Economic and Profitability Analysis of Walnut Production in Kashmir Valley, India

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ABSTRACT

The Jammu and Kashmir union territory is the largest producer of walnuts in India, and this crop provides an important source of livelihood for many farmers. This study aims to measure the economic efficiency and profitability of walnut orchards and explore constraints in cultivation in the Kashmir Valley. It relies on a cross-sectional database collected from 240 walnut growers in the study area during the 2018/19 production period. Results reveal that walnut cultivation is highly labor-intensive as it incurs 80 percent of total production costs. The cost-benefit ratio of 1:5.35 per hectare indicates better economic prospects for the walnut industry in Kashmir Valley. The factors affecting productivity include farmyard manure, labor, chemical fertilizers, plant density, women participation, and information. The regression coefficients of production analysis, marginal value product, and marginal factor cost ratio indicate that there is ample scope for the expansion of walnut cultivation in the research area. However, walnut growers are confronted by several problems that tend to be location specific. The study calls for policy intervention concerning improved access to extension services, credit, and farmer training programs to boost walnut production in the study region.

Keywords: walnut, efficiency, profitability, extension services, cost-benefit ratio
JEL codes: C21, C83, D33, D61, E24, P43

INTRODUCTION

Economic efficiency refers to using resources in a way that maximizes profit and attains their highest and best purpose (Al-Sharafat and Al-Fawwaz 2017). If there is room for expanding agricultural activity, given the number of inputs and technologies already available, it may be measured by resource use efficiency (Haque 2006; Chiedozie, Blessing, and Oliver 2010). In addition, it highlights economic and technological

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inefficiencies that may be addressed to increase productivity and profitability in relation to agricultural land-use systems (Lone et al. 2023; Goni, Umar, and Usman 2013; Shrestha, Huang, and Pradhan 2015). Because of these, it is crucial to assess the economic viability of various crops.

Horticulture is vital in the economy of Jammu and Kashmir, a union territory of India, contributing USD 0.6052 to 0.8472 million annually to its GDP (Gov't of J&K 2020; Bhat et al. 2019). It plays a significant role in strengthening the financial conditions of small and marginal farmers. One of Jammu and Kashmir's major cash crops, walnut, is an important part of its booming horticulture industry. It generates considerable profits and contributes to alleviating poverty in the region. The enormous potential of walnut stems from its being organic since it can be grown with few chemical inputs, having a long shelf life, and being in high demand both locally and internationally (Dar 2021). The state enjoys a monopoly of walnut cultivation, producing around 0.266 million metric tons in 2018, which contributed over 98 percent to the total walnut production in India. Walnut cultivation also surpasses other horticultural crops in higher net income returns, ease of management, and the least requirement of capital inputs. It also adapts to a wide range of climatic conditions and topography and is relatively drought-resistant, which makes it environmentally remunerative to replace subsistence farming (Abeje et al. 2019). This may aid in alleviating poverty in harsh agroecosystems such as rainfed, wasteland, and hilly areas.

As a prominent cash crop of India, walnut has annual foreign earnings of more than USD 24.13 million. However, walnut cultivation is limited in a few geographical pockets of the country, including Jammu and Kashmir, Himachal Pradesh, Uttarakhand, and Arunachal Pradesh. Jammu and Kashmir has an 80.6 percent share of the total area and 91.6 percent share of walnut production in the country.

Although walnut cultivation requires less care and management compared with other horticultural crops such as apple, pear, peach, and plum, which are also grown in the study area, it faces stiff competition and criticism in terms of per acre productivity, economic returns per unit of land, and harvesting risks, among other things. Globally, China has the largest area for walnut cultivation, followed by the US, Turkey, Mexico, Iran, and India. On the other hand, Romania has the highest walnut productivity (24.44 t/ha) in the world followed by Pakistan (8.71 t/ha), Ukraine (8.10 t/ha), Egypt (7.33 t/ha), and Iran (6.53 t/ha). India lags in terms of walnut productivity (1.90 t/ha) and ranks 34th in the world despite having the sixth-largest global walnut area (Ahmed et al. 2012).

