Research Article

Indian Journal of Extension Education
Vol. 59, No. 2 (April–June), 2023, (98-102)

ISSN 0537-1996 **(Print)**
ISSN 2454-552X **(Online)**

Efficiency of Pineapple Production and its Determinants: A Case Study of Manipur

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ARTICLE INFO

Keywords: Technical, Efficiency, Inefficiency, Stochastic frontier model, Pineapple

http://doi.org/10.48165/IJEE.2023.59221

Conflict of Interest: None

ABSTRACT

The study was conducted in the hills and valley regions of Manipur with the objectives of assessing the level of technical efficiency and determining the factors influencing the technical inefficiency of pineapple production in the state during the year 2022-23. A total of 240 farmers were interviewed in person to gather primary data. A stochastic frontier technique was used in the study to achieve the stated objectives. Results showed that pineapple production was a profitable business. However, the study's efficiency score of 0.603 indicated that farmers were operating inefficiently. The estimated stochastic production frontier model showed an adverse association between the cost of the sapling, transportation, fertilizer, and manure to the efficiency of pineapple production. According to the technical inefficiency effect model, the only factors that positively explained the technical inefficiency in pineapple production were the farmers' age and household size while factors like education, years of farming experience, credit availability, and contact with extension agents had a negative effect. Therefore, the study concludes that attracting youth in agriculture, extension services, and production inputs availability has to give due attention to augment the effectiveness of pineapple production across the state and nation as a whole.

INTRODUCTION

Pineapple is the third most important tropical fruit in the world after banana and citrus (Sivakkolundu, 2021). It is one of the best-known and most valuable commercial crops in India, ranking sixth with the production of over 7 per cent of the total global output of pineapple and yields of more than 15 t/ha lower than that of the global average of 21 t/ha (Royand Gosh, 2022a). The most prominent nations in the world for the cultivation of pineapples are Thailand, Brazil, India, Nigeria, the Philippines, and China. With an output of 1774 thousand MT and a contribution of 107 thousand hectares, India is a significant player in the pineapple trade (GoI, 2021).

The diverse agro-climatic conditions of the North East region (NER) favour the cultivation of a variety of horticulture crops, particularly the diversity of fruit crops (Marak et al., 2023), and pineapple is the most notable of them which was taken up since time immemorial (Das et al., 2015; Priyanka & Gosh, 2022b). The region contributes roughly 64.4 per cent and 46.81 per cent of the nation's pineapple area and production, respectively, with 57.3 thousand hectares and 662.49 thousand MT of production (GOI, 2021). Due to its favorable temperature and soil, Manipur is one of the top producing States for pineapples in the NER, contributing roughly 21.29 per cent and 16.69 per cent, respectively, of the region's pineapple area and production (GoI, 2018). The most widely grown pineapple varieties in Manipur are *Kew* and *queen*. From an economic standpoint, the fruit has become the main source of revenue for the large number of farmers. Therefore, it can be stated that Manipur's alternative industry for creating

Received 20-02-2023; Accepted 29-03-2023

significant employment opportunities and a significant source of income might be pineapple farming. The cultivation of pineapple opens up new avenues for employment and income to the farming folk in Manipur (Thingbaijam et al., 2015). However, the area and the production of pineapple in Manipur fluctuated over the study period of 2011-12 to 2020-21. The fluctuation in input utilization, which are *inter alia* the factors controlling crop productivity under the specific combination of ecological management and technical conditions at a certain point in time, may be the cause of the variation in the area and production of pineapple in Manipur. Keeping all these in views, the research problem is identified and taken up with the objectives to examined the level of technical efficiency and determines the factors influencing technical inefficiency of pineapple production using the stochastic frontier approach.

