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Resource Use Efficiency of Onion Production in Western Undulating Agroclimatic Zone of Odisha

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ABSTRACT: India produces onions, one of the agricultural products that is closely monitored. This crop has several personalities; it makes traders happy, farmers fear, and customer's tear. A study involving 90 onion farmers in India during the Rabi season 2022-2023 found that potash fertilizer and machine labour significantly impact onion production. However, resources like human labour, bullock labour, seed cost, and plant protection cost were underutilized. Efficient utilization of input resources like machine labour, manure, nitrogen, phosphorus, potash, and irrigation charges could improve economic management and increase profits. Major constraints included fluctuating market prices, lack of storage facilities, and high transport costs. Odisha has a comparative advantage in onion production as DRCs were 0.58 and 0.53 in Kalahandi and Nuapada respectively.

Keywords: Resource use efficiency, Onion, Comparative advantage, Profitability.

INTRODUCTION

India produces onions, one of the agricultural products that is closely monitored. This crop has several personalities; it makes traders happy, farmers fear, and customer's tear. Over 500 onion species exist in the northern hemisphere, with the USSR having the most varieties (Wright, 1992). Onions have higher dietary value, intermediate protein content, and high calcium and riboflavin content (Purse glove *et al*., 2000). They are grown on 5.4 million hectares globally and produce 104.5 million tons per year (FAO, 2020). India leads in onion output with 26.7 MT (FAO, 2020), but its productivity is lower than its peers. India's daily diet heavily consists of onions (Premi & Premi 2017). India is the third-largest exporter of onions, after Spain and the Netherlands. The country leads the world in onion cultivation and produces 21.0% of the crop (Horticulture Statistics, 2021). Onions are used in Indian daily meals, as a spice, and are also used as medicine (Bose and Som, 1990). In 2022-2023, India exported 2,525,258.35 MT of fresh onions, valued at Rs. 4,522.79 crores (Horticulture Statistics, 2021). Research on onion adoption practices (Anik, and Salam, 2015), economic assessments, technical efficiency margin (Mahmood, 1995; Shaha, 1999; Hasan, 2010; Haque *et al.*, 2011; Miah and Rashid 2015; Bapari *et al.*, 2016; Grema and Gashua, 2014), measurement of technical efficiency (Baree, 2012; Haile, 2015; Mari and Lohano 2007; Banai *et al*., 2013), and production and marketing constraints (Ali *et al*., 2015) has been limited. This study evaluates the comparative advantage, financial profitability, and economic profitability of onion production in India, examining issues and potential for further development. Manures, cakes, irrigation charges, and plant protection chemicals significantly impact gross income. Training farmers on pest and disease-resistant varieties can reduce costs. Creating awareness about efficient resource utilization can improve yield realization (Kantariya *et al*., 2018). The findings will help policymakers and researchers make appropriate policies and suggestions for onion production in India.

Rationale of the study. The marketing of vegetables is complex due to their perishability, fragility, seasonality, and bulkiness. Implementing measures like improved pre- and post-harvest technology and water and pest control practices can increase crop productivity, quality, and area cover. Onion prices fluctuate due to seasonal supply and inelastic demand, leading to uncertainty in consumer prices and grower income. Policy makers in India are concerned about the low share of producers in consumer rupees. Economic analysis of onion production, including profitability, gross margin (Mahmood, 1995; Shaha, 1999; Pajankar *et al.*, 2000, Hasan, 2010; Haque *et al*., 2011; Miah and Rashid, 2015; Bapari *et al.*, 2016; Grema and Gashua 2014, Meena *et al.*, 2020), technical efficiency (Baree, 2012; Haile, 2015; Mari and Lohano 2007; Banai *et al.*, 2013) and production and marketing constraints, is essential for stabilization schemes (Ali *et al.*, 2015). Therefore, the above study was undertaken in the western undulating agroclimatic zone of Odisha, India with the following objectives.

Objectives

1. To estimate the marginal value product of farm inputs and to examine the resource use efficiency on farms of different sizes.

METHODOLOGY

Primary and secondary data sources were used in this study, depending on the goals of the investigation. The districts of Kalahandi and Nuapada were specifically chosen because, like other parts of Odisha, a significant portion of its farmers cultivate onions during the winter. In addition, the soil, climate, and surroundings are favourable to produce onions. The multi-stage random sampling technique will be adopted in the study. Ninety farmers in all, 65 from the districts of Kalahandi and 25from the districts of Nuapada, were chosen at random and conducted in-person interviews. Using a structured questionnaire covering the crop calendar for 2021, the relevant data regarding inputs and outputs on onion production was collected. Tabular analysis, log-linear multiple regression analysis, frequency and percentage method were used to analyze the data in the present study.

