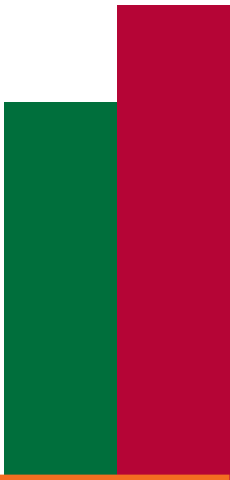


Working Paper Series No. 40

ICRISAT Research Program
Markets, Institutions and Policies



Baseline Scenario of Rainy Season Pearl Millet in Haryana

N Nagaraj, KK Kundu, Surajit Haldar, Cynthia Bantilan
and MG Chandrakanth



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Abstract

Pearl millet has been cultivated in Haryana as a dual purpose crop where grain and fodder are most often valued equally, which supports poor smallholders and livestock in the harsh agro-climatic region. Currently, the productivity levels are low because of limited adoption of dryland technologies by the poor. The HOPE project aimed at increasing the productivity of pearl millet by 35-40 % over the base level by 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 carried out 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 areas (non-HOPE), where improved technologies have not been made. The objective of this 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. Pearl millet is the major crop in the rainy season followed by mustard and gram in the rabi (postrainy) season. The average productivity of pearl millet ranges from 1.54 – 1.79 t/ha as against the potential yield of 2.5 – 2.9 t/ha, leaving a yield gap of 58-101%. In the HOPE clusters, adoption rate of hybrids is at the peak, covering around 48% (out of 124.5 ha) under public bred hybrids (HHB 67, HHB 67 Improved), and 50 % under proprietary hybrids. While the same in non-HOPE area was 35% (out of 54.8 ha) under public bred hybrids, and rest of the area is under proprietary hybrids. The yield gap of improved hybrids of pearl millet was estimated as 58-101%, as compared to the potential yield, which shows further scope for improvement in productivity levels. On an average, farmers were reaping a net benefit of ₹ 2108 per ha in HOPE areas, while it was ₹ 6238 per ha in non-HOPE area, after accounting the total costs. Farmers most preferred traits in public hybrids of pearl millet inter alia include more palatable grain and fodder quality and disease-pest-moisture stress. Key critical constraints expressed by the farmers are shortage of labour especially during harvesting, high wage rate, moisture stress and lack of appropriate machinery. Targeting the key recommended technologies and management practices is vital as there is a significant yield gap between the baseline and the potential from the improved cultivars.

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Baseline Scenario of Rainy Season Pearl Millet Economy in Haryana

N Nagaraj, KK Kundu, Surajit Haldar, Cynthia Bantilan
and MG Chandrakanth

This work has
been undertaken
as part of the



**International Crops Research Institute
for the Semi-Arid Tropics**

Patancheru 502 324, Andhra Pradesh, India



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Summary

The HOPE project aimed at increasing the productivity of sorghum and pearl millet by 35-40% over the base level in South Asia through its introduction of on-shelf-technology and improved management practices in targeted clusters over a period of four years. 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 areas (non-HOPE), where improved technologies have not been introduced. This enabled the collection of baseline data from participating and non-participating farmers that helped to identify comparable counterfactual data in impact evaluation. The baseline survey was carried out in selected cluster villages in Haryana 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 hybrids and practices adopted, yield gaps, input-output levels and the profitability of crop production, technology and trait preferences of farmers, income and consumption levels, labour participation and earnings, marketing channels and costs and gender participation. The key findings are summarised below.

The results revealed that pearl millet is used for food, feed, and fodder, as well as industrial purposes in Haryana, supporting poor smallholders and livestock. Agriculture forms the primary occupation of all farmers in both the areas, while more than 75 percent of them are middle aged with an average age of 43 years, and having 5-9 years of school education. In both the areas, the proportion of backward households in the sample is small (22%), while that of other communities is around 78 percent. About 52% of the households are marginal with small holdings of about 1.3 ha in size, and with access to irrigation for 60% of the total operating land. The Bajra-Buffer combination (BBC) is followed by more than 90 percent of farm families where the average livestock value ranged from ₹ 80,000 to ₹ 90,000.

Most farmers own a farm house, a residential house, two wheelers, radio and fan/air cooler. More than 60 percent of the farmers own irrigation pump sets and sprinkler sets in the arid state, an indicator of the importance of irrigation. Around 20 percent of them possess tractors, which indicates the importance of farm mechanization in pearl millet cultivation. Farmer derived an annual income ranging from ₹ 93,000 to ₹ 109,000 from crops, accounting for more than 90% of their total income (₹ 120,000), followed by an income from dairy and livestock (5%), and other sources such as non-farm wages, salaried jobs, NTFS (non-timber forest products) that forms the remaining 5% of their incomes. The per capita income in the HOPE area is ₹ 21,145 while the same is ₹ 23,872 in non-HOPE areas.

Among the crops, pearl millet occupied the largest proportion (20%) of area in HOPE area followed by cluster bean (16%) and cotton (11%), while in non-HOPE areas, pearl millet occupied 17%, followed by cluster bean (26.8%). During the *rabi* (postrainy) season, in the HOPE area, mustard and gram occupy around 70% of the area, while mustard and wheat occupy around 60% in non-HOPE area. The relative performances of private bred hybrids are better than public hybrids in pearl millet and respond well to irrigation facility in both, the HOPE and non-HOPE areas. In the HOPE clusters, the adoption rate of public bred pearl millet hybrid (HHB 67, HHB 67 Improved) is the highest, covering around 48% (of 124.5 ha) under public bred hybrids and 35%

under proprietary hybrids. Similarly in the non-HOPE areas, 35% of the total area (of 54.8 ha) is under public bred hybrids and the remaining area is under proprietary hybrids.

The difference in productivity is pronounced in the rainfed areas in the above normal years (2.4 tons per ha of public bred hybrids and 3.0 tons per ha of private hybrids) and is similar under irrigated conditions (3.4 tons per ha by public hybrids and 3.6 tons per ha by private hybrids). However, no private hybrids are available to perform when the rainfall is below normal and the only recourse is to cultivate the public hybrids in such situations. By and large, the productivity of hybrid pearl millet is relatively higher under irrigation compared to dryland situations, but irrigation is the limiting factor. The yield level of pearl millet also differs according to different input usage of farmers. Farmers managing under high input use (HMG) realized a higher grain yield of 30-40% than low input use farms (LMG).

The yield gap of improved pearl millet hybrids was estimated as 58-101% compared to the potential yield, which shows an immense scope for improvement in productivity level by the introduction of recommended package of practices, soil and moisture conservation along with improved hybrids. There was substantial difference in the cost of cultivation of pearl millet between the groups of farmers under rainfed land and with protective irrigation facility in HOPE and non-HOPE areas. Considering the total cost of production, HOPE farmers spent ₹ 12,241/ha compared to non-HOPE farmers (₹ 10,358/ha) due to intensive input use with protective irrigation. The cost per kg of producing pearl millet in HOPE areas was ₹ 7.96 with a net return of ₹ 2109 per ha. Bt-cotton is an important competing crop that fetches twice to thrice the return compared to pearl millet (Return to cost ratio above 3) in HOPE and non-HOPE areas. Farmers prefer private hybrids due to their relative higher fodder yields and harvest index, while public hybrids have better drought resistance. The cooking quality and taste of public bred hybrids is better than that of private hybrids, which rule over the public hybrids with respect to price, demand and bolder grain size.