METHODOLOGY

The study was conducted in hills regions as well as the valley region of Manipur. A multistage sampling technique was employed in the study. In the first stage, one district from hills region and the other from the valley region was selected on the basis of area and production. Therefore, Senapati (hills) and Thoubal (valley) district were selected purposively as these districts have the highest area and production of pineapple in the regions. The second stage involved the selection of blocks. One block each *viz.* Purul and Thoubal blocks from senapati and Thoubal district, respectively were selected purposively. From each block, 6 villages from Purul block namely, Kapao, Khongdei Khuman, Khongdei Shimphung, Lakhamei, Lower Phaibung and Ngamju and from Thoubal block Chandrakhong, Charangpat Maklang, Charangpat Mamang Khangabok, Khoirom and Khongjom were selected. Finally a sample size of 140 farmers' from Senapati district and 100 farmers from Thoubal district to make a total sample size of 240 farmers in the study. For the investigation, primary data were collected through direct interview with pineapple farmers during the year 2022-23.

The technical efficiency/inefficiency was estimated using stochastic frontier production function developed by Aigner et al., (1977) and Meeusen and Van den Brock (1977). The general from of the stochastic frontier production function is

$$yi = g(xi, \beta) + \varepsilon i \text{ for } i = 1, 2, \ldots, N \quad \ldots (1)$$

Where, y = output, x = input vector, β = parameter vector, ε = *error term*, i = firm or production unit. The error term β, consists of two independent components,

$$\beta i = vi - ui \quad \ldots (2)$$

Where, vi is the random-error assumed to be identically and independently distributed N(0, σ^2_v) and u_i is the inefficiency effect assumed to follow a truncated (at zero) normal distribution N (u_i, σ^2_u).

This paper used the most appropriate functional forms by employing the log likelihood ratio test to the Cobb-Douglas models. The Cobb-Douglas specification is presented as follow:

$$yi = \beta_0 \prod_{j=1}^{n} x_{ij}^{Bij}\, e^{\varepsilon i} \text{ For i=1, 2, ..., n} \quad \ldots (3)$$

Where, y = output, x_j = the j^{th} input, $i = i^{th}$ farmer, $\varepsilon i = vi - ui$ $\beta_0\, \beta_j$ = parameter. Transforming into form yields;

$$\ln y_i = \ln \beta_0 \sum_{j=1}^{n} \beta_{ij}\, ln x_{ij} + \varepsilon_i \quad \ldots (4)$$

The detail model specification for the case of pineapple production is

$$lny = ln\beta_0 + \beta_1 lnx_1 + \beta_2 lnx_2 + \beta_3 lnx_3 + \beta_4 lnx_4 + \beta_5 lnx_5 + vi - ui \ldots(5)$$

Where, y = total output (Rs.), x_1= farm size, x_2 = sapling/ seedling cost, x_3 = transportation cost, x_4 = fertilizer and manure cost and x_5 = human labour cost.

$$u_i = \delta_0 + \sum_{m=1}^{n} \delta_m Z_m \quad \ldots (6)$$

Where, Z_m = determinants affecting the efficiency of pineapple production (Z_1 = farmers' age, Z_2 = Education, Z_3 = Farming experience, Z_4 = Household size, Z_5 = Access to credit, Z_6 = Contact with extension agents).

RESULTS AND DISCUSSION

Sample characteristics

The mean and standard deviations of the variables used in the estimation of technical efficiency and its determinants are presented in Table 1.

Perusal of Table 1, it was found that the average farm size under pineapple cultivation in Manipur was estimated to be of 0.25 ha. The general characteristics of the sampled farmers such as their age, education level, farming experience and the household size were examined. The age of the respondents in the study area

Table 1. Mean and standard deviations of key variables

Items	Mean value
Farm size (ha)	0.25 (0.19)
Age of the Farmer (years)	44.23 (9.13)
Education of the farmer (Illiterate=1, Primary=2, middle=3, Secondary=4, Higher secondary=5, Graduate and above=6)	2.19 (1.09)
Experience in crop production (Years in farming)	23.23 (9.13)
Household Size (Number of family member)	6.04 (1.58)
Access to credit (yes=2 and no=1)	1.49 (0.50)
Contact with Extension Agent (yes=2 and no=1	1.31 (0.46)
Sapling cost (Rs.)	21160.13 (14945.24)
Transportation Cost (Rs.)	2838.31 (1599.99)
Fertilizer and Manure Cost (Rs.)	687.55 (571.39)
Human Labour cost (Rs.)	23509.74 (7718.04)
Total Cost (Rs.)	48195.97 (23521.50)
Return from the Pineapple (Rs.)	66690.00 (53624.31)

