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Agronomic Interventions for Enhanced Productivity of Minor Millets

Minor millets consist of a group of small seeded cereal species that are genetically diverse and adapted in varied range of agro-climatic conditions where major cereals such as rice, wheat and maize were relatively uneconomical. Millets played an important role in traditional farming and food culture in many developing countries like South Asian and African countries. Minor millets include fingermillet (*Eleusine coracana* L.), foxtailmillet (*Setaria italica* L.) Beauv), prosomillet (*Panicum miliaceum* L.), kodomillet (*Paspalum scrobiculatum* L.), barnyardmillet (*Echinochloa frumentacea* Roxb., Link) and littlemillet (*Panicum sumatrense* Roth.ex Roem. and Schultz).

Minor millet

INTRODUCTION

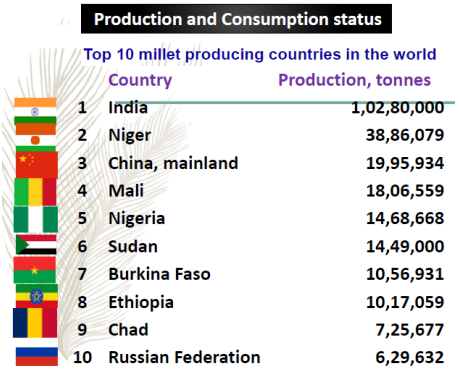
Minor millets mature very quickly, which is a most important trait for rainfed farming and require relatively low inputs when compared to major cereals. These can withstand severe biotic and abiotic stresses with sustainable yields and are more nutritious than major cereals, hence considered as "Miracle Nutri-cereals". They grow in poor soils under varied range of day lengths, making them attractive climate smart crops, as their adaptations to current challenging environment are better than the many major crops. Despite of these advantages, the area under minor millets in India is declining from 6.80 m ha during 1950-51 to 1.34 m ha during 2018-19 and has been diverted to more remunerative crops. Further, production also declined from 3.17 m t to 1.57 m t with a productivity of 734 kg ha^{-1} (www.indiastat.com).

GLOBAL AND INDIAN SCENERIO

India, Niger and China are the leading producers of millets in the world, which accounts for more than 55% of world production. For many past years, India was the world's major producer of millets. In recent years, millet production has increased in Africa. Area under millets is 30.03 m ha, with a production of 27.43 m t and productivity of 1019 kg ha^{-1}.

REASONS FOR DECLINE OF AREA UNDER MINOR MILLETS

- Green revolution.
- Lack of support in terms of credit to farmers in terms of crop loans and insurance.
- Negligence of scientists in development of millet production technologies and farmers in adoption.
- Lack of efficient modern technologies for processing and utilization are the reasons for area



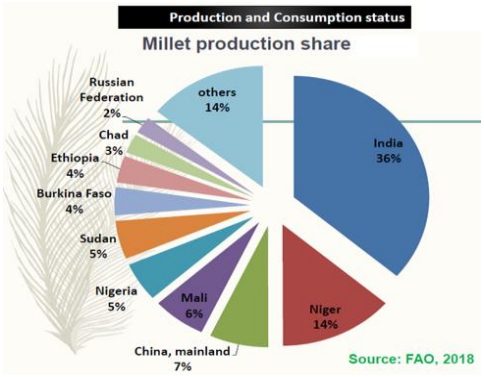


Table 1. Area, production and yield of minor millets in major producing states of India

States	Area (lakh hactres)	Production (lakh tonnes)	Productivity (kg ha-1)	
			Fingermillet	Other small millets
Karnataka	5.46	6.94	1285	882
Tamil Nadu	1.01	2.91	3257	1573
Uttarakhand	1.48	1.8	1194	1248
Maharashtra	1.27	1.15	1164	453
Madhya Pradesh	0.89	0.59	-	663
Andhra Pradesh	0.45	0.49	1348	462
Odisha	0.69	0.42	690	518
Chhattisgarh	0.94	0.3	214	332
Arunachal Pradesh	0.27	0.27	-	1023
Jharkhand	0.14	0.11	805	-
Others	0.85	0.73	804	587
All India (2018-19)	13.45	15.72	1390	734
All India (1950-51)	68.08	31.79	596	380

reduction under millets.

- Easy availability of fine cereals like rice and wheat at a cheaper price under subsidy through Public Distribution System (PDS).
- Tedious and time consuming process of Nutri-cereals preparation.
- Change in food habit particularly preference to fast food by younger generation.

