Cultivation and Utilization of Grain Sorghum and Small Millets from Nandurbar District of Maharashtra State

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Landraces of sorghum and small millets were collected from a newly constituted tribal district Nandurbar in Maharashtra state. The collections includes 61 accessions of 13 sorghum landraces, 11 of proso millet, 11 of little millet, 28 of foxtail millet, 18 of barnyard millet, 11 of finger millet and 8 of kodo millet. The accessions show variability in morphogenetic characters. The tribals of Nandurbar district utilize these millets in nine different cooking styles and prepare as many as 72 items. But there is a gradual decline in the area of cultivation of these crops. Measures for evaluation and conservation of the rich genetic diversity of these millet crops are urgently required. The scope for bringing more area under their cultivation is also discussed.

Key Words: Sorghum, Small millets, Germplasm utilization, Biodiversity, Tribal district

Millet is a prominent group among rainfed crops. India is the largest producer of many kinds of millets. Among these, sorghum and small millets are grown in diverse soils, varying rainfall regimes, different altitudes and areas with varying thermo and photoperiods. Due to this reason, they are indispensable to tribal and hill agro ecosystem. Food security involves focusing research on neglected crops such as small millets which can perform in times of environmental stress (Paroda, 1996).

Recently, Kimata *et al.*, (1997 and 2000) reported the cultivation and utilization of small millets in hill regions of Uttar Pradesh, Himachal Pradesh and South India. Similar reports from hill and dry regions of Maharashtra are not found.

Tribals of Nandurbar district traditionally grow some small millets and certain landraces of sorghum. The hill farmers have developed methods of cultivation to suit to the prevailing environmental factors and also evolved ways and means of utilizing these millets to fulfill their food requirements.

In the present paper we report, for the first time, the cultivation of certain sorghum and some small millet crops and their utilization as food by the native people in a predominately tribal district Nandurbar.

Materials and Methods

Study area: Nandurbar is a newly constituted district in Maharashtra State, and is declared by the Government as a tribal district. It is situated in the North West part of the state, bordering Gujarat and Madhya Pradesh (M.P.). It has six talukas of which three are mostly in the Satpura hill ranges. Toranmal in Dhadgaon taluka is the second highest peak among Satpura hills, next only to Panchmari in M.P. Due to the poor developmental activities and the hilly terrain, most of the villages of Dhadgaon, Akkalkuwa and Navapur talukas are accessible only with great difficulty. Certain villages like Chulvad, Khadki can be reached only after a few hours of walking. Shahada and Nandurbar talukas are a bit developed. They are totally in the plain region at 200 m. above sea level. Two westward flowing rivers Narmada and Tapi take their course through the district. While Narmada passes through the hills along the border, Tapi flows in the plains making the valley region very fertile. The soil in the plains is clay with good water holding capacity. Agriculture in the district falls into three main agro ecosystems viz irrigated, dryland and hill agro ecosystems. Sorghum is grown in all three systems while small millets are grown only in dryland and hill agro ecosystems.

Pawra, Bhil and Konkni are the tribes inhabiting the district. Dhadgaon is dominated by Pawra tribe while Navapur and Akkalkuwa talukas have more population of Bhil and Konkni tribes. The Pawras are believed to be descendants of Rajputs as their ancestors have migrated to this region from Rajasthan about 400 years ago.

Methodology

The areas under the cultivation of sorghum landraces and different small millets were visited during 2001-2002. The farmers were contacted on form. Observations on their cultivation practices and utilization of grains

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as food were noted from several consultations. Plants and their grains were collected mostly from the standing crop. Important morphological observations of all landraces were recorded. Passport information of every collection was prepared and the collections were deposited at Botany department P.S.G.V.P. Mandal's A.S.C. College, Shahada. Their detailed evaluation studies are yet to be carried out. The data from the preliminary survey are presented in this paper.

Results and Discussion

Table 1 shows the number of accessions of sorghum landraces and small millets collected from each taluka of Nandurbar district. Among the Sorghum cultivars Lal chikni was collected earlier by Bhaskar (2000) from Shahada taluka. He reported that it was not found among the 28000 and odd sorghum germplasm collections of ICRISAT. It is a popular *kharif* crop of the district. This is evident from the large number of (24) accessions collected in the present study. Safed Chikni was collected only from Navapur taluka. Gopal Reddy and Varma (1996) collected Pivli Chikni from the same taluka but they did not mentioning its making quality. Safed buri dadar, Kaliburi dadar, Pivli dadar, Safed dadar & Lalburi dadar are *rabi* cultivars and grown only in Shahada taluka. Rajwadi was collected from plains under rainfed ecosystem of Taloda taluka. The cultivars Satpani and Badi jawar are *kharif* crops and grown only on hills. Badi jawar is also a late maturing variety and resistant to diseases. Andheri dadar was reported earlier from Shahada taluka by Bhaskar (2000). It is a popular *rabi* sorghum cultivar of the taluka. Mani is the second popular landrace of sorghum (16 accessions) in the district.

