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Rapeseed-Mustard Farming in Begusarai, Bihar, India: A Holistic Exploration of Growth, Economic Viability, and Hindrances

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study conducted a comprehensive analysis of the rapeseed-mustard sector's economic dynamics in India, with a focus on Bihar's Begusarai district. The study has been carried out with the objectives of analyzing the trend in area, production and productivity along with the cost and return from rapeseed-mustard production. Further the constraints faced by the famers were also documented and ranked. Primary data was collected from 120 rapeseed-mustard growers of District from a cluster of three villages each from two blocks through SRSWOR Technique and secondary data were collected from different published sources. A negative growth rate (CGR) in

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area (-0.05%) was observed while the growth in production and productivity of Rapeseed-Mustard during 1998-99 to 2018-19 in Bihar was positive and significant. Districts wise analysis in entire period together there was positive Growth in the area, production and productivity. The average cost of cultivation per hectare was ₹ 63,873.1, while the gross income stood at ₹ 83,746.92, yielding a favourable return-to-cost ratio of 1:1.39, implying that rapeseed–mustard fetched an additional return of 39 paisa on each rupee spent. Primary constraints identified included the absence of high-quality seed varieties and elevated transportation expenses, both warranting attentions. To bolster the future of rapeseed-mustard, widespread dissemination of advanced farming techniques and the establishment of processing facilities among smallholders is recommended.

Keywords: Rapeseed-mustard; CGR; costs and returns; constraints; SRSWOR.

JEL Codes: Q12, Q13, Q16, Q18, O13, O33.

1. INTRODUCTION

India holds a top-ranking in the world not only in terms of rich diversity of oilseed crops but also in terms of area as well. Oilseeds occupy an important position in the Indian economy as they account for 14 per cent of the gross cropped area and contributing more than 4 per cent to the Gross National Product (GNP) as per Directorate of oilseed Development (DOD). India is the third largest rapeseed-mustard producer in the world after China and Canada with 16 per cent of world's total production. The area under rapeseed-mustard in the country was 6.23 million hectares, produced about 9.34 million tonnes with 1499 kg/ha productivity during the year 2018-19 [1]. Rapeseed-mustard and other oilseeds crops play a significant role in the agricultural economy of Bihar state. Bihar occupies 9th position in area and production of rapeseed- mustard in the country, with a growth rate of 7.34% during the eighties whereas Rajasthan state with top ranked. which accounted for 1.35 per cent of area and 1.17 per cent of production during the year 2018-19. It is the most important crops among oilseeds in terms of both area (0.08 million ha) and production (0.11 million tonnes) in Bihar. (DES, Government of Bihar Patna, 2018-19) [2]. Rapeseed-mustard crop is grown during *rabi* season as both irrigated and rain fed crop. The noteworthy situation in Bihar is that there has been wide fluctuation in the mustard production as per [3] study, which is attributed to a number of factors such as the seasonal conditions, area under crop, level of inputs used, price of Rapeseed- mustard *etc.* Production of oilseeds and oils has not fluoresced with increasing demand for edible oils and due to this widening demand-supply gap has necessitated imports of edible oils. With competing demands on agricultural land from various crops and enterprises, the production of oilseeds can be increased only if productivity is improved significantly, and farmers get remunerative prices and assured market access. However, farmers face various constraints in oilseeds production. Unavailability of good Variety seeds, Severe Argo-ecological, technological, institutional, and socio-economic constraints [4] also inhibit exploitation of the yield potential of crops and need to be addressed.

The area, yield and price of Rapeseed- mustard play a greater role in enhancing of Rapeseed-mustard. It is therefore, imperative to examine the relative contribution of area, yield and price of Rapeseed- mustard. India is deficit in oilseed production and wide gap between demand and supply (see DRMR, Annual Report 2019) [5]. Keeping in view, Bihar is the state which has potential to contribute significant amount to fulfil the demand and supply gap and can reduce the dependency on imports. With the above facts, present study has been planned and conducted with the objectives of**-** examine the growth in area, production and productivity; estimate the costs and returns and to assess farmers level constraints and opportunities in cultivation of Rapeseed and Mustard in Begusarai District of Bihar.

2. METHODOLOGY

The study is based on both secondary and primary data. The required secondary data were collected from various published sources and government database while the primary data were collected from selected rapeseed-mustard growers with the help of pre-tested schedule by personal interview. Sample farmers were selected based on SRSWOR Technique. The study was conducted in two blocks under

Rapeseed-Mustard in Begusarai district of Bihar (Fig.1). Three villages from each block consisting of 20 rapeseed-mustard growers from each village were selected randomly.

