

ICAR-All India Coordinated Research Project on Small Millets

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Introduction

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 a source of food, feed and fodder. They are grown from sea level to mid hills right from Tamil Nadu in the South to Uttarakhand in the North, and Gujarat in the West to Arunachal Pradesh in the Northeast. The crops are grown in a variety of agro-ecological situations viz., plains, coast and hills as well as in diverse soils and varying rainfall. They are known for resilience and drought enduring capacity and are relatively less prone to major pests and diseases. These are indispensable in tribal and hill agriculture where crop substitution is difficult.

Small millets have always been of local and regional important and as a result have attracted little attention both at national and International level. Millets in general started receiving with attention with launching of All India Coordinated Millets Improvement Project (AICSMIP) 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 crops specific lead research centres in the country under IDRC assistance. They were Almora in Uttarakhand (barnyard millet), Dholi in Bihar (proso millet), Dindori in Madhya Pradesh (kodo millet), Semiliguda in Odisha (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 headquarters at The University of Agricultural Sciences, GKVK, Bengaluru. Prior to launching an independent project, the research needs of these crops were looked after by the All India Coordinated Millets Improvement Project with Pearl millet receiving maximum attention, resulting in inadequate allocation of resources, time and efforts for the small millets. 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.

Crop	Major growing states
Finger millet	Karnataka, Maharashtra, Uttarakhand, Tamilnadu, Andhra Pradesh., Jharkhand, Orissa , Chattisgarh, Gujarat
Little millet	Karnataka, Maharashtra, Tamilnadu, Andhra Pradesh, Madhya Pradesh, Jharkhand, Orissa, ,Gujarat and Chattisgarh
Kodo millet	Madhya Pradesh, Chattisgarh, Maharashtra, Tamilnadu, Karnataka
Barnyard millet	Uttarakhand, Uttar Pradesh, Karnataka, Madhya Pradesh., North East and Tamilnadu
Foxtail millet	Telangana, Andhra Pradesh., Karnataka, Rajasthan, Madhya Pradesh,

	Tamilnadu and Chattisgarh
Proso millet	Bihar, North East, Tamil Nadu, Karnataka and Maharashtra.

Area, production and productivity

Five-yearly analysis of data indicates a steady decline in the area from 7.56 m ha during 1951-55 to 1.86 m ha during 2011-15; with a drastic decline in the area of small millets other than finger millet from 5.29 to 0.69 m ha. The production of finger millet fluctuated between 1.61 m t in 1951-55 and 1.87 m t in 2011-15 with high of 2.65 m t during 1976-80 despite huge reduction in area. This was due to doubling of productivity of finger millet from 704 kg/ha to 1601 kg/ha and wide spread cultivation of high yielding blast tolerant varieties. From the inception of the project in 1986, the productivity increase was 47% in finger millet and 39% in other small millets, but reduction area was 50% in finger millet and 75% in other small millets.

Quinquennial area, production and productivity of small millets in India

Year	Finger millet			Small millets		
	Area ('000 ha)	Production ('000 t)	Productivity (kg ha ⁻¹)	Area ('000 ha)	Production ('000 t)	Productivity (kg ha ⁻¹)
1951-55	2274	1605	704	5290	2177	410
1956-60	2454	1873	764	5022	1955	389
1961-65	2555	1888	743	4677	1889	404
1966-70	2420	1887	779	4741	1784	376
1971-75	2442	2227	909	4489	1745	388
1976-80	2588	2650	1021	4326	1743	402
1981-85	2474	2612	1054	3459	1391	401
1986-90	2306	2510	1088	2754	1198	437
1991-95	1891	2511	1331	1950	851	439
1996-00	1718	2413	1402	1492	738	435
2001-05	1563	2088	1331	1173	510	435
2006-10	1350	1976	1471	970	467	480
2011-15	1169	1873	1601	695	419	606

The total area under these crops during the year 2015-16 was 1.79 m. ha with a production of 2.21 m. tons. . The finger millet alone occupied 1.14 m ha with a productivity of 1.82 m. tons and productivity of 1601 kg/ha.

