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Empowering farmers with improved finger

millet production technologies for higher productivity

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Finger millet is a highly nutritious and climate-resilient crop, primarily cultivated for both food and fodder. It thrives in sub-tropical climates at high altitudes and is notable for its high calcium, dietary fiber and high quality protein, making it a highly nutritious grain. India produces 1.8 million tonnes annually, with Karnataka contributing about 60%. The crop adapts well to kharif season rainfed conditions and prefers loamy to sandy soils with good drainage. Various improved and nutrient-rich varieties were developed with resistance to major diseases and pests. Improved practices such as proper land preparation, seed treatment, spacing, timely irrigation and weed control enhance productivity. Intercropping with legumes and crop rotation with pulses improve soil fertility and yield sustainability, making finger millet an ideal crop for climate-resilient and nutrition-sensitive agriculture. Improved finger millet production interventions led to notable increases in yield and profitability, achieving up to a 21% gain compared to existing traditional techniques.

Keywords: Disease resistance, Economic impact, High nutrition, Improved production interventions, Intercropping system, Sub-tropical, Sustanable cultivation

FINGER millet *(Eleusine coracana* L.*)* is third most important millet next to pearl millet and sorghum, grown for food and fodder, commonly known as Ragi, *Mandika, Marwah* (Hindi), *Nagli, Nachni* (Marathi), Ragi (Kannada), *Ragulu, Chodi* (Telugu), *Keppai, Kelvaragu* (Tamil), *Marwa* (Bengali), *Nagli, Bavto* (Gujrati), *Mandia* (Oriya), *Mandhuka, Mandhal* (Panjabi). Grains of finger millet are rich in calcium (250–350 mg/kg) and known for dietary fiber and quality protein. In India, finger millet is cultivated in an area of 1.18 million ha with productivity of 1,600 kg/ha and production of 1.8 million tonnes. Karnataka occupies about 60% of the area in cultivating finger millet, followed by Tamil Nadu, Maharashtra and Uttarakhand. Finger millet grows well in subtropical climate and can be cultivated up to an altitude of 2,100 m. The minimum temperature required is 8–10°C. A mean temperature range of 26–30°C during the growth is the best for proper development and good crop yield. Finger millet contains 7.2% protein, 66.8% carbohydrates, 11.2% dietary fiber and 2.5–3.5% minerals. It has the highest calcium content among all cereals and millets (344 mg/100 g). The major phenolics found in finger millet are ferulic acid and p-coumaric acid and the bound phenolic fraction accounts for 64–96% and 50–99% of total ferulic acid and p-coumaric acid contents of millet grains, respectively. High calcium content of finger millet is useful for growing children, elderly people and lactating women. Building strong bones in childhood was found to be associated with maintaining bone strength, in elders especially after menopause. Regular consumption of high calcium reduces the chance of kidney stone formation from dietary oxalates. Calcium binds with oxalic acid in intestines and prevents absorption of oxalates by the body.

Improved varieties

Several high yielding and nutri-rich varieties were developed and released for cultivation in different states. The list of latest and popular varieties recommended for different states and nutri-rich varieties were given in the tables.

Soil and climate

Finger millet is grown in all cropping seasons except winter, however 90% of the area is under *kharif* rainfed conditions. The crop is widely adaptable to a range of environmental conditions and is grown in

