



Productivity and Profitability of Cereal Legume Strip Cropping System In North Western Plains of India

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ABSTRACT

Background: Legume cropping systems are widely recognized for their potential to enhance productivity, improve resource use efficiency and increase farm income under diversified cropping situations. However, the performance of such systems largely depends on the choice of compatible crop combinations and their suitability to different seasons. In many parts of North-Western India, continuous dominance of cereal-based cropping has resulted in stagnation of system productivity and profitability. Therefore, evaluation of season specific cereal-legume strip cropping systems is necessary to identify productive and economically viable cropping options.

Methods: A field investigation was carried out during summer (*zaid*) and *kharif* of 2024 and 2025 at the Research Farm, Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu. The experiment comprised of nine cereal legume strip cropping systems arranged in a randomised block design with three replications. Various combinations of fodder (maize, sorghum and bajra) and legumes (mash, mungbean, cowpea and soybean) were assessed for their effect on yield attributes, equivalent yields and economic returns.

Result: The findings indicated that both productivity and profitability of the cropping systems differed significantly among seasons. Certain cereal legume combinations, particularly those involving mungbean and mash during summer (*zaid*) and soybean during *kharif*, consistently produced higher yields and system productivity. These systems also recorded higher gross and net returns along with better benefit cost ratio, thereby proving their economic advantage over the other cropping systems.

Key words: Cereal, Economics, Legume, Strip cropping, System productivity.

INTRODUCTION

India has made remarkable progress in food grain production from 50.82 million tonnes in 1950-51 to 332.98 million tonnes in 2022-23, mainly due to crop intensification of irrigated production systems (MoA and FW, 2023). Prolonged dependence on cereal monocropping has led to declining soil fertility, depletion of groundwater and protecting agro-ecosystem. Globally, diversified cropping systems are progressively encouraged as climate adaptive approaches to improve yield while reducing environment footprints. In the present times agriculture is increasingly seeking climate friendly, sustainable and highly productive cropping systems. Intensified crop diversification is crucial for meeting the fundamental needs for legumes and fodder. Also, the intensive cropping system must be highly productive, profitable, stable over time and maintain soil fertility for the future. This approach is recognized as an effective strategy to achieve national food security, income, growth, poverty alleviation, efficient land and water use with sustainable agricultural development besides employment generating. Therefore, crop intensification is proposed as a new strategy to enhance and stabilize productivity. Cereals and legumes in combination offers a promising solution by reducing dependence on nitrogen fertilizers while enhancing productivity, quality and profitability. Cereal-legume strip cropping systems are widely practiced in the

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tropics and subtropics because of their ability to enhance overall productivity, improve resource use efficiency and sustain soil fertility (Willey, 2023; Beets, 2022). In India, where cereal-based cropping systems dominate, integration of legumes into cropping systems plays a crucial role in maintaining system productivity, nutritional security and ecological sustainability (Rao and Willey, 2008).

Food legumes including (*Vigna radiata* L.), mash (*Vigna mungo* L.), cowpea (*Vigna unguiculata* L.), soybean (*Glycine max* L.) play a vital role in sustainable forage-based systems due to their capacity for biological nitrogen fixation and high nutritional value. By enriching soils with nitrogen and organic carbon. Legumes create long-term nutrient reserves that sustain cropping systems (Jharia *et al.*, 2018). In India, pulses have historically been regarded as the “protein of the poor,” yet their availability has steadily declined from 60.54 grams per capita in 1950-51 to just 53 grams in 2021-22. Also, their integration into farming practices contributes to healthier soils, reduced erosion, improved water conservation and even cleaner air (Stagnari *et al.*, 2017; Meena *et al.*, 2022). Although these legumes are traditionally cultivated as sole crops, integration with cereals enhances system productivity through complementary canopy structure, root distribution and nutrient uptake, leading to improved nutrient cycling and forage quality (Vandermeer, 1989).

However, the performance of cropping sequences is highly influenced by seasonal variations, choice of crop combinations and their adaptability to specific agro-ecological conditions (Dhima *et al.*, 2007). In regions like Jammu, where cropping is practiced under diverse seasonal environments such as *summer* and *kharif*, inappropriate selection of crop combinations often results in sub-optimal productivity and profitability. Although strip cropping is widely practiced, systematic information on the relative performance of different cereal legume combinations across seasons under the agro-climatic conditions of this region is still limited.