IMPORTANCE OF MINOR MILLETS

Minor millets can be grown on poor fertile soils, which include problematic soils like acidic and saline soils. Grown in areas rainfall average is less than 500 mm in sandy and slightly acidic soils. Minor millets can be grown in all seasons like kharif, rabi and summer. Matures within 60-110 days compare to other cereals which take more than 130 days. While single cereal crops such as rice and wheat can succeed in meeting food security for India, millets can do more. They can contribute to both food nutrition securities through fodder, fibre, health and livelihood Minor millets produce edible stalks which are the most relished fodder for cattle. Most millet grown under traditional practices constitute a farming system and not merely crop fields which are inherently biodiverse with a sustaining ecology. This is the tradition of millet farming in the country where six to twenty crops are planted in the same space at same time. Baranaja cropping systems is one of the famous in the Himalayas region. In this system, 12 different millet crop varieties are grown in the same field at same time. Saatdhan in Rajasthan and pannendu Pantalu system in south Indian region promotes growing millets along with pulses and oilseeds combination, thus making it a holistic farming system. Minor millets are very rich in nutrition especially micronutrients, minerals and vitamins, offer health benefits if included in daily diet and help in the management of disorders like diabetes, obesity, hyperlipidemia, cancer etc. Less susceptibility to storage pest and diseases act as famine reserves.

Millets are capable of meeting the global challenges

Good for the planet
Good for the consumer
Good for the smallholder farmer

CONSTRAINTS IN MINOR MILLETS PRODUCTION

ABIOTIC CONSTRAINTS

1) Climatic: Rainfall, temperature, solar radiation and relative humidity.

2) Soil: Soil temperature, fertility, moisture content and organic matter

BIOTIC CONSTRAINTS

1) Pest and Diseases: Among all fungal diseases causes higher yield losses

2) Weeds: Yield losses up to 34%

AGRONOMIC CONSTRAINTS

- Delayed sowings
- Lack of availability of HYV
- Poor plant population
- Grown on poor soils without any fertilizers
- No profitable cropping systems
- Weed infestation during initial crop stages
- Lack of protective irrigation

AGRONOMIC INTERVENTIONS

1. Time of sowing
2. Variety & optimum plant population
3. Nutrient management
4. Intercropping system
5. Weed management
6. Irrigation management

1. TIME OF SOWING

Time of sowing depends on receipt of rainfall, variety and cropping system etc. Increased yield due to favorable environment. Flowering is induced after sufficient vegetative growth. Moisture stress can be avoided at critical stages.

Table 2. Crop duration of different minor millets

Crop	Duration (days)		Yield (q ha^{-1})	
	Local cultivars	Improved varieties	Grain	Straw
Finger millet	90-130	80-100	25-30	60-70
arnyard millet	75-95	45-60	12-15	20-25
Foxtail millet	75-120	70-95	15-18	20-40
Proso millet	65-90	60-80	20-23	50-60
Kodo millet	100-140	75-95	15-18	30-40
Little millet	80-110	70-110	12-15	20-25

Examples

Kharif crops : II FN of June or I FN of July
Rabi crops : II FN of October to I FN of November

Summer crops : I FN of January

2. VARIETY AND OPTIMUM PLANT POPULATION

Farmers are growing old traditional varieties. Replacing of low yielding varieties with high yielding varieties/hybrids will increase productivity and farmers income.

Crop	Improved varities
Finger millet	A- 404, V L-124, , V L-149, Indaf-8, Godavari , Ratnagiri , Birsa Gourav, Gujrat Nagli, and PR-202
foxtailmillet	Si A 326, Si A 3085, Si A 3088, Si A 3156, Lepakshi, Sreelaxmi , K O 12, Narasimharaya, TNAU 196 and TNAU 43
Barnyard millet	VL 172, RAU 11, VL 181, VL 207, Anurag, CO 1 and CO 2
Kodo millet	GPUK 3, RBK 155, CO 3, TNAU 86, JK 13, JK 65 and JK 48
Proso millet	TNAU- 151, TNAU- 164, GPUP- 8, Pratap chena- 1, Bhawana, Nagarjuna, PRC- 1 and K- 1
Little millet	OLM 203, JK 8, Paiyur 2, TNAU 63, JK-4 and JK 36.

Plant population and yield are related to each other. If all the resources in optimum condition, then higher population is advantageous. In dry lands, population should not be more. Sowing depth for small seeded millets 3–4 cm. Sowing in line method is beneficial helps in inter-cultivation and control of weeds effectively. To get higher productivity optimum plant population should be maintained with adoption of appropriate seed rate and spacing. Broadcasting, sowing behind the plough, seed drilling and transplanting nursery seedlings are different sowing methods are followed in millets.

