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Baseline Scenario of Postrainy Season Sorghum Economy in Marathwada Region of Maharashtra

N Nagaraj, Sachin More, Surajit Haldar, Cynthia Bantilan and MG Chandrakanth

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Abstract

Postrainy season sorghum is one of the major dietary staple cereal crops in Marathwada region supporting food and fodder security. Currently, the productivity levels are extremely low because of limited adoption of dryland technologies by the poor. Thus, the HOPE project aimed at increasing the productivity of sorghum and pearl millet by 35-40% over the base level in South Asia through introducing on-shelf technology and improved management practices in the targeted clusters over a period of four years. In this regard, the baseline survey was conducted in the primary project intervention area (HOPE) where improved technologies have been introduced and in matching control villages with comparable agro-ecological and market conditions in non-intervention area (non-HOPE), where improved technologies have not been made. The objective of the baseline survey was to appraise the existing situation of the targeted cluster villages with respect to adoption of technologies, productivity, income, yield gaps and other socioeconomic issues. The coverage area of improved rabi sorghum varieties were around 15% in HOPE and 5% in non-HOPE areas, where the yield gap was estimated at 40–50% as compared to the potential yield for the improved varieties. The productivity of rabi sorghum in the HOPE area was 1.17 t/ha and in the non-HOPE area 1.2 t/ha. However, in the HOPE area farmers are receiving a net return of ₹ 2017 per ha and in the non-HOPE ₹ 2421 considering all costs. The annual per capita income in the HOPE area is ₹ 32,029, while in the non-HOPE area, it is ₹ 40,669, of which 65% is derived from crop enterprise only. There is significant involvement of women in activities such as land preparation, intercultural operations, harvesting and threshing. Moisture stress especially during sowing and/or terminal stage and shortage of labor especially during harvesting and threshing were some of the key critical constraints expressed by the farmers in adoption of improved rabi sorghum technologies.

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N Nagaraj, Sachin More, Surajit Haldar, Cynthia Bantilan
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This work has been undertaken as part of the CGIAR RESEARCH PROGRAM ON DrylandCereals

ICRISAT Science with a human face

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Summary

Postrainy season sorghum is one of the major staple food and fodder crops in Marathwada region supporting fodder and food security. The HOPE project aims at increasing the productivity of sorghum and pearl millet by 35-40% over the base level in South Asia through introducing technology that is not yet known to farmers and improved management practices in the targeted clusters over a period of four years. In this regard, a baseline survey was carried out with an objective of appraising the existing situation of the targeted cluster villages with respect to the status of resource endowments, socio-economic profile of farmers, cropping pattern, improved varieties and practices adopted, yield gaps, input-output levels, profitability of crop production, technology and trait preferences of farmers, income and consumption levels, labor participation and earnings, marketing channels, costs and gender participation.

The baseline survey was conducted in the primary project intervention area (HOPE) where improved technologies have been introduced and in matching control villages with comparable agro-ecological and market conditions in the non-intervention area (non-HOPE), where improved technologies have not been used. This enables collecting baseline data from participating and non-participating farmers, which helps to identify comparable counterfactuals in impact evaluation. About 34 percent of farmers (49 percent) in HOPE project area (non-HOPE area) belong to marginal and small holdings with medium level of school education (7.5-8 years). Around 66% of farmers who depend on agriculture as primary source of occupation are middle-aged. On an average, farmers owned 3.1 ha of dryland in HOPE (76% of total) as against 2.2 ha (62% of total) in non-HOPE areas. More than 75% of farmers possess two draft animals (valued at ₹ 33,000) and around 30-35% of the farmers possess two milch animals (valued at ₹ 20,000-40,000). More than 60 percent of the farmers possess bullock cart along with wooden plough, which indicated that indigenous method of cultivation is still prominent in farm activities. It has to be noted that less than 10 percent of the farmers have tractor and associated machineries, which signals the opportunity for farm mechanization in this region.

In both the areas, agriculture is the major source of income. Most of the farmers are over middle-age and will obviously be sensitive to farm drudgery. Integration of crop with livestock component is the dominant feature among farmers in both HOPE and non-HOPE areas offering nutritional security. Most of the fodder produced is retained for consumption of livestock. Out of the total income, 65% is derived from crops. The annual per capita income in the HOPE area is ₹ 32,029, while in the non-HOPE area it is ₹ 40,669. India's per capita income is around ₹ 53,000 per year. Thus, the per capita income in HOPE and non-HOPE areas, still falls short of India's per capita income.

The cropping pattern indicates low diversity in both HOPE and non-HOPE areas. In the postrainy season, the largest proportion of area is allocated to sorghum (73%) followed by wheat (12%), sorghum with intercrops like safflower or sunflower (10%) and chickpea with other crops (5%). In non-HOPE area, sorghum occupied 92% of total postrainy season area followed by wheat (6%) and sorghum with intercrops like safflower (2%). In HOPE and non-HOPE areas, the productivity differential between normal and below normal is around 0.5 to 0.57 tons/ha. However, in above normal years the productivity has greatly improved from 0.55 tons/ha

to 2.5 tons/ha, as opined by the farmers. The proportion of area under improved varieties of sorghum is around 15% in HOPE area as against 5% in non-HOPE area. The yield gap of postrainy season sorghum was estimated as 40-50% as compared to the potential yield (1.6 t/ha) for the improved varieties, which shows further scope for improvement in productivity level by introduction of recommended package of practices along with improved varieties.

On an average, the cost of production per hectare of postrainy season sorghum is ₹ 13,968 in HOPE and ₹ 14,056 in non-HOPE areas. Out of the total cost, labor component accounts for 50-58% in both HOPE and non-HOPE areas. The productivity of sorghum in the HOPE area is 1.17 tons/ha as against 1.2 tons/ha in the non-HOPE area. However, in the HOPE project area, farmers are receiving a net return of ₹ 2017 per ha as compared to non-HOPE farmers (₹ 2427) considering all costs. The relative profitability of competing crops indicates that gram is more profitable than safflower, wheat and postrainy season sorghum. The farmers realized a productivity of 0.70 to 0.75 tons/ha in low input use situation compared to 1.1 tons/ha under high input use situation. The majority of the farmers in HOPE and non-HOPE areas preferred to sell sorghum in regulated as well as weekly markets.

The postrainy season sorghum (Maldandi) farmers in both HOPE and non-HOPE areas have indicated low productivity, pest and disease incidence, long duration as the major constraints in adoption. With regard to improved varieties, pest and disease incidence and long duration are the constraints opined in common by both HOPE and non-HOPE area farmers. In HOPE and non-HOPE areas, consumption of sorghum is 34% while that of other cereals is around 64%. Farmers prefer short duration, drought, pest and disease resistant and high productive varieties in the postrainy season. In both HOPE and non-HOPE areas, farmers as consumers prefer to have tasty sorghum with less cooking (roti) time and high keeping quality in both local and improved varieties. Qualitative fodder with more palatability and storability has been of prime importance since livestock forms a strong component of the farming activity. Therefore, preference for high productive fodder with more palatability and storability is in order. The market for the local variety as reflected in the price is of concern in both HOPE as well as non-HOPE areas. The bigger grain size is of concern for the improved variety in both the areas.