Table 1. Recommended improved varieties of finger millet in different states

Varieties	Adaptation	Crop duration (days)	Yield (q/ha)
CFMV-1*(Indravathi)*	Andhra Pradesh, Karnataka, Tamil Nadu, Puducherry and Odisha	110–115	30–32
CFMV–2	Andhra Pradesh, Chhattisgarh, Gujarat, Maharashtra and Odisha	119–121	29–31
VL–378	Rainfed organic conditions of the Uttarakhand hills	110–114	22–24
VL–382	Rainfed organic conditions of the Uttarakhand hills	106–108	11–13
Chhattisgarh Ragi–3 (FMV–1102) (BR–14-3)	Northern Zone (Assam, Bihar, Chhattisgarh, Jharkhand, Uttarakhand and MP)	110–115	33
ATL–1 (TNEc-1285)	Tamil Nadu	105–110	30
Dapoli 3 (DPLN–2)	Konkan region of Maharashtra	125–130	20–22
Birsa Marua–3	Jharkhand	110–112	26.9
Gossaigaon Marua Dhan (AAU-GSG-Marua *Dhan*–1) (FMV1156)	Assam	125–130	30.51
Phule Kasari (KOPN 942)	Maharashtra	100–110	22.44
CFMV–4 (FMV1166)	Andhra Pradesh, Maharashtra, Tamil Nadu	113	GY: 28.66 FY: 60.29
VL *Mandua* 400 (CFMV5) (FMV1162)	Madhya Pradesh, Karnataka, Chhattisgarh, Bihar, Jharkhand, Gujarat and Andhra Pradesh	102	GY: 34.77 FY: 84.80
Gosthani (VR 1099)	Andhra Pradesh	110–115	GY: 38–39
Siri (KMR–316)	Zone 5,6 of Karnataka	105–110	30–35
Shreeratna (OUAT Kalinga finger millet–1) (OEB 601)	Odisha	117	23.5

GY= Grain yield, FY= Fodder yield

Table 2. Recommended nutri-rich varieties of finger millet in different states

Name	Adaptation	Special features
CFMV-2	Andhra Pradesh, Chhattisgarh, Gujarat, Maharashtra, Odisha	Resistant to leaf blast, foot rot, brown spot, grain mold and moderately resistant to neck blast, finger blast and banded blight
CFMV-1 *(Indravathi)*	Andhra Pradesh, Karnataka, Tamil Nadu, Puducherry, Odisha	Resistant to finger blast, neck blast, banded blight and foot rot, shoot aphids, stem borer and grass hoppers; rich in calcium (428.3 mg/100 g), iron (58.3 mg/kg), zinc (44.5 mg/kg)

altitudes ranging from mean sea level to the foothills of the Himalayas. The crop can tolerate a certain degree of alkalinity. The best soil is alluvial, loamy and sandy soil with good drainage. The minimum temperature for germination is 8–10°C and mean temperature of 28–32°C is ideal for good crop development.

Land preparation

In the month of April or May, one deep ploughing with a mould-board plough helps in retaining more soil moisture followed by, harrowing twice is necessary. Before sowing, secondary tillage with a cultivator using multiple-tooth hoe to prepare smooth seedbed is necessary. Minor land smoothening before sowing helps in better *in situ* moisture conservation. Seeds are very small and take 5–7 days to germinate. Hence, good seeds, land preparation helps in better germination, minimize weeds problems and effective soil moisture conservation. In Uttarakhand, where frequent ploughing operations are difficult to carry out, effective digging and turning of soil, removing perennial weeds, land smoothening and providing an inward slope with a shallow drain help in taking out excess rainwater.

Soil and moisture conservation practice

To increase soil quality, summer ploughing or ploughing after the harvest of previous crop can be done across the slope. Preparation of small section bunds at an interval of 10–12 m, depending on the slope and levelling, helps in better management for operations. Opening a dead furrow at 3.3–4.0 m intervals is beneficial.

Seed rate

Use 8–10 kg/ha (3–4 kg/acre) for line sowing is advised and 4-5 kg/ha (1.5–2.0 kg/acre) for transplanting. A seed rate of 10 kg/ha is found to be optimum for drill sowing and 5 kg/ha for raising transplanted seedlings.

Seed treatment

Seed should be treated with Thiram or bavistin @2.5 g/kg of seed to prevent diseases. Treating seeds with *Azospirillum brasilense* (N-fixing bacterium) and *Aspergillus awamori* (P-solubilizing fungus) @25 g/kg seed is beneficial. In case seeds are to be treated with seed dressing chemicals, treat the seeds first with seed dressing chemicals and then with bio-fertilizers at the time of sowing.

