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Assessment of Resource Use Efficiency of Rapeseed/Mustard Production in District Deoria, Eastern Utter Pradesh, India

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A B S T R A C T

The oilseed complex in India is undergoing visible changes in the new environment of liberalized trade. Consumption patterns are changing, as consumers are beginning to accept oils other than those consumed traditionally. Change in cropping patterns has also taken place with the help of technology mission and prices support. Oilseed sector is greatly disappointed with the outcome of the budget. The country is heavily dependent on import of several tones of edible oil per year to fulfill the requirement of the people. An estimated 9.20 million tons of rapeseed mustard are produced in India each year (2020–2021). To enhance the productivity of rapeseed/mustard there is urgent need of technological intervention. The research study was conducted on 60 farmers of Rudrapur and Gauri Bazar blocks of Deoria District. Multistage stratified random sampling technique was adopted to select the farmers. The requisite data was collected through personal interview with the farmers with the help of pre-tested comprehensive schedule related to Rapeseed/Mustard crop for the year 2022-23. Cobb-Douglas production function has been applied to analyze resource productivity in rapeseed/mustard production, considering Gross return (qt./ ha') as a dependent variable and the input factors, namely the Area (ha. term), Fertilizer (kg. term), Irrigation charge (value term.), Seed (kg. term), Tractor (Value term) and Human labor (men days) as the independent variables. The regression coefficient of area, seed, irrigation, tractor and human labor inputs uses turned out to be positive and significant in different size of farms.

Introduction

India occupies largest cultivated area under oilseeds in the world. The area under rapeseed/mustard enhanced by 29 percent from 68.56 lakh hectares in 2019-20 to 88.58 lakh hectares in 2022-23 (Statist, https://www.statista.com, 2022-23). Timely action by state and central government made this remarkable achievement possible. The continual rise in demand for edible oils and related products has led to a significant expansion in the production of rapeseed mustard worldwide, particularly in a number of nations (Dheeraj Kumar Verma, *et al.,* 2011; Priyanka Rai, *et al.,* 2024a, b). In the world, rapeseed mustard was expected to have

36.59 million hectares (M ha), 72.37 million tons (Mt), and 1,980 kg/ha of production and yield in 2018–2019 (ICAR- Directorate of Rapeseed/Mustard Research, 2022-23).

Over time, there has been an increase in demand for rapeseed cake, and at the moment, 20% of cakes produced are consumed directly. Being a significant crop of Rabi oilseed, it benefits from the monsoon-induced soil moisture (Dubey, *et al*., 2014). There is more potential for rapeseed to boost domestic production of edible oil availability.

Even though oilseed has a good quality and can adapt to a variety of agro-climatic conditions, biotic and abiotic stressors as well as India's domestic price support program have caused fluctuations in the area, output, and yield of oilseed in the country.

Rapeseed, however, has the ability to provide nutritional security and can make a substantial contribution to the farmers' security of livelihood. Crops that yield oilseeds are essential to the growth of the agricultural economy. The agricultural sector plays a very important role in India's social security and overall economic welfare

Materials and Methods

The Deoria District served as the site of the study. Deoria District was selected purposely, because of the total production of oilseeds in the district, rapeseed/mustard accounts for the second position (40.70%) after groundnut (57.85%). In District Deoria, two blocks namely Rudarpur and Gauri Bazar Blocks which were selected for the study.

Three villages from each block were selected randomly. Farmers were classified in different categories i.e. marginal, small, medium and large on the basis of their land holding capacity. From each village, 10 farmers were randomly selected. Thus, the final sample consisted of 60 farmers from six villages.

Resource use efficiency

Cobb-Douglas production function has been applied to analyze resource productivity in rapeseed/ mustard production.

Cobb-Douglas production function used in this study was of the following form:

$$Y = a\, X_1^{b1}\, X_2^{b2}\, X_3^{b3}\, X_4^{b4}\, X_5^{b5}\, X_6^{b6} \ldots\ldots X_n^{bn}$$

Where,

Y=Yield (qt/ha)

a = efficiency parameter (constant)

b_1, b_2, b_3, b_4, b_5, b_6 = coefficient of elasticity of production with respect to resources.

