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A COMPARATIVE ANALYSIS OF THE ECONOMIC VIABILITY OF HONEY PRODUCTION AND MARKETING IN THREE ECOLOGICAL ZONES OF CROSS RIVER STATE, NIGERIA

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Abstract

Honey production and marketing have the potential to create jobs in rural communities, increase household income through sustainable agroforestry practices, and reduce deforestation by promoting alternative energy sources, income generation, ecosystem maintenance, and market gaps. However, there is a lack of information on honey production and economic viability in Cross River State, Nigeria. This study analyzed the profitability, costs, and efficiency of honey producers (bee-keepers and bee-hunters) and marketers over five years (2017-2021) in three ecological zones of the state. Honey production contributes significantly to household income, representing (28.2%) of total revenue in the study area. The results show that honey producers (beekeepers and hunters) had varied profitability. Beekeeping was observed to be more profitable than bee hunting due to greater hive ownership and increased production levels. Honey sales fluctuated across ecological zones due to varying environmental conditions. Unit prices showed a steady increase, rising from ₦2,057.6 in 2017 to ₦2,661.0 in 2021 for bee hunters, and from ₦2,069.2 to ₦2,651.2 for beekeepers. The cost of production remained relatively stable (due to the long-life span of equipment used), with the highest expenses attributed to transportation and beehives. However, profit efficiency was high at (90.7%) for production and (92.1%) for marketing. The study concludes that honey production and marketing in the area are highly profitable and competitive, with strong potential for growth due to increasing demand, improved production practices, and favourable market conditions. Thus, it is recommended that training programs be implemented to help honey hunters adopt modern and sustainable beekeeping practices. Additionally, research and development of marketing strategies are essential for improving productivity and expanding market access.

Keywords: Beekeeping, Economics, Honey, Production, Sustainability.

INTRODUCTION

Honey production serves as a substantial source of income for many rural households in Nigeria. Beekeeping requires minimal initial investment and can yield high returns, making it an attractive enterprise for small-scale farmers (Devkota, 2020). Honey and other bee products (such as beeswax and propolis) provide a diversified income stream, reducing dependence on traditional agricultural activities that may be susceptible to seasonal fluctuations **(**Prodanovic *et al.*, 2024**)**. Honey production and trading provide cash income for rural

households, thereby enhancing their economic well-being.

The honey value chain creates employment opportunities in various sectors, including beekeeping, processing, and marketing of honey. Women and youth, in particular, benefit from job opportunities within the honey value chain, promoting inclusive economic growth (Dafar, 2018). The contributions of honey value chains to economic growth and development are diverse and significant. These contributions encompass income generation, employment opportunities, and foreign exchange earnings **(**Ogboagha *et al.*, 2022**)**.

Honey production is deeply rooted in cultural practices and traditions in many societies worldwide (Bahta, 2018). It holds cultural significance as a natural sweetener, food source, and traditional medicine, preserving local knowledge and heritage related to beekeeping practices (Nayik *et al.,* 2014). Furthermore, honey production is generally considered environmentally friendly due to minimal waste generation and low energy consumption in processing (Sillman *et al.,* 2021). Natural beekeeping methods promote ecological balance and reduce the use of synthetic chemicals, contributing to environmental sustainability (Etxegarai-Legarreta and Sanchez-Famoso, 2022; Prodanovic *et al.*, 2024).

Despite the numerous advantages of honey production and marketing, the sub-sector remains largely underdeveloped. This is primarily because honey production is still regarded as a traditional activity, often passed down through generations, without receiving proper recognition or adequate valuation. As such most beekeeping farmers have not fully appreciated its potential and value as a commercial enterprise capable of generating income for sustainable livelihood, hence, there is a need to investigate this entrepreneur in Cross River State. There are scanty studies on honey production and marketing in the study area. Thus, this study aims to analyze the economic viability of honey production and marketing in three ecological zones of Cross River State, Nigeria.

The hypotheses for this study expected differences in productivity, marketing, technology adoption, and costs across the three ecological zones, helping clarify the research objectives. Thus, the hypotheses include Hypothesis 1: There is a significant difference in the productivity and profitability of honey production between the three ecological zones of Cross River State, with the Southern zone showing higher economic viability due to more favourable environmental conditions for beekeeping. Hypothesis 2: Honey marketing channels and access to markets vary significantly across the ecological zones, with producers in the Northern zone facing more challenges in accessing markets than those in the central and Southerner zones of the study area. Hypothesis 3: The adoption of modern beekeeping practices is higher in the Southern zone, contributing to better economic outcomes in honey production than in the central and Southern zones of the study area.

