

Assessment of honey processing as a sustainable entrepreneurial venture in southwest Nigeria

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Submission: 4 November 2023

Revised: 23 December 2023

Accepted: 30 December 2023

ABSTRACT

Background and Objectives: More research must be conducted on the operational efficiency and performance of honey processors in the southwest region of Nigeria. Hence, the study aims to fill this gap by shedding light on the socioeconomic characteristics, costs, returns, and challenges faced by honey processors in the area. This investigation is crucial for developing effective strategies to enhance the overall performance of the honey industry in the region.

Methodology: Primary data from 144 randomly selected respondents representing 10% of the honey processors population were collected and analyzed using descriptive statistics, budgetary techniques, the stochastic frontier model, and the relative importance index. These methodologies allowed for a comprehensive assessment of the honey processing industry's operational aspects, economic viability, and efficiency.

Main Results: The research findings indicate that the majority of honey processing businesses in the region are operated by married male respondents who are literate and energetic with requisite honey processing experience. Though the enterprise is profitable with a gross margin of ₦233,058.52 and a profit of ₦208,574.77, the majority (62.5%) of the honey processors still operate at a local small-scale level. The average technical efficiency is 0.92, while the average economic efficiency is 0.55. Capital turnover analysis reveals approximately ₦1.81k is generated for every ₦1 invested in the honey processing business. Several key challenges were identified, including issues with electricity supply, limited access to capital and modern technology, and high materials and labor costs.

Conclusions: The honey processing business is very lucrative in the study area, considering the high value of 80.95% return on investment (ROI) on the business. The study recommends encouraging honey processors to operate beyond their present stage 1 under production level on their return to scale (RTS) by increasing significant variables positively affecting technical and allocative efficiencies to enhance output and income.

Keywords: Honey processors, southwest Nigeria, efficiency, costs, returns

Thai J. Agric. Sci. (2023) Vol. 56(3): 147–164

INTRODUCTION

Beekeeping is an important sector of agriculture for earning a source of livelihood for both rural and urban communities with low capital requirements. It is an agricultural investment that can accelerate the economy and employment of both local and urban farming communities. It provides a beneficial food and income source for rural households in developing countries (Agboola *et al.*, 2021). Products such as honey, beeswax, bee pollen, propolis, royal jelly, and venom are good sources of food, social economic, and medicinal value to many developing countries such as Nigeria. Honey, which is mainly composed of monosaccharides such as fructose and glucose, is a sweet and viscous liquid with small quantities of proteins, minerals, organic acids, and vitamins useful for human health (Mothershaw and Jaffer, 2004).

The world's honey shows great variety, especially in color, flavor, and aroma, because different plants contribute their characteristic constituents. Honey is produced under many different climatic conditions, but all honey's main constituents are the same (Abeshu and Geleta, 2016). Honey is a natural product created when honeybees collect, modify, and store nectar and sweet deposits from plants in their honeycomb. As a result, a variety of variables influence its makeup, which might change (Abeshu and Geleta, 2016). The large variety of characteristics seen in most honey corresponds to the diversity of honey sources. When it comes to honey harvesting in conventional hives, beekeepers may use signs such as the ripening of field crops, the end of the rainy season, and the beginning of the dry season to determine when to begin collecting honey. Outside the hive, bees congregate, and foragers' activity near the entrance to the hive comes to a halt. A flowering calendar will allow the beekeeper to plan various management procedures, such as where to install a hive and when to collect the honey, at the proper time. The bee's food resources: nectar, pollen, and honeydew have little or no economic use unless honeybees collect them. The economic yield of honey produced per hive varies greatly in different parts of

the world. Nevertheless, owing to the utilization of low production technology, Africa exhibits the lowest yield per colony compared to other continents. For instance, Oceania boasted an average yield of 39 kg in 1996, while North America and the USSR each achieved an average of 24 kg. In 1984, America had an average yield of 8 kg per colony (FAO, 1996). Despite the overall estimated annual honey production exceeding 2,000 tons, Nigeria's production seems negligible, as it went unrecognized by the Food and Agriculture Organization (FAO, 1996). The economic output of honey per hive can vary based on factors such as beekeeping practices, bee species, environmental conditions, and the region's flora. According to Agwu and Njokuocha (2004), the economic yield of honey produced per hive depends on the duration of the season when temperatures are high enough for the bees to fly and for plants to grow and flower, the amount of nectar, honeydew, and pollen within flight range of bees, the genetic honey-producing capability of the colonies, and the expertise and equipment of the beekeeper. In Nigeria, honey production is mainly by *Apis mellifera* (one of the most well-known and widely kept species of honeybee) because of the diversified vegetation pattern, which results in species richness and variety with distinct blooming seasons characteristic of the tropics. The climate is rather mild and non-seasonal (Agwu and Njokuocha, 2004). The value of honey in Nigeria is influenced by market demand, quality, and local and international prices. Additionally, factors such as packaging and certification can affect the value of honey.

Honey quality varies according to its geographical origin, botanical source of nectar or honeydew collected by the bees, and method of harvesting. These characteristics, such as color, lightness, thickness, and taste, often influence the physical appearance of honey, which also influences consumers' preference for the product (Ramly *et al.*, 2021). Honey processing usually involves the various activities undertaken to improve the quality and standard of honey collected from the producers, thereby making it attractive and acceptable to marketers and honey consumers. During processing, honey processors often collect

other beekeeping products, such as propolis, pollen grains, and beeswax, from raw honey obtained from the honey producers.

