# Assessing the efficiency and profitability potentials of honey input supply: The case of South West Nigeria

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**The problem of limited understanding of the efficiency and profitability of the input supply in the honey industry has hindered the development of effective strategies and interventions. This study bridged the gaps by assessing the efficiency and profitability of input suppliers in South West Nigeria using data from 144 respondents. The analyses employed included descriptive statistics, budgetary techniques, the stochastic frontier model, and the relative importance index. Results indicate male dominance in the industry, with a gross margin of ₦581,260.00 and a profit of ₦267,760.00. Technical efficiency averages 0.93, while economic efficiency stands at 0.56. The main challenges include electricity problems, lack of capital, outdated technology, and high material costs. The study recommends promoting factors that improve efficiency to boost output and income for input suppliers. The research leads to a better understanding of honey input supply efficiency in South West Nigeria, aiding evidence-based decisions for industry stakeholders.**

**Keywords**: Efficiency, honey, input supply, profitability, stochastic frontier model

The agricultural sector in Nigeria has remained undeveloped and relies heavily on a traditional agricultural system with deteriorated low fertile soils, low modern farm input use, lack of storage facilities, as well as high crop losses before and during harvest (Bjornlund et al. 2020; Ikuemonisan et al. 2020; Olutumise 2022). This has resulted in low productivity and fluctuating agricultural product prices (Adedeji and Omoba 2016; Olutumise 2022). Despite these difficulties, agriculture, which employs approximately 70% of Nigeria's workforce, is a vital engine of the country's economy. Honey production can help alleviate poverty and provide food security by turning honey into a valuable commercial commodity for the beekeepers that maintain bees, collect honey, and process it (Adebo and Osundare 2015; Adedeji and Omoba 2016; Orji et al. 2020). Honey is a very profitable enterprise in many parts of the globe because of its many economic and health benefits. Okpokiri et al. (2015) and Adedeji and Omoba (2016) affirmed the profitability of beekeeping enterprises in Nigeria; Santos et al. (2018) and Etxegarai-Legarreta and Sanchez-Famoso (2022) reported that honey production is very lucrative in Brazil and Spain, respectively, while Vaziritabar and Esmaeilzade (2016) reported that honey production is profitable in Iran. As long as it is correctly managed, honey production may easily co-exist with other agricultural operations, such as crop cultivation, horticulture, and animal husbandry (Ibrahim et al. 2021). In addition, bees perform a vital environmental function by pollinating 75% of world crops, thus directly contributing to strengthening food security and increasing yields (Amulen et al. 2019). Also, the sales of honey by-products like beeswax, royal jelly,



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and bee venom can be a valuable source of income for beekeepers (Dagnachew 2020).

The honey industry plays a significant role in the agricultural sector of Nigeria, particularly in the South West, where the favourable climate and abundant floral resources support thriving beekeeping activities (Okpokiri et al. 2015; Adedeji and Omoba 2016; Ibrahim et al. 2021). However, despite the importance of honey production, there is a lack of comprehensive research specifically focusing on the efficiency and profitability of the honey input supply chain in the region. This knowledge gap hinders the development of evidence-based strategies and interventions to improve the performance of honey production. One fundamental issue that needs to be addressed is the limited understanding of the costs and returns associated with honey input supply. Previous studies (Okpokiri et al. 2015; Biruk et al. 2018; Amulen et al. 2019) have not adequately explored the dynamics of costs and returns, leading to a lack of critical information for decision-making and resource allocation. To ensure the sustainable growth of the honey industry, it is crucial to assess the economic viability of input suppliers and identify factors that contribute to their profitability. Furthermore, there is a dearth of research that comprehensively evaluates the technical, economic, and allocative efficiencies of honey input suppliers, especially in Nigeria. Previous studies (Okpokiri et al. 2015; Shrestha et al. 2016; Dagnachew 2020) focused on specific aspects of efficiency or lacked a comprehensive analysis, making it challenging to compare the performance of input suppliers accurately. Understanding the levels of technical, economic, and allocative efficiencies is essential for identifying areas of improvement and implementing targeted interventions to enhance the productivity and profitability of honey production. Another research gap is the limited identification and analysis of the major challenges faced by honey input suppliers in the study area of South West Nigeria. Therefore, without a comprehensive assessment of these challenges, it will be difficult to develop effective strategies and interventions to address them. This study aimed to bridge these gaps by examining honey input supply efficiency and profitability in South West Nigeria. It assessed costs, returns, technical, economic, and allocative efficiencies, and identifed key challenges faced by input suppliers. It sought to provide valuable insights for stakeholders and policymakers to enhance the honey industry performance and sustainability, promoting evidence-based decision-making and improving the livelihoods of input suppliers.

## Materials and methods

The study was conducted in South West Nigeria which is located between 2° 31 - 6° 00 E and 6° 20 - 8° 37 N (Figure 1). The respondents to this study are made up of input suppliers in the honey value chain. Input suppliers manufacture and supply the beekeeping equipment or materials used by beekeepers (producers) and other actors in the value chain. Data used for the study were collected from primary sources, through a direct personal interview using a well-structured questionnaire. A multistage sampling procedure was used to select the respondents for the study. In the first stage, three states were purposively selected from the six states in South West Nigeria. Ondo, Ekiti, and Ogun States were selected based on the preliminary investigations which revealed that beekeeping is widely practiced in those states. The second stage involved a purposive selection of six local government areas from each of the three states where beekeeping practice is prominent. The local government areas (LGAs) selected in Ondo State were Odigbo, Ile-Oluji/Okeigbo, Ondo West, Akure South, Owo and Ose. In Ekiti State, the LGAs were Ise /Orun, Ikere, Ikole, Oye, Ado, and Ijero. In Ogun State, the LGAs were Abeokuta North, Odeda, Ijebu-East, Ijebu Ode, Odogbolu, and Yewa North. In the third stage, a community was purposively selected in each LGA based on the population of the input suppliers in the LGAs as supplied by the Agricultural Development Programme office. In each of the 18 communities, eight respondents were randomly selected from each community to have a total of 144 respondents.

