

## Comprehensive economic analysis of the Mustard and production trend in Hardoi district of Uttar Pradesh

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ARTICLE INFO	ABSTRACT
<p><b>Research Article</b> Received on March 23, 2023 Revised on April 04, 2023 Accepted on April 25, 2023 Published on May 10, 2023</p> <p><b>Article Authors</b> Sachin Kumar Verma, Shiv Kumar, Hargovind Bhargava, Aditya Bhooshan Srivastava</p> <p><b>Corresponding Author Email</b> <a href="mailto:sachinssv974@gmail.com">sachinssv974@gmail.com</a></p>	<p>This study presents a comprehensive analysis of the economic and production trends in mustard cultivation within a specific study area. It delves into various cost concepts and income measures, revealing the intricate structure of expenses and revenues associated with different farm sizes. The study underscores the significance of efficient resource allocation, particularly in terms of irrigation and human labor, to minimize costs. Moreover, it explores the income variations among farm sizes, showcasing the potential of small farms in generating net income and the advantage of medium farms in gross and family labor income. The resource use efficiency analysis underscores the importance of factors such as seed, fertilizer, irrigation, and labor, and their varying influence on different farm sizes. By analyzing production trends, the study demonstrates a positive growth trajectory, while also recognizing the need for ongoing innovation to counter potential plateaus. Challenges faced by mustard growers, including machinery unavailability and weather conditions, are highlighted, emphasizing the importance of addressing these constraints for sustained growth. Overall, this study provides valuable insights for mustard farmers, policymakers, and stakeholders, offering a roadmap for enhancing productivity and profitability in mustard cultivation.</p>
<p style="background-color: #d3d3d3; text-align: center;"><b>PUBLICATION INFO</b></p> <p>International Journal of Agricultural Invention (IJAI) <b>RNI:</b> UPENG/2016/70091 <b>ISSN:</b> 2456-1797 (P) <b>Vol.:</b> 8, <b>Issue:</b> 1, <b>Pages:</b> 72-80 <b>Journal Homepage URL</b> <a href="http://agriinventionjournal.com/">http://agriinventionjournal.com/</a> <b>DOI:</b> 10.46492/IJAI/2023.8.1.11</p>	<p style="background-color: #d3d3d3; text-align: center;"><b>KEYWORDS</b></p> <p>Economic Analysis, Cost and Return, Trend, Constraints</p>

### HOW TO CITE THIS ARTICLE

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Mustard is an annual herb cultivated as oil seed crop or as vegetable or as fodder, of which, 3 species are known for its condiment value. They are pale yellow or white mustard (*Brassica hirta*), brown mustard (*Brassica juncea*) and black mustard (*Brassica nigra*). India is the third largest producer of rapeseed-mustard after Canada, China and contributing to around 11 % of world's total production mustard is cultivated in majority of states of the country, bulk of the production comes from Rajasthan (44.97 %), Haryana (12.44 %), Madhya

Pradesh (11.32 %) Uttar Pradesh (10.60 %) and West Bengal (7.53 %) during (2014-15 to 2018-19). The oil content varies from 37 % to 49 %. It is necessary to have sustainable diversified agriculture, which focuses on the need for continued growth in agricultural productivity while maintaining the quality of the resource devoted to agriculture. Mustard crop production is estimated to be around 115.25 lakh tonnes in 2022-23, according to the Solvent Extractors' Association (SEA) of India.

While releasing the all-India estimate of the rapeseed-mustard crop during 2022-23, SEA said India is heading for a record rapeseed-mustard crop as remunerative prices in the past year encouraged record plantings of the oilseed. SEA had estimated the crop at 110 lakh tonnes in 2021-22. The estimated area, production and yield of rapeseed-mustard in the world was 36.59 million hectares, 72.37 million tonnes and 1980 kg/ ha, respectively, during 2018-19 (Globally, India account for 19.8 % and 9.8 % of the total acreage and production (USDA), (Handbook of Mustard Sauce Preparation). The U.P. state of Hardoi of has a long history of manufacturing mustard. The district's mustard production in 2022 was estimated to have been 118680 metric tonnes on 12749 hectares of land. The output per hectare was 9.31 q/ha. There is still room to increase the productivity of this input output ratio in the district, as mustard productivity in Hardoi is much lower than that at the national level (<https://Hardoi.kvk4.in>).

