**Measures of Resource use Efficiency and Constraints of Rapeseed-Mustard crop in Prayagraj District of Uttar Pradesh**

**Abstract:**

This study evaluates the resource use efficiency in rapeseed-mustard cultivation across different farm sizes, focusing on marginal, small, and medium farms. The analysis reveals that marginal farms exhibit the highest production elasticity for inputs X1, X2, and X5, indicating significant responsiveness in production with the increase of these inputs. Small farms show the highest elasticity for X3, while medium farms generally demonstrate lower production elasticity across all input variables. The sum of elasticity/return to scale is greatest in marginal farms, suggesting higher operational efficiency, followed by small and then medium farms. The R² values suggest the regression models explain 79%, 83%, and 85% of production variability for marginal, small, and medium farms, respectively, indicating the best model fit for medium farms. Marginal Value Productivity (MVP) data shows that investment in all inputs can yield higher returns, with notable variances across farm sizes. Key constraints to rapeseed-mustard production include high input costs, fertilizer shortages, and labor availability. Recommendations include education on pesticide use, cost reduction strategies, organic waste recycling for compost, and establishing community credit systems. Implementing these measures could enhance production efficiency and increase rapeseed-mustard yields.

**Keywords:** Resource Use Efficiency, Input-Output relationship, farm sizes, Constraints and Suggestions etc.

**Introduction:**

Rapeseed (*Brassica campestris*) and Mustard (*Brassica juncea*) are crucial rabi oilseed crops in India, significantly contributing to the nation's oilseed output. Collectively known as rapeseed-mustard, these crops are extensively cultivated across 24 states, playing a vital role in the country's agricultural landscape. Rapeseed-mustard is predominantly used in cooking, frying, and as condiments, especially in northern India. The by-products, such as oil cake and green stems, are valuable as cattle feed and fertilizers (Chauhan *et al*., 2020).

Rapeseed-mustard ranks second among the seven major edible oilseed crops in India but leads in contributing to the country's total oil supply, accounting for about 36% (Bhatia, 2019). The production of rapeseed-mustard has seen significant growth, reaching 11.75 million tonnes in 2021-22 (Ministry of Agriculture & Farmers Welfare, 2022). Major producing states include Rajasthan, Madhya Pradesh, Haryana, Uttar Pradesh, and West Bengal. Globally, in 2018-19, the area, production, and yield of rapeseed-mustard were 36.59 million hectares, 72.37 million tonnes, and 1980 kg/ha, respectively (FAO, 2019). India has made a substantial contribution to global acreage and production, being the fifth-largest producer of mustard globally in 2022, with a production of 115 lakh tonnes (USDA, 2022). Within India, Rajasthan leads in mustard production, followed by Madhya Pradesh, Haryana, and Uttar Pradesh.

Despite its significant production, there is limited research on the economic aspects of rapeseed-mustard farming, particularly in Uttar Pradesh. This study aims to bridge this gap by analyzing the resource use efficiency in rapeseed-mustard production across different farm sizes in the region. By examining production elasticity, marginal value productivity, and the constraints faced by farmers, this research provides valuable insights into optimizing resource allocation and improving the productivity of rapeseed-mustard farming in Uttar Pradesh.

1. To work out the resources use/efficiency of mustard crop in study area;

2. to identify the constraints faced by farmers in Production of Rapeseed-Mustard crop and suggest suitable policy measures.

 **(2) Methodology:**

**Sampling Technique:**

 Purposive cum random sampling design was used for the selection of district, tehsil, block, villages and respondents.

**Selection of the district**:

 Keeping in view the limitation of resources and time of the investigator district Prayagraj of Uttar Pradesh was selected purposively.

**Selection of tehsil**:

 A list of all the 8 tehsil in Prayagraj district was arranged in ascending order according to number of Rapeseed-mustard cultivators in the region. Phulpur tehsil was selected purposively from the bottom.

 **Selection of block:**

 All the 23 blocks of Phulpur tehsil were again arranged in ascending order according to number of Rapeseed-mustard cultivators in the region and one block namely Baharia was selected purposively from the bottom.

**Selection of villages**:

 A list of all villages of selected bikapur block was prepared separately along with their area under sugarcane cultivation and five villages namely Benipur, Maliakapoora, Basrahi, Dadupur and Jamha were selected randomly.