Table 3. Spacing adopted in different Minor millets

Crop	Spacing	Seed requirement in kg ha-1	
		Broad casting	Line sowing
Finger millet	22.5 ×10 cm	25	10 (TP : 5)
Foxtail millet	25 x 8-10 cm	12-15	8-10
Barnyard millet	25 ×10 cm	12-15	8-10
Proso millet	25 ×10 cm	15	10
Kodo millet	22.5 ×10 cm	15	10
Little millet	22.5 ×10 cm	12	8

3. NUTRIENT MANAGEMENT

Organic manures like FYM are applied @ 5-10 t ha^{-1} about a month or 2-3 weeks before sowing. Seed treatment with bio-fertilizers: *Azospirillum brasilense* (Nitrogen fixing bacterium) and *Aspergillus awamori* (Phosphorus Solubilizing fungus) @ 25 g kg^{-1} is beneficial. Entire dose of P_2O_5 and K_2O are to be applied at the time of sowing, whereas nitrogen is to be applied in two or three split doses depending upon moisture availability. In areas of uncertain rainfall, 50% at sowing and the remaining 50% around 35 days after sowing is recommended. In areas of good amount of rainfall and moisture availability, 50% of recommended nitrogen is to be applied at the time of sowing and the remaining 50% in two equal splits at 25-30 and 40-45 days after sowing.

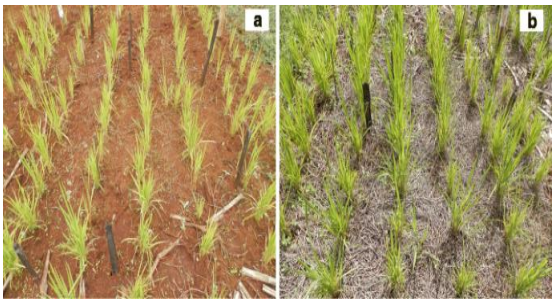
Crop	N-P_2O_5 and K_2O (kg ha^{-1})
Finger millet	40-20-20 Rainfed
	60-30-30 Irrigated
Foxtail millet	40-30-0
Barnyard millet	40-20-0
Proso millet	20(40)-20-0
Kodo millet	20(40)-20-0
Little millet	20(40)-20-0

4. IRRIGATION MANAGEMENT

Millets are drought tolerant crops. Water use efficiency of finger millet is high. Critical stages are transplanting, heading and flowering. Moisture conservation practices like tank silt collection and application and use of crop residue as mulch to

Tank silt collection

Tank silt application



Use of crop residue as mulch

reduce evaporation losses. For millets irrigation is given at 50% depletion of available soil moisture.

5. WEED MANAGEMENT

Weeds are more vigorous and compete with the millets for resources. Thumb rule: 1/3rd of crop growth period should be weed free. Reduction in yield of crop depends on critical period of crop weed (20-45 DAS).

CULTURAL METHODS

1. Intercropping with legumes.
2. Higher seed rate.

MECHANICAL METHODS

Two times Inter-cultivation is needed, one hand weeding in line sown crop and two hand weedings in broadcasted crop are useful for efficient control of weed control.

CHEMICAL METHODS

Pre emergence application of atrazine or isoproturon @ 1.0 kg a.i. ha^{-1} spray is effective.

Application of 2, 4-D Na salt (80%) @ 1.0 kg a.i. ha^{-1} at 20-25 days after sowing as post emergence is effective for controlling broadleaved weeds.

6. INTERCROPPING SYSTEMS

Growing of two or more crops simultaneously with a definite row pattern on the same piece of land, thus cropping intensity in space dimension is achieved.

ADVANTAGES

1. Insurance against total crop failure
2. Increase in total productivity per unit land area
3. Judicious utilization of available resources

SUCCESSFUL INTERCROPPING

Peak nutrient demands of component crops should not overlap. Competition for light should be minimum among the component crops. Complementary should exist between the component crops. Differences in maturity of component crops should be at least 30 days.

Crop	Cropping systems
Finger millet	Fingerl millet + Red/black/green gram 6 or 8:2 or soyabean 4:1 ratio
Foxtail millet	Foxtail millet + G.nut/cotton/red gram 5:1 ratio
Barnyard millet	Barnyard millet + ricebean in 4:1 row ratio
Proso millet	Proso millet + Green gram 2:1 ratio
Kodo millet	Kodo millet + Soyabean/ Red /Black/Green gram 2:1 ratio
Little millet	Little millet + Black/Red gram/ Soyabean/Sesamum 2:1 ratio

CONCLUSION

Enhanced productivity of minor millets can be achieved by agronomic interventions like optimized sowing window, improved high yielding varieties, better plant geometry, balanced nutrient application, effective weed control, protective irrigation at critical stages and remunerative cropping systems.

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