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Are the Rice Cultivars Efficient in Manipur? Measuring Technical Efficiency of Rice Production

Manish Sharma[1], Ram Singh[2] and S.M. Feroze[3]

ABSTRACT

The study was carried out to examine the technical efficiency of rice cultivars, *i.e.,* black rice and normal rice in Manipur. A sample of 180 rice producers was collected by conducting interviews in Manipur's Imphal West and Imphal East districts. The technical inefficiency of rice growers was tested using a stochastic frontier production function with input variables and socio-economic factors of rice growers. The black rice production was more profitable than the normal rice, as the cost of cultivation of black rice and normal rice was accounted for as ₹11,611.40 and ₹28,720.87 per ha, respectively. High cultivation costs were observed for normal rice due to more expenditure on fertilizer and manures, plant protection chemicals, irrigation charges, and labour wages. Land size, fertilizers, manures and machinery charges had a positive influence on the yield of black as well as normal rice. Education years of farmers positively influenced the yield of black rice, whereas old age still reduced elements of the yield of black rice growers. Moreover, most sampled farmers experienced 10-20 per cent inefficiency in black rice cultivation, whereas low efficiency was recorded in the case of normal rice. The study recommended that farmers adopt the scientific method of cultivation and apply the recommended quantity of inputs, which would help enhance the productivity of normal rice and black rice.

Keywords: Frontier production function, technical efficiency, rice, black rice, farm efficiency measures

JEL codes: D24, D61, Q12, R15

I

INTRODUCTION

Rice is the staple food crop of Manipur, contributed 85.29 per cent of total foodgrain production in 2021, with the majority of output recorded from the valley and plain regions of the state (Sarungbam and Prasad, 2011; Prakash and Singh, 2016; Singh *et al.* 2016; Government of India, 2024). However, rice cultivation in Manipur depends mainly on the region's weather conditions and seasonal rainfall. In the state, permanent cultivation is followed in valley areas, terrace cultivation is followed in hill areas, and *jhum* cultivation is mostly performed on hills. Numerous varieties of rice are cultivated in Manipur. Major indigenous traits of rice are *Chakhao Amubi*, *Chakhao Poireiton*, *Chakhao Anganba*, *Langphou Chakhao*, *Moirangphou Angangbi* and *Phouoibi* cultivated in the state (Shijagurumayum *et al.* 2022). Due to the lack of production resources and the prevalence of subsistence farming in the state, most rice growers follow conventional rice cultivation methods, *i.e.,* broadcasting. The geographical area of the state is divided into 16 districts, of which rice cultivation is limited to nine districts, mostly situated in valley and plain regions of the state. The cultivated area, production and rice yield were recorded at 200.03 thousand ha, 567.37

[1]Dr. Bhimrao Ambedkar University, Agra, U.P. – 282 006. [2] College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Shillong, Meghalaya – 793 103. [3] ICAR- National Academy of Agricultural Research Management (NAARM), Hyderabad, Telangana – 500 030.

thousand Mt and 2.84 MT/ha, respectively, in 2021 in the state (Government of India, 2024).

The rich biodiversity and natural resources of the state have provided an opportunity to attain surplus rice production despite its low productivity in the state. The state achieved a 32.34 per cent surplus in rice production, while the North Eastern region had a 9.53 per cent deficit in rice production in 2014 (Roy *et al.* 2015). On the other hand, the state's population is persistently increasing; therefore, to fulfil the demand of the forthcoming population, there is a need to increase overall agricultural production, which can be achieved by busting the productive efficiency even in the scarcity of production resources. As rice is the major foodgrain crop, and consumption in the state is rice-based, there is an opportunity to increase rice productivity by applying the optimum quantity of resources scientifically (Aheibam and Singh, 2017). Variations could be observed between the realized yield and the potential yield. There were significant variations in resource use and output level among the different varietal traits (Mythili and Shanmugam, 2000). Singh and Bera (2016) reported that the elasticity value of rice in Manipur was 0.65, indicating a decreasing return to scale, and found overutilization of chemical fertilizers and seeds and underutilization of plant chemical protection, machine labor and human labor in the valley region, whereas all the critical inputs taken into consideration were underutilized by the farmers of the hill region excepting seeds. Devi *et al.* (2023) conducted their study in Manipur, reporting 51.20 per cent elasticities in *Chak-hao* production. They recommended a reduction in expenditure on seed, machinery, and labor. Gogoi *et al.* (2023) conducted their research in Assam and reported a sum of elasticities of 79.10 and 89.50 per cent for mechanized and non-mechanized rice farming, respectively, and observed overutilization of resources in farming.