Bio-fertilizer culture is specific to the crop to be used at 25 g/kg of seed. A sticker solution is necessary for effective seed inoculation. This can be prepared by dissolving 25 g jaggery or sugar in 250 ml water and boiling for 5 min. The solution thus prepared is cooled. Smear the seeds well using the required quantity of sticker solution. Then add culture to the seeds and mix thoroughly to achieve a fine coating of culture on the seed. The culture-coated seed is to be dried well in shade to avoid clumping of seeds. Use of the inoculated seeds for sowing can be done.

Sowing time

Suitable time for sowing for *kharif* is in June to July, and for *rabi*- September to October. In certain regions, it is grown in summer under irrigated land conditions.

Method of sowing

Line sowing is beneficial, helps in inter cultivation and control weeds effectively. Maintenance of optimum

plant population of 4–5 lakh plants/ha and this is attained by line sowing using seed drill with spacing of 22.5–30.0 cm between rows and 7.5–10.0 cm between plants. Transplanting is also done in irrigated conditions.

Nursery preparation

An area of 150–200 m^2 is required to raise seedlings to cover 1.0 ha of main land. Apply 2–3 baskets of well decomposed farmyard manure (FYM) along with 1.0 kg super phosphate, half kg muriate of potash and half kg ammonium phosphate and 750 g zinc sulphate per bed. Sow the seeds by opening rows at every 3 inch uniformly. Cover the seed with well decomposed FYM and soil/sand/water in every bed. Top dressing with urea 500 g/bed when the seedlings are 12–14 days old is necessary. Seedlings of 21–25 days old are ideal for transplanting in rows of 22.5–25 cm with 2 seedlings/hill with 10 cm between hills.

Spacing and fertilizers

In direct sowing, spacing between rows should be 22.5–30 cm, plant-to-plant 7.5 cm and depth 3-4 cm. Application of additional quantities of organic matter in soil is considered beneficial, since it helps to improve the physical condition of soil, which helps soil to retain moisture for a longer period. Apply 5–10 t/ha FYM about a month before sowing. The crop responds well to fertilizer application. The general recommendation for finger millet is 60 kg nitrogen, 30 kg P and 30 kg K/ha under irrigation and 40 kg nitrogen, 20 kg P and 20 kg K/ha is for rainfed conditions. Entire P and K fertilizers are to be applied at sowing, whereas nitrogen is to be applied in two or three split doses, depending upon moisture availability.

In areas of good rainfall and moisture availability, 50% of recommended nitrogen is to be applied at sowing and the remaining 50% in two equal splits at 25–30 and 40–45 days after sowing.

In areas of uncertain rainfall, 50% N at sowing and the remaining 50% around 35 days after sowing is recommended.

Irrigation management

Finger millet is generally grown during *kharif* under rain-fed conditions. If there is any longer dry spell, then irrigation would be required. Depending on soil type, weather conditions and duration of variety, for light soils irrigate the crop once in 6–8 days, and for heavy soils once in 12–15 days under limited irrigation. The crop may be irrigated at critical growth stages like tillering, flowering and grain filling.

Important weeds

***Grassy weeds*:** *Echinochloa colonum, Echinochloa crusgulli* (sawan), *Dactyloctenium aegypticum* (makra), *Elusine indica* (kodo), *Setaria glauca* (banra), *Cynodon dactylon* (doob), *Phragmites karka* (narkul), *Cyperus rotundus* (motha), *Sorghum halepanse* (banchari) are common weeds.

Broad-leaved weeds: *Celosia argentia* (chilimil), *Commelina benghalensis* (kankoua), *Phylanthus niruri* (hulhul), *Solanum nigrum* (makoi) and *Amaranthus viridis* (chaulai) are common weeds.

