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Technical and Allocative Efficiency of Jute Production in Brahmaputra Valley of Assam

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ABSTRACT

The jute industry is occupying an important place in India's national economy. In India jute is mostly grown in Eastern and North-Eastern parts of the country, viz. West Bengal, Assam, Northern Bihar, South East Orissa, Tripura and Eastern Uttar Pradesh share more than 70 per cent of the total jute production of the country. Along with food grain production the eastern India have shown an impressive increase in productivity of fibre crops specially jute and allied fibres. The jute industry occupies an important place in the national economy. Jute fibre and jute fibre products have future potential which may create a lot of employment opportunities. Except rice, there is enormous potential for increasing the acreage under fruits, vegetables, and tea and fibre crops. In this study an attempt is made to find out the resource use efficiency of jute in different agro-climatic zones of Assam. The specific objective of the study is to measure the resource use efficiency of jute production in Assam. The entire study was carried out on the basis of both primary and secondary data. The secondary data were collected from various Government websites, books, journals and published or unpublished sources. The primary data were collected from households of three major jute growing zones of Brahmaputra Valley. Cobb- Douglass production function was used to estimate the efficiency in jute production. The production function was first estimated through the Ordinary Least Square (OLS) method. Technical efficiency was measured by estimating stochastic frontier production function, which assumes time-invariant technical efficiency as the study was done for one year data. The stochastic frontier production function was estimated using FRONTIER version FRONT4.1 computer software. The farm specific efficiency analysis in jute production brought out a fairly high technical efficiency in almost all the three zones. Farmers were allocatively efficient in maximizing their profit. There was a need for improvement of managerial skill of the farmers by imparting adequate extension support along with adequate technology and infrastructure facilities. This study suggests that there is a need to organize training for the farmers for increasing the efficiency in allocating and using the available resources in an optimum way, which would enhance jute production.

Keywords: Efficiency, Technical, Allocative, Production function

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INTRODUCTION

In microeconomics theory of production, a production process is defined in terms of maximum output that can be produced from a specified set of inputs, given the technology available to the firms. A production process indicates the process by which a set of inputs is transferred into a single or multiple outputs and is represented by an appropriate but specific production function. A production function thus represents a specific technology for which, any production process assumes efficiency in production. A production process is said to be efficient if there exists no alternative process, which produces more outputs with the same inputs or produces the same outputs with less input. Economic efficiency of any firm thus defined refers to the extent to which the firm maximizes profit, given the production technology, set of available inputs, and the prices of outputs and inputs.

The jute industry is occupying an important place in India's national economy. In India jute is mostly grown in Eastern and North-Eastern parts of the country, viz. West Bengal, Assam, Bihar and Orissa share more than 95 per cent of the total jute area of the country. In 2025-26, around 98 per cent of total jute production belonged to these states. However, a vast country like India with marked regional diversities in agro-climatic environment, resource endowment and population density are likely to be characterized by uneven development among regions. Despite the dynamism shown by the agricultural sector as a whole, the performance of eastern India, which is characterized by rain fed agriculture, had remained somewhat dismal. Along with food grain production the eastern India have shown an impressive increase in productivity of fibre crops specially jute and allied fibres. Floods have been the exogenous source of handicap to the development of Assam. Apart from floods, inadequate attention to agriculture has also been responsible for slow agricultural development in Assam. Many agricultural

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developments related schemes have been introduced by the Government to increase productivity. These schemes encourage farmers to grow more food grain and commercial crops.