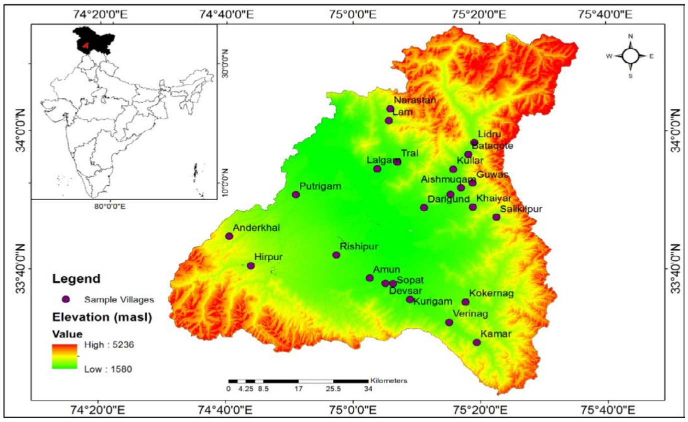
Numerous research studies have been conducted on resource use efficiency in agricultural and horticultural crops (Lone et al. 2022a; Lone et al. 2022b; Shrestha, Huang, and Pradhan 2015; Ashfaq et al. 2012; Karthick, Alagumani, and Amarnath 2013; Ibitoye, Shaibu, and Omole 2015; Shantha, Ali, and Bandara 2013). Nonetheless, fewer studies on walnuts have highlighted the significance of economic efficiency for this vital cash crop (Banaeian, Zangeneh, and Omid 2010; Russo, Green, and Howitt 2008; Adem et al. 2000). In contrast to publications concentrated on the nutritional, ecological, phytochemical, genetic, and medicinal purposes of walnut, socioeconomic literature is relatively scarce (Shigaeva and Darr 2020). This is the first study of this kind, addressing economic efficiency and profitability analysis coupled with constraint analysis for policy intervention and decision making, in the current study area for walnut.

MATERIALS AND METHODS

Study Area

This research was carried out in the four districts referred to as South Kashmir (located in southern Kashmir Valley): Anantnag, Pulwama, Kulgam, and Shopian. The total area covered by South Kashmir is around 5,400 km^2 and varies from 1,580 m above mean sea level (amsl) to 5,236 m amsl (Figure 1) (Ganaie et al. 2022a; 2022b).

Figure 1. Location map of the study area showing sample villages



According to the 2011 India census, the study area has a population density of around 359 people per square kilometer, most of whom reside in the rural areas.

Out of 0.5 million hectares total area, 30.2 percent is used for agricultural and horticultural purposes. Agriculture, the dominant economic activity in the region, is characterized by mixed crop-livestock production mostly on a subsistence level (Rathar et al. 2021). There are around 62,000 farm-operating families (Gov't of J&K 2020) in the study area. South Kashmir has a temperate climate with an average annual temperature of 11.6°C and annual precipitation of around 1,177 mm (Shafiq et al. 2018; Shafiq et al. 2019). Walnut is cultivated mainly in rainfed areas. The research area constituted 4.3 percent of the total walnut area and produced 42.9 percent of the total national walnut production in 2017/18.

Sampling and Data Source

Bulk of the data used in the study was collected from walnut orchardists in the research area using scheduled questionnaire as a basic research tool. Farm data were collected using stratified random sampling from 240 walnut growers for the 2018/19 production period. The areas where walnuts are grown were first identified and simple random sampling method was used to identify the villages/pockets where data could be obtained. Data on the inputs used to produce walnut were gathered from the individual growers, along with value of output in Indian Rupees (INR). The details about walnut cultivation such as acreage, costs involved in production and marketing, the output obtained, quantity supplied, price fluctuations, socioeconomic and demographic characteristics of walnut growers, and constraints faced were collected. Costs were the aggregation of monetary expenditures on fertilizers/manure, labor for different farm operational activities, transportation, marketing charges, and miscellaneous overheads. Farmland in hectares was included in the analysis, while labor was measured in man-days/working units in hours.

This study incorporates a relatively new variable called "women participation score" in explaining the resource-use efficiency of walnut orchards. This variable was previously used by Bozoglu and Ceyhan (2007) to explain the technical efficiency of vegetable farms in Turkey.

