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Resource use efficiency of Kala Namak production in Gorakhpur district of Uttar Pradesh

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Abstract
This study investigates the resource use efficiency in Kala Namak (black salt) production in Gorakhpur district, Uttar Pradesh, focusing on the agricultural year 2021-2022. Employing a multistage stratified purposive cum random sampling technique, the research selected the district, blocks, villages, and respondents. Six villages were randomly chosen from a list of all villages in the Sahajanwa and Campierganj blocks. Respondents were categorized into three strata based on landholding size: Marginal (below 1 ha.), Small (1-2 ha.), and Medium (2-4 ha.). The study encompassed 60 respondents with average land holdings of 0.548, 1.517, and 3.630 hectares for the Marginal, Small, and Medium categories, respectively. Primary data were collected through scheduled surveys conducted via personal interviews. The Marginal Value Product (MVP) analysis was employed to assess the efficiency of resource use, revealing that MVP exceeded one in most cases, signifying potential opportunities for further investment in variable inputs to optimize income. The study sheds light on the intricacies of resource utilization in Kala Namak production, offering insights that can inform decision-making processes for farmers in similar agro-economic contexts. This research contributes to the existing body of knowledge on agricultural resource management and can serve as a valuable reference for policymakers, agricultural practitioners, and researchers interested in enhancing the efficiency and sustainability of Kala Namak production systems in the region.

Keywords: Resource use efficiency, Kala Namak production, MVP, Optimum income

Introduction

Kala Namak rice, a distinct variant of *Oryza sativa* L., illuminates its rising prominence due to not only its enticing aroma but also its exceptional nutritional profile. Enriched with vital micronutrients like Iron and Zinc, this rice variety is hailed for its potential in combatting diseases rooted in nutrient deficiencies, including its purported role in Alzheimer's prevention. With an impressive 11% protein content, nearly double that of common rice strains, and a low Glycemic Index ranging from 49% to 52%, Kala Namak rice emerges as a dietary boon, particularly beneficial for individuals managing diabetes. Its uniqueness lies not just in cultivation but also in the presence of Beta Carotene, a precursor to Vitamin A. Freshly harvested grains boast 0.42 mg/100 g of Beta Carotene, while one-year-old samples retain a notable value of 0.18g/100 g, albeit reduced. The ongoing investigation into the conversion rate of Beta Carotene into Vitamin A underscores the ongoing research interests in this variety (Khan, 2015; Yadav *et al.*, 2019) [12, 13].

This aromatic rice, predominantly cultivated and cherished in the North-Eastern part of Uttar Pradesh and the western and central regions of Nepal Tarai, holds a pivotal position within the agricultural landscape. Revered for its distinct fragrance, Kala Namak rice commands premium prices for farmers, distinguishing itself from other rice varieties. Acknowledging its significance, the government of Uttar Pradesh has embraced Kala Namak rice under the One District One Product (ODOP) initiative, allocating a substantial project fund of Rs. 12.00 crore to propel its promotion. The Ministry of Consumer Affairs, Food & Public Distribution reports a notable surge in Kala Namak rice production over the past three years, escalating from 4,311 MT in 2019 to an impressive 15,000 MT in 2021. This surge signifies an escalating recognition and demand for this unique rice variety.

Furthermore, its accreditation with the Geographical Indication (GI) Tag in 2012 by the Government of India solidifies its exclusivity, mandating its exclusive production within a delineated geographical region. This demarcated area spans between 26° 42′ to 27° 75′ North Latitude and 81° 42′ to 83° 88′ East Longitude in Uttar Pradesh, encompassing 11 districts within Zone 7, strategically situated in the divisions of Gorakhpur, Basti, and Devipatan. This geographical specification further underscores the regional and cultural significance of Kala Namak rice (Chaudhary *et al.*, 2012) [10].

In light of this burgeoning acclaim and importance, the objective of this study is to delve into the "Resource Use Efficiency of Kala Namak Production." This examination aims to comprehensively understand and analyze the utilization of resources in the cultivation of Kala Namak rice, recognizing its distinctive qualities and socio-economic significance within the specified geographical area.

Materials and Methods

Different techniques used and methods adopted in this study are described and the methodology of the present study has been discussed under the following heads.

1. Sampling technique.
2. Method of enquiry and collection of data.
3. Period of enquiry.
4. Methods and techniques of analysis.

Sampling Techniques

Multistage stratified purposive cum random sampling techniques has been applied for selection of respondents to deal with the investigation.

Method of Enquiry and Collection of Data

The primary data were collected through survey method with the help of personal interview of pre-structured schedule while secondary data were collected from Zila Vikas Bhawan, Zila Sankhyaki Patrika, Department of Agriculture at block and district headquarter, journal reports, books and internet etc. Gorakhpur district of Uttar Pradesh was selected was selected purposively seeing the acerage under Kala Namak rice, time & money constraints of the investigator. Two blocks namely Sehajanwa and Campierganj was selected for the study. A list of all the villages falling under selected blocks was prepared and arranged in ascending order according to area and six villages from these blocks were randomly selected for the study.

