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Socio-economic status and millet-based farming: Comparative assessment for pearl millet and sorghum

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Abstract

This study examined the relationship between farm size, socio-economic status, and millet-based cropping patterns among agricultural households in Jaipur district of Rajasthan. Millets, particularly pearl millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*), play a crucial role in ensuring food security, nutritional sustainability and climate resilience. A Multistage stratified random research design was used in selection of 100 millet farmers to collect primary data through well-structured survey schedule. The study employed descriptive statistics and comparative analyses to assess variations in socio-economic attributes, resource ownership and cropping pattern decisions among the Jaipur district farmers. The results indicated the total population to represent 595 members, (349 adults, 122 children, and 124 senior citizens) from the surveyed household. The average family size was 6 members and the literacy levels were relatively high, with 480 literate members compared to 115 illiterate members. Medium farm holding had a mean of 2.71ha, compared to marginal (1.68 ha) and small farmers (0.91ha). The occupation diversity was higher in medium farmers (3) in relation to small and marginal which had mean of 2. In terms of cropped area, sorghum occupies the highest share (23.84%), followed by wheat (20.44%) and pearl millet (15.36%). 95% of cultivated area is distributed between Kharif and Rabi seasons, while Zaid cultivation remains limited. Human labour constituted the largest cost component (22.45%), followed by rental value of land (23.06%) and machinery charges (15.88%). The overall cost of sorghum cultivation stood at (30,692.87/ha) which is approximately 41.5% higher than the production cost of pearl millet (₹21,683.45/ha). Therefore, policymakers and concerned agencies can utilize the data to emphasize on cultivation of millets towards climate resilience and food and nutrition security.

Keywords: Cost and return, CACP, Cropping pattern, millets

1. Introduction

Agriculture is a key player in rural livelihood in Rajasthan, however sustainable agriculture is challenged in semi-arid regions by weather variability, decline in natural resources, and market fluctuations. Cultivation of resilient crops able to withstanding adverse environmental conditions has become a priority for ensuring food, nutrition and livelihood security, Kumar *et al.*, (2024) ^[9]. Among such crops, pearl millet and sorghum which have historically served as the foundation of farming systems in Rajasthan due to their adaptability to low rainfall, minimal input requirement, poor soil fertility, and high temperature conditions, Harish *et al.*, (2024) ^[6]. Beyond their agronomic advantages, these crops contribute significantly to nutritional security, livestock feeding, and income generation for rural households, with the declaration of millets as climate-smart and nutritionally important crops further enhancing their relevance within contemporary agricultural development strategies, Saxena *et al.*, (2018) ^[14].

Millets are known nutritional hub with potential to mitigate food insecurity constraints globally, Kumar *et al.*, (2024) ^[9]. They are marginalised food crops of various forms such as finger millet, proso millet, pearl millet and sorghum, among others. They are essential for balanced diet, as they provide a wide range of nutritional benefits such as high protein content, dietary fibre, vitamin, and mineral content for optimal health and wellbeing, Kumar *et al.*, (2024) ^[9]. Additionally, millets exhibit remarkable adaptability and durability to various agroecological conditions, making them a valuable resource for smallholder farmers functioning in resource-poor regions, Jain *et al.*, (2026) ^[7].

Sorghum (*Sorghum bicolor*) and Pearl millet (*Pennisetum glaucum*) are important cereal valued for their dual purpose as a food and fodder crop and performs well under moisture-stress conditions, Peter and Harish *et al.*, (2024) [6]. During 2020–21, Rajasthan state cultivated area under sorghum was approximately 0.56 million hectares which was 12.8 per cent of the national sorghum area of 4.38 million hectares, Yadav *et al.*, (2025) [20]. The crop is grown under rainfed conditions and contributes towards livelihood resilience in the semi-arid regions of Rajasthan. Pearl millet, on the other hand has unique tolerance to drought, high temperatures, and poor soil conditions, accounts for 55.7% of the national pearl millet area, Bairwa *et al.*, (2024) [2] and Jain *et al.*, (2026) [7]. Pearl millet and sorghum are low-input and risk-minimizing crops, adapted to adverse climatic conditions which makes them economically viable crops for resource-poor farmers, Singh *et al.*, (2025) [16]. Socio-economic characteristics of millet growers plays a key role in determining production decisions, resource allocation, and the adoption of improved agricultural practices. Differences in landholding size, educational status, occupational diversification, and access to productive resources often result in varying production strategies, resource utilization patterns, and levels of crop diversification among farmers. Understanding these variations is essential for identifying the constraints and opportunities associated with millet cultivation. Jaipur district, located in the eastern part of Rajasthan presents a unique setting for examining these variations due to the widespread cultivation of pearl millet and sorghum in the area. Against this backdrop, the present study investigates the socio-economic status, farm size characteristics, and cropping pattern diversity of pearl millet and sorghum growers in Jaipur district. The study aims to generate empirical evidence on how resource ownership and household characteristics shape agricultural decision-making and identify policy implications that can strengthen the productivity, profitability, and sustainability of millet-based farming systems in Rajasthan. The objective of the study was to: determine the socioeconomic characteristic of the farming community in Jaipur and the cropping patterns in the study area.

