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Shubhi Singh
Ph.D., Research Scholar, Department of Agricultural Economics, Indira Gandhi Krishi Vishwavidyalaya University, Raipur, Chhattisgarh, India

Dr. Ajay Kumar Gauraha
Professor and Head, Department of Agribusiness Management and Rural Development, Indira Gandhi Krishi Vishwavidyalaya University, Raipur, Chhattisgarh, India

Dr. Vijay Kumar Chaudhary
Professor and Head, Department of Agricultural Economics, Indira Gandhi Krishi Vishwavidyalaya University, Raipur, Chhattisgarh, India

Dr. Hulas Pathak
Professor, Department of Agribusiness Management and Rural Development, Indira Gandhi Krishi Vishwavidyalaya University, Raipur, Chhattisgarh, India

1.

Corresponding Author:
Shubhi Singh
Ph.D., Research Scholar, Department of Agricultural Economics, Indira Gandhi Krishi Vishwavidyalaya University, Raipur, Chhattisgarh, India

Assessing resource use efficiency of paddy crop in tribal and non-tribal farm households: A case study of Chhattisgarh

Shubhi Singh, Dr. Ajay Kumar Gauraha, Dr. Vijay Kumar Chaudhary and Dr. Hulas Pathak

Abstract
Efficient resource use is crucial for sustainable and productive agricultural systems. This study aims to assess the resource use efficiency of paddy crops grown by both tribal and non-tribal farm households in Pathalgaon, Jashpur District of Chhattisgarh, India. The study employed a multistage random sampling technique to select the district, block, villages, and farm households. Primary data were collected through farm-level surveys, and secondary data were collected from published sources of various government and non- government organizations. The Cobb-Douglas production function was used to estimate resource use efficiency by analysing the efficiency of seed, human labour, machine, fertilizers, and plant protection used in the production of paddy. The level of resource use efficiency was calculated using the ratio of the marginal value product to the marginal factor cost. The findings indicate that there is a disparity in the resource use efficiency of paddy crops between tribal and non-tribal farm households. Non-tribal farm households have higher efficiency in seed, human labour, and machine use, while tribal farm households have higher efficiency in fertilizer and plant protection use. The study provides important implications for sustainable agriculture and rural development policies and practices in regions where both tribal and non-tribal farm households engage in agricultural practices.

Keywords: Resource use efficiency, tribes, non tribes, cobb Douglas production function, and regression coefficient

Introduction
Resource use efficiency is a critical factor in agricultural productivity and sustainability. Understanding the efficiency with which crops utilize resources can help farmers and policymakers make informed decisions about crop selection and management practices. In this study, we aim to assess the resource use efficiency of paddy crop grown by both tribes and non tribes in a particular region, by comparing the resource use efficiency of these crop across different communities, we hope to identify potential areas for improvement and inform policies and practices that can lead to more sustainable and productive agricultural systems. Specifically, we will analyse the efficiency of seed, human labour, machine, fertilizers and plant protection use in the production of paddy. The findings of this study will have important implications for sustainable agriculture and rural development, particularly in regions where tribes and non tribes both engage in agricultural practices the state of Chhattisgarh is largely rural, with a high dependence on agriculture for livelihoods, that's why pathhalgaon of jashpur district of Chhattisgarh selected for the study with an objective of assess the resource use efficiency of paddy with comparison study of tribal and nontribal farm household.

Material and Methods
The selection of sample was undertaken by multistage random sampling for this study.

Sampling Design
The selection of the sample was undertaken by multistage random sampling for this study. The sampling design involved the selection of the district, block, villages, and farm households. Jashpur district was selected for the present study, as it had both the tribe and non-tribe population. Pathalgaon block was selected proportionately to conduct this study, due to the higher population of this block among all eight blocks. The study was based on both primary as well as secondary data.

Primary data were collected through farm-level surveys, and secondary data were collected from published sources of various government and non-government organizations. The data was collected through well-prepared schedules and questionnaires to fulfill the requirements of different objectives of the study.

Analytical frame work

Estimation of Resource Use Efficiency

We used Cobb-Douglas production function to assess resource use efficiency following the methods mentioned by Rahman and Lawal (2003) [11].

Y= ax1b1. x2b2. x3b3.x4b4.x5b5.

Where,

Y = Total return from paddy production in Rupees (Rs.)

X1 = Total cost of seed used in paddy production in Rupees (Rs.) X2 = Total cost of manure used in Rupees (Rs.)

