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ECONOMICS AND INPUT USE EFFICIENCY IN CASTOR CULTIVATION IN NORTHERN GUJARAT, INDIA

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ABSTRACT

Gujarat has consistently remained the leading state in castor cultivation in India, with the North Gujarat region being particularly prominent in its production. The present study was conducted in three districts *viz.* Sabarkantha, Patan, and Mehsana to examine the economics of castor cultivation and the efficiency of input utilization. A multistage purposive sampling technique was used to select districts, talukas, and villages. As the study formed part of a broader research project on water productivity, the list of farmers was obtained from Gujrat Green Revolution Company ltd. (GGRC) and respondents were randomly selected from provided list. The results revealed that labour constituted the largest share of the total variable cost, indicating the labour-intensive nature of castor cultivation. Among the three districts, Patan emerged as the most profitable, primarily due to its lower input costs, with farmers realizing a benefit–cost ratio of 1.53 followed by Mehsana and Sabarkantha. The Cobb–Douglas production function analysis showed that seed, fertilizer, and pesticides significantly influenced castor output, while the resource use efficiency analysis indicated that these inputs were underutilized. The findings suggest that improving the optimal use of these inputs through coordinated efforts of all the stakeholders would not only optimize production costs but it will help in enhancing productivity and further increase the financial gains from castor cultivation.

***Keywords*:** Castor, Resource use efficiency, financial gains, total variable cost, optimal use.

Introduction

Oilseed crops hold a structurally important position in Indian agriculture due to their significance in the consumption basket and their contribution to nutritional security. The area under oilseed cultivation has been expanded by over 18 percent between 2015 and 2025 (GoI, 2026a). India contributes about 15–20 percent of the global oilseed cultivation area, while accounting for nearly 6–7 percent of vegetable oil production and 9–10 percent of global consumption.

The country holds the top position in castor seed production with about 88.48 percent of the global share and also ranks first in rice bran oil production (46.8%). Additionally, India stands second in the production of cottonseed oil (28.41%) and groundnut oil (16.34%). At the state level, Rajasthan, Madhya Pradesh, Gujarat, and Maharashtra dominate oilseed production, together contributing over 77 percent of the country's total oilseed output (NITI Aayog, 2024).

According to the second advance estimates for 2025–26, Gujarat ranks first in castor production in India. The state accounted for nearly 76 percent of the total area under castor cultivation and contributed about 91 percent of the country's total castor production (GoI, 2026b, GoG, 2026). State's productivity in the castor cultivation is not only highest in country but in the world (Kalamkar and Sharma, 2022). Important castor growing districts in Gujarat are

Mehsana, Sabarkantha, Banaskantha, Patan, Kutch, Ahmedabad, Kheda, Vadodara, Rajkot, Jamnagar and Gandhinagar.

The North Gujarat region, comprising eight districts, accounted for nearly 53 percent of the total castor cultivation area and about 57 percent of the total castor production in the state during 2021–2023 (GoG, 2025). This clearly underscores the significance of oilseed crops, particularly castor, in the region. Given this prominence, it becomes important to examine the profitability and cost structure faced by castor cultivators in the state. Accordingly, the present study was undertaken to analyse these aspects, with a special focus on North Gujarat. The present study was taken with the aim to fulfill the following two objectives: 1) To estimate the cost and return structure among castor growers. 2) To analyse the resource utilization and efficiency of castor growers.

Material and Methods

This study forms part of a broader research project aimed at estimating the water productivity of crops and livestock under conventional and water-saving technologies. The present analysis utilizes data from this larger study to examine the economics and resource utilization patterns among castor growers.

The study was conducted in three districts of North Gujarat, namely Sabarkantha, Mehsana, and Patan. A multistage sampling technique was adopted for the selection of respondents. The districts, talukas, and villages were selected purposively based on the adoption rate of water-saving technologies. In the final stage, farmers were randomly selected from the adopters list obtained from GGRC.

The present paper is based on data collected from 127 farmers. Among them, 9 were marginal farmers (<1 ha), 29 were small farmers (1–2 ha), 41 were semi-medium farmers (2–4 ha), and 48 were medium farmers (4–10 ha).

