

## Original Research Article

# How **the** banana farmers are efficient? An evidence from the Tiruchirappalli district of Tamil Nadu

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### ABSTRACT

**Aims:** The main aim of this study is to assess the resource use efficiency and technical efficiency of banana production and to determine factors that influence the technical efficiency of banana production in Tiruchirappalli district of Tamil Nadu.

**Place and Duration of Study:** The study was carried out using the primary data from the sample banana farmers of Tiruchirappalli district from April 2022 – May 2022.

**Methodology:** The Cobb Douglas production function and Stochastic Frontier Analysis was used to find resource use efficiency and technical efficiency of banana production in the study area.

**Results:** The results shows that organic manure, chemical fertilizer, and micronutrient were significant resources. An increase in the usage of these resources will increase the yield, and the other resources which are not significant should be appropriately used to increase the yield. The mean technical efficiency of banana farmers in the Tiruchirappalli district is around seventy per cent, which shows that thirty per cent of farmers were not technically sound.

**Conclusion:** The finding of the study reveals that the good quality suckers and appropriate chemical fertilizers should be incorporated to increase production and productivity. Government should concentrate on extension activities by properly disseminating information to farmers, such as correct production technologies and the required quantities of inputs used, and create awareness about the availability of good quality suckers in the formal institutions.

**Keywords:** (Banana Cultivation, Resource Use Efficiency, Stochastic Frontier, Technical Efficiency)

### 1. INTRODUCTION

Banana and their by-products are the world's fifth most traded agricultural product, after cereals, sugar, coffee, and cocoa. Such nutritive and tasty fruit of banana is reported to be cultivated in 120 countries with a total production of 86 million tonnes. Out of the total production, only 20 per cent of the fruits are found to be exported, and the remaining 80 per cent of the fruits are consumed locally (Jeffery, 2013). About ten big banana-growing countries comprise more than 70 per cent of the world's total banana production. Also, India, China, the Philippines, Brazil, Ecuador, and Indonesia make up more than 60 per cent of all bananas worldwide. (UNCTAD, FAO Statistics, 2020)

The countries that export the most bananas are Ecuador, Colombia, Costa Rica, and the Philippines. India, China, the Philippines, Brazil, Ecuador, and Indonesia make up more than 60 per cent of all bananas worldwide. Banana production in the world increased by 1.96 per cent, from 117.53 million

tonnes in 2019 to 119.83 million tonnes in 2020. Latin America and the Caribbean countries produced around 7 per cent of global exports. (FAO Statistics,2021)

India is the world's leading banana-producing country, with a production share of 31.5 million tonnes. However, there are not enough bananas grown in the country right now. When the production numbers for bananas were compared over ten years, they showed a seasonal pattern, where India has low productivity compared to Indonesia and Guatemala. Andhra Pradesh grew the most bananas, with 5834.70 million tons, which makes it the most productive state. Andhra Pradesh, Maharashtra, Tamil Nadu, Gujarat, Uttar Pradesh, Karnataka, Madhya Pradesh, Bihar, Kerala, and West Bengal are major banana-growing states. The Department of Horticulture and Plantation Crops should put much effort into raising people's awareness of precision farming (National Horticultural Board, 2021).

According to statistics, Erode, Thoothukudi, Tiruchirappalli, Coimbatore, Theni, Cuddalore, Kanyakumari, and Tirunelveli are some of Tamilnadu's most important banana-growing regions. Tiruchirappalli district produces around 25-30 per cent of the state's banana production. Tiruchirappalli district banana production is also affecting the Tamil Nadu banana market. The study's chosen district maintains over 25 per cent of Tamil Nadu's production. The banana harvest has dropped to 2,81,500 metric tons after years of growth (Directorate of Economics and Statistics). Even though Tiruchirappalli has suitable soil for banana cultivation, its contribution to Tamil Nadu has declined recently. Long-term declines in banana prices are pressuring growers and workers. Low demand and increased production have lowered prices, so studying resource use efficiency and technical efficiency would help identify the reasons for the decline in production and productivity.

