__Original Research Article__

Efficiency of Resource Allocation of Large Cardamom Production: a case for Nepal East corridor

ABSTRACT

Aim: This research aimed to assess the resource allocation efficiency of large cardamom production in Nepal east corridors.

Method and duration of research: A comprehensive analysis of socio-economic characteristics and economic aspects of large cardamom production was conducted using data collected in 2022 in eastern corridor Nepal with 480 samples.

Result: The socio-economic characterization of large cardamom farmers revealed that the majority of households were headed by males (75.4%), and most had *kacchi* and semi-pakki houses (77.3%). Nuclear families were more prevalent (71.9%) than joint families (28.1%). Basic education was the most common educational level among household heads (51.7%), and Aadibasi/Janajati was the predominant ethnic group (52.9%). The study identified significant associations between family types and members abroad with the study corridors ($p < 0.05$). The economic analysis revealed the capital costs and labor costs involved in large cardamom production over a six-year period. Gap filling had a significant positive impact on Marginal Value Product (MVP), increasing it by 182.21 units (99.45%). However, certain factors like chemical costs had a negative impact on MVP, reducing it by 38.33 units (102.61%). Resource use efficiency analysis showed that labor for postharvest activities positively influenced MVP, increasing it by 1.52 units (34.27%). On the other hand, transportation labor had a negative impact, decreasing MVP by 9.89 units (110.11%).

Conclusion: The study contributes valuable insights for policymakers, researchers, and farmers in understanding the socio-economic and economic dimensions of large cardamom farming in the study area. Addressing gaps in production, optimizing resource utilization, and focusing on postharvest activities can lead to improved resource efficiency and higher returns for farmers. The findings are crucial for designing targeted policies and interventions to support the large cardamom farming community and promote sustainable agricultural practices.

Keywords: Cost, Efficiency, Large cardamom Marginal Value Product, Resource, and socio-economic

1. INTRODUCTION

Large cardamom has evolved as an important cash and exportable crop in Southeast Asian countries like Nepal in recent years [1] It is critical to the lives of mountain populations in the Himalayan region, owing to its high value with limited volume[2] Large cardamom has great economic significance, as it is Nepal's top foreign currency earner [3][4]. Surprisingly, Nepal is the world's top most producers and exporter of large cardamom, accounting for roughly 68% of the global market, with India accounting for approximately 22% [5]. Farmers including Nepal, Bhutan and Indian, continue to rely on large cardamom cultivation. Around 22,000 households in Nepal alone are engaged in large-scale cardamom production, with the vast majority being smallholder farmers [1] [6] [7]. Furthermore, the crop contributes substantially to the household income of both small and large farmers [8].

Although subsistence farming continues to dominate agricultural production in Nepal, a considerable movement towards high-value agriculture has occurred. The planting of high-value crops such as chili, garlic, ginger, turmeric, and large cardamom has expanded, showing that farmers and traders are becoming more interested in products with higher economic value [9]. Through supportive agriculture and trade policies, the Nepalese government intends to boost export-led high-value products such as big cardamom [10].

With its expanding contribution to the country's economy, large cardamom has eclipsed tea as the leading foreign exchange earner[7] In Nepal, it has become a prioritized export-led high-value crop, accounting for 5% of total export value since 2018 [11]. Although subsistence farming continues to dominate agricultural production in Nepal, there has been a noticeable shift towards. Finally, large cardamom has emerged as a prominent high-value crop in Southeast Asia, especially in Nepal, with its production giving significant economic benefits to mountain people and adding to the country's foreign exchange revenues. Because of its distinct qualities and global demand, it has become a major asset to Nepal's agricultural sector.

Productivity can be increased by either improving technology or increasing the efficiency of the resources employed. Farmers may use resources rationally, but not at an economically optimal level, owing to a lack of information about resource optimization [12]. According to[13] Barmon and Islam (2017),farmers observed a diminishing return to scale in wheat output, indicating that there was still room to expand wheat production by utilizing more seed, chemical fertilizers, manure, and pesticides. Rice demand may be met by increasing domestic rice production and enhancing the resource use efficiency of existing rice fields [14]. The most essential means of boosting product output is resource efficiency, particularly for poor farmers who are responsible for the majority of product consumption in developing countries [15].Thus this research was conducted with the aim to assess the resource use efficiency of large cardamom in eastern Nepal.