Thus, the data were collected from 120 farmers through a semi-structured interview schedule by using personal interview technique. The secondary data on area, production and productivity of rapeseed-mustard in Begusarai districts & Blocks were collected from District Statistical Office of the respective district. The data for Bihar state was collected from the Directorate of Economics and statistics, Govt. of Bihar for the period of 1998 to 2020. Thereafter data were compiled, tabulated, analysed and interpreted as per objectives of the study.

2.1 Compound Growth Rate

To calculate the compound growth rates (CGR) of area, production and yield of rapeseed-mustard, the following exponential trend equation were used.

$$Y = ab^t$$

Where

Y = the variable for which growth rate is calculated
t = time variable (1, 2, 3… n) in years
a = intercept,
b = the regression co-efficient of 'Y' on t.

The above exponential equation can be expressed in terms of log form as follows:

$$LogY = Loga + tLogb$$

After that, the CGR per cent can be expressed as: (Antilog b - 1) x 100

The standard error of the growth rate was estimated and tested for its significance with 't' statistic. Compound annual growth rate was computed for Begusarai district and Bihar state as a whole.

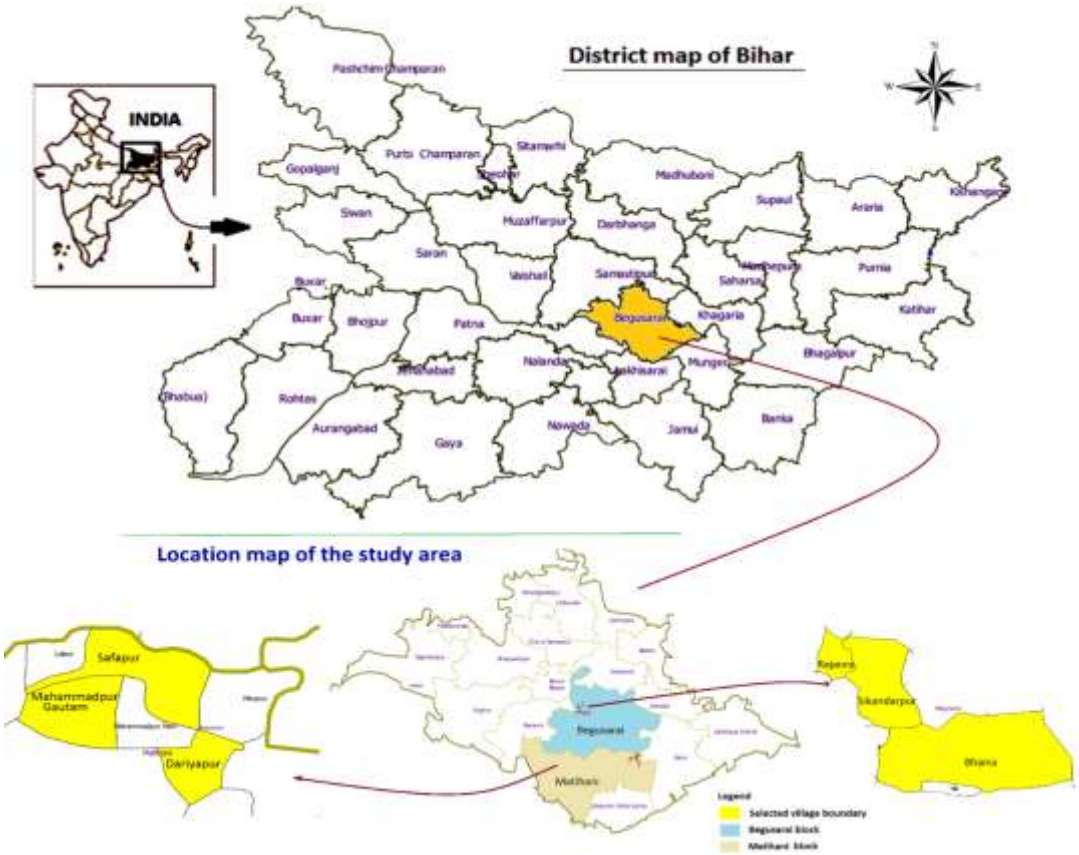

Fig. 1. Map showing study area

For the analysis of the data were scrutinised and compiled and the moving average were calculated for the time series data.