MATERIALS AND METHODS

Description of the Study Area

Data for this study were collected from Cross River State in Nigeria. Cross River State, located in the tropical rainforest of Nigeria, has a land mass of approximately 21,265km^2 and lies between latitude 4°30'0" N and 7°0'0"N Northern and longitude 8°30'0"E and 9°30'0"E East of the Greenwich Meridian (Figure 1). The state records heavy rainfall during the wet season (April-November) and the annual rainfall varies from 1800mm to 4000mm and the annual temperature ranges from 10^{0}C to 32^{0}C. The rainfall decreases from the Southern 3500mm in the coastal region to 1500mm in the Northernern part of the state (Macarthy *et al.* 2010).

The state has about 50% of the remaining tropical high forests in Nigeria (Macarthy *et al.* 2010; CRSFC, 2018). These forests are made up of the Forest Reserves, Community forests and Cross River National Park forests. The forest resources of the state cut across three ecological zones with multiple forest products, including Tropical High Forest, Swamp Forest, and Savannah Forest. The total forest area is approximately 8,968 km^2, with the Tropical High Forest covering 7,292 km^2 (CRSFC, 2018).

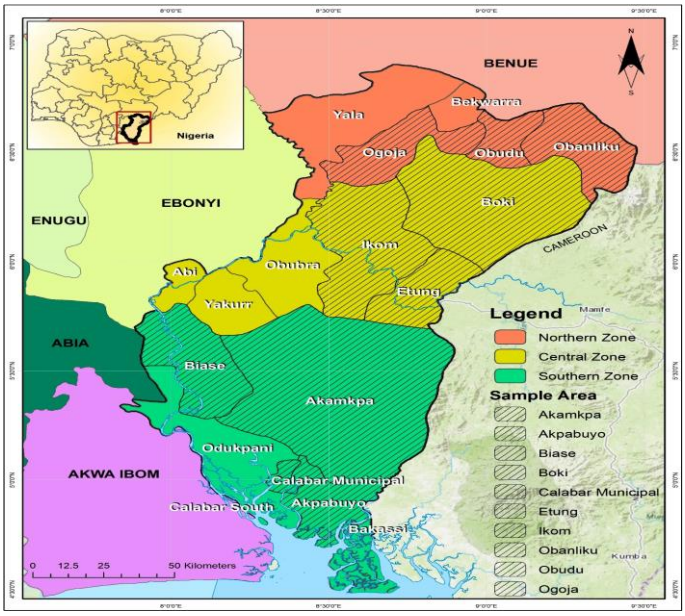

Fig 1: Map of Cross River State Showing the three distinct senatorial zones sampling

Sampling Technique

The study employed a multistage and purposive sampling technique to select respondents from the three ecological zones in Cross River State, Nigeria. A purposive sampling technique was used to target specific groups, measures were taken to ensure that the selection of Local Government Areas (LGAs), council wards, and communities reflected a representative sample of honeybee farmers and marketers across each ecological zone. We carefully selected the LGAs, and wards based on available data on honey production and marketing activities, ensuring that both high- and low-activity areas were included. Additionally, we consulted with local agricultural officers and beekeeping associations to identify communities with diverse honey production scales and market participation. This helped capture a variety of farming practices and market dynamics within each ecological zone. Moreover, we employed stratified sampling within the purposive approach by considering the geographic and socio-economic diversity of the zones, ensuring the representation of different farm sizes, experience levels, and marketing channels. This strategy helped mitigate the potential bias associated with purposive sampling, resulting in a more comprehensive and representative dataset for the study.

The state was stratified into Northern, Central, and Southern ecological zones, with 10 Local Government Areas (LGAs) selected based on the presence of organized and non-organized honeybee farmers, bee hunters, retailers, and consumers. The sample size was determined using the Taro Yamane formula, given a total of 684 respondents selected, comprising 242 bee farmers, 162 marketers, 59 honeybee hunters, and 221 consumers. The population size was estimated using data from local agricultural offices and beekeeping associations, which provided records of registered honeybee farmers and marketers in each ecological zone. Error tolerance was set at 5% to balance precision and feasibility, as this is a standard level commonly used in agricultural research. This choice allows for a confidence level of 95% while maintaining manageable sample sizes. These selections were made to ensure that the results would be statistically valid and representative of honeybee farmers and marketers across the ecological zones.

The sampling procedure involved purposive selection of ecological zones, LGAs, council wards, and communities noted for honeybee farming and marketing. Snowball sampling was used to select honeybee hunters and consumers, while the Taro Yamane formula was used to determine the sample size for each group. The study also

included 10 Key Informant Interviews (KII) and three Focus Group Discussions (FGD) for triangulation of information. The sample size was calculated using the formula n = N / (1 + N(e)^2), where N is the population size and e is the error degree of tolerance.