Selection of districts

Gorakhpur district was selected purposively seeing the acreage under Kala Namak rice, time and money constraints of the investigator.

Selection of blocks

A list of all 19-block falling under Gorakhpur district was prepared in ascending order according to area under Kala Namak rice and, two blocks enjoying highest acreage under Kala Namak rice was selected purposively.

Selection of villages

A separate list of all villages of selected blocks growing Kala Namak rice was prepared and 3 villages from each selected block was selected randomly.

Selection of respondents: A separate list of all respondent growing Kala Namak rice of each selected village prepared and stratified into three groups *i.e.*, Marginal (less than 1 ha), Small (1-2 ha.) and Medium (2-4 ha and above). Ultimately sample of 60 respondent was selected following proportionate random sampling technique. Finally, 60 respondents *i.e.*, 30 marginal, 17 small, 13 medium were selected for the study.

Functional analysis

Production function analysis was carried out to examine the efficiency of different resources used on the sample farms. Different types of production functions were explored, out of them only Cobb-Douglas production function was found best fit for analysis (Singh *et al.*, 2013; Asodiya *et al.*, 2014; Dhakal *et al.*, 2019) [6, 1, 2].

Mathematical form

$$Y = a\, x_1^{b1} x_2^{b2} x_3^{b3} x_4^{b4} x_5^{b5} \mu e$$

Log form of the function

$$Y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + \mu$$

Where,
Y = Dependent variable (output values Rs./ha.).
X_i = i^{th} independent variable (input values Rs./ha.).
X_1 = Human labour (Rs./ha.).
X_2 = Labour (Rs./ha.).
X_3 = Seed (Rs./ha.).
X_4 = Manure and Fertiliser (Rs./ha.).
X_5 = irrigation (Rs./ha.).
a = Constant.
b_i = Production elasticity with respect to X_i.
μ = Error term.

The values of the constant (a) and coefficient (b_i) in respect of independent variables in the function have been estimated by using the method of least squares (Gopala *et al.*, 2012) [3].

Significance test of the sample regression coefficients

Having estimated the elasticity coefficients it is desirable to ascertain the reliability of these estimated. The most commonly used 't' test was applied to ascertain whether the sample production elasticity coefficient, b_j is significantly different from zero or not at some specified probability level.

$$\text{'t' calculated} = \frac{bj}{S.E.of\ bj}$$

Where,
bj = production elasticity of Xj
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.

$$F = \frac{\text{Regression mean square}}{\text{Error mean squre}} = \frac{SSR/K}{\sum e^2/n-K-1}$$

(vi) 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 (Singh *et al.*, 2013) [6].

$$MVPxj = \frac{bi\ \bar{y}}{\bar{X}i}$$

Where,
bj = Production elasticity with respect to Xj
$\bar{y}$ = Geometric mean of y (output values in Rs./ha.)
$\bar{X}i$ = Geometric mean of Xj (input values in Rs./ha.)
j = 1, 2, 3, 4, 5

The production function analysis was used to evaluate the effectiveness of the basic inputs, including labour costs, equipment costs, seed, manure, and fertilizer, irrigation, and plant protection as explanatory variables used in the production of Kala Namak rice. In the results of the investigation Cobb-Douglas production function, was chosen as the best fit (Suresh *et al.*, 2006; Tripathi *et al.*, 2018) [8, 9].

Results and Discussion

Elasticity of production

In Table 1, for the production of Kala Namak rice by various size groups of farms, the production elasticity, standard deviation, coefficient of multiple determination (R2), and returns to scale have been calculated.

Coefficient of multiple determinations

The marginal, small, and medium size groups of farms had coefficients of multiple determinations (R^2) of 0.95, 0.88, and 0.83, respectively, indicating that all the explanatory factors human labour, machinery costs, seed, manure & fertilizer, irrigation, and plant protection contributed 91.0, 91.20, and 91.5 percent in those groups, respectively.

Significance of factor of production

Table 1. Demonstrates that, on marginal farms, the production elasticity with respect to labour was statistically significant at the 5% level of significance, showing that these input parameters significantly influenced the output. At a 5% and 1% level of significance, respectively, it was demonstrated that the elasticity of production with reference to human labour and irrigation was substantial in the case of small farms. At the 1% level of significance, it was determined that the production elasticity with respect to fertilizer, manure, and equipment expenses was considerable in the case of medium farms. It was found that the remaining production elements that contributed to the production process were statistically negligible. One would presume that these inputs could no longer be employed in the production of Kala Namak rice.