**Selection of farmers**:

 A separate list of farmers growing Rapeseed-mustard of selected villages was prepared along with their holding size.

 Based on size of holding, farmers were classified into three group i.e.

1. Marginal farmer below 1 ha

2. Small farmer 1-2 ha and

3. Medium farmer 2 ha & above

Finally, 100 respondents were selected randomly through proportionate allocation to the population.

**Period of Study**:

The data was collected for the agricultural year 2022-2023.

 **Method of enquiry**: For the interpretation of data the following analytical tools were used:

1. **Tabular Analysis:**

Tabular analysis was made to compare different aspects of analysis of costs and returns on different categories of the sample farms.

1. **Average:**

The simplest and the most important measures of average mean and weighted mean were applied. The formula of mean and W.A. is given below:



Where,

 X= Value of variable

 N= Number of observation

$W.A.=\frac{∑Wi Xi}{∑Wi}$

Where,

 W.A. = Weighted Average

Wi = Weight of Xi

 Xi = Variable

(b) Percentage = Simple comparisons have been made on the basis of percentage.

**Functional analysis:**

To study resource use efficiency in mustard production, various forms of production functions were considered. However, the Cobb-Douglas production function was found to be the most suitable fit for the data.

**The Mathematical form of cob-douglas production function is:**

Y= a x1b1x2b2 x3b3 x4b4 x5b5……. xnbn eµ

Where,

Y = Dependent variable (output values Rs./ha.)

Xi = ith independent variable (input values Rs./ha.)

X1 = Human labour (Rs./ha.)

X2 = Seed (Rs./ha.)

X3 = Manure and fertilizer (Rs./ha.)

X4 = Irrigation (Rs./ha.)

X5 = Plant protection (Rs./ha.)

a = Constant

bi (i=1,2,3,4,5,..) = Production elasticity with respect to Xi (input variables)

e = Error term or disturbance term

µ = Random variables

The values of the constant (a) and coefficient (bi) in respect of independent variables in the function have been estimated by using the method of least squares.

**Cobb-Douglas Production function in log form:**

Log Y = log a + b1log x1 + b2log x2 + b3log x3 + b4log x4 + b5log x5 + e

**Significance test of the sample regression coefficients:**

After estimating the elasticity coefficients, it is important to assess the reliability of these estimates. The most commonly used method for this purpose is the 't' test, which is applied to determine whether the sample production elasticity coefficient, 𝑏𝑗*bj*​, is significantly different from zero at a specified probability level.

$$'t^{'}calculated=\frac{b\_{j}}{S.E. of b\_{j}}$$

Where,

t-test = For each coefficient, it tests that the coefficient differs significantly from zero value.

$b\_{j}$ = production elasticity of $ X\_{j}$

S.E. = standard error

If calculated ‘t’ value is greater than the table value of ‘t’ at specified probability level and ‘n-k-1’ degree of freedom, $b\_{j}$ is said to be significantly different from zero ‘K’ is number of independent factors and ‘n’ is sampled size.

$$F=\frac{Regression mean square}{Error mean sqaure}=\frac{SSR/K}{\frac{∑e^{2}}{n-k-1}}$$

Where,

SSR = sum of square due to regression

$∑e^{2}$ = sum of square of error term

Constraints faced by farmers have been analyzed through surveys. Farmers identified constraints such as lack of awareness, higher production expenditure, non-availability of labor, and shortages of fertilizer and manure. The Garrett ranking technique is a crucial aspect of the research for providing suggestions to government policies and addressing farmers' problems. Respondents were asked to rank the constraints, and these rankings were converted into scores. (Gautam *et al.,* 2022).

100 × (Rij-0.5)

 Percent position =

Nj

Where,

Rij= Rank given for ith factor by jth individual

Nj= Number of factors ranked by jth individual

**Results and Discussion:**

**4.2.3 Resource Use Efficiency in Rapeseed-Mustard**

The analysis of production elasticity across different farm sizes (marginal, small, and medium) reveals significant variations in responsiveness to inputs X1 (human labor), X2 (seed), X3 (manure and fertilizers), X4 (irrigation), and X5 (plant protection).

**Marginal Farms:**

Marginal farms exhibit the highest production elasticity for X1 (0.2011, p<0.05), X2 (0.3492, p<0.01), and X5 (0.1162, p<0.05), indicating that these inputs result in a relatively larger increase in production compared to small and medium farms.

