Genetic improvement of small millets In India during Pre and Post Crop Coordinated Project era.

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After decades of neglect, small millets are figuring in the Agricultural Development Agendas in some states. Millets are increasingly viewed as nutritive grains and hence the recent surge of interest in these crops. Nutritionists opine that regular inclusion of millet grains in the diets help in minimizing the wide spread nutrition deficiency especially of minerals and vitamins in children, large urban and rural working men women and vulnerable sections of population. Further, the large population in the country is compelling to increase production of all crops, whether major or minor and grown on small or large area.

Small millets in India are a group of 6 grass cereal crops such as finger millet (ragi), foxtail millet (kangni), kodo millet (kodo), proso millet (cheena), barnyard millet (sawan) and little millet (kutki). The area under these crops during the last 6 decades has significantly shrunk from 8 million in 1949-50 to around 2.3 million in 2011-12. This is also reflected in diminishing production, from around 4 million tones produced in late forties to around 2.5 million tones in 2011-12. The loss of area is very severe in all small millets other than finger millet. However, in the last 15 years, the finger millet also has lost ground and area has come down from 2.4 million to 1.4 million ha and likely to loose further in the coming years. As regards productivity is conserved, finger millet has kept pace with most other major dry land crops in compound growth rates(CGR) for yield while the other small millets have shown little progress. By and large, the low productivity of these crops is largely due to meager attention received in terms of inputs; water and technology back up which is further compounded by low value status of grain.

Progress in crop improvement

Small millets improvement efforts in India have been in progress since the beginning of the 20 the century (Seetharam, 1998). But, the launching of coordinated crop improvement programs during late 1950s and 60s has contributed significantly by way of developing new superior varieties and concomitant production and protection technologies in all small millets. The release of these varieties and production packages for general cultivation has helped in 5 fold increase in grain production from 50 million to 250 million tones in the country. It is generally seen that this increase has largely come from two major crops –rice and wheat- and less from dry land crops such as millets and more so from small millets. The small millets have been the last priority crops in the agriculture developmental agenda in the country. Finger millet among small millets has received a little more attention than the rest especially in the southern states. An attempt has been made here to trace the progress especially in the field of crop improvement during the last 100 years.

Crop improvement efforts during pre- coordinated project era.

Before the launching coordinated project in 1950s and 60s; the crop improvement in small millets was confined to a fewer states such as Tamil Nadu, Andhra Pradesh, Karnataka and Uttar Pradesh. The emphasis was on varietal improvement through selection of better types from local cultivars. In Tamil Nadu, Millet Research Station was established in 1923 at Coimbatore under the erstwhile Madras Presidency and the work later extended to Anakapalle (A.P.) and Hagari (Karnataka). Finger millet work in Karnataka dates back to 1900, initiated at Bangalore especially on finger millet and in Uttar Pradesh at Kanpur and Gorakhpur in 1944. As a pre requisite to millet improvement, the inheritance of qualitative and quantitative characters, period of anthesis, pollination and crossing methods were studied at Ciombatore.

The first finger millet variety released in the country was H 22 as early as 1918 in Karnataka. The other finger millet varieties released were Co 6 (1935); R 0870, ES13, K1, ES11 (1939); Hagari1 (1941), Co1, Co2, Co3, Co4 (1942), VZM 1, VZM 2 (1958) and T36 B (1949). Interest in finger millet improvement got a fillip in Karnataka during 1950-60 and several new varieties such as Aruna, Udaya, K1, Purna, ROH 2 and Cauvery were released. Similarly, many varieties were released in other small millets also in many states (Seetharam, 1998). This included little millet variety Co 1 (1954); foxtail millet varieties Co1, Co2, Co 3 (1943), H1, H2 (1948), T 4 (1949); kodo millet varieties PLR 1(1942, T 2 (1949), Co 1 (1953), proso millet variety Co 1 (1954) and barnyard millet varieties T 46, T25 (1949).