## Material and Methods

### Data Collection

This empirical investigation of resource use efficiency has made extensive use of primary data. The schedules that have been pre-structured and pre-tested have been used to gather the farmers from the community. The population sample was drawn using a multi-stage stratified random sampling technique. By selecting the Hardoi district on purpose, the sampling process has begun. First, a list of each of the 19 blocks in Hardoi district of Uttar Pradesh was created, along with an average ranking for mustard farming. One block Kothawan which has the most mustard growing land, was specifically chosen for this investigation. Thereafter, a list of all the villages in the Kothawan block was created and placed in ascending order of the area planted with crops. From these lists a sample of 100 respondents were drawn following the proportionate allocation to the different categories. Under marginal farmers category 64, small famers 22 and medium farmers 14 have occurred out of hundred samples.

### Period of Enquiry

The data pertained to agriculture year 2022-2023 estimation of costs and returns.

**Cost A<sub>1</sub>:** It includes costs and kind expenses actually incurred by cultivators which are as follows:

- Wage of hired human labour
- Charges for bullock labour
- Hired labour charges of implements and machinery
- Cost incurred on manures and fertilizers
- Seeds
- Plant protection/ intercultural chemicals
- Irrigation charges
- Land revenue
- Depreciation
- Repair charges on farm assets

**Cost A<sub>2</sub>:** Cost A<sub>1</sub> + Rent paid for leased in land

**Cost B<sub>1</sub>:** Cost A<sub>2</sub> + Interest on owned fixed capital assets

**Cost B<sub>2</sub>:** Cost B<sub>1</sub> + Rental value of owned land

**Cost C<sub>1</sub>:** Cost B<sub>1</sub> + Imputed value of family labour

**Cost C<sub>2</sub>:** Cost B<sub>2</sub> + Imputed value of family labour

**Cost C<sub>3</sub>:** Cost C<sub>2</sub> + 10% of cost C<sub>2</sub> (managerial cost)

**Gross Income** = Value of total output

**Net Income** = It is computed by deducting cost C<sub>3</sub> from gross income.

### Regression Analysis

Production function analysis was carried out to examine the productivity and efficiency of different resources of the sample farms. Multiple regression analysis was done to examine the cost-benefit relationship and productivity of farms. Different types of production functions were explored, out of them only Cobb-Douglas production function was found best fit for analysis. (Verma *et al.*, 2023). The mathematical form of Cobb - Douglas production function is given below:

$$Y = aX_1^{b_1} X_2^{b_2} \dots \dots \dots X_k^{b_k} e^{\mu}$$

Where, Y = Dependent variable (output values in Rs/ha), X<sub>i</sub> = i<sup>th</sup> independent variable (input values in Rs/ha), X<sub>1</sub> = labour (Rs/ha), X<sub>2</sub> = seed (Rs/ha), X<sub>3</sub>=Manure & Fertilizer (Rs/ha), X<sub>4</sub> = irrigation (Rs/ha), a = Constant, b<sub>i</sub> = Production elasticity with respect to X<sub>i</sub>, e = Error term or disturbance term, μ = Random variables.

The value of the constant (a) and coefficient (b<sub>i</sub>) in respect of the independent variables in the function have been estimated by using the method of least squares.

**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 (Mishra, A. *et al.*, 2021).

Where,  $(MVP)_i = \frac{b_i \bar{y}}{x_i}$

$B_i$  = Production elasticity with respect to  $X_i$

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

$X_i$  = Geometric mean of  $X_i$

(MVP) = Marginal value product of  $i^{th}$  impact

**Trend Models**

The model can be described as a means of presenting a process/ system. The statistical model generally traces the path of the process along with its statistical properties and implications. In the present topic, we are interested in studying the path and nature of the series under our preview through different models, which are briefly given in table 1.