In HOPE and non-HOPE areas, consumption of rice and wheat is almost on par with consumption of sorghum and pearl millet. In both HOPE and non-HOPE areas, policy support to rice and wheat is influencing consumption of millets. This will directly affect the market for millets in the long run. Only 6 to 14 percent of the farmers indicate increase in consumption of postrainy season sorghum in prospect, while 44 to 83 percent of them hint at reducing their consumption. Easily available wheat is responsible for reduction in sorghum consumption and will affect the sustainability of sorghum production, which in turn affects sustainability of livestock, as it is dependent on fodder. About 92 to 94 percent of the farmers recognized the crucial role of women in harvesting and weeding and 60 percent of the farmers indicated their role in land preparation and threshing. Moisture stress especially during sowing and/or terminal stage, shortage of labor especially during harvesting and threshing, shortage of fertilizer and FYM, high wage rate, lack of credit, lack of quality seed and lack of appropriate machineries were some of the key critical constraints expressed by the farmers.

I. Significance of the study

The bulk of the rural poor are smallholder and marginal farmers owning less than 2 hectares, living in dryland areas and are food insecure. To cope with the harsh agro-climatic conditions, they tend to grow dryland cereals such as sorghum and millet, which are the hardiest crops and less risky. Sorghum is predominately grown in semi-arid regions of India and it continues to play a prominent role in the dryland economy in view of the limited scope for expansion of irrigated area. Rabi sorghum is a staple crop, nutritionally superior, mostly consumed at farm level and provides both food and fodder security.

The productivity of rabi sorghum is extremely low in South Asia, as it is grown in the postrainy season and is subjected to moisture stress. Further, most of the smallholder and marginal farmers deter from investing in improved technologies due to the risk and uncertainty associated with biotic and abiotic stresses. Hence, in order to increase the productivity of dryland sorghum, household incomes and food security, the HOPE project has been implemented in South Asia. To achieve this vision, six specific objectives were chosen that attend to market chain and delivery constraints/opportunities, genetic and production systems specific to these crops and for better targeting. In an endeavor to achieve better targeting, the baseline study was undertaken in predominantly rabi sorghum-growing village clusters of Maharashtra state. Thus, the overall objective of this study is to provide critical baseline information inventory of the existing scenario in the targeted clusters and develop a database to track the changes in adoption and impact of crop management, improvement and market access to food, fodder, and income security.

In India, sorghum is cultivated both in rainy and postrainy season, in an area of 7.38 million hectares, with annual production of 7.0 million tons and productivity of 949 kg per hectare (2010-11). Maharashtra is the largest producer of sorghum (3.57 million tons forming 53% in 2009) followed by Karnataka (21%), Madhya Pradesh (8.43%), Andhra Pradesh (6.52%), Tamil Nadu (3.31%), Uttar Pradesh (2.52%), Gujarat (2.55 %), Rajasthan (1.56 %), Haryana (0.54%) and Orissa (0.09%). Maharashtra ranked the first in area with 4.18 million hectares (54%), followed by Karnataka (18%), Rajasthan (9.23 %), Madhya Pradesh (5.73 %), Andhra Pradesh (4.94 %), Tamil Nadu (3.06%), Uttar Pradesh (2.45%), Gujarat (2.09 %), Haryana (0.92%) and Orissa (0.12%).

II. Importance of postrainy season sorghum in Maharashtra

In Maharashtra, the area under postrainy season sorghum in 2010-11 was 2.64 million ha producing 2.09 million tons with a productivity of 790 kg per hectare. About 30% of postrainy season sorghum is cultivated in the Marathwada region. Since the past few decades, the area under postrainy season sorghum has been stagnant.

As a vital staple diet, sorghum has a crucial role in the food and feed basket of the rural poor in the semi-arid tropics of Maharashtra. Although, sorghum is nutritiously rich, its consumption is declining significantly since the past three decades due to (i) laborious and time consuming process of preparation of food items, (ii) the policy of supplying wheat and rice at highly subsidized prices to the poor, who are the main consumers of sorghum, and (iii) sorghum is less preferred with rise in incomes. While on the one hand this policy has improved physical access

of superior cereals such as rice and wheat as food to the rural poor and not as much fodder, on the other, this has hampered the cultivation of sorghum.

Sorghum is also the climate change crop meeting both food and fodder requirements with its wide adaptability. There are no alternative crops to postrainy season sorghum in these areas, since in the post *kharif* season, the crops need to survive just on the residual moisture. During periods of droughts/floods, while the Government may rely on the buffer stock of rice and paddy as food, there is no buffer stock of fodder. Hence, it is evident that sorghum needs to be promoted essentially to meet both food and feed requirements of vast stretches of semi-arid tropics spread over Andhra Pradesh, Karnataka, Maharashtra, Rajasthan and Gujarat. In addition, in order to boost the consumption of sorghum in urban areas, it is essential that processing for value-addition leading to affordable, healthy and palatable food items on industrial scale is facilitated. This requires the policy to develop the technology of processing sorghum, increasing its shelf life before and after processing, converting those to palatable consumable products and dissemination as health food in urban areas and as staple food in semi-arid tropical areas.

III. Sorghum in the Marathwada region of Maharashtra

Postrainy season sorghum is one of the major food and fodder crops in Marathwada region with an area of 10.80 lakh hectares and production of 718 thousand tons with a grain productivity of 0.70 t/ha and fodder productivity of 1.30 t/ha. Postrainy season sorghum is largely for food and *kharif* sorghum is largely for feed. The prominent postrainy season sorghum producing districts inter alia include Parbhani, Beed and Jalna districts of Marathwada region where it is the main dryland crop being cultivated and there is no perfect substitute for it.

Due to the policy of distributing wheat and rice, the expansion of sorghum area is affected and farmers restrict cultivation of sorghum largely to meet their home food and fodder requirements and not as much for the market. Among the dry fodders, sorghum fodder is preferred as it is palatable for all types of livestock and there is no perfect substitute for sorghum dry fodder.

IV. Sampling

The target area of sorghum under the HOPE project was earmarked based on the secondary data on area, production and productivity, biographical features, soil type, and climate. Marathwada region covers eight districts of Maharashtra and the districts were arranged in descending order of area under postrainy season sorghum. The top three districts in postrainy season sorghum area that have been sampled are Parbhani, Beed and Jalna. In Parbhani district, Sanpuri cluster of villages, in Beed district, Limbaganesh cluster of villages and in Jalna district, Wakulni cluster of villages were selected in the initial stage during 2009-10. Thereby, in total, eight villages from Sanpuri cluster (Sanpuri, Jalalpur, Hingla, Nandkheda, Dharangaon, Karadgaon, Takli and Nadapur), five villages from Limbaganesh cluster (Muluk, Masewadi, Mahajanwadi, Pokhari and Limbaganesh) and seven villages from Wakulni cluster (Wakulni, Wahegaon Bazar, Roshangaon, Nanegaon, Galatgaon, Kadegaon and Malegaon) were selected under the HOPE project.

