Economic Affairs, Vol. 68, No. 01, pp. 455-461, March 2023
DOI: 10.46852/0424-2513.1.2023.14

AESSRA

Research Paper

Resources Use Efficiency in *Sali* (Winter) Rice Cultivation in Upper Brahmaputra Valley Zone of Assam- A Comparative Study of Mechanised and Non-mechanised Farm

Horindra Gogoi[1]*, R.A. Halim[1], Trishnalee Saikia[2], Nivedita Deka[1] and Soibam Peter Singh[3]

[1]Department of Agricultural Economics and Farm Management, Assam Agricultural University, Jorhat, India
[2]Krishi Vigyan Kendra, Assam Agricultural University, Jorhat (Teok), Assam, India
[3]Krishi Vigyan Kendra, Anjaw, Arunachal Pradesh, India

*Corresponding author: horindra.gogoi@aau.ac.in (**ORCID ID:** 0009-0008-7904-3623)

Received: 15-12-2022 **Revised:** 22-02-2023 **Accepted:** 01-03-2023

ABSTRACT

The present study was conducted in Upper Brahmaputra Valley Zone of Assam, India in January, 2020 to study resource use efficiency in *Sali* rice cultivation in mechanised and non-mechanised farms. A sample of 120 farmers was selected randomly from two Agricultural Development Officer Circle (ADO Circle) each comprising of 5 villages. Results revealed that human labour and seed were used comparatively in lesser quantities in mechanised farms than the non-mechanised farms, while manures and fertilizers were applied in higher quantities in mechanised farms than the non-mechanised farms. Coefficient of fertilizer was significant in both mechanised and non mechanised farms. On the other hand, coefficients of elasticity of seed and machine labour were positively significant in mechanised farms, while FYM was observed to be positively significant in non-mechanised farms. Human labour was found to be negatively significant in non-mechanised farms. In mechanised farms, the ratio of Marginal Value Product (MVP) to Marginal Factor Cost (MFC) was highest for machine labour (1.85) followed by seed (1.59) and fertilizers (1.52). The coefficients of the production function were estimated to be positively significant for seed, fertilizers and machine labour used, while the allocative efficiency ratios revealed that an additional expenditure of one rupee on these inputs would increase the gross returns by ₹ 1.59, ₹ 1.52 and ₹ 1.85 respectively. In case of non-mechanised farms, the ratio of MVP to MFC for area, seed, plant protection chemicals, human labour and bullock labour were found to be less than unity.

HIGHLIGHTS

- In mechanised farms, the utilization of human labour and seed was comparatively less than the non-mechanised farms, while more quantities of manures and fertilizers was utilized in mechanised farms as compared to the non-mechanised farms.
- The MVP to MFC ratio in mechanised farm was greater than unity for human labour, seed and fertilizer indicating that an additional expenditure of one rupee on those inputs would increase the gross returns by ₹ 1.59, ₹ 1.52 and ₹ 1.85 respectively.
- The non-mechanised farms depicted the over utilization of the area, seed, plant protection chemicals, human labour and bullock labour as indicated by the ratio of MVP to MFC less than unity.

Keywords: Resource use efficiency, *sali* rice cultivation, resource utilisation

How to cite this article: Gogoi, H., Halim, R.A., Saikia, T., Deka, N. and Singh, S.P. (2023). Resources Use Efficiency in Sali (Winter) Rice Cultivation in Upper Brahmaputra Valley Zone of Assam- A Comparative Study of Mechanised and Non-mechanised Farm. *Econ. Aff.*, **68**(01): 455-461.