Despite the fact that being the most important fibre crop next to cotton, jute crop was not given so much importance because food grains were gaining the first priority in research and development. The technical efficiency varies widely across cereal crops in Himachal Pradesh and is time invariant. The under-utilization of human labour and excessive use of seeds has resulted in sizable deviations from the optimum allocation of input resources (Sharma et al., 2008.). A higher technical and allocative efficiency of 87.6 and 93.7 per cent respectively in jute production was observed in Southern Bangladesh, where farmers may produce a specified amount of output at the lowest feasible cost by decreasing the cost of jute production by 17.7%, given the available resources (Chokdar, 2026). The farmers of the central region do not have much scope to increase productivity of wheat through technical efficiency improvement under the existing conditions of input use and technology (Kaur et al., 2010). A perusal of farm-specific variables indicates low crop returns, low use of fertilizers, insecticides, and machinery and small farm-size in the sub-mountainous region (Sekhon et al., 2010). There is no significant difference between farm sizes. Even the larger size groups the higher technology efficiency in rice production (Cai and Yan, 2018). There exists a non-linear relationship between Output Oriented technical efficiency and capital Intensity as well as Output Oriented technical efficiency and Employees' contribution in the Jute industry in India. Technical and allocative inefficiencies lead to increase input demand and higher cultivation costs across three different millet crops (Flex, Ramappa and Govindarajan, 2024). There is enormous potential for farmers to increase their efficiency by 30 to 40 per cent in crops such as pulses, oilseeds and cash crops (The results of these studies are useful for policy makers to rationalize the development policies for a particular crop in a region. However, no attempt has been made to analyze the efficiency of jute production at zonal level in Assam. In this study, an attempt is made to find out the resource use efficiency of jute in different agro-climatic zones of Assam. The specific objective of the study is to measure the resource use efficiency of jute production in Assam

MATERIALS AND METHODS

The entire study was carried out on the basis of both primary and secondary data. The secondary data were collected from various Government websites, books, journals and published or unpublished sources. The primary data were collected from households of three major jute growing zones of Brahmaputra Valley. These are the Lower Brahmaputra Valley Zone, Central Brahmaputra Valley zone and North Bank Plain Zone of Assam. Under each zone 200 sample farmers were randomly selected comprising a total of 600 sample farmers for the study purpose. The data were collected through a personal interview method using a pretested and well-structured schedule prepared for the purpose. The choice of the samples was such

$$ln(Y_j) = b_0 + b_1\, ln(L_j) + b_2\, ln(HL)_j + b_3\, ln(FP_j) + b_4\, ln(FR_j) + b_5\, ln\, SD_j + \mu_j \quad \text{.....(1)}$$

that they were widely spread and represented the respective zone. The primary data corresponding to the agricultural year 2019-20 were collected from the sample farmers using a structured questionnaire prepared for the purpose.

The empirically estimated Cobb-Douglas production function was expressed as-

where,

Y = value of output of jute
L = land in ha
HL = value of human labour
FP = value of farm power or machinery power (tractor)
FR = value of fertilizer
SD = value of seed
j = 1, 2……..n, were sample farm families
b1, b2……...b5= regression coefficients
μ = error term

All the variables were expressed in value terms in rupees on 'whole farm' basis and land in hectare basis. To value the inputs, input prices were assumed to be the same for each farm family in a particular zone because of the homogeneity in market conditions of the sample farmers. However, they vary across the zones.

The stochastic frontier production function for estimating farm level technical efficiency is specified as:

$$Y_{it} = f(X_{it};\beta) + \varepsilon Y_{it} = f(X_{it};\beta) + \varepsilon_{it}$$

i=1,2,…n
and t=1,2,..T (1) (2)

Where 'i' is the nth observations and t id tth time periods. Yit is output, Xit denotes the actual input vector, β is vector of production function and is the error term that is composed of two elements, that is

$$\varepsilon = V_{it} - U_{it} \qquad \varepsilon = V_{it} - U_{it} \quad (3)$$

Where, Vit is the symmetric disturbances assumed to be identicallv, independently and normally distributed as $(0, \sigma_{vt}^2 \sigma_{vt}^2)$ given the stochastic structure of the frontier. The second component Uit is a one sided error term that is independent of Vit and is normally distributed as $(0, \sigma_{vt}^2 \sigma_{vt}^2)$, allowing the actual production to short fall below the frontier but without attributing all short falls in output from the frontier as inefficiency.

The production function in equation (i) was first estimated through the Ordinary Least Square (OLS) method. Technical efficiency was measured by estimating stochastic frontier production function, which assumes time-invariant technical

efficiency as the study was done for one year data.