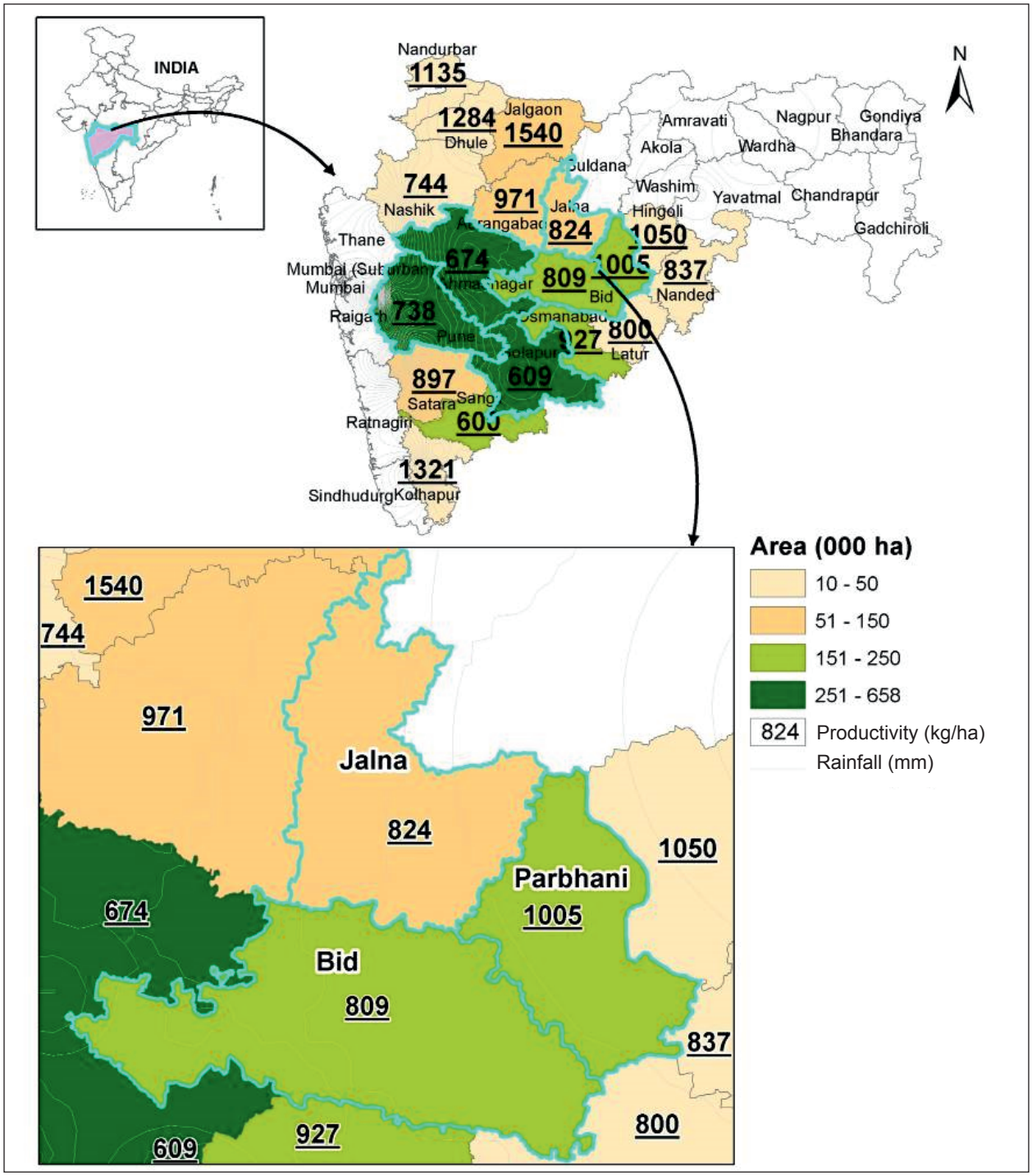

Figure 1. Map of the study area.

The baseline survey was conducted in both the regions of Maharashtra (Western Maharashtra and Marathwada) with the total sample size of 540. From Marathwada region, 270 sample farmers were chosen from three districts, Parbhani, Beed and Jalna. From each district, three villages comprising two as project beneficiary (60 samples) and one as non-beneficiary (30 samples) were selected. Therefore, the total beneficiary sample as 180 and non-beneficiary as 90 were chosen considering stratified random sampling based on Probability Proportional to Size (PPS) method to farm size. The sampling framework is shown below (Figure 2).

V. Results and discussions

General characteristics of sample farmers

Even though the average family size is around six members, there is a wide range in the family size from 2 to 20 per family. About 34 percent of farmers in HOPE project area and 49 percent of farmers in non-HOPE area belong to marginal and smallholder category. Thus, medium and large farmers form more than 50 percent of the sample in both the situations. Agriculture continues to be their major primary occupation and more than 60% of the sample farmers belong to the age group 35 to 55 years (Table 1).

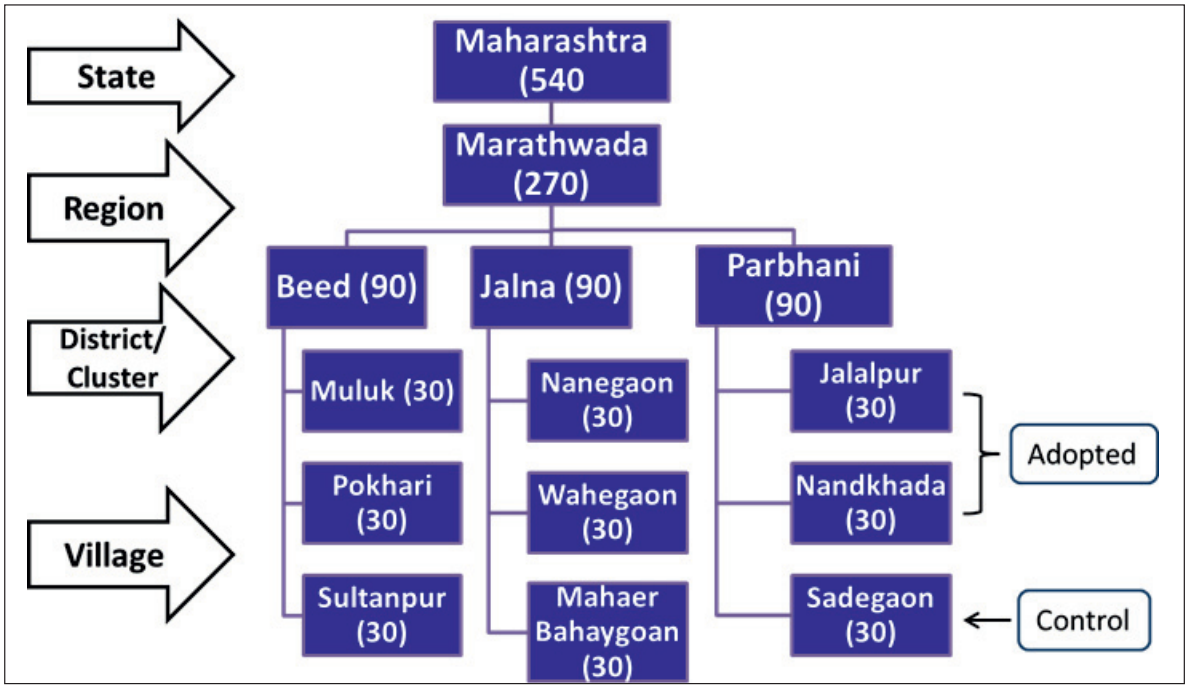

Figure 2. Sampling framework.

Table 1. Characteristics of sample households in Marathwada region of Maharashtra, 2010

Characteristics	HOPE project area	non-HOPE project area
Family size (No.)	6.3	6.4
Male	2.6 (53%)	2.7 (53%)
Female	2.3 (47%)	2.4 (47%)
Average Literacy (yrs of schooling)	7.5	8
Proportion of literate farmers in the sample	81.0	92.0
Social classification (% of farmers)		
SCs + STs	5.0	2.2
Backward Classes	8.9	15.6
Others	86.1	82.2
Size Class of holdings		
Small and Marginal: <2 ha (%)	34	49
Average size	1.6	1.5
Medium & large: >2.01 ha (%)	66	51
Average size	4.9	5.5
Agriculture as Primary occupation (% of holdings)	99	100
Age cohort of farmers		
1. Youth (< 35 yrs) % Average age in years	16.7	16.7
2. Middle aged (35-55 years) %	61.1	66.7
Average age in years	43.6	41.7
3. Aged farmers (> 55 years) %	22.2	16.7
Average age in years	63.5	64.9

Land holding pattern

The size of the holding is around 3.5 to 4 ha per farm family, with a meagre 20% of their land irrigated (Table 2). The leasing operations are not common. The land left fallow forms a miniscule proportion of the total.

