

Resource Use Efficiency of Cauliflower Production in Sultanpur District of Uttar Pradesh

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Abstract: The present study investigates the resource-use efficiency and returns to scale in cauliflower production across different farm sizes in Sultanpur district, Uttar Pradesh. A multistage stratified purposive cum random sampling method was employed to select 120 cauliflower growers categorized into marginal, small, and medium farm sizes. Primary data were collected through personal interviews using a pre-tested schedule, while secondary data were obtained from district-level government sources and relevant literature. To evaluate the economic efficiency of key inputs, the Cobb-Douglas production function was applied using least square estimation techniques. The analysis revealed that the coefficients of multiple determination (R^2) for marginal, small, and medium farms were 0.863, 0.881, and 0.900 respectively, indicating a high explanatory power of the model. The sum of production elasticities across all input variables suggested decreasing returns to scale in all farm categories. The input variable such as seed, machinery charges, plant protection, and irrigation were found to be significant contributors to yield, with variations across farm sizes. Marginal value productivity (MVP) estimates for all inputs were positive, underscoring the scope for enhancing input use efficiency. These findings provide critical insights into optimizing resource allocation and enhancing productivity in cauliflower cultivation, particularly in resource-constrained regions.

Keywords: cauliflower, cobb-douglass, decreasing returns to scale, resource use efficiency.

INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis*) is one of the most important cruciferous vegetables cultivated globally, valued for its nutritional quality, adaptability, and commercial significance. It is a rich source of vitamin C, fiber, folate, and phytochemicals with anti-carcinogenic properties, making it a vital component of a balanced diet (Kumar *et al.*, 2020). Due to its moderate climatic requirement and compatibility with multiple cropping systems, cauliflower is cultivated widely during the rabi and late kharif seasons in India (Rathore and Yadav, 2018). The crop's

short duration and high market demand make it highly remunerative for small and marginal farmers across diverse agro-climatic zones.

India is among the leading producers of cauliflower in the world. As per the recent horticultural statistics, cauliflower is cultivated over an area of approximately 472 thousand hectares, with a production of nearly 9.5 million tonnes, resulting in an average productivity of around 20.1 tonnes per hectare (NHB, 2023). The increase in production and productivity over the past two decades is attributed to the adoption of hybrid varieties, improved pest

and disease management, and better post-harvest practices (Sharma and Roy, 2021). The National Horticulture Board and agricultural census data indicate a consistent growth in acreage and yield, especially in states where vegetable cultivation is intensively practiced (Kumar & Chauhan, 2021).

Uttar Pradesh, being the most populous and agriculturally dominant state of India, plays a pivotal role in cauliflower production. The state accounts for a significant share of India's total area and output under cauliflower, contributing approximately 17% to the national production (Tripathi *et al.*, 2022). The average productivity of cauliflower in Uttar Pradesh ranges between 18 to 22 tonnes per hectare, which, though slightly below the national average, reflects the immense potential for enhancing resource-use efficiency (Singh & Meena, 2019). Regions with high intensity of vegetable cultivation—such as Varanasi, Gorakhpur, Faizabad, and Sultanpur divisions—have shown considerable diversification toward horticultural crops including cauliflower (Verma *et al.*, 2023).

Despite its economic significance, empirical studies have shown that cauliflower cultivation in India is often constrained by inefficient input use, leading to sub-optimal productivity (Patel *et al.*, 2020). Factors such as imbalanced fertilizer application, inadequate irrigation, limited mechanization, and lack of technical knowledge influence overall farm efficiency (Gopala *et al.*, 2012). Therefore, analyzing the elasticity of production with respect to various inputs becomes crucial in identifying their individual contribution to output and guiding resource allocation decisions (Singh *et al.*, 2013). The Cobb-Douglas production function has been widely used for such analysis, owing to its simplicity and interpretability (Reddy and Rani, 2016). Furthermore, estimation of marginal value productivity (MVP) of inputs helps determine the economic efficiency of resource use and provides empirical evidence for policy formulation (Kumar *et al.*, 2020).

The study was undertaken to assess how efficiently resources are utilized in cauliflower farming across different farm sizes, aiming to identify input-output variations and suggest measures for improving productivity and profitability.