More than 50% of the fodder produced on the farm is retained for use by livestock and the rest is marketed. Since the consumer preference for pearl millet is falling over time, the only major driver for the cultivation of pearl millet is for its fodder. As income from fodder almost matches the income from grain, farmer gets the additional benefit of grain. Given the fact that livestock forms a strong component of farming activity, and since fodder quantity is crucial to support dairy, and since milch cows and buffaloes feed on pearl millet fodder, a by-product of pearl millet production, the demand for milk will drive the demand for pearl millet in Haryana.

In both HOPE and non-HOPE areas, the pearl millet consumed at home is around 20% of the harvest, and 80% is sold in the market. The consumption of pearl millet is drastically reducing due to wheat consumption in both HOPE and non-HOPE areas. In Haryana, pearl millet is becoming an inferior good. Pearl millet however becomes a superior food grain item, since milch animals invariably feed on pearl millet fodder. Women's role in pearl millet cultivation is important in some activities, such as bird scaring, harvesting and threshing, which require considerable bending, while the rest of the farm operations are dominated by male labor. Some of the key critical constraints expressed by the farmers are economic scarcity of labor, moisture stress, lack of appropriate machinery and shortage of fertilisers.

I. Significance of the study

In arid and semi-arid harsh environmental conditions, the cropping choice is restricted due to moisture stress, low soil fertility, poor and saline soils and lack of assured sources of irrigation. Dryland cereals such as pearl millet are hardy and sturdy crops that thrive in such adverse agro-ecological situations and are less risky for production. Pearl millet is predominately grown in arid and semi-arid regions of India, where there is no assured source of irrigation, and continues to occupy a prime place in smallholder farming systems in providing employment, income and food for human consumption and feed for livestock. It is a staple crop, nutritionally superior providing health and nutrition security to the rural poor.

Most smallholder and marginal farmers hesitate to invest in improved technologies due to risk and uncertainty associated with biotic and abiotic stress. As a result, the productivity levels in marginal harsh rainfed areas is low. The potential productivity of millet in the rainfed marginal environments varied from 1.8 t/ha to 2.9 t/ha across states, whereas the current productivity levels varied from 0.8 to 1.8 t/h indicating a yield gap of 53 to 175% across major production states. Hence, the HOPE project was implemented in South Asia to increase the productivity of millet, narrow yield gaps, and increase household incomes and food security. To achieve this vision, six specific objectives were chosen that attend to market chain and delivery, constraints/opportunities, and to the genetic and production systems specific and better targeted to these crops. One of the objectives of the HOPE project is better targeting. In this endeavor, the baseline study was undertaken in the predominantly pearl millet growing districts of Bhivani and Mahendragarh. 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 on food, fodder, and income security.

II. Importance of pearl millet in India

Pearl millet a dual purpose crop cultivated for human consumption and for fodder. It is the third most important food grain in India, grown both as a *kharif* (rainy season) crop from June to October and as a summer crop from February to May. Pearl millet possesses an inherent capability to survive under extremely high temperatures. Therefore, it is widely distributed in arid zones and semi-arid tropics. Major pearl millet growing states in India are Rajasthan, followed by Maharashtra, Gujarat, Uttar Pradesh, Haryana, Karnataka and Madhya Pradesh, which accounted for 95.25 of the total pearl millet area (8.75 million ha) and 95.96% of the production (8.89 million tons) in 2008-09. Pearl millet accounted for about 9% of the area and 13% of production of all India area and production in 2008-09.

III. Pearl millet in Haryana

In Haryana, pearl millet is grown mainly as a rainfed crop and also in irrigated areas during the *kharif* (rainy season). Haryana is ranked 4th in pearl millet acreage and 3rd in production in India. During the 2008-09 *kharif*, pearl millet was cultivated in an area of 612.90 thousand hectares in Haryana with a production of 1087 thousand tons and the average productivity of 1773 kg/ha.

Bhiwani district accounted for about 28% of the area and 23% of pearl millet production. Mahendragarh district accounted for 16.79% of the area and 16.74% of the production of pearl millet in Haryana. A small quantity of pearl millet in Haryana is utilized for human consumption and animal feed, and the remaining quantity is marketed. Fodder obtained from pearl millet is utilized in the case of non-availability/shortage of wheat straw. Most of the dry fodder of pearl millet is purchased by the farmers of the neighbouring state of Rajasthan.

In Haryana, the unique combination of *bajra*–buffalo farming, leading to millet–milk production is impressive (*bajra* is the local name for pearl millet). Without such an integration of millet and livestock, perhaps the rainfed economy of Haryana, Gujarat and other northern Indian states would have been hard hit. This report presents the baseline survey of Haryana with regard to the HOPE and non-HOPE sample areas with particular reference to pearl millet.