Table 2. Pattern of land holding among sample farmers in Marathwada region of Maharashtra.

	HOPE project area		non-HOPE project area	
	Area (ha)	% to total operating land	Area (ha)	% to total operating land
Own land				
Dry	3.1	75	2.2	60
Irrigated	0.8	19	1.3	36
Fallow	0.2	5	0.1	3
Leased in land				
Dry	0.04	1	0.04	1
Operating land				
Dry	3.1	76	2.2	61
Irrigated	0.8	19	1.3	36
Fallow	0.2	5	0.1	3
Total	4.1	100	3.5	100

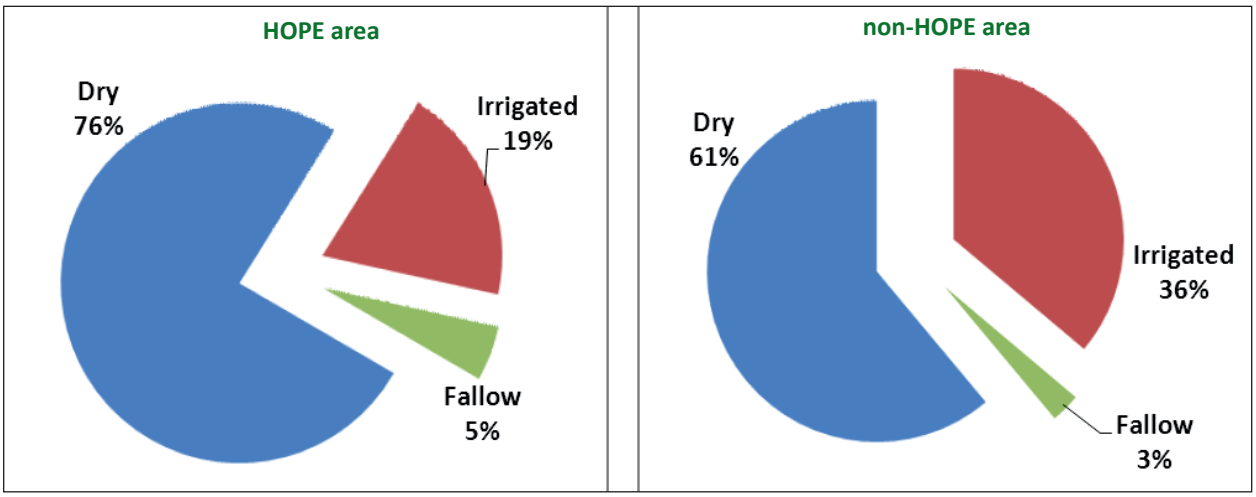

Figure 3. Land holding pattern among sample farmers in Marathwada.

Pattern of livestock holding

In both HOPE and non-HOPE areas, more than 70% of the farm families possess draft animals. Hence organic manure availability on the farm is complemented by the draft bullock pair. In addition, in HOPE area, around 45 percent of the families owned local cows, while in non-HOPE area around 32 percent of the families owned local cows. Similarly she-buffaloes were owned by 30 percent of the farm families in both situations. Thus, livestock activity is impressive in both HOPE and non-HOPE areas complementing income and organic manure (Table 3).

Table 3. Pattern of livestock holding among sample farmers in Marathwada region of Maharashtra.

	HOPE (N=180) project area			non-HOPE (N=90) project area		
Particulars	No. per family	% of farmers owning	Value of the livestock (₹)	No. per family	% of farmers owning	Value of the livestock (₹)
Draft animals	1.9	92	33365	2.1	74	33403
Local cows	2.0	45	22441	1.8	32	16726
Crossbred cows	3.1	19	62842	2.6	23	62932
She-buffaloes	2.0	29	28920	2.4	34	42020
Sheep and goats	2.3	14	5409	3.4	11	5185
Others	11.8	49	6375	16.0	42	11513

The average cropped area is a meagre 1.1 ha in HOPE and around 1 ha in non-HOPE. The sorghum fodder market is more vibrant than the grain sorghum market since more than 75% of the fodder produced is sold in HOPE area and 95% of fodder produced is sold in non-HOPE area. This shows the potential of sorghum fodder to not only meet farm fodder needs but also the market needs (Table 4).

Table 4. Fodder production and utilization by sample farmers in Marathwada region of Maharashtra.

	HOPE project area (N=180)			non-HOPE project area (N=90)	
	No sale	Village market	Formal market	No sale	Village market
Average crop area (ha)	1.1	1.7	2.3	1.0	0.8
Fodder produced (tons)	1.32	2.72	2.15	1.85	1.25
Fodder used to feed own livestock (tons)	1.26	0.63	1.08	1.75	0.04
Fodder used for other purpose (tons)	0.06	0.0	0.05	0.1	0.0
Fodder sold (tons)	-	2.09	1.02	-	1.21
Price received (₹/ton)	-	2400	2300	-	3500
Marketing cost (₹/ton)	-	225	462	-	910

Pattern of farm machinery and household items

A striking feature regarding the farm infrastructure is that in both HOPE and non-HOPE areas, around 50 percent of the farmers possess irrigation pump sets. This is an indicator that around 50 percent of the sample farmers have access to (groundwater) irrigation. In both the areas, farmers are well-connected as more than 80 percent of them possess mobile phones. Around 60 percent of them have bullock carts and 40 percent of them have two wheelers. Other than irrigation pump sets, the farm level mechanization in both the areas is modest (Table 5).

Table 5. Pattern of farm machinery and equipment holding among sample farmers in Marathwada region of Maharashtra.

	HOPE project area (N=120)			non-HOPE project area (N=90)		
Particulars	No. per family	% of farmers owning	Current value (₹)	No. per family	% of farmers owning	Current value (₹)
Agro processing equipment	1	1	12500	1	1	5000
Farm house	1	61	10201	1	62	21250
Harvester	1.2	3	47000	-	-	-
Irrigation pump set	1.3	48	14293	1.5	61	20263
Bullock cart	1.0	81	7684	1	58	8834
Wooden plough	1.0	61	1156	1.0	59	1505
TV	1.1	67	5912	1.0	67	7647
Residential house	1.2	98	244601	1.3	100	221022
Tractor	1.4	3	500000	1.1	8	514285
Bicycle	1.0	81	7684	1	58	8834
Two-wheeler	1.1	42	31752	1.1	37	47424
Mobile phone	1.3	83	2875	1.4	84	3992
Radio	1.1	38	561	1.2	33	1293
Other farm assets	9.2	100	4748	6.4	98	3514

Assessment of various sources of income

Income from crops constitutes the major share of total income of the farmers in HOPE and non-HOPE areas. Further, more than 80 percent of the sample farmers earn income through wages from working on other farmers' lands or other work outside agriculture. This shows that wage incomes are playing a crucial role in total income (20% in HOPE and 26% in non-HOPE areas).