Functional Analysis. The resources productivity and resources use efficiency are to be analyzed by application of functional analysis. In functional analysis, Cobb-Douglas (power production function) production function will be used. Cobb-Douglas production function (non-linear) is used to determine the resources productivity and resources use efficiency of onion production. The data are, therefore, subjected to functional analysis by using the following form of equation:

$$Y = aX_1^{b_1} \times X_2^{b_2} \times X_3^{b_3} \times \ldots \times X_n^{b_n} \times e^u$$

This function can easily be transformed into a linear form by making logarithmic transformation, after logarithmic transformation this function is:

$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + \ldots + b_n \ln X_n + \ln e$

Where

ln = Natural logarithm

a = constant

Y = Onion output (kg)

X_1 = Family labour (mandays)

X_2 = Hired labour (mandays)

X_3 = Bullock labour (pair days)

X_4 = Quantity of seeds (kg)

X_4 = Quantity of seeds (kg)

X_5 = Manure used (quintals)

X_6 = Cost of fertilizer (Rs.)

X_7 = Machine labour (hours)

X_8 = Cost of plant protection (Rs.)

b_1 to b_8 = Regression co-efficient of respective variables

c = Random term with zero mean and constant variance

Resource use efficiency is determined by the ratio of marginal value products (MVP) of resources to their factors cost. MVPs higher than opportunity or market cost indicate potential for increased resource use, while those below indicates non-profitable use. The most efficient factor is identified by MC = MR. The marginal value product (MVPs) of individual resources was estimated and compared with the marginal cost (MC), indicating the gross value of farm production for each unit increase. The MVPs of various inputs is worked out by the following formula:

$$MVP = b_i \frac{Y}{X} P_y$$

Where,

b_i = Partial regression co-efficient of independent variable

$\bar{X}$ = Geometric mean of independent variable (input)

$\bar{Y}$ = Geometric mean of dependent variable (output)

P_y = Price of dependent variable

Return of scale. It refers to the summation of b_i values, return of scale = Σb_i

If, $\Sigma b_i = 1$ *i.e.* Constant return to scale

$\Sigma b_i = < 1$ *i.e.* Decreasing return to scale

$\Sigma b_i = > 1$ *i.e.* Increasing return to scale

RESULTS AND DISCUSSION

The onion cultivation production function is estimated in terms of yield elasticities, standard errors of regression coefficients, significance, and coefficients of multiple determination (R2). It reveals the anticipated effects of changes in resource usage on production. Ten inputs, including human labour, bullock labour, machine labour, seed cost, manures, nitrogen, phosphorus, potassium, irrigation, and plant protection, are essential for agricultural productivity. The Cobb-Douglas type of production function is presented in Table 1.

Table 1: Results of Cobb-Douglas type of production function of Onion growers.

Sr. No.	Particulars	Kalahandi		Nuapada		Overall	
		Calculated (N=65)	*p-Value*	Calculated (N=25)	*p-Value*	Calculated (N=90)	*p-Value*
1.	Constant (a)	2.9326	0.678	22.25402	0.032	3.9188	0.24
2.	Human labour (X1)	-0.1923	0.259	-0.11404 NS	0.288	-0.0309 NS	0.64
3.	Bullock labour (X2)	0.1542 NS	0.250	-0.18364	0.271	0.0928	0.37
4.	Machine Labour (X3)	0.0502 NS	0.261	-0.04013 NS	0.753	0.0581*	0.10
5.	Seed Cost (X4)	0.0583 NS	0.556	-0.20978 NS	0.274	0.0587 NS	0.48
6.	Manure (X5)	-0.0548 NS	0.844	-0.08490 NS	0.717	-0.0262 NS	0.88
7.	Nitrogen(X6)	0.5701 NS	0.427	0.23289	0.736	0.2712 NS	0.55
8.	Phosphorus (X7)	0.0453 NS	0.810	-0.59434***	0.010	-0.0110 NS	0.93
9.	Potash (X8)	0.1293 NS	0.482	0.57528**	0.050	0.2629**	0.05
10.	Irrigation charges (X9)	-0.1454 NS	0.358	0.05351 NS	0.713	-0.0856 NS	0.38
11.	Plant protection (X10)	0.5432 NS	0.229	-0.78612	0.179	0.3930 NS	0.24
12.	R^2	0.2789		0.6422		0.3427	
13.	Observation	65		25		90	
14.	D.F.	64		24		89	