Usually, the dry season honey is lighter and milder in flavor than the darker, richer, rainy season honey. If the whole crop is taken at once, crystallized honey might cause a slew of issues during extraction. Frames and supers should be removed when entirely capped, but they must be at least three-quarters capped. To prevent the issue of high-moisture honey, beekeepers should not pick partly-capped frames. Depending on the scale of the operation, several strategies for removing supers from colonies might be utilized. Because of its influence on the flavor of the honey, smoke is employed while removing combs or supers. When it's time to take the honey, the excluder stops the queen from laying in the honey supers, and the bee flees unless it's restricted by the excluder. Early in the morning, before the bees start to fly, is the best time to remove honey supers that have been cleansed of bees. From the extraction stage through the commercialization stage, a number of variables influence honey quality. It is vital to provide a final packaged product of the best quality honey that will appeal to customers, regardless of how small or big the business is. From the time the comb is sealed, honey is regarded to be of the highest quality. Honey may be produced with little quality loss if it is handled carefully throughout extraction and processing. Raw or unprocessed honey is preferred by many customers (heated).

Some market outlets, on the other hand, need honey that can be stored for a long time. To delay granulation and avoid fermentation, filtering, and moderate heating may be used. The finished product should be well-trained, low in moisture, devoid of extraneous flavors and contaminants, and preserve the delicate flavor and scent it was born with. Excess air bubbles, pollen, and wax fragments absorbed into the honey during extraction are further variables that reduce the quality of honey (Judith, 2014). Honey extracted from combs in apiaries contains pollens, propolis, beeswax, and other undesirable materials, besides yeast, that should be removed through processing to enhance

better quality and shelf life. Two important stages of honey processing before packaging in bottles and containers are filtration and heating. Filtration usually involves straining which is done after extraction through hydraulic press using white cloth or fine sieve, which are frequently cleaned to remove the suspended particles. This method usually retains the natural taste, moisture content, antioxidants, and other enzymes present in the honey. However, the rate of fermentation and crystallization is often higher with this method.

Honey processing could also involve the use of heat to reduce the moisture content and eliminate the microorganisms (yeast count) which often aid the fermentation and crystalline process of the honey. This heating method also has its shortcomings, as some of the natural antioxidants, minerals, and proteins are often lost to excessive heat during processing. Hence, the study aims to assess the efficiency and economic performance of honey processing in southwest Nigeria by examining the socioeconomic characteristics of honey processors, estimating their costs and returns, analyzing their technical, economic, and allocative efficiencies, and identifying key constraints they face.

MATERIALS AND METHODS

Study Area

The study was conducted in southwest Nigeria. The zone comprised Ogun, Ekiti, Oyo, Lagos, Osun, and Ondo States. The area is located between 2° 31' and 6° 00' E longitude and latitude 6° 20' and 8° 37' N latitude (Faleyimu *et al.*, 2010). The derived savannah and humid forest zones have a tropical wet and dry climate with mean annual rainfall of roughly 1,500 mm and 2,000 mm, respectively. The two distinct seasons in the zone are the rainy season, which lasts from April to October, and the dry season, which lasts from November to March (Odekunle, 2004). Agriculture is the primary occupation of people in the area. Trees or cash crops such as oil palm, mango, cocoa, rubber, cola nut, and arable crops such as yam, cassava, cowpea, and maize dominate the agricultural landscape. In addition to these, there

are also widespread nectar-producing flowering plants such as sunflower (*Tithonia diversifolia*) that could encourage insect (bee) visitation in the region, thereby making the area conducive for honeybee rearing. The zone also has forest tree products like Teak, Mahogany, Mansonia, Obeche, Iroko, Arborea, Cedar, and Oma which are used in building beehives. There are also animal products such as rats, snakes, squirrels, and insects such as bees.

Sources of Data Collection

Data used for the study were collected from the primary source between January 2022 and April 2022 during the peak season of honey production in the area. The data were obtained using a direct personal interview and a well-structured questionnaire to obtain pertinent information on the socioeconomic characteristics of the respondents, costs, and returns involved in the honey processing, and the constraints faced by the processors.

Validity of Questionnaire

The validity of the content and construction of the questionnaire was determined by expert judgment of some selected honey processors in Ondo and Oyo States, top management staff of the Beekeeping Unit of Ondo State Agri-business Empowerment Centre (OSAEC), and Lecturers of the Department of Agricultural Economics and Extension Services of Ekiti State University, Ado-Ekiti.

Sampling Technique and Sample Size

The study population comprised honey processors in the study area. A multistage sampling procedure was used to select the respondents for the study. In the first stage, three (3) states were purposively selected from the six states in southwest Nigeria. Ondo, Ekiti, and Ogun States were selected based on preliminary investigations that revealed that beekeeping is widely practiced in the area. The second stage involved a purposive selection of six (6) Local Government Areas from each of the three (3) states where beekeeping practice is prominent. The local government areas selected in Ogun State included Abeokuta North,

Odeda, Ijebu-East, Ijebu Ode, Odogbolu, and Yewa North. In Ekiti State, the Local Governments are Ise/Orun, Ikere, Ikole, Oye, Ado, and Ijero. In Ondo State, the Local Government Areas are Odigbo, IleOluji/Okeigbo, Ondo West, Akure South, Owo, and Ose. In the third stage, eight (8) communities were randomly selected from each of the Local Government Areas to have a total of one hundred and forty-four (144) respondents.