State-wise area, production and productivity of Finger millet in India: 2015-16

States/UTs	Area (In ' 000 Hectare)	Production (In' 000 Tonne)	Productivity (In Kg./Hectare)
Andhra Pradesh	32.0	34.0	1063
Bihar	6.9	9.9	1429
Chhattisgarh	6.9	1.3	188
Dadra and Nagar Haveli	0.9	1.6	1900
Goa	-	-	-
Gujarat	19.0	15.0	789
Himachal Pradesh	1.9	1.9	1027

Jammu and Kashmir	-	-	-
Jharkhand	14.3	9.2	644
Karnataka	705.0	1188.0	1685
Kerala	0.1	0.1	1180
Madhya Pradesh	1.0	1.0	1000
Maharashtra	92.0	93.0	1011
Nagaland	0.3	0.3	970
Odisha	45.7	28.3	620
Puducherry	-	-	-
Sikkim	2.9	3.0	1042
Tamil Nadu	90.0	271.2	3013
Telangana	1.0	1.0	1000
Uttar Pradesh	-	-	-
Uttarakhand	107.4	150.6	1402
West Bengal	11.0	12.5	1136
India	1138.2	1821.9	1601

Sate-wise area, production and productivity Small millets in India: 2015-16

States/UTs	Area (In ' 000 Hectare)	Production (In' 000 Tonne)	Productivity (In Kg./Hectare)
Andhra Pradesh	51.0	49.0	961
Arunachal Pradesh	27.5	27.6	1002
Assam	6.6	4.4	674
Bihar	1.8	1.3	756
Chattisgarh	94.8	15.0	158
Dadra and Nagar Haveli	-	-	-
Goa	-	-	-
Gujarat	18.0	20.0	1111
Himachal Pradesh	4.2	3.0	728
Jammu & Kashmir	5.9	2.3	395
Jharkhand	-	-	-
Karnataka	28.0	10.0	357
Kerala	0.0	0.0	714
Madhya Pradesh	180.0	73.3	407
Maharashtra	76.0	31.0	408
Meghalaya	2.9	2.8	950
Nagaland	8.7	9.8	1122
Odisha	25.4	12.7	501
Punjab	-	-	-
Rajasthan	13.9	6.7	482
Sikkim	3.6	3.5	980
Tamil Nadu	31.3	36.4	1164
Telangana	1.0	1.0	1000
Tripura	0.1	0.1	820
Uttar Pradesh	8.0	5.0	625
Uttarakhand	59.0	74.3	1259
West Bengal	2.3	1.7	733
India	649.9	390.9	602

Source: Ministry of Agriculture and Farmers Welfare, Govt. of India. (ON1394)

Compound growth rates (CGR) for area, production and yield of finger millet and small millets

The area under finger millet showed a declining trend in all the decades' except during 70's. Similarly, production showed the positive growth rate only during the 70's and 90's. However, the productivity was positive during all the decades except in 60's. The other small millets had negative trend both in area and production. However, productivity trend was marginally positive, but was positive for yield during 70's, 80's and 2000's.

Decade wise compound growth rates (CGR) for area, production and yield of finger millet and small millets during 1951 to 2010

Year	Compound growth rate (CGR)					
	Ragi			Small millets		
	Area	Production	Yield	Area	Production	Yield
1951-1960	1.57	4.48	2.85	0.57	0.32	-0.12
1961-1970	-0.28	-1.00	-0.72	-0.32	-1.68	-1.35
1971-1980	1.25	4.28	2.99	-0.76	-0.51	0.25
1981-1990	-1.21	-0.10	1.13	-4.35	-3.26	1.36
1991-2000	-1.80	0.93	2.78	- 5.36	- 5.38	- 0.09
2001-2010	-3.17	-1.73	1.70	- 4.92	-2.93	2.08

After years of neglect, small millets, which can suitably designated as climatic resilient crops or climate smart crops or nutri-cereals are now receiving more attention in agricultural R&D agenda in the country. Rich diversity of small millets crops has made them well suited for contingency crop planning and also to address the issues of climate change. The plasticity exhibited has made them flexible for apparent early as well as delayed planting, very low and high rainfall areas, various elevations and different soil regimes. These positive features have not been duly recognized and exploited in the country. The versatile small millets like foxtail millet, barnyard millet, proso millet and little millet would fit in any situations of climatic change and would save the farmers from a total crop failure. The farmers who had shifted from millets to other crops are keen to go back to millets in view of the stable harvests ensured, easy crop production, drought resistance, and eco-friendly production.