Data Collection

The study adhered to best practices and research ethics by obtaining Free Prior Informed Consent (FPIC) from all data collection communities to ensure inclusive participation and reduce suspicion. Primary data was collected using semi-structured questionnaires. The questions were developed through a comprehensive literature review and input from subject matter experts to ensure relevance and clarity in addressing themes related to honey production and marketing. A pilot test was conducted with a small cohort of honeybee farmers and marketers, to identify ambiguities and enhance the reliability of the questionnaire. Feedback from participants informed necessary revisions, ensuring that the final instrument effectively captured the experiences and perspectives of the target population. The semi-structured questionnaire was administered to honeybee farmers, bee hunters, marketers, and consumers through the electronic Kobo Toolbox, which enhanced objectivity and efficiency

Several tactics were used to reduce response bias for sensitive inquiries concerning expenses and obstacles in honey production and marketing. Initially, we ensured that participants would remain anonymous, and their responses would be kept confidential to promote truthful answers. Secondly, the questions were formulated in a neutral and non-threatening manner, and indirect questioning methods were employed to alleviate any discomfort when addressing personal financial matters. Establishing a connection with participants before data gathering also encouraged open dialogue.

Ten Key Informant Interviews (KII) and 3 Focus Group Discussions (FGD) were conducted to triangulate and supplement information (Ugbe *et al.*, 2024). Geographical Positioning System (GPS) was used to note sample points and authenticate locations (Ugbe *et al.*, 2024). The instrument's validity and reliability were ensured through expert consultation, revision, and GPS validation. The data collected included socio-economic variables, cost variables, marketing and consumption dynamics, and challenges in the honeybee farming and marketing business.

The qualitative insights from Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) were merged with the quantitative data through the triangulation method. Qualitative information added crucial background and insight to the quantitative results, as important patterns were discovered using a coding procedure. This information was important in interpreting the numerical findings of the root causes behind observed patterns, such as increased production expenses. This thorough method greatly improved the research's accuracy by successfully connecting statistical information with the firsthand experiences of honey production and marketing stakeholders.

Data Analysis

The data analysis involved various statistical and economic tools to achieve the study's objectives. Production and marketing index, cost and returns analysis, and factor analysis with Likert scale were analyzed using SPSS and R program to determine trends, profitability, and challenges in the honey value chain. The analysis also involved calculating total revenue, gross margin, net returns, and profit margins (on SPSS version 22.00) to evaluate the performance of honey production and marketing in Cross River State. Mapping of key production and marketing points was done using GPS and QGIS software (version 3.34.1) to enhance

access to key locations and create a favourable business plan.

RESULTS

Key Honey Production and Marketing Locations

Information on honey production and marketing locations facilitates business flow between producers and marketers, thereby making the value chains sustainable by linking all stakeholders. The results in (Fi**gure 2**) indicate key honey production locations across the three district zones of Cross River State, Nigeria. Based on the results of this finding, honey production is mainly focused in the Northern district of the state, specifically in Obanlikwu and Obudu Local Government Areas. The major honey markets for sourcing honey are concentrated in Obanlikwu and Obudu LGAs. Key informant Interviews (KII) reveal that it is based on a higher number of honey keepers in the location, coupled with market integration from Benue State and neighbouring country - Cameron with a similar interest in honey production.

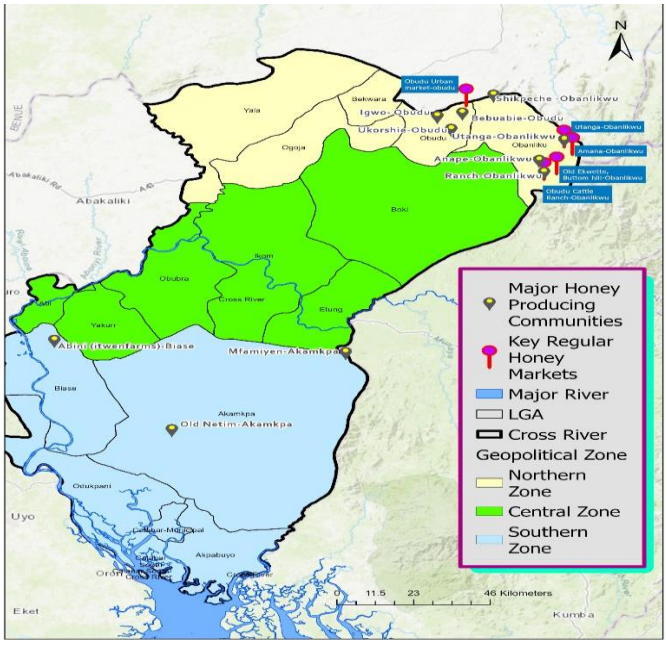

Figure 2: Key producing communities and honey markets in Cross River State, Nigeria