Analytical Tools

The data collected were analyzed using descriptive statistics such as frequency counts, percentages, mean, standard deviation, charts, and ranking. Budgetary analysis, stochastic frontier model, and relative importance index were also used in the analysis.

Budgetary Analysis

Gross margin (GM)

Gross margin analysis is a financial tool used to estimate the costs and returns on investment (Girei *et al.*, 2013; Taphe *et al.*, 2015). It was used to estimate the costs and returns to honey processors in the area. It was mathematically expressed as:

$$GM = PQ - \sum_{j=1}^m C_j X_j \quad \text{----- (1)}$$

where GM is the farm gross margin, P is the market price of processed honey output/liter or kg, Q is the quantity of output processed by the i^{th} processor, per cycle/annum, C_j is the unit price of the variable input j incurred by the processor, X_j is the quantity of variable inputs j used by the processor, and M is the number of variable inputs used by the i^{th} processor.

TFC = Total fixed cost incurred on honey processing by an i^{th} processor.

TVC = Total variable cost incurred on honey processing by an i^{th} processor.

Capital turnover

Capital turnover is a measure of how effectively a business organization uses its assets to produce sales.

$$\text{Capital turnover} = \frac{\text{Total revenue}}{\text{Total cost}} = \frac{\text{TR}}{\text{TC}} \text{ ----- (2)}$$

Net income (NI)

It can be expressed as the profit a business earns after all expenses have been deducted. It is a longer-term measure of the ability of the farm to survive as a viable income-earning business (Britton, 2008). It is expressed mathematically as:

$$\text{NI} = \text{GI} - \text{TC} \text{ ----- (3)}$$

where GI is the gross farm income and TC is the total costs

Return on investment (ROI)

This is a performance measure used to evaluate the efficiency of an investment or compare the efficiency of several different investments (Botchkarev and Andru, 2011). It is expressed mathematically as

$$\text{ROI} = \frac{\text{Net profit}}{\text{Cost of investment}} \times 100 \text{ ----- (4)}$$

The elasticity of production (E_p) is a measure of a firm's success in producing maximum output from a set of inputs. It is represented as: E_p = Percentage change in output divided by the percentage change in input.

$$E_p = \frac{dQ}{dX_j} \times \frac{Q}{X_j} \text{ ----- (5)}$$

where Q is the honey output in volume/kg, X_j is the various inputs used in the production, and X and Q are the averages of input and output, respectively. ΣE_p = Summation of elasticity of responses.

Since the Cobb-Douglas production function gave the best fit, the regression coefficient still represents the elasticities used to measure the rate of return, which is a measure of a firm's success in producing maximum output from a set of inputs. Hence, for the honey processors $\Sigma EP = b_1 + b_2 + b_3 + b_4 + b_5 + b_6 + b_7$. Where b_1 is the coefficient of the raw honey, b_2 is the coefficient of labor, b_3 is the coefficient of packaging cost, b_4 is the

coefficient of transportation, b_5 is the coefficient of depreciation cost on fixed items, b_6 is the coefficient of advertisement, and b_7 is the coefficient of the price of honey.

Stochastic Frontier Production Function

Technical efficiency (TE) refers to the ability of the farms to attain the highest level of output given a set of inputs. It refers to a farmer's capacity to get the most out of a given input or group of inputs (Laha, 2013; Mahgoub *et al.*, 2017). For this study, the technical efficiency of the honey processor was measured using a stochastic frontier production function specified as follows:

$$\ln Q = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + (V_i - U_i) \text{ ----- (6)}$$

where ln is the natural logarithm (logarithm to base e), Q is the volume of honey processed in liters/kg, X_1 is the quantity of raw honey in naira, X_2 is the labor in man-days, X_3 is the cost of packaging in naira/quantity of bottle used, X_4 is the cost of transportation in naira, X_5 is the depreciation cost on fixed inputs in naira, X_6 is the cost of advertisement in naira, and X_7 is the price per liter of honey in naira.

Also, the Cobb-Douglas cost function for the processors was explicitly expressed as:

$$\ln C_i = \beta_0 + \beta_1 \ln P_1 + \beta_2 \ln P_2 + \beta_3 \ln P_3 + \beta_4 \ln P_4 + \beta_5 \ln P_5 + \beta_6 \ln P_6 + \beta_7 \ln Y^* + (V_i + U_i) \text{ ----- (7)}$$

where ln is the natural logarithm (logarithm to base e), C_i is the total processing cost of the i^{th} processor in naira, P_1 is the wage rate (labor) in (₦)/man-day, P_2 is the cost of raw honey in (₦), P_3 is the cost of packaging (₦)/cost of bottle (₦), P_4 is the cost of transportation in (₦), P_5 is the depreciation cost on fixed inputs in (₦)/hive, P_6 is the cost of advertisement in (₦), Y is the volume of honey processed, $\beta_1 - \beta_7$ is the coefficients estimated, V_i is the random variables which are assumed to be IID ($N(0, \sigma_v^2)$), and independent of the $U_{it} = (U_i \exp(-\eta_i(t - T)))$, U_i is the 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 $N(\mu, \sigma^2)$ distribution, and η is the parameter to be estimated.

