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Socio-economic appraisal of small and marginal farmers of Jammu for sustainable livelihood

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Abstract

The cropping and farming systems of households in the Jammu region were analysed based on primary data collected from a sample of 480 farmers in the year 2022-2023. The study area encompassed Jammu, Samba, Reasi and Udhampur districts. Predominantly, the study area exhibited cereal-based and livestock-based farming systems. Livestock and cereals served as the primary sources of farm income across all districts, while non-farm activities contributed significantly to their overall income. The research aimed to assess the livelihood diversification of rural farmers in the state of Jammu. The purposive sampling technique was employed to select sample communities, from which a total of 480 households were randomly chosen for the study. Data collection involved both quantitative and qualitative methods. The quantitative approach employed a structured questionnaire, while the qualitative approach involved the use of Participatory Rural Appraisal (PRA) tools. The study revealed that the mean age of the sampled farmers was 38.3 ± 0.6 years, falling within the range of 19 to 68 years and above. Additionally, there were more adults aged 43.8 ± 1.7 years in the range of 20 to 70 in the study area. In terms of gender distribution, males constituted 71.15% of the sample, while females constituted 28.85%. Educational levels were distributed across four categories: illiterate (63.54%), primary (20.2%), secondary (12.5%), and university (3.75%). The primary occupation for income generation within the communities was trading, whether related to farming or non-farm activities, with proportions of 90.2% and 9.8%, respectively. Household sizes ranged from a mean of 7.4 ± 0.3 individuals, constituting 27.5% of the variation. Access to land ownership, rentals and community use stood at 73.05%, 21.22% and 5.72%, respectively. Mechanization tools such as tractors, trolleys, ploughs, cattle and others were used in percentages of 2.45%, 2.15%, 16.9%, 19.5% and 59%. These findings underscore the limited access rural farmers have to productive assets, leading them to heavily rely on non-farm activities for income. The study highlighted challenges concerning access to credit facilities within the communities. Existing groups lacked the strength to influence the market or serve as pressure groups to secure access to credit. The study recommends that stakeholders introduce a straightforward and functional micro-credit delivery system, enhancing the farmers' ability to access loans and subsequently bolstering their economic activities. Additionally, business advisory services should be extended to enterprise groups to assist them in achieving these objectives.

Keywords: Socio-economy, livelihood, farming systems, Small Marginal farmers, Jammu

Introduction

In the state of Jammu, the agriculture and allied sectors contribute to 25.81% of the Gross State Domestic Product (Govt. of Jammu, 2023). Nearly 70% of the population directly or indirectly rely on this sector for their livelihoods. The predominant cropping systems in the Jammu region are rice-wheat (63.15%) and maize-wheat (76.41%) for irrigated and rain-fed areas, respectively. Other farming activities encompass various combinations of mono or multiple cropping, horticultural crops, agro-forestry, livestock, poultry, fishery and goat/sheep rearing (Bazaz, 2013) [3]. However, comprehensive studies on farming systems in the Jammu division are currently scarce. With a growing emphasis on the farming system approach, it became evident that understanding primary farming systems, their economics and resource productivity of crop and non-crop enterprises in this region is crucial. Such insights would enable both academicians and policymakers to formulate targeted, region-specific recommendations, as opposed to generic ones.

Agriculture, the backbone of Jammu and Kashmir's economy, supports a substantial 80% of its population. The state is divided into three agro-climatic zones: Jammu, Kashmir and Ladakh. Each of these zones has distinct geo-climatic conditions that dictate cropping patterns and productivity levels. While rice dominates in Kashmir zone, with maize, barley and wheat as secondary crops, the Jammu region excels in both maize and wheat production (Kaloo & Choure, 2015)^[9]. Jammu's terrain comprises a mix of plains bordering Punjab and hilly areas. According to the Agriculture Census of 2020-2021, maize and wheat production prevails in the Jammu region, accounting for about 65% of the total area and contributing significantly to overall production.

Despite yields that might not be exceedingly high, the Jammu region plays a substantial role in the national production of other cereals and millets. This is particularly remarkable given the dense population, resulting in limited per capita arable land. Prior to commencing farming system research activities, a baseline survey was conducted in 2019-2020. This survey aimed to comprehend existing crops, varieties, cropping patterns, input usage, production costs, socio-economic and agro-climatic conditions, challenges and potentials affecting the present farming systems. The insights gained from this survey paved way for a well-informed research program, targeting increased productivity, reduced environmental degradation, sustainable land use and an enhanced quality of life for farming families.

Materials and Methods

Study area and Sample size: The present study was carried out across organic, inorganic and integrated farming systems (IFS) located in Jammu, Samba, Reasi and Udhampur districts of the Jammu division. A total of 480 farmers participated in the study. Specifically, 160 farmers from organic, inorganic and integrated farming systems (IFS) (20 farmers from each of the 8 selected villages) were sampled for characterization. Necessary measures were taken to ensure the unbiased collection of data from the selected farmers. Face-to-face interviews were conducted using a recall-based approach. Additionally, focus group discussions (FGDs) were held in each of the selected locations to further enrich the insights obtained. Primary data was collected over a four-year period from 2018 to 2022, encompassing three rice crop seasons including. The data collection spanned various farming operations, including livestock rearing, poultry farming, homestead enterprises as well as non-farm activities. In addition to primary data collection, secondary sources of information were also consulted. Handouts, reports, publications, notifications and relevant documents related to this study were utilized to enhance the understanding context of the research.

Climate: Jammu experiences a humid subtropical climate (Javid *et al.*, 2024)^[7]. The region witnesses extreme summer temperatures that can reach as high as 46 °C (115°F), while winter temperatures occasionally drop below 4 °C (39°F). The hottest month is June, with average highs around 40.6 °C (105.1°F), while January stands as the coldest month, with average lows reaching approximately 7 °C (45°F). Annual precipitation averages around 42 inches (1100 mm), with majority of rainfall occurring between June and September. However, even during winter months, the area can experience significant rainfall. During winter, dense smog can lead to

inconveniences and temperatures plummet to as low as 2 °C (36°F). Subsequent to the scorching hot season, the monsoon arrives, bringing heavy downpours accompanied by thunderstorms. Rainfall during this period can accumulate to approximately 669 mm (26.3 in) in the wettest months.

Characterization survey: Surveys were conducted between 2018 and 2022 to gather data for the study. In each chosen village, a minimum of 20 households were randomly selected using the transect method for individual interviews, resulting in a total of 480 participating farmers. Due to the ethnic diversity in the area, local translators were recruited from the community to facilitate effective discussions and interactions with the farmers. Once the research objectives were presented to the farmers, data collection took place using a semi-structured questionnaire. The questionnaire covered a range of topics including socio-demographic and economic characteristics of the agricultural respondents (such as age, gender, education, household size, livestock, irrigation, years of experience in various farming systems like organic, inorganic and integrated farming, agricultural training, household income sources, farm resources and involvement in farmers' associations). Other areas of focus included the crop production system, cultural practices (such as area under cultivation, number of crop plots, types of cultivated crop varieties, bird control, frequency of fertilizer applications, labor types, weeding frequency, yield and the number of ox-ploughs used), and production constraints. Alongwith individual surveys, the altitude and geographical coordinates of the crop fields were recorded using GPS (Global Positioning System).