Organic agriculture has contributed significantly to the economy and provided employment in the North Eastern Hilly Region (Rajavardhan *et al.* 2020; Gogoi *et al.* 2022). Black-scented rice, known as *Chak-hao*, is a specific rice cultivated in Manipur. Even black rice is cultivated as organic, but growers do not invest sufficient resources in its cultivation. Mostly, black rice farmers follow natural farming due to insufficient resource availability. Generally, the productivity of black rice is lower than that of normal rice, but its high market price makes it profitable (Sharma *et al.*, 2023). Keeping all points in view, the study investigated the technical inefficiency of rice cultivars in Manipur. Technical efficiency refers to the ratio of potential and actual output, whereas technical inefficiency is reciprocal (Bhende and Kalirajan, 2007).

II

METHODOLOGY

Manipur is the NEH region state of India; majority of people are considered employed in agriculture and allied sectors. The sector played a crucial role in the state's economy as it has dominance in the State Domestic Product (SDP) and provided employment to 52.81 per cent of the total workers of the state. The state's total geographical area is divided into valleys and hilly regions, and only 7.41 per cent of its total area is used for cultivation purposes. Generally, two common agricultural practices are followed in the state, *viz.,* (i) settled (permanent) farming practiced in the plains, valleys, foothills and terraced slopes and (ii) shifting cultivation (*Jhum*) practiced on the hill slopes (Government of Manipur, 2023). Rice is a staple food crop of the state, as the consumption pattern is rice-based. Still, most of the area is cultivated using the conventional method for homestead consumption. In the state, it is not possible to increase the area so that an increase in productivity can increase production. Farmers experience varying levels of resource use efficiency due to resource availability and socio-economic status variations. Less resource use efficiency is observed due to the unavailability of suitable High Yielding Varieties (HYVs), less and unbalanced application of chemical fertilizers, plant protection chemicals, less availability of irrigation facilities, etc. (Borah *et al.*, 2018; Moyon, 2021; Susmitha and Singh, 2024).

Sampling Framework and Data Collection

Primary data were used to analyse the study, which was collected by conducting a sample survey during 2021–22. A sample of 180 rice farmers was collected through a pre-structured schedule from the Imphal East and Imphal West of Manipur districts. A total of 60 black rice growers and 30 normal rice growers were selected purposively from each selected district. These two selected districts were leading in rice production in Manipur and, therefore, were selected purposively for study purposes. Both districts were located in the middle of the state in the valley region. Six villages were selected purposively from each district according to the availability of black rice growers due to the unavailability of secondary statistical data on black rice in the state. The research schedule included information on the area of cultivated land under black rice and normal rice and expenditure on seed, fertilizer manures, and machinery application. Expenditure on these factors was estimated by analyzing the yield and selling price of paddy, quantity of input materials and their market price, the requirement of person-days of male and female labor and their prevailing wage rate. Cost of irrigation and plant protection chemicals are also important factors for rice, but most farmers do not use them for cultivation. However, socio-economic factors like the age of the farmers, education level (years of formal schooling), and years of farming experience were used as variables in the inefficiency model.

Analytical Tools

Cost of Cultivation

The cost of cultivation was analyzed by applying a specific recommended method by the Special Expert Committee of the Commission for Agricultural Costs and Prices (1979).

Cost A_1 = It is the summation of wages of hired labour + hired machinery charges + imputed value of own machinery + wages of hired machinery labour + seed cost + imputed value of own seeds + market value of manure and fertilizers + irrigation charges + market rate of pesticides, herbicides and hormones + interest on working capital + depreciation on farm machinery, implements, farm building and irrigation structures + rental value of land and taxes.

Cost A_2 = Cost A_1 + rent paid for leased-in land.

Cost B = Cost A_2 + rental value of own land less land revenue + interest on own fixed capital excluding the value of land.

Cost C = Cost B + imputed value of family labour

Evaluation of Gross and Net Return of Producers

Gross return was estimated by summing the multiplication quantity and price of paddy and straw. Net return was calculated by deducting the total cost of cultivation from gross return.