2. MATERIALS AND METHODS

Koshi and Mechi corridor were purposively selected as a research site being first rank in terms of large cardamom production in Nepal (MOALD). Households were selected randomly. With consulting Local Bodies' Administration, Agriculture Knowledge Centre, and Federal Large Cardamom Entrepreneur Nepal representative and [16] MoALD (2017) reported that over 21960 households in 51 districts were actively involved in large cardamom production in Nepal. These are considered as population of study. A structure interveiw schedule was developed and used to the collect production of large cardamom . Sample size were determined as following

Sample size (n) $= \frac{N}{1+Ne2}$ [17]

N = total population

e = margin of error (0.05)

From above, the sample size were 392 and 25% of non-response households were added. Then total represented samples were 490.Then, sampling framework was prepared and samples were selected randomly. Farmer having more than 3 years experiences were selected for interview. Finally, Absolute samples were 480.Data were coded and entered in MS EXCEL and analysis was done in Statistical Package for Social Science (SPSS Version 20.0). Both descriptive and analytical methods were used to analyse the quantitative data. Cost of large cardamom production, the study considered only variable costs. Variable cost included labour for land preparation, mannuring, fertilization irrigation plant protection, intercultural operation harvesting transportation and postharvest activities and manure, plant protection, operation cost of irrigation and other costs, if included. Total variable cost was calculated by summing all the variable cost items as in the following.

$$Cost\ of\ large\ cardamom\ production(Rs) = C_{land} + C_{land\ preparation} + C_{planting\ material} + C_{harvesting} + C_{postharvest} + C_{fertilizer} + C_{protection} + C_{Intercultural\ operation} + C_{other}$$

2.1.Cobb-Douglas production function as estimation of efficiency ratios

Resources allocation efficiency was estimated using Cobb-Douglas production function in large cardamom production. The regression coefficients of each input were used to compute marginal value product (MVP) and compare with Marginal Factor Cost (MFC) in order to determine the optimum, over and under use of resources [18].

Cobb-Douglas production function was;

$Y= aX_1^{b1}X_2^{b2}X_3^{b3}$

The dependent and explanatory variables were extended to log function

$lnY\ lna+b_1lnX^1+b_2lnX_2+b_3lnX_3$

Where,

Y= Total value production of large cardamom production/ ha

X_1= Fertilizer and manure cost

$X_{2.....}$= Labour cost

X_3= Pesticide cost

A=Intercept

The efficiency ratio was calculated by formula

Efficiency ratio (r) =Marginal value product (MVP)/ Marginal factor cost (MFC)

The marginal value products were as determined by using the formula:

$$MVP_i = b_i \times \frac{y}{X_i}$$

Where, bi= regression coefficients

y= Geometric mean of total value product of large cardamom

X=Geometric mean of inputs

The relative change in marginal value product of each resource was estimated as follow:

D = (1-MFC/MVP)*100 or, D = (1-1/r)*100

Where, D = Absolute value of percentage change in MVP of each resource

2.2.Return to scale (RTS)

Coefficient of regression of each input was used for RTS calculation as follow:

RTS $=\sum b_i$

Where, b_i = coefficient of i^t explanatory variables obtained from Cobb-Douglas production function. Criteria for Return to Scale was based on value less , equal and greater than 1 as decreasing return to scale, constant return to scale and increasing return to scale respectively.