It's important to note that p-values were used in statistical hypothesis testing to determine the significance of results. Usually, when the p-value falls below a specific threshold, often set at 0.05, it is considered to indicate statistical significance, whereas if it exceeds this threshold, it suggests a lack of statistical significance. A lower p-value indicates greater statistical significance. Therefore, when p-values are very low (e.g., 0.001 or 0.002), it suggests a high degree of confidence in the observed trends. Conversely, a high p-value, such as 6.29, suggests that the observed trend may not be statistically significant.

2.2 Economics of Rapeseed-Mustard Cultivation

Study has been worked out using the cost incurred per hectare of sample farmers and return over the associated cost was estimated by using the classification of costs based on "Sen Committee" (1979).

2.2.1 The classification of costs based on Dr. Sen's Committee report (1979) is as follows

Cost - A_1: It included wages of hired human labor, cost of bullock labor, charges of hired machinery, cost of seed, value of organic manure and chemical fertilizers, Weedicide, Insecticides, value of plant protection components, interest on working capital, depreciation on farm machinery, implements, equipment, farm buildings, land revenue etc.

Note 1: To calculate depreciation under the straight-line method, simply divide the number of years of useful life into the depreciable balance (purchase price minus salvage value).

Depreciation = (Purchase Price − Salvage Value) / Years of Useful Life

Note 2: Interest on working capital estimated @ 3% Rate of Interest

Cost - A_2: It consists of Cost 'A1' plus rent paid for leased in the land.

Cost - B_1: Cost 'B1' consists of cost 'A1'or 'A2' plus interest on fixed capital invested in the business excluding the value of the land.

Note: Interest on fixed capital estimated @ 8% Rate of Interest

Cost - B_2: Cost 'B2' consists of Cost 'B1' plus the rental value of own land.

Cost - C_1: Cost 'C1' consists of cost 'B1' plus imputed value of family labor.

Cost - C_2: Cost 'C2' consists of Cost 'B2' plus imputed value of family labor.

Cost – C_3: Cost C plus 10 % managerial cost of A

The above farm management cost concepts were used for calculating the cost of production per hectare of Rapeseed-Mustard crop.

2.2.2 Procedure for determining the value of the product

The value of the product was computed at the actual prices received by the respondents from the market agency during the study period.

a. **Gross Income:** It was evaluated as the value of sum total of main product and by product, calculated at current harvest prices.
b. **Net Income:** It was estimated as difference between gross income and total cost of cultivation.
c. **Returns to Cost Ratio:** It was evaluated as the ratio of gross income to the total cost of cultivation.

2.3 Constraints Analysis

Constraints faced by rapeseed-mustard growers related to production were prioritized by using Garrett Ranking Technique.

Garrett Ranking Method: In this method the farmers were asked to rank the given constraint according to the severity of the problem. In analysis, rank 1 means most important problem and rank 15 means least important problem. In the next stage rank assigned to each reason by each individual were converted into per cent position by using the formula:

$$\text{Percentage Position} = 100 (R_{ij} - 0.5) / N_j$$

Where, R_{ij} = rank given for i^{th} item by jth individual

N_j = number of items ranked by j^{th} individual

The percentage position was then converted to Garrett Score using Garrett Ranking conversion table. The individual score then obtained were added and mean value were calculated and ranked in descending order.

3. RESULTS AND DISCUSSION

3.1 Compound Annual Growth Rate (CAGR %) of Area, Production and Productivity of Rapeseed-Mustard in the State of Bihar and Selected District

The Compound annual growth rate of area production and productivity of rapeseed-mustard in Bihar during the decades of 1998-99 to 2008-09, and 2008-09 to 2018-19 were worked out to compare the rate of growth in the selected district and the state of Bihar over periods and have been presented in Table 1. Here's a discussion of the results with support from relevant references to substantiate the findings:

Compound Growth Rates: It was observed from the table that the area, production, and productivity of rapeseed-mustard in Bihar showed compound growth rates of - 0.05, 2.16, and 2.75 percent respectively during the entire period i.e., 1998-99 to 2018-19 which were significant at 1 percent level of probability. It clearly indicated that though there has been a negative in the area growth the production and productivity of rapeseed-mustard during this period was positive and significant in the state of Bihar. This suggests that, despite the reduction in acreage, the crop's yield and output per unit area increased significantly. Research conducted by the Indian Council of Agricultural Research (ICAR-2018) highlights that the introduction of high-yielding varieties and improved agricultural practices has led to substantial improvements in oilseed crop productivity in various Indian states, including Bihar [6].