The information gathered from the surveys was subjected to descriptive and multivariate statistical analysis. The socio-demographic profile of the surveyed rice farmers and the farm characteristics underwent Pearson chi-square test and ANOVA using IBM SPSS version 23.0 statistical software. This analysis aimed to compare the variations among the different surveyed regions. The significance level was set at 0.05, and means were differentiated through the Student Newman Keuls test (Newman, 1939)^[12]. The classification of crop farming systems in the study area was carried out in two main steps: First, a Factorial Analysis on Mixed Data (FAMD) was conducted, resulting in an intermediate data representation. Subsequently, a Hierarchical Cluster Analysis (AHC) was performed based on the representative factors extracted from the FAMD. Discriminant variables of the generated clusters were identified through canonical discriminant analysis. The differentiated crop farming systems were described and compared using the final fit package. To visualize the distribution of rice farming systems across the surveyed villages, GPS data from rice fields were utilized. The collected data formed a matrix with 480 rows representing the surveyed crop farmers and 23 columns representing variables of both quantitative and qualitative nature (Table 1). This matrix was analyzed through cross-sorting between the variables of interest (such as rice and wheat) and the other 28 variables, using the approach proposed by Xie and Ermon (2019)^[18]. This approach entails providing means and standard deviations for continuous quantitative variables, frequency tables for discrete qualitative variables and conducting univariate tests on each variable.

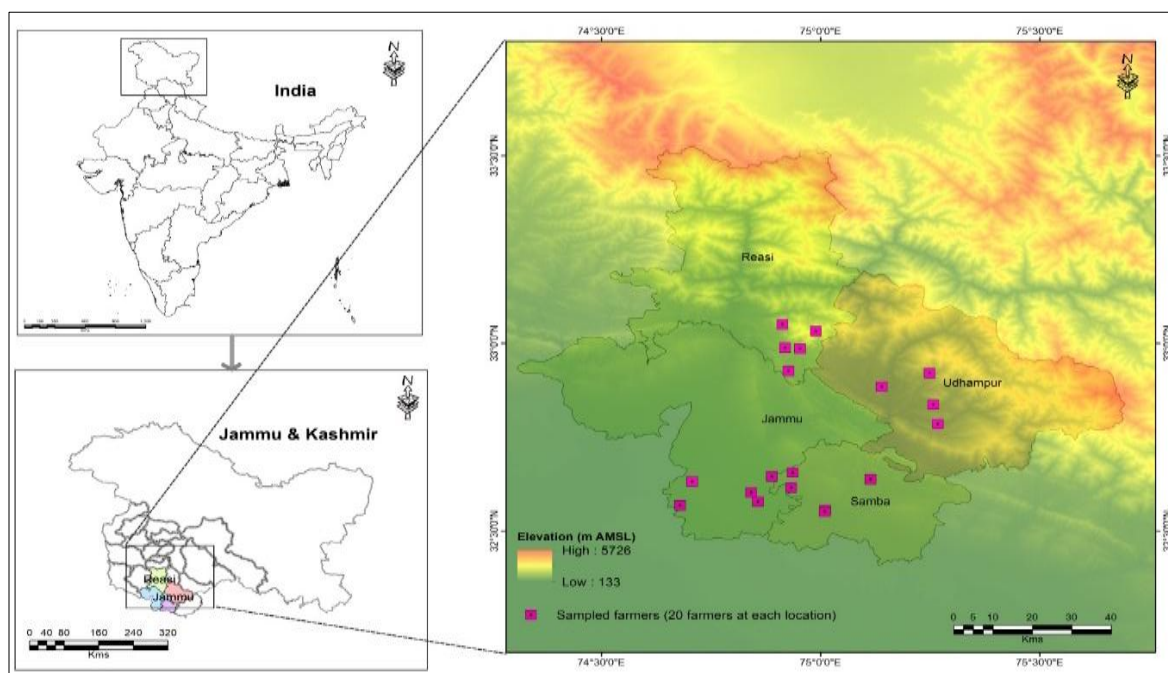


Fig 1: Section for Survey Villages

Table 1: Characterizing Components and Describing Predicted Adoption Values

Component	Codes	Value	Predicted
Dependent Variable			
Adoption for crops	AC	1 for adopted 0 not adopted	Nil
Independent variables			
Socio-demographic factors			
Male head of family	MHF	1 male 0 female	+/-
Education level family head	E	1 literate 0 illiterate	+
Age of family head	Age	Years	+/-
Experience in Agriculture	EA	Years	+
Household size	HS	Number	+/-
On-farm income	OFI	1 off farm income, 0 none	-
Farm resources factors			
Land	L	1 owns cultivated land, 0 otherwise	+
Livestock	LS	Number	+
Total farm size	TFS	Hectares	+
Machinery	M	1 if farmer owns any machinery, 0 otherwise	+
Hired farm labour	HFL	1 if farmer use hired labour, 0 otherwise	+
Size of land under crops	LCS	Hectares	+
Family workforce	FW	1 if household members contribute, 0 otherwise	+
Total workforce	TW	Number	+
Management factors			
Crop diversification	CD	1 if there is risk averse, 0 otherwise	-
Main crop	MC	1 rice is the main crop, 0 otherwise	+
Farmers Training	FT	1 if yes, 0 otherwise	
Use of pesticides	UP	1 if yes, 0 No	+
Farmers Association Member	FAM	1 if yes, 0 otherwise	+
Use of fertilizers	UF	1 if yes, 0 otherwise	+
Farmers output of Crops	FOR	Tonnes/Kg.	+
Irrigation	I	1 if irrigated system, 0 otherwise	+

Institutional factors			
Non-governmental organizations	NGOS	1 if attached with NGOs, 0 otherwise	+
Government extensions	GE	1 if attached with extension services, 0 otherwise	+
Geographical factors			
Organic Farming	Jammu Region	1 if organic, 0 otherwise	+/-
Western	Jammu Region	1 western, 0 otherwise	+/-
Central	Jammu Region	1 central, 0 otherwise	+/-

The model comprised twenty-three explanatory variables, and initially, the variance inflation factor (VIF) was assessed for each variable to gauge collinearity. As per Hossain *et al.* (2015) [6] VIF values between 0 and 5 indicate no significant multicollinearity, values between 5 and 10 imply moderate multicollinearity and values exceeding 10 indicate high multicollinearity among predictors. Considering the presence of collinearity in numerous explanatory variables, a stepwise variable selection approach was employed prior to model adjustment to mitigate collinearity issues (correlations) between these variables. Here, $\pi(x)$ signifies the probability of farmers adopting improved rice and wheat varieties based on their socio-cultural characteristics. This probability was expressed as a function of socio-cultural characteristics using the formula (Eq. 1):

$$\pi(x) = \exp(\alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \dots + \alpha_{15} x_{15}) \quad (1)$$

$$1 + \exp(\alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \dots + \alpha_{15} x_{15})$$

The coefficients $\alpha_0, \alpha_1, \dots, \alpha_{15}$ were estimated using the maximum likelihood method through R software version 4.0.3. The independent variables ($x_1, x_2, \dots, x_{15}$) are described in Table 1. The extent of susceptibility (likelihood) to adopt improved varieties, based on the selected factors, was gauged using odds ratios. Variables that demonstrated significant impact within the final model were identified *via* an overall test on the model.