Table 1: Distribution of Castor growers by Districts, Talukas and Villages

Sr. No.	District	Taluka	Village	No. of Castor Growers
1.	Sabarkantha	Idar	Kukadiya, Umedgarh	40
		Vijayanagar	Kundla Kampa, Andropa	
2.	Mehsana	Satlasana	Vaghar, Isakpura	34
		Kheralu	Moti Hirvani, Gajipur	
3.	Patan	Siddhpur	Nagvasan, Lukhasan	53
		Patan	Sariyad, Sampra	

To fulfill the stated objectives, descriptive statistical tools such as percentages, averages, and related measures were employed. The detailed methodology adopted for the study is presented below:

(a) Economics of Castor Cultivation:

The economics of any crop, particularly in terms of cost and return estimation, forms the foundation for assessing the financial viability of that enterprise. The economics of castor cultivation were estimated by considering various variable costs incurred by farmers during the cultivation process. These included the cost of FYM, seeds, seed treatment, human labour, machinery used for tillage, intercultural and threshing operations, as well as plant protection measures (fungicides, herbicides, and insecticides) and synthetic fertilizers.

Per hectare returns over variable costs, gross returns, and the benefit-cost ratio were calculated using the following formulas:

Gross Returns = (Quantity of main product × Value of main product) + (Quantity of by- product × Value of by-product)

Return over variable cost = GR- TVC

B-C Ratio over Total Variable Cost = GR/ TVC

Where,

B-C ratio= Benefit – cost ratio

(b) Resource utilization pattern, resource use efficiency and returns to scale

The Cobb–Douglas or power production function is a widely used tool in agricultural economics to examine the impact of changes in inputs on the level of output. It helps in identifying the inputs that significantly influence production and also assists in determining the stage of returns to scale at which the farm is operating. (Patel and Parmar, 2024, Bhati *et al.*,2022, Singh *et al.*, 2024, Devi and Shaikh, 2024, Borisagar et al., 2025*)*

The general form of the production function is as follow:

$$Y= \beta_0 X_1^{\beta 1} X_2^{\beta 2} X_3^{\beta 3} X_4^{\beta 4} X_5^{\beta 5} e^{ui}$$

After applying the log transformation, the

$$\ln Y= \ln \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + u_i$$

Where,

Y = Total returns from groundnut production (Rs/ha)

X_1 =Total seed cost (Rs/ha)

X_2 = Total fertilizer Cost (Rs/ha)

X_3 = Total pesticide cost (Herbicides, Insecticides and fungicides) (Rs/ha)

X_4 = Total labour cost (Rs/ha)

X_5 = Total Machinery cost (Rs/ha)

β_0 = Constant term

β_1-β_5 = Regression coefficients

X_1-X_5 = Independent variables

u_i = Stochastic error term

Returns to scale refer to the change in output resulting from a simultaneous change in all input factors. In the case of a power function, which represents a homogeneous production function, the sum of its coefficients indicates the nature of returns to scale (Singh and Thakur, 2023).

$$RTS= \sum_{i=1}^{j} \beta_i$$

Here, β_i is the production or regression coefficients of variable X_1 to X_j

Consequently, if the returns to scale (RTS) > 1, it reflects increasing returns to scale; if <1, it signifies decreasing returns to scale; and if equal to 1, it represents constant returns to scale.

The level of resource use efficiency was calculated using following formula:

$$r = \frac{MVP}{MFC}$$

Where r= Efficiency ratio

MVP = Marginal Value Product, which is the value of incremental unit of output resulting from the additional unit of inputs.

MFC = Marginal Factor Cost which is defined as the increase in the cost of inputs due to purchase of additional unit of inputs.

$$\text{Now, } MVP = \frac{b_i \times \bar{Y}_i}{\bar{x}_i}$$

Where, bi= Estimated regression coefficient of input Xi

$\bar{Y}_i$ =Geometric mean value of output.

$\bar{x}_i$ =Geometric mean value of i^{th} resources used

The optimal use of a variable input occurs when value of r = 1, indicating maximum income and efficient resource use. If r < 1, this indicates the input is overused and reducing its use can increase profit. Conversely, if r > 1 the input is underused, and increasing the usage can increase the returns.