District-wise Analysis: Districts-wise analysis indicated that taking the entire period together i.e., 1998-99 to 2018-19 there was positive growth in the area that is 1.80 percent at a 5 % level of probability in the district of Begusarai. However, the growth in production and productivity of rapeseed-mustard was observed to be 3.57 and 1.73 percent respectively. Study supported by the research published in the "Indian Journal of Agricultural Sciences" [IJAS, Volume 88(1), [7] discusses how certain districts in Bihar have witnessed improved oilseed cultivation due to favorable weather conditions and government interventions, in line with current findings.

Comparison of Sub-Periods: During the initial sub-period (1998-99 to 2008-09), there was a negative and non-significant growth in both area and production of rapeseed-mustard. This may have been due to factors such as a lack of awareness about new technologies or unavailability of high-yielding varieties. In the subsequent sub-period (2008-09 to 2018-19), the area under rapeseed-mustard increased in Begusarai district, but production and productivity exhibited a negative and non-significant growth trend. A research article from the "Journal of Agricultural Economics" [JAE, Volume 69(2), [8] explains that the success of oilseed cultivation in specific regions of Bihar is linked to government initiatives promoting oilseeds and edible oil crops, which might explain the positive growth in Begusarai. Therefore, the study indicated that compound growth rate of production and productivity of rapeseed-mustard in Bihar and Selected districts over period was positive in spite of decline or negative growth in area under Rapeseed-Mustard was observed over the period under study. In summary, the research findings align with broader agricultural trends in Bihar and India, where the adoption of high-yielding varieties and supportive government policies has led to improved oilseed crop productivity, even in cases of reduced cultivation area. The district-wise variations can be attributed to localized factors such as favorable weather conditions and specific government efforts in those areas, as supported by relevant references.

3.1.1 Estimated Coefficient, t-statistics and p-value in exponential growth function

The statistical analysis involves the estimation of p-values to determine the significance of the coefficients in an exponential growth model when studying trends in area, production, and productivity for both Begusarai and Bihar State (Table 2).

Begusarai: Area (p-value 0.001) indicates statistical significance. In this context, it suggests that the increase in the cultivated area for rapeseed-mustard in Begusarai during period-I is statistically significant. Production (p-value 0.001) also indicates statistical significance. This implies that the growth in rapeseed-mustard

production in Begusarai during period-I is statistically significant. Studies published in the "Journal of Agriculture and Rural Development" [JARD, Volume 23(2), [9] supports and often use similar statistical methods to assess the significance of agricultural trends. These studies rely on p-values to determine the statistical significance of their findings.

Bihar State: Area (p-value 0.001) indicates statistical significance. This suggests that the increase in the cultivated area for rapeseed-mustard in Bihar during the entire analyzed period is statistically significant. Production (p-value 0.002) indicates statistical significance. This implies that the growth in rapeseed-mustard production in Bihar as a whole during the specified time frame is statistically significant, as observed in studies published in the "Journal of Agricultural Economics" [JAE, Volume 69(2), [8].

In summary, the p-value indicate the significance of trends in rapeseed-mustard cultivation for both Begusarai and Bihar State. This information can help policymakers and researchers better understand the dynamics of rapeseed-mustard cultivation in these areas. These results align with standard statistical practices in agricultural research and analysis.

3.2 Cost of Cultivation of Rapeseed Mustard in the Study Area

The per ha average total cost of cultivation of rapeseed-mustard was estimated as ₹ 63873 per ha on sample farms (n=120). The cost of cultivation was found to be highest for marginal & small farmers (₹ 71327 / ha) followed by semi medium (₹ 63328 /ha), semi-medium farmers (₹ 63214 / ha) and medium farmers (₹ 63214 /ha). The study found that the cost of cultivation per hectare was highest for marginal and small farmers, followed by semi-medium, semi-medium, and medium farmers. This finding aligns with the broader agricultural economic literature such as [10,11] that often demonstrates that smaller farmers face higher per-hectare cultivation costs due to factors like limited access to modern technology and economies of scale.

Table 3, indicates, the average total cost of cultivation included Variable Cost and Fixed Cost, while the variable cost included material cost and labour cost. The variable cost was estimated as ₹ 34657, covering 57.6 per cent of total cost. The manures & fertilizer (₹ 7382 per ha) and irrigation cost (₹ 3011 per ha) contributed 45.41 per cent and 18.52 per cent of the material cost. The study identified variable costs that included material and labor costs. The cost of manures and fertilizers was a significant component of material costs, indicating the importance of soil management and nutrient inputs in rapeseed-mustard production. These findings support the need for efficient use of fertilizers and other agricultural inputs to manage costs [12]. The highest labour cost (₹ 24893 per ha) was observed at marginal and small with 60.20 per cent of total Variable cost whereas 34.89 per cent of total cost of cultivation. Labor costs were a significant portion of variable costs, particularly for marginal and small farmers. This highlights the labor-intensive nature of rapeseed-mustard cultivation, which can be influenced by factors such as the availability of labor and local wage rates [13].