Keeping these aspects in view, the present investigation was undertaken to evaluate the productivity and profitability of legume under legume fodder cropping system under *summer* (*zaid*) and *kharif* at Jammu. The study aimed to identify efficient and economically viable crop combinations that could enhance system productivity and provide sustainable cropping options for the region.

MATERIALS AND METHODS

Field experiment was conducted at the Research Farm, Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, during the summer (*Zaid*) and *kharif* of 2024 and 2025 to study the productivity and profitability of different cereal legume strip cropping systems. The experimental site is situated at 32°40' N latitude and 74°58' E longitude with an altitude of about 332 m above mean sea level (Fig 1). The soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction (pH 7.56), low in organic carbon (4.28 g kg⁻¹), available nitrogen (228.73 kg ha⁻¹) but medium in available phosphorus (14.89 kg ha⁻¹) and potassium (145.65 kg h⁻¹). The experiment was laid out in a randomised block design with three replications and comprised nine cereal-legume strip cropping systems. During the summer (*zaid*), maize, sorghum and bajra were strip cropped with mash, cowpea and mungbean, while during the *kharif*, maize, bajra and sorghum were strip cropped with soybean, mungbean and mash with different strip combinations. The cropping systems included maize + mash followed by bajra + soybean, maize + cowpea followed by bajra + mungbean, maize + mungbean followed by bajra + mash, bajra + mash

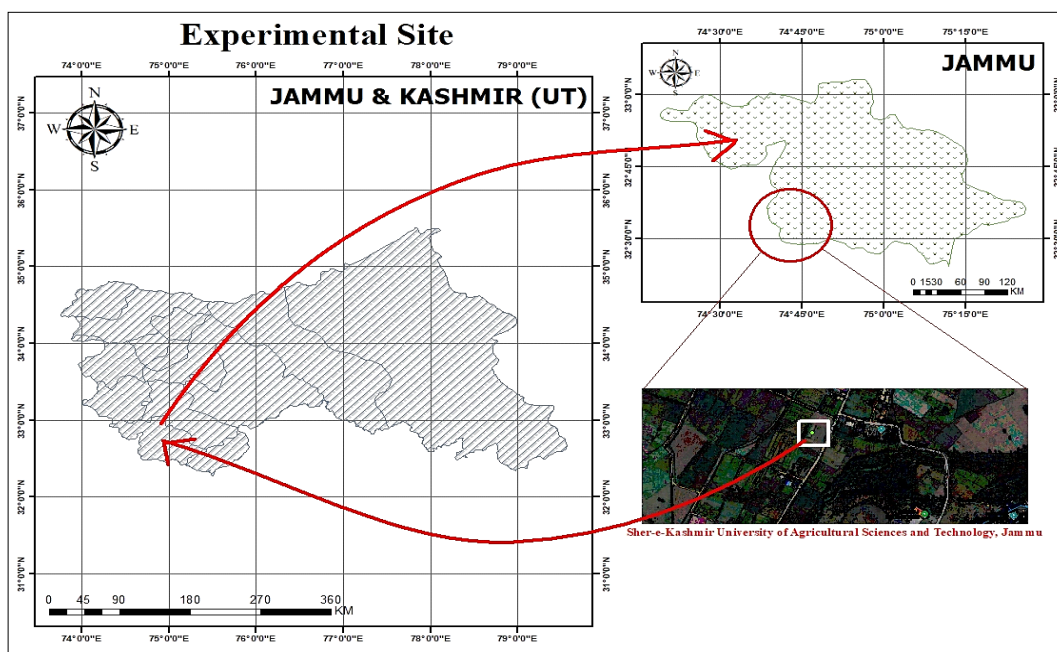


Fig 1: Study area and map.

followed by maize + soybean, bajra + cowpea followed by maize + mungbean, bajra + mungbean followed by maize + mash, sorghum + mash followed by sorghum + soybean, sorghum + cowpea followed by sorghum + mungbean and sorghum + mungbean followed by sorghum + mash. Gross plot size 4.0 m × 3.6 m (14.4 m²) and crops were grown in strip arrangement. All crops were sown manually were applied as per the package of practices of SKUAST-Jammu for respective crops. Pendimethalin @ 1.0 kg ha⁻¹ was applied as pre-emergence herbicide with knap snak sprayer with Tjet nozzle and further weed control was done manually when required. Fodder crops were harvested in two cuts in *kharif* and one cut in summer (*zaid*) whereas food crops were harvested at physiological maturity. Observations on yield attributes viz., 1000 test weight (g), seeds per pod, no of seeds per pod and yield (seed, stover yield and harvest index) of food were recorded from five randomly selected plants in each plot, while seed and stover yields were recorded and expressed in q/ha.

