

Improved millets cultivation

for enhancing farmers' income in rainfed areas

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Millets have huge potential to enhance the income of the resource poor farmers in dryland and rainfed agriculture using location-specific improved production technology with diversification approach. It requires synergy among technologies, marketing systems, input supplies, credit, policies and concerned institutions to achieve the goal of doubling farmers' income emphasizing plough to plate transition.

Key words: Farmers' income, Millets, Promotion, Technology interventions

Large segment of the Indian population is dependent on agriculture which governs food and nutritional security of the country, and accounts for approximately one-fifth of the total gross domestic product (GDP). Millets are one of the cheapest sources of energy, containing high digestive fibres, protein, vitamins and minerals. In terms of nutrient intake, sorghum accounts for about 35% of the total

intake of calories, protein, iron and zinc in the dominant production/consumption areas. Thus, it is essential to make them most preferred crop choices particularly in the low and average rainfall areas of the country. Millets (sorghum, pearl millet, finger millet, foxtail millet, proso millet, kodo millet, barnyard millet, little millet) are a major source of staple food for human, forage for the livestock, and industrial raw

material. It is grown in semi-arid climate where other cereal crops do not stand well. Impact of climate change on agriculture is threatening not only food security but also sustainability. There is urgent need for promotion of climate smart crops like millets, being C₄ plants these can perform resiliently under changing climate scenario due to their ability to grow and complete their life cycle in less than 400mm water. To achieve

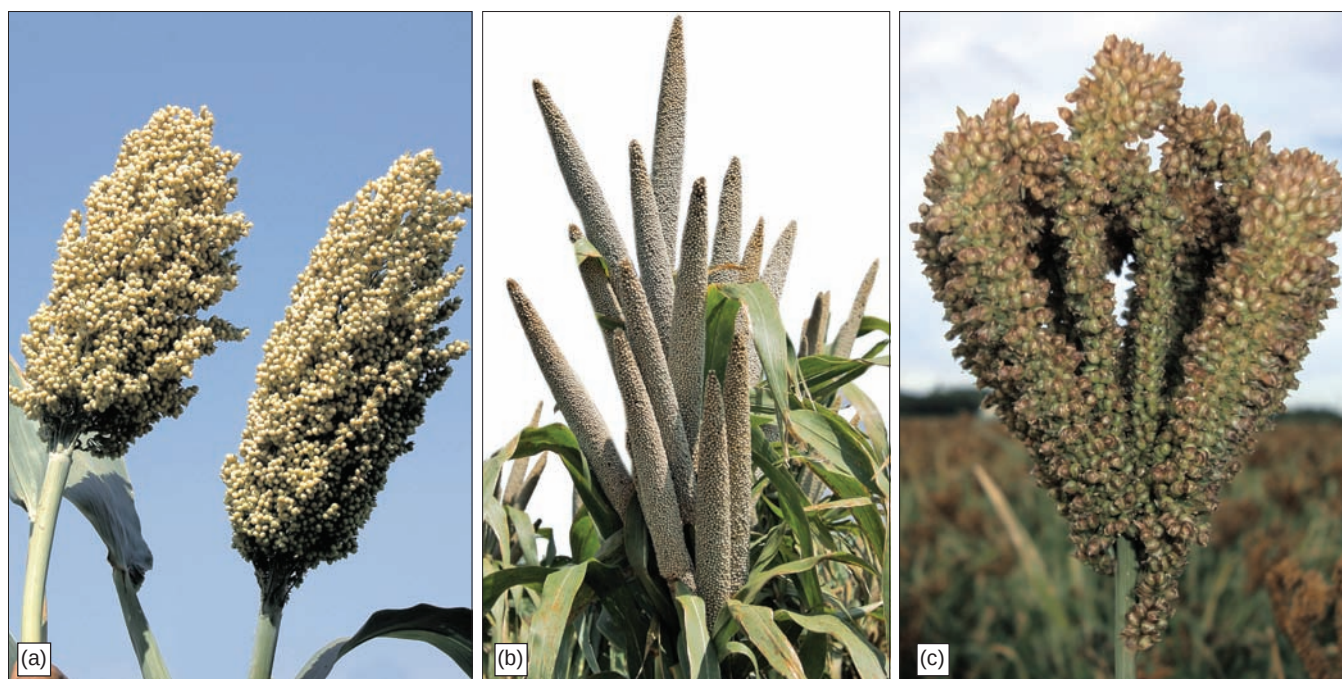


Fig. 1. Millet varieties: (a) Sorghum, (b) Pear millet and (c) Finger millet

the goal of doubling farmer's income, appropriate production technologies and establishment of value-chain is required.