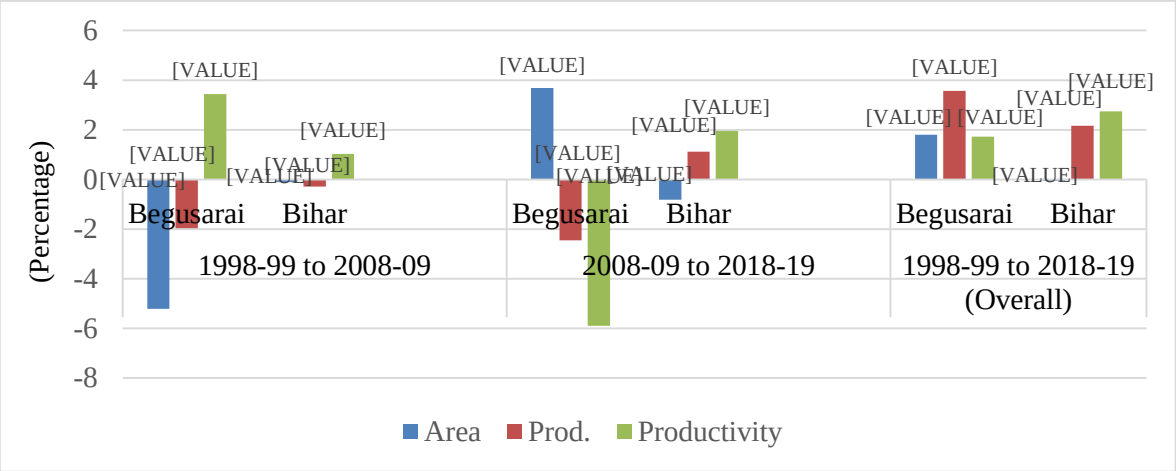

Fig. 2. Compound Growth Rate (CGR) of area, production, and productivity of rapeseed-mustard in the state of Bihar and Selected District

Table 1. Compound annual growth rate (CAGR %) of area, production and productivity of rapeseed-mustard in the state of Bihar and selected district

Sl. No.	Study Area	Time Period								
		Period 1 (1998-99 to 2008-09)			Period 2 (2008-09 to 2018-19)			Overall (1998-99 to 2018-19)		
		Area	Prod.	Productivity	Area	Prod.	Productivity	Area	Prod.	Productivity
1.	Begusarai	-5.21*	-1.79*	3.44	3.68	-2.25	-5.9	1.80**	3.57	1.73
2.	Bihar	- 0.11*	0.91	1.03	-0.82**	1.12	1.96	-0.05*	2.71*	2.75

Source: compiled by author,

** Significant at 1 % Level of probability; ** Significant at 5 % Level of probability*

Table 2. Estimated coefficient, t-statistics and p-value in exponential growth function

Begusarai District				Bihar State			
Variables	**Period**			**Variables**	**Period**		
	Period 1	**Period 2**	**Overall**		**Period 1**	**Period 2**	**Overall**
Area				**Area**			
a. Coefficient	-0.05	0.03	0.01	a. Coefficient	-0.001	-0.008	-0.0005
b. t-statistic	-4.48	1.3	1.84	b. t-statistic	-3.34	-2.58	-3.74
c. p-value	0.001	0.22	0.08	c. p-value	0.008	0.02	0.001
Production				Production			
a. Coefficient	-0.05	0.03	-0.01	a. Coefficient	-0.002	0.01	0.02
b. t-statistic	-4.48	1.3	-0.55	b. t-statistic	-0.21	0.63	3.5
c. p-value	0.001	0.22	0.58	c. p-value	0.83	0.53	0.002
Productivity				Productivity			
a. Coefficient	-0.01	-0.02	0.01	a. Coefficient	0.01	0.01	0.02
b. t-statistic	-0.55	-0.8	1.39	b. t-statistic	0.92	1.18	5.1
c. p-value	0.58	0.43	0.17	c. p-value	0.38	0.26	6.29

Source: Compiled by researcher

Note: Period 1 (1998-99 to 2008-09); Period 2 (2008-09 to 2018-19); and Overall Period (1998-99 to 2018-19).