Weed control

The field should be kept weed-free up to 25–30 days after sowing. It is essential to control weeds in the initial stage of plant growth and development. The inter-cultivation and weeding should be done with a hand hoe at 25 days after sowing (DAS). Weed problems in finger millet crop can be effectively managed by cultural and mechanical operations. In line sowing, 2–3 intercultivations and one hand weeding is suggested. For the broadcast crop, 2 hand weedings will minimize weeds. In assured rainfall and irrigated areas, pre-emergence weedicide spray with Isoproturon at 0.5 kg a.i./ha needs to be done. In rainfed areas, spray of Oxyfluorfen at 0.1 L a.i./ha (irrigated areas) can be done. For post-emergence spray, 2, 4–D sodium salt at 0.75 kg a.i./ha should be done at around 20–25 days after sowing to control these weeds.

Intercropping

Intercropping in finger millet improves resource use efficiency, reduces pest and disease incidence and enhances overall crop productivity. Finger millet is a resilient and nutritious cereal, is widely intercropped with legumes and oilseeds across India to improve soil fertility and increase farmers' income. The intercropping ratios and companion crops vary based on regional agro-climatic conditions.

Table 3. Intercropping systems of finger millet in different states of India

State	Crop system
Karnataka, Tamil Nadu and Andra pradesh	Finger millet + Pigeon pea; 8-10:2
	Finger millet + Field bean; 8:1
	Finger millet + Soybean; 4:1
Bihar	Finger millet + Pigeon pea; 6:2
Uttarakhand	Finger millet and soybean mixed in 90:10% proportion by weight basis
North hilly areas	Finger millet + Soybean in *kharif* and oats in *rabi* is an ideal
Maharashtra (Kolhapur)	Finger millet + Black gram/moong bean 6-8: 1

Crop rotation year-wise

Northern states: Rotation with legumes like green gram/black gram/rice bean/soybean.

Southern states: In southern states, horse gram, pigeon pea, field bean or groundnut are good for crop rotation. This practice will minimize inorganic fertilizer application and sustain higher yields. Finger millet-finger millet rotation must be discouraged as it affects the sustainability of soil as well as crop yield.

Crop sequence

Northern Bihar: Potato-paddy-finger millet cropping sequence is highly remunerative than other cropping sequences.

Table 4. Insect-pests and diseases identification symptoms and their management

Insect pest	Key identification	Control measures
Army worms and cut worms	Caterpillars cut seedlings at the base during early stage, which appears as it was grazed by domestic animal. They are active during night. In later stages, these insects act as defoliators.	Apply poison baits, comprising 10 kg rice bran + 1 kg jaggery + 1 L quinolphos (25% EC). Prepare small balls and broadcast in the fields, preferably in the evening time. Spraying Chloroantraniliprole 18.5 SC at 0.4 ml/litre water control armyworms/cutworms.
Leaf aphid	It occurs throughout the crop growing period. The nymphs and adults suck the sap from tender leaves and stem. They can cause serious damage at the seedling stage up to 30 days.	Spraying of Quinolphos (0.05%) or Imidacloprid 17.8 SL at 0.25 ml/L give effective control.
Pink stem borer	The larva bores into the stem, resulting in dead heart.	Spraying the crop with Chloroantraniliprole 18.5 EC at 0.4 ml/litre helps in control of borer.
Ear head caterpillars	Ear head caterpillars appear at dough stage on ears and persist till harvest. The caterpillars bite the maturing seeds and make a fine web out of their casting and half eaten grains. This further attracts saprophytic fungi.	Dust Chloroantraniliprole 18.5 EC at 0.4 ml/litre or Quinolphos 1.5% at 24 kg/ha.
Diseases		
Blast *(Piricularia* fungi */Pyricularia grisea)*	Diamond-shaped lesions with gray center and dark margin appear on the leaf. Any part of plant including leaves, peduncle, and fingers can be infected. Infected fingers become brown to black in colour with poor or no seed setting in the infected parts. Grains on blast affected fingers become shriveled, discoloured and light in weight.	Treating seeds with fungicides like Carbendazim at 2g/kg a day before sowing. Spraying the nursery with Kitazin or Tricyclazole at 0.1% a.i 10-12 days after sowing is recommended depending on disease incidence. Spray the fungicide at 50% flowering stage and repeat 10 days later for controlling neck and finger blast.
Brown spot	Many small to medium-sized brown to dark brown spots appear on the leaf, leaf sheath, and other plant parts. Damage could be severe if the crop is subjected to drought or nutritional deficiency.	Proper nutrition and water management can effectively manage the disease. Need-based spraying of Mancozeb (0.2%) can be taken up.