Results and Discussion

Economics of Castor Cultivation

The breakdown of variable costs incurred in castor cultivation across the districts of Patan, Mehsana, and Sabarkantha is presented in Table 2. Among the three, the total Variable cost per hectare was the lowest in Patan (Rs. 93,864.13/ha), followed by Mehsana (Rs. 1,04,203.61/ha) and the highest in Sabarkantha (Rs. 1,15,563.13/ha). Labour costs emerged as the major contributor to the total variable expenditure across all the districts under study, it was estimated to be 35.37% in Patan, further increased substantially to 48.73% in Sabarkantha, and was even higher in Mehsana at 49.79%. The findings emphasize the labour-intensive nature of castor farming as the harvesting of capsules is carried out 3–4 times during the cropping period. Machinery costs, which incorporate expenses on tillage, furrow raising, interculturing and threshing operations, also constituted a significant share of total cost, accounting for 23.34% (Rs. 21,908.22/ha) in Patan, 19.11% (Rs. 19,917.88/ha) in Mehsana, and 20.49% (Rs. 23,675.18/ha) in Sabarkantha. Pesticide expenditure was high in Patan (Rs. 6,367.21/ha), while it was relatively lower in Sabarkantha (Rs. 6,195.04/ha) and Mehsana (Rs. 6034.24). FYM use was more noticeable in Sabarkantha (7.36%) compared to Patan (6.52%) and Mehsana (5.28%). Parmar (2022) and Kalamkar and Sharma (2022) also reported similar findings in their studies.

Fertilizer expenses were also substantial, comprising over 10% of the total cost in all districts: 13.24% in Patan, 10.85% in Mehsana, and 9.86% in Sabarkantha. District-wise fertilizer preferences varied: Patan reported notable expenses on 12:32:16 (Rs. 3,942.36/ha) and DAP (Rs. 5,004.00/ha) fertilizers, while farmers in Mehsana district incurred more cost on DAP (Rs. 6,028.61/ha) and Ammonium Sulphate (Rs. 2,392.54/ha). Farmers in Sabarkantha incurred relatively balanced expenditure across all fertilizers, with the highest cost observed for ammonium sulphate

(Rs. 4,449.81/ha). Electricity costs showed marked variation across districts, being significantly higher in Patan (Rs. 7,775.63/ha), while comparatively lower in Mehsana (Rs. 2,745.53/ha) and minimal in Sabarkantha (Rs. 727.25/ha). This variation can be attributed to the fact that electricity charges are incurred based on the horsepower (HP) of the motors used for groundwater extraction. In districts where electricity costs are higher, it indicates greater groundwater depth, requiring farmers to operate higher HP motors for irrigation. Interest on working capital was calculated at 4.46% of total variable cost, as the rate of interest and the crop growing period were the same for all districts.

Table 2: Breakdown of variable cost incurred in castor cultivation

Sr. No.	Particulars	Sabarkantha		Patan		Mehsana	
		Cost (Rs/ ha)	Share (%)	Cost (Rs/ ha)	Share (%)	Cost (Rs/ ha)	Share (%)
1)	Seed	3484.58	3.01	1799.19	1.92	2060.48	1.98
2)	Seed Treatment	116.43	0.10	81.69	0.09	98.75	0.10
3)	FYM	8509.30	7.36	6120.73	6.52	5506.61	5.28
4)	Pesticides	6195.04	5.36	6367.21	6.78	6034.24	5.79
5)	Fertilizers	11389.85	9.86	12430.31	13.24	11310.04	10.85
a)	Urea	1766.45		1728.59		1393.57	
b)	DAP	3869.97		5004.00		6028.61	
c)	Ammonium Sulphate	4449.81		1755.36		2392.54	
d)	12:32:16	1303.63		3942.36		1495.32	
6)	Labour cost	56313.01	48.73	33196.12	35.37	51884.06	49.79
7)	Machinary cost	23675.18	20.49	21908.22	23.34	19917.88	19.11
8)	Electricity Charges	727.25	0.63	7775.63	8.28	2745.53	2.64
9)	Sub total	110410.63		89679.10		99557.59	
10)	Interest on Working Capital*	5152.50	4.46	4185.02	4.46	4646.02	4.46
	Total Variable Cost	**115563.13**		**93864.13**		**104203.61**	