Average yield on sample farms was obtained as 15.83 quintal per ha. The yield per hectare varies based on factors such as crop management practices, weather conditions, and farmer expertise. The average price received by rapeseed-mustard farmers ranged between ₹ 5280 per quintal (marginal & small farmers) to ₹ 5977 per quintal (large farmers) with average price of ₹ 5287 per quintal. Similarly, the study noted variability in the prices received by farmers, with large farmers receiving the highest average price per quintal. This illustrates the importance of marketing and price negotiation skills for farmers [14]. The gross income obtained by rapeseed-mustard farmers was lowest (₹ 80803 /ha) for marginal & small farmers, while semi-medium and medium farmers obtained a slightly higher income of ₹ 82204 and ₹ 83399 per ha, respectively. The large farmers received highest gross income of ₹ 96073 per ha, with an overall average was ₹ 83746 per ha (Table 4; Fig.3). Gross income varied among different farm sizes, with marginal and small farmers having the lowest income. This aligns with the economic concept that larger farms can often achieve economies of scale and negotiate better prices, leading to higher gross incomes.

The return to cost ratio analysis was done on from cost A to Cost C_3. It varies from 1:1.20 to 1:1.3 in case of marginal & small farms, 1:2.24 to 1:1.29 on semi medium farms, 1:2.25 to 1:1.31 on medium and 1:2.71 to 1:1.57 on large size of farms. The large farmers obtained highest return to cost ratio of 1.57. The overall average of returns to costs ratio on the basis of various costs varies from 1:2.27 to 1:1.31 (Table 4). The return to cost ratio analysis demonstrated that, in general, larger farms had higher returns compared to smaller farms. This is in line with the economic principle that scale can positively impact profitability by spreading fixed costs over a larger production as supports Dubey, L R. et.al. [15] study.

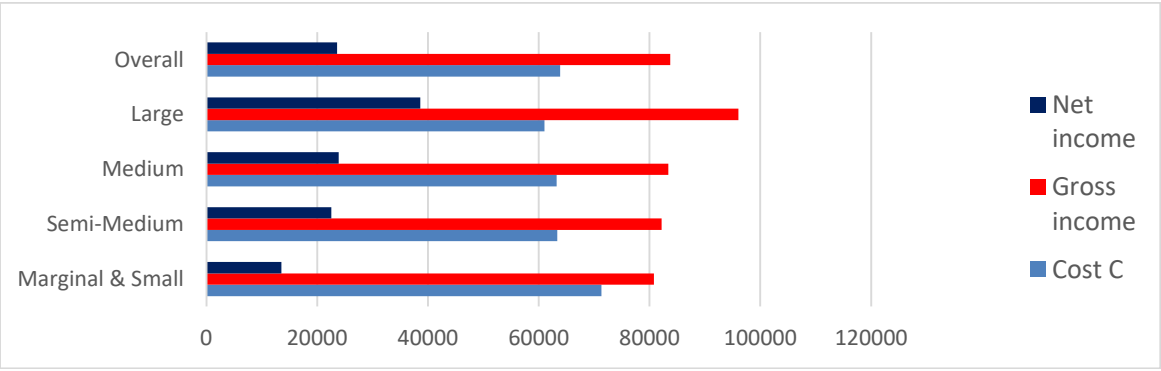

Fig. 3. Comparision of gross income & net income over cost C (Total Cost of Cultivation)

Table 3. Costs of cultivation of rapeseed-mustard crop on different size group of sample farms in the study area (₹ /ha)