Source: Authors' calculation, Figure in parentheses indicates standard deviations was found to be at the average of 44.23 years. The estimate shows that the respondent attained a primary level of education with an average of 2.19 years. The farming experience that the respondents had in the study area was estimated to be of 23.23 years. The average number of the family members was found to be of 6.04 members. More than 50 per cent of the sampled respondents do not have access to credit in the production of pineapples, according to the reported access to credit value of 1.49 (2=yes and 1=no). Similar findings were found in the case of respondents' interactions with extension agents, where more than 50 per cent of respondents had no contact with extension personnel. Among the various cost incurred in pineapple production, human labour cost was observed to be highest with an estimate of Rs. 23509.74 followed by sapling cost (Rs. 2160.13), transportation cost (Rs. 2838.31) and fertilizer and manure cost (Rs. 687.55). The study depicted that the farmers in the study area used less amount of fertilizers and manure in the production of pineapple. The total cost and the total return of the pineapple work out to be of Rs. 48195.97 and Rs. 66690.00, respectively.

Production frontier estimates

The outcome of maximum likelihood estimate of stochastic frontier production function was elucidated in Table 3. The sigma square (σ^2) value of 0.022 which was positive and also significant at 10 per cent level indicates a good fit and the correctness of the independent variable specified. A value of 0.957 was obtained for the gamma (γ) which measured the influence of technical inefficiency on the recorded output. This suggests that technological inefficiency was responsible for 0.957 per cent of the volatility in the return from pineapple. The finding showed that the farm size coefficient (0.007) was positive which implies that there is an opportunity to expand pineapple production with an increase in the area dedicated to pineapple cultivation. Similar results were reported by Amarasuriya et al., (2010); Das et al., (2014); Thingbaijam et al., (2015); Balogun et al., (2018); Akter et al., (2020) were they found that area under pineapple cultivation had significant effect on the production.

The negative and non-significant coefficient of the planting material (Sapling) cost (-0.011) implies that with increase of investment in purchasing planting material (sapling) in pineapple cultivation it will result in diminishing return. Therefore farmer should be educated in identifying the planting material from their own field which will lead to reduce production cost of pineapple. Transportation cost showed a negative coefficient (-0.044) which portrayed that high cost of transportation will reduce returns from pineapple. Similarly, the negative coefficient of fertilizer and manure cost (-0.058) also implies the reduction in returns of pineapple with the increase in fertilizer and manure cost. However the findings was in contrary with the finding of Amarasuriya et al., (2010) in which they stated that the amount of fertilizer used was closely related to the production of pineapples, and agronomic data confirmed that fertilizer use affects pineapple yields (Spironello et al., 2004). A positive coefficient for human labour (1.040) shows that the labour force was effectively utilized, along with other inputs, to prevent redundancy and a declining rate of return on labour.

Technical efficiency scores

Table 3 depicts the percentage distribution of the technical efficiency scores of pineapple growers in the study area. The scores run from 0.21 to 1.00, with a mean of 0.603 indicating that on average, producers are able to produce 60.30 per cent of their maximum yield using a certain combination of production inputs. The technical efficiency indices also show that average farmers might raise their output by about 38.78 per cent if they were to reach the technical efficiency level of their most efficient counterparts. Similar to this, an inefficient farmer implies a gain of nearly 74.62 per cent if the farmer could reach the same degree in technical efficiency as his or her most effective counterpart.

Table 3. Technical efficiency levels of pineapple growers

Efficiency Level	Frequency	Percentage
0.21-0.40	3	1.25
0.31-0.50	12	5.00
0.51-0.70	115	47.91
0.71-0.80	58	24.17
0.81-1.0	52	21.67
Total	240	100.00
Mean	0.603	
Minimum	0.25	
Maximum	0.985	
Possible yield enhancement for average farmers (%)	38.78	
Possible yield enhancement for most inefficient farmers (%)	74.62	

Source: Authors' calculation

Table 2. Maximum likelihood estimates of stochastic frontier model for pineapple farmers