Source of Support: None; **Conflict of Interest:** None

India's agricultural policy during last few decades emphasized primarily on enhancement of agricultural production, productivity and improving food and nutritional security of the country which has made India self-sufficient. Agriculture and allied activities have continued to remain as the main livelihood option for more than half of the India's population. Productivity of crops and other enterprises is one of the most important factors that can improve the farmers' income as well as the economy of the country. Paddy in *kharif* and wheat in *rabi* have been the most important crops covering about 38% of gross cropped area in the country (Sarma *et al.* 2017). The share of agriculture in gross domestic product (GDP) has increased to 19.90 per cent during 2020-21 (Economic Survey, 2021-22) which has been possible due to mechanisation of farm sector. Agricultural mechanisation stimulates the adoption of modern technologies like high yielding varieties (HYV) seeds, chemical inputs and scientific practices/ methods in crop cultivation as evidenced from green revolution. Farm mechanisation economically contributes to farmers by saving inputs like seeds and fertilizers up to 15–20% and human labour requirement and operational time by 20–30%, while it increases cropping intensity by 5–20% and productivity by 10–15% (Tiwari *et al.* 2019, Singh and Sahni, 2019; Roy and Bezbaruah, 2002). The sole purposes of mechanisation of agricultural operations are mostly to produce more output per unit of land, to complement other inputs use, achieve higher productivity (Sidhu and Grewal, 1990). Though, the farm mechanization in India (40–45%) is lower in comparison to developed countries, the availability of farm power has increased from 0.28 KW ha^{-1} in 1960-61 to 2.10 KW ha^{-1} in 2013-14 and expected to increase to 5.17 KW ha^{-1} by 2032–33 (Tiwari *et al.* 2019).

Efficiency of resource use refers to relative performance of transferring given inputs into outputs in a production process. Efficiency studies help in understanding the current performance and opportunities to improve the production performance of the crops under consideration. The productivity of crops can be increased without raising the input application, by adopting corrective measures to mitigate the reasons for the low efficiency (Suresh and Reddy, 2006, Ali and Choudhury, 1991, Umesh and Bisalaiah, 1991) and this will help in achieving higher productivity in long-term. Cobb-Douglas type of production function is used for studying the relationship between output and input variables to estimate production elasticities, because of its wide acceptability, theoretical fitness to agricultural data and simple in calculation (Devi and Singh, 2014; Ahmed *et al.* 2018).

Rice is the staple crop in the state of Assam. Rice production in the state increased from 4.73 mt in 2017 to 5.1 mt in 2020, growing at an annual average rate of 2.73%. The total farm power availability on Indian farm has increased at a compound annual growth rate (CGAR) of 4,58% to 1,841 KW /ha during the last 41 years, while the state Assam has achieved farm power availability of 0.97 KW /ha during the same period (https://diragri.assam.gov.in, 2023). Though the level of farm mechanization in Assam has been categorized into low to medium, and still below the national average, yet the increased rice production in the state can be achieved by improving the productivity of the crop through adoption of agricultural mechanisation and high yielding technologies as well as efficient utilisation of resources. However, no in-depth study was observed on resource use efficiency of rice crop production due to farm mechanization. Thus, the present study was under taken with the objectives viz., to examine resource utilisation pattern in *Sali* rice cultivation in mechanised and non-mechanised farms in Upper Brahmaputra Valley Zone (UBVZ) of Assam; to identify the factors affecting the *Sali* rice cultivation in mechanised and non-mechanised farms; and to study resources use efficiency in *Sali* rice cultivation in mechanised and non-mechanised farms.

METHODOLOGY

Study area and sampling

The study was carried out in Upper Brahmaputra Valley Zone (UBVZ), Assam, India during the year 2020 (January). The primary data were collected from 120 sample farmers both comprising of mechanised and non–mechanised farms (bullock operated) by adopting multistage stratified random sampling method from 2 Agricultural Development Officer Circle (ADO Circle) each comprising of 5 villages. The relevant data were collected

by personal interview method with the help of specially designed and pretested schedules and pertains to the year 2019–2020. Descriptive statistics like simple averages, percentages and averages were used to draw the inferences of the results in the present study.