Similarly, income from dairy is also playing a crucial role by contributing around 10% of total income in the HOPE and non-HOPE areas and is earned by around 60-70 percent of the farmers in both the areas. The per capita income from all sources is ₹ 32,029 in HOPE area and ₹ 40,669 in non-HOPE area of which income from agriculture is ₹ 22,230 in HOPE area and ₹ 26,435 in non-HOPE area. Thus, on per capita basis, the proportion of income from agriculture is around 65% in both HOPE and non-HOPE areas allowing for the balance 35% to be met out largely from non-farm income and dairy income (Table 6).

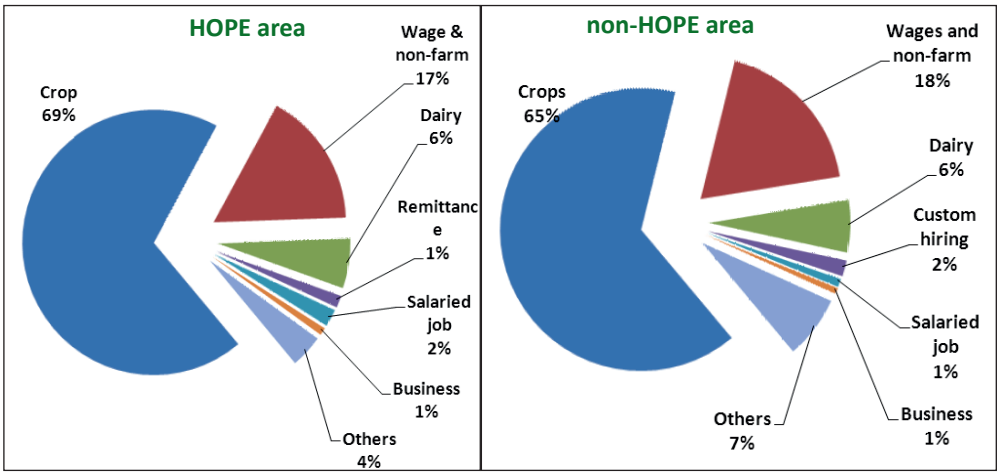

Figure 4. Different sources of income among sample farmers in Marathwada region of Maharasthra.

Table 6. Sources of income for sample farmers in Marathwada region of Maharashtra.

	HOPE project area		non-HOPE project area	
	Value (₹)	% of farmers responded	Value (₹)	% of farmers responded
Income from crops	140050	99.4	169189	100
Wage income and non-farm income	40286	82.8	67969	71.1
Income from dairy	19549	61.7	25872	58.9
Wage income from hiring bullock labor	25000	0.6	15000	1.1
Income from livestock	25000	0.6	26000	2.2
Income from custom hiring	62500	2.8	84000	6.7
Rent from land, building and machinery	60000	0.6	-	-
Caste occupations (specify)	50000	0.6	75000	2.2
Business (specify)	82500	2.8	80000	2.2
Regular salaried jobs (Govt.)	56857	5.6	53000	4.4
Regular salaried jobs (Private)	180000	1.1	-	-
Out migration (seasonal)	31533	8.3	-	-
Remittances	132500	2.2	-	-
Interest on savings and money lending	10418	17.2	50000	1.1
Cash and kind gifts including dowry received	25500	3.3	46000	8.9
Pension from employer	51000	1.1	0 (0-0)	0
Government welfare/development programs	60000	0.6	71429	8.9
Others	-	-	110000	5.6
Total income	201780	100	260280	100
Per capita Income	32029		40669	
Crop income per ha	34159		48340	

Crop production, cropping pattern and yields

In *kharif* season, commercial crops (cotton and cotton + pigeonpea) occupy around 60% of the area while in postrainy season, sorghum occupies around 75% of the area cultivated. This shows that sorghum has great resilience capacities to thrive under bare minimum moisture (Table 7).

Table 7. Choice of crop varieties among sample farmers in Marathwada region of Maharashtra.

	HOPE project area				non-HOPE project area			
Crops	Area (ha)	% of GCA	% of season area	Yield (t/ha)	Area (ha)	% of GCA	% of season area	Yield (t/ha)
***Kharif* (rainy season) crops**								
Cotton + Pigeonpea	1.17	25.2	35.6	-	1.06	24.2	37	-
Cotton	0.78	17	24	1.62	0.45	10.4	15.9	1.61
Pearl millet	0.47	10.2	14.4	1.37	0.33	7.7	11.7	1.17
Green gram	0.4	8.6	12.2	0.64	0.45	10.3	15.7	0.4
Soya bean	0.17	3.6	5.1	1.62	0.16	3.6	5.6	2.17
Black gram	0.08	1.7	2.4	0.53	0.06	1.3	2	0.31
Onion	0.07	1.4	2	6.78	0	0.1	0.2	9.88
Pigeonpea	0.05	1.1	1.6	0.86	0.16	3.6	5.6	0.59
Others	0.09	2	2.8	-	0.18	4.1	6.3	-
***Kharif* total**	**3.27**	**70.8**	**100.0**		**2.86**	**65.3**	**100.0**	
***Rabi* (postrainy season) crops**								
Sorghum	0.82	17.8	73.1	0.84	1.29	29.4	91.5	0.92
Wheat	0.13	2.7	11.2	1.39	0.08	1.9	5.9	1.27
Sorghum + Safflower	0.08	1.7	7	-	0.03	0.7	2.2	-
Chickpea	0.05	1.2	4.8	0.56	0	0.1	0.3	0.25
Sorghum + Sunflower	0.03	0.6	2.6	-	-	-	-	0
Others	0.01	0.3	1.3	0	-	-	-	0
Postrainy season total	**1.13**	**24.3**	**100.0**		**1.41**	**32.2**	**100.0**	
Annual and Perennial crops								
Sweet orange	0.15	3.1	64.5	7.42	0.01	0.3	12	0
Sugarcane	0.04	0.9	18	1.07	0.1	2.3	88	4.1
Sweet orange + Green gram	0.02	0.3	7		-	-	-	0
Pomegranate	0.01	0.3	6		-	-	-	-
Sweet orange + Cotton	0.01	0.1	3		-	-	-	
Others	0	0.1	1.5		-	-	-	
Annual and Perennial total	**0.22**	**4.9**	**100**		**0.11**	**2.6**	**100**	
Gross cropped area	4.62	100.0			4.38	100.0		

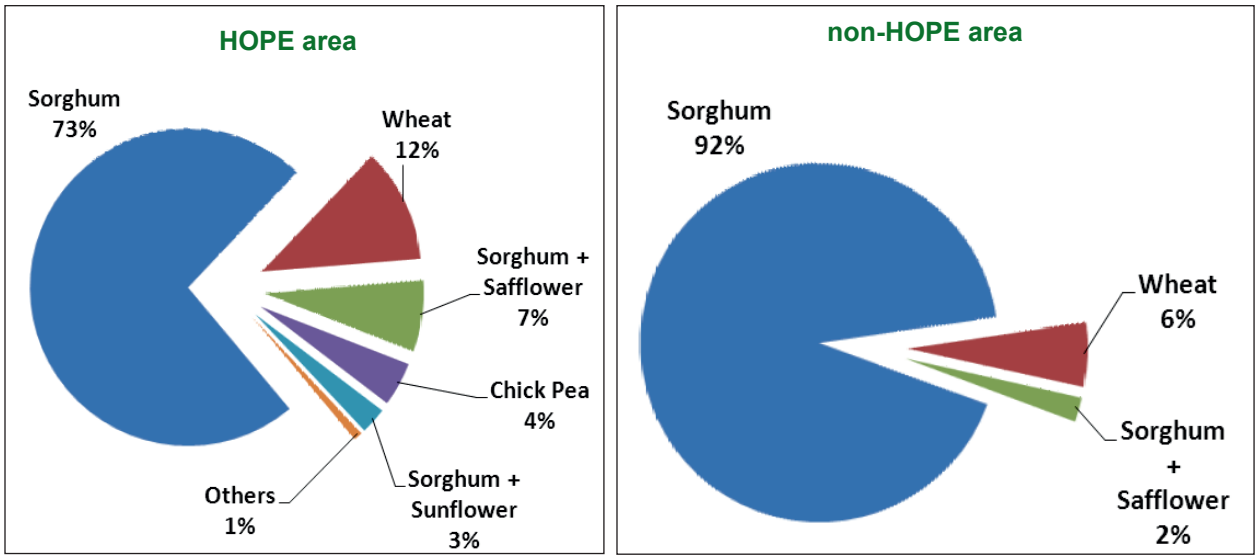

Figure 5. Choice of crop varieties during postrainy season in Marathwada region of Maharashtra.