In fodder crops, green fodder and dry matter yields were recorded from the entire net plot area. For comparison among different cropping systems, yields of summer crops were converted into mash and maize equivalent yield and *kharif* crops into soybean and sorghum equivalent yield based on prevailing market prices.

The experimental data recorded on various yield attributes and yield parameters, equivalent yield, relative

economics, were summarized as mean values along with the standard error of mean (SEM ±) for comparison of treatments. However, the equivalent yield data were subjected to analysis of variance (ANOVA) appropriate to the randomized block design (RBD) to test the significance of treatment effects. The significance of differences among treatment means was tested at 5% level of probability ($P \leq 0.05$) and the critical difference (CD) was calculated wherever the treatment effects were found significant following the procedure described by Gomez *et al.* (1984).

RESULTS AND DISCUSSION

Summer (Zaid)

Yield attributes and seed yield of legumes

The yield attributes and seed yield of legumes were significantly influenced by different cereal-legume strip cropping systems during both years (Table 1 and 2). Among the different combinations, sorghum + mungbean consistently produced the highest test weight, number of pods per plant and number of seeds per pod, which resulted in the maximum seed yield. This was followed by maize + mungbean, whereas bajra-based systems recorded comparatively lower values. The superior performance of mungbean when strip cropped with sorghum may be attributed to better light interception, reduced interspecific competition and more efficient

Table 1: Yield attributes of food (pulse) at different intervals during *summer* season.

Treatment details	1000 test weight (g)		Seeds per pod		No. of pods per plant	
	2024	2025	2024	2025	2024	2025
T ₁ - Maize+Mash	35.16±0.91	37.84±0.52	6.67±0.09	7.28±0.10	15.51±0.34	16.23±0.43
T ₂ - Maize+Cowpea	10.85±0.27	11.97±0.37	11.56±0.26	11.65±0.33	15.56±0.38	15.72±0.32
T ₃ - Maize+Mungbean	36.76±1.65	39.21±1.87	9.53±0.41	9.91±0.26	10.75±0.18	11.24±0.57
T ₄ - Bajra+Mash	36.04±0.61	38.83±2.26	7.00±0.47	7.72±0.29	15.84±0.67	16.67±1.14
T ₅ - Bajra+Cowpea	11.53±0.37	12.77±0.15	11.69±0.70	11.87±0.34	16.39±0.64	16.67±0.30
T ₆ - Bajra+Mungbean	37.13±0.53	39.85±1.13	9.80±0.47	10.45±0.29	10.87±0.23	11.63±0.48
T ₇ - Sorghum+Mash	36.40±1.76	39.38±0.99	7.33±0.28	8.25±0.16	15.65±0.63	16.67±0.95
T ₈ - Sorghum+Cowpea	11.67±0.82	13.03±0.19	11.67±0.39	11.96±0.47	16.61±0.51	17.01±0.33
T ₉ - Sorghum+Mungbean	37.64±2.05	40.47±0.94	10.12±0.15	10.88±0.41	11.17±0.62	12.04±0.68

Table 2: Seed, stover yield (q/ha) and harvest index (%) of *summer* season.

Treatment details	Seed yield (q/ha)		Stover yield(q/ha)		Harvest index (%)	
	2024	2025	2024	2025	2024	2025
T ₁ - Maize+Mash	3.11±0.12	3.80±0.12	6.03±0.11	6.82±0.41	33.99±2.28	35.79±0.97
T ₂ - Maize+Cowpea	3.52±0.06	4.23±0.12	9.07±0.52	9.97±0.58	27.96±0.54	29.80±1.89
T ₃ - Maize+Mungbean	4.49±0.11	5.23±0.33	8.98±0.36	9.23±0.23	33.34±0.41	36.17±2.46
T ₄ - Bajra+Mash	3.24±0.14	3.88±0.22	6.24±0.33	7.00±0.21	34.17±1.31	35.67±1.77
T ₅ - Bajra+Cowpea	3.66±0.13	4.25±0.27	9.32±0.32	10.67±0.32	28.19±1.35	28.49±1.85
T ₆ - Bajra+Mungbean	4.63±0.25	5.27±0.17	9.26±0.25	10.09±0.23	33.33±2.07	34.33±1.22
T ₇ - Sorghum+Mash	3.38±0.04	4.15±0.09	6.42±0.23	7.48±0.16	34.49±0.34	35.66±2.43
T ₈ - Sorghum+Cowpea	3.94±0.05	4.74±0.13	9.87±0.42	10.42±0.49	28.50±1.98	31.24±0.35
T ₉ - Sorghum+Mungbean	4.77±0.29	5.60±0.23	9.54±0.41	10.67±0.59	33.33±0.33	34.41±2.33