X3 = Total cost of Human labour used in Rupees (Rs.) X4 = Total cost of Machine used in Rupees (Rs.)

X5 = Total cost of Plant Protection used in paddy field in Rupees (Rs.) a= Intercept b1, b2 …..b5 are the regression coefficients to be estimated. Both dependent and explanatory variables were transformed to natural logarithm. The above equation was transformed to linear form for ease in computation.

The level of resource use efficiency was calculated using following formula: r =MVP/MFC

Where,

r = Efficiency ratio

MVP = Marginal Value Product; which is the value of incremental unit of output resulting from the additional unit of inputs.

MFC = Marginal Factor Cost which is equal to one since both dependent and explanatory variables are converted to monetary value; and is defined as the increase in the cost of inputs due to purchase of additional unit of inputs.

Now,

$$MVP = bi * \bar{Y}_i / \bar{X}_i$$

Where,

bi = Estimated regression coefficient of input Xi

$\bar{Y}_i$= Geometric mean value of output.

$\bar{X}$ i= Geometric mean value of ith resources used

Decision rule:

r= 1; Efficient use of resource r>1; Underused of the resource r<1; Overused of the resource

Finally, the relative percentage change in MVP was calculated using following way: D= (1-MFC/MVP) × 100

Or, D= (1-1/r) × 100

Where, D= absolute value of percentage change in MVP of each resource (Mijindadi1980).

Result and Discussion

Table 1: Production Function Analysis for Estimation of Resource Use Efficiency for paddy with disparity between tribal and nontribal farm household

S. No.	Particulars	Parameters	Tribal			Non-Tribal		
			Regression Coefficient	Standard Error	P-Value	Regression Coefficient	Standard Error	P-Value
1	Intercept	A	-4.93267	3.444975	0.154417	4.07156***	1.5315549	0.009078
2	LOG (Seed)	X1	1.120574***	0.274452	7.44E-05	0.259984**	0.1237465	0.038039
3	LOG (Human Labour)	X2	0.071538**	0.037073	0.055675	0.06553**	0.0320619	0.043452
4	LOG (Machine)	X3	0.077986	0.151461	0.607438	-0.10147***	0.0259997	0.000168
5	LOG (Fertilizers)	X4	0.096152	0.136985	0.483895	-0.0505823	0.0803152	0.530195
6	LOG (Plant Protection)	X5	-0.27143***	0.081315	0.001081	-0.1875264**	0.080228	0.021314
7	R square	R^2	0.876433			0.02131445		
8	Return to Scale (Sum of bi)	$\sum bi$	-3.83785			4.05749753		

*** 1% significance level,

**5% significance level

Table 1 presents the results of a multiple regression analysis that explores the impact of different factors on agricultural productivity in tribal and non-tribal areas. The table includes six variables (X1 to X5), along with their regression coefficients, standard errors, and P-values for both tribal and non-tribal areas. The intercept (A) is also included for each group.

The variables under consideration include the logarithm of seed used (X1), human labour (X2), machine use (X3), fertilizers (X4), and plant protection (X5). The results indicate that the logarithm of seed used (X1) has a positive and significant impact on agricultural productivity in both tribal and non-tribal areas. The impact of human labour (X2) is also positive but not significant in either group.

Machine use (X3) has a significant negative impact on agricultural productivity in non- tribal areas, while it is not significant in tribal areas. Fertilizers (X4) have a positive impact on productivity in tribal areas but not in non-tribal areas. Plant protection (X5) has a negative impact on productivity in both tribal and non-tribal areas, and this effect is significant in both groups.

The R-square value of the model is 0.876 for tribal areas and 0.021 for non-tribal areas, indicating that the model explains a high proportion of the variance in productivity for tribal areas but not for non-tribal areas. The sum of the regression coefficients (∑ bi) is negative for tribal areas and positive for non-tribal areas, indicating that returns to scale are decreasing in tribal areas and increasing in non-tribal areas.

Resource use efficiency for paddy

Table 2: Resource use efficiency of paddy with disparity of tribal and nontribal

S. No.	Variables	Tribal					Non-tribal				
		MVP	MFC	R	Remark	D Value	MVP	MFC	r	Remark	D Value
1	Seed	0.0143	1	0.0143	Over utilised	6888.5	0.003904	1	0.003904	Over utilised	-25516.3
2	Human Labour	0.001557	1	0.001557	Over utilised	64126.1848	0.201251	1	0.201251	Over utilised	-396.893
3	Machine	NS	-	NS	-	-	-0.05796	1	-0.05796	Over utilised	1825.293
4	Fertilizers	NS	-	NS	-	-	NS	-	NS	-	-
5	Plant Protection	0.001988	1	0.0019886	Over utilised	50385.6326	0.043965	1	0.043965	Over utilised	2374.5206

(MVP-Marginal Value Product, MFC-Marginal Fixed Cost, r = MVP/MFC, NS= Non Significant)

The table 2 shows the marginal value product (MVP) and marginal fixed cost (MFC) of five inputs: seed, human labour, machine, fertilizers, and plant protection. The data is split into two groups: tribal and non-tribal.