During the baseline survey, the adoption of improved varieties was very less in HOPE as well as non-HOPE regions. The proportion of area under improved varieties of sorghum was around 15% in HOPE area (yield of 1370 kg) as against 10% in non-HOPE area (yield of 1340 kg). Improved varieties showed an increase in yield of 35–50% of local varieties (Table 8).

Table 8. Area of adoption (in ha) of improved and local postrainy season sorghum varieties in Marathwada region of Maharashtra.

	HOPE project area	Yield (kg)	non-HOPE project area	Yield (kg)
Improved variety	81 (15%)	1370	22 (10%)	1340
Local variety	454 (85%)	970	196 (90%)	1000

Note: Figures in parentheses are percentage to total.

In the years with normal rainfall, the productivity difference between irrigated and rainfed is low in HOPE area, while that in non-HOPE area is relatively high. In years with above normal rainfall, there is higher productivity under irrigation than under rainfed conditions.

However, irrigated yields are always better than rainfed yields. In the below normal years, the productivity of sorghum remains low as the farmers having access to irrigation during postrainy season do not irrigate sorghum as they prefer to irrigate other competing crops such as gram or safflower (Table 9).

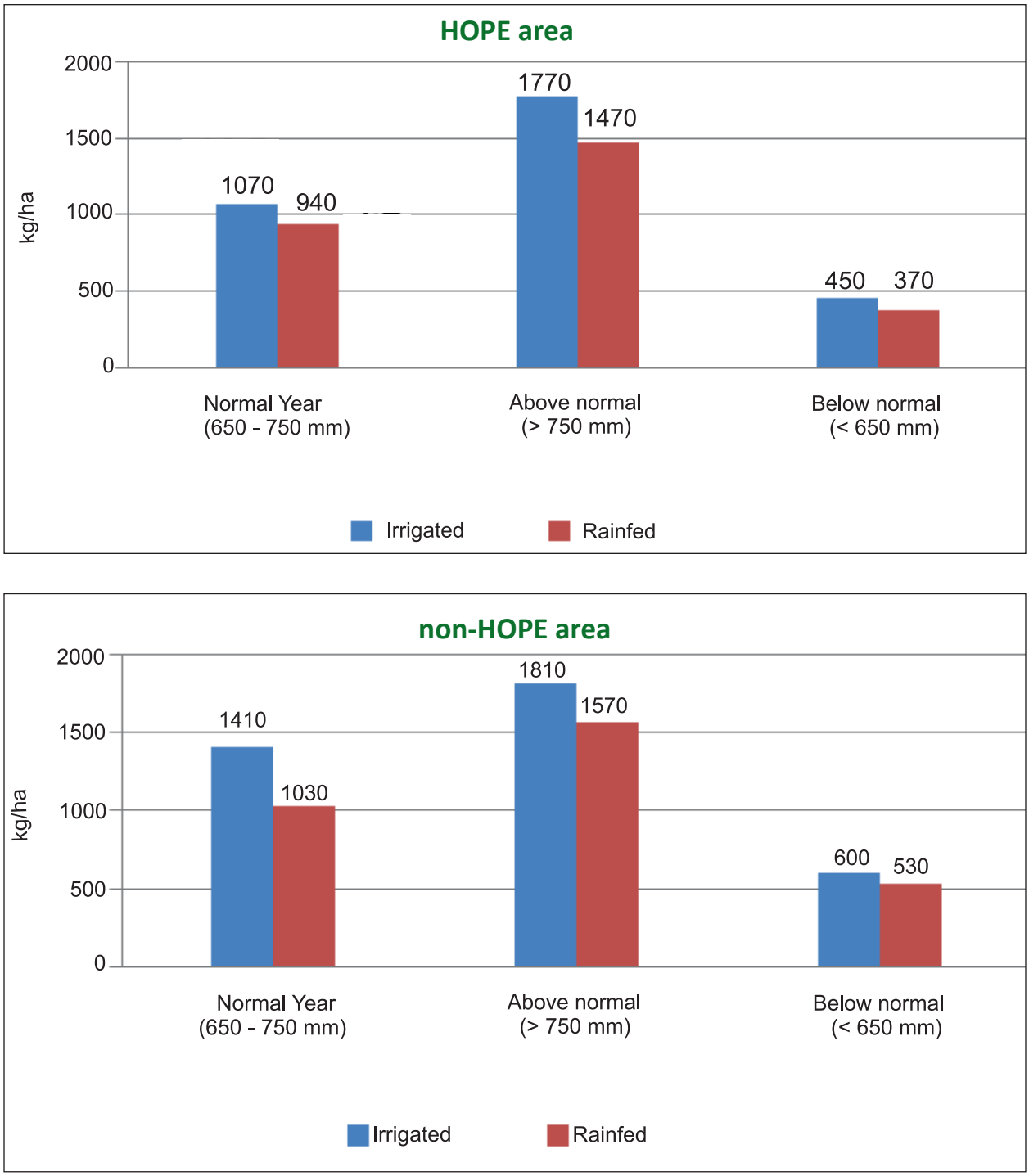

Figure 6. Crop productivity in postrainy season sorghum among sample farmers in Marathwada region of Maharashtra.

Table 9. Opinion survey on crop productivity in postrainy season sorghum among sample farmers in Marathwada region of Maharashtra (tons per ha).

HOPE project area		non-HOPE project area	
Irrigated	Rainfed	Irrigated	Rainfed
Normal Year (650 mm to 750 mm)			
1.07	0.94	1.41	1.03
Above normal (> 750 mm)			
1.77	1.47	1.81	1.57
Below normal (< 650 mm)			
0.45	0.37	0.6	0.53

The yield gap between actual and potential indicates how much more the yield could be increased from the existing level under good management, given that the yield gap constraints are alleviated. The estimated yield gap of postrainy season sorghum was 153% (as per recommendation, the grain yield is 2.0 tons/ha) for the improved varieties, which shows further scope for improvement in productivity level by introduction of recommended package of practices along with improved varieties.

Economics of postrainy season sorghum according to input use and relative profitability

Significant differences were observed between the groups of farmers in the cost of production of postrainy season sorghum in HOPE and non-HOPE areas. Considering total cost of production, HOPE farmers spent ₹ 13,968/ha as compared to non-HOPE farmers (₹ 14,056/ha) and this is because of high input use with protective irrigation (Table 9). Land preparation (₹ 3090) and harvesting (₹ 2543) account for the highest proportion followed by costs of inputs (₹ 2533), sowing (₹ 2041) and weeding (₹ 1038). The per kg cost of producing sorghum in HOPE areas was ₹ 13.65 while the same was ₹ 13.51 in non-HOPE areas. Considering all the factors contributing to the cost of cultivation, labor for all farm operations costs around 50% of the total cost in both HOPE and non-HOPE areas in the cultivation of postrainy season sorghum. Other major items of costs are fertilizer use and manures (Table 10).