Table 2 shows the morphogenetic characters of sorghum landraces collected from Nandurbar district. There are seven *kharif* varieties and six *rabi* varieties. Of these, the *kharif* varieties show more plant height and longer panicles than *rabi* varieties. Only Lal chikni and Safed chikni cultivars have drooping (bent) panicles while the remaining cultivars have straight panicles. There is a great variation in the distance between flag leaf and the panicle. It varied from 5 cm (in dudhmogra) to 36 cm (in Lalburi dadar). Variation was also observed in grain colour and glume colour.

Table 3 shows the morphogenetic characters of landraces of small millets. Proso millet, little millet and kodo millet have only one landrace while two landraces each of foxtail millet, barnyard millet and finger millet are cultivated in the district. Foxtail millets show variation in awnness, tillers and pigmentation. Of these, the cultivar rala is taller with longer panicles. Barnyard millets are also distinguished from the plant height and panicle length as they are referred as lahan (small) barti and mothi (big) barti. They also differ in stem characters like tillers, pigmentation and shape. The landraces of finger millet are named after the shape of their panicles. Pekri cultivar bears panicle with open and straight fingers while goliv cultivar bears compact and inwardly curved fingers. The colour of their grains is also different.

Table 4 shows the utilization of sorghum landraces by the people of Nandurbar district. Three landraces are used for making flakes; of these, Andheri dadar is the most popular variety. It is also a bird proof variety. Murthy *et al.,* (1982) screened 9862 accessions for popping quality and found only 36 to be better. Hence, these three landraces from Nandurbar district may provide valuable genetic resource for this character. According to the natives of Shahada the bhakri of Andheri dadar is good for diabetic patients. On the other hand the bhakri prepared from the flour of Mani cultivar is sweet in taste. We observed ants crawling over the stem of mani at the time of flowering. This indicates that this landrace must be a sweet sorghum type. Lal chikni and Safed chikni are consumed in five and six cooking styles respectively. They are, however, most preferred for their papad making quality. It is for this reason that the Lal chikni is cultivated in large areas both under irrigated and rainfed conditions during *kharif* season in the entire district while the affluent families of this region prepare sweet dishes like laddu and halwa from wheat flour. These items are prepared from the flours of chikni and Dhudh mogra cultivars of sorghum by tribals.

The popular items prepared from the flours of these landraces show good processing characteristics, acceptable quality and storability. Flours of hybrid and local variety of sorghum differ in their fermentation characteristics as determined by swelling volume of the batter (Subrahmanyan and Jambunathan, 1992). Hence, the collected sorghum germplasm from Nandurbar district should be evaluated for morphological, physiological and biochemical characters to determine their utility in future breeding programme. At the same time *in situ* conservation steps must also be taken up to save their biodiversity.

Table 1 shows that more than 70 percent of accessions of small millets are collected from Akkalkuwa, Dhadgaon and Navapur talukas. These three talukas are hilly areas and predominately tribal and also receive maximum

Table 1. Accessions of grain sorghum and small millets germplasm collected from different talukas of Nandurbar district in Maharashtra State

Name cultivar	No. of accessions						
	Akkalkuwa Taluka	Dhadgaon Taluka	Nandurbar Taluka	Navapur Taluka	Shahada Taluka	Taloda Taluka	Total No. of accessions
Sorghum:							
Lal chikni	05	06	03	04	03	03	24
Safed chikni	–	–	–	02	–	–	02
Satpani	01	01	–	–	–	–	02
Dudh mogra	02	01	–	–	–	–	03
Rajwadi	–	–	–	–	–	01	01
Badi jawar	01	02	–	–	–	–	03
Mani	04	03	02	03	02	02	16
Safedburi dadar	01	–	–	–	02	–	03
Lalburi dadar	–	–	–	–	01	–	01
Kaliburi dadar	–	–	–	–	02	–	02
Andheri dadar	–	–	–	–	02	–	02
Safed dadar	–	–	–	–	01	–	01
Pivli dadar	–	–	–	–	01	–	01
Total	14	13	05	09	14	06	61
Millet							
Proso millet: kalimor	03	05	–	02	01	–	11
Little millet : badimor	03	05	–	02	01	–	11
Foxtail millet:							
Bhadi	03	04	–	02	02	03	14
Burali rala	–	–	–	02	–	–	02
Rala	02	04	–	03	02	01	12
Barnyard millet :							
Lahan barti	04	04	01	02	01	02	14
Mothi barti	–	01	–	02	01	–	04
Finger millet :							
Pekhri	–	–	–	04	–	–	04
Goliv	01	–	02	04	–	–	07
kodo millet–kodra	02	03	–	03	–	–	08
Total	18	26	03	26	08	06	87
Grand Total	32	39	08	35	22	12	148