Frontier Production Function

The stochastic frontier production function used by Aigner *et al.* (1977), Battese (1992), and Battese and Coelli (1995) was followed in the study

$$Y_i = f(X_i;\beta) \text{-exp}(V_i\text{-}U_i) i = 1, 2,\ldots\ldots, N \quad (1)$$

where, Y_i indicates the possible level of production of i^{th} firms bounded above by $f(X_i;\beta)$ is the Cobb-Douglas function of X_i vectors of i^{th} firms, hence termed as *stochastic frontier, and* β vector is the unknown parameter. V_i is the random error of i^{th} firms, which assumes independent and identical distribution, *i.e.*, N $(0, \sigma^2_v)$ random variables. U_i indicates disturbance terms which assume non-negative truncations of the $N(0, \sigma^2)$. Under assumptions of stochastic frontier production function, the coefficients of model equation (1) were analysed through maximum likelihood estimate (MLE) as follows because standard regularity condition had hold

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + (V_i - U_i) \quad (2)$$

In indicates the natural logarithm, intercept (β_0), parameters of factors (β_1 to β_5) to be estimated, X_1 indicates land size (ha), X_2 indicates labour charge (₹), X_3 indicates seed cost (₹), X_4 is the fertilizers and manures cost (₹) and X_5 is the machinery charges (₹).

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 \quad (3)$$

where U_i is the disturbance term reflecting the technical inefficiency of a farm, α_0 indicates intercept, parameters (α_1 to α_3) to be estimated, Z_1 indicates age of the farmers (years), Z_2 indicates education (formal schooling years), and Z_3 indicates farming experience years.

Coelli and Battese (1996) suggested that β and α coefficients are unknown parameters to be estimated together with the variance parameters, which have been expressed in terms of

$\sigma^2_s = \sigma^2_v + \sigma^2$ (4)

$\gamma = \sigma^2 / \sigma^2_s$ (5)

where the value of γ varies from zero to one. The stochastic frontier production function parameters were measured using maximum likelihood estimates (MLE) Coelli (1992, 1994).

To analyse the inefficiency effects of the model, it is necessary that inefficiency effects be stochastic and should have a specific distribution. Therefore, the null hypotheses are constructed as if inefficiency effects are absent in model H_0: $\gamma = \alpha_0 = \ldots\ldots = \alpha_4 = 0$; if inefficiency effects are stochastic H_0: $\gamma = 0$; whereas if variable coefficients are zero for inefficiency effects H_0: $\alpha_1 = \ldots\ldots = \alpha_4 = 0$. The above null hypotheses are constructed to test by using the generalized likelihood ratio statistic (**λ**):

$$\lambda = -2 \ln \frac{L(H_0)}{L(H_1)} \quad (6)$$

where, values of livelihood function are $L(H_0)$ and $L(H_1)$ specified for specification of null hypotheses. Suppose the constructed null hypothesis is observed as true. It means λ close Chi-square or mixed Chi-square distribution. If the constructed null hypothesis follows $\gamma = 0$, it follows a mixed Chi-square distribution (Coelli, 1995).

The farm technical efficiency (at a point in time) can be defined as the ratio of observed production and frontier production of an efficient firm which observed zero inefficiency. Technical efficiency of i^{th} the farmers drew observation at point of time for stochastic production function specified in equations (1) and (2) defined as:

$TE = \exp(-U_i)$ (7)

The range of technical efficiency varies from zero to one, inversely changing with the inefficiency effect. Efficiency is observed by using a predictor that follows the condition of expectation $\exp(-U_i)$ presented by Battese and Coelli (1993).

III

RESULTS AND DISCUSSION

Various cost estimates of black rice and normal rice cultivation are mentioned in Table 1. Generally, the cost of cultivation of black rice was observed to be less than normal rice. The cost A_1 of black rice was estimated at ₹11,611.40 per ha, whereas in the case of normal rice, it accounted for ₹28,720.87 per ha. A high cost of cultivation was observed for normal rice due to more expenditure on fertilizer and manures, plant protection chemicals, irrigation charges, and labour wages. In contrast, less expenditure was observed for black rice. The machinery cost contributed the maximum percentage share of total working capital (8.69%) and (21.41%), respectively. Normal rice requires more and deeper ploughing than black rice, which increases the expenditure of machinery charges. High and frequent rainfall in the state reduces the expenditure on irrigation despite the high water requirement of normal rice. Generally, black rice requires less water, ploughing and plant protection chemicals than normal rice. Moreover, black rice is attributed to disease and pest tolerance due to its phenolic and anthocyanin contents (Singh and Sharma, 1998; Fasahat *et al.*, 2012; Vagiri *et al.*, 2017; Borah *et al.*, 2018). Therefore, the farmers did not apply plant protection chemicals for black rice cultivation. These agro-economic values were observed to be responsible for reducing the cost of cultivation of black rice and making it more profitable than normal rice.