Resource Use Efficiency Analysis

To assess the resource productivity of different farming systems for enhancing farmers' economic conditions and to evaluate the specific factor's contribution in conjunction with other factors that drive changes in output levels, a multiple regression analysis was employed. The Cobb-Douglas production function, presented below, was fitted to the data:

$$Y_i = b_0 X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} + u_i$$

Where:

Y = Gross farm income in Rupees

X1 = Area under cereals in hectares (AUC)

X2 = Area under other crops in hectares (AOTH)

X3 = Number of dairy animals per farm (DA)

X4 = Expenditure on seeds in Rupees

X5 = Expenditure on fertilizer and chemicals in Rupees (TFC)

X6 = Education index (EI)

i = 1, 2, 3, 4, ..., n farms

b_0 = Constant

b_i = Regression coefficient

u_i = Random variable

Marginal Value Productivity (MVP)

The productivity of different inputs used in basmati rice production was examined by calculating the marginal value productivities of inputs, which will be estimated at geometric mean levels of inputs.

$$MVP = b_i * GM(Y)/GM(X_i)$$

Where,

MVP (X_i) is the marginal value productivity of i^{th} resource.

b_i is the regression Coefficient (estimated).

GM(Y) is the Geometric Mean of Output (yield).

GM(X_i) is the Geometric Mean of the Input

Results and Discussion

The distribution of various inputs within the total variable cost reflects the cost structure, which is influenced by the level of technology and utilization of modern inputs. Disparities in input usage across different farm sizes highlight discrepancies in the level of technology implemented on each respective farm. Understanding the cost and return structure is essential for evaluating the necessity of interventions to bridge gaps and enhance the overall economic viability of farming (Vroegindewey and Hodbod, 2018) [17]. Regarding the structural characteristics of agricultural farms, it's notable that men (71.15%) were predominant in crop production within the study area. Among the surveyed farmers, a significant proportion (63.54%) lacked formal education, with an average age of 40.85 years farmers in the Jammu region exhibited less experience in crop production compared to those in other regions (Table 2). Additionally, household sizes were significantly larger in the Samba, Reasi and Udhampur regions compared to the Jammu region. On average, surveyed farmers cultivated an area of 0.9 hectares in Udhampur region featuring the largest plots sown on average. Agriculture stood as the primary income source for the surveyed farmers across all regions. While a majority (73.05%) owned the land where they cultivated rice and wheat, there remained a portion (21.2%) facing issues of land access and resorting to cultivating on rented lands. There were also limited instances of community-owned cultivation plots. In Jammu and Samba regions, crop production relied heavily on family labor, while in the Reasi region, a substantial portion of farmers (34.4%) hired external workers. The scarcity of farm mechanization was evident in all regions.

Table 2. Socio-demographics characteristics of surveyed farmers (SE=Standard Error).

Characteristics	Jammu (N=120)	Samba (N=120)	Reasi (N=120)	Udhampur (N=120)	Study Area (N=480)	χ^2 -test	F-test
Age (years)							
Mean±SE	38.3±0.6	41.1±1.0	43.8±1.7	40.2±0.5	40.85±0.95	-	2.718 ns
Range	[19-68]	[23-69]	[20-70]	[25-65]	[22-68]		
Sex (%)							
Male	71.6	68.9	73.3	70.8	71.15	0.813 ns	-
Female	28.4	31.1	26.7	29.2	28.85		
Education (%)							
Illiterate	64.17	68.33	59.17	62.5	63.54	11.216 ns	-
Primary	17.5	15.83	22.5	25	20.2		
Secondary	13.33	11.67	15.83	9.17	12.5		
University	5	4.17	2.5	3.33	3.75		
Household size (%)							
Mean±SE	8.7±0.3	7.3±0.4	6.9±0.3	6.6±0.2	7.4±0.3	-	5.012**
Range	[1-30]	[1-24]	[1-27]	[1-29]	[27.5]		
Cultivated area (ha)							
Mean±SE	0.8±0.1	1.1±0.2	1.3±0.3	0.7±0.1	0.9±0.1	-	26.689***
Range	[0.04-12]	[0.30-7]	[0.29-9]	[0.35-14]	[0.24-11]		
Experience (years)							
Mean±SE	16.3±0.9	14.1±1.8	12.4±0.4	15.6±0.7	14.6±0.7	-	3.479**
Range	[1-58]	[1-39]	[1-55]	[1-65]	[1-54]		
Access to land (%)							
Owner	76.4	73.3	70.2	72.3	73.05	-	-
Rental	22	26.7	19.7	16.5	21.225		
Community	1.6	0	10.1	11.2	5.725		
Total workforce (%)							
Family	78.1	62.4	48.2	63.5	63.05	-	-
Paid worker	18.4	35.3	49.5	34.4	34.4		
Community	3.5	2.3	2.3	2.1	2.55		
Sources of income (%)							
Agriculture	91.2	86.7	92.8	90.4	90.275	-	-
Business	7.5	6.1	3.9	6.5	6		
Govt. Servant	0	4.4	0.8	0.9	1.525		
Whitewash	0.3	1.9	0.7	0.6	0.875		
General store	0.3	0	0.4	0.2	0.225		
Plumber	0	0	0.4	0.2	0.15		
Electricity	0.1	0.3	0.3	0.2	0.225		
Welder	0.2	0.2	0.3	0.4	0.275		
Carpenter	0.2	0	0.2	0.3	0.175		
Transporter	0.2	0.4	0.2	0.3	0.275		
Agricultural equipment (%)							
Tractors	3.4	2.1	2.4	1.9	2.45	-	-
Trolley	3.1	1.9	2	1.6	2.15		
Plough	22.4	15.6	17.2	12.4	16.9		
Cattle	21.6	26.7	19.2	10.5	19.5		
None	49.5	53.7	59.2	73.6	59		

Factors affecting the utilization of improved rice-wheat systems were observed among farmers who adopted at least one improved rice-wheat variety. These farmers were notably older ($p < 0.05$) and belonged to larger households when compared to those who didn't adopt any improved varieties at all (refer to Table 3). The decision to utilize at least one improved rice-wheat variety was significantly ($p < 0.05$)

associated with factors such as off-farm income, hired farm labor, farmer training in agriculture, membership in agricultural associations, prioritizing rice as the main crop, fertilizer usage, interaction with government extensions, NGOs, and international institutes, as well as the region in which the farmers were situated.

Table 3: Summary statistics for adopters and non-adopters of improved rice-wheat systems. Probability values that are significant at 0.05 level are in bold.

