# Role of millets in doubling farmers' income and sustainable development of Vidarbha region of Maharashtra

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**Introduction**

Large segment of the Indian population (70%) is dependent on agriculture which governs national economy, also food and nutritional security of the country and accounts for approximately one-fifth of the total gross domestic product (GDP). With increasing population, agriculture has prolonged scope for sustainable development to feed the mouth of vast population and livelihood support for rural population. The initiative taken by the Hon'ble Prime Minister of India to double the farmers' income by 2021-22 is the call of the hour. To begin with an experimental trial on pilot-basis for Vidarbha region of Maharashtra as "site of learning" is contemplated and further will be extended to other regions of the country in a phased manner up to 2022. For doubling farmers' income, challenges of agro-ecological potential and climate change impacts must be considered along with growing water scarcity, land degradation while devising the agroeco-region wise interventions.

**Agro-ecological scenario of Vidarbha**

This region comprises of eleven districts in two divisions of eastern Maharashtra viz; Amravati division comprising Buldhana, Akola, Washim, Amravati, Yavatmal and Nagpur division comprising Wardha, Nagpur, Bhandara, Gondia, Chandrapur, Gadchiroli districts. The Vidarbha region is significantly underdeveloped compared to the rest of the Maharashtra and India. Vidarbha region is home to about 2.3 crores people, comprising about 23% of state's total population. About 73% of population in Vidarbha belongs to rural regions compared to 55% for Maharashtra state. With a total geographical area of 9.72 million ha (32% of state), about 4.98 million ha (28% of state) is net sown and about 6.45 million ha is gross cropped area. Vidarbha region is characterized by dominance of agricultural sources of livelihood. It is also more vulnerable to climate change impacts. Soils are mostly deep black cotton soils (Vertisols and associated intergrades).

Vidarbha has three major agro-ecological zones (Fig. 1) *viz*., (1) Western Vidarbha zone (Akola, Amaravati, Buldhana, Washim and western part of Yeotmal districts), (2) Central Vidarbha zone (Wardha, Nagpur, eastern part of Yeotmal and western part of Chandrapur districts), and (3) Eastern Vidarbha zone (Gadchiroli, Gondia, western part of Chandrapur and Nagpur districts). Southwest monsoon sets over Vidarbha by second week of June and the rains normally recede by the end of October. Rainfall during winter is low and uncertain. Annual rainfall varies from 700 to 950 mm in the western parts to more than 1250 mm in the eastern parts. Great spatial variability in rainfall; in Amravati district, rainfall varies from 700 mm 1600 mm across taluks. Number of rainy days varies from 45 to 65. In the northwestern region, Chikhaldara and Dharni taluks of Amravati district receive high annual rainfall of 1000 to 1600 mm. Parts of Bhandara, Gondia, Chandrapur and Gadchiroli receive high annual rainfall of 1200 to 1600 mm. July is the rainiest month followed by August. However, dry spells of 15-25 days duration occur in second half of July and August and first half of September. Because of these dry spells, agricultural drought occurs once in four to five years.

Major crops grown are paddy, sorghum, pigeonpea, soybean and cotton during the rainy (*kharif)* season and wheat and chickpea during the post-rainy (*rab*i) season. The major cash crops are cotton, soybean and oranges. Traditional crops are sorghum, pearl millet and paddy. Largest cultivated crop in Vidarbha is cotton but farmers do not get remunerative price which, leads to high distress among them.

**Climate change impacts**

Agriculture is more vulnerable due to warming and related aridity, shifts in rainfall patterns, and to the increased frequency and duration of extreme events. Climate projections for Vidarbha region based on the Model BCC_CSM1.1 RCP8.5 for the year 2050 are used to assess the changes in thermal and moisture regimes. Projected monthly changes for Vidarbha show that there is great month to month variation in both maximum and minimum temperatures and rainfall. Rainfall in first-half of *kharif* is projected to be less; June and July rainfall is crucial for rice and soybean as they will be in vegetative phase; Water management is crucial. Minimum temperature during *rabi* is projected to increase by 2.5°C compared to the present conditions. Projected increases in *rabi* temperatures have great impacts on wheat and chickpea crops. The overall impact of climate change on agriculture, industries as well as livelihoods is expected to be negative, threatening not only food security but sustainability. There is urgent need for promotion of climate smart crops.