IV. Methodology

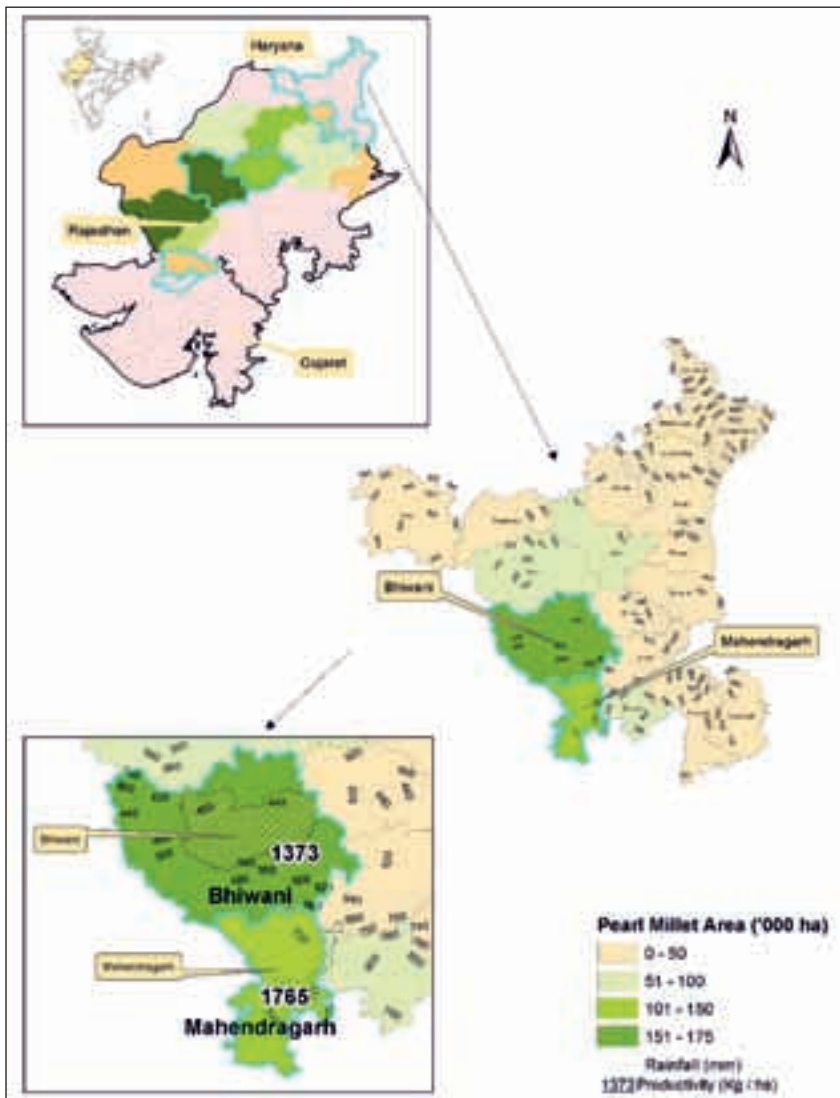


Figure 1. Map of the study area.

1. Sampling

The target area of pearl millet under the HOPE project was earmarked on the basis of secondary data on area, production and productivity levels, biographical features, soil type, and climate.

The baseline survey was conducted in Bhiwani and Mahendergarh districts where project interventions are being implemented. From each district, 90 sample farmers were chosen and allotted to two villages, each for Mahendergarh district, Bhojawas and Jhigwan, and for Bhiwani district, Bhaktawarpura and Dhaniramjas as representatives for HOPE beneficiary villages. The villages Gomli and Rupana serve as controls in the non-HOPE areas. In all, a sample of 120 farmers was chosen from HOPE area and 60 farmers were chosen from non-HOPE project area based on probability proportional to size (PPS) method to farm size. The sampling framework is shown in Figures 1 and 2.

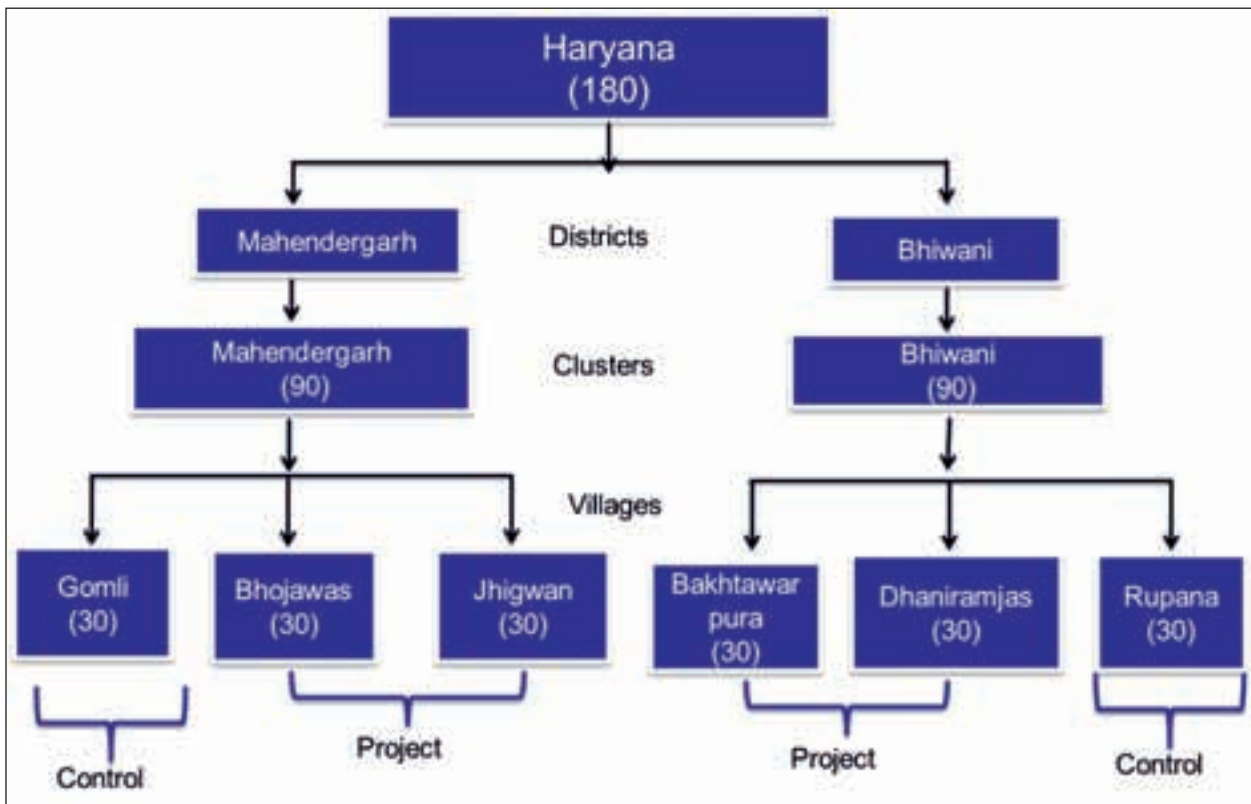


Figure 2. Sampling Framework of the HOPE project in Haryana.

V. Results and discussion

1. General characteristics of sample farmer

The marginal and smallholder farmers form around 50 percent of the sample households in HOPE and non-HOPE areas with an average holding of around 1.4 ha each. Farmers with more than 2 ha constitute the rest, with their average size of holdings of around 4.2 ha. *Prima facie*, there is inequality in the distribution of land holdings. Agriculture forms the primary occupation of all farmers in both the areas. More than 75 percent of the sampled farmers are in the middle age group of 35 to 55 years with an average age of 44 years. In both HOPE and non-HOPE areas, the proportion of backward class households in the sample is 22 percent, while that of other communities is around 80 percent (Table 1).

Table 1. Characteristics of sample households in Haryana state in 2010.

Characteristics	HOPE area	non-HOPE area
Family size (No.) and range	5.5 (3-13)	5.2 (2-10)
Male (%)	2.8 (50%)	2.7 (52%)
Female (%)	2.3 (41%)	2.0 (39%)
Children (%)	0.5 (9%)	0.5 (9%)
Average Literacy (yrs of schooling) and range	5.3 (0-15)	9.6 (0-15)
Proportion of literate farmers in the sample	63.0	56.0
Social classification (% of farmers)		
Backward classes	22	20
Others	78	80
Size Class of holdings		
Small and Marginal : <2 ha (%)	52.5%	58.3%
Average size(ha) and range	1.3 (0.4-2)	1.5 (.6-2)
Medium & large: >2.01 ha (%)	47.5%	41.7%
Average size (ha) and range	4.1 (2.4-13.2)	4.3 (2.4-7.2)
Agriculture as primary occupation (% of holdings)	100.0%	100.0%
Age cohort of farmers		
1. Youth (< 35 years)	12.5%	13.3%
Average age in years	29.8	28.8
2. Middle aged (35-55 years)	76.7%	83.3%
Average age in years	43.7	43.8
3. Aged farmers (> 55 years)	10.8%	3.3%
Average age in years	60.5	61.0
Note: Figures in parenthesis show range		

2. Land holding pattern

Irrigated land formed around 80% of the area cultivated in the non-HOPE area, while it formed around 68% in the HOPE area. Thus, in both HOPE and non-HOPE areas, sample farmers have access to irrigation, strengthening their resource base by comparing productivity in dry or irrigated food vs other crops. (Table 2)

Table 2. Pattern of Land holding among sample farmers in Haryana State.