Particulars		Adopters (N=390)		Non-adopters (N=90)		p
Age	Mean (SD)	49.3	12.64	38.5	42.78	0.017
Education	Illiterate	216	55.38	46	51.11	0.429
	Primary	97	24.87	23	25.56	
	Secondary	64	16.41	12	13.33	
	University	13	3.33	9	10.00	
Household size	Mean (SD)	7.2	1.85	8.6	9.56	0.013
Experience	Mean (SD)	14.8	3.79	13.2	14.67	0.382
Off-farm income	No	295	75.64	79	87.78	<0.003

	Yes	95	24.36	11	12.22	
Land ownership	No	102	26.15	17	18.89	0.274
	Yes	288	73.85	73	81.11	
Livestock ownership	0	15	3.85	7	7.78	0.43
	2	297	76.15	52	57.78	
	3	53	13.59	21	23.33	
	4	25	6.41	10	11.11	
Machinery ownership	No	330	84.62	70	77.78	0.09
	Yes	60	15.38	20	22.22	
Total farm size	Mean (SD)	4.2	1.08	4.1	4.56	0.779
Land size under wheat cultivation	Mean (SD)	1.1	0.28	0.89	0.99	0.089
Total workforce	Mean (SD)	7.6	1.95	6.4	7.11	0.248
Family workforce	No	75	19.23	13	14.44	0.131
	Yes	315	80.77	77	85.56	
Hired farm labour	No	196	50.26	62	68.89	<0.001
	Yes	194	49.74	28	31.11	
Crop diversification	No	52	13.33	15	16.67	0.382
	Yes	338	86.67	75	83.33	
Membership of farmers association	No	120	30.77	65	72.22	<0.012
	Yes	270	69.23	25	27.78	
wheat main crop	No	125	32.05	51	56.67	0.002
	Yes	210	53.85	39	43.33	
Use of fertilizer	No	78	20.00	42	46.67	<0.001
	Yes	312	80.00	48	53.33	
Use of pesticides	No	129	33.08	36	40.00	0.891
	Yes	261	66.92	54	60.00	
Animal traction	No	340	87.18	70	77.78	0.191
	Yes	50	12.82	20	22.22	
Irrigation	No	310	79.49	67	74.44	0.138
	Yes	80	20.51	23	25.56	
Farmer's output of wheat	Mean (SD)	2.4	0.62	1.7	1.89	0.231
Government extensions	No	207	53.08	72	80.00	<0.003
	Yes	183	46.92	18	20.00	
NGOs	No	319	81.79	74	82.22	0.036
	Yes	71	18.21	16	17.78	
International institutes	No	318	81.54	90	100.00	0.082
	Yes	17	4.36	0	0.00	
Regions	Jammu	90	23.08	30	33.33	<0.002
	Sambha	90	23.08	30	33.33	
	Reasi	90	23.08	30	33.33	
	Udhampur	90	23.08	30	33.33	

The yield of basmati rice from marginal farms was subjected to regression analysis against various production factors, namely human labor, machine labor, seed, manure & fertilizer, plant protection chemicals, and irrigation charges. These factors were considered as explanatory variables. Upon examining the data presented in Table 4, it becomes evident that the production function for basmati rice on small farms, with an R^2 value of 0.97, was highly statistically significant. This signifies that 97 percent of the total variation in yield could be attributed to the aforementioned variables. Furthermore, the regression analysis indicated that the coefficients of human labor and manure & fertilizers were significantly significant at a probability level of 1 percent. Additionally, the coefficient for seed was significant at a 5

percent probability level, with values of 1.087, 0.378, and 0.378, respectively. Conversely, machine labor and irrigation charges exhibited negative significance at the 5 percent and 1 percent levels, respectively, with corresponding values of -0.412 and -0.313. The coefficient for plant protection chemicals, on the other hand, was negatively non-significant. The analysis also revealed that the marginal value productivity of human labor, seed and manure & fertilizers were positive, with values of 6.253, 19.456 and 5.236, respectively. Conversely, the marginal value productivity estimated for machine labor, plant protection chemicals, and irrigation charges was negative, with values of -4.056, -0.423 and -13.256, respectively.

Table 4: Estimated regression coefficients of various factors, their standard errors and marginal value product (MVP) for *Basmati* rice cultivation in the study area.

Variables	Regression Coefficients	Standard error	MVP
Constant	0.718*	0.189	-
Human labour (X ₁)	1.087*	0.168	6.253
Machine labour (X ₂)	-0.412	0.184	-4.056
Seeds (X ₃)	0.481**	0.196	19.456
Manure & Fertilizer (X ₄)	0.378*	0.151	5.236
Plant protection chemicals (X ₅)	-0.049	0.061	-0.423
Irrigation charges (X ₆)	-0.313	0.143	-13.256

Coefficient of Determination (R^2) = 0.97*

* Significant at 1% level of significance. ** Significant at 5% level of significance.

Cost of Basmati Production and Marketing (Rs/ha)

The various components comprising the per-hectare cost of cultivation are detailed in Table 5. The total variable cost for the sample farms, encompassing costs associated with post-harvest operations, amounted to Rs. 37,510 per hectare. Within this, variable input costs accounted for approximately 97 percent, while the remaining 8 percent constituted post-harvest/marketing expenses. When analyzed by category, the lowest cost of Rs 36,655 per hectare was observed on medium-sized farms, while the highest cost of Rs 39,267 per hectare was observed on marginal category farms. This indicates that as farm size increases, the cost of basmati production and marketing tends to decrease. The proportionate share of variable input costs in the total cost

was fairly consistent across all farm categories, ranging from 95.57 to 96.28 percent across all groups. Labor costs contributed significantly to the total variable input cost, amounting to Rs. 18,520 on marginal farms, Rs. 19,260 on small farms, and Rs. 19,835 on medium farms, respectively. Machinery costs, on the other hand, totaled Rs. 6,691 per hectare overall, with values of Rs. 6,750 on medium farms, Rs. 6,620 on small farms, and Rs. 6,580 on marginal farms, respectively. Similarly, pesticide/weedicide costs averaged Rs. 2,373 per hectare across all farms, with figures of Rs. 2,415 on medium farms, Rs. 2,230 on marginal farms, and Rs. 2,305 on small farms. Notably, the usage of labor intensifies as farm size decreases (Nene 2005) ^[11].

Table 5: Cost of basmati production and marketing (Rs/ha)

Particulars	Farm Category				
	Marginal	Small	Medium	Large	Overall
I) Input Costs (Rs/ha)					
Seed	1530	1610	1690	1710	1635
Irrigation	2150	2280	2340	2450	2305
Manure and fertilizer	3245	3360	3420	3560	3396
Labour (bullock + human)	18520	19260	19835	20150	19441
Machinery hires charges	6580	6620	6750	6815	6691
Pesticides/weedicides	2230	2305	2415	2542	2373
I) Total input cost	34255	35435	36450	37227	35842
II) Storage, Transportation, and Marketing Costs (Rs/ha)					
Storage	0	24	35	40	16
Transportation cost	1560	1450	1380	1300	1078
Marketing (unloading, cleaning, etc.)	840	760	720	700	575
II) Total storage, transportation and marketing cost	2400	2234	2135	2040	1669
Percent share to the total cost (I+II)					
Total input cost(I)	95.57	98.87	98.33	96.28	97
Total storage, transportation and marketing cost (II)	6.8	7.5	7.9	8.2	8
Productivity (q/ha)	33.15	31.5	34.8	35.6	34
Total cost (I+II)	36655	37669	38585	39267	37510

Farmers practicing rainfed and irrigated lowland rice farming tend to cultivate improved varieties compared to those practicing rainfed upland rice productions. Moreover, farmers practicing irrigated lowland rice production used

more sowing than transplantation. Little difference was observed between the proportion of farmers practicing the different rice production systems in terms of ploughing, soil fertility management or pest management Table 6.