ANALYTICAL TOOLS

Analysis of Resource Use Efficiency

The Cobb-Douglas production function was used to estimate the resource use efficiency in *Sali* rice production in mechanised as well as non mechanised farms under study, as it has advantages over other production functions in the sense that the input coefficients of Cobb-Douglas production function constitute the respective elasticity. The Cobb-Douglas production function used in the analysis of the current study was of the following form,

$$Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} X_7^{b_7} X_8^{b_8} \quad \ldots(1)$$

The linear logarithmic form of the Cobb-Douglas function can be expressed as in,

$$\ln Y = (\ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8) \quad \ldots(2)$$

X_1, X_2, X_3, X_4, X_5, X_6, X_7 and X_8 are all parameters affecting the level of Y.

b_1, b_2, b_3, b_4, b_5, b_6, b_7 and b_8 are coefficients of elasticity.

'a' Constant term

In the above equation;

Y = Total returns from cultivation of crops (₹)

X_1 = Area under crop cultivation (ha)

X_2 = Value of seed (₹)

X_3 = Value of FYM (₹)

X_4 = Value of fertilizers (₹)

X_5 = Value of pesticide (₹)

X_6 = Value of irrigation (₹)

X_7 = Cost on Human labour (₹)

X_8 = Cost on Machine labour (₹) (for mechanised farms) and

Bullock labour (₹) (for non-mechanised farms)

For efficient resource(s) use in crop(s) production, marginal value product (MVP) must be equal to the marginal factor cost (MFC). The resources are said to be efficiently used (allocative efficiency), if its MVP is equal to its acquisition unit price. It was calculated by using the formula as shown below (Suleiman and Ibrahim, 2014, Suresh and Reddy, 2006).

$$AE = \frac{MVP}{MFC} \quad \ldots(3)$$

where, AE = allocative efficiency

MVP = Marginal value product

MFC = Marginal factor cost,

If, AE = 1, it indicates efficient use of resource.

AE < 1, it indicates particular resource is over utilised, i.e., the profit level can be increased by decreasing the quantity of particular input used.

AE > 1, it indicates particular resource is being under utilised, i.e., the profit level can be increased by increasing the quantity /rate input particular used.

In Cobb-Douglas production, marginal value product (MVP) of X_i, the i^{th} input factor is given by the following formula;

$$MVP \text{ of } X_i = MPP_i \times P_y \quad \ldots(4)$$

MPP_i = Marginal physical product of the i^{th} input

P_y = Price of output

$$MPP_i = b_i(Y/X_i) \quad \ldots(5)$$

Where, b_i = Elasticity coefficients of the i^{th} independent variable or production elasticity X_i

Y = Geometric mean of the output, and

X_i = Geometric mean of the i^{th} input

RESULTS AND DISCUSSION

Resource Utilisation Pattern in *Sali* Rice Cultivation in Mechanised and Non-mechanised Farms in Upper Brahmaputra Valley Zone (UBVZ) of Assam

Information on per hectare resource utilization in *Sali* rice cultivation both in mechanised and non

mechanised farms in Upper Brahmaputra Valley Zones (UBVZ) (Table 1) reveals that comparatively more human labour was utilised in non–mechanised farms (117.23 mandays) than the mechanized farms (86.20 mandays). The reduction in labour use in case of Tractor Operated Farm than bullock operated farms was also observed by Sidhu and Grewal (1990). The bullock labour utilization in case of mechanised farm was not found, while in non-mechanised farm it was found to be 30.23 bullock pair days. On the other hand, the machine power utilization in mechanised farm was estimated to be 15.27 h. This result was in consistence with findings of Verma and Tripathi (2015) who reported that mechanization displaced animal power to the extent of 50–100%. Seed was found to be utilized comparatively in less quantity in mechanized farm (41.84 kg ha^{-1}) than the non-mechanised farms (57.90 kg ha^{-1}). Similarly, manure and fertilizers were utilized in higher quantity in mechanised farms accounting to 208 kg ha^{-1} and 47.44 kg ha^{-1}, respectively, as against 145 kg and 19.92 kg respectively in non-mechanised farms. The table also shows that the mechanised paddy farmers used 60.54 L fuel (diesel) per hectare. Of course plant protection chemicals were found to not be utilised by both mechanised and non-mechanised farm in paddy cultivation.