**Small Farms:**

 Small farms show the highest elasticity for X3 (0.1687, p>0.05), suggesting their sensitivity to changes in manure and fertilizer inputs.

**Medium Farms:**

Medium farms generally display lower production elasticity across all inputs compared to marginal and small farms, indicating potentially less efficient input utilization.

**Sum of Elasticity/Return to Scale**

The sum of elasticity/return to scale provides insights into operational efficiencies: Marginal farms demonstrate the highest sum of elasticity/return to scale, suggesting they operate relatively efficiently compared to small and medium farms. Small farms show a slightly lower sum compared to marginal farms but higher than medium farms, indicating some inefficiencies in their production scale. Medium farms exhibit the lowest sum of elasticity/return to scale among the groups, highlighting potential inefficiencies in their operational scale.

**Coefficient of Determination (R2)**

The coefficient of determination (R2) assesses the goodness of fit of the regression models:

Marginal farms have an R2 of 0.79, indicating that approximately 79% of the variability in production is explained by the model. Small farms show an R2 of 0.83, suggesting that the model explains approximately 83% of production variability. Medium farms have the highest R2 value of 0.85, indicating a relatively better model fit compared to marginal and small farms, explaining approximately 85% of production variability.

**Table 1: Resource Use Efficiency in Rapeseed-Mustard Crop**

|  |  |  |  |
| --- | --- | --- | --- |
| **Size Group of sample farms/** | **Production Elasticity/** | **Sum of****Elasticity/****return to scale/** | **R2/** |
|  | **X1** | **X2** | **X3** | **X4** | **X5** |  |  |
| **Marginal** | 0.2011\* (0.0426)  | 0.3492\*\* (0.0297)  | 0.1824\* (0.0726)  | 0.0083 (0.0147)  | 0.1162\* (0.0253)  | 0.8572 | **0.79**  |
| **Small** | 0.1871\* (0.0526)  | 0.2544\*\* (0.0461)  | 0.1687 (0.4002)  | 0.098 (0.0986)  | 0.1002\* (0.0380)  | 0.8084 | **0.83**  |
| **Medium** | 0.1127 (0.0616)  | 0.2902\*\* (0.0422)  | 0.1826\* (0.0668)  | 0.0243 (0.0182)  | 0.1187\* (0.0330)  | 0.7285 | **0.85**  |

(Size Group of Sample Farms, Production Elasticity, Sum of Elasticity/Return to Scale, R2 values for inputs X1-X5)

**4.2.4 Marginal Value Productivity (MVP) of Factors**

Marginal farms demonstrate high MVP values across all inputs, particularly notable for X2 (seed) and X5 (plant protection), indicating efficient resource use. Small farms also show competitive MVP values, suggesting effective utilization of inputs despite lower absolute values compared to marginal farms. Medium farms generally exhibit lower MVP values, indicating potential for improving input efficiency.

**Table 2 illustrates the MVP of inputs X1 to X5 in different farm sizes.**

|  |  |
| --- | --- |
| **Size group of farms/** | **Marginal Value Productivity/ (MVP) of input/factors/** |
|  | **X1** | **X2** | **X3** | **X4** | **X5** |
| **Marginal** | 0.9806 | 14.2862 | 2.8481 | 0.0814 | 3.0111 |
| **Small** | 0.8726 | 8.6991 | 2.5703 | 0.9632 | 2.2019 |
| **Medium** | 0.5592 | 10.5563 | 2.9595 | 0.2541 | 2.7749 |

**4.2.5 Constraints in Rapeseed-Mustard Production**

**Table – 3 Problem of Rapeseed-mustard production on various size sample farms:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.N.** | **Mustard Production Constraints** | **Garret Position** | **Garret Value** | **Garret score** | **Final rank** |
| **1** | Lack of awareness of insecticide and pesticide and high price of insecticide and pesticide | 6.25 | 80 | 57.64 | I |
| **2** | High input cost for mustard cultivation | 18.75 | 68 | 48.02 | VIII |
| **3** | Shortage of fertilizer and manures | 31.25 | 60 | 43.3 | VII |
| **4** | Higher production expenditure | 43.75 | 53 | 48.89 | V |
| **5** | Non availability of labour when needed and higher labour charge | 56.25 | 47 | 51.37 | III |
| **6** | Lack of availability of sufficient quality seed | 68.75 | 40 | 52.49 | II |
| **7** | Lack of availability of credit | 81.25 | 32 | 48.18 | VI |
| **8** | Lack of awareness about new technology and practices | 93.75 | 20 | 50.86 | IV |

Constraints such as lack of awareness about insecticides/pesticides, high input costs, and shortages of fertilizer and quality seeds are prominent across all farm sizes.