Table 6: Agricultural practices of farmers in function of rice production systems.

Practices	Modalities	Rainfed lowland (N = 360)	Rainfed upland (N = 30)	Irrigated lowland (N = 90)
Soil labour	Manual	240	17	54
	Plough	75	6	26
	Tractors	45	7	10
Type of produced rice	Local	90	25	20
	Improved	270	5	70
Type of sowing	Sowing in pockets	235	21	10
	Nursery transplantation	95	6	78
	Broadcast sowing	30	3	2
Weed management	Manual	180	16	60
	Herbicide	180	14	30
Soil fertility management	Chemical fertilizers	180	10	30
	Organic fertilizers	90	10	30
	No fertilizer	90	10	30
Insect pest management	Chemical pesticides	120	12	35
	No management	240	18	55

Cost A1 = Expenditure on casual labour, farm machinery, seeds, manure & fertilizer, plant protection chemicals, irrigation charges, miscellaneous expenditure (cost of transportation), and interest on working capital + depreciation + land revenue.

Cost A2 = Cost A1 + rent paid for leased-in land.

Cost B1 = Cost A1 + interest on the value of owned fixed capital excluding land.

Cost B2 = Cost B1 + rental value on owned land (net of land revenue)+rent paid for leased-in land.

Cost C1 = Cost B1 + imputed value of family labour.

Cost C2 = Cost B2 + imputed value of family labour.

Cost C3 = Cost C2 + value of management input @10% of Total Cost C2

Table 7: Per hectare cost of cultivation of wheat on sampled farms (Rs./ha.)

Categories / Particulars	Marginal	Small	Medium	Large	All Farms
Cost -A1					
Casual Labour	4250.00	4432.00	4620.00	4875.00	4544.25
Farm Machinery	6580.00	6325.00	6189.00	6025.00	6279.75
Seed	3860.00	3700.00	3742.00	4010.00	3828.00
Manure & Fertilizer	5380.00	5236.00	5142.00	5012.00	5192.50
Plant protection chemicals	2430.00	2541.00	2785.00	2647.00	2600.75
Irrigation charges	4325.00	4421.00	4126.00	4285.00	4289.25
Miscellaneous expenditure	920.00	852.00	800.00	1200.00	943.00
Interest on working capital (5%)	1387.25	1375.35	1370.20	1402.70	1383.88
Total Cost- A1	29132.25	28882.35	28774.20	29456.70	29061.38
Cost -A2					
Cost-A1	29132.3	28882.4	28774.2	29456.7	29061.4
Rent paid for leased-in land	0	8000	11500	14500	8500
Total Cost-A2	29132.3	36882.4	40274.2	43956.7	37561.4
Cost -B1					
Cost -A1	29132.25	28882.4	28774.2	29456.7	29061.4
Interest on fixed capital (excluding land)	1456.61	1444.12	1438.71	1472.84	1453.07
Total Cost- B1	30588.86	30326.47	30212.91	30929.54	30514.44
Cost -B2					
Cost -B1	30588.86	30326.47	30212.91	30929.54	30514.44
Rental value of owned land	16542	18543	17854	19625	18414
Rent paid for leased-in land	0	8000	11500	14500	8500
Total Cost-B2	47130.86	56869.47	59566.91	65054.54	57428.44
Cost C1					
Cost -B1	30588.86	30326.47	30212.91	30929.54	30514.44
Family labour	3516.00	3021.00	2652.00	2015.00	2801.00
Total Cost-C1	34104.86	33347.47	32864.91	32944.54	33315.44
Cost -C2					
Cost -B2	47130.86	56869.47	59566.91	65054.54	57428.44
Family labour	3652.00	3245.00	3021.00	2715.00	1207.61
Total Cost-C2	50782.86	60114.47	62587.91	67769.54	58636.05
Cost-C3					
Cost-C2	50782.86	60114.47	62587.91	67769.54	58636.05
Managerial cost	2815.00	3012.00	3521.00	3846.00	3298.50
Total Cost-C3	53597.86	63126.47	66108.91	71615.54	61934.55

Cost and Return Structure of Wheat Production

The costs incurred and returns realized across different farm categories are presented in Table 8. Among these, the total cost was highest on large farms, amounting to Rs. 90,874.72, followed by Rs. 70,531.82, Rs. 75,436.53 and Rs. 83,952.38 on medium, small and marginal farms, respectively. Overall, the total cost averaged Rs. 80,198.96 per hectare. This figure comprises a total variable cost of Rs. 43,910.00, a total fixed cost of Rs. 32,989.88 and a managerial cost of Rs. 9,298.86 per hectare. The gross return was highest on medium farms, reaching Rs. 1,24,140.00, followed by Rs. 1,23,330.00, Rs.

1,17,900.00 and Rs. 1,15,600.00 on large, marginal and small farms, respectively. The gross return averaged Rs. 1,20,242.50 per hectare. The net return was highest for marginal farms, amounting to Rs. 47,368.18, followed by Rs. 40,163.47, Rs. 40,187.62 and Rs. 32,455.28 for small, medium, and large farms, respectively. The net return averaged Rs. 40,043.64 across all farms. In terms of the cost-benefit ratio, the highest ratio was observed on marginal farms at 1.88, followed by 1.69, 1.63, and 1.61 for small, medium, and large farms, respectively. The average cost-benefit ratio across all farms was 1.70.

Table 8: Per hectare cost and return of wheat on sampled farms under study (Rs.)