**Table 1. Different trend models**

Model	Form
Linear Model	$Y_t = b_0 + (b_1 t)$
Quadratic Model	$Y_t = b_0 + (b_1 t) + (b_2 t^2)$
Compound Model	$Y_t = b_0 (b^t)$ Or $\ln(Y_t) = \ln(b_0) + t \ln(b_1)$
Cubic Model	$Y_t = b_0 + (b_1 t) + (b_2 t^2) + (b_3 t^3)$
Exponential Model	$Y_t = b_0 e^{(b_1 t)}$ or, $\ln(Y_t) = \ln(b_0) + (b_1 t)$
Logarithmic Model	$Y_t = b_0 + b_1 \ln(t)$
Growth Model	$\ln(Y_t) = b_0 + b_1 t$

**Note:** Where,  $Y_t$  is the value of the series at time  $t$  and  $b_0, b_1, b_2, b_3$  are the parameters (Srivastava *et al.*, 2022)

**Results and Discussion**

**Structure of Cost and Income**

For the data analysis, various cost concepts such as cost  $A_1, A_2, B_1, B_2, C_1$  and  $C_2$  were explored. Similarly, for the sample farms, several income measures such as gross income, net income, farm business income, family labour income, and farm investment income were determined. The expenses of producing mustard and the input: Output relationships have also been calculated using other costs.

**Cost of Cultivation in Mustard**

The cost per hectare of various input components in mustard production was calculated

**Analytical Tools Garrett’s Ranking Technique**

The ranks given by the respondents were then converted into percentage position with the help of formula given by Garrett Garrett’s formula for converting ranks into percent is: (Singh *et al.*, 2022 a & b)

Percent Position =  $\frac{100(R_{ij}-0.5)}{N}$

Where,  $R_{ij}$  is the rank given to it  $h$  item by the  $j^{th}$  individual and  $N$  is the number of item ranked by the  $j^{th}$  individual. The per cent position of each rank thus obtained was converted into scores using Garrett’s table. Then for each reason the cores of individual respondents were added and divided by the total number of respondents. Thus the mean score for each constraints was ranked by arranging them in a descending order.

and is shown in table 2. According to this table, the average cost of cultivating mustard per hectare was Rs.57919.67. The marginal farm had the highest cultivation cost (Rs.56744.30), followed by the small farm (Rs.59257.84) and the medium farm (Rs.61189.91). The total cost on a marginal farm was highest due to high outflows on irrigation and staff. According to the study, the cost of irrigation on a small farm was (10.95 %), followed by human labour (18.69 %) and the cost of seed on a medium farm was (7.65 %) and machinery charges (11.04 %) and manures and fertilizers (8.36 %). The distribution of costs on an overall farm average revealed that irrigation was the most expensive (10.99 %), followed by human labour (19.02 %).

**Table 2. Per hectare costs of different inputs used in mustard crop on different size group of sample Farm (Rs in per ha)**