Land Pattern	HOPE area		non-HOPE area	
	Area (ha)	Proportionate to total operating land	Area (ha)	Proportionate to total operating land
Own land				
Dry	0.78	29	0.55	21
Irrigated	1.84	68	2.10	79
Fallow	0.04	1	-	-
Leased in land				
Irrigated	0.04	2	-	-
Operating land				
Dry	0.78	29	0.55	21
Irrigated	1.88	69	2.10	79
Fallow	0.04	2	-	-
Total	2.70	100	2.66	100

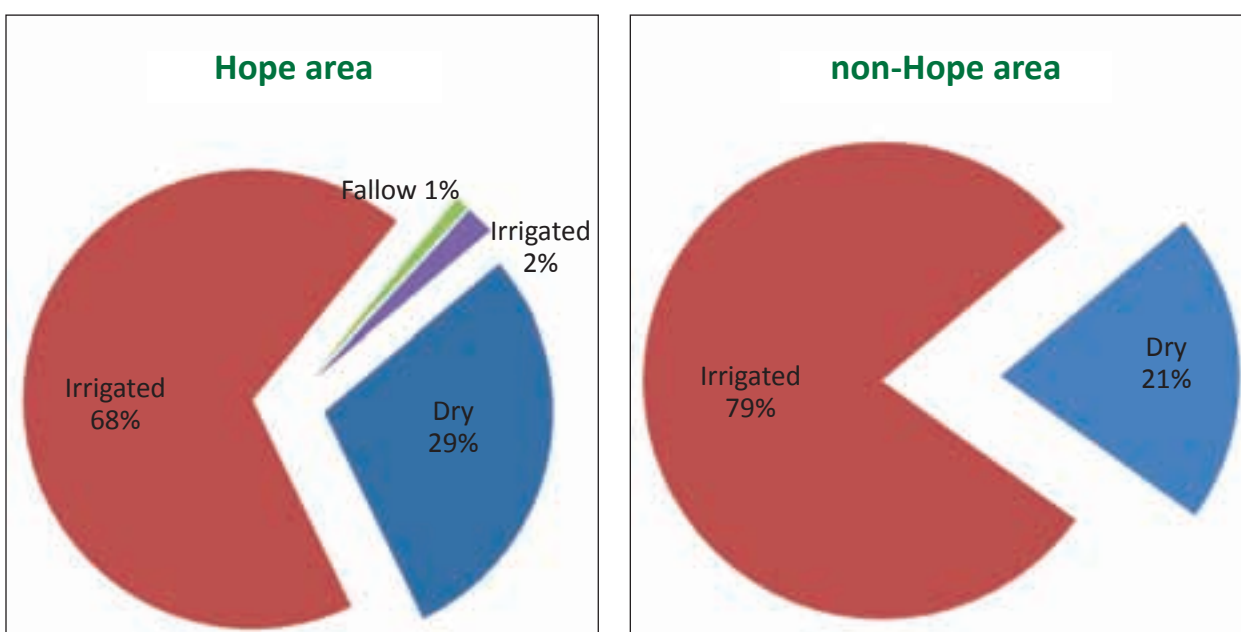


Figure 3. Land holding pattern among sample farmers in Haryana.

3. Pattern of livestock holding

The pattern of livestock on the farm reflects that most of the sample farmers invariably possess two local/improved buffaloes and the associated young stock of animals (Table 3). The milch cow/buffalo component is vibrant in Haryana in both HOPE and non-HOPE areas. The stronger the livestock component, the stronger is the scope for an integrated farming system. This necessitates cultivation of millet for both food and feed (fodder) in the harsh climatic conditions. Thus, the *bajra* – buffalo combination (BBC) leads to millet – milk yield in Haryana. Such a combination offers sustainability in both subsistence and commercial farming opportunities. The subsistence part is the consumption of millets and the commercial part is the sale of milk. This millet – milk combination brings sustainable farm incomes to the farming community of Haryana.

Table 3. Pattern of Livestock holding among sample farmers in Haryana

Particulars	HOPE area (N=120)			non-HOPE area (N=60)		
	No. Per family	% of farmers owning livestock	Current value (₹)	No. Per family (range)	% of farmers owning livestock	Current value (₹)
Draft animal	4	1	80000	-	0	-
Local cows	1	18	19364	2	10	35000
Improved cows	1	8	18111	1	7	22250
Local/Improved she buffaloes	2	98	69855	2	100	76683
Goat/sheep	1	1	3000	-	0	-
Others	2	98	7915	2	92	7400

4. Pattern of farm machinery and household items

Around 60 percent of the sample farmers possess irrigation pump sets and a sprinkler irrigation facility. This indicates that farmers have access to protective irrigation through irrigation wells in the harsh climatic conditions in Haryana. Farmers also recognize economic efficiency in the use of irrigation water. The value of sprinkler sets is around 25% the value of irrigation pump set. Around 16 percent of the farmers in HOPE and 27 percent of the sample farmers in non-HOPE areas possess tractors valued at ₹ 3.75 to 4.25 lakhs. Only around 10 to 20 percent of the sample farmers possess harvesters. Almost all the farmers possess a farm house and dwelling, reflecting on farm infrastructure (Table 4).

Table 4. Pattern of farm machinery and equipment holding among sample farmers in Haryana.

Particulars	HOPE project area (N=120)			non-HOPE area (N=60)		
	No. per family	% of farmers owning	Current value (₹)	No. per family	% of farmers owning	Current value (₹)
Tractor	1	16	378,158	1	27	429,688
Harvester/ thresher	1	9	48,182	1	18	49,091
Sprinkler	1	65	44,141	1	57	44,382
Pump set	1	56	160,746	1	63	162,132
Manual/power sprayers	1	45	1080	1	50	1027
Residential house	1	100	292,783	1	100	370,950
Farm house	1	91	89,358	1	93	95,661
2 wheeler	1	49	46,034	1	67	48,850
Cycle	1	17	1645	1	7	1800
TV	1	69	7506	1	78	7606
Fridge	1	34	7768	1	40	7363
Washing machine	1	20	6771	1	5	6333
Radio	1	35	827	1	50	930
Air cooler	2	84	2904	2	90	3556

5. Assessment of various sources of income

In the HOPE area, average holding size is around 2.65 ha per farm. A majority of the farmers realize a seasonal gross income of around ₹ 93,000 per farm, which is around 80% of their total income, followed by dairy income of around ₹ 73,786 per farm from 2 Murrah buffaloes, supported by the fodder from pearl millet (Table 5).