## **2. MATERIAL AND METHODS**

### **2.1. Sampling and data collection**

Tamil Nadu's Tiruchirappalli district, traditionally the state's most prominent banana producer, has seen its size and output diminish in recent years and is now in fifth place in terms of banana area. A district with this much potential will not have low levels of output or productivity. There may be significant issues with banana agriculture, which necessitates an investigation into the causes of the decrease in area, production, and productivity in the Tiruchirappalli district.

With a total of 507 revenue villages, the Tiruchirappalli district comprises 14 blocks. In the Tiruchirappalli district, there are 14 blocks, but just two of them, Lalgudi and Andanallur, have 60 per cent of the district's total banana area; hence they were specifically picked for the second stage. There was just 40 per cent of the total banana acreage in the other 12 blocks. In order to get a total sample size of 80, three villages from each of the three blocks were randomly picked based on the area available in the village. An equal sample of 12 farmers was selected randomly from each of the selected six villages. The Assistant Director of Horticulture provided the information required to make the selection at the Department of Agriculture in Tiruchirappalli, Tamil Nadu. A pre-tested interview schedule was used to collect data from the sample farmers.

## **2.2 Methodology**

### **2.2.1 Resource Use Efficiency**

It can handle econometric estimation problems like serial correlation, heteroskedasticity, and multicollinearity well and efficiently. It also makes computations easier and has the properties of uniformity, representability, and flexibility.

The Cobb-Douglas production function can be expressed mathematically as,

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + \beta_7 \ln X_{7i} + u_i$$

where,

Ln represents the natural logarithm

Y is the ascertained farm yield (t/ha);

X<sub>1</sub> is the total seedling (sucker rate) (Nos/ha);

X<sub>2</sub> is the total organic manure (t/ha);

X<sub>3</sub> is the quantity of Chemical Fertilizer applied (tons/ha);

X<sub>4</sub> is the quantity of Micronutrient applied (kg/ha);

X<sub>5</sub> is the unit of plant protection chemicals (Nos/ha);

X<sub>6</sub> is the total machine hours used (hrs/ha); and

X<sub>7</sub> is the labour use of family and employed labour (person-days/ha).

e = Base of the natural logarithm

U = Stochastic random error term

Where  $\beta_0$  is intercept and  $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7,$  and  $\beta_8$  are the coefficients of the regression.  $u_i$  is normally and independently distributed with zero mean and constant variance.

## 2.2.2 Technical Efficiency analysis

### 2.2.2.1 Stochastic frontier analysis

A higher yield (direct and indirect) is expected to result from adopting new technology, which leads to increased productivity and a higher income. Technical efficiency (TE) was estimated to determine the causes of efficiency (or inefficiency) and whether technology adaptation leads to higher efficiency. According to the Battese and Coelli (1995) [2] stochastic function approach, all parameters were estimated using a single-stage maximum likelihood (ML) procedure, with the technical inefficiency effects in a stochastic frontier being an explicit function of other farm-specific explanatory variables. as follows: The stochastic frontier is described by

$$\ln Y_i = \beta_0 + \sum \beta_j \ln(X_{ij}) + (v_i - u_i)$$

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + \beta_7 \ln X_{7i} + \beta_8 \ln X_{8i} + v_i - u_i$$

where,

Ln represents the natural logarithm;

Y is that the ascertained farm yield (t/ha);

X<sub>1</sub> is the total sucker rate (Nos/ha);

X<sub>2</sub> is the total organic manure (t/ha);

X<sub>3</sub> is the quantity of nitrogen applied (kg/ha);

X<sub>4</sub> is the quantity of phosphorous applied (kg/ha);

X<sub>5</sub> is the quantity of potash applied (kg/ha);

X<sub>6</sub> is the amount spent on plant protection chemicals (Rs./ha);

X<sub>7</sub> is the total machine hours used (hrs/ha); and

X<sub>8</sub> is the labour use of family and employed labour (person-days/ha).