S. N.	Particulars	Size Group of Farms			
		Marginal (64)	Small (22)	Medium (14)	Overall Average
1	Human Labour	10880.81 (19.18)	11072.68 (18.69)	11561.10 (18.89)	11018.26 (19.02)
a.	Family Labour	7838.56 (13.81)	6650.36 (11.22)	4824.78 (7.88)	7155.23 (12.35)
b.	Hired Labour	3042.25 (5.36)	4422.32 (7.46)	6736.32 (11.01)	3863.04 (6.67)
2	Machinery Charges	6263.15 (11.04)	6400.34 (10.80)	6682.48 (10.92)	6352.04 (10.97)
3	Seed	3544.75 (6.25)	4358.75 (7.36)	4681.18 (7.65)	3882.93 (6.70)
4	Manure and fertilizer	4745.48 (8.36)	5308.55 (8.96)	5565.75 (9.10)	4984.18.619 (8.61)
5	Irrigation	6267.73 (11.05)	6487.59 (10.95)	6635.19 (10.84)	6367.54 (10.99)
6	Plant Protection	4015.85 (7.08)	4325.34 (7.30)	4540.74 (7.42)	4157.42 (7.18)
7	Total working capital	35717.77 (62.95)	37953.25 (64.05)	39666.44 (64.83)	36762.39 (63.47)
8	Interest on working capital	336.00 (0.59)	353.00 (0.60)	375.00 (0.61)	345.20 (0.61)
9	Rental value of land	15000 (26.43)	15000 (25.31)	15000 (24.51)	15000.00 (25.90)
10	Interest on fixed capital	531.96 (0.94)	564.51 (0.95)	585.75 (0.96)	546.65 (0.94)
11	Sub total	51585.73 (90.91)	53870.76 (90.91)	55627.19 (90.91)	52654.24 (90.91)
12	Managerial Cost@10% of sub-total	5158.57 (9.09)	5387.08 (9.09)	5562.72 (9.09)	5265.42 (9.09)
Grand Total		56744.30 (100)	59257.84 (100)	61189.91 (100)	57919.67 (100)

**Note:** Figures in parenthesis indicate the percentage to the per hectare investment

Overall spending on machinery charges, manures and fertilizers, seed, amounts to 10.97 %, 8.61 %, 6.70 % respectively.

### Measures of Cost and Return of Mustard Crop in Study Area

This table 2 revealed that, on average cost A<sub>1</sub>/A<sub>2</sub>, cost B<sub>1</sub>, B<sub>2</sub>, cost C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub>, came to Rs.29952.36, Rs.30499.01, Rs.45499.01, Rs.37654.24, Rs.52654.24 and 57919.67 respectively.

On an average, gross income was recorded Rs.66323.00 and net income came to Rs.8403.33. On medium farms, gross income was highest, which was recorded Rs.71100, followed by small farms Rs.68150 and marginal farms Rs.64650, respectively. The net income was highest on small farms Rs.9910.09, followed by medium Rs.8892.16, and lowest marginal Rs.7905.70. On an average family labour income, farm investment income and farm business income were observed to Rs.20823.99, Rs.29215.41 and 36370.64, respectively.

**Table 3. Per hectare cost and income from the production of mustard crop on different size group of farms (Rs in per ha)**

S. N.	Particulars	Size Group of Farms			
		Marginal (64)	Small (22)	Medium (16)	Overall Average
1	Cost A <sub>1</sub> /A <sub>2</sub>	28215.21	31655.89	35216.66	29952.36
2	Cost B <sub>1</sub>	28747.17	32220.40	35802.41	30499.01
3	Cost B <sub>2</sub>	43747.17	47220.40	50802.41	45499.01
4	Cost C <sub>1</sub>	36585.73	38870.76	40627.19	37654.24
5	Cost C <sub>2</sub>	51585.73	53870.76	55627.19	52654.24
6	Cost C <sub>3</sub>	56744.30	59257.84	61189.91	57919.67
7	Yield l/ha.	12.93	13.63	14.22	13.26
8	Gross Income	64650	68150	71100	66323.00
9	Net return over cost C <sub>3</sub>	7905.70	8892.16	9910.09	8403.33
10	Family Income	20902.83	20929.60	20297.59	20823.99
11	Farm Business Income	36434.79	36494.11	35883.34	36370.64
12	Farm investment income	28596.23	29843.75	31058.56	29215.41
13	Cost of production (q/ha.)	4388.58	4347.60	4303.09	4367.59
14	Input- output ratio				
a	on the basis of Cost A1	1:2.29	1:2.15	1:2.02	1:2.22
b	On the basis of cost B1	1:2.25	1:2.12	1:1.99	1:2.18
c	On the basis of Cost B2	1:1.48	1:1.44	1:1.40	1:1.46
d	On the basis of Cost C1	1:1.77	1:1.75	1:1.75	1:1.76
e	On the basis of Cost C2	1:1.25	1:1.27	1:1.28	1:1.26
f	On the basis of Cost C3	1:1.14	1:1.15	1:1.16	1:1.14