Technology interventions

The new technologies should be less input and labour intensive, cost-effective, and economically viable. Some promising interventions are underlined in order to enhance farmers' income and their livelihood.

Use of high yielding cultivars specific to soil types: Latest 20 *kharif* sorghum cultivars yielded better than the existed ones in seven states across the rainfed regions under frontline demonstrations (FLDs). They yielded 78% more grain and 60% stover than the local cultivars which resulted in 51% more net returns than the local cultivars. Similar results were obtained in *rabi* sorghum in these areas. Soil of sorghum growing areas is classified into three major categories based on soil depth, *viz.*, shallow (<45 cm depth), medium (45-60 cm depth) and deep (>60 cm depth) with low-medium water holding capacity. Similarly, four HYVs of finger millets also gave encouraging results in Koraput district of Odisha. Several small millet varieties are also available and performing better than the existing cultivars across the locations (Table 1).

Improved practices and timely management: Impact of the demonstrated production technologies under FLDs shows that adoption after FLD period was significantly increased by more than 48% especially in practicing seed treatment (85%), use of high yielding varieties (70%), use of nitrogen fertilizer (57%), following time of sowing (49%) and maintaining plant spacing (48%). It resulted in higher net returns (170%), followed by grain yield (58%) with better quality (78%) and fodder yield (26%), found to be significantly positive over the pre-FLD. Similarly, better yield performance of production technologies of small millets like, finger millet (41%), foxtail millet (35%), proso millet (27%), kodo millet (54%), barnyard millet (28%)

and little millet (55%) than the existing farmer's practices was observed during five years from 2012-13 to 2016-17. It proves that even small changes in use of low-cost recommended practices and timely management can have large effects on yields and monetary benefits.

Water conservation practices: Dependency on rainfall for *kharif* and residual moisture for *rabi* millet crops is a major concern. Although, the millets require less water than other cereals, but life-saving irrigation under prolonged dry-spell and adequate moisture at critical stages of crop can make much difference in yield. Cultivation of *rabi* sorghum and pearl millet on residual soil moisture and occurrence of terminal drought are the major reasons of low productivity of *rabi* sorghum and pearl millet. *In-situ* moisture conservation practices like, compartmental bunding in *rabi* sorghum conserved 12.6% more soil moisture and produced 20.6% higher grain yield over farmers' practice. Moreover, organic mulching are the important management options for improving productivity. These practices can also be used for other small millet crops like, pearl and finger millet.

Millets-based inter cropping: To achieve appropriate land use, efficient inter- and sequence-crop systems were recommended based on soil type, rainfall and length of growing seasons. Intercropping sorghum with legumes is a typical crop system which not only produces higher yields per unit area and time, but also provides nutritional security, economic benefits and improves soil health. Sorghum+pigeonpea (2:1/3:1/6:2) and sorghum+soybean (3:6/2:4) are the two most common intercropping systems. Medium duration sorghum genotypes are most suitable for intercropping. Soybean followed by *rabi* sorghum was found more productive and economically viable system in areas receiving annual rainfall above 700 mm and medium to deep soils having high water retention capacity, and sorghum (*kharif*)-chickpea, safflower and mustard (*rabi*) under limited irrigation conditions. Many other

millets-based intercrop and sequence cropping are found to be more profitable. Promising intercropping with other small millets are: pearl millet + greengram, pearl millet + groundnut, finger millet + pigeonpea, finger millet + blackgram, finger millet + field bean, barnyard millets + ricebean, foxtail millets+pigeonpea, foxtail millets + fieldbean; kodo and finger millet + pigeonpea and oilseeds; little millet + pigeonpea, greengram and soybean, and proso millet+greengram. Crop sequence with pearl millet followed by chickpea and, finger millet followed by blackgram and greengram are also recommended.