2. Methodology

Jaipur District is located in the eastern part of Rajasthan state. The study utilised survey through a multistage stratified sampling cum purposive research design in selection of the respondents in Jaipur district of Rajasthan.

3. Results and Discussion

3.1 Age-wise Distribution of Respondents

These results on age distribution (Fig. 1) revealed that agricultural production in Jaipur district was undertaken by individuals that belonged to economically active age group 25 – 45 years, (77%) of the total respondents which coincides with a study by Wang and Zhong, (2026) [18]. About 7% were young farmers (18–25 years) and 16% were above 45 years. Among marginal farmers, 42 respondents belonged to the middle age category compared to 4 respondents each from young and older age groups. A trend that was also identified in small and medium farmers. This dominance of middle-aged farmers shows that farming activities in the study area were highly managed by people with adequate farming experience while maintaining physical ability needed for intense agricultural work, Kabir *et al.*, (2024) [8]. It is an age group that is largely receptive when it comes to technological innovations, improved crop management practices as well as market-oriented farming compared to older farmers, Akinbobola *et al.*, (2025) [1].

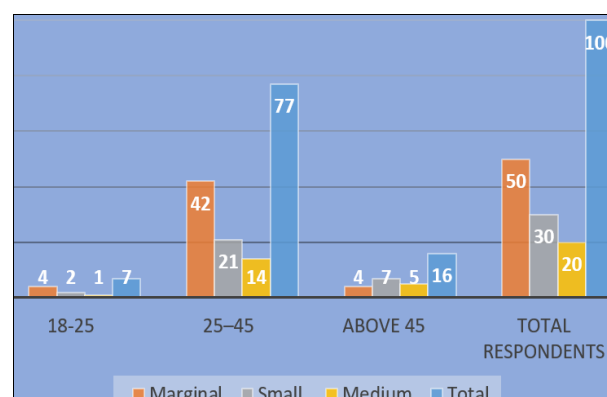


Fig 1: Age-wise Distribution of Respondents

3.2 Level of Education of Respondents in the Study Area

From the total respondents (fig. 2), 33% were illiterate, 30% had acquired education level below high school, 21% completed high school, 10% were at intermediate education level, with only 6% having graduated or higher qualifications. Illiteracy was highest among marginal farmers, where 19 out of 50 respondents lacked formal education. Studies show that education is an important socio-economic determinant capable of influencing farmers' managerial ability, adoption of technologies and ability to make decision, O'Donoghue and Heanue, (2018) [10]. This profile indicates low literacy levels across all farm size categories, an indication that although basic education was accessible in rural Rajasthan, a great deal of farmers continue to possess limited formal education.



Fig 2: Respondents' Level of Education in the Study Area

This is because limited education constraint farmers' ability in accessing scientific information, interpreting extension recommendations, maintaining farm records and utilization of digital agricultural information, Paltasingh and Goyari, (2018) [11]. While, respondents with secondary and higher education indicates gradual improvement in human capital, which may facilitate the adoption of improved crop varieties, mechanization, and better farm management practices, Verma, (2026) [17].

3.3 Cropping Pattern under Different Farm Size Groups

The cropping pattern (table 1) from the study area demonstrated that cereal-based farming systems was dominant but had limited diversification across seasons, with an average operational holding under cropping being 4.038 hectares. Where 47.96% of the cultivated area was growing Kharif crops, 46.92% Rabi crops and 5.13% only allocated for Zaid crops, an indication of intensive utilization of land within two major cropping seasons.

In Kharif season, bajra (15.36%) and sorghum (23.84%) emerged the principal crops, reflection of their suitability for semi-arid agro-climatic conditions of Jaipur district. Sorghum occupied a progressively larger proportion of land as farm size increased, suggesting that medium farmers possess greater capacity to cultivate this crop on larger areas due to better access

to land, capital, and production resources. Bajra also occupied a substantial share of cultivated land, reaffirming its importance as a drought-tolerant staple crop. Other Kharif crops such as maize and guar occupied comparatively smaller areas, indicating limited diversification during the rainy season.