**Table 4. Resource use efficiency estimator of mustard on different size of sample farms in the study area**

Size Group of Sample Farms (ha)	Production Elasticity				Elasticity of Production	R <sup>2</sup>
	X1 (Labour)	X <sub>2</sub> (Seed)	X <sub>3</sub> (Manure and Fertilizer)	X <sub>4</sub> (Irrigation)		
Marginal	0.1921**	0.2116	0.1621**	0.2769*	0.8427	0.87
Small	0.2054	0.1624**	0.2683*	0.2362	0.8723	0.89
Medium	0.1686**	0.2308	0.2246*	0.1678**	0.7918	0.90

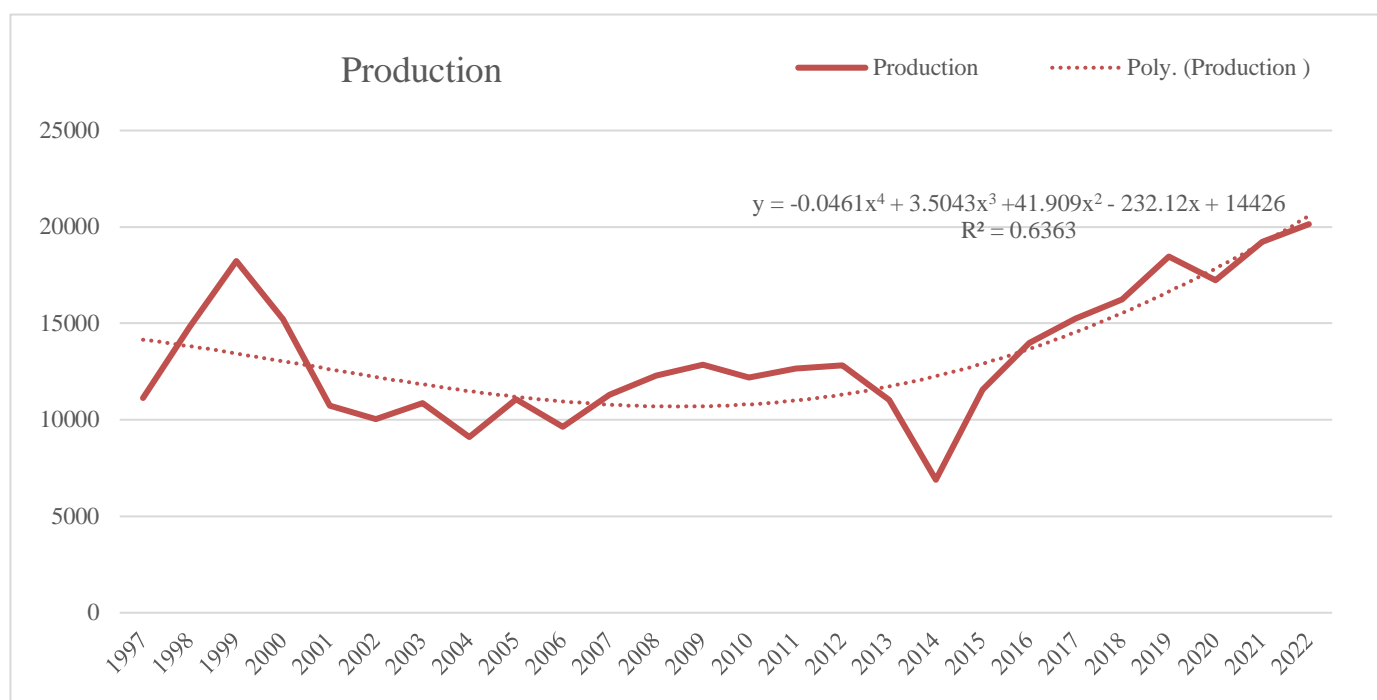
Note: Figures in parenthesis denoted standard error of respective variable, \*\*significant at 1% percent level, \*significance at 5% percents level