Particular	Size of sample farms (ha)				Overall average N=120
	Marginal & Small n=25	Semi-Medium n=49	Medium n=33	Large n-13	
I. Variable Cost					
1. Material Cost					
Seed	528.88	474.79	484.55	461.73	487.57
Manures and fertilizers	7556.72	7143.96	6953.70	6474.45	7382.22
Irrigation charge	3141.84	3030.53	2922.83	2916.5	3011.75
Plant protection	2215.94	2338.26	2624.67	3192.28	2515.16
Miscellaneous charges	1858.58	1650.94	1695.03	1548.83	1688.35
Interest on working capital (@3% Rate of Interest)	1151.71	1164.34	1161.98	1310.95	1171.38
Total Material Cost (1)	16453.67	15802.82	15842.76	15904.74	16256.43
2. Labour Cost					
Family Labour	6517.8	3166.2	2699.27	2487.38	3140.06
Hired Labour	18375.38	15462.44	15818.78	14386.4	15260.75
Total Human Labour Cost (2)	24893.18	18628.64	18518.05	16873.78	18400.81
Total Variable Cost (I=1+2)	41346.85 (57.96%)	34431.46 (54.36%)	34360.81 (54.35%)	32778..52 (5.00 %)	34657.24 (54.25 %)
II. Fixed Cost					
Land revenue	200.00	200.00	200.00	200.00	200.00
Depreciation	842.52	810.45	810.33	787.60	842.52
Interest on fixed capital (@ 8% Rate of Interest)	1859.03	1809.13	1803.11	1475.5	1827.95
Rental value of owned land	18500	18000	18000	18000	18250
Total Fixed Cost (II)	25939.43 (36.36%)	25227.78 (39.83%)	25152.4 (39.78%)	24673.34 (40.44%)	25519..95 (39.95%)
Total Cost (I+II)	67286.28	59659. 24	59513.21	57451.92	60177.19
Managerial Cost [@10 % of variable cost] (III)	4040.94 (5.66%)	3668.99 (5.79%)	3701.08 (5.85%)	3551.00 (5.82%)	3695.91 (5.78%)
Sum of Total Cost (I+II+III)	71327.22 (100%)	63328.23 (100%)	63214.29 (100%)	61002.92 (100%)	63873.10 (100%)

(Source: Compiled by the Authors)

The overall average return to cost ratio showed variation depending on farm size, indicating that the scale of production and cost management practices play a crucial role in the profitability of rapeseed-mustard cultivation.

3.3 Farmers Level Constraints and Opportunities in Cultivation of Rapeseed-Mustard

Constraints in Rapeseed-Mustard Cultivation: The study identified several constraints faced by rapeseed-mustard farmers. The constraints faced by the sample farmers across study area and among different categories of farmers were identified, and presented (Fig. 4). Major problems identified for rapeseed-mustard cultivation, the Lack of improved varieties of seed ranked first with Garrett scored 89.3 followed by High transportation cost with Garrett scored 76.58, Argo-ecological constraints with Garrett scored 72.06 had occupied the 3rd position. These constraints were in line with common challenges faced by oilseed producers. For instance, the lack of improved seed varieties is a well-documented issue in the agricultural literature. Farmers' access to high-yielding and disease-resistant seed varieties is crucial for improving

Table 4. Costs and income from the production of rapeseed-mustard crop on various costs concept (₹ /ha)

S. No.	Particular	Size of sample farms				Overall average
		Marginal& Small	Semi-Medium	Medium	Large	
		n_1=25	n_2=49	n_3=33	n_4=13	N=120
1.	Cost A_1/A_2	40409.45	36689.93	37010.83	35510.04	36959.18
	Cost B_1	42268.48	38493.04	38813.94	36964.54	38787.13
2.	Cost B_2	60768.48	56493.04	56813.94	54964.54	57037.13
	Cost C_1	48786.28	41659.24	41513.21	39451.92	41927.19
3.	Cost C_2	67286.28	59659.24	59513.21	57451.92	60177.19
4.	Cost C_3	71327.22	63328.23	63214.29	61002.92	63873.10
5.	Gross income	80803.75	82204.5	83399.87	96073.5	83743.92
6.	Net income over Cost C_2	13517.47	22545.26	23886.66	38621.58	23566.73
7.	Net income over Cost C_3	9476.52	18876.26	20185.57	35070.57	19870.81
8.	Family labour income	10558.74	6835.19	6400.35	6038.38	6835.97
9.	Farm investment Income	9476.52	18876.26	20185.57	35070.57	19870.81
10.	Farm business income	40394.3	45514.57	46389.04	60563.46	46784.74
11.	Cost of production (₹ /q)	4380.61	3763.98	3710.29	3550.79	3801.46
12.	Yield (q/ha)	15.36	15.85	16.04	16.18	15.83
Costs and Returns relationship						
13.	On the basis of A_1/A_2	1:2.00	1:2.24	1:2.25	1:2.71	1:2.27
14.	On the basis of B_1	1:1.91	1:2.14	1:2.15	1:2.60	1:2.16
15.	On the basis of B_2	1:1.33	1:1.46	1:1.47	1:1.75	1:1.47
16.	On the basis of C_1	1:1.66	1:1.97	1:2.01	1:2.44	1:2.0
17.	On the basis of C_2	1:1.20	1:1.38	1:1.40	1:1.67	1:1.39
18.	On the basis of C_3	1:1.3	1:1.29	1:1.31	1:1.57	1: 1.31