MATERIALS AND METHODS

Different techniques used and methods adopted in this study are described and the methodology of the present study has been discussed under the following heads:

- (i) Sampling technique
- (ii) Method of enquiry and collection of data
- (iii) Period of enquiry
- (iv) Methods and techniques of analysis

Sampling Techniques

Multistage stratified purposive cum random sampling techniques has been applied for selection of respondents to deal with the investigation.

Method of Enquiry and Collection of Data

The primary data were collected through survey method with the help of personal interview of pre-structured schedule while secondary data were collected from Zila Vikas Bhawan, Zila Sankhyaki Patrika, Department of Agriculture at block and district headquarter, journal reports, books and internet etc. Sultanpur district of Uttar Pradesh was selected was selected purposively seeing the acreage under cauliflower, time & money constraints of the investigator. Two blocks namely Kadipur and Karaudi Kala was selected for the study. A list of all the villages falling under selected blocks was prepared and arranged in ascending order according to area and five villages from these blocks were randomly selected for the study.

Selection of districts

Sultanpur district was selected purposively seeing the acreage under cauliflower, time and money constraints of the investigator.

Selection of Blocks

A list of all 14-block falling under Sultanpur district was prepared in ascending order according to area under cauliflower and, two blocks enjoying highest acreage under cauliflower was selected purposively.

Selection of Villages

A separate list of all villages of selected blocks growing cauliflower was prepared and five villages from each selected block was selected randomly.

Selection of Respondents

A separate list of all respondent growing cauliflower of each selected village prepared and stratified into three groups *i.e.*, Marginal (less than 1 ha), Small (1-2 ha.) and Medium (2-4 ha and above). Ultimately sample of 120 respondent was selected following proportionate random sampling technique. Finally, 120 respondents *i.e.*, 77 marginal, 28 small, 15 medium were selected for the study.

Functional Analysis

Production function analysis was carried out to examine the efficiency of different resources used on the sample farms. Different types of production functions were explored, out of them only Cobb-Douglas production function was found best fit for analysis:

Mathematical form

$$Y = a x_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4} x_5^{b_5} x_6^{b_6} \mu e$$

log form of the function

$$Y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + b_6 \log x_6 + \mu$$

Where,

Y = Dependent variable (output values Rs./ha.)

X_i = ith independent variable (input values Rs./ha.)

X₁ = Seed (Rs./ha.)

X₂ = Machinery Charge (Rs./ha.)

X₃ = Human labour (Rs./ha.)

X₄ = Manure and Fertiliser (Rs./ha.)

X₅ = Plant Protection (Rs./ha.)

X₆ = Irrigation (Rs./ha.)

a = Constant

b_i = Production elasticity with respect to X_i

μ = Error term

The values of the constant (a) and coefficient (b_i) in respect of independent variables in the function have been estimated by using the method of least squares (Gopala *et al.*, 2012).

Significance test of the sample regression coefficients

Having estimated the elasticity coefficients it is desirable to ascertain the reliability of these estimated. The most commonly used 't' test was applied to ascertain whether the sample production elasticity coefficient, b_j is significantly different from zero or not at some specified probability level.

$$'t' \text{ calculated} = \frac{b_j}{S.E. \text{ of } b_j}$$

Where,

b_j = production elasticity of X_j

S.E. = Standard error

If calculated 't' value is greater than the table value of 't' at specified probability level and 'n-k-1' degree of freedom, b_j is said to be significantly different from zero. 'K' is number of independent factors and 'n' is sampled size.

$$F = \frac{\text{Regression mean square}}{\text{Error mean square}} = \frac{SSR / K}{\Sigma e^2 / n - K - 1}$$

Estimation of Marginal Value Product

The marginal value product of input was estimated by taking partial derivatives of returns with respect to the input concerned, at the geometric mean level of inputs (Singh *et al.*, 2013).

$$MVP_{X_j} = \frac{b_i \bar{y}}{\bar{X}_i}$$

Where,

b_j = Production elasticity with respect to X_j

\bar{y} = Geometric mean of y (output values in Rs./ha.)

\bar{X}_i = Geometric mean of X_j (input values in Rs./ha.)

$j = 1, 2, 3, 4, 5$

The production function analysis was used to evaluate the effectiveness of the basic inputs, including labour costs, equipment costs, seed, manure, and fertilizer, irrigation, and plant protection as explanatory variables used in the production of cauliflower. In the results of the investigation Cobb-Douglas production function, was chosen as the best fit (Tripathi *et al.*, 2018).