**Table 5. Marginal Value Productivity (MVP) of included factors of production process in mustard production**

Size Group of Farms	Marginal Value Productivity (MVP) on Different Size Group Farms			
	X1	X2	X3	X4
Marginal	3.68	0.98	1.28	1.25
Small	3.08	1.24	2.15	3.75
Medium	2.26	2.43	1.42	2.68

**Table 6. Trends in production of mustard in Hardoi district**

Model Summary and Parameter Estimates						
Equation	Model Summary		Parameter Estimates			
	R Square	Significance	Constant	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>
Linear	0.2052	0.000	10560.00	200.840		
Exponential	0.1644	0.000	0.000	0.013		
Logarithmic	0.0567	0.000	11001	963.561		
Quadratic	0.6363	0.000	14426	-232.120	41.909	3.504
Cubic	0.6354	0.000	14859	-506.78	1.8838	1.013
Compound	0.1644	0.000	0.000	0.013		
Growth	0.1644	0.000	0.000	0.013		

**Fig 1. Observed and expected trends of Production under mustard in Hardoi****Table 7. Major constraints faced by the mustard growers in the study area**

S. N.	Mustard Production Constraints	Average Score	Rank
1	Lack of training facilities and market access.	48.24	IX
2	Lack of Quality of Seed	62.78	II
3	Scarcity of labour	57.67	IV
4	Unfavorable weather condition	56.07	V
5	Unavailability of irrigation sources	62.14	III
6	Lack of electric power supply	46.74	X
7	Lack of subsidy funds	52.24	VIII
8	Problem of plant protection chemicals and weedicide	55.66	VI
9	Lack of harvesting problem	54.39	VII
10	Unavailability of machines and tractor	68.23	I

Family labour income was highest on marginal farms followed by small and medium farms & farm investment income was highest on medium farms followed by small and marginal farms and farm business income was highest on marginal farms followed by small farms and medium farms. On an average, cost of production per quintal and yield per hectare were estimated to Rs.2446.44 and 11.13 quintal, respectively. On an average input output ratio the basis costs  $A_1/A_2$ ,  $B_1$ ,  $B_2$ ,  $C_1$ , and  $C_2$  were recorded 1:2.22, 1:2.18, 1:1.46, 1:1.76 and 1:1.26, respectively. On the basis of cost  $C_3$  input output ratio was highest on medium farms (1:1.16) followed by small (1:1.15) and marginal (1:1.14), respectively.

### Resource use Efficiency of Mustard

Resource use efficiency, elasticity of production, return to scale and other qualities of interest in mustard crop of different size group of farms are displayed in table 4. High value of  $R^2$  of the fitted function indicates that sufficient and maximum proportion of the total variation in the dependent variable was explained by the included factors in production process. The four variable viz., seed, manure and fertilizer, irrigation and human labour jointly explained 0.87 %, 0.89 % and 0.90 % variation of the dependent variable on marginal, small and medium farms respectively. In case of marginal farms, seed, manure and fertilizer and human labour were found statistically significant at 1 and 5 % probability level while on factor viz., irrigation was found statistically non-significant. In case of small farms seed and human labour were found statistically significant at 1 and 5 % probability level while manure and fertilizer and irrigation were non-significant.

In case of medium farms, and human labour were found statistically significant at 1 and 5 % probability level while seed, manure and fertilizer and irrigation were non-significant.  $X_1$ ,  $X_2$ ,  $X_3$  and  $X_4$  stand for seed, Manure and fertilizer, irrigation and human labour respectively. Return to scale on marginal, small and medium farms were found 0.8427, 0.8723, 0.7918 respectively, which are less than unit. It is therefore, concluded that cultivation of mustard is characterized by decreasing return to scale on each size group of farms.