Using the parameterization of Alem (2018) who replace σ_v^2 and σ_u^2 with $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / (\sigma_v^2 + \sigma_u^2)$. This is done with the calculation of the maximum likelihood estimates in mind. The parameter, Γ , must lie between 0 and 1, and thus, this range can be searched to provide a good starting value for use in an iterative maximization process such as the Davidon-Fletcher-Powell (DFP) algorithm (Alem, 2018).

Y^* is the adjusted output of honey in liter/hive or the volume of honey processed. The adjusted coefficient of determination considers the number of variables in the data set. It specifies how the numerous regression equations for the sample data fit together. The fraction of variation, defined by the predicted regression line, is also calculated.

The adjusted coefficient of determination is based on a range of 0 to 1. It illustrates how the dependent variables are affected by the percentage of variation of the independent variables. If the modified coefficient of determination approaches 1, the calculated regression equation matches the data. In addition, when additional independent variables are introduced to boost the power of the regression equation, the value of the modified coefficient of determination rises. As a result, multiple regression analysis often uses the modified coefficient of determination (Bravo-Ureta *et al.*, 2012; Alem, 2018).

The inefficiency model was therefore stated as:

$$\text{Exp.}(-U_i) = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \dots + \delta_{11} Z_{11} + \varepsilon_i \quad \text{----- (8)}$$

where Z_1 is the age in years, Z_2 is the sex (male = 1 and female = 0), Z_3 is the marital status (married = 1 and 0 = otherwise), Z_4 is the educational status (educated = 1 and 0 = otherwise), Z_5 is the experience (years), Z_6 is the household size (numbers), Z_7 is the extension contacts (number of visits), Z_8 is the technology used (1 = modern and 0 = traditional), Z_9 is the membership of honey

processors associations/ cooperative societies (a dummy variable: 1 = member and 0 = otherwise), Z_{10} is the access to credit (access = 1 and 0 = otherwise), Z_{11} is the source of labor (combined hired and family = 1 and 0 = otherwise), and $\delta_0, \delta_1, \delta_2, \dots, \delta_{11}$ are regression parameters estimated.

Relative Importance Index (RII)

The relative importance index was utilized to find the most popular factor to choose based on the replies of the honey processors. 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. The equation is given as:

$$\text{RII} = \frac{\sum W}{A \times N} \quad \text{----- (9)}$$

where W is the weighting given to each problem by the honey processors (1 to 4), A represents the highest weight (4), and N is the total number of the honey processors. Therefore, the RII value ranges from 0 to 1 (0 not included).

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents

As presented in Table 1, the results showed that most (84.7%) respondents were male and married. This implies that marriage male-dominated the enterprise. This result was consistent with the findings of Bhandari and Kattel (2020), who reported that males dominated the value chain activities of the honey sub-sector in Nepal but contrary to the findings of Koledoye and Deji (2015), who opined that the majority of women engaged in processing enterprise. The result indicates that the mean age of the honey processor was 49.1 years old. This indicates that most of the respondents were still within the economically active age. The finding is similar to Kuboja *et al.* (2017). The average years spent in school by the respondents was 13.3. This implies that most of the respondents were literate, implying that their level of understanding and the

rate at which they adopt new processing technologies might be relatively high. The results of this study agreed with the findings of Adebo and Osundare

(2015) that the majority of honey actors had higher educational qualifications. The results revealed an average of 10.9 years of honey processing experience.

Table 1 Distribution of the respondents by socioeconomic characteristics

Socioeconomic characteristics	Frequency	Percentage (%)	Mean	Standard deviation
Gender				
Male	122	84.7		
Female	22	15.3		
Marital status				
Single	22	15.3		
Married	122	84.7		
Age (year)				
			49.1	12.1
≤ 20	6	4.2		
21–40	32	22.2		
41–60	78	54.2		
> 60	28	19.4		
Number of years of education				
			13.3	3.6
1–4	2	1.4		
5–9	16	11.1		
10–14	60	41.7		
>14	66	45.8		
Access to credit				
Yes	50	34.7		
No	94	65.3		
Business experience (year)				
			10.9	8.2
1–10	90	62.5		
11–20	38	26.4		
21–30	12	8.3		
31–40	4	2.8		
Membership of association				
Yes	82	56.9		
No	62	43.1		
Source of labor				
Family	38	26.4		
Hired	90	62.5		
Both	16	11.1		
Category by processing operation				
Local small scale	90	62.5		
Medium scale	46	31.9		
Large scale	8	5.6		

The finding reiterated that many of the respondents had been involved in honey processing for a long time and could have learned from their past mistakes. It was revealed that only 34.7% of the respondents had access to credit/loans, while many of the respondents did not have access to credit facilities to finance their businesses, thereby causing expansion limitations. According to Etonihu *et al.* (2013), poor accessibility to credit facilities may account for the poor financial base of the actors and, hence the inability to employ modern technology. This finding follows Vaziritabar and Esmailzade (2016), who reported that about 82% of the beekeepers do not have access to credit facilities in their study carried out in Karaj State, Iran. The results indicated that 56.9% belonged to trade associations. This finding is in accord with the findings of Jiboye *et al.* (2019), who reported that membership in cooperatives is a vehicle for entrepreneurial development since cooperatives provide informal loans to their members. Findings revealed that 62.5% of the honey processors used only the hired labor while 26.4% engaged the services of the family labor only. Unlike other agricultural enterprises, the use of both hired and family labor was very rare among the honey processors in the study area. The study revealed that the majority (62.5%) of the respondents were local small-scale processors producing pure honey and beeswax only, while 31.9% were medium-scale processors producing pure honey, processed honey, and beeswax only. On the other hand, only 5.6% of the respondents were large-scale processors producing pure honey, processed honey, beeswax candles, beeswax polish, processed propolis, and processed pollen grains in the study area.