In the Kashmir Valley, women play a crucial role in walnut cultivation and participate in several farm operational activities such as the application of fertilizer/manure, hoeing, watching and warding, harvesting, picking/windrowing, hauling, grading, hulling, drying, and packing. Each activity was given a score of 5 points and, thus, total women participation varied between 0–55. The maximum women participation score meant that all the activities were performed by women alone, while the minimum score expressed no participation by women in walnut cultivation. Similarly, an information score was calculated by using farmers' responses to specific questions about access to extension services and farm advisors.

Cost-Benefit Analysis

Various costs were included in the estimation of the cost-benefit ratio. The expenses in cash and in kind incurred in both production and marketing of walnut are for the following:

a. fertilizer/manure;
b. labor, both hired and imputed value of family labor;
c. labor for the application of fertilizer and manure;
d. labor for watching and warding for 1.5 months active period;[1]
e. labor for harvesting, picking/windrowing, hauling, hulling, drying, grading, packing, loading, and unloading;
f. transportation; and
g. miscellaneous overheads, including for subsistence consumption.

On the other hand, output was taken as the cash received by the walnut grower.

Multiple Regression Model

To determine the efficiency of input on output, production analysis was carried out using a Cobb-Douglas type of production function (Fasasi, 2006; Ibitoye, Shaibu, and Omole 2015; Gani and Omonona 2009; Ashfaq et al. 2012; Mohammed et al. 2014; Tsomu 2016). The method specifies multiple regression models for the corresponding inputs to obtain the parameters for the measurement (elasticities) of resource use efficiency of factor inputs. The factor inputs denoted X1 to X6 in the model represent human labor (X1), application of fertilizers (X2), application of manure (X3), plant density (X4), women participation ratio (X5), and information score (X6). For sample walnut orchards, the equation may be expressed as:

$$\log Y = \log a + b1 \log X1 + b2 \log X2 + b3 \log X3 + b4 \log X4 + b5 \log X5 + b6 \log X6$$

Where,

Y = output (yield, kg/ha);

a = intercept/constant;

b to b6 = elasticity coefficients for input variables;

X1 = human labor (days/ha);

X2 = application of fertilizer (kg/ha);

X3 = application of manure (kg/ha);

X4 = plant density (no. of trees/ha);

X5 = women participation score (0 if no involvement in walnut operational activities and 55 if maximum); and

X6 = information score (dummy takes the value of 1 if farmers have access to information sources such as extension services or training programs and 0 if otherwise).

Allocative Efficiency Index

The allocative efficiency of resources used (factor inputs) for the sampled walnut orchards was determined by using marginal value product (MVP) and marginal factor ratio (MFC). The marginal value productivities (MVPs) of different resources were calculated by multiple regression coefficients of given resources with the ratio of geometric means of output to the geometric mean of given resources. Several studies have used this procedure (Taru et al. 2019; Al-Sharafat and Al-Fawwaz 2017; Anene, Ezeh, and Oputa 2010; Ashfaq et al. 2012; Tsomu 2016). The MVP of a given resource represents the expected addition to the gross output caused by an addition of one unit of that resource.

MVP_{xi} was computed using the following formula:

$$\boldsymbol{MVP_{xi} = (b_i)\frac{\overline{Y}}{\overline{X}_i}(P_y)}$$

Where,

$\overline{Y}$ = geometric mean of the output;

$\overline{X}_i$ = geometric mean of the input;

b_i = regression coefficients, where i = 1, 2, n; and

P_y = price of walnut per unit (INR).

Based on economic theory, a firm or enterprise maximizes profit with respect to

1 Fruiting period from premature to ripening, during which there are threats of theft of walnut fruits.

resource use on the basic condition that the ratio of the marginal returns to the marginal opportunity costs is one. Thus, the value exceeding 1 indicates underutilized, less than 1 means overused, and 1 means optimally used.

The relative percentage change required in inputs to obtain optimum resource use efficiency or a condition where MVP = MFC was calculated using the following formula adopted from (Mijindadi 1981)–

$$D = \left(1 - \frac{MFC}{MVP}\right) x\ 100 = (1 - r^{-1}) = \left(\frac{1}{1} - \frac{1}{r}\right) x\ 100$$

Where,

D = absolute value of percent change required in MVP of each resource; and

r = efficiency ratio.