X_1 = Land (hectare)

X_2 = Manures/fertilizers (Rs.)

X_3 = Irrigation (Rs.)

X_4 = Seed (Kg.)

X_5 = Tractor (Rs.)

X_6 = Human Labor (Days)

The double log form of production function

$$\text{Log } Y = a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X + U$$

Results and Discussion

Regression analysis has been to analyze the input-output relationship by fitting a Cobb-Douglas type production function.

1. Marginal farm

$$Y=5.334\, X_1^{0.646}\, X_2^{-0.007}\, X_3^{-0.006}\, X_4^{-0.06}\, X_5^{0\,0.156}\, X_6^{0.208}$$

2. Small farms

$$Y=2.222\, X_1^{-0.008}\, X_2^{-0.110}\, X_3^{-0.195}\, X_4^{0.337}\, X_5^{0.667}\, X_6^{-0.02}$$

3. Medium farms

$$Y=5.669\, X_1^{0.569}\, X_2^{-0.223}\, X_3^{-0.006}\, X4^{-0.01} X_5^{0.240}\, X_6^{0.559}$$

4. Large farms

$$Y=7.789\, X_1^{0.901}\, X_2^{-0.07}\, X_3^{-0.003}\, X_4^{0.06}\, X_5^{0.003}\, X_6^{0.03}$$

5. All farms

$$Y=7.697\, X_1^{0.975}\, X_2^{-0.02}\, X_3^{0.228}\, X_4^{-0.006}\, X_5^{-0.193}\, X_6^{0.007}$$

Marginal farm

Table 1 reveals that the value of the coefficient of multiple determinations R^2 in rapeseed and mustard crop was 0.957. It indicates that 95.70 percent of variations in the logarithmic value of gross returns per hectare is explained by the independent variables included in the equation, while rest of the variation in gross return is explained by those factors that have not been taken into considerations. As regards Area, the regression coefficient was a positive and significant effect on yield, indicating that 1 percent increase in area (hectare term) would bring about an increase in gross return by 0.646 percent in oilseed production keeping other resource variables constant at their geometric mean levels.

The coefficient of elasticity of production (regression coefficient) attached to the variable fertilizer application turned out to be negative in mustard production. However, as the coefficient for these resources was statistically insignificant, no impact of these resources was visible on the gross return. This may be because of the excessive use of this input in the crop. The regression coefficient of irrigation was negative and insignificant effect on yield. The obvious reason for the insignificant coefficient of irrigation resources could be the practice of adherence to a uniform rate of application of irrigation in crops in the marginal size of farmer-applied recommended practices.

The regression coefficient of seed was also positive and insignificant effect on yield. The obvious reason for the insignificant coefficient of seed resources could be the practice of adherence to a uniform rate of application of seed by the marginal size of farmers, applied recommended practices. The elasticity coefficient of tractor power use turned out to have a positive and significant effect on yield. The significant coefficient of tractor use with a positive sign indicated that 1 percent increase in tractor use (hour terms) would bring about an increase in the gross return by 0.156 percent, keeping the other variable resources considered in the equation constant at their geometric mean levels.

The coefficient of elasticity of production (regression coefficient) ached to the variable human labor turned out to be positive and its coefficient has a significant effect on yield. The positive and significant coefficient of human labor use in mustard, crop indicates that a 1 percent increase in human labor use (men days) would bring about an increase in the return by 0.208 percent, keeping the other variables resources considered in the equation constant at their geometric mean level. The findings in the line observation made by Rashid and Anwar (2004).