The central tropical zone of the state had an average of 17 owned bee hives in 2021, consistent with the previous year (Table 1). This represents a gradual increase from 13 in 2017 to 16 in 2019. Colonized bee hives averaged 15 in 2021, up from 11 in 2017 and 13 in 2019. The Northern zone maintained an average of 26 owned bee hives in 2021, stable since 2020. This follows an increase from 18 in 2017 to 24 in 2019. Colonized bee hives averaged 21 in 2021, rising from 15 in 2017 to 20 in 2019. The Southern zone had the highest average number of owned bee hives, peaking at 32 in 2021. This represents a slight decrease from 33 in 2020 but an overall increase from 23 in 2017 to 29 in 2019. Colonized bee hives averaged 26 in 2021, with minimal fluctuations since 2018.

The Southern zone consistently had the highest average number of owned and colonized bee hives, this was followed by the Northern zone which ranked second in both categories (Table 1). The Central zone had the lowest average number of bee hives. Therefore, there was a gradual growth in beekeeping interest and infrastructure from 2017 to 2019. Stabilization or slight fluctuations were observed from 2020 to 2021.

Table 1: Average Number of Be Hives Own and Colonized in Five Years Frame

	Number Owned				
Zone	**2021**	**2020**	**2019**	**2018**	**2017**
Central	17	17	16	14	13
North	26	26	24	21	18
South	32	31	29	23	23
	Number Colonized				
Central	15	15	13	12	11
North	21	21	20	17	15
South	26	27	25	20	20

Table 2 presents the result of the average quantity of honey produced by beekeepers and hunters across three geographical zones in the study area over five years (2017-2021). Beekeepers in the Southern tropical ecological zone consistently produced the highest average quantity of honey, ranging from 156.9 kg in 2017 to 210.7 kg in 2021. In contrast, the Central zone had the lowest average production, increasing from 70.5 kg in 2017 to 113.7 kg in 2021. The Northern zone ranked second, with an average production of 180.3 kg in 2021, fluctuating from 121.5 kg in 2017 to 172.3 kg in 2020. The results showed that hunters had a different trend. The Central zone had a spike in 2017, with production reaching 131.5 kg, followed by a significant decline to 6.3 kg in 2021. In contrast, the Northern and Southern zones maintained relatively stable production levels, ranging from 4.9 kg to 6.7 kg.

A comparative analysis of the zones reveals that beekeepers in the Southern zone produced significantly ($p=0.001$) more honey than those in the Central and Northern zones. However, hunters' production levels were substantially lower across all zones. An examination of the trends indicates that beekeepers in the Central and Southern zones experienced a gradual increase in production from 2017 to 2021. In contrast, the Northern zone exhibited fluctuations during this period. Hunters in the Central zone had a decline in production from 2017 to 2021, while those in the Northern and Southern zones maintained relatively stable levels. The fluctuations could be due to ecological differences in beekeeping practices, climate, or flora that may influence honey production, indicating that targeted support for beekeepers in the Central zone could enhance production. Additionally, the lower production levels among hunters imply a lack of participation or the use of substitute honey sources.

Table 2: Average Quantity of Honey Produced in Five Years within the Study Area

Producers	Zone	2021	2020	2019	2018	2017
Keepers	Central	113.7	120.5	107.6	119.9	70.5
	North	180.3	172.3	166.3	169.2	121.5
	South	210.7	223.2	196.2	161.5	156.9
Hunters						
	Central	6.3	7.3	7.3	7.8	131.5
	North	4.9	6.0	6.7	6.6	65.5
	South	5.0	6.4	4.9	5.3	5.7

Figure 3 illustrates the mean quantity of honey sold across ecological zones by beekeepers and hunters. The Southern zone had the highest mean quantity sold, with 674.4 kg per year, significantly surpassing the Central (173.8 kg) and Northern (169.4 kg) zones. The Central and Northern zones showed relatively similar mean quantities sold, with a difference of only 4.4 kg. The mean quantity sold was substantially lower compared to beekeepers. The Central zone had the highest mean quantity sold among hunters, with 10.4 kg per year. The Northern and Southern zones had identical mean quantities sold, with 9.4 kg per year. The average amount of honey sold by beekeepers in the Southern zone was higher than that of the Central and Northern zones. Hunters sold minimal quantities of honey, with no significant differences between zones.

The Southern zone has a more developed beekeeping industry, potentially due to favourable ecological conditions or better market access. Beekeepers in the Central and Northern zones may face challenges in scaling production or accessing markets. Hunters' minimal honey sales indicate limited engagement or alternative income sources.