Table 2. Some morphogenetic characters observed in sorghum landraces from Nandurbar district in Maharashtra State

Name of cultivar	*Kharif/Rabi*	Plant height(cm)		Panicle length(cm)		Panicle	Grain	Glume colour	Flag leaf distance from panicle (cm)	
		Min.	Max.	Min.	Max.				Min.	Max.
Sorghum :										
Lal chikni	*Kharif*	251	325	17	30	Bent	Red	Red	25	30
Safed chikni	*Kharif*	267	279	16	28	Bent	White	Reddish	15	28
Satpani	*Kharif*	225	270	18	26	Straight	White	White	10	17
Dudh mogra	*Kharif*	215	256	22	26	Straight	White	White	5	8
Rajwadi	*Kharif*	270	320	23	38	Straight	White, bold	White	12	25
Badi jawar	*Kharif*	215	277	20	30	Straight	White	White	21	32
Mani	*Kharif*	127	171	39	62	Straight	Bright, white	Black	8	18
Safedburi dadar	*Rabi*	165	210	18	23	Straight	White	White	14	20
Lalburi dadar	*Rabi*	175	215	13	18	Straight	White	Red	30	36
Kaliburi dadar	*Rabi*	170	212	16	19	Straight	White	Black	16	19
Andheri dadar	*Rabi*	147	179	13	17	Straight	White, small	Brown	18	21
Safed dadar	*Rabi*	161	205	13	17	Straight	Bright, White, small	White	13	18
Pivli dadar	*Rabi*	160	208	10	14	Straight	Yellowish	Yellow	12	17

Table 3. Some morphogenetic characters observed in small millet collections from Nandurbar district in Maharashtra State

Millet	Plant height (cm) Min.	Max.	Panicle/Finger length (cm) Min.	Max.	Grain colour	No. of fingers Min.	Max.	Other morphological characters
Proso millet:								
Kalimor	45	80	9	18	Black			Tillers 2-3, pigmentation present
Little millet:								
Badimor	81	105	21	31	White			Tillers 2-3, pigmentation present
Foxtail millets:								
Bhadi *(S. glauca)*	23	59	4	9	White			Awns absent, tillers 1-2
Buralirala *(S. italica)*	50	61	8	10	Brownish			Awns present, tillers absent
Rala *(S. italica)*	115	130	15	24	White			Awns present, tillers absent, nodal pigmentation
Barnyard Millets								
Lahan barti	41	58	6	9	White			Tillers 2-5, pink pigmentation at nodal region stem cyclindrical
Mothi barti *(Echinocloa colonum)*	118	149	11	13	White			Tillers absent, pink pigmentation on stem, leaves and inflorescence, stem stout and angular
Finger millet								
Pekhri	93	105	9.0	9.5	White	4	5	Nodal tillers absent, green pigmentation present, ear with compact and curved fingers
Goliv	83	95	6.0	6.5	Copper brown	6	7	Nodal tillers present, green pigmentation present, ear with compact and curved fingers
Kodo Millet								
Kodra	50	64	6.0	7.1	Brown	2	3	Nodal pigmentation

Table 4. Different cooking styles followed for the consumption of sorghum and small millets as food in Nandurbar district in Maharashtra State (▲ – Seldom; ● – Often)

Ingredient	Bhat	Bhakri	Roti	Kheer	Laddu	Halwa	Papad	Drink	Flake	Total items
Sorghum										
Lal chikni		▲	▲		●	▲	●			05
Safed chikni		▲	▲		●	▲	●		▲	06
Satpani		●				▲				02
Dudh mogra		●			●					02
Rajwadi		●					●			02
Badi jowar		●			●					02
Mani		●					▲			02
Safedburi dadar		●					▲			02
Lalburi dadar		●					▲			02
Kaliburi dadar		●					▲			02
Andheri dadar		▲					▲		●	03
Safed dadar		▲					●		▲	03
Pivli dadar		▲					●			02
Total	00	13	02	00	04	03	10	00	03	35
Millet										
Proso millet: kalimor	●	▲		▲	▲					04
Little millet : badimor	●	▲		▲						03
Foxtail millet										
Bhadi	●	▲	▲	▲		▲				05
Burali	●	▲	▲	▲		▲				04
Rala	●		▲		▲	▲				04
Barnyard millet										
Lahan barti	●	●		●	▲					04
Mothi barti	●	●		●	▲					04
Finger millet										
Pekhri		▲					●	▲		03
Goliv		▲					●	▲		03
Kodo millet: Kodra	▲	▲						▲		03
Total	08	08	03	06	04	03	03	03	00	37
Grand Total	08	21	05	06	08	06	21	03	03	72