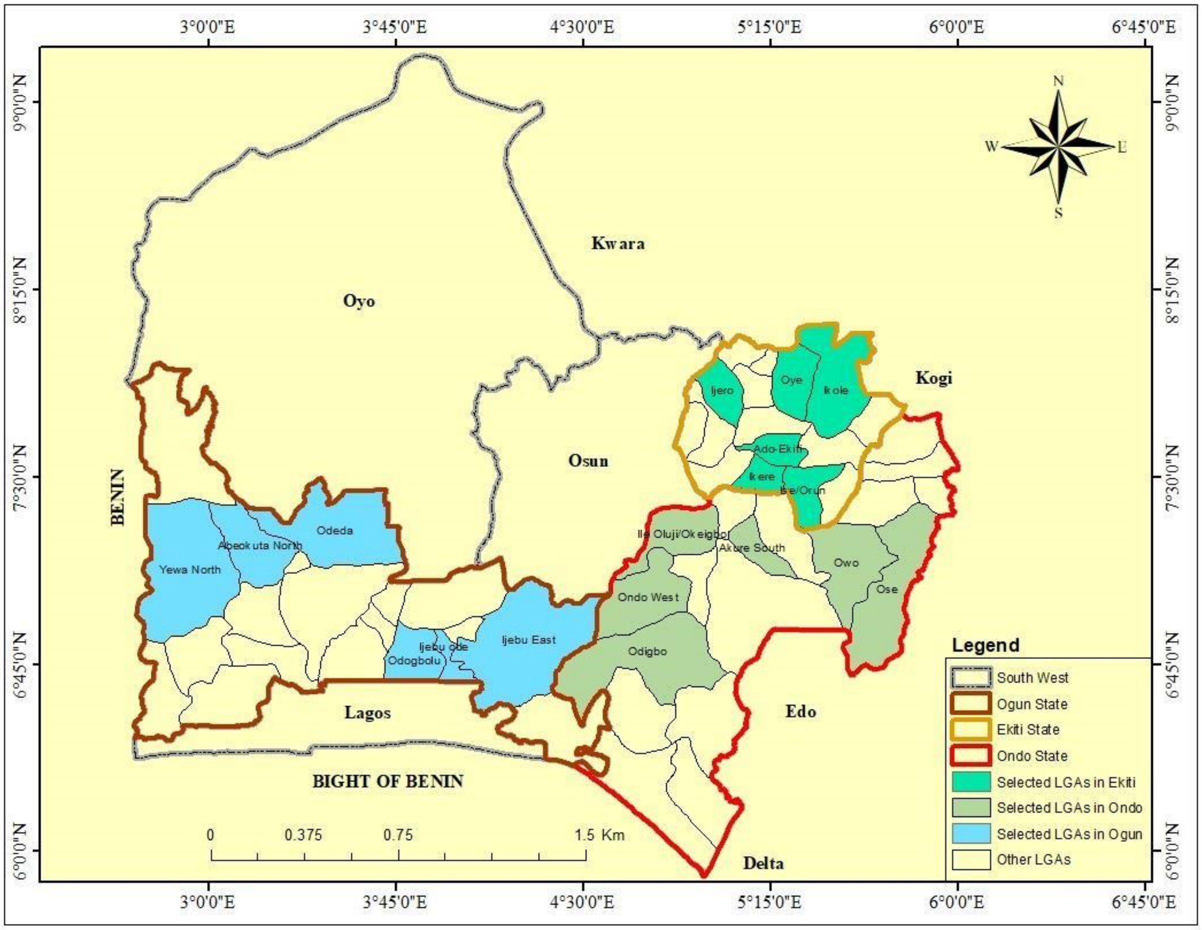


Figure 1: Map of South West, Nigeria.

## Analytical tools

Data collected were analysed using descriptive statistics, budgetary analysis, stochastic frontier model, and relative importance index.

## Model specifications

Budgetary analysis

Gross margin is a financial tool used to estimate the costs and returns of an investment (Taphe et al. 2015):

$$GM = P_i Q_i - \sum_{i=1}^{m} C_j X_j$$

GM = farm gross margin; $P_i$ = market price of output/L or kg received by input supplier i; $Q_i$ = quantity of output sold by input supplier i, per cycle or annum; $C_j$ = unit price of the variable input *j* incurred by the input supplier i; $X_j$ = quantity of variable inputs *j* used by the input supplier; m = number of input suppliers.

Capital turnover is a measure of how effectively a business organisation uses its assets to produce sales:

$$\text{Capital turnover} = \frac{Total\ Revenue}{Total\ Cost} = \frac{TR}{TC}$$

Net income is the profit a business earns after all expenses have been deducted:

$$NI = GI - TC$$

NI = net income; GI = gross farm income; TC = total costs.

Economic efficiency is a measure of how well a market or the firms within it are performing:

$$EE = \frac{NI}{TC}$$

EE = economic efficiency; NI = net income;
TC = total costs.