During fifties, with food production remaining stagnant and with raising population the importance of millet crops to Indian agriculture started gaining recognition, as they formed the important constituents of dry land agriculture. Project for intensification of research on cotton, oil seeds and millets was launched during this period with several centres working on millets, The importance of genetic resources as primary raw material for crop improvement was recognized prior to initiation of coordinated project and the first attempt to collect the germplasm of millets in the country was made in 1961 under the PL 480 project on "storage, Maintenance and distribution of millets germplasm " resulted in the collection of nearly 3000 genetic stocks of various small millets _718, finger millet,584 in kodo millet,431 9 in little millet,615 in foxtail millet 250 in proso millet and 399 in barnyard millet.

Crop improvement efforts during coordinated project era.

Small millets have always been of local and regional importance and as a result have attracted little attention both at national and International level. Millets in general started receiving with attention with the launching of All India Coordinated Millets Improvement Project (AICMIP) in 1969. In this project small millets also started receiving some attention at a selected few centres. Small millets improvement received the major boost during 1978-79 with the establishment of five crop specific lead research centres in the country under IDRC assistance. They were Almora in Uttarakhand (barn yard millet), Dholi in Bihar (proso millet), Dindori in Madhya Pradesh (Kodo millet), Semiliguda in Orissa (Little millet) and Nandyal in Andhra Pradesh (foxtail millet.) in this project finger millet was not included as it was already receiving some attention in the Coordinated Millets Improvement Project. The IDRC project continued till 1985 and the "All India Coordinated Small Millets Improvement Project" (AICSMIP) was established in the year 1986 with head quarters at The University of Agricultural Sciences, Bangalore. The centres that were functioning under IDRC project became part of AICSMIP. With the inception of separate AICRP, research on small millets has been getting focused attention for developing varieties and other agro production and protection technologies suitable to different regions. There are 14 centres functioning under AICSMIP spread all over the country to address to the research needs of small millets. Small millets are known for their suitability to dry land areas, hill and tribal agriculture and contribute to food and nutritional security of the disadvantaged regions. The research in the project is focused to state / regional needs from the point of developing appropriate varietal and agro production technology for maximizing production / productivity. The work is multi-disciplinary and applied in nature.

Germplasm availability

In the past small millets scientists hardly had access to germplasm and worked with a handful of local collections which lacked diversity. This blunted the opportunities for of yield improvement through breeding. This situation was to some extent rectified in the 1960 when first attempts were made by ICAR to pool the collections under PL 480 project as mentioned earlier. The conservation activities further gained momentum with NBPGR, New Delhi, playing a key role in augmenting the small millets collection. Recognizing the importance and conservation and easy access to germplasm, AICMIP established a separate germplasm unit at Bangalore in 1979. This unit since then has been making efforts to collect as well as pool the available germplasm from various sources and make it available to breeders in the country. This unit is also recognized as National Active Germplasm Site (NAGS) by ICAR/NBPGR and has the mandate to assist in collection, conservation, evaluation and documentation of small millets germplasm in the country (Seetharam, 2006). Presently the unit at Bangalore is maintaining one of the largest collections of more than 15000 accessions of 6 small millets (7122 in finger millet,2821 foxtail millet,1537 kodo millet,939 proso millet,1657 little millet and 988 barnyard millet)in the country (AICSMIP,2012).

Utilization of germplasm.

The full utilization of germplasm depends on two factors: (1) evaluation and characterization and (2) identification of useful gene sources. These two areas have received considerable attention during the last 25 years and majority of the accessions have been screened for agronomic, physiological, pathological and even important grain quality parameters. The breeding value of many accessions has been judged by growing in field trials more than once. There is good data base available for most accessions and germplasm catalogues have been brought out (Seetharam *et al* 2006). In order to improve the efficiency for utilization of germplasm, core subsets have been formed and made available to breeders working at different centres. Selected germplasm have also been evaluated in the all India testing network and a number of superior accessions were identified and a couple of them have been released for general cultivation in different parts of the country. The exotic collections especially from Africa in finger millet have been largely used in recombination breeding resulting in release of many superior high yielding varieties in many states. The African germplasm have thick stem, dark leaves, robust growth, large ears, and high grain density and source of resistance to blast disease (Naik *et al,*

1993). Hybridization between African and Indian elite varieties has been highly rewarding and has resulted in the release of many high yielding varieties in the country (Seetharam, 1998).