In the non-HOPE area, average holding size is around 2.66 ha. The farmers earn an annual income of around ₹ 109,533 per farm from crops, and about ₹ 125,143 from dairy income from 2 buffaloes.

Table 5. Sources of income for sample farmers in Haryana state.

Sources of income	HOPE area	% of farmers receiving income	non-HOPE area	% of farmers receiving income
Size of holding (ha)	2.65		2.66	
Family size	5.5		5.2	
Income from crops	93,308	100	109,533	100
Income from dairy	73,786	11.7	125,143	11.7
Regular salaried jobs (Govt.)	96,000	1.7		
Regular salaried jobs (Private)	120,000	0.8		
Pension from employer	72,000	0.8		
Income from all other sources	11,183	10		
Total income from all sources	116,300	100	124,133	100
Per capita income	21,145	100	23,872	100

Note: Figures in parenthesis show range

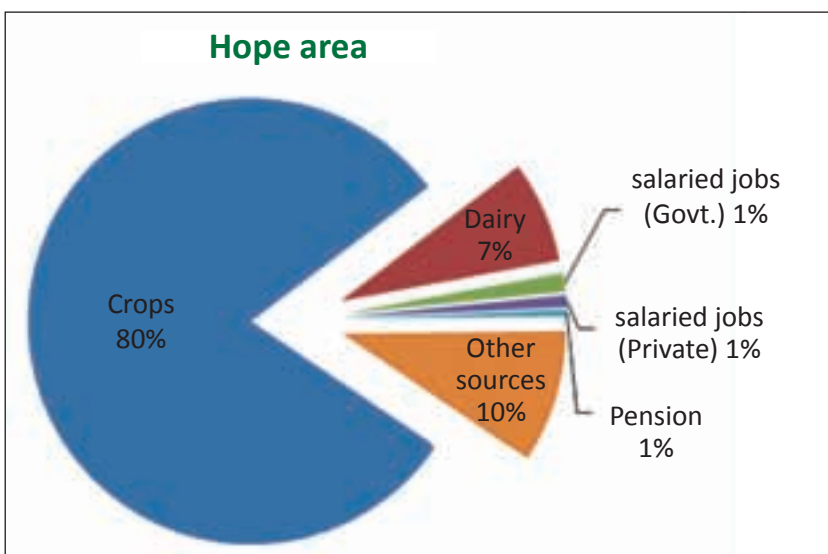


Figure 4. Different sources of income among sample farmers in Haryana

6. Crop production, cropping pattern and yields

Due to the presence of irrigation, there is crop diversification in both HOPE and non-HOPE areas in Haryana. In the *kharif*, pearl millet occupies the largest proportion (20%) of gross cropped area (GCA) in HOPE areas, followed by cluster bean (16%) and cotton (11%). In non-HOPE areas, cluster bean occupies the largest proportion (26.8%) followed by pearl millet (17%). In the *rabi* season, mustard and green gram occupy around 35% of the gross cropped area (GCA) in the HOPE areas and around 45% in the non-HOPE areas.

Table 6. Choice of crop varieties/hybrids among sample farmers in Haryana.

Sl. No.	Crops including fodder	HOPE area				non-HOPE area			
		Area (ha)	% of GCA	% of season area	Yield (t/ha)	Area (ha)	% of GCA	% of season area	Yield (t/ha)
A Kharif									
1	Pearl millet	1.34	19.9	40.5	1.50	1.08	16.5	33.4	1.40
2	Cotton	0.72	10.7	21.8	2.15	0.36	5.6	11.3	1.88
3	Cluster bean (rainfed)	0.04	0.6	1.2	0.98	-	-	-	-
4	Cluster bean (Irrigated)	1.12	16.6	33.8	1.19	1.75	26.8	54.1	0.90
5	Green gram (rainfed)	0.02	0.3	0.6	0.58	-	-	-	-
6	Green gram (Irrigated)	0.07	1.0	2.1	0.69	0.04	0.6	1.3	0.43
7	Mustard	0.05	0.7	1.5	1.36	-	-	-	-
8	Moth bean	0.01	0.1	0.3	0.25	-	-	-	-
	Total kharif crops	3.31	49.0	100.0		3.23	49.5	100.0	
B Rabi									
9	Mustard	1.56	23.2	45.4	1.52	1.64	25.1	49.7	1.36
10	Gram (rainfed)	0.81	12.0	23.5	0.85	1.20	18.4	36.4	0.74
11	Wheat	1.00	14.8	29.0	3.78	0.42	6.4	12.7	3.66
12	Fenugreek	0.01	0.2	0.4	0.37	0.00	0.0	0.0	-
13	Barley	-	-	-	-	0.04	0.6	1.2	3.46
	Total rabi crops	3.45	51.0	100.0		3.30	50.5	100.0	
	GCA	6.75	100			6.53	100		

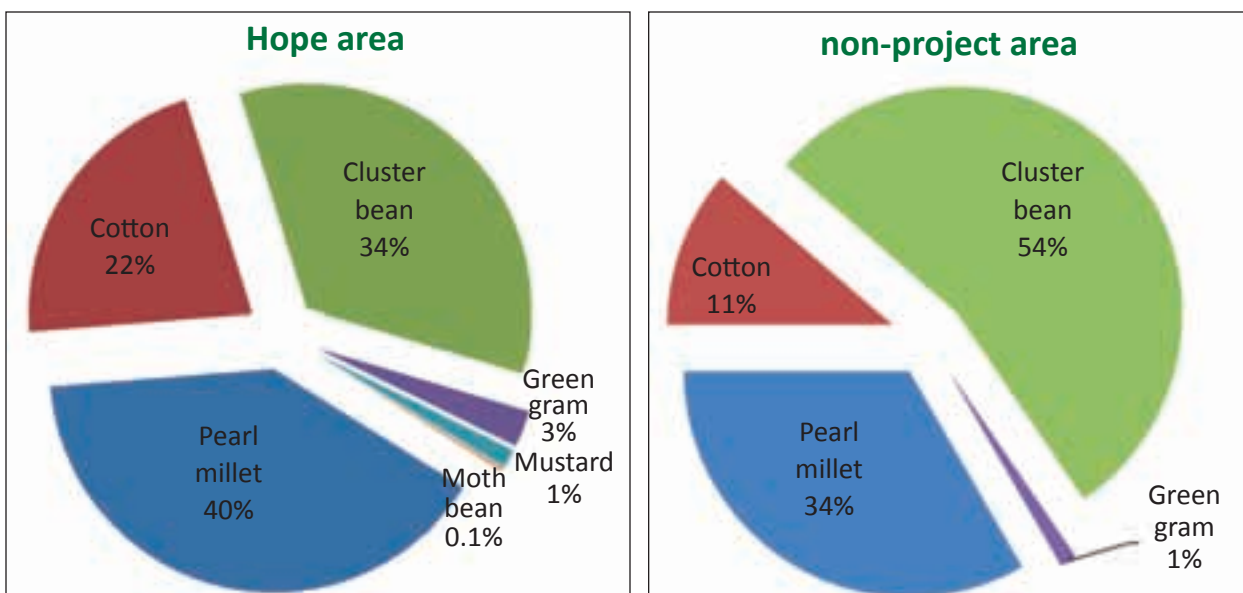


Figure 5. Choice of crops during kharif season in Haryana.

