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Region-wise per hectare resource use structure and yield gap in castor and rapeseed-mustard in Banaskantha district

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Abstract

The study was conducted for two major oilseed crops in the Banaskantha district of Gujarat state. The study was totally based on primary data. The crops were selected based on the highest triennium average area as per the year from 2016 to 2018. Two talukas were selected purposively for each crop from the Banaskantha district for the study. These talukas were selected based on their highest triennium average area occupied as per the year from 2019 to 2021. Four villages were selected randomly from each taluka, and from each village, ten farmers were randomly selected. Thus, a total of 160 farmers were selected randomly for the study. The cost of cultivation was higher for small farmers for castor and rapeseed-mustard in the district. It might be because the raw materials purchased are in less quantity, and for the same, the price paid may be higher.

Keywords: Castor, rapeseed-mustard, cost of cultivation, yield gap, Banaskantha district

Introduction

In India, there are two major sources of Oilseeds i.e. Primary and Secondary. Primary sources are made combining the edible group [(Groundnut, Rapeseed (Toria, Mustard and Sarson), Soybean, Sunflower, Sesame, Safflower and Niger)] and non-edible group (Castor and Linseed). Similarly, secondary sources have been established combining edible group (Seasonal crops: Cottonseed, Ricebran, Maize germ, Watermelon, Plantation crops: Coconut, Red-oilpalm, Tree borne oilseeds: Sal seed, Mahua, Mango-kernel, Cheura / Phulwara, Kokum, Dhupa, Simarouba) and non-edible group (Seasonal crops: Mesta seed, Tobacco seed, Plantation crops: Rubber – seed, other Tree Borne Oilseeds: Neem, Karanj, Pilu or Khakan, Palash, Nahor, Undi, Pisa, Wild-apricot, Rattan-jyot, Maroti, Jojoba, etc). Castor crop cultivated in *kharif* season mainly in India but it is also cultivated in *rabi* season. Castor contains 35 to 58 per cent oil. Castor seeds are mostly used to make castor oil, which is utilized in lubricants, medicines, and the cosmetics industry. Rapeseed-mustard are major *rabi* oilseed crops of India. The oil content varies from 37 to 49 per cent. The seed and oil are used as condiment in the preparation of pickles, curries, vegetables, hair oils, medicines and manufacturing greases. Mustard oil, which is widely used for cooking in many parts of India; it is extracted from crushed mustard seeds.

Methodology

The crops were selected based on the highest triennium average area as per the year from 2016 to 2018. Anonymous (2022) [2]. Primary data were collected through the sample survey method. Two talukas were selected purposively for each crop from the Banaskantha district for the study, viz., for the castor crop, Bhabhar and Kankrej taluks were selected, and for the rapeseed-mustard crop, Tharad and Dhanera taluks were selected from the Banaskantha district. These talukas were selected based on their highest triennium average area occupied as per the year from 2019 to 2021. And the data of these talukas were collected from each district, Head Office of Agriculture Department. Four villages were selected randomly from each taluka, and from each village, ten farmers were randomly selected. Thus, a total of 160 farmers were selected randomly for the study.

Resource use costs and returns structure

The standard cost concepts such as Cost 'A', Cost 'B' and cost 'C' was used for estimation of costs and returns.

Functional analysis

The relationship between output and factors determining the output levels in oilseeds production was estimated by using the following Cobb-Douglas type of production function. As it gives specific scales of returns i.e., diminishing, increasing or constant.

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}\dots X_n^{b_n}e^u$$

The logarithmic form of the function,

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + \dots + b_n \log X_n + u \log e$$

Selection of input variables

While fitting the production function in respect of selected oilseed crop, following seven inputs were considered as important factors responsible for contributing to the production of these crops.

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}X_5^{b_5}X_6^{b_6}X_7^{b_7}e^u$$

Where,

Y = Output of main produce (q ha⁻¹)

a = Intercept.

X1 = Human labour (man days ha⁻¹)

X2 = Bullock power (pairs days ha⁻¹)

X3 = Machine power (hr ha⁻¹)

X4 = Manure (q ha⁻¹)

X5 = Nitrogen (kg ha⁻¹)

X6 = Phosphorus (kg ha⁻¹)

X7 = Potassium (kg ha⁻¹)

U = Error term

bi's = Regression coefficients of respective variables

Estimation of marginal value product

The marginal value products (MVP's) of the individual resource was estimated and compared with the marginal cost (MC). The MVP of resources was estimated by using the following formula,

$$\text{Marginal value product (MVP) of } X_1 = b_1 \frac{Y}{X_1} P_y$$

Where,

bi = Elasticity of production of ith input

Y = Geometric mean of output

X = Geometric mean of ith input

Py = Per unit price of output (₹)