3. RESULT AND DISCUSION

3.1 Socioeconomics characterization of large cardamom farmers

Table1. Socioeconomic characterization of large cardamom farmers in study area 2022

Variables	Corridors		Total	chi square value
	Koshi	Mechi		
Gender of Household Head				
Female	64(26.70)	54(22.50)	118(24.60)	1.124
Male	176(73.30)	186(77.50)	362(75.40)	
Type of House				
Kacchi and semi Pakki	182(75.80)	189(78.80)	371(77.30)	0.582
Pakki	58(24.20)	51(21.30)	109(22.70)	
Type of Family				
Joint	57(23.80)	78(32.50)	135(28.10)	4.545**
Nuclear	183(76.30)	162(67.50)	345(71.90)	
Education level of Household Head				

Illiterate	64(26.70)	88(36.70)	152(31.70)	
Literate	8(3.30)	13(5.40)	21(4.40)	10.55**
Primary Level	42(17.50)	40(16.70)	82(17.10)	
Secondary Level	91(37.90)	75(31.30)	166(34.60)	
Basic Education	133(55.40)	115(47.90)	248(51.67)	
High School	29(12.10)	23(9.60)	52(10.80)	
University Level	6(2.50)	1(0.40)	7(1.50)	
Ethnicity				
Brahmin/Chhetri	96(40.00)	95(39.60)	191(39.80)	0.278
Aadibasi/Janajati	128(53,30)	126(52.50)	254(52.90)	
Dalit	16(6.70)	19(7.90)	35(7.30)	
Members Abroad				
No	164(68.30)	138(57.50)	302(62.90)	6.036**
Yes	76(31.70)	102(42.50)	178(37.10)	
Irrigation facility				
Yes	204(85.00)	201(83.30)	405(84.40)	0.142
No	36(15.00)	39(16.30)	75(15.60)	
Resource sharing				
No	66(27.50)	72(30.00)	138(28.70)	0.366
Yes	174(72.50)	168(70.00)	342(71.30)	
Source Planting Material				
Own source	173(72.10)	185(77.10)	358(74.60)	1.583
Others source	67(27.90)	55(22.90)	122(25.40)	

According to the data reported in Table 1, which characterized the socioeconomic features of large cardamom farmers in the research region in 2021, 362 (75.4%) of the total 483 surveyed families were headed by males, while 118 (24.6%) were headed by females. Furthermore, 371 (77.3%) of the households had *kacchi* and *semi-pakki* dwellings, while 109 (22.7%) possessed *pakki* houses. In terms of family structure, 345 (71.9%) homes were categorized as nuclear families, while 135 (28.1%) were classed as joint families. Concerning the education level of household heads, 248 (51.7%) had attained basic education, while 152 (31.7%) were illiterate. Furthermore, 191 (39.8%) of the houses were Brahmin/Chhetri, while 254 (52.9%) were Aadibasi/Janajati. In terms of members abroad, 302 (62.9%) households had no members abroad, while 178 (37.1%) had at least one member abroad.

In addition, 405 (84.4%) of the families had access to irrigation, whereas 75 (15.6%) did not. 342 (71.3%) households shared resources, whereas 138 (28.7%) did not share resources. In terms of planting supplies, 358 (74.6%) families used their own source, whereas 122 (25.4%) received them by sharing them with others.

At the 0.05 level of significance, the results showed that family types and members overseas had a statistically significant association with the study corridors, with chi-square values of 4.545 and 6.036, respectively. The remaining variables, on the other hand, did not reveal any meaningful association with the study corridors.

Table 2. Socioeconomics characterization of large cardamom farmers (continuous variable) 2022

	Corridors			Mean	
Variables	Koshi	Mechi	Total	Diff.	T value
Household head age(year)	51.21(10.25)	53.23(11.45)	52.22(10.90)	-2.02	-2.03**
Year of schooling	6.31(4.57)	5.07(4.46)	5.69(4.56)	1.24	3.01***
Average family size	6.18(2.56)	6.42(2.68)	6.3(2.62)	-0.24	-1.01
Member involved	2.55(1.11)	2.51(1.12)	2.53(1.11)	0.04	0.39
Land (Ropani)	31.55(33.46)	30.54(28.91)	31.05(31.24)	1.02	0.36
Khar Bari (Ropani)	7.16(21.17)	7.03(17.83)	7.1(19.55)	0.13	0.08
Lease (Ropani)	1.97(13.04)	0.95(4.20)	1.46(9.69)	1.03	1.16
Cardamom Area (Ropani)	23.06(20.51)	23.03(20.37)	23.05(20.42)	0.03	0.02
Farming experience (year)	21.32(13.11)	20(11.77)	20.66(12.46)	1.33	1.17
LSU	6.73(4.40)	6.89(5.07)	6.81(4.74)	-0.15	-0.36