utilization of soil moisture and nutrients. Similar advantages of cereal legume intercropping, particularly sorghum based systems, have also been reported earlier by Kumar *et al.* (2018) and Duvvada *et al.* (2020). The relatively poor performance of soybean and mash during summer could be due to their comparatively longer duration and sensitivity to high temperature stress prevailing during the season.

Equivalent yields

Equivalent yield in terms of total fodder yield, pulse yield and equivalent yields varied significantly among the strip cropping systems (Table 3). Sorghum-based systems recorded markedly higher green fodder yield compared to maize and bajra, reflecting the higher biomass production potential of sorghum. Among all different cropping sequences, sorghum + mungbean produced the highest pulse yield as well as mash and maize equivalent yields, indicating its superiority in overall system productivity. Higher equivalent yield under this system may be attributed to the combined effect of higher fodder yield of sorghum and better grain yield of mungbean. These findings are in close agreement with earlier reports that highlighted the productivity advantage of sorghum legume cropping sequences (Rana *et al.*, 2017; Patel *et al.*, 2019).

Economics

The economic analysis of the different cropping systems revealed considerable variation in profitability across both years of experimentation (Table 4). Among the evaluated systems, sorghum + mungbean consistently recorded the highest gross, net returns and benefit-cost ratio, followed closely by maize + mungbean. The higher gross, net returns and benefit-cost ratio observed under these cropping sequences were mainly due to the combined advantage of food and fodder yields, along with relatively lower costs of cultivation. In context of equivalent yield, the superior performance of sorghum + mungbean can be attributed to its higher productivity and the comparatively greater market value of mungbean grain, which significantly enhanced overall profitability. Thus, sorghum + mungbean emerged as the most economically viable option, offering farmers both higher returns and greater stability through its balanced contribution of grain and fodder. In contrast, bajra based cropping systems recorded comparatively lower gross and net returns as well as benefit cost ratio. Similar trends have also been reported by Ginwal *et al.* (2019) and Yadav *et al.* (2022) who observed that sorghum-based cropping sequences with legumes significantly enhanced productivity and profitability compared to sole cropping.

Kharif

Yield attributes and seed yield of legumes

During *kharif*, yield attributes and seed yield of legumes were significantly affected by different cropping systems (Table 5 and 6). Sorghum + soybean recorded the test weight, highest number of pods per plant, seeds per pod

Table 3: Yield (q/ha) of food -fodder during summer season.

Treatment details	Total fodder yield (q/ha)		Food yield (q/ha)		Mash equivalent yield (q/ha)		Maize equivalent yield (q/ha)	
	2024	2025	2024	2025	2024	2025	2024	2025
T ₁ - Maize+Mash	170.88±12.50	179.21±5.60	3.11±0.05	3.80±0.23	8.88±0.48	9.54±0.44	262.86±8.33	297.80±19.58
T ₂ - Maize+Cowpea	172.89±4.74	181.69±3.78	3.52±0.08	4.23±0.06	9.65±0.44	10.06±0.24	285.54±14.45	313.72±19.44
T ₃ - Maize+Mungbean	172.51±6.86	182.92±3.81	4.49±0.22	5.23±0.24	11.10±0.54	11.09±0.40	328.54±12.59	346.08±9.17
T ₄ - Bajra+Mash	114.35±6.28	122.30±3.65	3.24±0.14	3.88±0.05	7.10±0.48	7.80±0.46	210.21±12.83	243.41±7.83
T ₅ - Bajra+Cowpea	116.94±2.99	126.06±8.47	3.66±0.21	4.25±0.20	7.91±0.36	8.23±0.40	234.01±7.53	256.72±17.85
T ₆ - Bajra+Mungbean	118.19±5.14	125.42±3.44	4.63±0.17	5.27±0.32	9.43±0.55	9.33±0.12	279.01±9.90	290.97±16.11
T ₇ - Sorghum+Mash	257.78±7.32	262.35±5.96	3.38±0.11	4.15±0.28	10.35±0.22	10.87±0.35	306.21±9.56	339.21±13.16
T ₈ - Sorghum+Cowpea	260.28±5.54	264.78±6.14	3.94±0.21	4.74±0.12	11.29±0.45	11.52±0.20	334.15±4.43	359.56±11.91
T ₉ - Sorghum+Mungbean	261.34±13.60	267.45±2.91	4.77±0.08	5.60±0.20	12.66±0.57	12.46±0.15	374.68±18.79	388.64±23.17
SEm(±)					0.21	0.38	4.37	4.98
CD(p<0.05)					0.64	1.14	13.11	14.93