Return on investment (ROI) is a performance measure used to evaluate the efficiency of an investment:

$$ROI = \frac{Net\ Profit}{Cost\ of\ Investment} \times 100$$

## Stochastic frontier production function

The two fundamental methods for assessing technical efficiency are the classical and frontier approaches. Due to the limitations of the classical approach, economists have developed more advanced techniques, including econometrics, statistics, and linear programming, all focused on the concept of a production frontier (Ogundari et al. 2006; Abdul-Malik and Mohammed 2012); efficient firms operate on this frontier, while inefficient ones operate below it (Abdul-Malik and Mohammed 2012; Olutumise et al. 2023). A parametric frontier approach was chosen because of the many variations underlying small-scale production in developing countries (Ogundari et al. 2006; Shrestha et al. 2016; Wu 2020). The stochastic frontier method decomposes errors into random errors and farm-specific inefficiencies (Babiker et al. 2017; Bibi et al. 2021; Khoiriyah et al. 2023). The mathematical expression is shown below, with variables and parameters described in Table 1.

$$\ln Q = \beta_0 + \beta_1 \ln X_1 + \beta_2 nX_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + (V_i - U_i)$$

Table 1: Description of the stochastic frontier production function variables

| Code | Variable name | Measurement | Expected sign |
|---|---|---|---|
| Q | Value of input supplied | Continuous: monetary value (Naira) | |
| $X_1$ | Cost of constructing the extractor | Continuous: monetary value (Naira) | -/+ |
| $X_2$ | Labour used | Continuous: man-day | - |
| $X_3$ | Cost of constructing beehives | Continuous: monetary value (Naira) | -/+ |
| $X_4$ | Cost of constructing smokers | Continuous: monetary value (Naira) | -/+ |
| $X_5$ | Depreciation cost on fixed inputs used | Continuous: monetary value (Naira) | -/+ |
| $X_6$ | Transportation cost | Continuous: monetary value (Naira) | - |
| $X_7$ | Unit price of input supplied | Continuous: monetary value (Naira) | -/+ |

ln: natural logarithm; $\beta_0 - \beta_7$ = parameters estimated
$V_i$ = random variables which are assumed to be IID $N(0,\sigma_V^2)$, and independent of the $U_{it} = (U_i \exp(-\eta(t-T)))$; $U_i$ = non-negative random variables which are assumed to account for technical inefficiency in production and are assumed to be IID as truncations at zero of the $N(\mu,\sigma_U^2)$ distribution; $\eta$ = parameter to be estimated; and the panel of data need not be complete (i.e., unbalanced panel data).

## Stochastic frontier cost function model

The two commonly used stochastic production functions are Cobb-Douglas and translog (Bibi et al. 2021). The Cobb-Douglas form is adopted for its simplicity and wide use in agricultural production technologies in many developing countries (Bravo-Ureta et al. 2012; Bibi et al. 2021; Olutumise et al. 2023). The model incorporates a deterministic component in the cost frontier function with the behaviour of the inefficiency component, and all parameters are estimated in one-step maximum likelihood estimation (Ogundari et al. 2006).

The Cobb-Douglas function is implicitly written as:

$$Y_i = f(\beta_0 X_i^{bi} e_i)$$

In the case of the cost frontier, the model is re-written as:

$$\ln C_i = f(P_i, Y_i; b).(V_i + U_i)$$

$C_i$ is the total production cost incurred by the i^th^ input supplier; $Y_i$ is the output level; $P_i$ is a vector of input prices; b is a vector of parameters to be estimated; $f(P_i, Y_i; b)$ is the minimum cost frontier; $V_i$ represents random effects: $U_i$ represents the inefficiency.

The Cobb-Douglas cost function used in this study is explicitly expressed below, with the variables and parameters described in Table 2.

$$\ln C_i = \beta_0 + \beta_1 \ln P_1 + \beta_2 \ln P_2 + \beta_3 \ln P_3 + \beta_4 \ln P_4 + \beta_5 \ln P_5 + \beta_6 \ln P_6 + \beta_7 \ln Y + (V_i + U_i)$$

Table 2: Description of the stochastic frontier cost function variables

| Code | Variable name | Measurement | Expected sign |
|---|---|---|---|
| $C_i$ | Total production cost | Continuous: monetary value (Naira) | |
| $P_1$ | Wage rate | Continuous: monetary value (Naira) | - |
| $P_2$ | Cost of constructing beehives | Continuous: man-day | -/+ |
| $P_3$ | Cost of constructing smokers | Continuous: monetary value (Naira) | -/+ |
| $P_4$ | Cost of constructing the extractor | Continuous: monetary value (Naira) | -/+ |
| $P_5$ | Cost of constructing other beekeeping equipment | Continuous: monetary value (Naira) | -/+ |
| $P_6$ | Transportation cost | Continuous: monetary value (Naira) | - |
| Y | Value of input supplied | Continuous: Monetary value (Naira) | + |

ln: natural logarithm; $\beta_0 - \beta_6$ = parameters estimated.
$V_i$ = random variables which are assumed to be IID $N(0,\sigma_V^2)$, and independent of the $U_{it} = (U_i \exp(-\eta(t-T)))$; $U_i$ = non-negative random variables which are assumed to account for cost inefficiency in production and are assumed to be IID as truncations at zero of the $N(\mu,\sigma_U^2)$ distribution; $\eta$ = parameter to be estimated; and the panel of data need not be complete (i.e., unbalanced panel data).

## Allocative efficiency

Allocative efficiency (AE) is the ability to use the inputs available to their optimal ratio given their respective prices and available production technology (Olutumise et al. 2023). Thus, the AE index can be obtained from the EE values assuming that EE = TE x AE.

Therefore $AE = \frac{EE}{TE}$

EE = economic efficiency; TE = technical efficiency.