New niches of millet cultivation (in rice fallows): New niches like rice fallows sorghum and other millets cultivation play significant role in economical security of the farmers. Sorghum hybrid; CSH 16 (7.50 t/ha) yielded significantly better than the locally popular hybrid *Mahalaksmi* 296 (5.86 t/ha) in rice fallows in Guntur district of Andhra Pradesh, during 4 years from 2012 to 2016. The significant increase of 27% was observed in grain and ultimately it resulted in 73% higher monetary benefit to the farmers which assures additional income to the farmers. Like-wise, other small millets like, pearl and finger millets was also grown in rice fallows with residual moisture under zero-tillage at different places.

Value-addition and post-harvest processing: Recently, millet consumption as well as area under cultivation has reduced. Increasing market surplus rate in sorghum indicated that there is lot of scope for value-addition and processing to earn more than the routine business. Creation of demand for millets and millet value-added products as healthy food will boost the production and consumption scenario of millets which will have a long-term impact. Millet based value-added products will boost help in realizing better prices for their produce. There is good demand for finger millet and sorghum biscuits in markets for diabetic patients.

Mechanization: Millets cultivation especially, sorghum and pearl millet is

Table 1. Latest high yielding millets cultivars for different regions

Millet cultivars	Year of release	Maturity (days)	Yield (q/ha)	Area of adaptation	Special features
<i>Kharif sorghum</i>					
CSH 25 (Hybrid)	2008	110	50	Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Gujarat, Rajasthan, Uttar Pradesh	<i>Kharif</i> hybrid-Tan, tall, white midrib, semi-compact ear-head, pearly white seed, medium almond shape, tolerant to Grain mold and shoot fly.
CSH 23 (Hybrid)	2005	105	40-42	As above	Medium bold round and whitish seed, early maturing and avoids terminal droughts and resistant to grain mold
CSH 27 (Hybrid)	2012	104	39-40	Rajasthan, North Gujarat, Uttar Pradesh, Andhra Pradesh and Tamil Nadu	Dual purpose hybrid with higher grain and fodder yields than CSH 16 and CSH 23
CSV 27 (variety)	2011	116	28-30	All <i>kharif</i> areas	Dual-purpose <i>kharif</i> variety, high grain with superiority of 13% over CSV 23 and fodder yields, and less susceptible to grain mold and stem borer
<i>Rabi sorghum</i>					
CSV 26R (Variety)	2012	108-110	10-12	Shallow soils in <i>rabi</i> sorghum growing regions	Early maturing variety and tolerant to drought, shoot fly, stem borer and charcoal rot
CSV 29R (Variety)	2012	115-120	20-30	Medium to deep soils in <i>rabi</i> sorghum growing regions	Tolerant to shoot fly, moderately tolerant to sugarcane aphids and shoot bug and also moderately tolerant to charcoal rot
<i>Pearl millet</i>					
GHB 905 (<i>Kharif</i> hybrid)	2013	80-85	35	Rajasthan, Gujarat, Haryana, Punjab, Delhi, UP, MP	Medium maturing, compact cylindrical earheads with bristles, resistant to downy mildew, globular grey brown seeds
MBC 2 (<i>Kharif</i> variety)	2011	80-85	25	Rajasthan, Gujarat, Haryana	Early maturing, oblate grey coloured seed
<i>Finger millet</i>					
GPU 48	2005	95-100	28-30	Karnataka	Pigmentation on all plant parts and highly resistant to blast
GPU 66	2009	112-115	35-40	Karnataka	Green plant parts with narrow leaves, medium compact ears with tip incurved fingers
GPU 67	2009	114-118	30-35	National	Non lodging (Semi dwarf)
KMR 340	2016	90-95	35-40	Karnataka	White ragi variety, specially for confectionary purpose, resistant to blast and blight diseases, tolerant to stem borer and aphids
<i>Foxtail millet</i>					
HMT 100-1	2011	80-85	20-30	All foxtail millet growing areas of the country	Resistant to blast and downey mildew.
SiA 3085	2012	70-75	20-25	All foxtail millet growing areas of the country	Non-lodging, early duration, suitable for double cropping.
Suryanandi (SiA 3088)	2012	85-90	20-25	Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh, TN and Uttarakhand	Highly responsive to nitrogenous fertilizers
<i>Kodo millet</i>					
JK 98	2010	100-105	25-30	National	Resistant to shoot fly and moderately resistant to head smut
RK 390-25	2012	100-105	25-28	National	Non-shattering and non-lodging.
Jawahar Kodo 137	2016	100-105	26-29	Rainfed areas of Madhya Pradesh	Resistant to drought, lodging, and key pest shoot fly and moderately resistant to head smut
<i>Barnyard millet</i>					
CO(KV) 2	2008	95-100	21-22	Tamil Nadu	Non-lodging, profuse tillering, and suitable for contingency planting.
DHBM 93-3	2016	90-95	22-24	National	Responsive to fertilizer application
<i>Little millet</i>					
JK 36	2009	75-80	10-12	Madhya Pradesh	Tolerant to shoot fly
DHLM 36-3	2016	95-100	14-16	National	Late maturing variety
GV-2	2016	115-125	26-28	Gujarat	Clean white colour and bold seeded, resistant to pest and diseases.
Jawahar Kutki 4 (JK 4)	2016	75-80	13-15	Rainfed area of Madhya Pradesh	Resistant to drought, lodging, and key pest shoot fly and moderately resistant to head smut
<i>Proso millet</i>					
PRC 1	2008	70-75	10-12	Uttarakhand hills	Resistant to leaf blight
TNAU 202	2011	70-75	18-20	National	Profuse tillering and bold grains