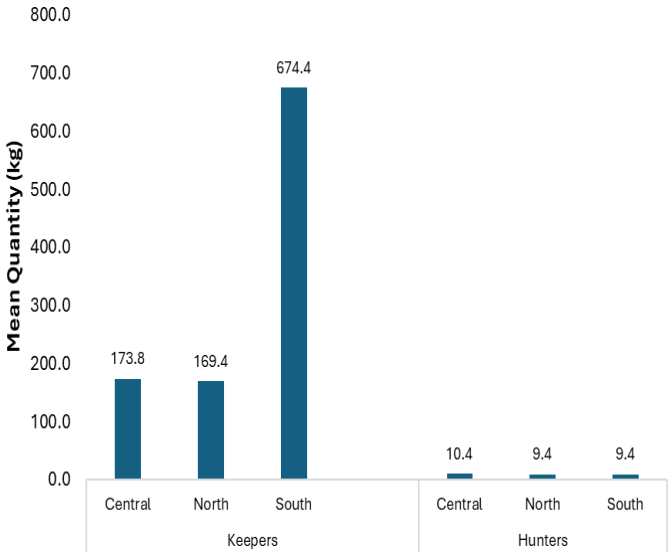

Figure 3: Mean Quantity (Kg) of Honey Sold across the Ecological Zones

The result of the average unit price per kilogram of honey for beekeepers and hunters across three geographical zones over five years (2017-2021) is presented in Tale 3. The average unit price per kilogram of honey for beekeepers increased steadily across all zones from 2017 to 2021. Specifically, the Central zone experienced a 37% increase, from ₦1,690.7 in 2017 to ₦2,316.3 in 2021. The Northern zone had a 41% increase, from ₦1,858.9 in 2017 to ₦2,620.4 in 2021. The Southern zone had the highest average price, increasing by 33% from ₦2,129.8 in 2017 to ₦2,830.7 in 2021.

A similar trend was observed among hunters, with average prices increasing across all zones. The Central zone saw a 32% increase, from ₦2,037.5 in 2017 to ₦2,681.3 in 2021. The Northern zone experienced a 28% increase, from ₦2,047.1 in 2017 to ₦2,623.5 in 2021. The Southern zone had the highest average price, increasing by 30% from ₦2,133.3 in 2017 to 2766.7 in 2021.

The Southern Zone consistently had the highest average unit price per kilogram of honey for beekeepers and hunters. Conversely, the Central zone had the lowest average price among beekeepers, while the Northern zone had the lowest average price among hunters. The steady increase in average unit price per kilogram of honey across all zones and producer types reveals growing demand for honey, potential improvements in honey quality or production practices, and regional market dynamics influencing pricing. These findings have significant implications for honey producers, processors, and consumers. Higher prices may incentivize increased production, while regional differences in pricing may impact market competitiveness. Consumers may face higher costs due to increasing prices.

Table 3: Average Unit Price (₦) per Kg of Honey Sold by Bee Producers in Five Years Frame

Producers	Zones	2021	2020	2019	2018	2017
Keepers	Central	2,316.3	2,200.0	2,014.0	1,836.0	1,690.7
	Northern	2,620.4	2,478.4	2,150.0	2,059.6	1,858.9
	Southern	2,830.7	2,680.7	2,507.0	2,305.6	2,129.8
Hunters	Central	2,681.3	2,593.8	2,437.5	2,287.5	2,037.5
	Northern	2,623.5	2,520.6	2,400.0	2,238.2	2,047.1
	Southern	2,766.7	2,688.9	2,488.9	2,377.8	2,133.3

Table 4 presents the results of the average costs, profits, and efficiency of honey production for beekeepers and honey hunters across three ecological zones from 2017 to 2021 (See Table 4 in Appendix). The Southern zone had the highest AVC for land rent (₦1,929.82), bee suite (₦3,982.46), and beehive (₦5,503.85). The central zone had lower AVCs across most categories, with noticeable exceptions in boots (₦1,964.29) and beehive stands (₦1,702.44). The Northern Zone consistently reported the lowest AVCs. The Central zone had the highest AVC for boots (₦5,166.67) and machetes (₦5,000.00).

The Southern zone reported the lowest AVC for beehive knives (₦710.00) and 20kg containers (₦2,444.44). The Southern zone incurred the highest total cost (₦60,796.78), while the Central zone had the lowest (₦35,187.93). The Northern zone generated the highest total revenue (₦129,382.98), followed closely by the Southern zone (₦151,535.09).