Where  $\beta_0$  is intercept and  $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7,$  and  $\beta_8$  are the coefficients of the regression.

The above equation has two error terms - one ( $v_i$ ) to account for random shocks (weather conditions, disease, measurement errors in the output variable. and the combined effects of unobserved/uncontrollable inputs on production) and the other ( $u_i$ ) to account for technical inefficiency in production. The  $v_i$  is a random error assumed to be independently and identically distributed  $N(0, \sigma_v^2)$  and independent of the  $u_i$ ;  $u_i$  is a non-negative random variable. The model, defined by the above equation, is a stochastic frontier function because the random error ( $v_i$ ) can be positive or negative, and the output values are bounded above by the stochastic (random) variable,  $\exp(X_i \beta + v_i)$ .

The estimation of technical efficiencies is based on the conditional expectation of  $\exp(-u)$ , given the model specification (Coelli, 1996, George E Battese & Broca, 1997).

### 3. RESULTS AND DISCUSSION

#### 3.1. Estimation of Resource use efficiency of banana

Cobb-Douglas production was used to estimate the output elasticity with esteem to the primary inputs in banana production. The assessed Cobb-Douglas production function for banana is fitted out in table 3.1.

**Table 3.1. Estimation of Resource Use Efficiency in the banana farms**

(N = 80)

| Sl. No. | Variables               | Regression coefficient | Standard error |
|---------|-------------------------|------------------------|----------------|
| 1.      | Intercept               | 1.949 <sup>NS</sup>    | 8.540802007    |
| 2.      | Sucker                  | - 0.281 <sup>NS</sup>  | 0.982725274    |
| 3.      | Machine labor           | 0.032 <sup>NS</sup>    | 0.055447375    |
| 4.      | Organic Manure          | 0.401 <sup>**</sup>    | 0.10861908     |
| 5.      | Chemical fertilizer     | 0.795 <sup>**</sup>    | 0.272910577    |
| 6.      | Micronutrient           | 0.408 <sup>*</sup>     | 0.19887444     |
| 7.      | Plant protection cost   | 0.229 <sup>NS</sup>    | 0.16599066     |
| 8.      | Labour                  | 1.350039184            | 0.754253035    |
|         | R <sup>2</sup>          | 0.70                   |                |
|         | Adjusted R <sup>2</sup> | 0.68                   |                |

**Note:** \*\*Significant at 1 percent level \*Significant at 5 percent level NS Non-significant

From Table 3.1, we may deduce that the multiple determinations ( $R^2$ ) coefficients were 0.70 and the adjusted ( $R^2$ ) coefficients were 0.68. It found that the independent factors in the model were responsible for 70per cent of the variance in banana production. The coefficients in the Cobb-Douglas production function describe the production elasticity for the resources employed. Inputs such as organic manure, chemical fertilizer (Sakamma and Umesh,2018), and micronutrients substantially impact yield.

The Cobb-Douglas production function found that organic manure, chemical fertilizer, and micronutrients impacted banana crops. All of the variables positively affect the banana crop are essential. The predicted elasticity values revealed that a one per cent increase in organic manure, chemical fertilizer, and micronutrient would improve output by 0.40, 0.79, and 0.40 per cent, respectively. This

research indicated that chemical and organic fertilizers impacted banana yields, but organic fertilizers are highly significant.

### 3.2. Technical Efficiency of Banana farms in Tiruchirappalli district

In this study, the Maximum Likelihood Estimator technique was used to estimate the stochastic frontier production function of the Cobb-Douglas form to measure banana farmers' technical efficiency.