Several useful genetic stocks have been identified in all small millets accessions possessing higher protein, desirable agronomic attributes with high carbon dioxide fixation and low leaf area suitable for rain fed situations, and genotypes which can germinate under limited moisture under hard soil crust have been identified(Sashidar *et al*,1983,1986; Seetharam *et al,*1984; B.T.S.Gowda *et al*.1986). Long glume types with higher ear photosynthesis reflecting in higher seed size and weight will be of interest in improving yield of finger millet in the coming years (Sashidar *et al,* 1983). Accessions capable of producing higher biomass, dual purpose types with superior stover quality are available for improving grain and Stover yield of cultivars. Identification several sources of stable resistance to blast disease of finger millet and their deployment in breeding research has been highly rewarding in evolution of high yielding blast resistant cultivars in finger millet in the country (B.T.S.Gowda *et al,*1986; Ravikumar *et al,*1990,1991; Seetharam and Ravikumar,1993; Byre gowda *et al*,1998,1999). There are finger millet germplasm with significantly higher grain calcium and protein and useful in breeding for improving quality parameters. In the secondary gene pool, *Eleusine coracana* sub sps *africana* will be of interest from the breeding point of view. This could be a useful gene source for improving tillering ability, fodder yield and quality, drought tolerance and even finger number and length. A care fully planned pre breeding is required for introgression of characters from *E.africana* to *E. coracana* for deriving lines useful in regular breeding programs.

In foxtail millet, new sources of dwarfing controlled by oligo genes have e been identified (Dinesh Kumar *et al,* 1992). These accessions are useful in breeding dwarf foxtail millet similar to the ones available in wheat. The variability available for protein content (7.176-15.73) and seed fat content (4.0-7.1) in foxtail millet is enormous and can be exploited directly and use in breeding (Laxminarayana *et al,* 1983).

The optimum use of utilization of germplasm in small millets is the most important in future breeding activities for making notable advances in the productivity of these crops and also to make small millets competitive *vis- a- vis* other crop options. Based on the evaluation and geographical origin, core set of germplasm have been formulated in finger, foxtail and proso millets for improving their utilization in the crop improvement. There is variability available for Stover quality parameters as well as quantity in the germ plasm of various small millets offering scope for the improvement of feed value of crop residues (Schiere *et al*, 2004; Subba Rao *et al*, 1995;)

Out come of crop improvement

The All India Coordinated Small Millets Improvement Project was established in the year 1986 with head quarters at University of Agricultural Sciences, Bangalore and with 14 centres spread over the country to address research needs of small millets. Small millets are known for their suitability to dry land areas, hill and tribal agriculture and contribute to food and nutritional security of the disadvantaged regions. The research in the project is focused to state / regional needs from the point of developing appropriate agro production technology for maximizing production / productivity. The work is multi-disciplinary and applied in nature.

The crop improvement is mainly aimed at developing high yielding varieties with resistance to blast disease quality fodder, early and medium maturity and white seed in finger millet, resistance to head smut in kodo millet and resistance to shoot fly in both proso and little millets. So far, a total of 236 varieties in 6 small millets have been released in the country (Table 1).

Table 1: No. of varieties released in various small millets in Pre and post coordinated project era.

State	Finger Millet	Foxtail millet	Kodo millet	Little millet	Proso millet	Barnyard millet	Total
A.P.	18	9	-	-	4	-	31
Karnataka	37	5	1	-	2	-	45
Tamil Nadu	20	9	7	8	11	4	59
Orissa	6	-	-	5	-	-	11
Madhya Pradesh	-	-	17	4	-	-	21
Chattissgarh	1	-	1	-	-	-	2
Uttar Pradesh	4	1	2	-	1	3	11
Bihar	1	-	-	-	3	2	6
Jharkand	4	-	-	1	-	-	5
Rajastan	-	5	-	-	1	1	7

Gujarat	5	-	2	1	-	1	9
Maharashtra	2	1	1	1	2	-	7
Uttarkhand	14	2	-	-	-	6	22
Total	**112**	**32**	**31**	**20**	**24**	**17**	**236**

Out of this 86 varieties were released before 1986 (pre coordinated era and 151 during 1986-2012 (post coordinated project era (Table 2).