Variable	Parameter	Coefficient	Standard Error	t-ratio
Intercept	β_0	12.037**	-0.992	12.133
Farm Size	β_1	0.007	0.513	0.013
Sapling Cost	β_2	-0.011	0.778	-0.015
Transportation cost	β_3	-0.044	0.616	-0.072
Fertilizer and manure cost	β_4	-0.058	0.456	-0.127
Human labour cost	β_5	1.040	0.665	1.565
Variance parameter	σ^2	0.022*	0.118	1.901
	γ	0.957	0.880	1.087
Log likelihood function	325.99			

Source: Authors' calculation, ** indicate significant at 5% level and * indicate significant at 10% level

Table 4. Determinant of technical inefficiency

Variable	Parameter	Coefficient	SE	t-ratio
Intercept	δ_0	0.001	0.998	0.001
Age of Farmer	δ_1	0.009	0.290	0.031
Education of Farmer	δ_2	-0.077	0.726	-0.107
Farming Experience of Farmer	δ_3	-0.014	0.342	-0.040
Household size of farmer	δ_4	0.027	0.824	-0.032
Access to credit	δ_5	-0.045	0.977	0.046
Contact with extension Agent	δ_6	-0.033	0.986	0.033

Source: Authors' calculation

The findings revealed that there is a production efficiency gap for pineapples and that improvement could be accomplished within the present system.

Factors of inefficiency in pineapple production

This section attempts to pinpoint the factors that contribute to the Manipur pineapple growers' technical inefficiency. The findings will serve as a foundation for developing agricultural policy regarding what must be done to increase pineapple producers' productivity. The result of technical inefficiency indicated that farmers' age and household size were the only determinants that positively explained the inefficiency whereas, the determinants such as education, years of farming experience, access to credit and contact with extension agents negatively explained the technical inefficiency in pineapple production (Table 4). The positive coefficient of the farmers age (0.009) indicates the older a farmer becomes, the less efficient they are at farming, and it's possible that older farmers are more risk-averse and reluctant to adopt new technology. Thus, it can be clinched that technical inefficiencies are lower for the younger farmers in the study area. This finding coincides with the results of Amao et al., *(*2011) and Adegbite and Adeoye (2015). The association between education and technical inefficiency has a negative coefficient (-0.077), indicating that more educated farmers will produce with more efficiency due to more effective skills, access to knowledge, and well-thought-out farm plans. Farmers with higher literacy skills are more inclined to adopt new production technology and are more competent to manage their farms' resources and agricultural activities. Similar results were attained in the works of Trujillo and Iglesias (2013). The years of farming experience of the farmers has negative coefficient (-0.014) means that farmers new in pineapple production business are less efficient compared to their counterparts with more years of experience. In the case of household size, the coefficient is positive (0.027) implies that household size contributed to technical inefficiency of pineapple production given that the youthful generation views farming as a poor man's profession and is unwilling to pursue it as a source of income. This is consistent with the Dolisca & Jolly (2008) that family size has a positive and significant relationship with technical inefficiency. The negative coefficient of the factor access to credit indicates that increase in the farmers' capital reduces the technical inefficiency which also implies that the ability of the farmers to get access to credit enable them to adopt necessary inputs in their farm and help them in enhancing the production efficiency. Technical inefficiency has a detrimental influence on the frequency of extension contact. Extension contacts are a means of transferring useful information and technology to farmers. This suggests that regular interaction between the extension agent and the farmer promotes the flow of new ideas, leading to an increase in agricultural productivity. The findings support Haq's (2013) assertion that agricultural extension services can offer farmers chances to engage in productive activities.

CONCLUSION

The economic analysis indicated that pineapple production is a profitable business. It is thus recommended that awareness of business opportunities in production of pineapple should be highlighted and realised to the farming community by the state government. However, the study painted a low efficiency scores in pineapple production in Manipur which is a reflection of inefficiency that characterizes small-scale agriculture and in consideration with the factors determining the technical inefficiency the study suggested that the government should provide a favourable environment to encourage more youth to engage in pineapple production in a bid to increase productivity as well as alleviate poverty status and unemployment. In addition, government has to give due attention to the education, extension services, credit availability and production inputs which need to be made available to augment the efficiency in pineapple production in the state and country as a whole.

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