### Marginal Value Productivity (MVP)

In case of all these categories of farms and all the variables were positive value of M.V.P. to factor costs table 4. Indicated that there is further scope to increase the investment on all the factors to realize more return than the costs.

### Trend Analysis of Mustard in Hardoi District

To determine the trend in production various parametric models such as linear, exponential, logarithmic, quadratic, cubic, compound and growth. The best model is chosen from among the competing models based on its largest  $R^2$  value, model significance, and coefficients. The non-linear patterns are visible in the Hardoi district (fig 1). Thus, one can see from the trend analysis that quadratic trends are noticeable in the production of mustard, indicating that in the recent past most likely series have reached maximum values and then either remained constant or decreased, which cause for concern is. It is evident from figure 1 that mustard production has increased. The output of mustard, which fluctuated greatly between 2001 and 2014 before rising from 11570,000 tonnes in 2019 to 18468.00 tonnes in 2019, illustrates how the region's growth has affected the situation. After 2020, mustard production will continue to rise steadily throughout the year. The positive nature of the  $b_2$  coefficient indicates that the production of mustard in Hardoi have increased in recent years. Farmers' interest in mustard production is increasing, as shown by the rising trend. During the study period, overall production in Hardoi increased, possibly due to the adoption of new technology such as hybrid crop, fertilizer usage and so on.

### Constraints Production in Mustard

The mustard growers faced various types of cost of cultivation problems in the study area. It is presented in table 6 shows the major constraints faced by the mustard growers in the study area were unavailability of machines and tractor with mean score value of 68.23 (rank I) followed by, lack of quality of seed overall Garrett score 62.78 (rank II). Unavailability of irrigation sources has mean Garrett score value of 62.14 (rank III), scarcity of labour which got rank IV with a Garrett score of 57.67.

Fifth major constraint reported by the mustard growers was unfavorable weather condition which resulted in decrease of farmer's share in consumer's rupee overall Garrett score 56.07 (rank V), problem of plant protection chemicals and weedicide was also one of the major constraints which got VI rank with overall Garrett score of 55.66. In addition to the above problems, lack of harvesting problem (rank VII), cheating, by lack of subsidy funds (rank VIII), lack of training facilities and market access (rank IX), existence of intermediaries between lack of electric power supply (rank X) in the study area.

## Conclusion

For achieving the stipulated objectives, the Hardoi district was selected purposively. The selection of the sample for the study was made by using the purposive cum random sampling technique. In the Hardoi district out of the 5 tehsils of the selected, sandila tehsil was selected purposively for the study. Out of the 19 blocks of selected tehsil, the Kothawan block was selected. Farmers were selected based on mustard cultivation in the region and five villages were selected randomly from the block. The study reveals that mustard cultivation in the study area is characterized by decreasing return to scale on each size group of farms. The average cost of cultivation for different size groups is Rs.29952.36, Rs.30499.01, Rs.45499.01, Rs.37654.24, Rs.52654.24 and 57919.67, respectively. Gross income is recorded at Rs.66323.00 and net income at Rs.8403.33. Family labor income, farm investment income, and farm business income are observed to be Rs.20823.99, Rs.29215.41 and 36370.64, respectively.

The average cost of production per quintal and yield per hectare are estimated to be Rs.2446.44 and 11.13 quintal, respectively. The input output ratio of the basis costs  $A_1/A_2$ ,  $B_1$ ,  $B_2$ ,  $C_1$  and  $C_2$  is highest on medium farms (1:1.16) followed by small (1:1.15) and marginal (1:1.14). The study also reveals that the four variables viz., seed, manure and fertilizer, irrigation and human labor jointly explained 0.87 %, 0.89 % and 0.90 % variation of the dependent variable on marginal, small and medium farms, respectively.

The study concludes that mustard cultivation is characterized by decreasing return to scale on each size group of farms. Additionally, the trend analysis highlighted a positive growth trajectory in mustard production over time in Hardoi district.

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