Factors Affecting the *Sali* Rice Cultivation in Mechanized and Non-mechanized Farms in Upper Brahmaputra Valley Zone in Assam

The results of Cobb Douglas production function (Table 2) fitted for crop production in mechanised and

Table 1: Resource Use in *Sali* rice Cultivation in Mechanized Farms and Non–mechanised Farms in Upper Brahmaputra Valley Zone of Assam (per hectare)

Sl. No.	Particulars	Mechanised Farm	Non-mechanised Farm	Increase /decrease over non-mechanised farm
1	Human Labour (Man days)	85.13	117.23	-32.10(-27.38%)
	Bullock Labour (BPD)	—	30.23	—
2	Machine labour(hr)	15.27	—	—
3	Seed (kg)	41.84	57.90	-16.06 (-27.74%)
4	Manure (kg)	208	145	63 (43.45%)
5	Total Fertilizers (Kg)	47.44	19.92	27.52(138.15%)
6	Fuel (Diesel) (L)	60.54	—	—

Figures within brackets indicate percentage over non-mechanised farm and (+) and (-) signs indicate the increase and decrease over non-mechanised farm respectively.

Table 2: Factors Affecting the *Sali* rice cultivation in Mechanized and Non-mechanised Farms in Upper Brahmaputra Valley Zone in Assam

Sl. No.	Particulars	Variable	Mechanized		Non mechanized	
			Coefficient	Standard error	Coefficient	Standard error
1	Intercept	A	9.083	1.063	2.943	1.627
2	Area(ha)	X_1	0.616	0.085	0.967	0.088
3	Seed (₹)	X_2	0.469**	0.054	-0.033	0.086
4	FYM (₹)	X_3	0.090	0.005	0.512*	0.064
5	Fertilizer (₹)	X_4	0.524***	0.011	0.544**	0.071
6	Plant protection chemicals (₹)	X_5	0.196	0.005	0.157	0.007
7	Irrigation (₹)	X_6	0.110	0.005	—	—
8	Human labour (₹)	X_7	-0.083	0.089	-0.278*	0.097
9	Machine labour (₹)	X_8	0.684*	0.074	—	—
10	Bullock labour (₹)	X_8	—	—	0.488	0.108
11	R^2		0.791		0.895	

*Note: *Significant at 10% level of probability; *Significant at 5% level of probability; ***Significant at 1% level of probability.*

non mechanised farms under Upper Brahmaputra Valley Zone (UBVZ) reveals that the coefficients of area (X_1), FYM (X_3), plant protection chemicals (X_5), and irrigation (X_6) were estimated to be 0.616, 0.090, 0.196 and 0.110, respectively. The coefficients were found to be positive, but statistically non-significant indicating that their use was irrational and beyond the point of optimum. On the other hand, the coefficient of elasticity of human labour (X_7) was estimated to be negative (-0.083) and statistically non-significant, indicating that a marginal increase in the amount of this input would not raise the total value of output realized.

However, the coefficients of elasticity of seed (X_2), fertilizer (X_4) and machine labour (X_8) were estimated to be 0.469, 0.524 and 0.680, respectively which were statistically significant with positive sign indicating that at current level these resources were under applied. Thus, an increase in seed, fertilizer and machine labour by one per cent individually over their geometric mean level would result in an increase of 0.47%, 0.52% and 0.68% increase in the total value of output respectively. The coefficient of multiple determination (R^2) for mechanised farm was estimated to be 0.791 indicating that 79% of variation in the total returns was explained by selected variables.

In regards to non-mechanised farms, elasticity coefficient of FYM (0.512) and fertilizer (0.544) were found to be positive and statistically significant at 10% and 5% probability level which indicated that these inputs were under utilised at current level, and 1% increase in FYM and fertilizer would result in an increase of 0.51% and 0.54% increase in total returns of farm. On the other hand, elasticity coefficient of human labour was observed to be statistically significant with negative sign indicating that every 1% increase in human labour use from mean level would reduce the returns by 0.28%. It strongly suggests that there was irrational or excessive use of human labour. Moreover, coefficients of elasticity area, plant protection chemicals and bullock labour were estimated to be non-significant with positive sign indicating that their use was irrational and beyond the point of optimum level. However, elasticity coefficient of seed (-0.033) in non mechanised farm was found to be negative and statistically non-significant which implies that a marginal increase in the amount of this input would not improve the total value of output. The coefficient of multiple determination (R^2) was 0.895 indicating that about 90% of variation in gross returns in the non mechanised farm was explained by the selected variables.