Constraint Analysis

The constraints faced by walnut growers were identified and ranked using the Garrett method (Zalkuwi et al. 2015; Tulika and Singh 2016; Hosmath et al. 2012). The growers were asked to identify and rank the constraints that they face in the production and marketing of walnuts. The outcomes of such ranking process were converted into score value using the following formula:

$$\frac{100\ (R_{ij} - 0.5)}{Nj}$$

Where,

R_{ij} = rank given for the *i*th variable by *j*th respondents; and

N_j = number of variables ranked by *j*th respondents.

The percent position of each rank given to different constraints was converted into scores using the table referred by Garrett and Woodworth (1969). The mean Garrett score is derived by dividing the Garrett score by the total respondents. The constraint with the highest mean value is considered as the most severe constraint in walnut cultivation in the study area.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Walnut Growers

The descriptive analysis of the socioeconomic characteristics of the walnut growers in the study area is important in drawing various inferences regarding the agronomic aspects of walnut cultivation. Table 1 highlights the demographic and farmland characteristics of sample orchardists in the study area. The mean age of walnut growers is 47 years with vast farm experience of 27 years. Labor force, household size, and schooling are of medium levels. Landholding size in the study area is shown to be exceedingly meager (.08 ha or 8,000 m^2). The huge differences in minimum and maximum walnut output and resultant gross farm incomes demonstrate the effect and significance of landholding size.

Women participation in walnut cultivation was scored at 35, indicating that women took part in about 64 percent of all walnut farming activities. On the other hand, the information score, which reflects access to extension services, training programs, and farm advisors, was found to be 5. This suggests a critical need to address farmers' information gap, and also helps explain the very low walnut yields in the area as compared with other walnut-growing countries, as cited earlier.

Cost-Benefit Analysis

The cost of walnut production consists of the expenses incurred on various farm operational activities to produce walnut. Since walnut is mainly grown as a cash crop in the study area, marketing costs were incorporated into the analysis to obtain a final cost-benefit ratio. The costs include expenses on fertilizer/manure, wages to labors, marketing costs, and miscellaneous overheads, including subsistence consumption costs.

Annex Table 1 summarizes the total cost incurred in the cultivation and marketing of sample bearing walnut orchards on a per-hectare

Table 1. Socioeconomic characteristics of sample walnut growers in the study area

Variables	Mean	Standard Deviation	Min	Max
Age	46.84	9.84	25	73
Farm experience (years)	26.75	7.50	4	56
Schooling (years)	6.34	2.50	0	17
Labor force (number)	2.30	1.10	0	5
Output (kg)	118.92	60.25	20	2,500
Gross farm income (INR)	17,754.25	5,321.00	3,250.00	220,000.00
Walnut plants per family	4.78	3.73	1	120
Landholding size (ha)	0.08	0.35	0.02	2.2
Household size (number)	6	1.20	3	11
Walnut density per *kanal* (0.05 ha)	3.99	1.43	1	12
Female-male participation ratio	35	20	10	45
Information score	5	12.5	0	15
Average tree age	43.57	27.08	27	130

Source: Compiled from field survey, 2018/19

basis with a plant population of 80 walnut trees. The data about walnut trees during the nonbearing period (e.g., initial investment) was not available since some trees were more than 40 years of age. This can be considered as the major limitation of the study.

Results show that walnut cultivation is highly labor intensive as 79.9 percent of the total cost is incurred by labor alone, which was also reported by Hussain et al. 2018 and Khanali et al. 2021. In fact, 58.8 percent of total labor cost is incurred in harvesting (23.9), picking (21.5), and watching and warding (13.4) during a 1.5-month active period. It is followed by hulling (6.3), hauling (5.9), grading (2.5), drying (1.5), and market-related labor cost for packing, loading, and unloading (2.2).