RESULTS AND DISCUSSION

The production function analysis was carried out to determine the efficiency of various resources (seed, machinery charges, hired labour, manure & fertilizer, plant protection,

and irrigation) used in the production of cauliflower. Cobb-Douglas production function was found best fit to the data, and applied for the analysis.

Elasticity of Production

The estimated value of elasticity of production, standard error, co-efficient of multiple determinations (R^2) and returns to scale for cauliflower production by different size group of farms are given in **Table-1**. It is evident from the Table that co efficient of multiple determinations (R^2) of marginal, small and medium size groups farms were 0.863, 0.881 and 0.900 respectively. The above co-efficient of multiple determination of marginal, small and medium size group of farms was of all six independent variables viz. seed, machinery charges, hired labour, manure & fertilizer, plant protection, and irrigation, thus it is clear that all input variable contributed 86.30 percent, 88.10 and 90.00 per cent under marginal and small and medium group of farms.

Table 1: Production Elasticity of Cauliflower on different size group of farms in the study area

Size group of the farm sample farm	Production elasticity						Sum of Elasticity	R^2
	X1	X2	X3	X4	X5	X6		
Marginal	0.251**	0.180	0.035	0.073	0.283**	0.091	0.913	0.863
Small	0.290**	0.192*	0.055	0.049	0.029	0.278	0.895	0.881
Medium	0.270**	0.194*	0.051	0.042	0.019	0.258	0.863	0.900

** Significant at 5% significant level

*Significant at 1% significant level

Where,

x_1, x_2, x_3, x_4, x_5 and x_6 stand for seed, machinery charges, hired labour, manure & fertilizer, plant protection, and irrigation (Rs.) respectively.

Out of six independent variables s seed, machinery charges, hired labour, manure & fertilizer, plant protection, and irrigation, three variable i.e. plant protection, machinery charges and irrigation were found statistically significant at 1% level of probability in case of marginal, small and medium size group of farms respectively. In case of small and medium

size group of farms manure & fertilizer and hired labour had significant relationship at 5% level of probability and rest variable were not associated significantly with the yield.

Returns to scale in case of marginal, and small and medium size group of farms were 0.913, 0.895 and 0.863 respectively. Returns to scale in all three categories of the farms were found less than unity. It indicates the production of cauliflower is characterized by decreasing returns to scale on the each farm situation.