Parenthesis indicate standard deviation; * and ** imply 1% and 5% level of significant

Above table displayed the socioeconomic features of major cardamom farmers in Nepal's two corridors, Koshi and Mechi. Data on continuous variables such as household head age, years of schooling, average family size, member involvement, land ownership, *khar bari* (a traditional sharecropping system), lease, cardamom area, agricultural experience, and land slope units (LSU) were included in the table. The mean differences and t-values for each variable were used to compare the two corridors. For example, the mean age of household heads in the Koshi corridor was 51.21 years, whereas it was 53.23 years in the Mechi corridor, resulting in a mean difference of -2.02. This difference's t-value was -2.03, which was deemed to be statistically significant at the 5% level. Similarly, the Koshi corridor had more years of schooling than the Mechi corridor, with a mean difference of 1.24. The t-value for this difference was 3.01, showing a 1% significant difference. There were no significant changes in average family size, member involvement, land ownership, *khar bari,* lease, cardamom area, agricultural experience, or LSU between the two corridors.

3.2 Economics of large cardamom production

Table 3. Capital Cost for large cardamom production per hector in study area 2022

	Year					
Capital cost (Nrs)	I	II	III	IV	V	VI
FYM	98038		65237	57386	80341	143466
Mulch	890		1425	1594	1336	1732
Pest management			1938	1932	1905	1923
Gap fill		4489	5971	974	2069	599
Urea			654.42	1059	1227	1308
Potash			415	442	455	442
Phosphorous			580	690	702	729
Interest		21787	21787	21787	21787	21787

Table 4. Labor cost for large cardamom production per hector in study area 2022

Labor use (Nrs)	Year					
	I	II	III	IV	V	VI
Land preparation &transplanting	54328					
Nutrient, pest & irrigation	9008		65236	19375	21804	24235
Mulching & intercultural operation	1671	12227	7331	8156	9184	10196
Harvesting			6874	21407	24083	26759
Transportation			4178	6443	7254	8060
Postharvest			24284	81281	91441	101601

Table 5. Cost and Production of large cardamom in study area 2022

Particulars	Year					
	I	II	III	IV	V	VI
Variable cost	163935	38503	205915	222528	263590	342841
Fixed cost and Initial Investment						
Sapling	16586					
Shade tree sapling	1284					
Harvesting equipment	3184					
Irrigation scheme	74268					
Drying and processing equipment	20339					
Total Fixed cost	115663					
Total cost	279598	38503	205915	222528	263590	342841
Production (Kg)			189.03	552.13	739.01	727.08
Total Value product (Nrs)			287336	946896	805511	746707
Price (Nrs)			1520	1715	1090	1027

3.3 Resource allocation efficiency of large cardamom

Table 6. Resource allocation n efficiency of large cardamom production in study area 2022

Variables	Coef.	t	P>t	MVP	MFC	R	D
Gap filling	0.13***	12.61	0.0	182.21	1	182.21	99.45
FYM /compost	-0.01	-0.82	0.41	-0.11	1	-0.12	963.77
Mulching materials	0.01	0.72	0.47	7.09	1	7.09	85.88
Cost chemical	-0.01**	-2.01	0.05	-38.33	1	-38.33	102.61
Pest disease management	-0.01	-0.18	0.85	-2.79	1	-2.79	135.76
Labor(FYM+pest+Irrigation)	-0.03	-0.69	0.49	-0.86	1	-0.86	216.35
Labor Inter mulching	0.03	1.46	0.14	2.10	1	2.10	52.49
Labor Harvesting	0.04	1	0.32	1.01	1	1.01	0.79
Labor transportation	-0.13***	-4.52	0.0	-9.89	1	-9.89	110.11
Labor postharvest	0.506***	17.57	0.0	1.52	1	1.52	34.27
_cons	3.176	8.59	0				
Number of obs =	480						
F(10, 469)	94.7						
Probality > F	0.00						
R-squared	0.67						
Adj R-squared	0.66						
Root MSE	0.08						
Elasticity of production	0.526						