The Northern zone reported significantly higher total revenue (₦711,500.00) compared to the Central (₦330,500.00) and Southern (₦190,500.00) zones. The Northern zone achieved the highest profit (₦94,195.05) and profit efficiency (72.80%). The Central Zone reported lower profits (₦39,199.32) and efficiency (45.87%) than other regions. The Northern Zone generated significantly higher profits (₦683,632.71) and efficiency (96.08%) than the Central and Southern Zones. These differences revealed variations in production costs, revenues, and efficiency among beekeepers and honey hunters across the eco-zones. The Southern Zone shows potential for economies of scale among beekeepers, while honey hunters in the Northern Zone exhibit exceptionally high profits and efficiency.

Profit and Efficiency of Honey Marketing between the Years 2017-20

Table 5 presents the average costs, profits, and efficiency of honey marketing across three zones (See Table 5 in Appendix). The average cost of purchasing honey per kilogram varied across zones, with the Central zone having the highest cost at ₦2,585.45, followed by the Southern zone at ₦2,191.11, and the Northern zone at ₦2,094.20. Transportation costs also differed, with the Northern zone incurring the highest cost at ₦2131.30, while the Southern zone had the lowest cost at ₦1,240.61. The Central zone's transportation cost was ₦1,890.91. Monthly tax payments ranged from ₦534.47 in the Southern zone to ₦698.33 in the Central zone. The Average Variable Costs (AVC) for honey filtering units were highest in the Northern zone at ₦851.48, while the Southern zone had the lowest AVC for 1kg containers at ₦164.44. The Total Cost (TC) of honey marketing was highest in the Northern zone at ₦13,350.68 and lowest in the Southern zone at ₦10,791.75.

Revenue generation varied, with the Central zone earning the highest revenue at ₦177,590.91, followed by the Northern zone at ₦169,566.04, and the Southern zone at ₦46,273.33. Profit margins were substantial, with the Central zone reporting a profit of ₦165,810.76, the Northern zone at ₦156,215.35, and the Southern zone at ₦35,481.58. Efficiency ratios revealed that the Central zone had the highest efficiency at 93.37%, closely followed by the Northern zone at 92.13%, while the Southern zone had the lowest efficiency at 76.68%.

Table 6 presents the average unit price per kilogram of honey across three zones over five years, from 2017to 2021 (See Table 6 in Appendix). The Central zone showed a steady increase in average unit price, rising from ₦1,963.64 in 2017 to ₦3,172.73 in 2021, representing a 61.5% increase. Similarly, the Northern zone had a 52.5% increase, from ₦1,654.21 in 2017 to ₦2,520.56 in 2021. The Southern zone displayed a 56.5% increase, from ₦1,768.89 in 2017 to ₦2,773.33 in 2021. Comparing the zones, the Central zone consistently had the highest average unit price per kilogram of honey, with a mean price of ₦2,822.21 in 2021. The Northern zone had the lowest average price, with a mean of ₦2,520.56 in 2021. The mean price across all zones increased steadily from ₦1,795.58 in 2017 to ₦2,822.21 in 2021, representing a 57.1% increase. This trend indicates that there is a growing demand for honey.

DISCUSSION

Key honey production and marketing locations in the area show a high concentration of honey production in the Northern zone of Cross River State, particularly in Obanlikwu and Obudu Local Government Areas, this

can be attributed to the higher number of bee honey keepers in these locations. Market integration from Benue State and neighbouring countries such as Cameroon, which share similar interests in honey production, also contributes to the concentration of honey markets in these areas. This result aligns with the study of Ezeudu and Obimbua (2014), who reported on the importance of market access and integration in the sustainability of agricultural value chains. The Key Informant Interviews (KII) further support this finding, showing the role of market integration in facilitating the flow of honey from producers to marketers. The study's reliance on a limited number of Key Informant Interviews and Focus Group Discussions may not fully capture the diverse experiences of all stakeholders in the honey value chain. These limitations indicate that while the findings contribute to understanding economic viability, further research could expand the sample size and incorporate additional data collection methods to enhance the robustness and generalizability of the results.

The result of this study agrees with the importance of Non-Wood Forest Products (NWFPs) (Dau and Elisha, 2013), who reported on the role of non-wood forest products as a source of income generation among rural people. Also, the result of this finding aligned with the report of Babatunde *et al.* (2007) and Okunlola *et al.* (2023), who reported that in market expansion and export potential, Nigeria has a growing domestic market for honey due to increasing awareness. The international demand for organic and natural honey presents export opportunities, by tapping into these markets' locations in Nigerians' beekeepers and honey producers to achieve higher profit margins and contribute to the country's foreign exchange earnings and revenue generation (Agboola *et al.,* 2021). This finding has enhanced honey producers' ability to market their products and marketers where to source large quantities of honey. This enhances their marketing entrepreneur and creates strong relationships with end users (consumers) as good information to source for honey in both quality (directly from keepers) and large quantity in the identified markets.