Comparison of mechanised and non-mechanised farms in regards to coefficients of variables included in the production function implies that coefficient of fertilizer was significant in both mechanised and non mechanised farms. On the other hand, coefficients of elasticity of seed and machine labour were positively significant in mechanised farms, while FYM was observed to be positively significant in non-mechanised farms. However, human labour was found to be negatively significant in non-mechanised farms. Other variables included in the model were found non-significant in both the mechanised and non mechanised farms.

Resource Use Efficiency

Determination of efficiency of resource use requires the estimation of marginal value products of resources, and the Marginal Value Product (MVP) of each input so estimated is compared the factor price or Marginal Factor Cost (MFC) of the factor input. In other word, comparison of marginal value product and marginal cost of an input gives a valid estimation of its (inputs) efficiency in the allocation in a production process (Reddy and Reddy, 2014).

Resource efficiency inputs requires the estimation of Marginal Value Product (MVP) of each input. The comparison of MVP with factor price or Marginal Factor Cost (MFC) of the factor input gives a valid estimation of its (inputs) efficiency in the allocation in a production process. The allocative efficiency of 1 indicates that farmers are price efficient in allocating a particular resource, while an allocative efficiency greater than unity indicates under-utilization of that particular resource and scope in increase in its application till the ratio becomes unity (Suresh and Reddy, 2006).

Resource Use Efficiency /Allocative Efficiency in *Sali* Rice Cultivation in Mechanized and Non-mechanised Farms in Upper Brahmaputra Valley Zone in Assam

The allocative efficiency in *Sali* rice cultivation in both mechanised and non-mechanized farms in UBVZ is presented in Table 3. For mechanised

Table 3: Marginal Value Product (MVP) to Marginal Factor Cost (MFC) Ratio in Sample Farms in Upper Brahmaputra Valley Zone in Assam

Variables	Mechanized Farm			Non-mechanized Farm		
	MVP	MFC	Ratio	MVP	MFC	Ratio
Area (X_1)	0.976	1	0.976	0.599	1	0.599
Seed (X_2)	1.59	1	1.59	-0.048	1	-0.048
FYM (X_3)	0.28	1	0.28	1.18	1	1.18
Fertilizer (X_4)	1.52	1	1.52	1.63	1	1.63
Plant protection chemicals (X_5)	0.45	1	0.45	0.92	1	0.92
Irrigation (X_6)	0.95	1	0.95	—	—	—
Human labour (X_7)	-0.93	1	-0.93	-0.164	1	-0.164
Machine labour (X_8)	1.85	1	1.85	—	—	—
Bullock labour (X_9)	—	—	—	0.352	1	0.352

farms, the ratio of MVP to MFC was highest for machine labour (1.85) followed by seed (1.59) and fertilizers (1.52). The coefficients of the production function were estimated to be positively significant for seed, fertilizers and machine labour used, while the allocative efficiency ratios revealed that an additional expenditure of one rupee on these inputs would increase the gross returns by ₹ 1.59, ₹ 1.52 and ₹ 1.85 respectively. On the other hand, the coefficient of human labour in production function analysis was found to be negative and non-significant, but the allocative efficiency ratio indicated that an additional expenditure of one rupee on human labour would reduce the revenue by ₹ 0.93. So, the farmers had to reduce the amount of expenditure on human labour to become economically efficient. From the table it observed that the ratios of MVP and MFC on area (0.976), FYM (0.28), plant protection chemicals (0.45) and irrigation (0.95) in mechanised farms were less than unity indicating over utilization of the said resources. On the other hand, the MVP to MFC ratios for seed, fertilizers and machine labour were greater than unity which indicated that the resources were under utilised.