(Figures in parentheses are standard errors of respective regression coefficients) *, ** and *** indicates significance level at 10, 5 and 1per cent level, respectively NS = non-significant

The study found that variables in the Cobb-Douglas type of production function explained 28% of onion production variation in Kalahandi and 64% in Nuapada. The elasticity coefficients for bullock labour, machine labour, seed cost, nitrogen, phosphorus, potash, and plant protection were positive but non-significant. Human labour, manure, phosphorus, and irrigation charges were negative but non-significant. The total production elasticity was 0.89, indicating diminishing returns to scale. The elasticity coefficients for bullock labour, machine labour, seed cost, nitrogen, potash, and plant protection were positive but non-significant. The onion yield varied by 34.3% due to input parameters.

Table 2: ANOVA (Overall) Cobb-Douglas type of production function of Onion growers.

ANOVA (OVERALL)					
	df	*SS*	*MS*	*F*	*F tab*
Regression	10	0.1282	0.0128	4.1196	1.95
Residual	79	0.2459	0.0031		
Total	89	0.3741			

The ANOVA table was calculated through proper analysis and showed whether the model was significant or not. At each model there were the different predictors for different models. Here the ANOVA table showed that each of the models was highly significant at 5% level of significance (Table 2).

In Table 3, revealed that the MVP/MC ratio analysis of onion production on sample farms revealed underutilization of resources like human labour, bullock labour, seed cost, and plant protection. Machine labour, manure, nitrogen, phosphorus, potash, and irrigation charges were underutilized. Increasing human, bullock, seed, and plant protection could maximize onion production profitability. The study supports Karthick *et al.* (2015) findings that plant protection chemicals' elasticity was significant in onion cultivation in Tamil Nadu, while Kantariya *et al*. (2018) found that variables like manures, cakes, irrigation charges, and chemicals significantly influenced gross income. The sum of the elasticities was less than one indicating diminishing returns to scale

Table 3: Resource Use Efficiencies of Onion Production In Kalahandi District.

Sr. No.	Particulars	bi Value	MVP	MC	MVP/ MC
1.	Human labour (X1)	0.000129	0.015	20670.42	7.2500*
2.	Bullock labour (X2)	0.002401	0.288	5024.97	5.7300*
3.	Machine Labour(X3)	0.002865	0.344	2040.10	0.0002***
4.	Seed Cost (X4)	0.00033	0.04	13210.12	3.0270*
5.	Manure (X5)	0.003456	0.415	2668.82	0.0002***
6.	Nitrogen(X6)	0.019855	2.385	1352.49	0.0018***
7.	Phosphorus (X7)	-0.00401	-0.481	1448.50	-0.0003***
8.	Potash (X8)	0.008493	1.02	1484.30	0.0007***
9.	Irrigation charges (X9)	-1.50E-05	-0.002	9227.61	-2.1674***
10.	Plant protection (X10)	0.004554	0.547	6351.50	8.6121*

*MVP/MFC > 1: underutilization of resources
**MVP/MFC = 1: optimal use of resources
***MVP/MFC < 1: over utilization of resources.

CONCLUSIONS

The functional analysis reveals that potash fertilizer and machine labour significantly impact onion crop production. However, resources like human labour, bullock labour, seed cost, and plant protection cost are underutilized, requiring increased input for better profitability. Overutilized inputs like machine labour, manure, nitrogen, phosphorus, potash, and irrigation charges are overutilized. Major constraints include fluctuating market prices, lack of storage facilities, high transport costs, and unavailability of market knowledge.

Policy Recommendation. The study suggests that government procurement agencies should focus on direct procurement from farmers, reducing middlemen and increasing profitability. Extension agencies and NGOs should raise technical knowledge and resource efficiency among farmers, especially those with less than 1 ha landholdings, to promote modern techniques like intercropping onion with sugarcane.

FUTURE SCOPE

— **Favourable Crop Diversification:** Onion fits well as a short-duration crop in cropping systems with rice, pulses, and vegetables. Suitable for both rabi (post-rice harvest with irrigation) and kharif (rainfed, less preferred due to humidity-related diseases).

— **Market Demand:** Odisha is a net importer of onions, especially during off-seasons. Local production can reduce dependence on onions from Maharashtra, Karnataka, and Andhra Pradesh.

— **Employment and Income Potential:** Onion cultivation has a high labour absorption rate, supporting rural employment. Provides better price realization compared to many other traditional crops in the region.

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Conflict of Interest. None.

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