Yield gap analysis

Yield gap was estimated by using the methodology developed by International Rice Research Institute (IRRI) Manila, Philippines. The methodologies for estimation of different types of yield gaps are,

$$\text{Yield Gap I} = Y_p - Y_d$$

Where,

Y_p = Potentail yield (Yield realized at research station)

Y_d = Demonstration plot yield (Yield realized on demonstration plots)

$$\text{Yield Gap II} = Y_d - Y_a$$

Where,

Y_d = Demonstration plot yield (Yield realized on demonstration plots)

Y_a = Actual yield (Yield realized on sample farms)

$$\text{Yield Gap III} = Y_p - Y_a$$

Where,

Y_p = Potentail yield (Yield realized at research station)

Y_a = Actual yield (Yield realized on sample farms)

Results and Discussion

Resource use costs and returns for castor and rapeseed-mustard in Banaskantha district.

For the estimation of costs and returns of castor and rapeseed-mustard in Banaskantha district, the standard cost concepts such as cost 'A', cost 'B' and cost 'C' were used for the year 2021-2022.

Table 1: Estimated cost and revenue particulars of castor cultivation in Banaskantha district.

Cost/revenue particulars	Size group			
	Small	Medium	Large	All
Cost of hired labour	9230 (13.19)	8820 (13.02)	7800 (11.93)	8616.67 (12.73)
Cost of bullock power	400 (0.57)	510 (0.75)	490 (0.75)	466.67 (0.69)
Cost of seed planting	2 400 (3.43)	2500 (3.69)	2480 (3.79)	2460.00 (3.63)
Cost of manures	1009 (1.44)	920 (1.36)	980 (1.50)	969.67 (1.43)
Cost of chemical fertilizers	3400(4.86)	3600 (5.32)	3700 (5.66)	3566.67 (5.27)
Cost of plant protection charges	1400 (2.00)	1200 (1.77)	900 (1.38)	1166.67 (1.72)
Cost of irrigation charges	10200 (14.57)	9840 (14.53)	8200 (12.54)	9413.33 (13.91)
Cost of machine power	8922 (12.75)	8530 (12.60)	8000 (12.24)	8484.00 (12.53)
Cost of deprecation on farm implements	500 (0.71)	740 (1.09)	590 (0.90)	610.00 (0.90)
Int. on working capital	3372 (4.82)	3300 (4.87)	2983 (4.56)	3218.33 (4.75)
Cost – A	40833 (58.34)	39960 (59.01)	36123 (55.26)	38972 (57.57)
Rental value of land	13000 (18.57)	12700 (18.75)	12500 (19.12)	12733.33 (18.81)
Int. on fixed capital	500 (0.71)	400 (0.59)	821 (1.26)	573.67 (0.85)
Cost – B	54333 (77.62)	53060 (78.36)	49444 (75.64)	52279.00 (77.23)
Cost of family labour	9300 (13.29)	8500 (12.55)	9980 (15.27)	9260.00 (13.68)
Cost – C1	63633 (90.91)	61560 (90.91)	59424 (90.91)	61539.00 (90.91)
10% of cost C1	6363.3 (9.09)	6156 (9.09)	5942.4 (9.09)	6153.90 (9.09)
Cost – C2 (Total cost)	69996.3 (100.00)	67716 (100.00)	65366.4 (100.00)	67692.90 (100.00)
Gross income	110726.00	117327.70	126096.00	118049.90
Net revenue (GI-TC)	40729.70	49611.70	60729.60	50357.00
B:C ratio (on total cost)	1.58	1.73	1.92	1.74

According to Table 1. results found that total cost of cultivation of castor was higher in small farmers ₹ 69,996.30 then medium farmers ₹ 67,716.00 and large farmers ₹ 65,366.40 respectively. It was also observed that gross income ₹ 1,26,096.00, net revenue ₹ 60,729.60 and B:C ratio 1.92 of large farmers were higher than medium farmers gross income ₹ 1,17,327.70, net revenue ₹ 49,611.70, B:C ratio 1.73 and small farmers gross income ₹

1,10,726.00, net revenue ₹ 40,729.70 and B:C ratio 1.58 respectively. Overall result concluded that average total cost of cultivation was ₹ 67,692.90, average gross income was ₹ 1,18,049.90, average net revenue ₹ 50,357.00 and average B:C ratio was 1.74. It was revealed that the cost of cultivation was higher in small farm. It might be because the raw material purchased are in less quantity and for the same the price paid may be higher.

Table 2: Estimated cost and revenue particulars of rapeseed-mustard cultivation in Banaskantha district.