The MVP is the additional output produced by a one-unit increase in an input, holding all other inputs constant. The MFC is the additional cost incurred by a one-unit increase in an input, holding all other inputs constant.

The MVP/MFC ratio is the ratio of the MVP to the MFC. A ratio greater than 1 indicates that the input is underutilized, while a ratio less than 1 indicates that the input is over utilized.

The D value is the difference between the MVP and the MFC. A positive D value indicates that the input is profitable, while a negative D value indicates that the input is not profitable.

The table shows the MVP, MFC, and MVP/MFC ratio (r) for different variables in both tribal and non-tribal areas. The D value is also provided to indicate the level of efficiency of the resources.

For the seed variable, the MVP is higher than MFC, indicating overutilization of this resource in both tribal and non-tribal areas. The MVP/MFC ratio is 0.0143 for tribal and 0.003904 for non-tribal areas, suggesting that the resource is highly over utilized in tribal areas compared to non-tribal areas. The D value for the seed variable is negative in both areas, indicating inefficiency in the use of this resource.

For the human labour variable, the MVP is higher than MFC in both tribal and non-tribal areas, indicating overutilization. The MVP/MFC ratio is 0.001557 for tribal and 0.201251 for non-tribal areas, suggesting that the resource is highly over utilized in non-tribal areas compared to tribal areas. The D value for the human labour variable is negative in both areas, indicating inefficiency in the use of this resource.

Machine, fertilizers, and plant protection variables have NS (Not Specified) for the MVP, MFC, and MVP/MFC ratio values in tribal areas. This could be due to the low usage of these resources in tribal areas or lack of data. In non-tribal areas, the machine variable is over utilized with an MVP/MFC ratio of -0.05796, whereas fertilizers and plant protection variables are over utilized with an MVP/MFC ratio of 1 and 0.04396531, respectively. The D value for machine, fertilizers, and plant protection variables is positive in non-tribal areas, indicating inefficient use of these resources.

Overall, the analysis suggests that there is a need to improve the resource use efficiency in both tribal and non-tribal areas. The overutilization of some resources and underutilization of others indicate the need for optimal allocation of resources to improve the economic returns from agriculture. The D values suggest that there is potential for improvement in the use of resources, which could be achieved through better technical knowledge and training of farmers and appropriate policies and interventions. The findings of this study suggest that inputs are important for increasing crop yield. The results also suggest that both tribal and non-tribal farmers can benefit from increasing the use of these inputs. Future research should be conducted to further investigate the relationship between crop yield and these factors.

Summary and Conclusion

Multiple Regression Analysis

- Positive and significant impact of logarithm of seed used (X1) on agricultural productivity in both tribal and non-tribal areas.
- Positive impact of human labour (X2) on agricultural productivity, but not significant in either group.
- Negative impact of machine use (X3) on agricultural productivity in non-tribal areas, but not significant in tribal areas.
- Positive impact of fertilizers (X4) on productivity in tribal areas but not in non-tribal areas.
- Negative impact of plant protection (X5) on productivity in both tribal and non-tribal areas, and this effect is significant in both groups.
- R-square value of the model is 0.876 for tribal areas and 0.021 for non-tribal areas, indicating that the model explains a high proportion of the variance in productivity for tribal areas but not for non-tribal areas.
- The sum of the regression coefficients (∑ bi) is negative for tribal areas and positive for non-tribal areas, indicating that returns to scale are decreasing in tribal areas and increasing in non-tribal areas.

Resource Use Efficiency for Paddy

- Overutilization of seed and human labour resources in both tribal and non-tribal areas.
- Lack of data for machine, fertilizers, and plant protection variables in tribal areas.
- Overutilization of machine in non-tribal areas, and fertilizers and plant protection variables are over utilized with positive D values, indicating inefficient use of these resources.
- Need for improving resource use efficiency in both tribal and non-tribal areas to optimize allocation and improve

economic returns from agriculture.

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