09	19.0
Finger millet	0.42	1.1	0.19	42	-	18.3	-	22.0
Little millet	0.3	3.2	0.09	0	-	9.0	-	-
Kodo millet	0.15	2.0	0.09	0	-	23.1	-	-
Foxtail millet	0.59	3.2	0.11	32	-	15.0	0.82	31.0
Barnyard millet	0.33	4.2	0.1	0	-	-	-	-
Proso millet	0.41	4.5	0.28	0	-	-	1.2	-
Rice	0.41	4.3	0.04	0	-	8.0	-	-
Wheat	0.41	5.1	0.1	64	0.57	36.6	-	-

(Source: Nutritive value of Indian foods, NIN, 2007; *MILLET in your Meals*, http://www.sahajasamrudha.org/)

Table 5. Micronutrient profile of millets (mg/100g)

Food grain	Magnesium	Sodium	Potassium	Copper	Manganese	Molybdenum	Zinc	Sulphur	Chlorine
Sorghum	171	7.3	131	0.46	0.78	0.039	1.6	54	44
Pearl millet	137	10.9	307	1.06	1.15	0.069	3.1	147	39
Finger millet	137	11.0	408	0.47	5.49	0.102	2.3	160	44
Little millet	133	8.1	129	1.00	0.68	0.016	3.7	149	13
Kodo millet	147	4.6	144	1.60	1.10	-	0.7	136	11
Foxtail millet	81	4.6	250	1.40	0.60	0.070	2.4	171	37
Barnyard millet	82	-	-	0.60	0.96	-	3	-	-
Proso millet	153	8.2	113	1.60	0.60	-	1.4	157	19
Rice	90	-	-	0.14	0.59	0.058	1.4	-	-
Wheat	138	17.1	284	0.68	2.29	0.051	2.7	128	47

(Source: Nutritive value of Indian foods, NIN, 2007; *MILLET in your Meals*, http://www.sahajasamrudha.org/)

Table 6. Fatty acid composition of millets

Food grain	Palmitic	Palmoleic	Stearic	Oleic	Linoleic	Linolenic
Sorghum	14.0	-	2.1	31.0	49.0	2.7
Pearl millet	20.9	-	-	25.4	46.0	4.1
Finger millet	-	-	-	-	-	-
Little millet	-	-	-	-	-	-
Foxtail millet	6.4	-	6.3	13.0	66.5	-
Proso millet	-	10.8	-	53.8	34.9	-
Rice	15.0	-	1.9	42.5	39.1	1.1
Wheat	24.5	0.8	1.0	11.5	56.3	3.7

(Source: Nutritive value of Indian foods, NIN, 2007; *MILLET in your Meals*, http://www.sahajasamrudha.org/)

Table 7. Amylose and amylopectin content of millets

Food grain	Amylose (%)	Amylopectin (%)
Sorghum	24.0	76.0
Pearl millet	21.1	78.9
Finger millet	16.0	84.0
Kodo millet	24.0	76.0
Foxtail millet	17.5	82.5
Proso millet	28.2	71.8
Rice (short grain)	12-19	88-81
Wheat	25.0	75.0

(Source: *MILLET in your Meals*, http://www.sahajasamrudha.org/)

From the above data it is evident that millets are superior in some or most of the nutritional components compared to most widely consumed rice and wheat, and can hence ensure nutritional security more readily through regular consumption. Though high fibre content and presence of some anti-nutritional factors like phytates and polyphenols in millets affect bioavailability of minerals, standardization of different processing and cooking methods may help in enhancing the bioavailability. More studies using state of art techniques are required to assess nutritional advantage of millets in total.

Conclusion

To conclude, millets contribute towards balanced diet and can ensure nutritional security along with keeping the environment safe as they are low input crops mostly adapted to marginal lands. They also contain fibre and health promoting phytochemicals which function as antioxidants, immune stimulants, etc. and hence millets are important candidates as functional foods. Declining millets cultivation has resulted in reduced availability of these nutritious grains to needy population. Immediate policy and market support, value addition and promotional activity are necessary for arresting the further decline in millets cultivation. Development of health foods and their

commercialization should receive focused attention to promote the millets among the urban elite, which would lead to reduction in life-style related disorders like diabetes, cardiovascular diseases, cancer, etc. Research programmes should solve major crop production constrains that restrict the realization of potential yield of improved cultivars under farmers' fields to ensure better returns as well as nutrition from dryland agriculture. Millet consumption can be increased by making them available through public distribution system and inclusion of millet based foods under feeding programmes like Mid-day meal and Integrated Child Development Services.

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