The role of the private sector in pearl millet seed production is increasing over time and is relevant to compare the productivity between public and private sector hybrids. The difference in productivity is pronounced in the rain fed areas in the above normal years (2.4 tons per ha by public hybrids and 3.0 tons per ha by private hybrids) and similarly in the irrigated conditions (3.4 tons per ha by public hybrids and 3.6 tons per ha by private hybrids) (Table 7). However, no private hybrids are available to perform when rainfall is below normal and the only recourse is to cultivate the public hybrids in such situations.

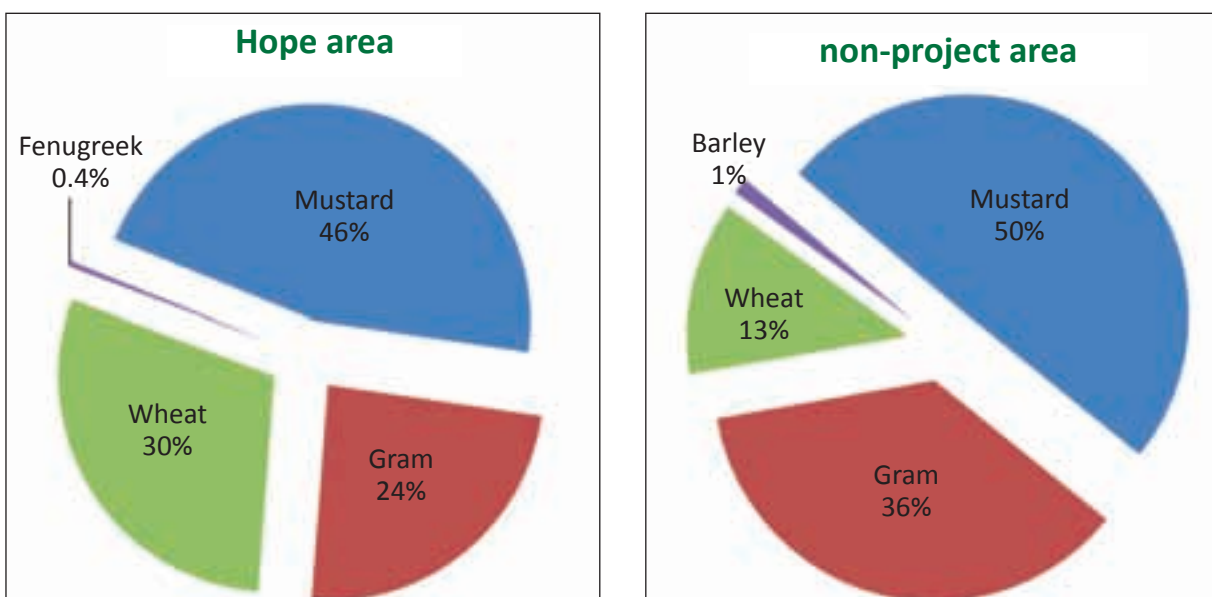


Figure 6. Choice of crops during rabi season in Haryana.

Table 7. Crop productivity in pearl millet among sample farmers in Haryana (kgs per ha): Opinion survey of farmers (tons per ha).

HOPE area				non-HOPE area			
Rainfed		Irrigated		Rainfed		Irrigated	
Public	Propriety	Public	Propriety	Public	Propriety	Public	Propriety
Normal Year (650 mm to 750 mm)							
1.9	-	2.6	2.7	1.8	-	3.1	3.1
Above normal (> 750 mm)							
2.8	2.5	3.0	3.4	2.4	3.0	3.4	3.6
Below normal (< 650 mm)							
0.5	-	1.3	1.3	0.4	-	1.8	1.5

In the HOPE clusters, the adoption rate of hybrids is at a peak covering around 48% (out of 124.5 ha) under public bred hybrids (HHB 67, HHB 67 Improved), and 50% under proprietary hybrids. Similarly in non-HOPE areas, 35% of the total area (out of 54.8 ha) is under public bred hybrids and rest is under proprietary hybrids (Table 8).

Table 8: Area adoption (in ha) of improved pearl millet hybrids in Haryana.

Particulars	HOPE area	non-HOPE area
Public hybrids (HHB 67 & HHB 67 Improved)	60 (48)	19 (35)
Proprietary hybrids (Pioneer 9444 & Nandi)	65 (52)	36 (65)

Note: Figure in parentheses is percentage of total

The yield gap of improved hybrids of pearl millet was estimated as 58-101% compared to a potential yield (as per recommendation the grain yield is 2.5-2.9 t/ha), which shows immense scope for improvement in productivity level with the introduction of recommended packages of practices, soil and moisture conservation and improved hybrids.

7. Economics of pearl millet according to input use and relative profitability

Considering the total production cost of pearl millet, HOPE farmers spent ₹ 10,739/ha as compared to non-HOPE farmers (₹ 10,060/ha), and this is because of their high input use with protective irrigation (Table 9). Of the various items of expenditure of sample farmers for pearl millet cultivation, the cost of harvesting dominates with 22% of the total cost. This is followed by input cost (seed, FYM and fertilizers). While comparing the total returns over all costs, HOPE farmers are realizing relatively low returns (₹ 14,349/ha) as compared to non-HOPE farmers (₹ 16,595/ha)

Comparing the cost of production with pearl millet, non-HOPE farmers are realizing higher returns, as compared to HOPE farmers. The net returns per ha in HOPE areas is ₹ 3610, while it is ₹ 6535 per ha in non-HOPE areas. This is due to the lower productivity of pearl millet in HOPE areas (1540 kg per ha) compared with 1790 kg per ha in non-HOPE areas.

Table 9. Economics of pearl millet among sample farmers in Haryana.

Particulars	HOPE area		non-HOPE area	
	value (₹)	Proportion to TC (%)	value (₹)	Proportion to TC (%)
Land preparation	925	9	1100	11
FYM application	823	8	725	7
Sowing	310	3	298	3
Input cost	1700	16	1625	16
Weeding	1402	13	1200	12
Harvesting	2320	22	2000	20
Threshing	630	6	759	8
Irrigation	1005	9	789	8
Bird watching	934	9	728	7
Marketing cost	82	1	267	3
Variable cost	10131	94	9491	94
Interest on variable cost @ 6% per annum	608	6	569	6
Total cost	10739	100	10060	100
Main product yield (t)	1.54		1.79	
Value of main product (₹ per t)	8227		8133	
By-Product yield (t)	2.6		3	
Value of by product (₹ per t)	646		679	
Total return	14349		16595	
Net return over total cost	3610		6535	
Return to cost ratio	1.34		1.65	

There are discernible differences among high and low management groups of farmers in the cultivation of pearl millet in Haryana. The grain output ranges from 1832 kg per ha in the high management group (HMG) to 1271 kg per ha in the low management group (LMG) in the HOPE area. Similar differences exist in non-HOPE areas. These differences are reflected in the fodder production in both the areas. Thus, it is imperative to improve grain and fodder output through management practices and this is possible by creating awareness among farmers (Table 10).