and seed yield, closely followed by sorghum + mash. The superior performance of soybean and mash under sorghum based systems may be attributed to favourable microclimatic conditions, better spatial complementarity and efficient utilization of growth resources. In contrast, maize and bajra-based systems recorded comparatively lower yields, possibly due to higher interspecific competition. The better performance of soybean and mash during *kharif* compared to mungbean and cowpea may also be related to their better adaptation to monsoonal conditions. These results corroborate the findings of Verma *et al.* (2019) and Choudhary *et al.* (2020).

Equivalent yields

Sorghum based cropping sequences again outperformed maize and bajra-based systems in terms of total fodder yield and equivalent yields during *kharif* (Table 7). Among the treatments, sorghum + soybean produced the highest pulse yield and soybean equivalent yield, while sorghum + mash recorded comparable system productivity. The higher system productivity under these treatments can be attributed to higher biomass production of sorghum and better yield potential of soybean and mash during *kharif*. The comparatively lower performance of bajra-based systems may be due to their lower fodder yield and weaker

Table 4: Relative economics of food fodder during *summer* season.

Treatment details	Cost of cultivation (₹/ha)		Gross returns (₹/ha)		Net returns (₹/ha)		Benefit:Cost ratio	
	2024	2025	2024	2025	2024	2025	2024	2025
T ₁ - Maize+Mash	26790.77	26790.77	65714.72	74449.02	38923.95	47658.25	1.45	1.78
T ₂ - Maize+Cowpea	26681.57	26681.57	71385.46	78431.19	44703.89	51749.62	1.68	1.94
T ₃ - Maize+Mungbean	27016.57	27016.57	82135.40	86520.28	55118.83	59503.71	2.04	2.20
T ₄ - Bajra+Mash	30695.5	30695.50	52553.00	60852.52	21857.50	30157.02	0.71	0.98
T ₅ - Bajra+Cowpea	30585.00	30585.00	58503.15	64180.65	27918.15	33595.65	0.91	1.10
T ₆ - Bajra+Mungbean	30920.50	30920.50	69751.59	72741.94	38831.09	41821.44	1.26	1.35
T ₇ - Sorghum+Mash	25841.57	25841.57	76553.20	84801.37	50711.63	58959.80	1.96	2.28
T ₈ - Sorghum+Cowpea	25216.57	25216.57	83537.48	89890.00	58320.91	64673.43	2.31	2.56
T ₉ - Sorghum+Mungbean	26136.57	26136.57	93668.80	97159.19	67532.23	71022.62	2.58	2.72

Table 5: Yield attributes of food (pulse) at different intervals during *kharif* season.

Treatment details	1000 seed weight (g)		No. of pods per plant		Seeds per pod	
	2024	2025	2024	2025	2024	2025
T ₁ - Bajra+Soyabean	8.95±0.31	10.07±0.61	13.46±0.52	13.52±0.60	9.16±0.80	9.28±0.36
T ₂ - Bajra+Mungbean	34.76±1.81	37.21±0.55	8.55±0.36	8.94±0.21	7.03±0.45	7.48±0.60
T ₃ - Bajra+Mash	33.06±2.25	35.74±0.57	13.21±0.40	13.83±0.39	4.07±0.78	4.75±0.26
T ₄ - Maize+Soyabean	9.33±0.36	10.57±0.21	13.99±0.34	14.17±0.87	8.99±0.34	9.23±0.96
T ₅ - Maize+Mungbean	34.83±1.05	37.55±0.66	8.37±0.42	9.03±0.52	7.90±0.16	8.62±0.23
T ₆ - Maize+Mash	33.64±1.99	36.43±0.53	13.24±0.24	13.97±0.35	5.00±0.54	5.79±0.58
T ₇ - Sorghum+Soyabean	9.17±0.40	10.53±0.59	13.91±0.55	14.21±0.28	9.57±0.52	9.93±0.97
T ₈ - Sorghum+Mungbean	35.04±0.80	37.87±1.42	9.27±0.65	10.04±0.51	7.92±0.56	8.75±0.33
T ₉ - Sorghum+Mash	33.70±1.64	36.68±1.61	13.65±0.31	14.57±0.91	5.03±0.21	6.01±0.43

Table 6: Seed, stover yield (q/ha) and harvest index (%) of *kharif* season.