S. No.	Particulars	Marginal	Small	Medium	Large	All farms
1	Cost					
	Total variable cost,	39560.00	42302.00	45215.00	48563.00	43910.00
	Total fixed cost	28156.20	30122.30	35215.80	38465.20	32989.88
	Managerial cost	2815.62	3012.23	3521.58	3846.52	3298.99
	Total cost	70531.82	75436.53	83952.38	90874.72	80198.86
2	Return					
	Main product (in q.)	33.50	32.50	35.80	35.10	34.23
	Value of main product	93800.00	91000.00	100240.00	98280.00	95830.00
	By-product (in q.)	48.20	49.20	47.80	50.10	48.83
	Value of by-product	24100.00	24600.00	23900.00	25050.00	24412.50
	Gross return	117900.00	115600.00	124140.00	123330.00	120242.50
3	Net return	47368.18	40163.47	40187.62	32455.28	40043.64
	B-C Ratio	1.67	1.53	1.48	1.36	1.50

Identification of Farming Systems in the Intermediate Zone

The data presented in Table 9 highlights that 43.2 percent of farmers were engaged in livestock-based farming systems, 56.8 percent were involved in cereal-based farming systems and a mere 0.6 percent were practicing fruit-based farming systems. This data underscores the prevalence of cereal-based farming systems in the intermediate zone of the Jammu region. The primary reason for farmers continuing to adopt livestock and cereal-based farming systems lies in the constraints posed by small land holdings. These limitations restrict their ability to transition to other enterprises. Farming in this region remains primarily subsistence-oriented, compelling farmers to cultivate crops that fulfill their family's needs. Notably, only one respondent possessed a substantial landholding, thereby adopting a fruit-based farming system. This demonstrates the potential shift to other profitable crops if farmers have larger land holdings that allow for increased income generation. This observation is consistent with Agrawal (2012)^[2], who found a predominance of cereal-based farming systems in the mid-western plains of the Jammu region. Similarly, Kumar *et al.* (2012)^[10] noted that the majority of households in the water-scarce region of Jammu were engaged in the wheat-mustard-

based farming system. Livestock-based farming systems accounted for 26.62 percent of the total land holdings, indicating smaller land holdings compared to cereal-based farming systems. The data implies that respondents' land holdings directly influence their choice of farming system. Greater land holdings correlate with a higher likelihood of adopting cereal-based farming systems, while smaller holdings are associated with livestock-based farming systems. This relationship stems from the higher income generation potential of cereal crops when cultivated on larger expanses of land. The classification of farming systems was based on gross returns from various enterprises. Interestingly, fruit-based farming systems exhibited the highest land holding per household at 2.67 percent of the total land. This suggests that fruit-based farming is primarily practiced by larger farmers who possess ample land beyond fulfilling their family's needs. The number of enterprises varied across different farming systems, ranging from three to five. This finding aligns with the results of Prasad (2009)^[13], who observed similar variability in the number of enterprises within identified farming systems in the Jammu region.

Table 9: Identification and Cropping Pattern of different of farming systems in subtropical zone of Jammu region

Code	Farming System Pattern	Number of farmers		Land holding		Total Area under different crops (ha)				No. of animals	No. of poultry birds
		No.	%	ha	%	Wheat	Rice	Mustard	Total		
Fruit based											
FSF1	Fruits + Livestock + Maize + Vegetables	2	10	5.2	2.67	2.6	2.35	0.6	5.55	1	36
Livestock based											
FSL1	Livestock + Rice + Wheat + Poultry	20	12.5	16.24	8.34	6.8	8.65	-	15.45	62	60
FSL2	Livestock + Rice + Wheat + Mustard + Poultry	16	10	10.9	5.59	5.9	3.95	1.3	11.15	46	78
FSL3	Livestock + Wheat + Rice + Poultry	28	17.5	20.23	10.38	10.35	4.25	-	14.6	81	129
FSL4	Livestock + Wheat + Poultry	8	5	4.5	2.31	2	-	-	2	30	38
FSL	Subtotal	72	45	51.87	26.62	25.05	16.85	1.3	43.2	219	305
Cereal based											
FSC1	Rice + Wheat + Mustard + Poultry	10	6.25	12.45	6.39	1.35	2.75	0.55	4.65	4	50
FSC2	Wheat + Rice + Livestock + Poultry	11	6.875	13.2	6.78	7	1.75	-		5	62
FSC3	Rice + Wheat + Poultry	24	15	27.01	13.86	4.9	9.35	-	14.25	2	90
FSC4	Rice + Wheat + Mustard + Livestock	7	4.375	8.56	4.39	1.05	1.5	0.15	2.7	1	0
FSC5	Wheat + Rice + Poultry	26	16.25	53.67	27.55	11.75	7.7	-	19.45	2	78
FSC6	Wheat + Rice + Mustard + Poultry	8	5	22.86	11.73	4.05	2.35	0.6	7	1	56
FSC	Subtotal	86	53.75	137.8	70.71	30.1	25.01	1.3	56.8	15	336
FS	Total	160	108.8	194.8	100	57.75	44.21	3.2	105.55	235	677

Farm management practices by the sample farmers

The agronomic management includes variety selection, seed rate, seeding date, transplanting fertilizer application date,

organic manures addition, weed control, water management, pesticide application, and harvesting. Agronomic managements of the cultivated crops have been indicated in the Table 10.

Table 10. Agronomic management practices of different field crops of the sample farmers

Factors	T. Aman (HYV) Rice	Wheat	Maize (Summer)	Jute	Potato	Mustard	Banana	Pulses (Green gram)
Variety	Local, Basmati 370, Swarna and Samba Mahsuri	HD 3226, Shalimar wheat	Hybrid	Indian	Silbilati, Cardinal, Diamant, Granola,	Tori- 7	Sagor	Bari mung
Seed rate (kg ha-1)	25-30	95-110	20	6-8	1.5 -2	8-10	5000-5500 Plants	25-30
Seeding date	June	Nov -Dec	Feb- Mar	April	Nov -Dec	Nov	Sep-Oct	Feb.-Mar.
Transplanting date	July	-	-	-	-	-	-	-
Urea (kg ha-1)	200	200-250	300	40-50	300-350	100-150	400-500	70-80
TSP (kg ha-1)	40	30-40	60 -70	-	200-250	30-40	100-150	-
MP (kg ha-1)	-	20-40	40-50	-	250-300	30-40	100-150	-
Cow dung (kg ha-1)	-	4-5	4-5	-	5-6	4-5	6-8	-
Weeding (no.)	2	1	2-3	2-3	1	1-2	2-3	1-2
Irrigation (no.)	-	2-3	5-6	-	3-4	1-2	4-5	1
Insecticide application (no.)	1-2	-	-	-	6-8	1-2	4-5	1
Harvesting date	Nov- Dec	April	May- June	June-July	Feb- Mar	Jan	Jul -Aug	May
Yield	24 qtl/ha.	40-45 qtl/ha.	20-25 qtl/ha.	30-35 qtl/ha.	200-250 qtl/ha.	18-20 qtl/ha.	1000 qtl/ha.	12-15 qtl/ha.
Straw	50-60 qtl/ha.	46-50 qtl/ha.	40-43 qtl/ha.	35-40 qtl/ha.	---	16-20 qtl/ha.	---	---

Cobb-Douglas Production Function for Resource Productivities of Major Farming Systems in Various Districts

The Cobb-Douglas production function was employed to assess the resource use efficiency of major farming systems in different districts of the Jammu region, as presented in Table 11. The production elasticity indicated that a one percent increase in the area under other crops (AOTH) across all districts led to a gross income increase ranging from 3.239% for livestock-based farming systems to 0.870% for cereal-based farming systems. Specifically, for Jammu, Doda and

Reasi districts, this relationship was positively significant across all farming systems. However, in Kathua and Rajouri, the relationship was found to be non-significant. Regarding the elasticity coefficients for cereal-based farming systems across all districts, they were found to be positive but non-significant (0.378). This suggests that the contribution of dairy animals to increased gross income in cereal-based systems is negligible. On the other hand, for livestock-based farming systems, the elasticity coefficient was negative and non-significant (-0.853).