Cost/revenue particulars	Farm size in ha.			
	Small	Medium	Large	All
Cost of hired labour	4730 (8.61)	4840 (9.22)	4780 (9.15)	4783.33 (8.99)
Cost of bullock power	430 (0.78)	400 (0.76)	450 (0.86)	426.67 (0.80)
Cost of seed planting	950 (1.73)	700 (1.33)	500 (0.96)	716.67 (1.35)
Cost of manures	1500 (2.73)	1670 (3.18)	1480 (2.83)	1550.00 (2.91)
Cost of chemical fertilizers	2840 (5.17)	2710 (5.16)	2570 (4.92)	2706.67 (5.09)
Cost of plant protection charges	500 (0.91)	600 (1.14)	450 (0.86)	516.67 (0.97)
Cost of irrigation charges	11090 (20.18)	10025 (19.10)	9830 (18.82)	10315.00 (19.38)
Cost of machine power	6000 (10.92)	5700 (10.86)	4990 (9.55)	5563.33 (10.45)
Cost of deprecation on farm implements	300 (0.55)	200 (0.38)	500 (0.96)	333.33 (0.63)
Int. on working capital	2539 (4.64)	2417 (4.61)	2300 (4.40)	2422.67 (4.55)
Cost – A	30891 (56.22)	29262 (55.75)	27850 (53.32)	29334.33 (55.12)
Rental value of land	8700 (15.83)	9000 (17.15)	9130 (17.48)	8943.33 (16.80)
Int. on fixed capital	600 (1.09)	650 (1.24)	700 (1.34)	650.00 (1.22)
Cost – B	40191 (73.15)	38912 (74.14)	37680 (72.15)	38927.67 (73.15)
Cost of family labour	9760 (17.76)	8800 (16.77)	9800 (18.76)	9453.33 (17.76)
Cost – C1	49951 (90.91)	47712 (90.91)	47480 (90.91)	48381.00 (90.91)
10% of cost C1	4995.9 (9.09)	4771.2 (9.09)	4748.0 (9.09)	4838.10 (9.09)
Cost – C2 (Total cost)	54946.1 (100.00)	52483.2 (100.00)	52228 (100.00)	53219.10 (100.00)
Gross income	91534.00	95899.00	97200.00	94877.67
Net revenue (GI-TC)	36587.90	43415.80	44972.00	41658.57
B:C ratio (on total cost)	1.66	1.82	1.86	1.78

From Table 2, results revealed that total cost of cultivation of rapeseed-mustard was higher in small farmers ₹ 54,946.10 then medium farmers ₹ 52483.20 and large farmers ₹ 52,228.00 respectively. Additionally, it was noted that large farmers gross income ₹ 97,200.00, net revenue ₹ 44,972.00 and B:C ratio 1.86 were higher than medium farmers gross income ₹ 95,899.00, net revenue ₹ 43,415.80, B:C ratio 1.82 and small farmers gross income ₹ 91,534.00, net revenue ₹ 36,587.90 and B:C ratio 1.66 respectively. Overall outcome showed that average total cost of cultivation was ₹ 53,219.10, average gross income was ₹

94,877.67, average net revenue ₹ 41,658.57 and average B:C ratio was 1.78. It was discovered that the cost of cultivation was higher in small farms. This could be because the raw materials were bought in less quantities and at a higher price. Similar result was found by Roy *et al.* (2022).

Estimation of marginal value product for castor and rapeseed-mustard in Banaskantha district.

The estimation was calculated by Cobb-Douglas production function and marginal value products of castor and rapeseed-mustard in Banaskantha district.

Table 3: Estimated Cobb-Douglas production function and marginal value products of castor crop in Banaskantha district.

Sr. No.	Variables	Regression coefficient of variable	MVP
1	Intercept	32.0886 (7.1721)	-
2	Human labour (man days ha ⁻¹)	0.0642** (2.1424)	8.89
3	Bullock power (pairs days ha ⁻¹)	-0.0104 (-0.1159)	-704.31
4	Machine power (hr ha ⁻¹)	0.0972* (1.7784)	5.33
5	Manure (q ha ⁻¹)	0.4749*** (6.6925)	64.38
6	Nitrogen (kg ha ⁻¹)	-0.0533* (-1.8094)	-0.06
7	Phosphorus (kg ha ⁻¹)	-0.2215*** (-2.9095)	-22.90
8	Potassium (kg ha ⁻¹)	-0.0188 (-0.1731)	-14.53
9	R ²	0.85	-

Figures in parentheses are t – value of respective regression coefficients.

Note: *, ** and *** represent significant at 10%, 5% and 1%, respectively.

Based on Table 3, results revealed that the value of co-efficient of R² was estimated as 0.85 at overall level. In case of castor human labour was significant at 5%, machine

power was significant at 10% level and manure was significant at 1% level which indicated that there is scope to increase the use of these resources to increase the output.