Interestingly, miscellaneous overheads, including subsistence consumption, constitute nearly 11 percent of total cost incurred during all stages of production and marketing. However, the cost of fertilizer/manure represents slightly less than 4 percent of the total cost, followed by packing material (3%), and transportation charges (2.4%). Table 2 shows that the total amount of INR 531,508/ha is obtained as gross returns from the sample walnut orchards. However, the price of walnut varies from the individual walnut grower with a minimum of INR 100/kg and a maximum of INR 165/kg, depending on the hardness of the walnut shell and other factors such as color, taste, and dryness of the kernel. The cost-benefit ratio, which is considered the index of profitability, worked out to 1:5.35/ha. This implies that walnut cultivation in the study area is a high-payoff economic activity as each unit of INR expenditure results in an average income of INR 5.35. This means that each unit of monetary input provides 5.35 times return. It should be emphasized that walnut trees do not require much care and other inputs such as pesticides, unlike other fruit trees (Colak 2021; Bhat, Kirmani, and Wani 2016).

Table 2. Total output for sampled walnut orchards with population of 80 trees/ha during bearing stage in the study area, 2018/19 (N = 240)

Total Walnut Production (kg)	3,560
Total Production Cost	INR 83,825.00
Average Production Cost (Per kg)	INR 23.55
Average Price (Per kg)	INR 149.30
Gross Returns	INR 531,508.00
Net Margin	INR 448,683.00
Cost-Benefit Ratio	INR 5.35

Nonetheless, the above profit computation is purely based on input-output analysis and not on the profit per unit of area; apples, for instance, produce more revenue per unit of land than walnuts.

Resource Use Efficiency

This section identifies various factors affecting walnut production in the study area using production function analysis, MVP (MVP_{xi}), and factor cost ratios (MVP_{xi}/P_{xi}). Farmyard manure, labor, chemical fertilizers, plant density, women participation ratio, and information score were identified as the main factors affecting the productivity of walnut farms. It was hypothesized that all these factors have a positive impact on the walnut yield.

The results of the regression analysis of the sample walnut orchards are presented in Table 3. The coefficient of determination R^2 = 0.91 signifies that 91 percent of the variation in the dependent variable (walnut production) is explained through the chosen inputs from the cross-sectional data obtained from the walnut orchardists. The adjusted coefficient of a model was found to be 0.86, which lies within the range of acceptable limits. Thus, the regression analyses depict a close association between the selected inputs and the resultant production of walnuts.

Table 3. Results of regression analysis for sample walnut orchards

Variables	Coeffi-cients	Standard Error	p-value
Constant	9.58***	2.457287	0.007
Farm yield manure	0.416**	0.215311	0.043
Chemical fertilizers	1.237**	0.291333	0.03
Labor	-0.025	0.312176	0.11
Plant density	-0.79***	0.318703	0.0004
Women participation ratio	0.15*	0.404947	0.08
Information score	0.004	0.099223	0.15

Notes: ***1 percent, **5 percent, and *10 percent levels of significance
Σ bi = 1.073, R^2 = 0.91, Adjusted R^2 = 0.86

Multiple Regression Analysis (Log-Linear Regression)

The regression coefficients concerning farmyard manure, chemical fertilizers, and women participation ratio were found significantly positive and an increase of one percent in these inputs, on average, would increase productivity by 0.416, 1.237, and 0.15, respectively. In the case of plant density per hectare, the results were negative, and the coefficient revealed that one percent change from the optimum would decrease productivity by 0.8 percent. This shows the irrational use of plant density by the walnut growers in the study area. The elasticity coefficients of labor and information score were found statistically insignificant. The overall returns to scale for walnut productivity were found to be increasing since the summation of statically significant variables (Σbi) was more than one. The use of resource efficiency of walnuts can be further enhanced by the optimum utilization of plant density, which otherwise proves a major hindrance in the overall returns to scale.

MVP-MFC Ratio Analysis

Economic theory explicitly asserts that the MVP must equalize the MFC for maximum efficiency. The ratio of the MVP of resources to their factor costs for the walnut orchards in the study area is presented in Table 4. The ratio of MVP to MFC for farmyard manure and chemical fertilizer was found to be 1.96 and 5.46, respectively. In other words, for every additional rupee spent on these factors of production, total earnings would increase by INR 1.96 and INR 5.46, respectively. Moreover, the MVPs of both farmyard manure and chemical fertilizers are substantially higher than unity, implying suboptimal levels of resource use by the orchardists. However, the elasticities for labor and plant density were found inelastic and one extra rupee spent on these variables would result in a loss of INR 0.45 and INR 3.92, respectively.