Table 11: Farming system-wise regression results for different farming systems in Jammu region of J&K state

Districts	Farming System	Intercept	Regression coefficients						R ² Adj	F ratio	Returns to scale
			AUC	AOTH	DA	Seed	TFC	EI			
Jammu	Livestock based	4.511**	0.454***	1.181*	-0.478	-0.177	0.263	3.355	0.169***	2.087	4.598
	Cereal based	4.818*	0.400***	0.003	0.096	-0.067	-0.096	0.024	0.036	1.25	0.361
Shambha	Livestock based	4.352	4.961***	1.171***	0.372	0.256	-0.845	1.482***	0.042	1.452	5.256
	Cereal based	2.361	1.061***	0.003***	0.785***	-0.919	1.008	0.062***	0.351	9.256	1.924
Udhampur	Livestock based	-0.246	1.315	-0.081	-0.089	0.299	0.951*	-0.168	0.396*	8.187	2.507
	Cereal based	3.050*	0.001*	-0.161*	0.002*	1.482*	-0.211	-0.53	1.003*	5.352	0.598
Reasi	Livestock based	-0.159	6.293*	0.440***	0.249	-0.16	0.123	-5.938	0.243*	3.95	1.006
	Cereal based	4.099*	-0.892	0.252**	-0.158	-0.147	0.675	0.867	0.007	1.054	0.598
Overall	Livestock based	2.137*	3.242**	0.718**	0.297*	0.223*	0.545	2.735*	-0.853*	3.919	3.239
	Cereal based	3.582*	0.588**	0.104**	0.26*	0.653	0.497	0.378	0.349	4.228	0.870

AUC, Area under cereals; AOTH, area under other crops; DA, dairy Animals; TFC, total fertilizer and chemicals; EI, Educational index;

*Significant at 0.01 los; **Significant at 0.05 los, ***Significant at 0.1 los

Annual income of sample farmers

It is observed from Table 12 that the average total income of the inorganic farms was Rs. 140211 and for organic farms, it was Rs. 126689. The income figure of inorganic farming is higher than the national average of Rs. 118542. Considering the farming systems, farmers practicing F-L-M-V system earned highest annual income Rs. 167085 under inorganic farming and in case of organic farming, farmers practicing F-L-M-V system got highest annual income Rs. 148521 than

other farming systems. This result is slightly similar with Uddin and Takeya (2005) ^[16] who found that income from non-agricultural enterprises is higher income Rs. 61172 for farmers in organic farming compared to those of inorganic farming income of Rs. 84868 in respect of farm sizes. It was calculated that Change in total annual income no farm activities of the inorganic farms was increased by the amount of Rs. 22962 in the study areas due to intervention which is statistically significant at 10 percent level.

Table 12: Income from various sources under major farming systems (Rs.)

Sources of income	Inorganic farming					Avg.	Organic farming					Avg.
	F-L-M-V	L-R-W-P	L-R-W-M	L-W-R-P	L-W-P		F-L-M-V	L-R-W-P	L-R-W-M	L-W-R-P	L-W-P	
Farm activities												
Crop	88456	79421	71254	76584	69548	77053	80123	78542	71253	69842	55412	71034
Livestock	46582	42132	31325	39546	40256	39968	45621	38452	51263	41253	39524	43223
Poultry	17521	16421	0	19452	15423	13763	14235	13256	0	5625	0	6623.2
Homestead	14526	8456	6717	7892	9542	9426.6	8542	7652	6421	3215	3215	5809
Total farm income	167085	146430	109296	143474	134769	140211	148521	137902	128937	119935	98151	126689
Non-farm activities												
Servicing	42312	36215	31256	0	19845	25926	30125	24125	0	0	21423	15135
Labour	19452	9542	0	16524	13520	11808	16524	12012	11423	7562	14215	12347
Tailoring	4652	0	0	0	6215	2173.4	0	0	0	0	0	0
Small business	18452	13251	24523	16520	15500	17649	14523	14250	50021	14523	9854	20634
Total non-farm income	84868	59008	55779	33044	55080	57556	61172	50387	61444	22085	45492	48116
Total income	251953	205438	165075	176518	189849	197767	209693	188289	190381	142020	143643	174805
Change in income	22962 (2.53*)											
*Fruits + Livestock + Maize + Vegetables (F-L-M-V), Livestock + Rice + Wheat + Poultry (L-R-W-P), Livestock + Rice + Wheat + Mustard + Poultry (L-R-W-M-P), Livestock + Wheat + Rice + Poultry (L-W-R-P) and Livestock + Wheat + Poultry (L-W-P)												
Source: Authors' calculation based on field survey, 2022.												
* Significant at 10 percent level												

Food security index of the sample households

The food security index for inorganic farm households was 1.21, while for organic farm households, it stood at 1.29. This index indicated a higher level of food security for both inorganic farming (1.21) and organic farming (1.29) among households categorized as food-secure. In contrast, the index

was 0.92 for inorganic farming and 0.85 for organic farming for households categorized as food-insecure. Both the headcount indices for inorganic and organic farm households in the study areas suggest a state of food security. Among the sampled households, 80 percent of inorganic farms and 85 percent of organic farms managed to meet the required daily

calorie intake of 2186 kcal and 2241 kcal per capita, respectively. Conversely, 1.56 percent of households practicing inorganic farming and 1.21 percent of households engaged in organic farming were categorized as food insecure (refer to Table 13). Notably, the average calorie intake of food-secure households surpassed the national average of 2200 kcal. Specifically, for inorganic farming households, the average intake was 2793.83 kcal, and for organic farming households, it was 2910.76 kcal. The food insecurity gap/surplus index provides additional insight. Food-secure households exceeded the food poverty line by 0.06 percent in

the case of inorganic farming and by 0.07 percent for organic farming. Conversely, food-insecure households fell short of the required calorie intake by -0.1 percent in the context of inorganic farming and by -0.09 percent for organic farming. Adekoya (2009)^[1] made a significant discovery regarding the role of inorganic rice farming in boosting food production. Their research demonstrated that the inorganic farming system outperforms rice monoculture in terms of resource utilization, diversity, productivity, as well as the quality and quantity of the food produced.

Table 13: Food security index for integrated farming and mixed farming

Type of farming	Food security indices	Food secure households	Food insecure households	Average
Organic	Food security index	1.29	0.85	1.56
	Per capita daily calorie intake (kcal)	2910.76	1953.1	2241
	Head count index	0.85	0.15	-
	Food insecurity gap/Surplus index	0.07	-0.09	-
Inorganic	Food security index	1.21	0.92	1.21
	Per capita daily calorie intake (kcal)	2793.83	1749.1	2186
	Head count index	0.80	0.2	-
	Food insecurity gap/Surplus index	0.06	-0.1	-

Contribution towards food and nutritional security

The provision of food and nutritional security to farming families stands as a fundamental objective of integrated farming systems. These well-integrated and complementary farming systems play a pivotal role in addressing the dietary needs of farm households, either partially or in full, contingent on the extent of integration and the scale of the farm. These systems constitute the foundation of Indian agriculture, serving as the primary source of staples for countless farm families. The integrated approach of these systems, such as the incorporation of short-duration vegetable crops, pulses, and livestock feed, allows efficient utilization of land and time. Additionally, these systems enable diverse applications of water resources, encompassing activities like fish, duck, or poultry rearing alongside crop irrigation.