Other inputs like nitrogen was negatively significant at 10% level, phosphorus was negatively significant at 1% level indicates that these resources decrease the output with increase their input level. Marginal value product indicated

that human labour, machine power and manure were higher than other resources. So, it indicates that profitability should be maximized by increasing these resources.

Table 4: Estimated Cobb-Douglas production function and marginal value products of rapeseed-mustard in Banaskantha district.

Sr. No.	Variables	Regression coefficient of variable	MVP
1	Intercept	18.2222 (5.2963)	-
2	Human labour (man days ha ⁻¹)	0.1306** (2.4038)	15.26
3	Bullock power (pairs days ha ⁻¹)	-0.0576 (-0.4834)	-1520.85
4	Machine power (hr ha ⁻¹)	0.5896*** (4.9980)	80.72
5	Manure (q ha ⁻¹)	-0.0152 (-0.1469)	-0.82
6	Nitrogen (kg ha ⁻¹)	-0.0335 (-0.8617)	-0.09
7	Phosphorus (kg ha ⁻¹)	-0.1519 (-2.2406)	-11.94
8	Potassium (kg ha ⁻¹)	-0.0320 (-0.2931)	-24.55
9	R ²	0.80	-

Figures in parentheses are t – value of respective regression coefficients.

Note: *, ** and *** represent significant at 10%, 5% and 1%, respectively.

According to Table 4, results indicated that the value of coefficient of R² was estimated 0.80 at overall level. Regarding rapeseed-mustard, human labour was significant at 10% level and machine power was significant at 1% level which showed the possibility to expand the utilization of these resources in order to increase the output. Other inputs were negatively non-significant which revealed that these resources decrease the output with increase in their input level. Marginal value product revealed that human labour and machine power were higher than other resources. Therefore, it implies that increasing these resources should maximize profitability.

Yield gap analysis for castor and rapeseed-mustard in Banaskantha district.

Yield gap was estimated by the potential yield, demonstration yield and actual yield of castor, rapeseed-mustard in Banaskantha. Potential yield and demonstration yield data were collected from different research stations

and actual yield data were collected through the primary survey of sample respondents.

Yield Gap I = Yp – Yd

Where,

Yp = Potential yield (Yield realized at research station)

Yd = Demonstration plot yield (Yield realized on demonstration plots)

Yield Gap II = Yd - Ya

Where,

Yd = Demonstration plot yield (Yield realized on demonstration plots)

Ya = Actual yield (Yield realized on sample farms)

Total Yield Gap III = Yp - Ya

Where,

Yp = Potential yield (Yield realized at research station)

Ya = Actual yield (Yield realized on sample farms)

Table 5: Yield gap of castor crop in Banaskantha district.

Yield obtained (kg/ha)					
Research station yield (Yp)	Demonstration yield (Yd)	Farmer's yield (Ya)	Yield gap – I (Yp - Yd)	Yield gap – II (Yd - Ya)	Yield gap - III (Yp - Ya)
3680	3082	2540	598	542	1140

According to Table 5, it was found that yield gap – III (1140 kg/ha) was higher than yield gap – I (598 kg/ha) and yield gap – II (542 kg/ha) respectively. Overall result revealed that farmer's yield was lower than research station yields

and demonstration yield. The reasons include dissimilarity in soil fertility status, agricultural practices and local climatic situation. Similar result was found by Prajapati *et al.* (2018) [3].

Table 6: Yield gap of rapeseed-mustard crop in Banaskantha district.

Yield obtained (kg/ha)					
Research station yield (Yp)	Demonstration yield (Yd)	Farmer's yield (Ya)	Yield gap – I (Yp - Yd)	Yield gap – II (Yd - Ya)	Yield gap - III (Yp - Ya)
2417	2325	1876	92	449	541

From Table 6, it was concluded that yield gap III (541 kg/ha) was found to be higher than the yield gap II (449 kg/ha) and the yield gap I (92 kg/ha), respectively. According to the overall findings, farmer yield was lower than research station yields and demonstration yield. Fluctuations in yield was observed mainly due to variation

in soil moisture availability, rainfall, sowing time and pest and disease attack. Comparable outcome was discovered by Singh *et al.* (2017) [5].

Conclusion

The study found that the cost of cultivation was higher on

small farms for castor and rapeseed-mustard in Banaskantha due to higher unit costs of raw materials. Marginal value product analysis highlighted that human labor, machine power, and manure were key drivers of profitability in castor, while human labor and machine power were critical for rapeseed-mustard. Yield gaps in both crops indicated lower farmer yields compared to research station and demonstration yields, primarily due to soil fertility differences, climatic variations, and agricultural practices in castor, and soil moisture, rainfall, sowing time, and pest issues in rapeseed-mustard. Improving resource use and addressing these constraints can enhance productivity and profitability.

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