The stochastic frontier production function was estimated using FRONTIER version FRONT4.1 computer software, (Coelli, 1996).

The firm-specific technical efficiency is defined in terms of observed output (Yit) to the corresponding frontier output (Yit) using the available technology derived which is defined as follows:

$$TE_{it} TE_{it} = \frac{Y_{it} Y_{it}}{Y_{it}^{*} Y_{it}^{*}} = \frac{E(Y_{it}|U_{it}, X_{it})}{E(Y_{it}|U_{it}=0, X_{it})} \frac{E(Y_{it}|U_{it}, X_{it})}{E(Y_{it}|U_{it}=0, X_{it})} = \frac{E[\exp(-U_{it})/\varepsilon_{it}]}{E[\exp(-U_{it})/\varepsilon_{it}]} \quad (4)$$

TE takes values within the interval (0, 1), where 1 indicates a fully efficient firm.

The allocative efficiency was calculated as the ratio of average value productivity (AVP and marginal value productivity (MVP). The average value productivity (AVP) and Marginal value productivity (MVP) for inputs (xi) were calculated using the following formula:

$$AVP = \frac{\bar{Y}\bar{Y}}{\bar{X}_i \bar{X}_i}$$

$$MVP = \beta_i \frac{\bar{Y}}{\bar{X}_i} \beta_i \frac{\bar{Y}}{\bar{X}_i}$$

Where,

AVP = average value product

MVP = marginal value product

$\bar{X}\bar{X}$ = geometric mean of xi

$\bar{Y}\bar{Y}$ = geometric mean of Y

$\beta_i \beta_i$ = Elasticity of output with respect to factor xi

Resource use efficiency was assessed by computing the ratio of marginal product and factor cost (opportunity cost). Equality of MVP to factor cost indicates the optimum resource use efficiency of a particular input, deviations, if any, indicates the resource use inefficiency.

RESULTS AND DISCUSSION

Estimates of OLS of Cobb Douglas production function for three zones of Assam are presented below. Since the zones of Assam are different from each other based on their agro-climatic factors, it was legitimate to run a separate function for each of the zones. A regression analysis was carried out with return (Rs.) from jute as the dependent variable (Y) and jute area in hectare (X1), value of human labour (X2), value of farm power (X3), value of fertilizer (X4) and seed (X5) in jute production as explanatory variables. For this purpose, OLS estimates of the Cobb Douglas production function were used to run the regression model. The results are presented below.

The results of OLS estimates of Cobb Douglas production function for LBV zone were presented in Table 1. It was found that the coefficients of human labour (0.222) had significant impact on return from jute production in Lower Brahmaputra Valley zone. Except human labour and farm power, none of the variables were found to have significant impact on return from jute. It was also noticed from the Table that the coefficient of variation of fertilizer is negative in LBVZ resulting in a negative impact on return from jute.

Table 1. OLS estimates of Cobb-Douglas Production Function in LBV, CBV and NBP zone

Variables	Parameters	LBVZ	CBVZ	NBPZ
Intercept	β_0	7.430*** (2.130)	11.718*** (0.148)	10.870*** (1.704)
Land	β_1	0.371 (0.261)	0.957*** (0.178)	1.024*** (0.219)
Human Labour	β_2	0.222*** (0.025)	0.058* (0.032)	0.171*** (0.053)
Farm Power	β_3	0.041 (0.095)	0.021 (0.080)	0.025 (0.079)
Fertilizer	β_4	-0.006 (0.138)	-0.033 (0.145)	-0.015 (0.115)
Seed	β_5	0.237 (0.198)	0.005 (0.047)	-0.129 (0.177)
R2		0.93	0.96	0.81
No. of observations		200	200	200

***Significance at 1 per cent probability level
**Significance at 5per cent probability level
* Significance at 10 per cent probability level

From Table 1 it was observed that, the coefficients of land (0.957) and human labour (0.058) had significant impact on the return from jute in the Central Brahmaputra Valley zone.