The break up for various small millets are 112 in finger millet (45 in pre and 67 in post coordinated project era respectively) ; 32 in foxtail millet (12 in pre and 20 in post coordinated project era respectively) ; 20 in little millet (6 in pre and 14 in post coordinated project era respectively) ; 31 in kodo millet (11 in pre and 20 in post coordinated project era respectively) and 21 in barnyard millet(4 in pre and 17 in post coordinated project era respectively). Pure line selection has been the approach so far in little and kodo millet and as a result the genetic gain made has been very limited and the varieties are less diverse too. On the contrary recombination breeding has been the approach especially in finger millet resulting in creation highly diverse and productive varieties (Table 3 & 4).

Table 2: Break up of no of varieties released during pre (before 1986) and post coordinated project era (after 1986)

Crop	**No of varieties released**		
	Before 1986	**After 1986**	**Total**
Finger millet (1918-2012)	45	67	112
Foxtail millet (1942-2012)	12	20	32
Little millet (1954-2012)	6	14	20
Proso millet (1954-2012)	8	16	24

Barnyard millet (1949-2012)	4	17	21
Kodo millet (1942-2012)	11	20	31
Total	**86**	**154**	**240**

Table 3: No of varieties released from various selection methods in different small millets

Selection Method	Foxtail millet	Little millet	Kodo millet	Proso millet	Barnyard millet	Total
Pure line selection	24	18	30	17	14	103
Bulk / Pedigree method	7	1	-	7	3	18
Mutation Breeding	1	1	1	-	-	3
Total	**32**	**20**	**31**	**24**	**17**	**124**

Table 4: No of varieties released from various selection methods in finger millet.

Selection Method	<1930	1931-50	1951-70	1971-80	1981-2000	2001-12	Total
Pure line selection	1	8	8	7	20	6	50
Bulk / Pedigree method	-	-	5	6	19	20	50

Mutation Breeding	-	2	-	1	6	-	9
MAS	-	-	-	-	-	1	1
Total	**1**	**10**	**13**	**14**	**45**	**27**	**110**

The search for genetic male sterility in finger millet has been successful and now available for use. The modern finger millet varieties has the genetic potential if 5- 6 tones/ha under optimum management. On the same lines recombination breeding has resulted in release of many superior varieties in foxtail, proso and barnyard millets also. With the launching of AICSMIP, the variety development and release has gained immense momentum in all major small millet growing states resulting in identifying varieties to different ecologies in the country. The large scale verification variety tasting on farmers fields in participatory mode (Gowda *et al,* 2000) and through large number of Front Line Demonstrations has helped in fine tuning recommendation domains and in popularization of high yielding varieties among farmers especially in finger millet. The varieties of released during the last 15 years for cultivation in different states are given in Table 5.

The research centres have undertaken the production and supply of breeder seed indented by the Department of Agriculture and Co-operation, GOI. However, large scale seed production and distribution which is the key to success in spread of HYV's is very week in many states especially in crops other than finger millet in the entire country. This has led to opportunity deprivation of benefits of improved varieties to farmers in most parts of the country. The harnessing of yield advantages from these improved varieties is the need of the hour in order to make small millets cultivation competitive and economically viable. The success of GPU-28 variety of ragi in Karnataka is a best example in harnessing the benefits of a good seed production and distribution program involving line departments like Karnataka State Seed Corporation Limited and Karnataka State Department of Agriculture.

The package of practices for cultivation different small millets such as time of sowing / planting, choice of varieties, time and method of application of fertilizers have been developed for different regions, of the country. Management practices for aberrant weather conditions for mitigating early, mid and late season drought have been worked out. Remunerative cropping systems involving different pulse crops

in millet for different regions have been evolved. Plant protection measures to control economically important diseases and pests have been evolved.