The local small-scale honey processors engage in the manual processing of honey into pure honey and beeswax. Their outputs are usually very low. Medium-scale processors use manual and less improved technology to process their honey into pure honey, processed honey, and beeswax for sales to marketers or consumers. This category of processors usually processes for commercial purposes at limited quantity but higher than that of the small-scale processors. The large-

scale processors are the major commercial honey processors that operate at a mechanized level with the use of improved technologies to produce pure honey, processed honey and beeswax candles, beeswax polish, processed propolis, and processed pollen grains. They usually sell their products in large quantities to marketers, and pharmaceutical and supermarket outlets.

Source of Credit to Processors

The distribution of the source of credit by the honey processors is shown in Figure 1. The result revealed that 65.3% of the processors sourced their credit through personal savings, while 16.7% and 4.2% sourced their credits through cooperative societies and agricultural banks. The result further revealed that credit facilitated through commercial banks and friends/relatives was 6.9% each. Thus, the findings revealed that most of the processors received their credits from the informal sectors, which could result from the ease of obtaining credit in the sector.

Purpose of Engaging in Honey Processing

The distribution of processors by the purpose of engagement in honey processing indicated that 56.9% of the processors engaged in processing honey for commercial purposes, while 43.1% engaged in processing for both commercial and consumption purposes in the study area. The engagement of more people in the commercial purpose could be due to the high level of patronage of the product with huge returns to their efforts.

Channels of Output Sales by Processors

Figure 2 illustrates the method of sales used by processors in the study area. The study revealed that 43.1% of the processors sold their products at the processing point. Also, the result indicated that 23.6% of the processors sold their honey at the urban market, while 18.1% and 9.7% of them sold their honey at the local market and supermarket, respectively. Only 5.5% of the processed honey was sold at the international market. Therefore, a high percentage of sales at the point of production could be from the marketers.