Table 6 examined the efficiency of use of resources in large cardamom production during 2022. With a coefficient of 0.13, the data demonstrated that gap filling had a considerably favourable impact on MVP (Marginal Value Product). This means that fixing gaps in huge cardamom production boosted the MVP by 182.21 units, a 99.45% gain. The application of FYM/compost, on the other hand, had no significant influence on MVP (p=0.41) and had a coefficient of -0.01, resulting in an absolute percentage change in

MVP of 963.77%. Similarly, mulching materials had no effect on MVP (p=0.47) with a coefficient of 0.01, resulting in an absolute percentage change in MVP of 85.88%.

Chemical costs had a substantial negative influence on MVP (p=0.05), with a coefficient of -0.01 indicating a negative impact on MVP and an absolute percentage change of 102.61%. Pest disease control, on the other hand, had no significant effect on MVP (p=0.85), with a coefficient of -0.01, resulting in an absolute percentage change of 135.76%. The labour required for tasks such as FYM application, pest management, and irrigation had no effect on MVP (p=0.49), with a coefficient of -0.03, resulting in a 216.35% absolute percentage change. However, labour required for inter-mulching showed a substantial positive influence on MVP (p=0.14), with a value of 0.03, indicating that it might raise MVP by 52.49%.

The amount of labour required for harvesting had no effect on MVP (p=0.32), with a coefficient of 0.04, resulting in an absolute percentage change of 0.79%. In contrast, transportation labour had a significant negative influence on MVP (p=0.001), with a coefficient of -0.13, suggesting a negative impact on MVP, with an absolute percentage change of 110.11%. Labour required for postharvest activities had a substantial positive influence on MVP (p=0.001), with a value of 0.506 indicating that it may enhance MVP by 34.27%.

The R-squared value was determined to be 0.67, indicating that the model explained 67% of the variation in MVP. Furthermore, the production elasticity was found to be 0.526, implying that a 1% increase in inputs might result in a 0.526% rise in output.

The gap filling costs have positive effect on the MVP which indicates that if farmer perform gap filling in their orchard increase the production. The increase in productive plant in orchard through removal of unproductive, diseases and damaged bushed by natural calamities like wind, rain, wild animals or frost is ensured by gap filling [1] [19]. Cost of chemical have negative MVP by MFC ratio which indicate the resources were over utilized similar result was found by [20][21]. The elasticity of production was decreasing return to scale which align with the finding of [20][22].

4.CONCLUSION

The study provides insights into the socioeconomic features of large cardamom growers, the economic elements of production costs and profits, and the resource allocation efficiency in the study area. Gap filling was revealed as a key element favourably affecting MVP, but transportation labour had a negative impact. The findings can help farmers and policymakers make informed decisions about large-scale cardamom production and resource management. However, more research may be required to understand the factors influencing resource allocation and efficiency in diverse contexts and countries.

DECLARATION

Ethical Approval and consent to participate: NA

Consent of Publication: NA

Data Availability Statement

Addition Information will be provided on request.

REFERENCES

[1] Sharma G, Sharma R, Sharma E. Traditional knowledge systems in large cardamom farming: Biophysical and management diversity in Indian mountainous regions. Indian Journal of Traditional Knowledge. 2009; 8(1):17–22

[2] Avasthe RK, Singh KK, Tomar JMS. Large cardamom (Amomum subulatum Roxb.) based agroforestry systems for production, resource conservation and livelihood security in the Sikkim Himalaya. Indian Journal of Soil Conservation. 2011; 39(2):155–160.