Recognizing their significance, these systems hold a critical position in realizing future food security and nutritional requirements for India's burgeoning population. A noteworthy example is the integration of fruits, vegetables, livestock, and mushrooms (F+L+M+V) as well as the integration of livestock, water resources, and poultry (L+W+P). These integration strategies, as depicted in Table 14, contribute significantly to fulfilling staple food needs for farm families. Additionally, the integration of homestead farming with livestock, such as the case in Jammu (1 ha), showcases a sustainable model capable of supporting a family of six members throughout the year. This model offers a diverse range of cereals, pulses, oilseeds, fruits, vegetables, milk, meat, eggs, and mushrooms, as documented by Kumar (2012)^[10].

Table 14: Food and nutritional security as provided by different integrations

Farming systems	Area (ha)	Cereals (kg)	Pulses (kg)	Oilseeds (kg)	Vegetable (kg)	Fruits (kg)	Green fodder (kg)	Dry fodder (kg)	Poultry meat (kg)	Goat meat (kg)	Milk (L)	Mushroom (kg)
Fruits + Livestock + Maize + Vegetables	1	3250	240	280	0	410	5023	4125	0	0	90	60
Livestock + Rice + Wheat + Poultry	1	2930	255	315	5825	312	7512	3856	513	425	85	90
Livestock + Rice + Wheat + Mustard + Poultry	1	2810	235	280	5502	480	7120	3742	502	513	79	120
Livestock + Wheat + Rice + Poultry	1	4130	310	315	5315	402	6210	4625	480	263	68	126
Livestock + Wheat + Poultry	1	4215	299	270	5478	505	6345	4123	623	430	71	85

Constraints and strategies for development

The computed values for the constraints facing Index (CFI) pertaining to 10 prevalent constraints encountered by farmers in the study area exhibited a range between 273 and 338 base points (Table 15). Notably, a significant number of farmers underscored several challenges, with prominent issues encompassing the depressed prices of agricultural outputs, the limited availability and/or elevated costs of High-Yield Variety (HYV) seeds, and the scarcity of concentrate feed and fodder. These concerns were substantiated by the highest CFI values recorded for these constraints: 303, 316, and 338, respectively. Furthermore, additional noteworthy predicaments were identified, encompassing the high

expenses associated with fertilizers and pesticides, as well as the deficiency in irrigation facilities. A pressing issue of labor scarcity for agricultural operations due to the migration of laborers to urban centres in search of non-agricultural employment was also acknowledged. To address these challenges, the adoption of novel technologies and enhanced agricultural practices holds substantial promise. Moreover, the promotion of crop diversification is recognized as a strategic avenue for augmenting both productivity and profitability within the study area. These insights are consistent with the findings of Kachroo and Kachroo (2007)^[8], emphasizing the potential of innovative agricultural approaches to alleviate constraints and enhance overall agricultural outcomes.

Table 15: Selected constraints (10) along with constraints facing index and rank order

Name of the constraints	Integrated farming					Rank order	Organic farming					Rank order	Inorganic farming					Rank order
	Extent of constraints (N = 160)				CFI		Extent of constraints (N = 160)				CFI		Extent of constraints (N = 160)				CFI	
	H-(3)	M-(2)	L-(1)	Not at all (0)			H-(3)	M-(2)	L-(1)	Not at all (0)			H-(3)	M-(2)	L-(1)	Not at all (0)		
Low price of outputs	57	43	46	14	303	1	51	41	40	14	275	8	55	50	42	13	307	4
Non-availability and high price of HYV seed	49	39	55	17	280	9	55	39	51	15	294	3	52	52	48	8	308	3
High price of fertilizers and pesticides	48	45	48	19	282	8	48	47	49	16	287	6	50	53	46	11	302	5
Non-availability of grazing land	54	40	51	15	293	3	55	41	50	14	297	2	48	46	51	15	287	7
Lack of education, adequate extension services and training facilities	57	38	47	18	294	2	51	45	46	18	289	5	43	51	48	18	279	9
Low facility in Animals Treatments	50	47	43	20	287	7	58	49	44	9	316	1	58	59	46	7	338	1
Animals (Monkey, Pig, Neel Cow)	52	42	50	16	290	4	46	51	52	11	292	4	47	48	50	15	287	7
High price of irrigation	53	41	48	18	289	5	42	50	47	21	273	9	49	43	48	20	281	8
Lack of storage and processing facilities	48	49	46	17	288	6	48	42	54	16	282	7	56	48	53	3	317	2
Scarcity of labour	53	45	44	18	293	3	55	40	52	13	297	2	52	41	54	13	292	6

Indicators: H-High, M-Medium, L-Low

Conclusion

Among the 18 million households in Jammu, roughly 83% are small farmers, with some being landless (Rather 2024). These small farmers practice diversified farming to meet household needs and mitigate risks, making the most of their farming systems. Our research findings, spanning various locations within the state, underscore the greater advantages of integrated farming over solitary cropping systems for small and marginal farmers. Integration of crops, livestock, poultry, fruits, and vegetables has consistently demonstrated elevated rice grain equivalent yields, augmented net returns and heightened energy efficiency. Remarkably, these benefits have been achieved without compromising soil quality or system performance. Moreover, this integrated approach has emerged as an environmentally sound practice, leveraging resource recycling of farm waste to curtail reliance on chemical fertilizers, pesticides, and weedicides. The challenges faced by small and marginal farmers distinguish them from their larger counterparts. These farmers rely on agriculture to meet their household needs, often facing resource constraints and exhibiting limited education and technical acumen. Consequently, the development of suitable agricultural technologies becomes imperative for this demographic. Integrated farming emerges as a viable strategy, surpassing specialized cropping systems. It addresses the multifaceted demands of these farmers, contributing to their well-being and socio-economic advancement. These integrated systems, tailored to the socio-economic and agro-climatic conditions, ensure an interdependence of resources, enhancing sustainability, overall production and household income. In this context, achieving sustainable food production amid population growth, economic expansion, changing consumption habits, urbanization and climate change is a formidable challenge. Solutions must involve using less land, water, labor and chemicals, while focusing on improving productivity and well-being for small-scale farmers. The interplay between components within farming systems highlighted by Shyam *et al.*, (2023)^[15] and others as a means to enhance productivity reduce environmental degradation and improve the lives of impoverished farmers play an active role in identifying research problems and testing potential solutions, thereby contributing to meaningful progress. The outcomes derived from this study carry potential implications for both farmers and researchers, offering insights into agricultural diversification. Furthermore, the findings provide a valuable foundation for effective agricultural planning by government bodies and policymakers. As we look ahead, it is imperative that future research delves into the interplay between farm size, social dynamics, environmental outcomes and the well-being of laborers, farmers and consumers.

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Author contributions

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Competing interests

The authors declare no competing interests.

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