Returns to scale

Returns to scale were evaluated and estimated to be, respectively, 0.910, 0.912, and 0.915, which were all found to be below unity for marginal, small, and medium farms. Functional analysis has a diminishing return to scale nature if the returns to scale value is less than unity. It follows that each farm setting's returns will only rise by 1% if all components are increased by 1% at once.

Table 1: Production elasticity of Kala Namak rice on different size group of farms

Size Group of farms	Production Elasticity						R2
	Human Labour (X_1)	Machinery charges (X_2)	Seed (X_3)	Manure & Fertilizer (X_4)	Irrigation (X_5)	Return to Scale	
Marginal	0.1581**	0.23058	0.0433	0.1073	0.0127	0.95	0.910
	(0.096)	(0.029)	(0.024)	(0.108)	(0.012)		
Small	0.2609**	0.1023	0.0238	0.0472	0.0522*		0.912
	(0.035)	(0.039)	(0.026)	(0.048)	(0.041)	0.88	
Medium	0.2297	0.0147*	0.0138	0.0462*	0.0298		0.915
	(0.036)	(0.035)	(0.024)	(0.040)	(0.021)	0.83	

*Significant at 1% level of probability
**Significant at 5% level of probability
Where,
X_1, X_2, X_3, X_4, and X_5 stand for human labour, machinery charges, seed, manure and fertilizers and irrigation (₹), respectively

Marginal value productivity (MVP) of Kala Namak Rice

In Table 2, it is clear that the variables in marginal, small, and medium farms that were greater than unity indicated that these variables could be used in the future to increase profits, with the exception of the variable that was less than unity, which indicates that this variable was being overused in marginal farms for human labour and irrigation costs and medium farms for machinery, seed, and irrigation costs. As a result, this variable needed to be decreased for profitability to rise.

In marginal farms, the MVP for labour costs was 0.87 for humans, 5.79 for machinery, 1.77 for seeds, 3.04 for manure and fertiliser, and 0.32 for irrigation. This demonstrates that the additional costs for various inputs are equal to the respected MVP for the production of one additional quintal of Kala Namak rice.

In small farms, the MVP of manpower costs was 1.50, 2.65 for machinery, 1.01 for seed, 1.41 for manure and fertiliser, and 1.41 for irrigation. This demonstrates that the additional costs for various inputs are equal to the respected MVP for the production of one additional quintal of Kala Namak rice.

In medium farms, the MVP for labour costs was 1.40 for humans, 0.39 for machinery,
0.61 for seeds, 1.45 for manure and fertiliser, and 0.84 for irrigation. This demonstrates that the additional costs for various inputs are equal to the respected MVP for the production of one additional quintal of Kala Namak rice.

Table 2: Marginal Value Productivity (MVP) of included factors in the production process of Kala Namak rice cultivation

Size group of farms	Marginal value productivity of input/factors				
	X_1	X_2	X_3	X_4	X_5
Marginal	0.87	5.79	1.77	3.04	0.32
Small	1.50	2.65	1.01	1.41	1.41
Medium	1.40	0.39	0.61	1.45	0.84

X_1, X_2, X_3, X_4 & X_5 stands for human labour, machine charges, seed cost, manures and fertilizers cost and irrigation cost respectively

Conclusion

In conclusion, the analysis of resource use efficiency in Kala Namak rice production across marginal, small, and medium-sized farms reveals noteworthy findings. The elasticity of production for human labor is statistically significant across all farm categories, emphasizing its crucial role in the production process. Similarly, in small farms and those employing irrigation, the significance of human labor is further underscored. Moreover, for medium-sized farms, the statistical significance extends to machinery costs and manure & fertilizer inputs. The examination of returns to scale in Kala Namak rice cultivation unveils a trend of declining returns on both marginal and small farms, as well as medium-sized sample farms.

This observation highlights the need for careful consideration and optimization of resource allocation, especially in smaller farm settings, to ensure sustainable and economically viable production. The identification of significant variables, such as human labor, equipment costs, seed, manure & fertilizers, and irrigation, in explaining the overall variance in the dependent variable is crucial. The R^2 values of 0.910, 0.912, and 0.915 for marginal, small, and medium-sized farms, respectively, suggest that the independent variables considered in the study explain a substantial portion of the variation in production. This underscores the importance of these factors in influencing resource use efficiency across different farm sizes.

Overall, the findings emphasize the nuanced dynamics of resource utilization in Kala Namak rice production, with implications for optimizing agricultural practices. The indication of decreasing returns to scale further underscores the need for strategic planning and efficient resource management to enhance productivity while considering the specific characteristics of each farm size category. These insights can guide policymakers, farmers, and stakeholders in formulating targeted interventions to improve the sustainability and profitability of Kala Namak rice cultivation in the studied region.

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