Being a rainfed crop, fixed costs form a miniscule. On an average, the grain yield of postrainy season sorghum per ha was 1.17 tons and the fodder yield 2.3 tons in HOPE area, which generates a gross income of ₹ 15,985. In the non-HOPE area, with 1.2 tons of grain yield per ha and 2.5 tons of fodder, the gross income is ₹ 16,477. The net return over total cost is ₹ 2017 per ha in HOPE and ₹ 2420 in non-HOPE areas, contributing to a return to cost ratio of 1.14 and 1.17, respectively (Table 10).

Table 10. Economics of postrainy season sorghum in Marathwada region of Maharashtra (per ha).

	HOPE project area		non-HOPE project area	
	Value (₹)	Proportion	Value (₹)	Proportion
Land preparation	3090	22.1	3369	24.0
FYM application	500	3.6	450	3.2
Seed treatment	40	0.3	55	0.4
Sowing	2041	14.6	1958	13.9
Input cost	2533	18.1	2290	16.3
Weeding	1038	7.4	1072	7.6
Plant protection	150	1.1	222	1.6
Supplemental irrigation	247	1.8	162	1.2
Watching	153	1.1	138	1.0
Harvesting	2543	18.2	2718	19.3
Threshing	918	6.6	766	5.4
Marketing	400	2.9	390	2.8
Variable cost	13653	97.7	13590	96.7
Interest on variable cost @ 6%	315	2.3	466	3.3
Total cost (TC)	13968	100	14056	100
Main product yield (t)	1.17	-	1.2	-
Value of main product (₹/t)	9855	-	9564	-
By-product yield (t)	2.3	-	2.5	-
Value of by-product (₹/t)	1937	-	2000	-
Total return	15985	-	16477	-
Net return over TC	2017	-	2421	-
Return to cost ratio	1.14	-	1.17	-

The profitability of respective crops between HOPE and non-HOPE areas are comparable. As evident from Table 11, in both the HOPE and non-HOPE areas, the farmers are earning more profit from gram (₹ 6447 and ₹ 10,482) than from other crops. Comparing economics of all other crops, what is apparent is the performance of gram in the HOPE area, which contributes substantially to farm returns of these farmers. The total return realized from gram is more or less the same in HOPE and non-HOPE areas. The relative ease of irrigation facility in non-HOPE areas has reflected the increased yield level and thereby net return. Safflower is one of the oilseed crops that is grown widely intercropping with sunflower in both the areas (Table 11). The non-HOPE area is performing better than the HOPE area in all the crops.

Table 11. Relative profitability of crops in Marathwada region of Maharashtra.

	HOPE project area				non-HOPE project area			
Particulars	Postrainy season sorghum	Wheat	Gram	Safflower	Postrainy season sorghum	Wheat	Gram	Safflower
Total cost (₹)	13968	20864	12412	10089	14056	21157	13564	11351
Total paid out cost	13653	20839	12390	10071	13590	21125	13542	11325
Main product yield (t)	1.17	1.8	0.8	0.7	1.2	1.9	1	0.84
Value of main product (₹/t)	9855	11500	23380	21810	9564	11720	23680	22450
By-product yield (t)	2.3	0.96	0.58	0.2	2.5	1.02	0.59	0.59
Value of by-product (₹/t)	1937	610	580	400	2000	630	620	520
Total return (₹)	15985	21469	18858	15414	16477	22911	24046	19165
Net return over total cost (₹)	2017	605	6447	5325	2421	1754	10482	7814
Net return over total paid out cost (₹)	2332	630	6468	5343	2887	1786	10504	7840
Return to cost ratio	1.14	1.03	1.52	1.53	1.17	1.08	1.77	1.69

Utilization of output (grain and fodder)

In both HOPE and non-HOPE areas, about 30% of the produce is retained for home consumption and the rest is the marketed surplus. However, in the case of fodder, more than 75% is retained for home consumption of cattle. This shows that sorghum is relatively serving the cause of feed security than food security. Around 45 percent of the farmers in both HOPE and non-HOPE areas sold sorghum in the regulated market. In the HOPE area, these farmers sold 38% of their produce in the weekly market, while in the non-HOPE area, these farmers sold a substantial portion (47%) of their produce. The village weekly market was another major market for sorghum sales where around 40 percent of the farmers from both the areas sold sorghum (Table 12).

Table 12. Utilization and marketing of grain and fodder in Marathwada region of Maharashtra (per farm).

	HOPE project area			non-HOPE project area		
Particulars	No sale (17%)	Regulated market (45%)	Village & weekly market (38%)	No sale (7%)	Regulated market (46%)	Village & weekly market (47%)
Grain produced (kg/farm)	637	1357	1306	750	666	773
Grain consumed (kg)	405	372	295	480	201	339
Grain retained for future use (kg)	33	19	30	42	9	17
Grain retained for other use (kg)	195	134	220	188	36	65
Marketable surplus	3	832	761	40	420	352
Grain sold (kg) calculated	0	642	454	0	628	250
Price received (grain) (₹/kg)	0	8	6	0	10	3
Distance to market (km)		30	4		29	31
Marketing cost of grain (₹)		64	33		60	63
Quantity of fodder produced (kg)	800	1800	1300	2700	1800	1700
Fodder retained for own use (kg)	800	1400	1200	2700	1500	1500
Quantity of fodder sold (kg)		300	100	0	100	200
Price received (fodder) (₹/kg)		1.35	1.15		1.35	1.31
Marketing cost of fodder (₹)		36	18	0	6	16

Production characteristics of technologies and trait performances of farmers

Productivity of sorghum is the major concern in both HOPE and non-HOPE areas for both local and improved varieties except for the improved variety in non-HOPE area. As compared to Maldandi, improved varieties are poor in taste and fodder quality as opined by an impressive percentage of farmers in both areas. Another constraint reported by farmers is the low market price for both local and improved varieties, except for improved variety in non-HOPE areas (Table 13).

Table 13. Production characteristics and traits of postrainy season sorghum in Marathwada region of Maharashtra (in percentage).

	HOPE project area		non-HOPE project area	
	Improved variety	Local variety	Improved variety	Local variety
Low yield	50	66	36	66
High pest incidence	-	19	-	34
High disease incidence	-	21	-	36
Long duration	-	10	-	4
Small grain size	17	29	9	14
Poor color	17	4	9	11
Poor taste	83	11	36	12
Low recovery/shelling %	-	9	-	33
Low market price	50	43	9	41
Does not fit in to cropping system	17	-	-	-
Susceptible to storage pest	-	3	27	8
Poor fodder quality	67	12	55	4

The local variety fits well into the cropping system compared with improved variety (Table 14.1). Drought resistance is appreciated in local variety, while pest resistance is appreciated in high yielding varieties. Disease resistance is appreciated in improved variety relative to local variety.

Tables 14.1 to 14.4 show preferred traits:

Table 14.1 Production.

	HOPE project area		non-HOPE project area	
	Improved variety	Local variety	Improved variety	Local variety
High yield	83	29	55	17
Short duration	17	16	0	12
Drought resistance	33	30	55	63
Pest resistance	67	38	100	52
Disease resistance	50	41	91	59
Fits in to cropping system	17	35	0	4
Improves soil fertility	0	37	0	6
More harvest index	0	0	0	0
Amenable to value addition	0	0	0	0

The taste of sorghum is of concern with regard to improved variety in both the areas and the associated *bhakari* making and keeping quality (Table 14.2).