Treatment details	Seed yield (q/ha)		Stover yield (q/ha)		Harvest index (%)	
	2024	2025	2024	2025	2024	2025
T ₁ - Bajra+Soyabean	15.78±0.46	17.05±0.99	35.37±1.74	36.15±0.39	30.85±0.35	32.05±1.11
T ₂ - Bajra+Mungbean	12.67±0.62	13.88±0.62	34.86±1.04	35.66±2.43	26.66±0.64	28.02±0.84
T ₃ - Bajra+Mash	13.67±0.22	13.96±0.57	31.93±1.06	32.70±1.81	28.41±0.79	29.92±2.11
T ₄ - Maize+Soyabean	16.94±0.26	18.18±1.15	34.54±0.54	35.39±1.46	32.91±0.83	33.94±1.70
T ₅ - Maize+Mungbean	12.89±0.37	14.10±0.76	34.58±1.78	35.44±0.37	27.15±0.85	28.46±1.14
T ₆ - Maize+Mash	13.5±0.42	14.77±0.71	31.64±1.29	32.48±0.83	29.91±1.56	31.26±1.12
T ₇ - Sorghum+Soyabean	17.72±0.48	19.17±0.60	34.82±0.35	36.81±0.82	33.72±1.80	34.25±0.41
T ₈ - Sorghum+Mungbean	13.43±0.58	14.85±0.21	35.82±0.80	36.13±2.50	27.27±0.39	29.13±0.47
T ₉ - Sorghum+Mash	15.84±0.32	17.32±0.71	32.12±0.50	33.09±2.16	33.03±1.94	34.36±0.52

Table 7: Yield (q/ha) of food-fodder during *summer* season.

Treatment details	Total fodder yield (q/ha)		Food yield (q/ha)		Soyabean equivalent yield (q/ha)		Sorghum equivalent yield (q/ha)	
	2024	2025	2024	2025	2024	2025	2024	2025
T ₁ - Bajra+Soyabean	194.67±10.04	209.07±6.92	15.78±0.39	17.00±0.59	18.66±0.90	19.75±0.30	1261.40±16.11	1437.84±26.53
T ₂ - Bajra+Mungbean	196.38±6.78	211.95±6.02	12.67±0.46	13.63±0.67	19.14±0.52	19.20±1.14	1293.86±36.12	1397.64±93.89
T ₃ - Bajra+Mash	197.65±13.28	218.23±11.46	13.67±0.71	14.91±0.18	17.89±0.73	18.77±0.41	1209.23±12.59	1366.65±71.12
T ₄ - Maize+Soyabean	234.72±6.33	277.22±14.82	16.94±0.49	17.73±1.23	20.41±0.32	21.06±0.22	1379.86±83.56	1532.96±70.35
T ₅ - Maize+Mungbean	235.12±12.24	258.95±5.39	12.89±0.27	13.94±0.89	19.99±0.55	20.14±0.67	1351.65±42.84	1465.93±31.90
T ₆ - Maize+Mash	236.08±5.03	257.77±12.32	13.5±0.79	15.72±1.07	18.27±0.77	20.21±1.40	1235.08±66.03	1471.49±31.33
T ₇ - Sorghum+Soyabean	272.45±18.30	334.78±9.82	17.72±0.39	18.12±1.08	21.75±0.67	21.94±1.42	1470.32±20.17	1596.92±40.80
T ₈ - Sorghum+Mungbean	274.83±11.70	345.28±12.74	13.43±0.62	14.00±0.38	21.27±0.44	20.72±0.22	1438.14±87.09	1508.41±104.90
T ₉ - Sorghum+Mash	275.92±15.66	344.72±8.32	15.84±0.27	16.27±0.98	21.42±1.03	21.36±0.60	1448.08±41.79	1554.95±101.52
SEm(±)					2.05	1.95	16.87	22.28
CD(p≤0.05)					6.15	3.25	50.57	66.78

Table 8: Relative economics of food fodder during *kharif* season.