rainfall (900-1000 mm). Barti *(Echinocloa colonum* var. *frumentacia)* was collected from all the talukas. It is a popular small millet in the entire district. Every tribal family stores its grain to prepare bhat in dinner. A sweet dish called kheer is also prepared with barti (Table 4) on special occasions. We could not collect nagli (finger millet) from Shahada and Taloda talukas, which comprise the most fertile black cotton soils of Tapi valley basin. Surprisingly, it was not found in cultivation even in Dhadgaon taluka. The papad prepared from nagli is very famous in the entire district and used even in snacks. Kimata *et al.,* (1997) reported the utilization of finger millet as bhat and also in preparing a fermented and distilled alcoholic drink in hill regions of Uttar Pradesh. But, hill tribes of Nandurbar district do not know these preparations. The flour of nagli is mixed in butter milk and given to lactating mothers in Navapur taluka. Two accessions of rala (foxtail millet) were collected from Shahada and Taloda talukas. The people grow them due to their food habit of eating bhat prepared from rala as dinner. Millets are utilized in two forms; Flour foods and grain foods. The small millets are mostly utilized as grain foods in preparing bhat (Table 4). Such grain foods are new variations that have appeared in rather recent times (Kimata *et al.,* 2000). The authors also showed in case of *S. glauca* (bhadi) that as the variations of cooking increased, the genetic landraces did so too. In Nandurbar district also this crop is utilized in five different cooking styles and we could collect 15 accessions of the crop. The cultivation practices of *S. glauca* in Nandurbar district are also similar to those observed by the above authors in dry arid areas of South India.

The cultivation practices followed for small millets were shown in Table 5. Akkalkuwa, Dhadgaon and Navapur talukas represent maximum diversity of small millets. kalimor (proso millet) and badimor (little millet) are very popular in these talukas. They are short duration crops but require plenty of water. They are sown immediately after receiving first showers and harvested during September-October. Kalimor is sown in more or less even land while badimor is grown is undulating land and along the hill slopes. Rala and bhadi are also cultivated in the same way. Line sowing or broadcasting method is used to raise the crops. Fertilizer is not used for any of these crops grown in hills. Organic manure is however used in Navapur, Taloda and Shahada talukas (Table 5). Finger millet is always grown by transplantation method. This may be a reason for it not being under cultivation in hilly Dhadgaon taluka. The cultivation of kodra (Kodo millet) is also confined to hills. It is today least preferred small millet in the region. The reason, tribals tell, is that the preparation of bhat from kodra grains is time-consuming process. The grains are not cooked directly as they contain a hazardous substance to health. So the grains are first soaked in tamarind juice for 8-12 hours during which time harmful substances leach out. Later the grain is cooked.

Table 5. Cutivation practices of small millets in Nandurbar district in Maharashtra state

Cultivation practices	Proso millet (Kalimor)	Little millet (Badimor)	Foxtail millet (Rala)	Foxtail millet (Bhadi)	Barnyard millet (Barti)	Finger millet (Nagli)	Kodo millet (Kodra)
Sowing Time	Aug.-Sept.	May–June	June–July	Sept.–Oct.	June–July or Sept.-Oct.	June-July	June-July
Sowing Method	Broadcasting/ Line sowing	Broadcasting	Broadcasting/ Line sowing	Broadcasting/ Line sowing	Broadcasting/ Line sowing	Broadcasting	Broadcasting/ Line sowing
Cropping system	Mixed with Proso millets	Mixed with Proso millets	Mixed with Proso millets	Mixed with Little millets	Mixed with Jawar/Tur	Mixed or Pure cropping	Mixed with Jawar, tur or pure cropping
Cultural practices	Weeds are cleared and burnt before tilling the land No manuring	Grown along hill slopes Weeds are burnt	Organic manure	Organic manure	Organic manure	Organic manure	–
Harvesting time	Sept.-Oct.	Oct-Nov.	Oct.	Oct-Nov.	Oct.-Nov.	Nov.-Dec.	Nov.-Dec
Harvesting Method	Ear heads cut for grain, Base cutting for fodder	Ear heads cut for grain; base cutting for fodder	Whole plant by sickle	Ear head cutting for grain	Whole plant by sickle	Ear head cutting for grain	Whole plant by sickle
Threshing	Trumpling by cattle	Trumpling by cattle	Trumpling by cattle	Trumpling by cattle	Trumpling by cattle	By Threshing stick	By Threshing stick
Rainfed/Irrigation	Rainfed	Rainfed	Rainfed/ Irrigation	Rainfed/ Irrigation	Rainfed/ Irrigation	Rainfed/ Irrigation	Rainfed/