TABLE 1. ESTIMATES OF THE COST OF CULTIVATION OF RICE IN MANIPUR

(n=180)

Particulars (1)	Black rice (₹/ha) (2)	Percentage (3)	Normal rice (₹/ha) (4)	Percentage (5)
Hired labour	3,427.11	6.88	6,259.48	9.06
Machinery charges	4,329.51	8.69	14,785.36	21.41
Fertilizers and Manure	409.21	0.82	1,117.88	1.62
Seed	1,556.35	3.12	1,119.02	1.62
Plant protection chemicals	225.15	0.45	795.49	1.15
Irrigation charges (₹/ hour)	275.52	0.55	1,158.58	1.68
Working capital(subtotal)	10,222.85	20.53	25,235.82	36.54
Depreciation on machinery and implements @10%	432.95	0.87	1,478.53	2.14
Interest on working capital (@7% for 6 months)	715.60	1.44	1,766.50	2.56
Land revenue (per 6 month)	240.00	0.48	240.00	0.35
Cost A_1	11,611.40	23.32	28,720.87	41.59
Cost A_2	25,861.40	51.93	42,970.87	62.22
Cost B	44,332.90	89.03	60,430.87	87.51
Cost C	49,795.63	100	69,056.30	100

Source: Authors' calculation, field survey, 2021-22

Welch's t-test was applied to compare the cost of cultivation of black rice and normal rice. The results of Table 4 show no significant difference between the cost of cultivation of black rice and normal rice, as indicated by the p-value of more than 0.05.

TABLE 2. ESTIMATES OF WELCH'S T-TEST

Particulars (1)	Welch's t-test (2)
Degree of freedom	23
t statistic	-0.93
One-tailed (p-value)	0.18
Two-tailed (p-value)	0.36

Table 3 infers that black rice and normal rice productivity were estimated at 16.50 and 30.72 quintals per ha, respectively. In contrast, the return on paddy was estimated at ₹1,02,850 and ₹63,097.50 per ha, respectively. Narayanamoorthy (2013) also reported a similar rice yield in their findings. The yield of normal rice was similar to the finding of Thingbaijam *et al.* (2019). The net farm income of black rice and normal rice was estimated at ₹58,974.36 and ₹1,721.20 per ha, respectively. The investment of family labour was observed to significantly reduce the net farm income of normal rice. On the other hand, less engagement of family labor was observed for black rice cultivation because it requires labor only for land preparation, sowing, harvesting and threshing. In contrast, normal rice engages them in additional practices such as irrigation, applying manure and fertilizer, and plant protection chemicals.

TABLE 3. PRODUCTION AND PROFITABILITY OF RICE IN MANIPUR

Particulars (1)	Black rice (2)	Normal rice (3)
Yield of paddy(qtl/ha)	16.50	30.72
Yield of by-product(qtl/ha)	14.80	19.20
Price of paddy(₹/qtl)	6,250	2,050
Price of by-product(₹/qtl)	400	400
Return on paddy	1,02,850	63,097.50
Return on by-product	5,920	7,680
Gross income (FGI)	108770	70777.50
Farm business income (FGI- Cost A_2)	82,908.59	27,806.63
Family labour income (FGI- Cost B)	64,437.09	10,346.63
Net farm income (FGI- Cost C)	58,974.36	1,721.20
Farm investment income (Farm business income – wages of family labour)	1,03,307.27	62,152.06
Net return over total variable cost (FGI-TVC)	98,547.14	45,541.67

Source: Authors' calculation, field survey, 2021-22

The statistics of variables applied in the stochastic frontier production function and inefficiency model are presented in Table 4. The average holding size of cultivated land was relatively small, i.e., 0.24 ha, with a wide range of variation (0.01 to 4 ha) in Manipur. The average expenditure on labor costs recorded was also high. Generally, the direct broadcasting method of sowing requires less labor, which applies to black rice growers. In comparison, the transplanting method requires more labor applicable for normal rice cultivation, which might be responsible for the high labor cost of normal rice. Moreover, high payment of labor for nursery raising, transplanting and fertilizer application in normal rice would be responsible for more labor costs in normal rice.