Treatment details	Cost of cultivation (₹/ha)		Gross returns (₹/ha)		Net returns (₹/ha)		Benefit:Cost ratio	
	2024	2025	2024	2025	2024	2025	2024	2025
T ₁ - Bajra+Soyabean	41469.00	41469.00	98131.50	143784.00	56662.50	102315.00	1.37	2.47
T ₂ - Bajra+Mungbean	44095.50	44095.50	149602.50	139763.84	105507.00	95668.34	2.39	2.17
T ₃ - Bajra+Mash	43870.50	43870.50	129525.00	136665.00	85654.50	92794.50	1.95	2.12
T ₄ - Maize+Soyabean	41651.00	41651.00	125403.00	153296.40	83752.00	111645.40	2.01	2.68
T ₅ - Maize+Mungbean	40191.57	40191.57	122566.00	146592.92	82374.43	106401.35	2.05	2.65
T ₆ - Maize+Mash	39966.57	39966.57	154465.50	147149.00	114498.93	107182.43	2.86	2.68
T ₇ - Sorghum+Soyabean	40476.80	40476.80	140826.00	159691.60	100349.20	119214.80	2.48	2.95
T ₈ - Sorghum+Mungbean	39371.57	39371.57	156022.00	150841.00	116650.43	111469.43	2.96	2.83
T ₉ - Sorghum+Mash	39016.57	39016.57	155958.00	155495.00	116941.43	116478.43	3.00	2.99

competitive ability under strip cropping. Similar observations on the superiority of sorghum-legume systems have also been reported by Meena *et al.* (2018) and Singh *et al.* (2022).

Economics

The economic performance of different intercropping systems during *kharif* followed a trend similar to equivalent yields (Table 8). Sorghum + mash recorded the highest gross returns, net returns and benefit cost ratio, closely followed by sorghum + soybean. Although sorghum + soybean produced the highest equivalent yield, the slightly higher profitability of sorghum + mash may be attributed to lower cost of cultivation and favourable market price of mash. Bajra-based strip cropping systems recorded the lowest economic returns due to their lower productivity. The close association between system productivity and profitability in strip cropping systems has also been emphasized by earlier workers (Gupta *et al.*, 2017; Islam *et al.*, 2020; Ngwira *et al.*, 2020) who observed that cereal legume cropping systems significantly improved system productivity and profitability compared with sole cropping. The higher economic returns were mainly attributed to better resource use efficiency and the additional income obtained from the legume component.

CONCLUSION

The study demonstrated that cereal legume strip cropping systems differed significantly in productivity and profitability across seasons. Among the tested combinations, sorghum-based strip cropping systems consistently outperformed maize and bajra-based systems during both *summer* and *kharif* seasons. During *summer*, sorghum + mungbean proved to be the most productive and profitable system in terms of higher seed yield, system productivity, net returns and benefit cost ratio. In *kharif*, sorghum + soybean and sorghum + mash emerged as the most efficient systems, with sorghum + mash recording the highest economic returns. The superiority of these systems was mainly attributed to higher biomass production of sorghum and better compatibility of associated legumes. Therefore, sorghum-based strip cropping, particularly sorghum + mungbean in summer and sorghum + soybean or mash in *kharif*, can be recommended for enhancing system productivity and farm profitability under subtropical conditions.

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Conflict of interest

All authors declared that there is no conflict of interest.