Table 1: Cropping Pattern under Different Farm Size Groups

S. No.	Crop grown under different Seasons	Marginal (24)	%	Small (40)	%	Medium (36)	%	Overall Average	%
A	Kharif	0.947	47.18	1.77	49.19	2.781	47.30	1.936	47.96
1	Bajra	0.455	22.67	0.635	17.65	0.714	12.14	0.620	15.36
2	Sorghum	0.354	17.64	0.85	23.62	1.493	25.39	0.962	23.84
3	Guar	0.031	1.54	0.068	1.89	0.166	2.82	0.094	2.34
4	Maize	0.107	5.33	0.217	6.03	0.408	6.94	0.259	6.42
B	Rabi	0.913	45.49	1.685	46.83	2.781	47.30	1.894	46.92
1	Wheat	0.429	21.38	0.716	19.90	1.211	20.60	0.825	20.44
2	Mustard	0.219	10.91	0.503	13.98	0.715	12.16	0.511	12.66
3	Barley	0.135	6.73	0.216	6.00	0.431	7.33	0.274	6.79
4	Gram	0.13	6.48	0.25	6.95	0.424	7.21	0.284	7.03
C	Zaid	0.147	7.32	0.143	3.97	0.318	5.41	0.207	5.13
1	Watermelon	0.042	2.09	0.031	0.86	0.097	1.65	0.057	1.42
2	Muskmelon	0.042	2.09	0.075	2.08	0.076	1.29	0.067	1.67
3	Cucumber	0.063	3.14	0.037	1.03	0.145	2.47	0.082	2.03
	Grand Total	2.00	100.00	3.59	100.00	5.88	100.00	4.038	100.00

During Rabi season, wheat utilised biggest share of cropped area (20.44%), followed by mustard (12.66%), gram (7.03%) then barley (6.79%). This is an indication that wheat remained principal winter crop due to high market demand, stable yields and comparatively better irrigation facilities during the season, Bisht *et al.*, (2014) ^[3]. Mustard also occupied a significant area owing to its commercial importance as an oilseed crop. Then Zaid season accounted only a small proportion of 5.13% out of the total cultivated area, having cucumber, muskmelon and watermelon as the major crops, which is attributable to water scarcity during summer months, higher irrigation costs, and greater production risks associated with extreme temperatures, Debnath *et al.*, (2024) ^[5].

3.4 Per Hectare Cost of Cultivation of Pearl Millet

From the cost structure (table 2) of pearl millet cultivation, human labour took the largest proportion of operational cost which was at an average ₹4867.10 per hectare, while fertilizer and manure expenditure followed second at a cost of ₹2622.49, then machinery, seed, irrigation and plant protection chemicals costed ₹2584, ₹493.20, ₹982 and ₹394.48 respectively. Therefore, the average operational cost was estimated to be ₹11943.29 per hectare, while after inclusion of fixed costs, rental value of land, interest on fixed capital and managerial cost the total cost of cultivation was ₹20260.80 per hectare.

Table 2: Pearl Millet Per Hectare Cost of Cultivation

S. No.	Particulars	Size group of sample farms			Overall Average (100)
		Marginal (24)	Small (40)	Medium (36)	
1	Human Labour	3832.29	4970.88	5441.67	4867.10
	a. Family Labour	3308.33	4360.75	4743.05	4245.79
	b. Hired Labour	523.96	610.12	698.61	621.298
2	Machinery Charges	1800	2500	3200	2584
3	Seed Cost	353.54	512.65	564.72	493.20
4	Manure & Fertilizers	2480.63	2291.62	3084.72	2622.49
5	Irrigation	750	970	1150	982
6	Plant Protection	296.67	458.43	388.61	394.4724
8	Total operational cost	9513.13	11703.58	13829.72	11943.28
9	Interest on working capital @ 4%	380.52	468.14	553.18	477.73
10	Rental value of owned land	5000	5000	5000	5000
11	Interest on fixed capital @ 10%	768.17	895.15	1265.2	997.89
12	Sub-Total	15661.82	18066.87	20648.10	18418.90
13	Managerial Cost @ 10% of sub-total	1566.18252	1806.68732	2064.81088	1841.89065
	Grand Total	17228.00772	19873.56052	22712.91968	20260.79715

It was worth noting the declining contribution of family labour and the increasing dependence on hired labour and mechanization when farm size increased. Medium farmers incurred larger expenditure in machinery, fertilizers, irrigation and fixed capital an indication of greater investment capacity and adoption of improved production practices, Sarkar, (2020) ^[12].