Small farm

Table 2 reveals that the value of R2 given by the fitted equation in rapeseed/ mustard crop indicated that 79.50 per cent of variations in the logarithmic value of gross returns per hectare is explained by the independent variables included in the equation viz. Area, Fertilizer, Irrigation, Seed, Tractor and Human labor whereas the rest of the variation in gross return (qt/hectare) would be attributable to factors exogenous to the model. The regression coefficient of seed input use turned out to be positive and significant in the case of small farmers. The value of the coefficient in the case of seed (value term) is 0.337, which indicated that the farmers used hybrid or improved seed varieties over the domestic varieties which leads to higher yields. The regression coefficients of tractor use turned out to have a positive and significant effect on yield. The significant coefficient of tractor uses with Positive indicated that a percent increase in tractor use (in value terms), would bring about an increase in the gross return by 0.667 percent, while other input variables are to be kept constant at their geometric mean levels. The findings are in line with observations made by Shabu (2016).

Medium Farms

Table 3 reveals that the value of R^2 in rapeseed/mustard crop was 0.740, indicating that 74 percent of variations in the logarithmic value of gross returns per hectare was attributable to the independent variables included in the equation. As regards Area, the regression coefficient had a positive and significant effect on yield, indicating that a 1 percent increase in Area (hectare term) would bring about an increase in gross return by 0.569 percent in oilseed production, keeping other resource variables constant at their geometric mean levels. The regression coefficient of the tractor used is statistically positive and significant (at 10 percent) probability level, which indicates that a 1 percent increase in tractor use (in value term), would bring about an increase in gross return by 0.240 percent while other input variables are to be kept constant at their geometric mean level. As regards human labor, the regression coefficient for the human labor input turned out to be a positive and significant effect on yield which indicates that a 1 percent increase in human

labor (man days) would bring about an increase in gross return by 0.559 percent in oilseed production (Haque, 2006).

Large farms

Table 4 reveals that the value of R^2 in the mustard crop was 0.884, indicating that 88 percent of the variation in the logarithmic value of gross returns per hectare was attributable to the independent variables. The regression coefficient for the variable Area turned out to be positive and significant effect on yield. The significant coefficient of the area with a positive sign indicates that a 1 percent increase in Area (hectare term), would bring about an increase in the gross return (quintal/ha.) by 0.901 percent, holding the other variable resources constant at their geometric mean level (Das, 2014).

All farms

Table 5 reveals that the value of the coefficient of multiple determinations R^2 given by the fitted equation in rapeseed/mustard production indicated that 98 percent of the variation in the logarithmic value of gross return per hectare is explained by the independent variable included in the equation viz. Area, Fertilizer, Irrigation, Seed. Tractor and Human labor whereas the gross returns would be attributable to factors exogenous to the model.

The regression coefficient for Area, Irrigation, and Tractor input turned out to be positive and significant effect on yield. The significant coefficient and positive sign of these variables indicate that a 1 percent increase in Area (ha. term) and Irrigation (value term) would bring about an increase in gross return by 0.975 and 0.228, respectively, holding the other variable resources constant at their geometric mean levels. As regards tractors, the elasticity coefficient of tractor use had a negative effect on yield. It was significant at a 1 percent probability level in the model. The significant and negative coefficient of tractor power input indicates excessive use of these resources, and hence, further increase would decrease gross return. The finding is in line with observations made by Dhakal *et al.,* (2015).

Table.1 Regression coefficients, standard errors (S.E.), t-values, and value of R2 for rapeseed/mustard

Variable	Reg. Coefficient	S.E.	t	R^2
Area	0.646*	0.068	9.551	
Fertilizer	-0.007	0.072	-0.106	
Irrigation	-0.006	0.017	-0.386	0.957
Seed	0.06	0.058	1.044	
Tractor	0.156*	0.055	2.854	
Human labor	0.208**	0.087	2.386	

*Significant at 1% level of significance F-value=478.93
** Significant at 5% level of significance

Table.2 Regression coefficients, standard errors (S.E.), t-values, and value of R2 for rapeseed/mustard