## Empirical specification of inefficiency model

The allocative efficiency of the production inputs is determined by estimating an average response model using ordinary least squares. The score is regressed against the socioeconomic factors to obtain its determinants. The explicit function of the model is shown in the equation below and the variables and the parameters are described in Table 3.

$$\mathrm{Exp}(-U_i) = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \ldots + \delta_{11} Z_{11} + \varepsilon_i$$

Table 3: Description of the variable determinants of allocative efficiency

| Code | Variable name | Measurement | Expected sign |
|---|---|---|---|
| Exp (-Ui) | Allocative efficiency | Continuous: monetary value (Naira) | |
| $Z_1$ | Age of the respondents | Continuous: years | -/+ |
| $Z_2$ | Sex | Dummy: male = 1 and female = 0 | + |
| $Z_3$ | Marital status | Dummy: married = 1 and 0, otherwise | -/+ |
| $Z_4$ | Educational status | Dummy: educated = 1 and 0, otherwise | + |
| $Z_5$ | Experience | Continuous: number of years spent in input supplying | + |
| $Z_6$ | Household size | Discrete: numbers | -/+ |
| $Z_7$ | Extension contacts | Discrete: number of visits per year | + |
| $Z_8$ | Technology used | Dummy: 1 = modern and 0 = traditional | + |
| $Z_9$ | Association membership | Dummy: 1 = member and 0, otherwise | + |
| $Z_{10}$ | Access to credit | Dummy: 1 = access and 0, otherwise | + |
| $Z_{11}$ | Source of labour | Dummy: 1 = combined hired and family labour, and 0, otherwise | + |

$\varepsilon_i$ = the two-sided error term; $\delta_1$- $\delta_{11}$ = vector of parameters (coefficients) estimated.

Relative importance index (RII)

Relative importance index (RII) was utilised to find the most popular factor to choose based on the replies of participants. Following Oseni et al. (2018), a four-point scale ranging from 1 (not at all) to 4 (extremely severe) was chosen and turned into relative importance indices (RIIs) for each issue, choice, and/or solution.

$$RII = \frac{\sum W}{A*N}$$

Where: $W$ is the weighting given to each problem by respondents (1 to 4); A represents the highest weight (4); $N$ is the total number of respondents. Therefore, the RII value ranges from 0 to 1.

## Results and discussion

Socioeconomic characteristics of the respondents

Table 4 shows the socioeconomic characteristics of the respondent. Most (87.5%) of the input suppliers were male; this agrees with the findings of Biruk *et al.* (2018) that the beekeeping value chain is male-dominated. Also, 93.3% of the respondents were married, with an average age of 47.6 years; the result is consistent with the findings by Shakib and Sayed (2016), indicating that input suppliers tend to be in their productive age. The average years spent in education by the input supplier was 14.9, implying a high level of literacy among the respondents; this may facilitate their understanding and adoption of new technologies, as also reported by Adebo and Osundare (2015). Furthermore, 80.6% of the input suppliers had a family size between 1 and 5 members, with an average of 4 persons; this finding agrees with Oseni et al. (2018) and Olutumise et al. (2023). Only 19.4% of respondents had access to credit/loans, limiting their ability to finance business expansion; this is consistent with the findings of Okpokiri et al. (2015) and Orji et al. (2020) who reported that limited credit accessibility hinders the adoption of modern technologies. The input suppliers had an average of 8.5 years of experience; this suggests that many respondents may have developed expertise over time. Lastly, 38.9% of input suppliers were members of cooperative societies; Shakib and Sayed (2016) reported that cooperative membership can facilitate entrepreneurial development by providing informal loans to members.

Table 4: Socioeconomic characteristics of honey input suppliers in the study area

| Variables | Frequency | Percentage | Mean value | Standard deviation |
|---|---|---|---|---|
| Gender | | | - | - |
| Male | 126 | 87.5 | | |
| Female | 18 | 12.5 | | |
| Marital Status | | | - | - |
| Single | 14 | 9.3 | | |
| Married | 130 | 90.3 | | |
| Age | | | 47.6 | **12.2** |
| < 20 | 10 | 6.5 | | |
| 20 – 40 | 22 | 15.5 | | |
| 41 – 60 | 82 | 56.9 | | |
| >60 | 30 | 20.9 | | |
| Number of years of education | | | 14.9 | **4.5** |
| 1 – 4 | 4 | 2.8 | | |
| 5 – 9 | 0 | 0.0 | | |
| 10 – 14 | 50 | 34.7 | | |
| >14 | 90 | 52.5 | | |
| Household size | | | 4 | **1.5** |
| 1 – 5 | 116 | 80.6 | | |
| 6 – 10 | 28 | 19.4 | | |
| Access to credit | | | | |
| Yes | 28 | 19.4 | | |
| No | 116 | 80.6 | | |
| Years of business experience | | | 8.5 | **7.2** |
| 1 – 10 | 98 | 68.1 | | |
| 11 – 20 | 38 | 26.3 | | |
| >20 | 8 | 5.6 | | |
| Membership of cooperative society | | | | |
| Yes | 56 | 38.9 | | |
| No | 88 | 61.1 | | |
| Sources of inputs | | | | |
| Local materials/markets | 105 | 72.9 | | |
| Foreign materials/international market | 6 | 4.2 | | |
| Urban markets | 33 | 22.9 | | |
| Channels of output sales | | | | |
| Point of production | 99 | 68.7 | | |
| Local markets | 22 | 15.3 | | |
| Urban market | 23 | 16.0 | | |

## Costs and returns analysis of the honey input suppliers

The budgetary analysis is presented in Table 5. The variable costs accounted for 34.45% of the total cost, with fixed costs making up the remaining 65.55%. This summed up to a total cost of ₦478,240.00, while the total revenue accrued was ₦746,000.00. The gross margin was ₦581,260.00, while the profit was ₦267,760.00, indicating a profitable enterprise. The value of return on investment (ROI) of 55.99% implies that an input supplier can repay interest on any loan collected for the business. The value of the capital turnover ratio of 1.56 indicated that respondents would realise ₦1.56k on every naira expended on the business affirming the profitability of the enterprise. The economic efficiency ratio of 0.56 underscores the effective utilisation of resources in input supplies. These results align with previous studies by Fatuase et al. (2015) and Al-Ghamdi et al. (2017), who reported similar capital turnover ratios of 1.55 and 1.56, respectively.