Southern Karnataka or Deccan plateau: Finger millet-potato-maize or finger millet-onion- finger millet is highly remunerative cropping sequence.

Assured rainfall areas: Raising crop of cowpea or green gram or sesamum, followed by sowing/ transplanting of early duration finger millet can be practiced.

Insect-pests and disease management

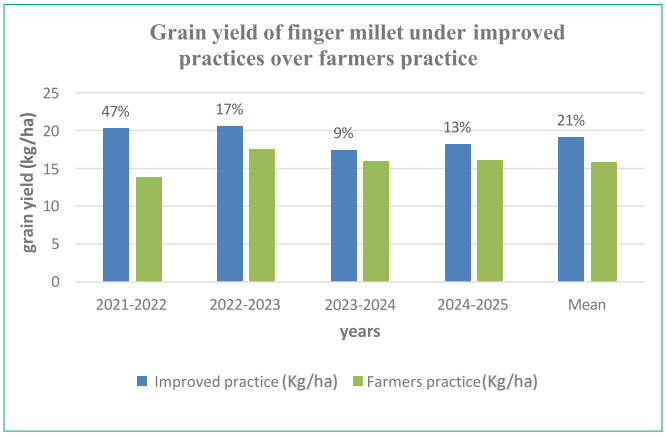
Finger millet though known for its resilience and adaptability to diverse agro-climatic conditions, is susceptible to a range of insect pests and diseases that can significantly influence its growth, productivity and grain quality. Timely identification and integrated pest and disease management practices are crucial for ensuring sustainable yield and profitability.

Harvesting and yield

The crop matures in about 95–110 days for early varieties and 115–125 days for medium to late duration varieties depending on the crop season. The panicles are harvested with ordinary sickles and straw is cut close to ground. At some places under rain-fed condition, the whole plant with panicles are cut, heaped, sun dry and then threshed. Average grain yield of 2.0–3.0 t/ha and 3.0–4.0 t/ha under well managed conditions and 6.0–9.0 t/ha fodder. The straw of finger millet makes nutritious fodder and it is preferred over paddy straw. It can be conserved by putting up in well-built stakes.

Performance of improved technologies in farmers' fields under Farmers FIRST Programme

The analysis of yield and economic data of the technology evaluation trials organized in Sangareddy district of Telangana state during 2021 to 2025 showed that improved agricultural practices consistently outperformed traditional farmers' practices in terms of productivity and net returns. The average yield obtained under improved practices was 19.08 kg/ha, which was 21% higher than farmers' practices (15.80 kg/ha), reflecting potential to bridge yield gap substantially. The most significant yield advantage was observed during 2021–2022, with a 47% increase, while the lowest was recorded (9%) in 2023–2024. Although the magnitude of improvement varied across years, likely due to environmental factors, resource availability, or levels of adoption, the overall trend indicates that improved agricultural practices contribute positively to enhancing the productivity and income to the farmers. These findings underscore the importance of promoting and supporting the adoption of improved technologies to achieve sustained finger millet productivity.



A mature finger millet earhead in the field

Grains of finger millet

SUMMARY

The adoption of improved finger millet production technologies led to significantly higher yields and profitability, achieving yield gains of up to 21% compared to conventional methods. These results show potential for finger millet farmers to enhance productivity through the implementation of these improved production interventions. To facilitate wider dissemination, conducting field demonstrations, farmer field schools. Strengthening the farmers through regular training, expert guidance and access to extension support will further accelerate the adoption of improved practices. A coordinated approach involving research institutions, extension systems and local stakeholders is essential for scaling these innovations and ensuring sustainable intensification of finger millet cultivation.

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