The black rice seed was found to be costlier, i.e., ₹60 per kg, than normal rice, i.e., ₹22 to ₹45 per kg, and increased cost incurred on black rice seed than normal rice. On the other hand, the broadcasting method required more seed quantity than the transplanting method, reducing expenditure on the seed cost of normal rice. Applying chemical fertilizers in black rice reduces the yield due to logging and the incidence of pests; therefore, using chemical fertilizers was not required; merely organic fertilizer was applied by growers. Generally, normal rice requires a high application of chemical fertilizer, which increases the cost incurred for normal rice. In the state, black rice was mainly cultivated in small areas by following the traditional method of cultivation: shallow ploughing, manual harvesting, and threshing, which was found to be responsible for reducing the cost incurred on machinery for black rice cultivation. The market price of black rice was observed more than two times despite its lower productivity and higher return than normal rice.

TABLE 4. SELECTED CHARACTERISTICS OF SAMPLED HOUSEHOLDS IN MANIPUR

(n=180)

Variable (1)	Mean (2)		Standard Deviation (3)		Minimum value (4)		Maximum value (5)	
	BR	NR	BR	NR	BR	NR	BR	NR
Value of output (₹)	1,08,770	70,777.50	91,461.21	67,259.14	1,800	1,800	4,87,425	3,28,000
Cultivated land (ha)	0.24	0.30	0.44	0.56	0.01	0.01	4	4
Labour charge (₹)	9,824.61	13,372.17	11,752.55	27,988.53	600	550	1,02,400	2,02,400
Seed cost (₹)	973.68	750.17	1,660.23	1,233.14	25	34	16,700	11,700
Fertilizer and manures (₹)	1,950.29	4,057.33	8,924.34	16,542.37	0.00	0.00	97,500	1,27,500
Machinery charges (₹)	2,568.75	3,230.17	6,518.83	9,102.25	0.00	90	71,060	91,363
Socio-economic factors								
Age of the farmers (years)	43.99	43.15	14.40	14.17	28	28	82	76
Education (years of formal schooling)	10.35	10.68	4.44	4.88	0.00	0.00	20	20
Farming experience (years)	9.63	9.28	7.06	6.29	1.00	1.01	30	28

Source: Authors' calculation, field survey, 2021-22
Note: *BR indicates Black rice *NR indicates Normal rice

The production function presented in equation (4), suggested by Battese *et al.* (1989), was applied to estimate the coefficients of maximum likelihood estimates (MLE) mentioned in Table 5. The estimates of MLE infer that land size highly and positively influenced the return of black rice cultivation, which was significant at a 1 per cent level. Even organic fertilizers and the use of machines positively influenced the return of black rice cultivation. However, there is scope for increasing the expenditure on organic fertilizers and using machines to increase the return of black rice. Coefficients of labor charge and seed were observed to negatively influence the return of black rice, indicating that farmers were applying an excess quantity of black rice seed for cultivation. Furthermore, most farmers sown black rice through broadcasting, which required more seed than other methods. Optimum seed use can be achieved using a seed drill or transplanting method. The reason behind the negative sign of the coefficient of labour charge was that black rice was cultivated by using labour for all farming operations like sowing of seed, harvesting and threshing, which can be substituted by using machines such as paddy transplanters for transplanting, rippers for harvesting and threshers for threshing of the black rice crop.

Among the socio-economic factors, the coefficient of age and farming experience had a negative sign. The significance at the 10 per cent level indicated that the old age of farmers was responsible for reducing the inefficiency (increasing the efficiency) of black rice production, and farmers who had more years of farming experience helped reduce the inefficiency of black rice production. Moreover, education (years of formal schooling) had a positive influence, which indicates that highly educated farmers were less efficient in black rice production. The same socioeconomic factors were used by Reddy and Sen (2004) and found to be responsible for affecting the efficiency of rice production. Production efficiency of black rice and normal rice was observed to be 81.10 per cent and 96 per cent, respectively, which was consistent with the findings of Chiphang *et al.* (2022), Goyal *et al.* (2006) and Kumar *et al.* (2024)

TABLE 5. MAXIMUM LIKELIHOOD ESTIMATES OF RICE USED UNDER STOCHASTIC FRONTIER PRODUCTION FUNCTION

(n=180)