[3] Sharma G, Partap U, Dahal DR, Sharma DP, Sharma E. Declining Large-Cardamom Production Systems in the Sikkim Himalayas: Climate Change Impacts, Agroeconomic Potential, and Revival Strategies, Source: Mountain Research and Development. 2016;36(3):286-298. Published By: International Mountain Society

[4] Bhandari N, Bhandari T. Marketing and socioeconomics aspects of large cardamom production in Tehrathum, Nepal. Journal of Nepal Agricultural Research Council. 2018; 4: 79-85 (pp. 80-81).

[5] Joshi NP , Piya L. Large Cardamom (Amomum Subulatum Roxb.) Production, marketing and trade in the Indian sub-continent. Journal of Contemporary India Studies: Space and Society. 2019; 9, 1-13.

[6] ICIMOD. Himalica Pilot Project Taplejung, Nepal Building resilience of highland communities by improving livelihoods and natural resource management. Kathmandu, Nepal.2016.

Retrieved from http://lib. icimod.org/record/32325/files/icimodHIMALICA16.pdf

[7] ITC. Nepal National Subsector Export Promotion Strategy for Large Cardamom 2017-2021. Kathmandu: International Trade Center/Government of Nepal. 2017.

[8] Pratap U., Sharma G, Gurung M. B, Chettri N, Sharma E. Large cardamom farming in changing climatic and socioeconomic conditions in the Sikkim Himalayas . 2014.

[9] MOAD. Statistical Infromation on Nepalese Agriculture 2014/15. Kathmandu, Nepal: Ministry of Agricultural Development. 2019.

[10]MoC. Nepal Trade Integration Strategy 2016: Executive Summary and Action Matrix. Government of Nepal, Ministry of Commerce. 2016.

[11]MoICS. Nepal Trade Integration Strategy 2019: Executive Summary and Action Matrix. Government of Nepal, Ministry of Industry ,Commerce and Supply. 2019

[12] Dhakal SC, Regmi PP, Thapa RB, Sah SK, Khatri-Chhetri DB. Resource use efficiency of mustard production in Chitwan district of Nepal. *International Journal of Applied Sciences and Biotechnology*. 2015;*3*(4), 604-608

[13]Barmon BK, Islam M. Resource Use Efficiency and Factors Affecting Land Allocation for Wheat (Triticum aestivum L.) Production in Bangladesh. *The Agriculturists*. 2017;*15*(1), 28-39.

[14] Osti R, Rizwan M, Assefa AK, Zhou D, Bhattarai D. Analysis of Resource-use Efficiency in Monsoon and Spring Rice Production in Nepal. *Pakistan Journal of Nutrition.* 2017; *16: 314-321.*

[15] Goni M, Umar M, Sman U. Analysis of resource-use efficiency in dry season vegetable production in Jere Borno State, Nigeria. *Journal of Biology and Agriculture Health*. 2013; *3*(19), 18-23.

[16] MOAD.Statistical Infromation on Nepalese Agriculture 2014/15. Kathmandu, Nepal: Ministry of Agricultural Development. 2017.

[17] Taro Y. Statistics, an Introductory Analysis, 2nd Ed., New York: Harper and Row. 1967.

[18] Gujarati DN. Basic Econometrics. Tata McGraw-Hill Education, New Delhi. 2009.

[19] Sharma G, Joshi SR, Gurung MB. *Climate-Resilient Practices for Sustainability of Large Cardamom Production System in Nepal.* Kathmandu: ICIMOD. 2017.

[20] Ali Q, Tariq M, Khan I, Ashfaq M. Resource use efficiency and return to scale analysis in off-season capsicum/bell pepper production in Panjab, Pakistan. *Advances in Environment Biology.*2016;*10*(10),113+.

[21] Singh S, Kaur SB, Guleria A. Resource use efficiency of celery production in Panjab. *Journal of Agricultural Development and Policy.* 2021; *31*(2), 147-152.

[22] Gurung B, Regmi R, Paudel A, Paudel U, Paudel A, Shrestha S. Pofitabiltiy, Marketing and resource use efficiency of ginger production in Rukum-west, Nepal. *Archives of Agriculture and Eniroment Sciences.* 2021; *6*(4), 426-435. doi:https://doi.org/10.26832/24566632.2021.060403