REFERENCES

- Beets, W.C. (2022). Multiple Cropping and Tropical Farming Systems. Westview Press.
- Choudhary, S., Sharma, R. and Singh, P. (2020). Productivity and profitability of cereal legume intercropping systems under subtropical conditions. *Journal of Agronomy*. **19(2)**: 101-110.
- Cochran, W.G. and Cox, G.M. (1963). Experimental Designs. Asia Publishing House, New Delhi. pp. 293-316.
- Dhima, K.V., Lithourgidis, A.S., Dordas, C.A. and Vlachostergios, D.N. (2007). Competition indices of common vetch-cereal intercropping systems in a Mediterranean environment. *European Journal of Agronomy*. **26(1)**: 39-46. <https://doi.org/10.1016/j.eja.2006.07.002>.
- Duvvada, S.K. and Maitra, S. (2020). Sorghum-based intercropping system for agricultural sustainability. *Indian Journal of Natural Sciences*. **10(60)**: 20306-20313.
- Ginwal, D.S., Kumar, R., Ram, H., Dutta, S., Arjun, M. and Hindoriya, P.S. (2019). Fodder productivity and profitability of different maize and legume intercropping systems. *Indian Journal of Agricultural Sciences*. **89(9)**: 1451-55.
- Gupta, R., Sharma, S. and Lal, R. (2017). Economic evaluation of cereal-legume intercropping systems under subtropical conditions. *Indian Journal of Agronomy*. **62(3)**: 321-328.
- Gomez, P., Coca, C., Vargas, C., Acebillo, J. and Martinez, A., (1984). Normal reference-intervals for 20 biochemical variables in healthy infants, children and adolescents. *Clinical Chemistry*. **30(3)**: 407-412.
- Islam, M., Nath, L.K. and Samajdar, T. (2020). Sustainable diversification of maize (*Zea mays* L.)-legumes cropping systems for productivity, profitability and resource-use efficiency in West Garo Hills of Meghalaya, India. *Legume Research*. **43(3)**: 427-431. doi: 10.18805/LR-3970.
- Jhariya, M.K., Banerjee, A., Yadav, D.K., Raj, A. (2018). Leguminous Trees an Innovative Tool for Soil Sustainability. Legumes for Soil Health and Sustainable Management. Springer, Singapore. pp. 315-345. https://doi.org/10.1007/978-981-13-0253-4_10.
- Kumar, R., Singh, M. and Verma, A. (2018). Performance of sorghum-legume intercropping systems under varying nutrient regimes. *Journal of Food Legumes*. **31(1)**: 45-52.
- Meena, R.S., Kumar, S. and Singh, J. (2018). Evaluation of sorghum-based intercropping systems for improved productivity in subtropical conditions. *Journal of Cereal Research*. **10(1)**: 55-63.
- MoA and FW. (2023). Agricultural Statistics at a Glance. Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.
- Ngwira, A.R., Kabambe, V., Simwaka, P., Makoko, K. and Kamoyo, K. (2020). Productivity and profitability of maize-legume cropping systems under conservation agriculture among smallholder farmers in Malawi. *Acta Agriculturae Scandinavica, Section B and Plant Science*. **70(3)**: 241-251.
- Patel, K.B., Patel, R.K. and Mehta, S. (2019). Productivity and economic feasibility of sorghum-legume intercropping systems. *Indian Journal of Agronomy*. **64(2)**: 245-251.

- Rana, R.S., Sharma, P. and Singh, A. (2017). Effect of intercropping on productivity and profitability of sorghum-based cropping systems. *Forage Research*. **42(1)**: 40-46.
- Rao, M.R. and Willey, R.W. (2008). Evaluating of yield stability in intercropping: Studies on sorghum/pigeonpea. *Experimental Agriculture*. **16(2)**: 105-116.
- Sharma, R., Verma, S. and Yadav, P. (2018). Economics of sorghum-legume intercropping systems under subtropical conditions. *Forage Research*. **44(1)**: 23-28.
- Singh, R., Meena, R. and Kumar, A. (2022). Comparative performance of cereal-legume intercropping systems under *kharif* season. *Indian Journal of Agronomy*. **67(1)**: 112-120.
- Stagnari, F., Maggio, A., Galieni, A. and Pisante, M. (2017). Multiple benefits of legumes for agriculture sustainability: An overview. *Chemical and Biological Technologies in Agriculture*. **4(1)**: 1-13. <https://doi.org/10.1186/s40538-016-0085-1>.
- Vandermeer, J.H. (1989). The Ecology of Intercropping. Cambridge University Press. <https://doi.org/10.1017/CBO9780511623523>.
- Verma, A., Choudhary, S. and Singh, D. (2019). Productivity and profitability of soybean intercropped with cereals under subtropical conditions. *Journal of Food Legumes*. **32(2)**: 90-96.
- Willey, R.W. (2023). Intercropping: Its importance and research needs. Part I. Competition and yield advantages. *Field Crop Abstracts*. **32(1)**: 1-10.
- Yadav, M.R., Singh, M., Kumar, R., Kumar, D., Meena, R.K., Ram, H. and Makarana, G. (2022). Integrated nutrient management in maize-cowpea intercropping system is an attractive option to improve the fodder productivity and quality. *Communications in Soil Science and Plant Analysis*. doi: 10.1080/00103624.2022.2101660.