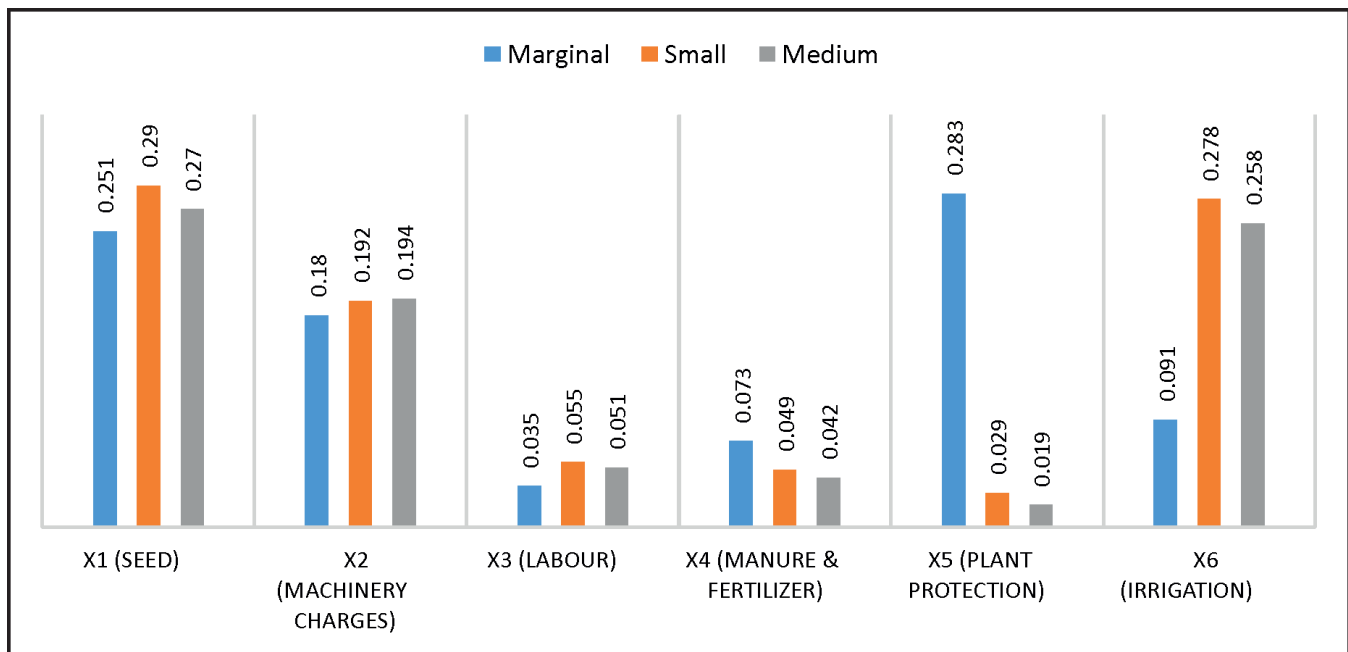


Figure 1: Elasticity of Cauliflower on different size group of farms in the study area

It is therefore inferred that increasing all the factors by 1% simultaneously results in increase of the return by less than one per cent.

Marginal Value Productivity

The marginal value productivity of different input factors are also presented in Table 2. It is depicted from the table that in case of all

the three categories of farms, for all the six independent variable i.e. seed, machinery charges, hired labour, manure & fertilizer, plant protection, and irrigation is the marginal value of productivity to factor cost were found positive, indicating that there is future scope for increasing the investment on all these factor in each farm situation to realize more return than the existing use of input.

Table 2: Marginal Value Productivity (MVP) of included factors in production of cauliflower crop in the study area

Size of the farm	Marginal value productivity (MVP)					
	X1	X2	X3	X4	X5	X6
Marginal	9.526	7.525	0.300	0.724	11.363	3.887
Small	5.170	7.564	0.430	0.745	1.286	11.413
Medium	7.678	6.262	0.401	0.449	0.568	8.891

Where, x_1 , x_2 , x_3 , x_4 , x_5 and x_6 stand for seed, machinery charges, hired labour, manure & fertilizer, plant protection, and irrigation (Rs.) respectively

CONCLUSION

The empirical findings of this study underscore that cauliflower cultivation in the Sultanpur district is operating under a regime of decreasing returns to scale across marginal, small, and medium farms. This suggests that while the addition of inputs continues to raise output, the rate of increase is diminishing. The Cobb-Douglas production function

analysis identified seed, machinery charges, and plant protection as statistically significant variables in influencing yield across different farm categories. Importantly, the marginal value productivity of all examined inputs remained positive, indicating underutilization and potential for increased economic returns through improved resource use. Notably, irrigation input recorded the highest MVP