**Constraints**

Living conditions of farmers in Vidarbha region are poor compared to India as a whole. There have been more than 200,000 farmers' suicides in Maharashtra in a decade, of which 70% being in the 11 districts of Vidarbha region. It is considered as the epicenter of the farmer suicide in the country, and recorded 942 farmer suicides in 2013. Nimbarte (2016) listed out major problems of farmers distress are: (i) due to natural calamities and vagaries nature of climate, most of the farmers got suffered and become poor, (ii) lack of irrigation facilities, crop production is low, (iii) use of science and technology by rich farmers, (iv) social, cultural, religious and economical causes, and (v) existing financial and slavery system. Along with water scarcity, land degradation, lack of good crop management are chief bio-physical constraints and need a roadmap for addressing individual parameters while focusing on enhancing system-level productivity. Unique problem of this region is irrigation has to be used very judiciously in black cotton soils to avoid salinization of soils as well as water-logging. Farmers need to be capacitated with suitable knowledge to use water judiciously and efficiently and, crops like, sugarcane and paddy to be avoided. Maharashtra state irrigation coverage, and specifically for Vidarbha region is much lower than the national average. Canal and open well irrigation covers the maximum irrigated area. Low water use efficiency in agriculture and declining per capita water availability due to increasing population and rising multi-sectoral water demand, are major issues of concern. In this scenario, there is need to concentrate on adoption of moisture conservation practices and water harvesting. Dynamics of development requires a wide array of human skill too.

**Importance of millets**

Millets are one of the cheapest sources of energy, higher content of digestive fibres, protein, vitamins and minerals (Ashok Kumar et al., 2012 and 2013). 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 (Parthasarathy Rao et al., 2006). Besides, being a major source of staple food for human beings, it also serves as an important source of fodder, feed and industrial raw material. It is grown in semi-arid climate where other cereal crops don't stand well (Paterson et al., 2009). Sorghum is the third cereal crop after rice and wheat in India, mostly grown under marginal and stress-prone areas of SAT. The threat of climate change is looming large on the crop productivity of millets. The area under cultivation millets and consumption is declining due to, low remunerative price, limited productivity, high drudgery involved in their processing, negative perceptions as a food of the poors and policy neglect when compared to other crops (Karthikeyan, 2016). However, the millets including

sorghum are emerging as a potential alternative food, feed, and fodder crop because of its resilience to high temperature and drought makes it a climate-ready crop.

In this globalization and modernization era, farmers' needs are changing very fast. Traditional crops in Vidarbha region are sorghum, pearl millet and paddy (Table 1). Sorghum and pearl millet are mainly used for human consumption and animal fodder. Whereas, area under sorghum and other millets is reduced drastically and productivity is also low (Fig. 2). It is mainly due to low remunerative price, dependent on monsoon rains, no use of soil type-based high yielding varieties (HYVs), non-adoption of soil moisture conservation practices and improved production technologies coupled with fast changing food habits of the people. However, national average yield of sorghum has doubled since 1980 due to adoption of both improved varieties and management practices by the farmers (Pray and Nagarajan, 2009). Though, we have potential sorghum and other millets technologies developed by the research organizations, there is a wide gap between the potential yield of the scientific technologies and that of the farmers obtain in their fields due to the several reasons like, lack of knowledge and skill and input support at grass-root level, etc. Marketed surplus ratio (MSR) of sorghum has increased significantly over the years from a mere 24 in 1950-51 to 64.14 in 2012-13 which implies that sorghum farmers have started selling off their products after meeting the consumption needs. Similarly MSR of bajra has also increased over the years. The marketed surplus ratio of ragi has become almost half as compared to the early 2000's (ASG, 2014). It means that there is lot of scope for value-addition and processing to earn more than the routine business.

Therefore, promotion of sorghum and other millets has a large scope to mitigate the risk in agriculture unlike other food crops in drought-prone region like; Vidarbha. Suitable intercropping of pulse crops with these millets and allied framings is also a viable option towards nutritional and economical security in sustainable way. There are four key pathways to achieve the goal are: (i) by increasing productivity, (ii) by reducing cost of cultivation, (iii) by increasing market opportunities and (iv) by developing sustainable value chain.

**Challenges related to millets in Vidarbha region**

Since, this region has wide variability in rainfall, soils, temperature, terminal droughts, and vulnerable to climate change impacts, there are following crucial challenges which need to be addressed with science-based solutions.