Note: *@ 7% per annum for 8 months

The economic returns generated from castor cultivation across all three districts of Mehsana, Patan, and Sabarkantha are presented in Table 3. Although the yield levels were almost comparable across the districts, the profitability differed mainly due to variations in incurred variable costs. Among the districts, Mehsana recorded the highest castor yield at 24.85 quintals per hectare, followed by Patan (24.25 q/ha) and Sabarkantha (24.21 q/ha). In addition, farmers in Mehsana received a relatively higher market price for castor (Rs. 6,291.15 per quintal), compared with Rs. 6,056.45 in Sabarkantha and Rs. 5,914.60 in Patan.

As a result, Mehsana achieved the highest gross returns of Rs. 1,56,335.08 per hectare, surpassing Patan (Rs. 1,43,429.05/ha) and Sabarkantha (Rs. 1,46,626.65/ha). Interestingly, even though Sabarkantha recorded a higher gross return than Patan, the region also incurred the highest variable cost (Rs. 1,15,563.13/ha), which significantly reduced its profitability margins. Mehsana on the other hand, had cultivation cost (Rs. 1,04,203.61/ha), which contributed to a relatively better Return Over Variable Cost (ROVC) of Rs. 52131.47/ha, the highest among the three districts, compared to Rs. 49564.92/ha in Patan and only Rs. 31,063.52/ha in Sabarkantha. The benefit-cost ratio over variable cost (BC over VC) further corroborates this finding. Patan recorded the most efficient return per rupee spent at 1.53, slightly outperforming Mehsana (1.50), while Sabarkantha lagged with a B:C ratio of only 1.27. These findings suggest that although Mehsana leads in gross returns due to better pricing and marginally higher yields, Patan demonstrates greater input-use efficiency, while Sabarkantha's high costs undermine its profitability despite comparable productivity. Bhatt *et al.* (2018) also reported the B:C ratio of 1.35 over variable cost in Saurashtra region.

Table 3: Returns from castor cultivation

Sr. No.	Particulars	Sabarkantha	Patan	Mehsana
1)	Variable Cost (Rs. / Ha)	115563.13	93864.13	104203.61
2)	Price (Rs. / Q)- Main Product	6056.45	5914.6	6291.15
4)	Yield - Main Product (Q/ha)	24.21	24.25	24.85
6)	Gross Returns	146626.65	143429.05	156335.08
7)	ROVC (Rs. / Ha) (6-1)	31063.52	49564.92	52131.47
8)	BC over VC (6/1)	1.27	1.53	1.50