Table 10. Economics of pearl millet according to input usage (HMG: LMG) in Haryana (per ha).

Particulars	HOPE area		non-HOPE area	
	HMG (81 %)	LMG (19 %)	HMG (85%)	LMG (15%)
Grain yield (tons/ha)	1.83	1.27	2.18	1.61
Grain price received	8397	8049	8122	8085
Fodder yield	3	2.3	3.4	2.8
Fodder price received	971	243	998	490
Total cost	13096	9163	13369	8882
Total returns	18281	10780	21099	14390
Net returns	5185	1617	7730	5508
Return to cost ratio	1.40	1.18	1.58	1.62

8. Relative profitability of crops in Haryana

The relative performance of pearl millet hybrids varies from region to region in the *kharif* season. In HOPE and non-HOPE areas, the competing crops are cotton and cluster bean cultivated under assured irrigation. Bt-cotton fetches a net return of around ₹ 67,000 per ha in the HOPE area and ₹ 55,000 per ha in the non-HOPE area with an impressive benefit to cost ratio exceeding 3. Next to Bt cotton, cluster bean is a competing crop fetching a net return of around ₹ 14,000 in both the areas. Pearl millet is widely cultivated under rainfed conditions and in a few pockets with protective irrigation and has a lower return to cost ratio (1.34 and 1.65) in both HOPE and non-HOPE areas compared to other cash crops that are more profitable (Table 11).

Table 11. Relative profitability of crops in Haryana.

Particulars	HOPE area			non-HOPE area		
	Pearl millet	Cluster bean	Cotton Bt	Pearl millet	Cluster bean	Cotton Bt
TVC (₹/ha)	10130	6983	24801	7931	6990	25834
TC (₹/ha)	10739	7297	26186	10060	7304	26996
Main product yield (t/ha)	1.54	0.86	2.2	1.79	0.94	1.88
Unit Price of main product (₹/t)	8227	23000	43500	8133	20720	43500
By-Product yield (t/ha)	2.6	1.47		3	1.33	
Unit Price of by product (₹/t)	646	1000		679	1150	
Total return (₹/ha)	14349	21251	93656	16595	20989	81650
Net return over total cost (₹/ha)	3610	13954	67470	6535	13685	54654
Net return over total variable cost (₹/ha)	4219	13954	67470	8664	13685	54654
Return to cost ratio	1.34	2.91	3.58	1.65	2.87	3.02

9. Utilization of output (Grain and Fodder)

The exposure of pearl millet farmers to market differs between HOPE and non-HOPE areas. In the HOPE area, about 50 percent of the farmers reported no sales, while in the non-HOPE area 32 percent of the sample farmers did not sell their produce (Table 13). Thus, it can be assumed that around 50 percent of the farmers in HOPE area consume pearl millet and the rest of the farmers sell pearl millet in different markets. In the non-HOPE area around 32 percent of the farmers consume pearl millet and the rest of the farmers sell their pearl millet in different markets. This gives an indication that consumption of pearl millet is reducing over time due to the availability of wheat in the sample areas.

In the HOPE areas, farmers who wished to sell pearl millet (26 percent), preferred to sell in a regulated market for ₹ 8150 per ton compared with other market modes, and in the non-HOPE area 50 percent of farmers sold in the village market for ₹ 8300 per t (Table 12). From Table 12 it can be inferred that the farmers selling in the village market are attaining a better price compared to sales in the regulated market.

Table 12. Utilization and marketing of grain in Haryana by farmers.

Particulars	HOPE area (N= 120)				non-HOPE area (N=60)		
	No sale (49%)	Regulated (26%)	Village (19%)	Weekly (6%)	No sale (32%)	Village (50%)	Weekly (18%)
Grain produced (kg/farm)	1246	4723	2809	3071	966	3627	2164
Grain consumed (kg)/farm	161	37	83	89	145	30	200
Grain retained for future use (kg)/farm	1085	83	62	300	821	55	505
Marketable surplus (kg/farm)	-	4603	2664	2683	-	3542	1459
Grain sold (kg/farm)	-	4571	2423	2683	-	3559	1459
Price received (grain) (₹/t)	-	8150	8430	8570	-	8300	7730
Total marketing cost of Grain (₹/farm)	-	297	72	175	-	30	718

Due to the presence of milch cattle on all the sample farms, more than 50% of the fodder produced on the farm is retained for use by livestock (Table 13). In addition, farmers sell their surplus fodder in the informal market. Thus, pearl millet has the great capacity to meet both feed and fodder demand, while being cultivated with low soil moisture under harsh climatic conditions.

Table 13. Fodder production and utilization by farmers in Haryana

	HOPE area (N=120)				non-HOPE area (N=60)		
	No sale (49%)	Regulated (26%)	Village (19%)	Weekly (6%)	No sale (32%)	Village (50%)	Weekly (18%)
Crop area (ha)	1.1	1.7	1.5	1.7	1.3	1.9	0.8
Quantity of fodder produced (t/ha)	-	7.0	4.1	5.8	-	6.2	4.7
Fodder retained for own use (t/ha)	-	4.5	2.4	3.0	-	4.8	1.6
Quantity of fodder sold (t/ha)	-	1.8	1.7	4.3	-	1.4	3.2
Price received (Fodder) (₹/kg)	-	30	73	90	-	47	113
Total marketing cost of fodder (₹/t)	-	-	-	1000	-	-	5450

10. Production characteristics of technology and trait preferences of sample farmers

Opinions of farmers regarding pearl millet hybrids is dismal with regard to productivity, pest incidence and disease incidence as represented in the Table 14. 63% farmers in HOPE area and 48% farmers indicated poor taste and 26% farmers in HOPE area, 44% farmers in non-HOPE area indicated poor fodder quality.

Table 14. Production characteristics and traits of Pearl Millet in Haryana (%).

Characteristics	HOPE area	non-HOPE area
Low yield	2	0
High pest incidence	2	4
High disease incidence	2	4
Long duration	2	11
Small grain size	2	0
Unattractive colour	2	7
Poor taste	63	48
Low recovery/shelling %	2	4
Low market price	0	0
Doesn't fit into cropping system?	7	0
Poor fodder quality	26	44
Susceptible to storage pest	0	0

14.1. Preferred Trait

14.1.1. Production:

Among the preferred traits (proprietary hybrids/varieties) opined by the farmers, 100 percent preferred lower pest and disease incidence, 98 percent preferred high productivity, and 94 percent desired that the variety should have a high harvest index. Similar trends were observed in the non-HOPE area also.