Variable (1)	Parameter (2)	Black rice (3)		Normal rice (4)	
		Coefficient	SE	Coefficient	SE
Intercept	β_0	12.690***	0.541	2.111***	0.428
Land size (ha)	β_1	0.939***	0.076	1.094***	0.066
Labour charge (₹)	β_2	-0.026^{NS}	0.050	-0.004^{NS}	0.052
Seed cost (₹)	β_3	-0.048^{NS}	0.088	-0.082^{NS}	0.043
Fertilizers and manures cost (₹)	β_4	0.002^{NS}	0.014	0.001^{NS}	0.007
Machinery charges (₹)	β_5	0.007^{NS}	0.023	0.10^{NS}	0.036
Inefficiency model					
Intercept	α_0	0.569^{NS}	0.653	-2.113^{NS}	1.463
Age of the farmer (years)	α_1	-0.084*	0.043	0.115^{NS}	0.046
Education (years of formal schooling)	α_2	0.020^{NS}	0.031	0.109^{NS}	0.055
Farming experience (years)	α_3	-0.062*	0.033	-0.047^{NS}	0.029
Diagnosis statistics					
Variance parameter	σ^2_v	0.672***	0.221	0.610^{NS}	0.160
Gamma	γ	0.811***	0.068	0.960***	0.015
Log-livelihood		-66.29		10.65	

Source: Authors' calculation, field survey, 2021-22
Note: SE indicates Standard error; *** and * indicate the level of significance at 1 per cent and 10 per cent levels, respectively; NS= Not significant

The farm profit inefficiency and their frequency are depicted in Table 6. The result showed a wide variation of farm profit inefficiency (less efficiency) among sampled farmers. However, minimum profit inefficiency (high efficiency) was estimated at 7.48 per cent and maximum at 73.23 per cent. On average, more than 50 per cent of sampled farmers experienced 10-20 per cent inefficiency in black rice production. Conversely, normal rice growers experienced higher production inefficiency (less efficiency) than black rice growers. The minimum inefficiency limit (maximum efficiency) of normal rice production was observed at 57.62 per cent, and the maximum limit (minimum efficiency) was recorded at 96.30 per cent. The average inefficiency of normal rice production was estimated to be (86.71 per cent) producers. Reddy and Sen (2004) reported less technical efficiency in rice production, and the results were also in conformity with those of Abdulai and Huffman (2000).

TABLE 6. TECHNICAL INEFFICIENCY OF SAMPLED FARMS IN MANIPUR

Inefficiency index (%) (1)	Black rice (2)		Normal rice (3)	
	Frequency	Percentage	Frequency	Percentage
0-10	18	15.00	32	53.33
10.10-20	67	55.83	22	36.67
20.10-30	22	18.33	5	8.33
30.10-40	8	6.67	0	0
40.10-50	3	2.50	1	1.66
50.10-60	0	0.00	0	0
60.10-70	1	0.83	0	0
70.10-80	1	0.83	0	0
Total farms	120	100	60	100
Average		18.54		86.71
Minimum		7.48		57.62
Maximum		73.23		96.30

Source: Authors' calculation, field survey, 2021-22

IV

CONCLUSIONS

Under the present study, the level of investment and profitability were investigated by applying cost and return analysis, and the extent of rice production inefficiency was tested using the stochastic frontier production function. The study showed that the cost of black rice cultivation was less than that of normal rice. Although the yield of black rice was low, the price was more than two times that of normal rice, increasing the profitability of black rice for farmers. Estimates of stochastic production function indicated that the area of land, fertilizers, manures, and machinery charges positively influenced the yield of black rice and normal rice. Even years of formal schooling of farmers were negatively influenced by black rice yield. Among the socio-economic factors, older farming experience and the age of rice growers were observed to have high yields. In the case of normal rice, older farming experience and age of rice producers experienced low yield; even more educated farmers were less efficient in rice cultivation. Mostly educated farmers were motivated towards government jobs, private jobs and business rather than farming. Younger and experienced farmers were more interested in having efficient manpower, which ultimately helped to target high yields. The production inefficiency was greater than that of black rice, i.e., black rice production was more efficient than normal rice. Most black rice growers recorded 10-20 per cent inefficiency, whereas normal rice growers experienced 0-10 per cent inefficiency.

The study recommended that black rice production is highly profitable for farmers. Farmers should cultivate it as a business motive under organic cultivation. The government should organize an awareness program regarding the extent of profitability and market linkage. It might be a major source of livelihood for the state's population, ultimately enhancing the economy and reducing the unemployment of the state.

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