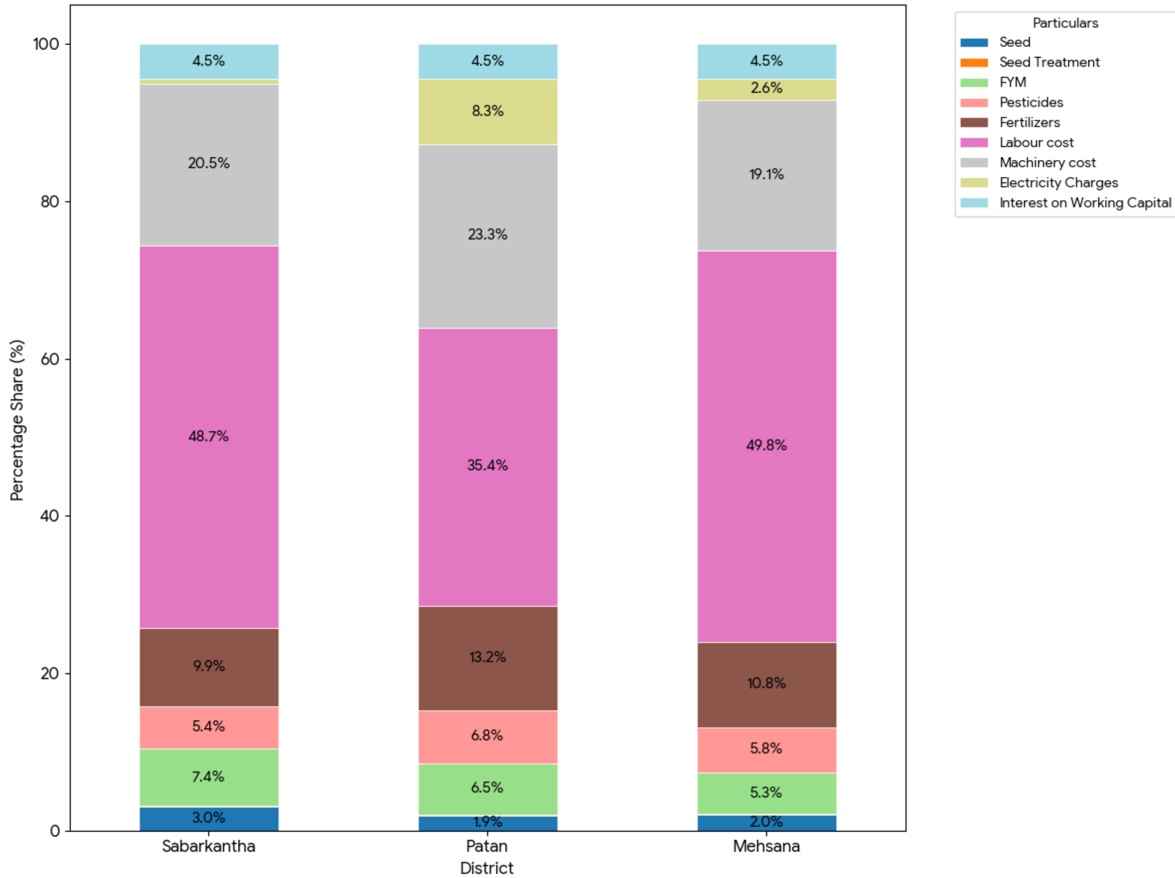

Fig. 1 : Proportion of different inputs and services in the total variable cost across the districts

Resource use efficiency of Castor Cultivation

The Cobb-Douglas production function was utilised to estimate the pattern of resource utilisation in castor cultivation in all selected districts and it is presented in Table 4, highlighting the influence of major inputs *viz.* seed, fertilizer, pesticides, labour, and machinery on output. In Sabarkantha, the model reveals a strong fit with R^2 = 79.54% and an adjusted R^2 of 76.44%. Pesticide use has emerged as the most significant factor, with coefficient (β = 0.3916) significant at 1% level. The returns to scale (RTS) was 0.32, indicating decreasing returns to scale. In Patan, the model explained 61.04% of the variation in output, with an adjusted R^2 of 56.9%. Here, seed (β = 0.0895) and Labour cost (β = 0.2764) were positively significant at 5% and pesticides (β = 0.3281) were positively significant at 1% level of significance. The RTS was 0.43, again reflecting decreasing returns. In Mehsana, the production function also showed a good fit **(**R^2 = 74.7%, adjusted R^2 = 70.18%). The most significant input was seed (β = 0.4115), highly significant at the 1% level, followed by fertilizers (β = 0.1950), significant at 5%. The RTS stood at 0.44, again pointing to decreasing returns to scale. Patel *et al.* (2025) also found that labour had a statistically significant influence on castor yield in their study conducted in North Gujarat.

Table 5 presents the Resource Use Efficiency (RUE) analysis for castor cultivation across three districts. In Sabarkantha, seed and fertilizer were found to be under-utilized, with RUE values of 3.15 and 6.53, respectively, which indicated scope for increasing their use to improve productivity. However, pesticides, labour and machinery shown RUE value of less than zero suggesting overuse and potential inefficiency.