Table 5: Costs and returns among honey input suppliers

| Item | Mean (₦) | % of total cost |
|---|---|---|
| **Variable costs** | | |
| Transporting materials to the workshop | 20,000 | 4.18 |
| Labour | 14,740 | 3.08 |
| Beesuit materials | 25,000 | 5.23 |
| Smokers' stainless plates | 20,000 | 4.18 |
| Wood | 50,000 | 10.46 |
| Honey extractor materials | 25,000 | 5.23 |
| Nails and waterproof cover | 10,000 | 2.09 |
| **Total variable costs (TVC)** | **164,740** | **34.45** |
| **Fixed costs** | | |
| Depreciation on hand saw | 6,000 | 1.25 |
| Depreciation on hammer | 2,500 | 0.52 |
| Depreciation on plane machine | 35,000 | 7.32 |
| Depreciation on sewing machine | 50,000 | 10.46 |
| Depreciation on welding machine | 95,000 | 19.86 |
| Depreciation on generating plant | 70,000 | 14.64 |
| Depreciation on grinding machine | 25,000 | 5.23 |
| Depreciation on workshop rent | 30,000 | 6.27 |
| **Total fixed costs** | **313,500** | **65.55** |
| **Total cost (TC)** | **478,240** | **100.00** |
| **Total revenue (TR)** | **746,000** | |
| **Gross margin = TR – TVC** | **581,260** | |
| **Profit = NI = (TR – TC)** | **267,760** | |
| **Capital turnover = TR/TC** | **1.56** | |
| **Economic efficiency = NI/TC** | **0.56** | |
| **Expense ratio: expenses divided by net sales (%)** | **64.11** | |
| **ROI: net profit divided by cost of investment (%)** | **55.99** | |

**Note:** $1 US = ₦460.89

## Estimation of stochastic production function for input suppliers

The maximum likelihood estimates of the stochastic production function are presented in Table 6. The estimated sigma-squared (6.031) is statistically significant and different from zero at a 1% probability level, confirming the appropriateness of the specified distributional assumption for the composite error term, as supported by prior studies (Ogundari et al. 2006; Olutumise et al. 2023). The magnitude of gamma (Γ) is estimated at 0.723, indicating that 72.3% of the variation in the value of input supplied in the study area could be attributed to technical efficiency.

The analysis revealed the costs of extractors and smokers were positive and significantly increased the value of input supplied. This can be attributed to suppliers passing on increased cost of materials to their products due to the lack of market organisation among actors. However, the coefficients for labour and other inputs showed negative and significant relationships with the income of honey input suppliers. This is likely due to increased production costs associated with higher labour expenses and input costs, which can reduce overall profits. The negative and significant coefficient of labour contradicted the findings of Ogundari et al. (2006) and Olutumise et al. (2023) among peasant farmers in Nigeria.

Table 6: Maximum likelihood estimates of the stochastic production function for input suppliers

| Variable | Parameter | Coefficient | Std. error | t-value |
|---|---|---|---|---|
| Constant | $\beta_0$ | 11.131*** | 4.290 | 2.594 |
| Cost of extractor materials | $\beta_1$ | 1.704*** | 0.462 | 3.684 |
| Labour | $\beta_2$ | -0.598* | 0.326 | -1.834 |
| Cost of wood for beehive | $\beta_3$ | 0.697** | 0.343 | 2.035 |
| Cost of smokers' plate | $\beta_4$ | 0.182* | 0.094 | 1.936 |
| Other inputs | $\beta_5$ | -1.158*** | 0.256 | -4.526 |
| Transportation | $\beta_6$ | -0.376 | 0.543 | -0.692 |
| Price | $\beta_7$ | 0.179 | 0.154 | 1.161 |
| Sigma-squared | $\sigma^2$ | 6.031*** | 1.019 | 5.916 |
| Gamma | Γ | 0.723*** | 0.028 | 26.097 |
| Likelihood ratio test | -166.852 | | | |

*,**, and *** indicate significance at 10, 5, and 1% respectively.

## Estimation of stochastic cost function for input suppliers

The results shown in Table 7 indicate that the sigma square ($\sigma^2$) indicates a good fit and correctness of the specified assumption of the composite distribution of the error terms. The value of gamma (Γ) was 0.699, which means that 69.9% of the variation in the total cost of input supplied was due to their cost-effectiveness. The coefficient estimate shows that wage rate, smokers, and hive costs were positive and significant in affecting the total cost. It can be interpreted that a 1% increase in the costs of labour, beehives, and smokers will significantly increase the total cost of production of inputs by 0.57, 0.47, and 0.18% respectively. The result shows that, on average, input suppliers operate in a state of increasing returns to scale (irrational phase of production) when considering the output against any input used, *ceteris paribus*. The positive and significant coefficient of wage rate (labour costs) is consistent with the findings of Ibrahim et al. (2021).