Table 15. Production traits of pearl millet in Haryana (%).

Parameter	HOPE area	non-HOPE area
High yield	98	96
Short duration	2	0
Drought resistance	0	0
Pest resistance	100	96
Disease resistance	100	96
Fits in to cropping system	7	7
Improves soil fertility	0	0
Higher harvest index	94	81
Amenable to value addition	0	0

14.1.2. Consumption:

The study showed that 4 percent of the farmers desired characteristics such as better taste, less cooking time and high cooking quality in HOPE and non-HOPE areas. (Table 16)

Table 16. Consumption traits of pearl millet in Haryana (%).

Parameter	HOPE area	Non-HOPE area
Better taste	4	4
Less cooking time	4	4
High cooking quality	4	0

14.1.3. Fodder:

In the HOPE area, 96 percent of the sample farmers opined that fodder quantity is a crucial parameter for their selection of varietal types since pearl millet fodder is the preferred feed for she-buffaloes; this is followed by storability of the fodder. The fodder quality as indicated by palatability–quality and taste is the third ranking variable. A similar pattern is seen in non-HOPE areas.

Table 17. Fodder traits of pearl millet in Haryana (%).

Characteristics	HOPE area	non-HOPE area
More fodder quantity with leaves	96	96
Palatability (quality/taste)	2	11
Storability of fodder	7	0

14.1.4. Marketing: (Grain & fodder)

About 96 percent of the farmers opined better marketability for pearl millet of bigger grain size as the most important trait of proprietary hybrids, followed by high-demand and higher price. In non-HOPE areas, these farmers ranked high demand first, followed by low price fluctuations, bigger grain size and higher price.

Table 18. Marketing traits of pearl millet in Haryana (%).

Parameter	HOPE area	non-HOPE area
High demand	93	100
Fetches higher price	83	33
Low price fluctuations	19	96
Bigger grain size	96	93

11. Consumption level

The consumption of pearl millet is drastically reducing due to the availability of wheat in both HOPE and non-HOPE areas. In Haryana, pearl millet is gradually being rendered as an inferior good (Table 19). For instance, of the total food grains consumed, pearl millet consumption formed around 15%, while the consumption of wheat formed 80% in both the areas. Thus, the major and the only driver for the cultivation of pearl millet in Haryana, is the existing and growing demand for pearl millet fodder for she-buffaloes. As long as the demand for milk continues to grow, the demand for pearl millet fodder will grow.

Table 19. Per capita cereal consumption per annum in Haryana.

Parameter	HOPE area (Average family size: 5.5)		non-HOPE area (Average family size: 5.2)	
	Avg Quantity consumed as food and feed (in kgs)	% consumed	Avg Quantity consumed as food and feed (in kgs)	% consumed
Rice	3.6	3	3.8	3
Wheat	94.7	81	101.3	82
Pearl millet	18.9	16	19.1	15
Total Food grain	117.1	100	124.2	100

Farmers are of the opinion that the percentage decrease in the consumption of pearl millet is hardly 2% (Table 20). However, this opinion is contrary to the quantity of pearl millet consumed in relation to wheat (Table 16).

Table 20. Opinion survey regarding consumption of pearl millet in retrospect and prospect in Haryana.

Particulars	HOPE area	non-HOPE area
Percentage decrease in consumption	2	2
Wheat available at low price through PDS	1	1
Wheat preferred more by children & adults	1	1
By which crop is pearl millet replaced		
Wheat	2	2

12. Participation of labor force in the cultivation process according to gender

Women's role in pearl millet cultivation is apparent in a few operations, namely intercultural, bird watching, harvesting and threshing, while the rest of the farm operations are dominated by male labor. The involvement of gender in pearl millet cultivation is in all cultural activities except for plant protection and irrigation in both HOPE and non-HOPE areas (Table 21). In HOPE areas, for land preparation and sowing, 100 percent of the farmers indicated that only men are involved. For harvesting, 100 percent farmers indicated that men were involved and 66 percent farmers indicated that women were involved. For threshing 100 percent farmers indicated that men were involved and 48 percent farmers indicated that women were involved. Similarly, fertilizer application, 98 percent of the farmers indicated that only men are involved, 96 percent of the farmers indicated that men are involved in weeding. With regard to marketing, 41 percent indicated that men are involved. Similar trends were observed in non-HOPE areas as well.

Table 21. Gender involvement in pearl millet cultivation in Haryana.

Particulars	HOPE area (area 1.3 ha)			non-HOPE area (area 1.5 ha)		
	Man days	Women days	% involvement of men, women	Man days	Women days	% involvement of men, women
Land preparation	1.7	-	100, 0	3.2	1	100, 2
FYM application	7.2	-	47, 0	5.5	7	38, 2
Sowing	1.4	-	100, 0	1.3	-	100, 0
Fertilizer application	1.1	-	98, 0	1.1	-	98, 0
Intercultural/weeding	8.7	3.9	96, 56	6.5	5.8	98, 83
Irrigation	13.9	-	48, 0	18.3	-	47, 0
Bird watching	12.8	9.5	42, 13	8	6.5	43, 43
Harvesting	14.2	5.6	100, 66	11.2	9.1	100, 97
Threshing	2	1.5	100, 48	1.5	1.2	100, 48
Marketing	1.1	-	41, 0	1.3	-	48, 0

VI. Conclusion and policy implication

Pearl millet is a staple food and fodder crop in Haryana supporting poor smallholders and livestock in the harsh agro-climatic region. The baseline survey results reveal that pearl millet occupied 1/3rd of the total cropped area. The most popular improved hybrids of pearl millet that are being cultivated include HHB 67 and HHB 67 Improved, occupying an area of 48% in HOPE and 35% in non-HOPE areas. The main competing crops for pearl millet include cotton and cluster bean. There is a strong evidence that wheat will replace pearl millet (at present only 20% of pearl millet is consumed at home and 80% is sold in regulated or weekly markets). The marketed surplus of grain and fodder was to the tune of 80% and 25-40%. Farmers most preferred traits in public hybrids of pearl millet included drought resistance, better palatable fodder and tasty grain. Similarly, in the case of proprietary hybrids, the preferred traits are disease/pest resistance and fodder quality. The key constraints faced by the farmers in the adoption of improved hybrids are laborious harvesting backed by high wage rate, moisture stress, lack of appropriate machinery and shortage of fertilizers. To improve productivity, besides targeting improved hybrids, targeting the key recommended technologies and management practices is vital as there is a significant yield gap between the base line and the potential from the improved cultivars. While, Minimum Support Price (MSP) is announced for dryland cereals, none of them, including pearl millet grains, are procured. Hence MSP should be followed by procurement to provide market support to farmers. Farmers preferred hybrids responding to low input usage, short duration with good quality of grain and fodder, and drought and downy mildew tolerant attributes. Hence, these value added attributes need to be incorporated into the breeding program of pearl millet.

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