Honey production contributes significantly to the income of individuals in the study area, accounting for 28.2% of the total income, with other sources contributing the most. This shows the importance of diverse economic activities, such as farming and trading, which also contribute to the overall income landscape (Al-Ghamdi *et al.,* 2017). Beekeeping operations in the study area were highly profitable, with 28.2% of their income derived from honey production. Bee keepers and hunters had steady hive ownership, leading to growing production levels over time.

Over the five years (2017-2021), honey production showed consistent growth between 52.5 to 61.5%, reflecting increased revenue. Honey production's total revenue has risen due to the rising demand, with fluctuations observed in yearly output, this increase could be driven by the higher adoption of improved production practices. This result aligned with the report of Kiwalaka, (2023), who reported that factors such as demand, cost of inputs, and practices impact honey production growth to determine increased revenue. Significant fluctuations observed in the quantity of honey sold are driven primarily by demand and influenced by external factors such as market conditions and weather (Erekalo *et al.,* 2018). Variations were observed across different ecological zones, with some areas reporting higher honey sales due to favourable conditions, while others experienced decreases.

The mean unit price of honey fluctuated between 2017 and 2021, with bee hunters recording an average unit price (of 2,072.6 per kg in 2017 and ₦2,690.50 in 2021) across the zones, while beekeepers (had ₦1,893.13 in 2017 and ₦2,589.13 in 2021). The increasing prices were due to rising demand and production costs (Ballco and

Jaafer, 2022). As consumer interest increased, prices increased, reflecting market trends and production efficiency (Handoyo *et al.,* 2023; Kiwalaka, 2023). Rising costs of transportation and packaging also contributed to price increases (Ballco and Jaafer, 2022).

Honey production operations were highly profitable, (with an average profit of ₦74,710.89 and a profit efficiency of 59.52%) from 2017 to 2021. The total revenue (of ₦524,606.8) exceeded the total cost of ₦481,109.8 reported by Hilma *et al.* (2011). Transportation and beehives were the highest items, while 1 and 2-kg containers had lower costs. Beekeeping remained a sustainable livelihood due to efficient management and increased market demand (Ijigbade *et al.,* 2023).

Honey marketing was equally profitable, with a total average marketing profit of ₦471,679.1 and a marketing efficiency of 92.1%. This result is higher than the value reported by Agbugba *et al*. (2020), who reported that the honey marketing enterprise was profitable with an average gross margin of N18,223.3 per month. The marketing profit in this study is lower than the one reported by Arowolo and Oladejo (2020), who reported that honey marketers generated a gross margin of ₦986.67k and a profit of ₦716.65k per liter of honey sold in Oyo state, Nigeria. Despite stable total costs over the years, marketing revenue increased due to rising demand. Marketers also demonstrated strong management practices, enabling consistent profit growth (Zaric *et al*., 2013; Upadani *et al*., 2022).

Honey producers and marketers in the area have demonstrated consistent profitability, with beekeepers incurring higher costs but achieving greater profitability than bee hunters. Beekeeping, though more capital-intensive, was more profitable due to larger production and sales volumes (Vaziritabar and Esmaeilzade, 2016). Honey availability peaked in March and February, while May exhibited lower availability, affecting market prices and sales volumes. This result agrees with the report of Agbugba *et al.* (2020), who reported that most honey marketers were confronted with the problem of inadequate honey supply. Efficient cost management, seasonality, and strong market strategies contributed to the success of honey operations (Adeola *et al.,* 2011). The findings reveal that honey production and marketing in Nigeria are competitive and sustainable, with strong prospects for growth (Arowolo and Oladejo, 2020; Cavlin *et al*., 2023).

CONCLUSION

The findings from this study show honey production and marketing are sustainable and profitable ventures in the region, contributing significantly to household income. Fluctuations in honey sales were observed in different ecological zones because of differences in environmental conditions, while unit prices for bee hunters increased steadily from ₦2,057.6 in 2017 to ₦2,661.0 in 2021, and for beekeepers from ₦2,069.2 to ₦2,651.2. Beekeepers spent more money on production but made more profits than the bee hunters. Production costs stayed consistent, with transportation and beehives being the most expensive, but profit efficiency was strong at 90.7% for production and 92.1% for marketing. Based on the findings, training programs are necessary to aid in the adoption of modern practices of honey hunting. Furthermore, increased access to modern technology and standardised market structures for honey producers and marketers, especially for women to boost efficiency and profitability. Research and development of marketing strategies are essential to improve productivity and expand market access, for the long-term sustainability of honey production as a viable livelihood option.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare

FINANCIAL DISCLOSURE

The authors declared that this study received no financial support

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AUTHORS' CONTRIBUTIONS

U. J. A. managed literature research, development of methods, data collection, results interpretation, manuscript writing, and funding. T. T. N. and A. P. U. supervised the development of techniques and data analyses and reviewed the manuscript. D. H. J. analyzed the data and reviewed the manuscript. All authors read and approved the manuscript.