Table 7: Maximum likelihood estimates of the stochastic cost function for input suppliers

| Variable | Parameter | Coefficient | Std. error | t-value |
|---|---|---|---|---|
| Constant | $\beta_0$ | -1.476 | 0.504 | -2.927 |
| Wage rate (labour) | $\beta_1$ | 0.568*** | 0.061 | 9.263 |
| Beehive cost | $\beta_2$ | 0.468*** | 0.062 | 7.553 |
| Smoker cost | $\beta_3$ | 0.182** | 0.063 | 2.894 |
| Extractor cost | $\beta_4$ | 0.003 | 0.014 | 0.244 |
| Other costs | $\beta_5$ | 0.003 | 0.036 | 0.085 |
| Transport cost | $\beta_6$ | 0.098 | 0.094 | 1.035 |
| Value of input supplied | $\beta_7$ | 0.034 | 0.042 | 0.806 |
| Sigma-squared | $\sigma^2$ | 1.493*** | 0.101 | 14.838 |
| Gamma | Γ | 0.699*** | 0.281 | 2.488 |
| Likelihood ratio test | -67.154 | | | |

*,**, and *** indicate significance at 10, 5 and 1%, respectively

## Allocative efficiency distribution of the input suppliers

The technical efficiency, economic efficiency, and allocative efficiency were found to be 0.927, 0.562, and 0.569, respectively (Table 8). These values indicate that input suppliers achieved about 92.7% of their potential maximum output due to supply efficiency, while slight drop backs of 56.2% and 56.9% of economic and allocative efficiencies, respectively were attributed to inefficiency. A high mean technical efficiency value for honey input suppliers showed a higher level of technical efficiency in the use of inputs than economic and allocative efficiency. The economic efficiency segment of the result shows that about 34.7% of input suppliers were in the efficiency range of 0.61 to 0.80. The allocative efficiency results segment further showed that 27.8% of input suppliers were in the efficiency range of 0.61 to 0.80. When comparing results, most input suppliers are technically efficient. This level of effectiveness could be a consequence of the method adopted in obtaining the necessary inputs in the study area. The average technical efficiency of this study was higher than the value (0.75) obtained by Bravo-Ureta et al. (2012).

Table 8: Technical, economic, and allocative efficiencies of input suppliers

| Efficiency range | Technical | | Economic | | Allocative | |
|---|---|---|---|---|---|---|
| | Frequency | Percent | Frequency | Percent | Frequency | Percent |
| ≤ 0.20 | 2 | 2.78 | 4 | 5.56 | 4 | 5.56 |
| 0.21 – 0.40 | 4 | 5.55 | 17 | 23.61 | 15 | 20.83 |
| 0.41 – 0.60 | 1 | 1.39 | 17 | 23.61 | 19 | 26.39 |
| 0.61 – 0.80 | 7 | 9.72 | 25 | 34.72 | 20 | 27.78 |
| 0.81 – 1.00 | 58 | 80.56 | 9 | 12.50 | 9 | 12.50 |
| > 1.00 | - | - | - | - | 5 | 6.94 |
| Total | 72 | 100.00 | 72 | 100.00 | 72 | 100.00 |
| Mean | 0.927 | | 0.562 | | 0.569 | |
| Standard deviation | 0.116 | | 0.256 | | 0.261 | |
| Minimum | 0.197 | | 0.140 | | 0.142 | |
| Maximum | 0.978 | | 0.999 | | 1.023 | |

## Factors affecting allocative efficiency among the input suppliers in the study area

Table 9 presents the findings from the ordinary least squares analysis that aimed to determine the factors influencing the allocative efficiency of honey input suppliers in the area. The $R^2$ value was 0.598, indicating that almost 60% of the variation in the dependent variable (allocative efficiency) was accounted for by the explanatory variables. The F-value of 24.62 was highly significant at the 1% probability level, confirming that the combined impact of all independent variables significantly affected the allocative efficiency of these input suppliers. The variables; age of input suppliers, experience, extension contacts, membership association, and source of labour; were all positive and significantly influenced allocative efficiency. It means that any increase in their values will significantly increase allocative efficiency, *ceteris paribus*. It can be deduced that older input suppliers might possess valuable experience, skills, and knowledge that aid in better resource allocation. Also, extension agents likely provide valuable education and guidance that enhances allocative efficiency, while being a member of an association could facilitate access to loans and discounted input purchases, which positively influences allocative efficiency. The results agree with the findings of Adebo and Osundare (2015), Dagnachew (2020) and Olutumise (2022).

Table 9: Determinants of allocative efficiency of input suppliers

| Variable | Parameters | Coefficient | Std. Error | P-value |
|---|---|---|---|---|
| Age | $Z_1$ | 0.004* | 0.002 | 0.050 |
| Sex | $Z_2$ | 0.062 | 0.229 | 0.834 |
| Marital status | $Z_3$ | 0.074 | 0.120 | 0.102 |
| Education | $Z_4$ | 0.016 | 0.204 | 0.219 |
| Experience | $Z_5$ | 0.011** | 0.006 | 0.043 |
| Household size | $Z_6$ | -0.026 | 0.111 | 0.113 |
| Extension contacts | $Z_7$ | 0.188* | 0.109 | 0.081 |
| Type of beehive produced | $Z_8$ | 0.012 | 0.105 | 0.420 |
| Membership | $Z_9$ | 0.118** | 0.053 | 0.019 |
| Access to credit | $Z_{10}$ | -0.021 | 0.190 | 0.201 |
| Source of labour | $Z_{11}$ | 0.147* | 0.078 | 0.067 |
| Constant | $Z_0$ | 0.853 | 0.799 | 0.421 |
| $R^2$ | 0.598 | | | |
| F-value | 24.62*** | | | |

*,**, and *** indicate significance at 10, 5, and 1%, respectively.