It was found from Table 1 that the coefficients of land (1.024) and human labour (0.222) had a significant positive impact on the return from jute production in the North Bank Plain zone. The value of multiple determinations was 81 per cent in this zone. This indicated that most of the variations in the return from total jute were explained by the strategic factors considered under the model. The OLS estimates implied that fertilizer was not a significant factor of production in any zone. The coefficient of fertilizers was negative in all the three zones as fertilizers might have been used in sub optimal levels. The overall analysis brought out that for all zones labour and in some cases, land had significant contribution towards increasing return from jute production. It may be seen from the estimated values of regression coefficients of all the inputs that the values of coefficients of multiple determination (R2) were quite high in all the cases. This indicated that the selected form of the production was the best fit.

Frontier version 4.1 (Colli, 1996) was used to estimate the stochastic frontier production function which have farm effects, Ui's and are assumed to be distributed as half normal

random variable (ε is assumed to be zero) as specified by (Battese & Coelli, 1992). The results of stochastic frontier estimates for different zones are presented in Table 2. In Lower Brahmaputra valley Zone the coefficient of human labour was found to have significant impact on total return from jute production indicating 0.234 per cent increase in return with 1 per cent increase in human labour. The estimates of gamma and sigma squared were found to be positive and significant, which showed technical inefficiency had an effect on the variation in return from jute production and that part of the variation was not explained by the variable included in the model.

Table 2. Maximum Likelihood Estimate of Stochastic Frontier Production Function Estimates

Variables	Parameters	LBVZ	CBVZ	NBPZ
Intercept	$ß_0$	7.823* (2.126)	12.73*** (1.325)	10.703** (1.453)
Land	$ß_1$	0.415 (0.260)	1.042*** (0.158)	0.956 (0.194)
Human Labour	$ß_2$	0.234*** (0.027)	0.021 (0.027)	0.094*** (0.035)
Farm Power	$ß_3$	0.027 (0.098)	-0.015 (0.069)	-0.034 (0.068)
Fertilizer	$ß_4$	-0.016 (0.137)	-0.098 (0.131)	0.056 (0.105)
Seed	$ß_5$	0.209 (0.196)	0.035 (0.042)	0.024 (0.166)
Gamma		0.51* (0.249)	0.729*** (0.115)	0.944*** (0.313)
σ2		0.024** (0.006)	0.016*** (0.003)	0.113*** (0.016)
Log likelihood		130.25	193.05	38.09
No. of observations		200	200	200

***Significance at 1 per cent probability level
**Significance at 5per cent probability level
*Significance at 10 per cent probability level

In the Central Brahmaputra valley Zone the coefficient of land was found to have significant impact on return from jute production in this zone indicating 1.042 per cent increase in return with 1 per cent increase in land. The coefficients of farm power and fertilizer were found to have negative effects but not significant. The estimate of gamma was significant indicating that the variation in return was explained by technical inefficiency in jute production in this zone. The significant value of sigma squared revealed that the variation in return was not explained by the strategic variables considered in the model. The results of the stochastic frontier estimate for North Bank Plain zone in Table 2 showed that the frontier coefficient of human labour has a significant impact on returns from jute production in this zone. This indicated that return could be increased by 0.094 per cent with 1 per cent increase in human labour. The estimate of gamma was significant indicating that the variation in return was explained by technical inefficiency in jute production in this zone.

Based on the estimated parameters from jute production average and marginal value product of land, human labour, farm power, fertilizer and seed for all the zones are computed for Ordinary Least Square (OLS) and Maximum Likelihood (ML) Estimates

It was found that the average value products (AVP) for all the factors based on OLS and ML estimates were greater than their respective marginal value product (MVP) for all size groups of farms in this zone. This showed declining average and marginal factor productivity in both average and frontier jute production. This implied that farmers of Lower Brahmaputra Valley Zone, whether they were at the frontier or below the frontier, operated somewhere in the stage two in the conventional production function surface where both average product and marginal product declined and average product exceeded marginal product. Both average and marginal value products of all the factors were not similar in OLS than ML estimates in both the groups. This showed that farmers were not using the factors of production efficiently. For overall size also, there was scope to increase the amount of all inputs to obtain maximum possible output.