Future needs

After years of neglect, small millets are finding a place in agricultural research, agendas in many institutions. They are increasingly being recommended by doctors and nutritionists as being important in health management. A couple of elite food chains have begun selling millets and millets based products on their shelves as health food. The productivity of these crops which is very low compared to other major food grains could be increased by 20 -50% by just adopting improved varieties in a big way. Since the seed rate is low for these crops (10 to 12 kg/ha) the extra expenditure incurred on seeds of high yielding varieties is not more than Rs.100 per hectare and could be considered as low cost technology with immence benefits. The harnessing of yield advantages from these improved varieties is the need of the hour in order to make small millets cultivation competitive and economically viable.

The germplasm availability has vastly improved with the launching of AICSMIP. More than 15,000 accessions of various small millets are conserved with good data base. Several superior genetic stocks are identified in each of these crops. The utilization of germplasm is poor now and careful deployment of desirable germlplasm in breeding research can bring in immense benefits in improving grain and straw yield, grain quality and composition, pest and disease résistance, drought tolerance and as well meeting the emerging needs in future.

The rate of genetic advancement being made now barring finger millet is slow in all small millets. The realizable genetic potential is much lower compared to other dry land crops. As a result, these crops are lagging behind and getting more and more marginalized year after year. This trend needs to be reversed and breeders should intensify efforts to improve productivity along with resilience to adjust to adverse climates which is unique to small millets.

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Table 5: VARIETIES OF SMALL MILLETS RELEASED FOR CULTIVATION DURING THE LAST 15 YEARS

1. FINGER MILLET

Sl. No.	Name of the variety	Pedigree	Year of release	Maturity	Average yield	Recommended domain
1.	Champavathi (VR 708)	Pure line selection	1998	90-95	2000-2500	AP, UP, TN, Karnataka, Odisha
2.	MR 1	Hamsa x IE 927	1998	125-130	3500-4000	Karnataka
3.	PR 230 (Maruthi)	Pure line selection	1998	90-100	2500-3000	Andhra Pradesh
4.	GPU 28	Indaf 5 x IE 1012	1998	110-115	3500-4000	Karnataka, TN, Chattisgarh, Odisha, Jharkhand
5.	BM 9-1	Mutation breeding	1999	105-110	2500-3000	Karnataka, Andhra Pradesh, Odisha, Madhya Pradesh, Maharashtra
6.	OUAT 2	Mutant of Co 9	1999	120-125	2800-3000	All ragi growing areas of the country
7.	L 5	Malawi x Indaf 5	1999	120-125	3500-4000	Karnataka
8.	GPU 26	(Indaf 5x Indaf 9) x IE 1012	2000	100-105	3000-3500	Karnataka
9.	GPU 45	GPU26 x L5	2001	95-100	2700-2900	Madhya Pradesh, Gujarat, Jharkhand, Karnataka, Maharashtra
10.	Chilika (OEB 10)	GE 68 x GE 156	2001	120-125	2600-2700	Odisha, Madhya Pradesh, Gujarat, AP, TN
11.	VL 315	SDFM 69 x VL 231	2004	105-110	2600-2700	Uttaranchal
12.	TNAU 946	Malavi 1305 x Co 13	2004	105-110	2500-2600	Tamil Nadu

	(CO 14)					
13.	GPU 48	GPU 26 x L5	2005	100-105	3000-3500	Karnataka
14.	GN 4	Pure line selection	2006	105-115	2800-3000	Gujarat
15.	VL 332	VL 127 x IE 1213824	2006	100-105	2300-2400	All ragi growing areas of the country
16.	PRM 1	Pure line selection	2006	110-115	2000-2500	Hills of Uttarakhand
17.	VL 324	VL 162 x IE 3808	2006	110-120	2000-2200	Lower and mid hills of Uttarakhand
18.	VR 762 (Bharathi)	Pure line from VMEC 134	2006	110-115	2600-3000	Andhra Pradesh
19.	Paiyur 2	VL 145 x Selection 10	2008	110-115	3000-3500	Tamil Nadu
20.	ML 365	IE 1012 x Indaf 5	2008	110-115	5000-5500	Zone 5 of Karnataka
21.	GN 5	Pure line selection	2009	120-125	3000-3200	Gujarat
22.	Srichaithanya (VR 847)	GPU 26 x L 5	2009	110-115	2600-2800	Andhra Pradesh
23.	GPU 66	PR 202 x GPU 28	2009	110-115	3500-4000	Karnataka
24.	KMR 301 (Gowri)	MR 1 x GE 1409	2009	120-125	4000-4500	Southern dry zone of Karnataka
25.	GPU 67	Selection from GE 5331	2009	115-120	3000-3200	Chhattisgarh, Jharkhand, Karnataka, Maharashtra, Tamil Nadu and Uttarakhand
26.	PRM 2	Pure line selection	2010	105-110	2500-2800	Hills of Uttarakhand
27.	VL 347	VR 708 x VL 149	2010	95-100	2000-2200	All ragi growing areas of the country
28.	KOPN 235 (Phule Nachni)	Pure line selection	2011	115-120	2500-2600	Sub mountain and Western Ghat zones of Maharashtra