## Constraints to honey input suppliers

Using RII, the following constraints were identified among input suppliers in the area: electricity problems (1st), lack of capital (2nd), lack of modern technology (3rd), high material cost (3rd), high labour cost (5th), high workshop rental cost (5th), high transportation cost (7th), lack of organised market (8th), and theft (9th) (Table 10).

The lack of reliable electricity infrastructure and insufficient access to funds pose a significant challenge, forcing businesses to rely on costly generators and combustion engines, increasing production expenses. The absence of modern technology limited productivity improvements, leading to continued reliance on outdated methods and tools. The rising costs of materials, exacerbated by economic conditions and limited availability of mature wood, contributed to expensive production processes. The cost of transporting materials to workshops surged due to rising fuel prices, government fees, and association fees, while the absence of an organised market structure led to poor pricing in the input market, affecting supplier profitability. These challenges collectively hampered the efficiency and competitiveness of input suppliers in the honey value chain. The study's findings align with other research in the field. Bhattarai et al. (2020) identified challenges such as insufficient technical knowledge, poor infrastructure, and limited modern inputs in their bee product value chain analysis. Shrestha et al. (2016) found that input suppliers in the honey value chain faced issues related to input material availability, infrastructure, working capital, and financial services.

Table 10: Constraints faced by the input suppliers in the study area

| Constraint | Very serious (4) Freq. | Serious (3) Freq. | Mild (2) Freq. | Not at all (1) Freq. | RII | Rank |
|---|---|---|---|---|---|---|
| Problem of electricity | 40 | 4 | 8 | 20 | 0.63 | 1st |
| Lack of capital | 30 | 14 | 12 | 16 | 0.60 | 2nd |
| Lack of modern technology | 27 | 10 | 8 | 27 | 0.50 | 3rd |
| High cost of materials | 18 | 21 | 11 | 22 | 0.50 | 3th |
| High cost of labour | 9 | 23 | 14 | 26 | 0.40 | 5th |
| High cost of rental of workshop | 10 | 16 | 25 | 21 | 0.40 | 5th |
| High cost of transportation | 6 | 24 | 19 | 23 | 0.39 | 7th |
| Lack of organised market | 12 | 14 | 12 | 34 | 0.35 | 8th |
| Theft | 4 | 7 | 12 | 49 | 0.17 | 9th |

RII: relative importance index

## Conclusion

This study investigated honey input suppliers in South West Nigeria, emphasising their efficiency, profitability, and challenges. The majority of these suppliers are educated, young, married males who source materials locally and sell essential beekeeping products. The honey input supply business is economically viable, yielding a profit that exceeds the initial investment, highlighting potential for income generation and sustainability. The research reveals that honey input suppliers exhibit a high level of technical efficiency, particularly among young, educated males with experience. Households with moderate family sizes, cooperative society memberships, and access to credit are also well-positioned for technical efficiency. However, significant challenges exist in the sector, including the absence of modern technology, inadequate electricity infrastructure, limited access to capital, high material costs, and the lack of organised markets. To foster growth and sustainability in the honey input supply sector, addressing these challenges is imperative. This can be achieved through policy support, investment in infrastructure, provision of financial resources, and the development of organised markets. These measures will contribute to the overall enhancement of the honey industry in South West Nigeria.

## Limitations and future research

The study is focused on South West Nigeria, limiting its findings' generalisability to other regions or countries with different honey industry dynamics. Future research should conduct comparative studies across Nigeria's regions to understand regional variations in the honey input supply industry.

## References


Abdul-Malik, A., and A. Mohammed. 2012. "Technical Efficiency of Beekeeping Farmers in Tolon-Kumbungu District of Northern Region of Ghana." *Journal of Development and Agricultural Economics* **4 (11)**: 304–310.

Adebo, G.M., and F.O. Osundare. 2015. "Assessment of the Fiscal Performance of Bee Keeping for Employment Generation and Poverty Reduction in Osun State, Nigeria." *Journal of Agricultural Studies* **3 (2)**: 237–247.

Adedeji, N.K., and O.J. Omoba. 2016. "An Assessment of Profitability of Honey Production in Edo State, Nigeria." *African Journal of Agricultural Economics and Rural Development* **4 (6):** 442–445.

Al – Ghamdi, A.A., N. Adgaba, Y. Tadesse, A. Getachew, and A. Maktary. 2017. "Comparative Study on the Dynamics and Performances of *Apis Mellifera Jemenitica* and Imported Hybrid Honey bee Colonies in Southwestern Saudi Arabia." *Saudi Journal of Biological Science* **24 (5):** 1086–1093.

Amulen, D.R., M. D'Haese, E. D'Haene, J.O. Acai1, J.G. Agea, G. Smagghe, and P. Cross. 2019. "Estimating the Potential of Beekeeping to Alleviate Household Poverty in Rural Uganda." Nicolas Desenex Institute Sophia Agro-biotech, France.

Babiker, O.M., A.M. Omima, and A.E.A. Sara. 2017. "Estimation of Technical Efficiency and Socio-economic Characteristics Affecting the Technical Efficiency of Crop Production in the Gezira Scheme, Sudan." *International Journal of Research and Review* **4 (3):** 1–5.

Bhattarai, S., S.R. Pandey, S.K. Bhattarai, R. Karn, S. Gurung, A. Chapain, S. Bhatta, and J.P. Dutta. 2020. "Value Chain Analysis of Honey Bee (*Apis mellifera*) Products in Chitwan, Nepal." *Azarian Journal of Agriculture* **7 (1)**: 26-35. http://dx.doi.org/ 10.29252/azarinj.026.

Bibi, Z., D. Khan, and I.U. Haq. 2021. "Technical and Environmental Efficiency of Agriculture Sector in South Asia: A Stochastic Frontier Analysis Approach."