Labor availability and credit accessibility also emerge as significant challenges impacting production efficiency.

The findings underscore the importance of optimizing input use efficiency and addressing critical production constraints to enhance rapeseed-mustard yield and profitability. Marginal farms appear to leverage their scale and input responsiveness effectively, while small and medium farms could benefit from targeted interventions to improve operational efficiencies and overcome production constraints.

**Recommendations**

1. Enhanced Education and Subsidies: Public education on pest management and subsidized inputs can mitigate challenges related to pesticide awareness and high input costs.

 2. Adoption: Adoption of cost-effective cultivation methods, investment in technology, and negotiation for bulk purchase agreements can reduce production expenditures and enhance efficiency.

3. Resource Optimization: Implementing recycling programs for organic waste, promoting seed banks, and enhancing credit accessibility can alleviate constraints related to input shortages and quality.

4. Capacity Building: Farmer education programs and demonstration plots can facilitate the adoption of new technologies and practices, further optimizing production processes.

These measures collectively aim to boost productivity and profitability in rapeseed-mustard farming, contributing to sustainable agricultural development.

**Resource Use Efficiency:**

Marginal Farms: Marginal farms demonstrate higher production elasticity for inputs X1 (human labor), X2 (seed), and X5 (plant protection), indicating their greater responsiveness to these inputs compared to small and medium farms. They also exhibit the highest sum of elasticity/return to scale, suggesting efficient operation at their scale.

**Small Farms:** These farms show higher elasticity for X3 (manure and fertilizers), highlighting their sensitivity to changes in these inputs. However, they demonstrate slightly lower efficiency in return to scale compared to marginal farms.

**Medium Farms:** Medium farms generally display lower production elasticity and return to scale across all inputs, indicating potential inefficiencies in input utilization and operational scale.

**Marginal Value Productivity (MVP):**

Marginal Farms: Marginal farms exhibit notably high MVP values, particularly for X2 (seed) and X5 (plant protection), indicating efficient utilization of these inputs to maximize output. Small Farms: Despite lower absolute MVP values compared to marginal farms, small farms demonstrate competitive efficiency in input utilization across all factors. Medium Farms: Medium farms show lower MVP values overall, suggesting opportunities for improving input efficiency and productivity.

**Constraints in Production:**

Critical constraints such as lack of awareness regarding insecticide and pesticide use, high input costs, shortage of fertilizers and quality seeds, labor availability issues, and limited access to credit are prevalent across all farm sizes. These constraints hinder production efficiency and profitability in rapeseed-mustard farming.

**Recommendations:**

**1. Education and Subsidies:** Promote public education on pest management and subsidize inputs to address issues related to pesticide awareness and high input costs.

**2. Adoption of Technology and Efficient Practices:** Encourage adoption of cost-effective cultivation methods, investment in technology, and negotiation for bulk purchase agreements to reduce production expenditures and improve efficiency.

**3. Resource Optimization:** Implement recycling programs for organic waste, establish seed banks, and enhance credit accessibility to mitigate shortages of inputs like fertilizers and quality seeds.

**4. Capacity Building:** Conduct farmer education programs and set up demonstration plots to facilitate the adoption of new technologies and practices, thereby optimizing production processes.

**Conclusion**

The analysis of resource use efficiency in rapeseed-mustard farming across marginal, small, and medium farms reveals significant insights into production elasticity, return to scale, marginal value productivity (MVP) of inputs, and key constraints affecting production**.**

In conclusion, optimizing resource use efficiency and addressing critical production constraints are essential for enhancing rapeseed-mustard yield and profitability across different farm sizes. Marginal farms demonstrate effective leverage of their scale and input responsiveness, while small and medium farms would benefit from targeted interventions to improve operational efficiencies. These measures collectively aim to promote sustainable agricultural development and ensure a robust future for rapeseed-mustard farming.

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