Table 14.2 Consumption.

	HOPE project area		non-HOPE project area	
	Improved variety	Local variety	Improved variety	Local variety
Better taste	100	73	45	88
Less cooking time	83	49	0	33
High cooking quality	100	71	55	42

Fodder quality is of concern for improved variety in the HOPE area. The storability of fodder is also a concern for improved variety in both the areas (Table 14.3).

Table 14.3 Fodder.

	HOPE project area		non-HOPE project area	
	Improved variety	Local variety	Improved variety	Local variety
More fodder quantity with leaves	100	85	45	93
Palatability (quality/taste)	83	59	36	63
Storability of fodder (free from pest & disease)	100	48	64	22

The market for local variety as reflected in the price is of concern in both the areas (Table 14.4). The bigger grain size is of concern for improved variety in both the areas.

Table 14.4 Marketing.

	HOPE project area		non-HOPE project area	
	Improved variety	Local variety	Improved variety	Local variety
High demand	67	70	73	69
Fetches higher price	83	21	55	35
Low price fluctuations	33	28	36	31
Bigger grain size	100	41	55	49

Consumption level

In the HOPE area, consumption of rice and wheat is almost on par with consumption of sorghum and pearl millet. In the non-HOPE area, consumption of rice and wheat dominates over consumption of millets. In both the HOPE and non-HOPE areas, policy support to rice and

wheat is influencing consumption of millets. This will directly affect the market for millets in the long run. Once the market for millets is on the downward trend, it becomes extremely difficult to sustain the millet economy, which includes both food and feed (Table 15).

Table 15. Per capita cereal consumption per annum in Marathwada region of Maharashtra.

	HOPE project area Family size: 6.3			non-HOPE project area Family size: 6.4		
Cereal/ Millet	Avg quantity consumed as food and feed (in kg)	Market price (₹/kg)	% consumed	Avg quantity consumed as food and feed (in kg)	Market price (₹/kg)	% consumed
Rice	13.3	28	11	11.9	27	10
Wheat	46.7	13	39	54.9	14	45
Sorghum	41.0	12	34	40.2	12	33
Pearl millet	17.6	11	15	13.9	11	11
Others (Pulses)	0.4	46	1	0.0	48	1
Total	119.0		100	121.0		100

The findings in Table 12 are reinforced by the opinions of farmers in Table 16. Only 6 to 14 percent of the farmers indicate increase in consumption of postrainy season sorghum in prospect while 44 to 83 percent of them hint at reducing their consumption. Wheat is responsible for reduction in sorghum consumption and will affect the sustainability of sorghum production, which in turn will influence the decision on sustainability of livestock dependent on fodder (Table 16).

Table 16. Opinion survey regarding consumption of postrainy season sorghum in retrospect and prospect in Marathwada region of Maharashtra.

	HOPE project area	non-HOPE project area
Percentage increase in consumption	14	6
Due to being more palatable than wheat	9	2
Easy to digest	2	-
Habit	1	-
Nutritious and good for health	3	2
Due to increase in family members	1	-
Family income increased	1	-
More fodder requirement	1	-
Traditional food	1	-
Grand Total	1	-
Percentage decrease in consumption	44	83
Wheat preferred more by children and adults	60	66
Wheat availability at low price through PDS	3	20
Standard of living increased	1	1
Special skill required to prepare sorghum roti	-	3
Sorghum price increased	-	3
Sorghum not produced	2	1
Sorghum is replaced by wheat	16	3
Sorghum is replaced by pearl millet	4	-
Sorghum is replaced by cotton	1	-
Sorghum consumption decreased	-	1
Poor taste	12	12
More consumption of wheat	16	-
Less yield & price of sorghum has increased	-	2
Less productive & cost of cultivation has increased	2	4
Less availability of labor	3	-
Fodder is less palatable	2	4
Fodder demand decreased due to disease and pest incidence	-	1
Cotton is more remunerative	1	-
Sorghum is sustaining	42	11

Participation of labor force in cultivation process according to gender

Involvement of women in land preparation, which involves substantial drudgery, is substantial in both HOPE and non-HOPE areas as was indicated by more than 50 percent of the farmers. It is to be noted that involvement of women is substantial in all the activities except application of plant protection chemicals and irrigation. Intercultural operations, weeding, harvesting and threshing are dominated by women. Similarly, weeding, harvesting and threshing are the three activities where a majority of the farm families indicated substantial involvement of women (Table 17).

Table 17. Gender involvement in postrainy season sorghum cultivation in Marathwada region of Maharashtra.

Farm activities	HOPE project area			non-HOPE project area		
	Man days	Women Days	% farmer responded (involvement of M, F)	Man days	Women Days	% farmer responded (involvement of M, F)
Land preparation	2.8	1.7	(95), (57)	0.9	6.0	(24), (69)
Preparatory tillage	0.0	0.0	(1), (1)	0.1	0.0	(2), (2)
FYM application	0.6	0.3	(33), (20)	0.5	0.6	(20), (17)
Sowing	1.1	0.7	(59), (35)	0.1	0.0	(6), (2)
Seed treatment	0.2	0.2	(14), (13)	0.1	0.1	(7), (6)
Fertilizer application	0.9	0.2	(59), (17)	0.9	0.9	(43), (33)
Interculture	0.5	0.7	(16), (3)	0.2	0.1	(7), (3)
Weeding	0.5	11.5	(18), (95)	0.0	12.3	(1), (83)
PPC application	0.0	0.0	(1), (0)	0.0	0.0	(1), (0)
Irrigation	0.1	0.0	(8), (0)	1.3	0.0	(38), (0)
Watch and ward	6.3	1.0	(61), (16)	13.7	1.2	(81), (8)
Harvesting	5.3	10.5	(89), (92)	4.6	11.7	(43), (94)
Threshing	2.0	4	(97), (74)	2.2	7.4	(68), (93)
Marketing	0.2	0	(65), (18)	0.1	2.6	(62), (19)

Note: PPC- Plant protection chemicals.

Conclusions and Policy Implications

Postrainy season sorghum has been cultivated as a dual purpose crop for food and fodder in Marathwada region, supporting poor smallholders and sustaining livestock in the region. Postrainy season sorghum fodder is valued more than the grain by the majority of the farmers, reflecting the relative importance of fodder and grain. Farmers usually rely on rainfed agriculture as more than 60% of their operating land is dryland in both HOPE and non-HOPE clusters. A majority of the rainfed farmers are practicing integrated farming system, integrating crops with livestock. Most of the fodder produced is retained for consumption of livestock. In the postrainy season, sorghum occupies a major proportion of the total cultivable land followed by wheat, safflower, sunflower, chickpea and others.

On an average, the productivity of improved varieties is around 35-50% higher when compared with the local cultivars. The proportion of area under improved varieties of postrainy season sorghum is very less in HOPE as well as non-HOPE areas. The estimated yield gap of 40-50% indicates further scope in improvement of technology as well as package practices.

The baseline results indicated that the bulk of the postrainy season sorghum area is occupied by local land races and M-35-1. Further, biotic and abiotic factors constrained yield improvement in postrainy season sorghum. Thus, the research priority in sorghum should address ways to enhance productivity of grain and fodder by addressing the key constraints. Any significant yield improvement requires the use of improved varieties, management practices and market support for economic incentive.

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