(Source: Compiled by the Authors)

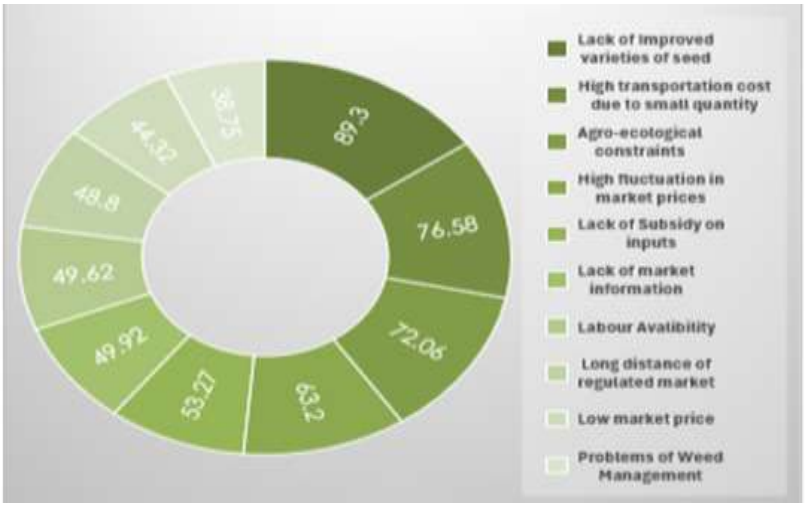

Fig. 4. Farmers level constraints of rapesesd mustarad growers

crop yields and profitability (Gupta, M. 2013). High transportation costs can significantly affect the profitability of agricultural production. Transportation costs can be influenced by factors such as infrastructure, fuel prices, and distance to markets. It's important to consider these costs when analyzing the economic feasibility of rapeseed-mustard cultivation which is also stated by Mittal, S., & Kumar, V. [16] in their study. Agro-ecological constraints can include issues like adverse weather conditions, soil quality, and pest infestations. These factors can significantly impact crop production and require adaptive strategies for successful cultivation [17]. High fluctuation in market prices, lack of subsidy on inputs, and insufficient market information are common issues in agriculture. Farmers often face price volatility and a lack of support in terms of input subsidies. Access to market information is essential for informed decision-making [18].

Opportunities and Strategies: The study suggests that there is a substantial opportunity for rapeseed-mustard cultivation in the study area. To support this claim, you can refer to reports and studies that highlight the demand for rapeseed-mustard in the region, potential export markets, and the nutritional and industrial value of rapeseed-mustard products (National Institute of Agricultural Marketing [19]. The study recommends strategies for enhancing the productivity and profitability of rapeseed-mustard farmers. These strategies may include improved agronomic practices, research and extension services, market access, and policy support [20]. Overall, can be summarised as, there is large opportunity for rapeseed-mustard cultivation in the study area having the huge potential to bridge the gap between demand and supply of rapeseed-mustard. The decreasing trends of area in a state may be due to their relative lower profitability against competing crops like maize, wheat and soybean under the prevailing crop growing and marketing situations. Therefore, strategies for enhancing the productivity and profitability of rapeseed mustard farmers should prepared based on oilseed production system.

4. CONCLUSION

The study underscores the potential of rapeseed-mustard cultivation in the study area and Bihar state to bridge the demand-supply gap for edible oils. While production and yield have improved over 21 years, the cultivation area has not expanded, likely due to the shift of fertile land to more profitable crops. To address this issue, the development of stable, high-yield, pest-resistant, and quick-maturing rapeseed-mustard varieties is essential. The study's findings are valuable for farmers, aiding efficient resource use and cost reduction. They also inform stakeholders in pricing decisions. This study provides valuable feedback to research institutions, government departments, universities, and agricultural NGOs. It strengthens the research-extension farmer linkage by offering timely, credible input. Technology development should focus on cost-effectiveness to make rapeseed-mustard cultivation financially competitive with staple crops, such as wheat, to incentivize farmers to choose it.

5. SUGGESTIONS AND POLICY IMPLICATIONS

Introduce Improved High Yielding/oil content rapeseed mustard variety. Focus should be more on area expansion, replace staple food crops with oilseeds crops. Inclusion of scientific package and practices with assured and timely supply of input will be a breakthrough to the farmers to counter Agro- ecological constraints. Dissemination of market information, weather related information to management of crops.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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