Fig. 2. Compartmental bunding before sowing *rabi* sorghum (left) and organic mulching with paddy straw after sowing (right)

more labour-intensive and more than 55% cost goes towards labour. Harvesting operations need more labour and takes major share. Hence, suitable harvesting-cum-threshing like combine machine is much essential. De-husking in kodo millets is laborious and difficult activity. Moreover, proper tillage and precise placement of seed and fertilizers in the moist zone are most critical for successful crop establishment in drylands. Mechanization can help reduce cost and labour requirements which will encourage millet farming.

Sustainable millets production and value chain through group approach: Most important factor that accelerates the competitiveness of the sorghum and other millets in the international as well as domestic markets is the grain quality and organic produce. Use of pest and disease resistant varieties and organic millets production could create more opportunities. Enhancement of export competitiveness of Indian millets in the international as well as targeted domestic markets will help the farmers to fetch good returns for their produces through their collectivization into farmer's producer organizations (FPOs) or self-help groups (SHGs).

Promotion of allied enterprises as integrated farming system: Since, the mono-cropping and traditional farming are not viable, addressing only a component of the farming system, e.g. crop variety, fertilizer use or even crop husbandry is not

expected to bring about a significant increase in the productivity as witnessed in irrigated areas. The soil, plant, animal cycle is the basis for all feed used by the animals. There is large unexploited scope to harness system level productivity and value chains, wherein women have income-generating opportunities through women-focused activities like, poultry, dairy, goat farming, piggy and apiculture as millet-based integrated farming system.

Drivers to strengthen millet-based value chain: The millet farmers have limited resources and diversified needs with several socio-economic and farming constraints which had become their primary concern in adoption of the new practices. Millets are less remunerative which requires necessary support as driver in value chain mode to enhance farmers' income. These are:

- Institutional support for technical knowledge
- Inputs support in time at grass-root level
- Financial support for mechanization
- Market support with buy back arrangement
- Infrastructure support for post-harvest management and transport, and
- Policy support for buy back assurance; implementation MSP, their inclusion in MDM and PDS system and insurance schemes.

SUMMARY

In spite of a wider climatic

adaptability, cultivation of diverse millet varieties is gradually decreasing in the recent past due to lack of institutional and policy support for millet crops in contrast to rice and wheat. Thus, a shift towards demand creation should become a focus for millets promotion among the consumers which may eventually plough back demand for millets cultivation in long term. Keeping the importance of driving factors of millets development process in view, there is need of viable strategy comprising of three major elements: (i) scientific crop cultivation with group approach and capacity building with support of R&D organizations coupled with inputs supply in single window mode, (ii) promotion of value-addition and creating market demands through collective action like, FPOs and SHGs, and (iii) policy support for buy back arrangements with minimum support price, crop insurance, inclusion in mid-day-meal and public distribution system, infrastructure for farm-gate processing and warehouses. In addition, targeting farm women and youth in both rural and urban areas for development of the entrepreneurship on millets-based products is needed for profit of all the targeted beneficiaries directly.

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