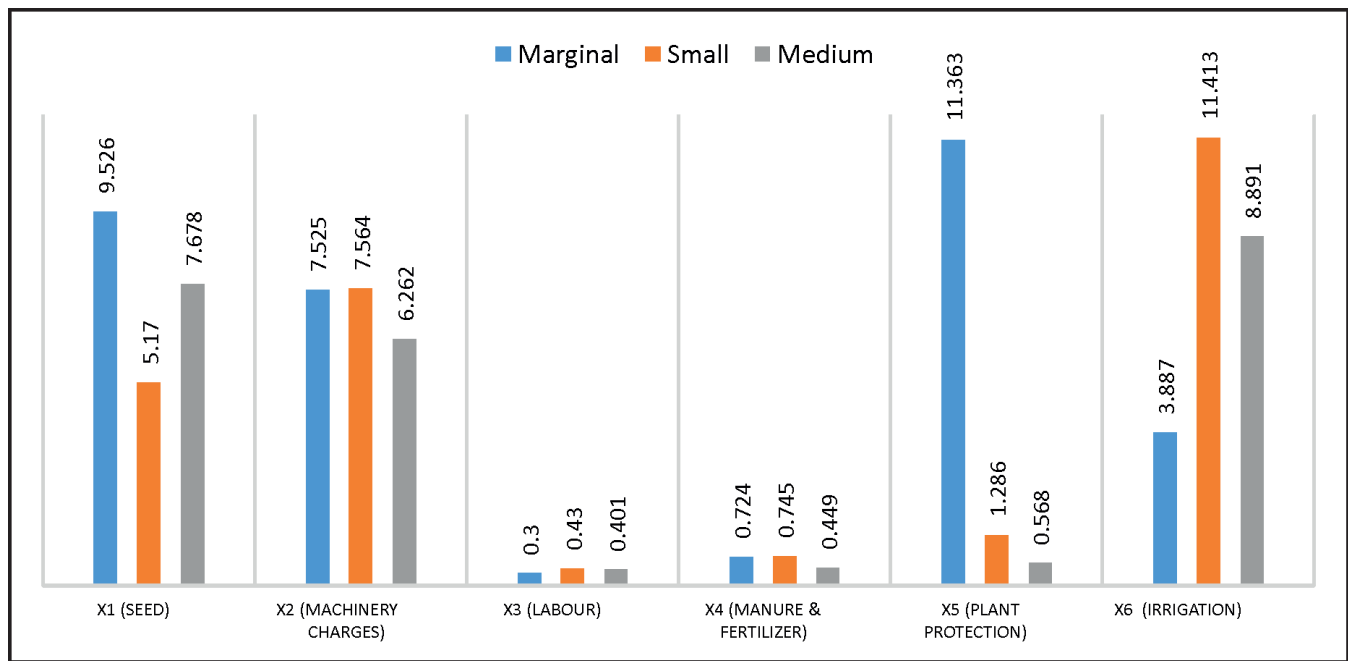


Figure 2: Marginal Value Productivity (MVP) of included factors in production process of cauliflower crop

in small farms, highlighting its critical role in enhancing productivity. These findings advocate for targeted extension services, better access to quality inputs, and training programs to optimize input utilization and improve farm income. Policymakers and agricultural planners should emphasize input-specific interventions and support services tailored to farm size categories to enhance cauliflower production efficiency in the region.

REFERENCES

- Gopala, M., Prasad, Y. E., & Reddy, B. V. (2012). *Production function analysis of major crops in Andhra Pradesh*. *Indian Journal of Agricultural Economics*, 67(2), 220–228.
- Gopala, Y. M., Krishnamurthy, B. & Bharathkumar, T. P., 2012, Production, marketing and storage constraints of maize growers in Chickaballapura district. *Karnataka Res. J. Agric. Sci.*, 3(4): 873-875.
- Nutrition, 16 (5): 314-321.
- Kumar, A., & Chauhan, K. (2021). Resource-use efficiency in vegetable production: A case study of cauliflower growers in Haryana. *Agricultural Economics Research Review*, 34(1), 115–124.
- Kumar, V., Mehta, R., & Singh, R. (2020). Nutritional and economic importance of cauliflower in vegetable farming. *International Journal of Vegetable Science*, 26(3), 289–296.
- National Horticulture Board (NHB). (2023). *Horticultural statistics at a glance*. Ministry of Agriculture and Farmers Welfare, Government of India.
- Patel, D., Jha, G., & Raj, R. (2020). An economic analysis of input use efficiency in vegetable crops in India. *Indian Journal of Economics and Development*, 16(4), 760–765.
- Rathore, R., & Yadav, M. (2018). Impact of improved agronomic practices on cauliflower yield. *Journal of Horticultural Sciences*, 13(1), 54–58.
- Reddy, R., & Rani, K. (2016). An empirical study on the Cobb-Douglas production function in agriculture. *Agricultural Situation in India*, 72(10), 47–53.
- Sharma, A., & Roy, A. (2021). Growth trends and productivity of horticultural crops in India. *Indian Journal of Horticulture*, 78(2), 207–214.
- Singh, P., & Meena, R. (2019). Horticultural crop diversification in Uttar Pradesh: Trends and determinants. *Economic Affairs*, 64(2), 337–343.
- Tripathi, A. K. & Singh, J. P. 2018. An economic analysis of production and marketing of wheat in Ghazipur District of Eastern U.P. *Journal of Pharmacognosy and Phytochemistry*, 7(1).
- Tripathi, A., Singh, B., & Yadav, S. (2022). Regional patterns in vegetable production: A study of eastern Uttar Pradesh. *Journal of Rural and Agricultural Research*, 22(1), 15–20.