- **Low productivity:** Due to inadequate irrigation facilities and low rainfall, most of the area under rain fed cultivation, no use of soil type-based high yielding cultivars, non-adoption of soil moisture conservation practices and improved production technologies led to the low productivity.
- **Biotic stress:** Difficulties in timely sowing and non-adoption of disease resistant cultivars resulted into severe infestation of shoot fly and grain mold disease, respectively in *kharif* sorghum. Due to less and isolated cultivation of sorghum is prone to severe birds' and wild boar damage.
- **Competition with cash/vegetable crops:** These millets are not treated as cash crops and therefore, growers cultivates them on medium to poor soils with low or no inputs, like fertilizers, irrigation, etc.
- **Low remunerative:** Due to low productivity, lack of standardized market, buy back arrangements based-on minimum support price (MSP) and non-inclusion in mid day meal (MDM) or public distribution system (PDS), farmers could not get remunerative price.

- **Fluctuating market prices:** Since, there are no standardized market facilities and intelligence and procurement by the governments, market prices of these millets are sometimes less than cultivation cost. Middlemen are dominated in fixation of the prices.
- **Unawareness about health and nutritional benefits:** Though, the millets are good for human health and overcome celiac diseases, their consumption is reducing drastically due to unawareness, lack of commercial ventures and policy ignorance.
- **Lack of irrigation facilities:** Since, irrigation facilities are scanty and these millets are low/no remunerative, the farmers grow other cash crop or vegetable with available irrigations. Lack of availability of assured water supply and protective irrigation for millets is a major reason for low yields.
- **Soil salinity:** Continuous rainfall and irrigation leads to accumulation of salts and drainage problems in black cotton soils. It is unique problem of this region. Therefore, the irrigation has to be used very judiciously to avoid salinization of soils as well as water-logging.
- **Low organic carbon content:** All most all rain fed soils are poor in organic carbon content, which is the important factor minimizing the productivity. Unavailability of organic fertilizers and continuous use of chemical fertilizers for cash crops led towards poor soil status.

**Technology interventions**

There is a large scope for increasing productivity and profitability for farmers through scaling-up of climate resilient agriculture; however, it calls for concerted efforts, adoption of location-specific and cost-effective technologies. The new technologies should also be less input intensive, cost-effective, less labour intensive and economically viable. Based-on experience of millets cultivation, some promising interventions are underlined.

**1. Use of high yielding cultivars specific to soil types**

Latest twelve *kharif* sorghum cultivars were introduced in seven sorghum growing states including Vidarbha region of Maharashtra under frontline demonstrations (FLDs). They yielded 78% more grain and 60% stover than the local cultivars which were resulted into 51 per cent more net returns than the local cultivars. Similar results were obtained in *rabi* sorghum in Maharashtra. Soils of sorghum growing areas has been classified into three major categories based on soil depths, viz., shallow (<45 cm depth), medium (45-60 cm depth) and deep (>60 cm depth) with low-medium in water holding capacity. The moisture retention capacity varies therefore; soil-types based varietal selection is more suitable.

**2. Improved practices and timely management**

Impact of the demonstrated technologies under FLDs shows that adoption after FLD period was significantly increased by more than forty eight percent 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 was resulted into increased 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. 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 (Chapke *et al*., 2011).

**3. Water conservation practices**

Dependent on rainfall for *kharif* and residual moisture for *rabi* crops is a major concern. Cultivation of *rabi* sorghum on residual soil moisture and occurrence of terminal drought are the major reasons of low productivity of *rabi* sorghum. In-situ moisture conservation practices like compartmental bunding and

ridges and furrows, adoption of soil-based improved cultivars, nutrient management and irrigation scheduling based-on water availability whereas, organic mulching in *kharif* are the important management options for improving sorghum productivity (Patil *et al*., 2013). Results revealed that compartmental bunding during *kharif* season conserved 12.6% more soil moisture and produced 20.6% higher grain yield over farmers' practice.

**4. 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 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 - *rabi* sorghum has been 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.

**5. New niches of millets cultivation (in rice fallows)**

Although millets are known to be climate resilient crops, their cultivation in traditional areas is reducing. New niches like rice fallows sorghum or millets cultivation plays significant role in economical security of the farmers. Sorghum hybrid; CSH 16 (7.50 t $ha^{-1}$) yielded significantly better than the locally popular hybrid Mahalaxmi 296 (5.86 t $ha^{-1}$) in rice fallows in Guntur district of Andhra Pradesh, during four years from 2012 to 2016. The significant increase of 27% was observed in grain and ultimately it was resulted into 73% higher monetary benefit to the farmers (Chapke *et al*., 2011a). The district yield average of sorghum is 6.80 t $ha^{-1}$ during 2014-15 which is around seven times more than the national yield average (0.90 t $ha^{-1}$), Such success story can be replicated in Vidarbha as there is scope in Gadchiroli and Chandrapur district to introduce sorghum and other millets in rice fallows which, assures additional income to the farmers.