Variable	Reg. Coef.	S.E.	T	R^2
Area	-0.008	0.195	-0.044	
Fertilizer	-0.110	0.279	-0.393	
Irrigation	-0.195	0.205	-0.950	0.795
Seed	0.337***	0.175	1.927	
Tractor	0.667*	0.223	2.993	
Human labor	-0.02	0.368	-0.055	

*Significant at 1% level of significance, F-value -8.41
***Significant at 10% level of significance

Table.3 Regression Coefficients, standard errors (S.E.), t-values, and value of R2 for mustard

Variable	Reg. Coeff.	S.E.	t	R^2
Area	0.569*	0.183	3.108	
Fertilizer	-0.223	0.145	-1.531	
Irrigation	-0.006	0.073	-0.088	0.740
Seed	-0.01	0.148	-0.112	
Tractor	0.240***	0.141	1.698	
Human Labor	0.559**	0.228	2.446	

*Significant at 1% level of significance F-value=18.53
**significant at 5% level of significance
***Significant at 10% level of significance

Table.4 Regression coefficients, standard errors (S.E.), t-value and value of R2 for rapeseed/mustard

Variable	Reg. Coeff.	S.E.	t	R^2
Area	0.901*	0.089	10.175	
Fertilizer	-0.07	0.081	-0.978	
Irrigation	-0.003	0.008	-0.458	0.884
Seed	0.06	0.048	1.287	
Tractor	0.003	0.047	0.087	
Human labor	0.03	0.068	0.452	

*Significant at 1% level of significance F-value=40.49

Table.5 Regression coefficients, standard errors (S.E.), t-value and value of R2 for rape seed/ mustard

Variable	Reg. Coef.	S.E.	T	R^2
Area	0.975*	0.091	10.67	
Fertilizer	-0.02	0.074	-0.311	
Irrigation	0.228*	0.074	3.077	0.980
Seed	-0.006	0.115	-0.060	
Tractor	-0.193*	0.067	-2.882	
Human labor	0.007	0.100	0.074	

*Significant at 1% level of significance F-value 190.25

In this section, the input-output relationship in rapeseed-mustard production has been analyzed using regression analysis with the Cobb-Douglas production function. The regression coefficient was positive and significant on yield, in small farm, the value of ($R^{2)}$ was 79.95 per cent, as regard seed, and tractor use turned out to be positive and significant effect on yield indicates that 1 per cent increase in seed and tractor use would bring about an increase in gross return by 0.337 per cent and 0.667 per cent in oilseed production respectively.

In medium farms, the value of multiple determinations R^2 was 0.740 indicating that 74 per cent of variations in the logarithmic value of gross return were explained by undependable variable under consideration. As regard area, tractor and human labor the regression coefficient were positive and have significant effect on yield. In large size, the value of R^2 was 0.884 indicating that 88 per cent of variation in the logarithmic value of gross return /ha was attributed to the independent variable.

The regression coefficient for the area turn out to be positive and significant effect on yield indicate that 1 per cent increase in area would bring about an increase in the gross return by 0.901 per cent. On all farms the value of R^2 was 0.98, indicate that 98.00 per cent of variation in the logarithmic value of gross return. As regards area, irrigation, the regression coefficient was positive and has

significant effect on yield. Where as in case of tractor, the elasticity coefficient was significant and negative, indicate that the resource is used excessively.

Policy Implication

1. From the findings, in all categories of farm, the major chunk of expenditure was spent on labor and then to irrigation, by and large expenditure was skewed towards purchased input. Thus there is need for government to provide incentives on the aspects of affordable seeds, agriculture chemicals, irrigation and other basic amenities required for farming in order to boost and stabilized the production.
2. The government should pay attention on oilseed research and to implement advance technology to enhance and sustain oilseed productivity.

Author Contribution

Dheeraj Kumar Verma: Investigation, formal analysis, writing—original draft. Pratibha Bhaskar: Validation, methodology, writing—reviewing. Priyanka Rai:—Formal analysis, writing—review and editing. Hraday Kumar: Investigation, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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