The report of all India coordinated small millets improvement project reveals that efforts are being made to produce improved varieties in all these small millet crops (Sitaram *et al.*, 2001). They conducted front line demonstrations (FLD) in different states to encourage farmers to grow HYV of small millets and increase the area under their cultivation. But, their FLDs were mostly in Karnataka, Andhra Pradesh, Tamil Nadu and Orissa while in Maharashtra state they could only cover just 6.6 hectares in Konkan region that too of only finger millet crop. There was no mention of either cultivation or collection of small millets from Maharashtra state by them. The publications of ICRISAT, which is a major sorghum and small millet collection centre, also do not mention any collection of small millets from Nandurbar region. The NBPGR regional station at Akola is yet to be contacted. The divisional office of the Department of Agriculture at Nandurbar maintains the records of area under cultivation of sorghum, bajra and maize crops grown every year. It, however, does not have record of cultivar wise crop area. For small millets, the records do not even show crop wise area under cultivation. The figures are for total area of all small millet crops grown in the year. These figures of area under cultivation in all the six talukas of the district for sorghum and small millets are given in Table 6. Mangala Rai (2002) observed that the statistics published by Ministry of Agriculture Government of India gave information about only three coarse cereals viz. maize, sorghum and pearl millet and nothing with respect to small millets. Among these three major millets also only maize showed a gradual increase in the area under cultivation. The author demanded appreciation and propagation of coarse cereals owing to their dual importance as nutritious as well as life supporting crops for sustainable production from frazil ecosystem. In fact, these coarse cereals are referred as nutricereals. The problem of pest and diseases is also negligible in small millets thus they are eco friendly crops and preferred crops for sustainable and green agriculture (Sitaram *et al.*, 2001). The tribals of Nandurbar have been conserving the biodiversity of sorghum and small millets *in situ* by their cultivation practices, food preferences, prevailing agro climatic conditions and their socio-economic status. But the scenario is fast changing. The agri-silvi plots distributed by forest department to tribals of Shahada, Nandurbar and Taloda talukas in 1970s were entirely converted into agriculture lands. There are no trees in these plots now. The traditional landraces cultivated in these lands are being replaced by the HYV. With the gradually improving socio-economic status, the principles and belief of the tribals are also changing. They no longer prefer bhat made of coarse cereals in dinner. Instead, they prepare roti of bajra and jawar. Thus flour foods are being increasingly preferred over grain foods. They started using chemical inputs to grow HYV. Some tribals have started cultivating cotton, chilli and sugarcane in their originally agri-silvi plots. This is evident from the fact that out of a total of 87 collections just 3, 8 & 6 small millets are available from Nandurbar, Shahada and Taloda talukas respectively (Table 1). The area under cultivation of small millets in these talukas is also very less (Table 6). It is extremely important to conduct a detailed survey of the district to estimate the area under cultivation of sorghum landraces and small millet crops in different agro-ecosystems. It should be followed by collection and conservation of the cultivars of these crops and the evaluation of their genetic diversity for use as potential genetic resources in future. The farmers of Nandurbar district especially tribals should be encouraged to grow improved varieties of small millets. This is possible only when our food industries and beverage industries launch the production of different weaning foods, fermented products, adjuncts and other food items with good shelf life from sorghum and small millets. Reports of such utilization of these grains at industry level are just appearing (Sitaram

Table 6. Area (in hectares) under cultivation for sorghum and small millets in Nandurbar district during 2003–2004

Taluka	Sorghum		Finger Millet	Other small millets	
	Kharif	*Rabi*		*Kharif*	*Rabi*
Nandurbar	5500	4500	50	300	–
Navapur	6000	8575	200	1500	–
Shahada	6250	1300	–	125	10
Taloda	3050	6300	–	200	50
Akkalkuwa	4100	6550	70	1205	10
Dhadgaon	4100	–	–	3020	25
Total	**29000**	**27225**	**320**	**6350**	**95**

Source: Divisional Office, Department of Agriculture, Nandurbar

et al., 2001 and Kazmi 2003). It may take some more time for the emergence of good demand for these so called coarse cereals from the industry.

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