Table 3 shows the factor productivity estimates and factor prices in Lower Brahmaputra valley Zone, Central Brahmaputra valley zone and North Bank Plain Zone. In Lower Brahmaputra valley Zone, MVP of human labour and seed were found to be higher in OLS and ML estimates, and land was found to be higher in ML estimate suggesting the possibility of increasing use of these inputs for maximizing jute production in this zone (Table 3). The average value products (AVP) for all the factors except land were greater than their respective marginal value product (MVP) in the Central Brahmaputra Valley zone in both OLS and MLE estimates. This indicated that the farmers of this zone were operating in the stage two of the conventional production function surface. It was also observed that farmers were not using the factors of production efficiently. In this zone MVPs of land and human labour were found to be higher in OLS estimate. In ML estimates land, human labour and seed were found to be higher suggesting the possibility of increasing the use of these inputs for maximizing jute production in this zone. The average value products (AVP) for all the factors were greater than their respective marginal value product (MVP) in the North Bank Plain zone in both OLS and MLE estimates. This indicated that the farmers of this zone were operating in the stage two of the conventional production function surface. In this zone, MVP of land and human labour was found to be higher in both OLS and ML estimate suggesting the possibility of increasing the use.

Table 3. Factor productivity estimates and factor prices in LBVZ, CBVZ and NBPZ

Zone		OLS					MLE				
		Land	Human labour	Farm Power	Fertilizer	Seed	Land	Human labour	Farm Power	Fertilizer	Seed
LBVZ	Factor price	1121.50	350.00	300.00	27.00	150.00	1121.50	350.00	300.00	27.00	150.00
	AVP	2694.00	16607.00	4355.92	2416.65	1341.12	2694.00	16607.00	4355.92	2416.65	1341.12
	MVP	999.47	3686.75	178.59	-14.49	265.54	1131.48	3819.61	130.68	-48.33	281.64
CBVZ	Factor price	3088.80	300.00	300.00	30.00	150.00	3088.80	300.00	300.00	30.00	150.00
	AVP	8898.39	19594.29	6152.88	2402.95	1032.13	8898.39	19594.29	6152.88	2402.95	1032.13
	MVP	8515.76	1136.46	129.21	-79.30	5.16	9253.92	4506.68	184.59	-48.06	216.74
NBPZ	Factor price	1769.61	350.00	300.00	30.00	250.00	1769.61	350.00	300.00	30.00	250.00
	AVP	5455.00	12513.00	6010.00	2100.00	1267.00	5455.00	12513.00	6010.00	2100.00	1267.00
	MVP	5585.92	2139.72	150.25	-31.50	-162.15	5236.80	11762.22	-180.30	126.00	25.34

these inputs for maximizing jute production in this zone. From the overall analysis, it was found that, average and marginal value product of land and labour were highest in the Central Brahmaputra Valley zone as compared to other two zones. Whereas, MVP of farm power and seed were found to be highest in Lower Brahmaputra Valley zone. The analysis of factor productivity brought out the fact that there was a difference across size groups of farms in all the three zones with respect to resource productivity in jute production.

In Lower Brahmaputra Valley zone, mean technical efficiency in jute production under LBV zone was 0.94 with maximum and minimum technical efficiency of 0.99 and 0.61 respectively. This indicated that there was some 6 per cent unexploited production potential in jute production in this zone. The highest percentages (57 per cent) of the farms were able to achieve technical efficiency above 95 per cent. (Table 4)

Table 4. Distribution of farmers according to the level of technical efficiency

Efficiency range	LBVZ		CBVZ		NBPZ	
	No. of samples	Percentage	No. of samples	Percentage	No. of samples	Percentage
<85%	22	11	15	7.5	80	40.0
85-90%	36	18	42	21.0	15	7.5
91-95%	28	14	117	58.5	22	11.0
>95%	114	57	26	13.0	83	41.5
Total no. of samples	200	100	200	100	200	100