29.	OEB 526	SDFM 30 x PE 244	2011	110-115	2400-2600	Odisha, Bihar, Chattisgarh, Karnataka, TN
30.	OEB 532	GPU 26 x L 5	2012	110-115	2200-2500	Odisha, Chattisgarh, Karnataka, Maharashtra, TN
31.	KMR 204	GPU 26 x GE 1409	2012	100-105	3000-3500	Karnataka
32.	VR 936 (Hima)	IE 2695 x PR 202	2012	115-120	2800-3000	Andhra Pradesh
33.	Vakula (PPR 2700)	KM 55 x U 22/B	2012	105-110	2500-3000	Andhra Pradesh
34.	Indira Ragi 1	HR 911 x GE 669	2012	120-125	2500-2600	Chattisgarh
35.	VL 352	VR 708 x VL 149	2012	95-100	3300-3500	All ragi growing areas of the country

2. LITTLE MILLET

Sl. No.	Name of the variety	Pedigree	Year of release	Maturity	Average yield	Recommended domain
1	Paiyur 2	Pure line selection	2000	95-100	800-1000	Tamil Nadu
2	Kolab (OLM 36)	Mutant of SS 81-1	2001	95-100	2800-3000	MP, Odisha, Chattisgarh, Bihar, Karnataka, Gujarat
3	Tarini (OLM 203)	Selection from KL 2	2001	105-110	2500-3000	Odisha, AP, Bihar, TN
4	Sabara (OLM 20)	Mutant of SS 81-1	2003	75-80	1100-2000	All little millet growing areas of the country
5	Co 4	Co 2 x MS 1684	2005	75-80	1600-2000	Tamil Nadu
6	JK 36	Pure line selection	2009	75-80	1000-1200	Madhya Pradesh
7	Soura (OLM 208)	Pure line selection	2009	100-105	1400-1500	Odisha, Gujarat, Chattisgarh
8	OLM 217	Pure line selection	2009	105-110	1500-1600	Odisha, Gujarat, Chattisgarh

3. PROSO MILLET

Sl. No.	Name of the variety	Pedigree	Year of release	Maturity	Average yield	Recommended domain
1	GPUP 8	S 7 x L111	2001	85-90	2500-2600	Karnataka and Tamil Nadu
2	GPUP 21	GPUP 14 x K 1	2003	65-75	1500-1600	Karnataka and Tamil Nadu
3	Pratap Cheena	Pure line selection	2006	65-70	1500-1700	All proso millet growing areas of the country
4	Co 5	PV 1403 x GPUP 21	2007	70-75	1800-2300	Tamil Nadu
5	TNAU 145	PV 1454 x TNAU 96	2007	70-75	1800-2000	All proso millet growing areas of the country
6	PRC 1	Selection from GPMS 519	2008	70-75	1000-12000	Uttarakhand hills
7	TNAU 151	TNAU 96 x PV 1673	2008	70-75	1800-2000	Tamil Nadu
8	TNAU 164	TNAU 137 x Co 4	2009	70-75	1800-2000	Andhra Pradesh, Bihar, Karnataka, Maharashtra, Tamil Nadu and Uttaranchal
9	TNAU 202	PV 1453 x GPUP 16	2011	70-75	1800-2000	Dry lands of India