*Environment, Development and Sustainability* **23:**9260–9279.

Biruk, J., G. Endrias, and Z. Lemma. 2018. “Honey Value Chain Analysis and Producers Financing in Damot Gale District, Southern Ethiopia.” *Food Science and Quality Management* **78:**28– 33.

Bjornlund, V., H. Bjornlund, and A.F. Van Rooyen. 2020. “Why Agricultural Production in Sub-Saharan Africa Remains Low Compared to the Rest of the World–A Historical Perspective.” *International Journal of Water Resources Development* **36 (1)**: S20–S53.

Bravo-Ureta, B.E., W. Greene, and D. Solís. 2012. “Technical Efficiency Analysis Correcting for Biases from Observed and Unobserved Variables: An Application to a Natural Resource Management Project.” *Empirical Economics* **43**:55–72.

Dagnachew, W. 2020. “Technical Efficiency and its Determinants of Honey production (The Case of Bibugn District of Amhara Region, Ethiopia).” *Academic Journal of Research and Scientific Publishing* **2 (18)**: 141–172.

Etxegarai-Legarreta, O., and V. Sanchez-Famoso. 2022. “The Role of Beekeeping in the Generation of Goods and Services: The Interrelation Between Environmental, Socioeconomic, and Sociocultural Utilities.” *Agriculture* **12 (4) :** 551.

Fatuase, A.I., L.O. Oparinde, and A.S. Aborisade. 2015. “Performance and Resource-Use Efficiency of Yam Production in Owo Local Government Area of Ondo State, Nigeria.” *Applied Tropical Agriculture* **20 (1)**: 83–88.

Ibrahim, K.H., M.A.S. Abba, K.C.O Margret, I.V. Ogechi, and A.V. Chinenye. 2021. “Apiculture (Beekeeping) an Easy Economic Venture Irrespective of Age Gender Religion and Profession.” *International Journal of Applied Agricultural Sciences* **7 (4)**: 69.

Ikuemonisan, E.S., T.E. Mafimisebi, I. Ajibefun, and K. Adenegan. 2020. “Cassava Production in Nigeria: Trends, Instability and Decomposition Analysis (1970–2018).” *Heliyon* **6 (10).**

Khoiriyah, N., D. Susilowati, D.S. Mintyastuti, R.M. Ali, and D. Forgenie. 2023. “The Technical Efficiency of Chrysanthemum Flower Farming: A Stochastic Frontier Analysis.” *Anjoro: International Journal of Agriculture and Business* **4 (2)**: 50–59.

Ogundari, K., S.O. Ojo, and I.A. Ajibefun. 2006. “Economies of Scale and Cost Efficiency in Small Scale Maize Production: Empirical Evidence from Nigeria.” *Journal of Social Sciences* **13 (2)**: 131–136.

Okpokiri, C.I., I.N. Nwachukwu, and C.N. Onwusiribe. 2015. “Determinants and Profitability of Honey Production in Ikwuano Local Government Area, Abia State, Nigeria.” *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development* **15 (3)**: 211–216.

Olutumise, A.I. 2022. “Determinants of Market Participation and Preference for Production of Pepper (*Capsicum spp*.) Among Farmers in Southwest, Nigeria.” *Heliyon* **8 (9)**.

Olutumise, A.I., A.S. Bankole, B.O. Olutumise, and O.A. Aturamu. 2023. “Gender Differential in Allocative Efficiency of Oil Palm Processors in Southwest, Nigeria.” *Kasetsart Journal of Social Sciences* **44 (2)**: 327–336.

Orji, A., J.E. Ogbuabor, O.I. Anthony-Orji, and A.J. Nkechi. 2020. “Agricultural Financing and Agricultural Output Growth in Developing Economies: Any Causal Linkage in Nigeria?” *International Journal of Finance, Insurance and Risk Management* **10 (2)**: 34–43.

Oseni, O.O., A.I. Olutumise, and B.O. Olutumise. 2018. “Performance Evaluation of Cocoa Marketing in Osun State, Nigeria.” *Journal of Perspectives on Financing and Regional Development* **6 (1)**: 97–112.

Santos, C.F., A. Otesbelgue, and B. Blochtein. 2018. “The Dilemma of Agricultural

Pollination in Brazil: Beekeeping Growth and Insecticide Use.” *PLoS One* **13 (7)**, p.e0200286.

Shakib, V., and M.E. Sayed. 2016. “Profitability and Socio-Economic Analysis of Beekeeping and Honey Productions in Karaj State Iran.” *Journal of Entomology and Zoology Studies* **4 (4)**: 1341–1350.

Shrestha, R.B., W.C. Huang, S. Gautam, and T.G. Johnson. 2016. “Efficiency of Smallscale Vegetable Farms: Policy Implications for the Rural Poverty Reduction in Nepal.” *Agricultural Economics* **62 (4)**: 181–195.

Taphe, B.G., F.G. Agbo, and E.C. Okorji. 2015. “Resource Productivity and Technical Efficiency of Small-Scale Groundnut Farmers in Taraba State, Nigeria.” *Journal of Biology, Agriculture and Healthcare* **5 (17)**: 25–34.

Vaziritabar, S., and S.M. Esmaeilzade. 2016. “Profitability and Socio-Economic Analysis of Beekeeping and Honey Production in Karaj State, Iran.” *Journal of Entomology and Zoology Studies* **4 (4)**: 1341–1350.

Wu, W. 2020. “Estimation of Technical Efficiency and Output Growth Decomposition for Small-Scale Rice Farmers in Eastern India: A Stochastic Frontier Analysis.” *Journal of Agribusiness in Developing and Emerging Economies* **10 (2)**: 139–156.