From Table 4 it was observed that the mean technical efficiency in jute production in the Central Brahmaputra Valley zone was 0.92. The maximum and minimum technical efficiencies were 0.98 and 0.78. This showed that there was some 8 per cent unexploited production potential in jute production in this zone. The highest percentages (58.5 per cent) of the farms were able to achieve technical efficiency ranging between 91 to 95 per cent. In the North Bank Plain Zone, the mean technical efficiency in jute production was 0.89 with maximum and minimum technical efficiency of 0.99 and 0.51 respectively. This indicated that there were at least 11 per cent unexploited production potential in jute production in this zone. The highest percentages (41.5 per cent) of the farmers were able to achieve technical efficiency above 95 per cent. The overall analysis brought out that, the mean technical efficiency in jute production was found to be marginally higher in the Lower Brahmaputra Valley Zone followed by Central Brahmaputra valley zone.

The average allocative efficiency was 0.95 in Lower Brahmaputra Valley zone with maximum and minimum allocative efficiencies of 0.99 and 0.91 respectively (Table 5). This revealed the proper allocation of existing resources. However allocative efficiency in jute production could be increased by another 5 per cent. A fairly higher percentage of (88 per cent) farmers were able to attain the allocative efficiency above 95 per cent.

Table 5. Distribution of farmers according to the level of allocative efficiency

Efficiency range	LBVZ		CBVZ		NBPZ	
	No. of samples	Percentage	No. of samples	Percentage	No. of samples	Percentage
<85%	0	0	9	4.5	16	8
85-90%	0	0	42	21.0	11	5.5
91-95%	24	12	114	57.0	55	27.5
>95%	176	88	35	17.5	118	59
Total no. of samples	200	100	200	100	200	100
Descriptive Statistics						
Mean	0.95	0.91	0.93			
Maximum	0.99	1.00	1.00			
Minimum	0.91	0.78	0.75			
Coefficient of Variation	2.23	4.98	8.59			

From Table 5 it was observed that the mean allocative efficiency of the Central Brahmaputra Valley zone was 0.91 indicating the possibility of increasing the allocative efficiency by 9 per cent with optimum allocation of existing resources in jute production in the Central Brahmaputra Valley zone. The maximum and minimum allocative efficiency in this zone was 1.00 and 0.78 respectively. A relatively higher percentage of (57 per cent) farmers were able to achieve allocative efficiency between 91 to 95 per cent in this zone. Around 17 per cent of the farmers were able to attain allocative efficiency above 95 per cent. The results further revealed that the average allocative efficiency was 0.93 in North Bank Plain Zone with maximum and minimum allocative efficiencies of 1.00 and 0.75, (Table 5). This revealed that with proper allocation of the existing resources allocative efficiency in jute production in this zone could be increased by another 7 per cent.

The overall analysis showed that the farmers of Lower Brahmaputra Valley Zone were more allocatively efficient followed by Central Brahmaputra Valley Zone and North Bank Plain zone. The analysis further revealed that there was an inverse relationship between the farm sizes in both the zones.

CONCLUSION

The analysis of farm specific efficiency in jute production brought out that, a fairly high technical efficiency was observed in almost all the three zones, indicating 89 to 94 per cent realization of the maximum possible income by the farmers from their given set of resources. Farmers were allocatively efficient in maximizing their profit as the highest allocative inefficiency of 9 per cent was observed in the Central Brahmaputra Valley Zone. There was a need for improvement of managerial skill of the farmers by imparting adequate extension support. However, the efficiency level could not be increased only by improved managerial skill of the farmers in absence of adequate technology and infrastructure facilities. The highest technical and allocative efficiency level was achieved by the farmers of Lower Brahmaputra Valley zone. The study on resource use efficiency suggests that there is a need to organize training for the farmers for increasing the efficiency in allocating and using the available resources in an optimum way, which would enhance production.

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