The future research priorities in small millets are utilization of trait specific germplasm, basic and strategic research for resistance to biotic (blast in finger millet, shoot fly in little, proso and foxtail millets) and abiotic stresses (drought, temperature, salinity), varietal diversification, development of parental lines and hybrid technology in finger millet /foxtail millet, gene discovery and allele mining from small millet genetic resources, developing innovative water moisture conservation practices, crop geometry, efficient nutrient management and precision farming, IPM technology for mitigating menace of shoot flies in little, barnyard, kodo and proso millets, selective mechanization of key operations like ploughing, inter cultivation and harvesting and value addition to increase the utility of small millets in food, feed and other allied industries and development of suitable versatile milling machinery for small millets.

Area, production and productivity in Recent years

Finger millet

Area, production and productivity in Finger millet (Average of 2009-10 to 2013-14)

State	Area (lakhs ha)	Production (lakhs ha)	Productivity (kg/ha)
Karnataka	6.96	12.54	1801
Maharashtra	1.25	1.34	1070
Uttarakhand	1.22	1.68	1372
Tamil Nadu	0.87	2.24	2580
Other states	1.66	1.40	843
All India	11.96	19.2	1604

- The major finger millet growing states are Karnataka, Uttarakhand, Maharashtra, Tamil Nadu, Odisha, Andhra Pradesh and Gujarat. Of the total area under finger millet Karnataka alone occupies 60% followed by Uttarakhand and Maharashtra with 10% each.
- Karnataka contributes nearly 70% of finger millet production in the country followed by Uttarakhand and Maharashtra with about 9 per cent. Tamil Nadu has the highest productivity (2580 kg/ha), followed by Karnataka (1801 kg/ha) and Uttarakhand (1372 kg/ha).

Other Small Millets

- In other small millets, the area declined is very drastic leading to lowering of production without any visible increase in productivity. This is largely attributable to confinement of these crops to marginal areas, non availability of quality seed of improved varieties and poor extension support.

Area, production and productivity in Small Millets (other than Finger millet)

(Average of 2009-10 to 2013-14)

State	Area (lakhs ha)	Production (lakhs ha)	Productivity (kg/ha)
Madhya Pradesh	2.40	0.92	384
Chattisgarh	1.41	0.29	212
Uttarakhand	0.71	0.88	1226
Maharashtra	0.64	0.30	471
Gujarat	0.47	0.46	995
Other states	1.95	1.40	843
All India	7.58	4.39	580

- Madhya Pradesh (32%) has the largest area under other small millets, followed by Chattisgarh (18%) and Uttarakhand (9%). Madhya Pradesh and Uttarakhand contribute 19 and 18 per cent

of small millets production which is closely followed by Gujarat 15 per cent. Productivity of other small millets as a whole is high in Uttarakhand and Gujarat.

Brief account of Research highlights

Germplasm conservation, evaluation and utilization

- Recognizing the importance and conservation and easy access to germplasm, AICSMIP established a separate germplasm unit at Bengaluru 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. Project coordinating 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. Presently the unit at Bengaluru is maintaining one of the largest collections of more than 10,000 accessions of 6 small millets.
- 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.

Crop Improvement

- The research in the project was 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 led to the development of 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 272 varieties in 6 small millets have been released in the country.

Crop Production

- 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.

Crop Physiology

- A quick screening technique for assessing genotypes for drought resistance based on determination of crop canopy air differences (CCATD) has been standardized. Using these techniques two types of genotypes namely negative CCATD (cooler canopy) and positive CCATD (warmer canopy) have been identified. Negative CCATD types are superior in water extraction and they possess higher root volume and root length.

Crop protection

- Several blast resistant lines were identified from the germplasm available at NAGS and crop protection for management of blast diseases has been recommended. Two sprays of *P.*

fluorescens (0.2%) or *P. fluorescens*+*T. harzianum* (0.2%) were comparable to edifenphos (0.1 %) for controlling *ragi* blast especially under organic production situations. Three new diseases viz., Banded sheath blight of *ragi*, Head smut of barnyard millet and Udbatta of kodo millet were recorded and reported. New donors resistant to banded sheath blight and smut have been identified.

- An IPM package involving clean cultivation, early sowing with higher seed rate (one and a half times) followed by trapping the adult flies with fish meal traps was found effective in mitigating the menace of shootfly in little, barnyard, kodo and proso millet.

Technology transfer

- Technology transfer attempted through frontline demonstrations on the farmer's field and on large scale station demonstrations have helped in narrowing down the yield gap that existed between farmers field, demonstration plot and research station trials. Participatory selection of varieties has also been helpful in fine tuning variety recommendation domain by narrowing down to identifying varieties with high degree of location specificity.