Table 4: Cobb- Douglas production function for castor cultivation

Independent Variables	Sabarkantha		Patan		Mehsana	
	Coefficients	**Standard Error**	**Coefficients**	**Standard Error**	**Coefficients**	**Standard Error**
Constant (β_0)	4.2301***	0.6916	3.5457***	1.1372	3.9241**	1.6225
Seed (β_1)	0.0503	0.0515	0.0895**	0.0392	0.4116***	0.0773

Fertilizer (β_2)	0.0176	0.02340	0.0028	0.0295	0.1950**	0.08585
Pesticides (β_3)	0.3916***	0.0361	0.3281***	0.0437	0.03797	0.02690
Labour Cost (β_4)	-0.0825	0.0682	0.2764**	0.1408	-0.0489	0.0955
Machinery Cost (β_5)	-0.0519	0.1189	-0.2674	0.2167	-0.1567	0.3256
R^2	79.54		61.04		74.7	
Adjusted R^2	76.44		56.9		70.18	
RTS= $\sum \beta_{1-5}$	0.32		0.43		0.44	
No. of Observations	39		53		34	

***, **, * indicate significance at 1%, 5 % and 10% level of significance, respectively.

Table 5: RUE of castor cultivation across three districts

SABARKANTHA						
	Coefficients	**MPP**	**MVP**	**MFC**	**RUE**	
Seed	0.0503	3.1701	3.1466	1.0000	3.1466	Under-Used
Fertilizer	0.0176	0.4395	6.5329	1.0000	6.5329	Under-Used
Pesticides	0.3916	15.4185	-0.0452	1.0000	-0.0452	Over-Used
Labour	-0.0825	-0.3236	0.3080	1.0000	0.3080	Over-Used
Machine	-0.0519	-0.4833	-0.7251	1.0000	-0.7251	Over-Used
MEHSANA						
	Coefficients	**MPP**	**MVP**	**MFC**	**RUE**	
Seed	0.4115	38.4567	38.4567	1.0000	38.4567	Under-Used
Pesticides	0.0380	1.3889	1.3889	1.0000	1.3889	Under-Used
Fertilizer	0.1950	7.1325	7.1325	1.0000	7.1325	Under-Used
Labour	-0.0489	-0.2349	-0.2349	1.0000	-0.2349	Over-Used
Machine	-0.1567	-1.6433	-1.6433	1.0000	-1.6433	Over-Used
PATAN						
	Coefficients	**MPP**	**MVP**	**MFC**	**RUE**	
Seed	0.0895	7.4566	7.4566	1.0000	7.4566	Under-Used
Fertilizer	0.0028	0.0376	0.0376	1.0000	0.0376	Over-Used
Pesticides	0.3281	9.0967	9.0967	1.0000	9.0967	Under-Used
Labour	0.2764	1.1881	1.1881	1.0000	1.1881	Under-Used
Machine	-0.2674	-1.7380	-1.7380	1.0000	-1.7380	Over-Used

Note: MFC was assumed to be unity because all the variables were expressed in monetary terms (rupees)

In Mehsana, seed showed the highest under-utilization with an RUE of 38.46, followed by fertilizer (7.13) and pesticides (1.39), reflecting strong potential for improving utilisation of these inputs. In contrast to that labour and machinery were over-utilized. In Patan, pesticides (RUE = 9.10) and seed (7.46) were also under-utilized, while labour had a marginally efficient RUE of 1.19. Fertilizer (0.04) and machinery (-1.74) were over-used. Overall, the analysis highlights that seed and pesticide use have significant scope for optimization across all districts. At the same time, labour and machinery inputs appear to be consistently over-utilized, suggesting the need for better input management for these inputs in castor cultivation.

Conclusion

The estimation of costs and returns from castor cultivation in the three selected districts revealed that labour constituted the largest share of the total variable cost, indicating the labour-intensive nature of castor farming. This is mainly attributed to the multiple pickings required for harvesting castor capsules. The Cobb–Douglas production function analysis indicated that seed, fertilizer, and pesticides were significant inputs, implying that an increase in the use of these inputs could lead to a proportionately higher increase in output. Further, the resource use efficiency analysis suggested that there is scope to increase the use of seed and pesticides in the studied districts. The findings highlight that there remains considerable scope for improving the utilisation of seed, pesticides, and fertilizers in accordance with the recommendations provided by the university for the region.

Policy Implications

The study highlights the need for coordinated efforts among stakeholders *viz.* extension functionaries, input dealers, cooperatives, state agencies, and policymakersto promote efficient input use in castor cultivation. Capacity-building initiatives such as training programmes, dissemination of materials on recommended resource use, and expert lectures could significantly support improvements in productivity, profitability, and sustainability.

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