4. FOXTAIL MILLET

Sl. No.	Name of the variety	Pedigree	Year of release	Maturity	Average yield	Recommended domain
1	TNAU 186	Co 5 x SiA 326	1998	80-85	1800-2000	Andhra Pradesh, Tamil Nadu, Karnataka
2	PS 4	Mutation of SiA 2616	1998	80-85	1800-2000	All foxtail millet growing areas of the country
3	Meera (SR 16)	Pure line selection	2000	75-80	1500-1700	Rajasthan
4	Srilakshmi	Pure line selection	2002	80-85	2300-2500	All foxtail millet growing areas of the country
5	Prathap Kangani (SR 1)	Pure line selection	2003	65-70	1600-1800	Rajasthan
6	Co 7 (TNAU 196)	Co 6 x Ise 247	2005	85-90	1800-1900	Tamil Nadu
7	HMT 100-1	RS 118 x PS 3	2008	90-95	2000-2500	Karnataka
8	SiA 3085	Pure line from 2644	2011	75-80	2000-3000	All foxtail millet growing areas of the country
9	Suryanandi	Pure line from 1244	2012	70-75	2000-2500	All foxtail millet growing areas of the country
10	SiA 3156	Pure line selection from 2871	2012	85-90	2000-2500	Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh Tamil Nadu and Uttarakhand

5. KODO MILLET

Sl. No.	Name of the variety	Pedigree	Year of release	Maturity	Average yield	Recommended domain
1	KK 1	Pure line selection	1999	80-85	1800-2000	Uttar Pradesh
2	JK 155 (RBK 155)	Selection from GPLMP 251	2000	80-100	2000-2200	Karnataka and Madhya Pradesh
3	JK 48 (DPS 48)	Pure line selection	2001	95-100	2600-2700	Madhya Pradesh
4	KK 2	Pure line selection	2002	80-85	2000-2300	Uttar Pradesh
5	JK 439	Pure line selection	2004	100-110	2200-2300	Chattisgarh and Madhya Pradesh
6	JK 13	Mutant of JK 76	2007	95-100	2200-3000	Madhya Pradesh, Chattisgarh, Uttar Pradesh, Andhra Pradesh, Karnataka and Tamil Nadu
7	JK 106	Pure line selection	2009	100-105	1900-2000	Madhya Pradesh
8	JK 65	Pure line selection	2009	105-110	2500-3000	Madhya Pradesh, Gujarat, Uttar Pradesh and Tamil Nadu
9	JK 36	Pure line selection	2009	75-80	1000-1200	Madhya Pradesh
10	JK 98	Pure line selection from 317	2010	100-105	2500-3000	Madhya Pradesh
11	DPS 9-1	Pure line selection	2011	105-110	2600-2800	Madhya Pradesh
12	Indira Kodo 1	Pure line selection	2012	105-110	2200-2500	Chattisgarh
13	TNAU 86	Pure line selection	2012	95-110	2700-2300	Andhra Pradesh, Chattisgarh, Gujarat, Karnataka, Madhya Pradesh, Tamil Nadu and Uttar Pradesh
14	RK 390-25	Mutant of RK 390	2012	100-105	2500-2800	Andhra Pradesh, Chattisgarh, Gujarat, Karnataka and Madhya Pradesh

6. BARNYARD MILLET

Sl. No.	Name of the variety	Pedigree	Year of release	Maturity	Average yield	Recommended domain
1	VL Madira 172	EF 2 x VHC 5205	2000	75-80	2200-2300	Uttar Pradesh, Gujarat, Karnataka
2	Sushrutha (RAU 11)	Pure line selection	2000	75-80	2000-2200	Zone 8 of Karnataka
3	VL Madira 181	ECC 27 x VL 60	2001	70-80	1600-1800	Bihar, Karnataka, Madhya Pradesh and Tamil Nadu
4	PRJ 1	Pure line selection from IEC 542	2003	115-120	2300-2500	Uttarakhand
5	Pratap Sawan 1 /ER 64	Pure line selection	2008	85-90	1500-1700	Rajasthan
6	VL Madira 207	VL 172 x GECH 506	2008	80-90	1600-1800	All barnyard millet growing states except Tamil Nadu and Gujarat
7	CO 2	Pure line selection from EF 79	2009	95-100	2100-2200	Tamil Nadu

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