Table 4. Allocative efficiency of various inputs used in the study

Variable	MVP_{xi}	MVP_{xi}/P_{xi}	Description
Farmyard manure	785.5	1.96	Underutilized
Chemical fertilizers	512.75	5.46	Underutilized
Labor	-1,380.5	-0.45	Overutilized
Plant density	-1,265.52	-3.92	Overutilized

This indicates that the overutilization of these resources is hampering overall monetary returns from walnut cultivation.

Constraints Faced by Walnut Orchardists

This section deals with the major constraints faced by walnut orchardists during all stages of production and marketing. The constraints are presented hierarchically in Table 5. The risk during harvesting of walnut is perceived to be the most challenging problem faced by growers, specifically because falling from walnut trees has proven to be fatal in most cases in the study area and it imposes a heavy financial burden. In the event of an accident or death, the growers will be held accountable to pay the harvester's compensation costs. Moreover, owing to the high risk during harvesting, the rate payable to the harvester is usually four times higher than normal wages, which ultimately puts an extra burden on the grower, consequently reducing his/her margin. For the harvester, who could be a breadwinner in most cases, any accident that may happen during harvesting will incapacitate him/her to work, leaving his/her entire family in jeopardy.

The next most severe problem perceived by the walnut cultivators is the small landholding size, which makes production less effective even if the cost-benefit ratios for walnut tends to be highly favorable. This is similar to the research results of Dixit, Sharma, and Ali (2014). The small landholding size is on account of the mountainous topography of the study area, leaving a limited area available for cultivation. Moreover, there is a common practice of generational partitioning of land among sibling heirs.

Another challenge is the extensive nonbearing stage of a walnut tree, which normally exceeds 15 years for traditional varieties. Frequent price fluctuation (69.40) is another major constraint faced by walnut growers in the study area. Interestingly, the lack of high-yielding plant varieties was ranked next with the average Garrett score of 64.51.

Price variability coupled with poor financial conditions in the region could discourage the growers to take interest in walnut cultivation. The walnut growers of Kashmir Valley suffer substantial economic losses due to frequent price fluctuations in the market. A similar result was reported by Hassan, Bhattacharjee, and Wani (2022). The sample data on the price of walnut per kilogram from 2014–2018 demonstrates the stagnant or

Table 5. Major constraints faced by walnut orchardists

Constraints	Garrett Score	Mean Garrett Score	Rank
Risk during harvesting	17,936	74.73	1
Small landholding size	17,646	73.53	2
Prolonged nonbearing period	17,206	71.69	3
Price fluctuations	16,656	69.40	4
Lack of high-yielding plant varieties	15,482	64.51	5
Excessive transportation charges	15,282	63.68	6
Lack of extension services	14,954	62.31	7
Financial position of grower	14,696	61.23	8
Lack of credit facilities	14,488	60.37	9
Lack of immediate market facilities	12,760	53.17	10
High risk to life, limb, and property	12,444	51.85	11
Climate change	11,400	47.50	12
Weak government policies	11,290	47.04	13
Lack of storage facilities	10,734	44.73	14

Table 6. Trend in gross revenue generated, walnut supplied, and average rate for walnut in South Kashmir from 2014 to 2018

Year	Rate (Range/40 kg)	Gross Revenue Generated (INR)	Supplied Walnut (kg)	Average Rate/ 40 kg
2014	6,400–7,200	4,252,500	25,200	6,750
2015	8,000–9,500	4,889,880	23,120	8,460
2016	7,000–7,700	4,581,750	24,600	7,450
2017	6,000–6,700	5,531,400	35,120	6,300
2018	5,500–6,500	4,261,022	28,540	5,972

Source: Field survey 2018/19

decreasing price trend, making walnut cultivation highly risky (Table 6).The limited market facilities, as well as the absence of specialized markets in and around Kashmir Valley for selling the produce, incur huge transportation cost for the growers. These findings are similar with that of Sofi, Nabi, and Anthony (2016).

The moderate constraints identified, using the Garrett ranking method (see Table 5), were poor financial conditions associated with walnut growers (61.23), lack of credit facilities (60.37), and lack of immediate market facilities (53.17). Poverty prevents farmers from acquiring necessary inputs for farming operations such as irrigation, fertilizers, good seed varieties, and improved technology. On the other hand, poor marketing conditions and lack of credit availability limit farmers in taking positive measures to improve their resource base by producing cash crops.