**Table 3.2. Maximum Likelihood Estimates for banana production in Tiruchirappalli district**

| Variables                         | Parameters            | Standard error | z-value |
|-----------------------------------|-----------------------|----------------|---------|
| Intercept                         | 6.8891                | 0.1562         | 44.09   |
| Farmyard manure                   | -0.0355 <sup>NS</sup> | 0.0560         | -0.63   |
| Sucker rate                       | -0.0754 <sup>**</sup> | 0.0132         | -5.68   |
| Nitrogen                          | -0.0070 <sup>NS</sup> | 0.0819         | -0.09   |
| Phosphorous                       | 0.0285 <sup>NS</sup>  | 0.1356         | 0.21    |
| Potash                            | -0.0996 <sup>**</sup> | 0.0076         | -13.01  |
| Plant protection chemical (Rs)    | 0.0073 <sup>**</sup>  | 0.0025         | 2.89    |
| Machine hours (Man days)          | -0.0801 <sup>NS</sup> | 0.0765         | -1.05   |
| Human labor (Man days)            | 0.0469 <sup>*</sup>   | 0.0241         | 1.94    |
| Lambda ( $\lambda$ )              |                       | 2.1913         |         |
| Sigma <sup>2</sup> ( $\sigma^2$ ) |                       | 1.444          |         |
| Sigma (v)                         |                       | 0.4526         |         |
| Sigma (u)                         |                       | 0.9918         |         |
| Variation in efficiency           |                       | 82.7636        |         |

Note: \*\* 1 per cent Significant level, \* 5 per cent Significant level, NS Non-significant

According to Table 3.2, plant protection cost and human labour in man-days positively impacted output at the one per cent and five per cent levels. On the other hand, sucker rate and potassium fertilizer were found to have a negative impact on yield at the one per cent level. The diagnostic variances ' $\sigma^2$ ' and ' $\lambda$ ' were both positive, demonstrating that the farm-specific variability contributed more to the variability in the output. This indicated that the overall variation in the production from the frontier is attributed to technical efficiency. The estimated value of the lambda ( $\lambda$ ) parameter in banana farms is 2.1913, which indicates that the total error variation is mainly attributable to inefficiency, whereas random errors play a much smaller role in the overall picture. The estimated variation in efficiency sigma u is 0.991848, much more considerable than the random error variance, whereas the Sigma v value is 0.4526 and the percentage of total variation due to efficiency is 82.763 per cent.

**Table 3.3. Technical efficiency distribution of banana farmers in Tiruchirappalli district**

| S.No. | Range | Frequency | Per centage |
|-------|-------|-----------|-------------|
| 1.    | < 50  | 8.00      | 10.81       |

|                                 |         |        |        |
|---------------------------------|---------|--------|--------|
| 2.                              | 51 - 60 | 15.00  | 20.27  |
| 3.                              | 61 -70  | 21.00  | 28.37  |
| 4.                              | 71 – 80 | 17.00  | 22.99  |
| 5.                              | 81 - 90 | 8.00   | 10.81  |
| 6.                              | > 91    | 5.00   | 6.75   |
|                                 |         | 74.00  | 100.00 |
| Mean Technical Efficiency (MTE) |         | 0.7121 |        |

Table 3.3 shows how banana farmers vary in how well they use technology. In the Tiruchirappalli district, 28.37 per cent of banana farmers have technical efficiency between 61 and 70 per cent, around 23 per cent have technical efficiency between 71 and 80 per cent, and 20.27 per cent have technical efficiency between 51 and 60 per cent. Noteworthy is the fact that the average technical efficiency of banana farmers in the Tiruchirappalli district's Lalgudi and Andanallur blocks was 71.21 per cent for banana growers.

#### 4. Conclusion

The study focused on assessing resource use and technical efficiency in banana plantations. The resource use efficiency results outlined that inputs like organic manure, chemical fertilizer, and micronutrients were statistically significant across banana farms and implied that the above inputs were the most determining factors influencing the yield. Hence, it should be appropriately allocated to enhance output and technical efficiencies. The independent variables that positively influenced the output of bananas should be increased dose by dose in different stages of growth to enhance farm production. The overdose of specific inputs should be avoided. It is observed from the study area that the farmers were technically efficient, with an average technical efficiency of above 70 per cent, indicating that most of the farmers in the study area were found to be technically knowledgeable and aware of the cultivation practices adopted for banana cultivation.