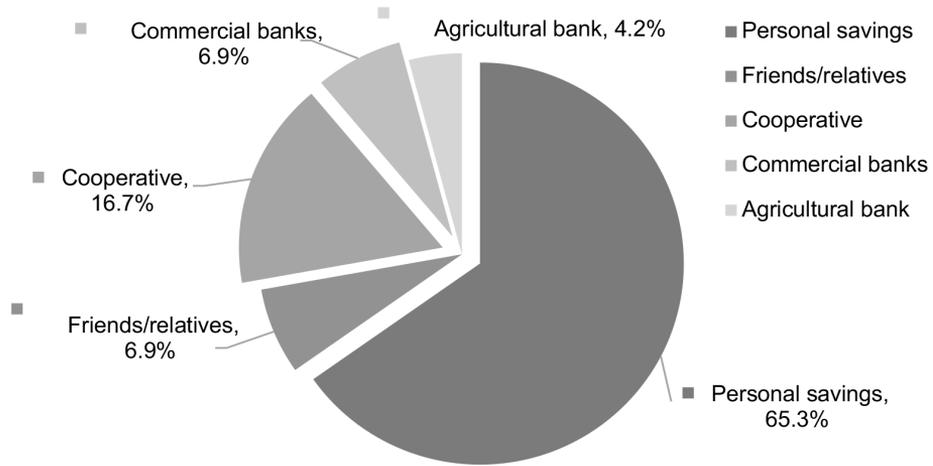


Figure 1 Source of credit to processors

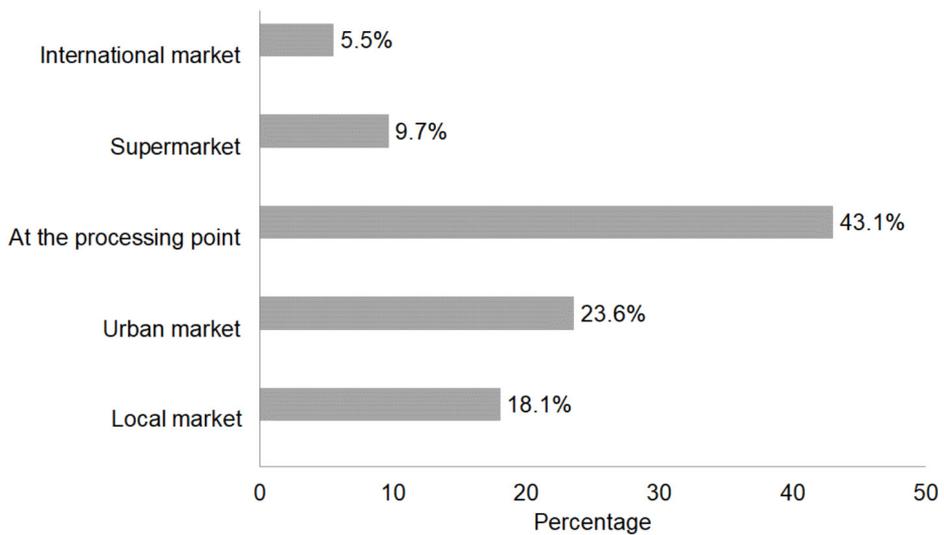


Figure 2 Distribution by method of sales

Costs and Returns Analysis of Processors

Table 2 depicts the budgetary analysis of the honey processors in the study area. The results indicated that variable costs accounted for about 90.50% of the total cost of processing, while fixed costs accounted for just 9.50% of the total cost of honey processing in the area. The cost of purchasing unprocessed honey from the producer accounted for the bulk (74.85%) of the total cost, followed by the cost of labor (5.69%), the cost of bottle (5.14%), and the cost of transportation (3.01%). Another variable cost was the cost of stickers, which was 1.81% of the total cost. In addition, depreciation costs on the sieve, plastic keg containers, bowls and buckets, and honey extractors accounted for 0.64%, 3.09%, 2.16%, and 3.61%, respectively, of the total cost in the area.

The analysis revealed that variable costs accounted for the bulk and major cost of processing in the value chain. The outcome of the cost analysis is in line with the findings of Fatuase *et al.* (2015). They

reported that variable costs always take more than 50.0% of the cost in most agricultural enterprises. The average total revenue of ₦466,215.38 was obtained by multiplying the unit price by the total average quantity of the honey processed for sale. The results of the gross margin and profit were ₦233,058.52 and ₦208,574.77, respectively. The result implies that honey processing is a profitable business in the study area. Again, the value of ROI of 80.95% implies that a honey processor can repay the interest on any loan collected.

The value of the capital turnover ratio of 1.81 indicated that about ₦1.81k is realized on every ₦1 invested in the processing business. The economic efficiency ratio of 0.81 is also an indication of the optimum use of resources in honey processing. The value of expense ratio (ER) of 55.26% indicates that the fixed cost incurred in the business is less than the money expended on the variable cost by 44.74%. All these profitability measures confirmed and reiterated the profitability of honey processing in the study area.

Table 2 Costs and returns among honey processors

Item	Mean (₦)	% of total cost
(A) Variable cost		
Cost of labor	14,659.25	5.69
Cost of purchasing unprocessed honey	192,837.00	74.85
Cost of bottles	13,246.88	5.14
Cost of stickers	4,666.67	1.81
Cost of transportation	7,747.06	3.01
Total variable cost (TVC)	233,156.86	90.50
(B) Fixed cost		
Depreciation cost on sieve	1,637.50	0.64
Depreciation cost on bowls and buckets	5,558.93	2.16
Depreciation cost on plastic keg containers	7,982.82	3.09
Depreciation cost on honey extractor	9,304.50	3.61
Total fixed cost (TFC)	24,483.75	9.50
Total cost (TC) = TVC + TFC	257,640.61	100.00
Average total revenue (TR)	466,215.38	
Gross margin = TR – TVC	233,058.52	

Table 2 Cont.

Item	Mean (฿)	% of total cost
Profit = NI = TR – TC	208,574.77	
Capital turnover = TR/TC	1.81	
Economic efficiency = NI/TC	0.81	
Expense ratio (ER)	55.26%	
Return on investment (ROI)	80.95%	

Note: 780 NGN (฿) = 1 USD (\$). The expense ratio is expenses divided by net sales, all multiplied by 100. Return on investment is net profit divided by cost of investment multiplied by 100.

Estimation of Stochastic Production Function for Processors

Table 3 shows the stochastic production function estimated for honey processors in the study area. The result of the technical efficiency of the processors revealed that the estimated sigma-squared (1.917) was statistically significant and different from zero at a 1% probability level. This indicates the goodness of fit and the correctness of the specified distribution assumption of the composite error term. In addition, the magnitude of the gamma (Γ) was estimated to be 0.802, indicating that the systematic influences unexplained by the production function are the dominant sources of errors.

The result implies that about 80.2% of the variations in the output of the processors in the study area were due to differences in their technical

efficiency. In addition, the results showed that the coefficients of the quantity of raw honey purchased, packaging cost, transportation cost, advertisement, and the unit price had a positive relationship with the output of the honey processed. In contrast, the variables such as labor and depreciation cost on fixed items negatively correlated with the output of the honey processed in the study area.

Elasticities of Production and Returns to Scale for Honey Processors

Table 4 illustrates the return to scale (RTS) analysis for honey processors in the study area. The obtained RTS value of 0.493 indicated that honey input processors operate at an inefficient level of stage 1. This means that some of the productive resources used by the honey processors in the study area were underutilized.

Table 3 Maximum likelihood estimates of stochastic production function for processors

Variable	Parameter	Coefficient	SE	t-value
Efficiency factors				
Constant	β_0	12.263***	2.670	4.594
Quantity of raw honey	β_1	0.365***	0.006	3.303
Labor	β_2	-0.031	0.080	-0.380
Packaging cost	β_3	0.060	0.069	0.862
Transportation	β_4	0.145	0.098	1.482
Depreciation cost on fixed items	β_5	-0.400*	0.213	-1.877
Advertisement	β_6	0.155	0.198	0.279
Price	β_7	0.199*	0.083	1.918
Sigma-squared	δ^2	1.917***	0.326	5.884
Gamma	Γ	0.802***	0.081	9.900

Table 3 Cont.