Other constraints such as climate change (47.50), inadequate government policy interventions (47.04), and lack of storage facilities (44.73) were ranked least severe by the sample farmers. However, these too, to some extent, affect the productivity and efficiency of walnut orchardists in the research area.

CONCLUSION AND POLICY IMPLICATIONS

This study attempts to explore the profitability and economic efficiency of walnut cultivation in Kashmir Valley, India. The high cost-benefit ratio of 1:5.35 confirms walnut cultivation as an economically profitable activity. Furthermore, investment details indicate that walnut cultivation is highly labor-intensive and, therefore, generates tremendous seasonal employment opportunities during the production, transportation, processing, and marketing stages. On the other hand, the production function analysis revealed that variables such as farmyard manure and chemical fertilizers positively affect the productivity of walnut cultivation in the study area, while plant density was found to have a statistically negative effect. The summation of coefficients of statistically significant variables tends to be more than one, which indicates increasing returns to scale for walnut cultivation despite the overuse and mismanagement of plant density in the area. The MVP and MFC ratio analysis also revealed that farmyard manure and chemical fertilizers are underutilized, while plant density and human labor are overutilized. These results provide a solid reference when drafting guidelines for the optimum use of resources to raise both the productivity and efficiency of walnut cultivation in the study area.

One of the key research issues highlighted in this discourse is the role of women in farm operations. The results revealed women participation is crucial in the overall efficiency of land-use systems and, as such, becomes a necessity not only to recognize the labor efficiency of women in agricultural systems but also to involve them in resource use management and in decision making. In other words, any policy directed toward improved participation of women is likely to be beneficial. Our results are consistent with several studies (Kabadaki 1994; Spio 1997; Shah 2000; McCoy, Carruth, and Reed 2002) about women efficiency in rural agricultural economies and gender differentiation in labor participation in agricultural activities all over the world.

Lastly, the constraint analysis revealed that although walnut cultivation is economically viable, it is hindered by several factors that tend to be location specific. Among these factors, risk during harvesting and small landholding size make walnut cultivation a risky and inefficient proposition, respectively. Therefore, this study calls for appropriate policy interventions related to developmental issues such as the promotion of targeted agricultural subsidies, price support, increasing credit availability to small landholders, diversifying nonfarm activities, disseminating market and climate information, increasing access to agricultural marketing, and facilitating extension services and research.

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Annex Table 1. Cost sheet of walnut production for one hectare with a bearing plant population of 80 (20–60 years of age)

Incurred Costs	Specific Inputs/Farm Operational Activities	Units			Quantity	Rates (INR)	Amount	Percent
Fertilizer/ manure	Farmyard manure	kg			220	3.75	825.00	0.98
	Urea and other fertilizers	kg			250	6.00	2,500.00	2.98
Labor			Family Labor	Hired Labor				79.87
	Applying/hoeing fertilizer/manure	Man-days	3	5	8	300.00	2,400.00	2.86
	Watching and warding for 1.5 months active period	Man-days	27	18	45	250.00	11,250.00	13.42
	Harvesting (shaking and windrowing)	Man-days	20	0	20	1,000.00	20,000.00	23.86
	Picking	Man-days	42	18	60	300.00	18,000.00	21.47
	Hauling	Man-days	12	2	14	350.00	4,900.00	5.85
	Hulling	Man-days	11	4	15	350.00	5,250.00	6.26
	Drying	Man-days	4	1	5	250.00	1,250.00	1.49
	Grading	Man-days	3	3	6	350.00	2,100.00	2.51
	Packing	Man-days	1	1	2	300.00	600.00	0.72
	Loading	Man-days	1	1	2	300.00	600.00	0.72
	Unloading	Man-days	1	1	2	300.00	600.00	0.72
Other costs	Packing material	Sacks	-	-	62	40	2,480.00	2.96
	Transportation charges						2,000.00	2.39
	Miscellaneous overheads, including subsistence consumption						9,070.00	10.82
Total cost incurred					83,825.00			

Source: Field survey, 2018/1