Proper variety should be selected, and sowing should be done in the correct season to avoid loss caused by natural calamities. Farmers should follow good production technology, such as using an appropriate amount of chemical fertilizer at the right time, and using high-quality suckers and the correct population in areas where the sucker rate among farmers was low, and labour should be used for appropriate field practices during the crucial stage. Government has to strengthen the extension activities by properly disseminating information about the proper production technology and should make awareness about the availability of quality suckers in Formal Institutions.

#### CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

#### REFERENCES

1. Alagumani, T. (2005). Economic analysis of tissue-cultured banana and sucker-propagated banana. *Agricultural Economics Research Review*, 18(347-2016-16655), 81-90.
2. Arti, P., & Leua, A. (2020). An analysis of resources use efficiency of Banana for South Gujarat. *IAHRW International Journal of Social Sciences Review*, 8(7-9), 274-277.

3. Coelli, T. J., & Battese, G. E. (1996). Identification of factors which influence the technical inefficiency of Indian farmers. *Australian journal of agricultural economics*, 40(2), 103-128.
4. Coelli, T.J., A Guide to Frontier, Version 4.1: A Computer Programme for Stochastic Frontier Production and Cost Function Estimation, CEPA Working Paper, No.7/96, Department of Econometrics, University of New England, Armidale, Australia, 1996.
5. Dulal, S., & Kattel, R. R. (2020). Resource use efficiency of banana production and impact of insurance scheme adoption on banana farming in Chitwan, Nepal. *International Journal of Applied Sciences and Biotechnology*, 8(2), 170-178.
6. Felix, K. T., Gopal, S. M., Ashok, K. R., Panneerselvam, S., & Duraisamy, M. R. (2018). Technical efficiency of maize production in different vulnerable agro climatic zones of Tamil Nadu. *Journal of Pharmacognosy and Phytochemistry*, 7(4), 498-502.
7. Hossain, M. M., Alam, M. A., & Uddin, M. K. (2015). Application of stochastic frontier production function on small banana growers of kushtia district in Bangladesh. *Journal of Statistics Applications & Probability*, 4(2), 337.
8. Jayaram, H., Chandrashekar, G. S., & Achoth, L. (1992). An economic analysis of technical efficiency in rice cultivation in Mandya: Some issues in resource pricing. *Indian Journal of Agricultural Economics*, 47(902-2018-3178), 677-683.
9. Jeffery, M. (2013). Banana-Their history, cultivation and production (Facts and figures details. com). Ministry of National Food Security and Research, Islamabad. Pakistan.
10. Karthick, V., Alagumani, T., & Amarnath, J. S. (2013). Resource–use efficiency and technical efficiency of turmeric production in Tamil Nadu—A Stochastic Frontier Approach. *Agricultural Economics Research Review*, 26(347-2016-17070), 109-114.
11. Ray, M., Roy, D. C., & Zaman, A. (2016). Evaluation of rice (*Oryza sativa*)-based cropping systems for increasing productivity, resource-use efficiency and energy productivity in coastal West Bengal. *Indian Journal of Agronomy*, 61(2), 131-137.
12. Sakamma, S., Umesh, K. B., & Rangegowda, R. (2018). Resource use efficiency and externality associated with banana production in Karnataka, (India).
13. Vinayagamoorthi, N., Sekhar, C., Palanichamy, N. V., Harishankar, K., & Balaji, P. (2019). Technical efficiency of banana production in central Tamil Nadu. *International Research Journal of Agricultural Economics and Statistics*, 10(1), 122-132.
14. Yekti, A., Hadi, D. D., Jamhari, J., & Hartono, S. (2015). Technical efficiency of melon farming in Kulon Progo: A stochastic frontier approach (SFA). *International Journal of Computer Applications*, 132(6), 15-19.
15. FAO Statistics (2021), Food and Agricultural Organization, <https://www.fao.org/faostat/en/#data/QV>