**6. Value-addition and post-harvest processing**

The increasing MSR 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 millets value-added products as healthy food will boost the production and consumption scenario of millets which will have a long term impact on the sector. Increase in demand for the millets and value added products will boost the farmers' morale towards millets cultivation and will also help in realising better prices for their produce.

**7. Mechanization**

As the millets cultivation especially sorghum is more labour-intensive and more than 55% cost goes towards labourer. Harvesting operations needs more labourer and takes major share. Hence, suitable harvesting–cum-threshing like combine machine is much essential. Moreover, proper tillage and precise placement of seed and fertilizers in the moist zone are most critical to for successful crop establishment in drylands. Since the sowing of crops must be completed in a short span of time, use of appropriate implements is necessary to cover large area before the seed zone dries out. The above mechanization can help to reduce cost and labour requirements which will encourage millets farmers.

**8. Promotion of bio-fortified cultivars**

Evolving a number of production technologies, arable cropping in drylands continues to suffer from instability due to aberrant weather and market fluctuations. To provide stability to farm income utilizing marginal lands for market driven trait-specific production of millets which have nutraceutical values is a commercial endeavor. Iron rich bio-fortified pearl millets varieties (Dhanshakti and Shakti 1201) are available which have 80 ppm iron is almost double than other cereals. To tap increasing market demands of iron rich millets as food for anemic women and children through bio-fortified millets production can fetch more profits.

**9. Sustainable millets production and value chain through FPOs**

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 in long term. For this and in view of small and marginal farmers' background, their collectivization into farmer's producer organizations (FPOs), may be an effective pathway to harness collective synergy.

**10. 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 per se 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. The livestock in the rainfed regions are weak. Farmers in this area often sell their cattle due to the scarcity of fodder. The land holdings are being reduced with increased population pressure. There is large unexploited scope to harness system level productivity and value chains, wherein women have income-generating opportunities through women-focused activities. Therefore, the millets-based integrated farming system approach with introduction of poultry, dairy, goat farming, piggery and apiculture at each household will help to supplement the farmers' income and women empowerment.

**Drivers to strengthen value chain**

The farmers have limited resources and diversified needs under several socio-economic and farming constraints which had become their primary concern in motivational perspectives before they decided for any changes and adoption of the new practices. Sorghum and minor millets are less remunerative which requires the following necessary supports as drivers in value chain mode to make them more profitable in order to enhance farmers' income.

- **Institutional support:** There is a large scope for increasing productivity and profitability for farmers through promising production technologies developed by research and development (R&D) organizations and scaling-up of climate resilient crops *viz*., millets. Weather forecasting- and resource-based crop selection coupled with soil test-based recommendation have crucial role in bridging out the wide yield gap. For adoption of new technologies and farm practices requires a wide array of human skill which is equally important component.
- **Input support:** Availability of quality inputs like, seeds of HVYs, fertilizers, agro-chemicals, in time and place are the keys for adoption of new technologies for increasing productivity and profitability. Varietal replacement with high-yielding and climate smart crop backed with developing de-

centralized seed systems group approach (farmers' cooperatives, SHGs, FPO, etc.) needs to be operationalized.

- **Financial support:** Hassle free and timely financial support for mechanization labour intensive operations is a stepping stone for encouraging farmers to overcome labour problems and to avoid losses for failing in timely operations. Promoting on-farm mechanization through PPP mode, incentives to entrepreneurs to set-up village level one-stop-center for agricultural mechanization and other ways are viable options.
- **Market support:** Standardized market facilities, intelligence development, get rid off from middlemen and buy back arrangements at grass root levels would enhance confidence of the millets farmers. These are the important burning issues to be addressed on priority.
- **Infrastructure support:** Millets are known to be healthy food, even primary processing can double the income of farmers as it is main bottleneck. To overcome short self-life problems of millets; storage, road, transport facilities and adequate electricity supply are essential.
- **Policy support**: There is lot of scope for value-addition and processing to earn more than the routine business. It can be promoted through entrepreneurship development in collective action mode through SHGs and FPOs. These apart, policy support for farm-gate processing, control of wild animals, buy back assurance; implementation MSP for all millets, their inclusion in MDM and PDS system will boost-up the economy of millets farmers in this region. Farmers should be covered under insurance schemes to avoid any loss due to crop failure and other natural calamities.

**Strategy**

From the discussions above this can be asserted that there lies a huge potential to enhance the income of the resource poor farmers in dryland conditions which needs such strategy that should be matched these challenges. The following key steps constitute the strategy emphasizing plough to plate transition in order to doubling the farmers' income in Vidarbha region by 2022.