3.5 Per Hectare Cost of Cultivation of Sorghum

Conversely, the cost assessment in sorghum cultivation (table 3) revealed production structure somehow differing from pearl millet. Its average total cost of cultivation was estimated at ₹28810.41 per hectare, lower than pearl millet majorly due to reduced labour requirements. Human labour costed on average ₹7077.88 per hectare, while machinery charges was at

₹5561.25 while fertilizers and seeds costed ₹4167.55 and ₹801.67 respectively representing major operational cost which was averaged in total to be ₹19596.5 per hectare, advancing to

₹26127.27 per hectare after including fixed costs and finally to ₹28810.41 per hectare when managerial cost was accounted for.

Table 3: Sorghum Per Hectare Cost of Cultivation

S. No.	Particulars	Size group of sample farms			Over all
		Marginal (24)	Small (40)	Medium (36)	Average (100)
1	Human Labour	3288.1	6540	11405.56	7077.88
	a. Family Labour	3162.5	5612.5	7147.22	5307.40
	b. Hired Labour	125.6	927.5	4258.33	1770.47
2	Machinery Charges	3245	5638.75	7800	5561.25
3	Seed Cost	655	800	950	801.66
4	Manures & Fertilizers	3103.33	4024.88	5374.44	4167.55
5	Irrigation	945	1382.5	1429.17	1252.22
6	Plant Protection	289.44	848.33	1070	735.92
8	Total operational cost	11525.87	19234.46	28029.17	19596.5
9	Interest on working capital @ 4%	461.0348	769.3784	1121.1668	783.86
10	Rental value of owned land	5000	5000	5000	5000
11	Interest on fixed capital @ 10%	678.16	537.23	1025.32	746.90
12	Sub-Total	17665.06	25541.06	35175.65	26127.26
13	Managerial Cost @ 10% of sub-total	1748.96	2558.44	3742.04	2683.14
	Grand Total	19414.02	28099.50	38917.69	28810.41

These results also indicated an increased trend in production costs as the farm sizes increased, whereby medium farmers experienced higher costs on plant protection measures, machinery, irrigation and fertilizers, reflecting greater resource availability and investment in improved cultivation practices, Chindarkar *et al.*, (2020) ^[4].

4. Limitations of the study

The study was done on selected villages in Jaipur district of Rajasthan. Thus, results reflect socio-economic attributes and cropping patterns of sampled farmers and may not be fit for generalization to other districts or agro-climatic regions that has differing farming systems, resource endowment and weather conditions.

The assessment was based on primary data collected within one agricultural year, failing to capture year-to-year fluctuations in rainfall, prices of input, yield and market conditions. Thus, including panel data from several years would give a more detailed understanding on changes in cropping patterns and farm performance.

5. Conclusion

From the discussion above we conclude that farming community in Jaipur district is primarily made up of middle-aged farmers with comparably low levels of formal education, especially within marginal farm setup. The cropping pattern is dominated by pearl millet and sorghum during Kharif season with wheat and mustard during Rabi season, which reflects how farmers were adapting to the semi-arid agro-climate conditions of the region. The analysis further revealed labour, fertilizer and machinery as the key components of pearl millet and sorghum per hectare cultivation that costed (₹4867.10, ₹2622.49 and ₹2584) and (₹7077.88, ₹4167.55 and ₹5561.25) respectively, with medium farmers investing higher in modern inputs and mechanization compared to marginal and small farmers. This study indicates that resource use, cropping decisions and investment capacity were influenced by size of the farm, while the sustained dominance of climate-resilient crops like pearl millet and sorghum showcase their importance in ensuring sustainable agricultural production. These findings suggest that if farmers access to education, extension services, modern

technologies and efficient input management were improved, then productivity, profitability and the long-term sustainability of farming systems in Jaipur district of Rajasthan will be enhanced.

Policy implications and recommendations

With considerable number of farmers, particularly marginal farmers possessing low levels of formal education, government agencies need to strengthen extension advisory services training the farmers regularly through farmer support programmes, demonstrations in the field and digital information services towards promotion of improved technologies, climate-resilient agriculture and efficiency in resource management.

Policies should encourage diversification to high-value and water-efficient crops since pearl millet and sorghum dominate the existing cropping pattern due to their resilience to semi-arid conditions.

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