Variable	Parameter	Coefficient	SE	t-value
Inefficiency factors				
Age	Z_1	-0.003	0.011	-0.272
Sex	Z_2	0.023*	0.013	1.769
Experience	Z_3	-0.014**	0.006	-2.333
Technology used	Z_4	-0.084*	0.050	-1.680
Extension contacts	Z_5	-0.158	0.129	-1.224
Education	Z_6	-0.011	0.101	-0.108
Household size	Z_7	-0.009***	0.002	-4.500
Marital status	Z_8	0.106	0.102	1.039
Membership of association	Z_9	0.147	0.071	2.070
Access to credit	Z_{10}	-0.326***	0.074	-4.405
Constant	Z_0	1.939***	0.383	5.062

Note: *, **, and *** mean significance at 10%, 5%, and 1%, respectively. SE = standard error.

Table 4 Elasticities of production and returns to scale for honey processors

Variables	Elasticities of production
Quantity of raw honey	0.365
Labor	-0.031
Packaging cost	0.060
Transportation	0.145
Depreciation cost on fixed items	-0.400
Advertisement	0.155
Price	0.199
Return to scale	0.493
	(Stage 1 of production)

Note: Criteria for return to scale estimation: $\Sigma EP = 1$: constant return to scale, $\Sigma EP > 1$: increasing return to scale, $\Sigma EP < 1$: decreasing return to scale.

Estimation of Stochastic Cost Function for Processors

The results presented in Table 5 showed that the significant value of the sigma square (δ^2) is evidence that the model has the goodness of fit and the correctness of the specified assumption of the composite error terms distribution (Aguinis and Lawal, 2013). The gamma (Γ) value was 0.899, which implied that about 89.9% variations in the total cost of honey processing were due to their cost efficiencies.

The labor coefficient was positive and statistically significant at 1% in influencing the total cost of processing. It indicates that a unit increase in the number of wages will increase the total cost of processing in the area by 0.21 units, all things being equal. The coefficient of transportation cost was also positive and significant at 1% in addressing the behavior of total cost in the area. The implication is that a unit increase in the cost of transportation will significantly increase the total cost of processing by 0.15 units, *ceteris paribus*.

Likewise, the coefficient of depreciation cost on fixed items was positive and significant at 1% in affecting total cost. It implies that a unit increase in the value of depreciation cost will increase the total cost by 0.38 units. The results were expected because most of the input suppliers are small-scale firms that operate under diseconomies of scale in honey processing. However, it is justifiable because most of the actors interviewed did not operate on a

large-scale production level. Other variables used in the model, such as the cost of raw honey, packaging cost, and volume of honey processed, had a positive relationship with the total cost. However, they were not statistically significant in the study at any of the probability levels. Oladimeji and Abdulsalam (2013) opined that labor cost, depreciation cost, and other variable costs positively affect the cost efficiency of processors.

Table 5 Maximum likelihood estimates of stochastic cost function for processors

Variable	Parameter	Coefficient	SE	t-value
Constant	β_0	3.780	0.554	6.823
Wage rate (Labor)	β_1	0.214***	0.048	4.458
Cost of raw honey	β_2	0.021	0.028	0.750
Packaging cost	β_3	0.019	0.040	0.475
Transport cost	β_4	0.151***	0.024	6.291
Depreciation cost on fixed items	β_5	0.382***	0.054	7.074
Volume of honey processed	β_6	0.050	0.033	1.515
Sigma-squared	δ^2	1.118***	0.189	5.915
Gamma	Γ	0.899	0.128	7.023
LR test	-60.104			

Note: *, **, and *** mean significant at 10%, 5%, and 1%, respectively. SE = standard error.

Allocative Efficiency Distribution of the Processors

The honey processors' average technical, economic, and allocative efficiencies in the study area were 0.917, 0.550, and 0.553, respectively (Table 6). Thus, it suggested that an average of about 91.7%, 55%, and 55.3%, respectively, of maximum

potential output was gained due to processing efficiency, while the shortfall could be attributed to inefficiencies. Furthermore, the mean technical efficiency for the honey processor was 0.917, which showed a higher level of technical efficiency than the economic and allocative efficiencies, which were 0.550 and 0.553, respectively.

Table 6 Technical, economic, and allocative efficiencies of processors

Efficiency range	Technical		Economic		Allocative	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
≤ 0.20	8	5.55	20	13.89	20	13.89
0.21–0.40	-	-	36	25.00	34	23.61
0.41–0.60	6	4.17	16	11.11	18	12.50
0.61–0.80	14	9.72	34	23.61	34	23.61
0.81–1.00	116	80.56	38	26.39	34	23.61
> 1.00	-	-	-	-	4	2.78

Table 6 Cont.