- Bridging yield gap by enhancing productivity using promising production technologies from R&D organizations
- Emphasis on moisture conservation practices and also link with watershed development programme
- Introduction of millets-based crop systems and allied farming involving women like, poultry, dairy, goat farming, piggery and apiculture
- Introduction of mechanization and hassle-free financial support
- Marketing facilities and inputs support in convergence mode (single window system) and collective action through FPOs
- Creating awareness about health and nutritional benefits of millets through effective mass and local media to bring change in the consumer preferences
- Promotion of value-addition through entrepreneurship development through group approach (SHGs, NGOs)
- Policy support for buy back arrangements with MSP, crop insurance, inclusion in MDM and PDS system, infrastructure for farm gate processing and warehouses

**Conclusion**

The farmers' socio-economic condition is complex and resource-poor where several factors were at interplay. The role of the farmers in the whole system is more on the receiving end as 'passive subjects' rather than 'active stake holders' despite the fact that sorghum and other millets constitutes one of their main sources of livelihood. In order to achieve the goal of doubling farmers' income through millets cultivation, there is need of viable strategy comprising of three major elements: (i) scientific crop

cultivation in participatory mode 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, formation of FPOs and SHGs, and (iii) policy support for buy back arrangements with MSP, crop insurance, inclusion in MDM and PDS system, infrastructure for farm-gate processing and warehouses.

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Fig. 1. Agro-climatic Zones of Vidarbha

Table. 1 Millets grown in Vidarbha region of Maharashtra during 2015-16 ("00" ha)

| S. No. | District | Kharif sorghum | | Pearl millet | | Rabi sorghum | |
|---|---|---|---|---|---|---|---|
| | | Area (00 ha) | Yield (Kg/ha) | Area (00 ha) | Yield (Kg/ha) | Area (00 ha) | Yield (Kg/ha) |
| 1 | Buldhana | 204 | 623 | 19 | 98 | 103 | 564 |
| 2 | Akola | 114 | 908 | 0 | 98 | 1 | 564 |
| 3 | Washim | 96 | 449 | 3 | 98 | 21 | 564 |
| 4 | Amravati | 254 | 730 | 1 | 98 | 0 | 0 |
| 5 | Yavatmal | 421 | 407 | 2 | 98 | 59 | 564 |
| 6 | Wardha | 43 | 523 | 0 | 0 | 22 | 364 |
| 7 | Nagpur | 40 | 876 | 0 | 0 | 7 | 443 |
| 8 | Bhandara | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Gondia | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Chandrapur | 27 | 644 | 0 | 0 | 57 | 354 |
| 11 | Gadchiroli | 0 | 0 | 0 | 0 | 2 | 424 |

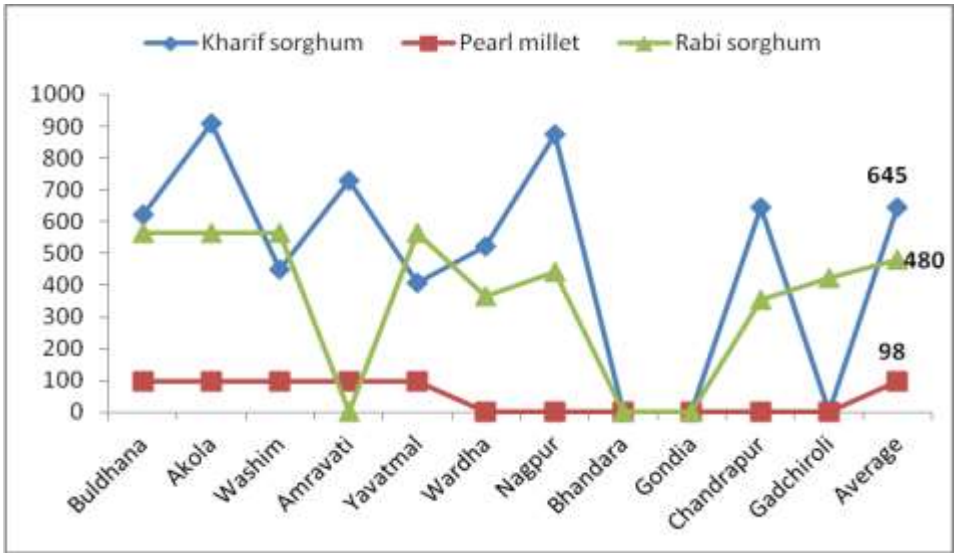


Fig. 2 Productivity of millets in Vidarbha region during 2015-16 (kg/ha)