In case of non mechanised farms in UBVZ, the ratio of MVP to MFC for area, seed, plant protection chemicals, human labour and bullock labour were found to be less than unity indicating over utilization of those resources

CONCLUSION

From the study it can be concluded that seed and human labour were used in higher quantities in non-mechanised than the mechanised farm. But manure and fertilizers was used in more amounts in mechanised farm. Coefficient of fertilizer was significant in both mechanised and non mechanised farms. Seed and machine labour were positively significant in mechanised farms, while FYM was positively significant in non-mechanised farms. Area, FYM, plant protection chemicals and irrigation were over utilized in mechanised farm, while seed, fertilizers and machine labour were underutilized.

REFERENCES

Ahmed, R., Verma, R.R., Sengar, V.S., Singh, K.K., Kumar, N., Singh, R.A., Singh, A.P. and Singh,G.P. 2018. Mustard: Economic Study on Resource Use Efficiency Analysis in Lakhimpur Kheri District of Uttar Pradesh. *J. Pharmacognosy and Phytochem.*, **7**(6): 623-625.

Ali, M. and Choudhury, M.A. 1991. Inter-farm Efficiency of Pakistan's Punjab: A Frontier Production Function Study, *J. Agri. Econ.*, **41**(1): 62–74.

Devi, L.G. and Singh, Y.C. 2014. Resource Use and Technical Efficiency of Rice Production in Manipur. *Econ. Aff.*, **59**(sppl.): 823–835.

https://diragri.assam.gov.in, 2023. Agriculture Mechanisation and Post-harvest Management.

Reddy, E.L. and Reddy, D.R. 2014. A Study on Resource Use Efficiency of Agricultural Inputs Factors with Reference to Farm Size in three Revenue mandals of Nellore District: Andhra Pradesh. *IOSR J. Humanities and Soc. Sc.*, **17**(1): 48–55.

Roy, N. and Bezbaruah, M.P. 2002. Agricultural Growth and Regional Economic Development (A Study of Borak Valley). Mittal Publication.

Sarma, C.K., Neog, M. and Bhattacharyya, H.C. 2017. Innovative Extension Approaches for Enhancing Farmers' Income in Assam. *In:* Proceedings of 8th National Seminar on Potential Prospect and Strategies for Doubling Farmers Income: Multi Stake holder Convergence. MOBILISATION

in collaboration with Assam Agricultural University, Jorhat and ICAR-ATARI, Guwahati, 9–11 November.

Sidhu, R.S. and Grewal, S.S. 1990. Factors Affecting Demand for Human Labour in Punjab Agriculture: An Econometric Analysis. *Ind. J. Agri. Econ.*, **40**(2): 125–133.

Singh, R.S. and Sahni, R.K. 2019. Transformation of Indian agriculture through mechanisation. *Econ. Aff.*, **64**(2): 297–303.

Suleiman, H.R. and Ibrahim, H. 2014. Relative Economic Efficiency of Mechanized and Non-mechanised Rice Farmers in Nasarawa State, Nigeria. *IOSR J. Econ. and Fin.*, **5**(2): 01–08.

Suresh, A. and Reddy, T.R.K. 2006. Resource Use Efficiency of Paddy Cultivation in Peechi Command Area of Thrissur District of Kerala: An Economic Analysis. *Agri. Econ. Res. Rev.*, **19**(1): 159–171.

Tiwari, P.S., Singh, K.K., Sahni, R.K. and Kumar, V. 2019. Farm Mechanisation -Trends and Policy for its Promotion in India. *Ind. J. Agri. Sc.*, **89**(10): 1555–1562.

Umesh, K.B. and Bisaliah, S. 1991. Efficiency of Groundnut Production in Karnataka: Frontier Profit Function Approach. *Ind. J. Agri. Econ.*, **46**(1): 22–23.

Verma, M. and Tripathi, A. 2015. Perspective of Agricultural Mechanization in Supaul District of North Bihar- A Research. *IOSR J. Agri. and Vet. Sc.*, **8**(8): 4–12.