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APPENDIX

Table 4: Average Cost (₦), Profits (₦) and Efficiency of Honey Production from Year 2017-2021

Variables	Honey Keepers			Honey Hunters		
	Northern	**Central**	**Southern**	**Northern**	**Central**	**Southern**
AVC-land-rent	1,251.77	1,139.53	1,929.82	-	-	-
AVC-Bee-suite	2,683.45	1,825.58	3,982.46	-	-	-
AVC-Boots	2,650.00	1,964.29	3,239.22	4,900.00	5,166.67	5,000.00
AVC-Hand-gloves	932.42	694.74	1,304.00	2,000.00	-	-
AVC-Bee-hive	4,504.34	3,475.61	5,503.85	-	-	-
AVC-Bee-hive-stand	2,200.71	1,702.44	2,980.77	-	-	-
AVC-Bee-hive-cover	1,508.57	1,245.24	2,115.38	-	-	-
AVC-Bee-hive-knife	874.29	724.39	973.08	500.00	650.00	710.00
AVC-Bee-hive-brush	730.96	602.44	960.15	-	-	-
AVC-Matchet	3,791.49	3,190.41	4,246.15	4,797.06	5,000.00	4,587.50
AVC-Bucket	3,717.86	2,916.67	5,497.12	10,405.88	8,587.50	8,611.11
AVC-Honey-filter	1,218.05	1,120.03	1,702.08	1,500.00	1,000.00	
AVC-Bee-smoker	2,745.45	1,327.91	3,400.00	-	-	-
AVC-Honey-presser	2,922.48	2,630.41	3,380.00	-	-	-
AVC-1kg-container	157.14	145.81	195.88	1,76.97	310.63	182.22
AVC-2kg-container	294.40	269.77	366.54	3,52.94	396.25	353.33
AVC-10kg-container	1,208.87	1,180.49	1,345.61	1,754.41	1,943.75	1,811.11
AVC-20kg-container	2,631.91	2,588.37	2,539.29	2,361.76	2,462.50	2,444.44
AVC-transport/month	6,820.57	4,443.81	9,798.85	1,538.24	1,768.75	3,277.78
Average--Tax/month	3421.07	2,000.00	5,336.54	511.76	581.25	633.33
Total Cost	**46,265.80**	**35,187.93**	**60,796.78**	**26,799.03**	**2,7867.29**	**27,610.83**
Total Revenue	**85,465.12**	**129,382.98**	**151,535.09**	**330,500.00**	**711,500.00**	**190,500.00**
Total profit	**39,199.32**	**94,195.05**	**90,738.31**	**303,700.97**	**683,632.71**	**162,889.17**
Profit efficiency	**45.87**	**72.80**	**59.88**	**91.89**	**96.08**	**85.51**

Table 5: Average Cost (₦), Profits (₦) and Efficiency of Honey Marketing within Five Years

Variables	Central	Northern	Southern
Cost of purchase per kg	2,585.45	2,094.20	2191.11
Cost of transportation	1,890.91	2,131.30	1,240.61
Tax per month	698.33	634.36	534.47
AVC Honey filter unit cost:	618.18	851.48	646.67
AVC 75cl container unit cost:	100.00	100.00	100.00
AVC 1kg container unit cost:	177.27	193.93	164.44
AVC 2kg container unit cost:	300.00	286.36	300.00
AVC 10kg container unit cost:	1,000.00	1,065.89	982.22
Avc 20kg container unit cost:	1,500.00	3,104.67	1,800.00
AVC Filtering bowl unit cost:	3,000.00	2,978.50	2,922.22
TC	**11,780.15**	**13,350.68**	**10,791.75**
Revenue	**177,590.91**	**169,566.04**	**46,273.33**
Profit	**165,810.76**	**156,215.35**	**35,481.58**
Proficient	**93.37**	**92.13**	**76.68**

Table 6: Average Unit Price (₦) per Kg of Honey Sold by Marketing in Five Years Frame

Zones	Unit cost per Kg in 2021	Unit cost per Kg in 2020	Unit cost per Kg in 2019	Unit cost per Kg in 2018	Unit cost per Kg in 2017
Central	3,172.73	2,954.55	2,581.82	2,254.55	1,963.64
Northern	2,520.56	2,358.88	2,121.70	1,815.68	1,654.21
Southern	2,773.33	2,268.89	2,224.44	1,920.00	1,768.89
Mean	**2822.21**	**2527.44**	**2309.32**	**1996.74**	**1795.58**