Efficiency range	Technical		Economic		Allocative	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Total	144	100.00	144	100.00	144	100.00
Mean	0.917		0.550		0.553	
Standard deviation	0.131		0.284		0.285	
Minimum	0.191		0.076		0.077	
Maximum	0.999		0.999		1.000	

The range of the technical efficiency segment shows that most (80.6%) of the processors in the study area were between the range of 0.81 and 1.00, with a minimum value of 0.191 and a maximum value of 0.999. The economic efficiency segment of the result shows that most (26.4%) of the processors were between the efficiency range of 0.81 and 1.00, while 11.1% of the processors were between the ranges of 0.41 and 0.60, and the efficiencies range from 0.076 to 0.999. Furthermore, the allocative efficiency result segment showed that about 2.78% of the processors had efficiency scores greater than one with a minimum value of 0.077 in the study area. In comparing the results, most processors are more efficient under the technical efficiency than they are efficient under the economic and allocative efficiencies. This efficiency level could result from the innovative processing method adopted by the honey processors in the study area. Olatubosun *et al.* (2016) examined efficiency differentials in honeybee enterprises. They found out that modern and traditional systems' technical efficiency was 0.84 and 0.59, which are less than the values obtained in this study. This result disagreed with Taraka *et al.* (2012), who investigated the technical efficiency of rice farms using the data envelopment analysis (DEA) approach. Their results showed that most farms operate at a lower level of technical efficiency.

Constraints to Honey Processors

The majority of the respondents agreed that the lack of modern technology (1st) was

the most important and serious problem facing them in business. It was observed that most of the processors were aware of the modern technologies that could help with their productivity and efficiency. Still, this equipment is not available for use at their disposal due to some factors. Lack of capital was ranked second (2nd), as presented in Table 7. It was unveiled that respondents did not have access to affordable credit to purchase modern equipment that could help in expanding the business. Most of their capital is through personal savings and borrowing from friends/relatives. This has affected the productivity and efficiency of the processors in delivering good-quality honey in the market. Likewise, the threat from adulterated honey (3rd) was an issue, especially when the honey was contaminated or in an attempt for the producers to profit. Corruption on the side of the producers contributed immensely to the problem of adulterated honey.

The lack of an organized market and the problem of electricity were ranked fourth (4th). However, this has affected the pricing system of the product and the cost of production due to the high cost of generators and fuel. The extraction method (6th) and high cost of transportation (6th) were ranked the same in the area. The extraction method caused problems because many of them still depended on the manual method of extraction, which limited the quantity of honey that could be extracted from the comb and reduced the efficiency of the processors. Since processors buy from producers whose sites are always far from the town, it is necessary for the processors to travel

to the source to purchase raw honey. In doing this, additional costs are normally incurred, which will positively affect the total cost of processing but decrease the profit accrued from the business.

The high cost of labor (8th) was also noted as a problem. Due to Western education, many children are released for schooling, which denies their participation in honey processing, thereby reducing family labor in the area. As a result, the wage rate of hired labor is becoming unbearable in

the area. The poor storage facility (9th) was identified as a problem in the study area. Despite the honey's long shelf life, processors do not have enough facilities to preserve it without changing color, taste, and texture and protect it from contamination. The results from this study were similar to the findings of Ehinmowo *et al.* (2015), who stated that inadequate capital, environmental hazards, high transportation costs, and poor storage facilities were the main constraints faced by small-scale cassava processors.

Table 7 Distribution of processors by constraints faced in the study area

Constraint	Frequency				RII	Rank
	Very serious (3)	Serious (2)	Mild (1)	Not at all (0)		
Lack of modern technology	72	36	26	10	0.67	1 st
Lack of capital	62	38	28	16	0.64	2 nd
Threat from adulterated honey	51	37	28	28	0.56	3 rd
Lack of organized market	36	64	24	20	0.50	4 th
Problem of electricity supply	36	64	24	20	0.50	4 th
Method of extraction	30	42	34	38	0.38	6 th
High cost of transportation	30	42	34	38	0.38	6 th
High cost of labor	26	28	28	62	0.34	8 th
Poor storage facility	8	16	40	80	0.21	9 th

Note: RII is the Relative Importance Index and its value ranges between 0 and 1. The higher the RII the higher the level of correlation or degree of the influence of the problem on the honey processing business.

CONCLUSIONS

The study concluded that honey processing is economically viable in the area considering the profit value of ₦208,574.77 and capital turnover of 1.81. It also indicated that the quantity of raw honey acquired, the unit selling price of processed honey in volume, wage rate (labor), transport cost, and depreciation cost on fixed items are significant in addressing honey processing in the area. The higher technical efficiency value indicated that the honey processors used processing equipment to obtain their products in the study area better. The constraints militating against honey processing business in the study area include lack of modern technology, lack of capital, threat to adulterated honey, lack of

organized markets, method/mode of extraction, high cost of transportation, and high cost of labor. Addressing these challenges entails leveraging policy support, investing in essential infrastructure, allocating financial resources, and fostering market development initiatives. These combined efforts hold the potential to make a substantial impact on the growth and sustainability of the honey processing sector. In addition, the study offers valuable insights for various stakeholders, including industry players, policymakers, and practitioners of honey processing. The results underscore the economic feasibility of this enterprise, highlight the primary factors contributing to technical inefficiency, and stress the importance of tailored interventions to tackle these critical constraints.

ACKNOWLEDGEMENTS

The authors are immensely thankful to the states, communities, and individuals who participated in this research, as well as honey processors who actively participated in data collection by responding

to our direct personal interview and well-structured questionnaire. The authors equally expressed their gratitude to the Department of Agricultural Economics and Extension Services, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria, for their material, moral, and logistic support during and after the study.

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