*Int Journal of Social Sciences Management and Entrepreneurship 8(3): 527-540 2024*

**ISSN 2411-7323**

www.sagepublishers.com



# INNOVATIVE ENTREPRENEURSHIP PRACTICES AND PERFORMANCE OF APICULTURE ENTERPRISES IN KENYA

**[1] Ciira Regina Wanjiru, [2] Dr. Gichana James Ongwae**

[1]Masters Student, Jomo Kenyatta University of Agriculture and Technology
[2]Lecturer, Jomo Kenyatta University of Agriculture and Technology

## ABSTRACT

Innovation is used to improve performance in organizations. Apiculture technology has improved globally. However, adoption of innovations in developing countries such as Kenya remains a challenge. This study examined innovative entrepreneurship practices and performance of apiculture enterprises in Kenya. The specific objectives were to establish how technology adoption and market development influence performance of apiculture enterprises in Kenya. The theories that supported this study were diffusion of innovation theory and economic entrepreneurship theory. Descriptive research design was used with questionnaire as the instrument for data collection. Data was collected among 357 beekeepers in Kitui County, Makueni County and Machakos County. The unit of observation was beekeepers in the counties. Simple random sampling was used to pick respondents. Data collected was analyzed using SPSS version 25 and presented in form of frequencies, descriptive and inferential statistics which were be used to derive conclusions. The study conducted a multiple regression analysis to determine the relationship between innovative practices and performance of apiculture. Correlation results revealed that innovative entrepreneurship practices influences performance of apiculture enterprises in Kenya. The results indicated that there was a positive and significant relationship between technology adoption, market development and performance management. The study recommends increased adoption of technology tools in apiculture and development of markets to ensure improved performance.

**Key Words:** Innovative Entrepreneurship Practices, Technology Adoption and Market Development

## Background of the Study

The growth of apiculture in many countries is enabled by adoption of modern apiculture management practices. In Europe, apiculture contributes largely to the economy with an estimated honey output of over 200,000 tones (Novelli, Vercelli & Ferracini (2021). It contributes about fourteen percent of the total global production due to utilization of modern apiculture methods. Yohana and Saria (2020) indicated that Sub-Saharan Africa experienced 33.1% increase in apiculture as an economic activity due to increased adoption of innovative business practices. Apiculture supports millions of household livelihoods in Sub Sahara Africa. Farmers had shifted from maize and sunflower farming due to availability of modern apiculture methods. In Kenya, the National and County Governments have introduced support systems for apiculture which has led to increased apiculture activities (Renton, 2021). However, challenges in adoption of innovative practices in Kenya limit the production capacity and growth of the apiculture sector. Nomo (2021) assert that increased productivity in apiculture can be achieved through modern apiculture methods such as use of modern technology, product and market development.

Globally, the apiculture sector has undergone great changes in business operations and market development. According to Danieli, Addeo, Lazzari, Manganello and Bovera (2023) the apiculture sector in the global scope is characterized by increased adoption of advanced technology such as artificial intelligence and development of new markets globally for new and existing products. Degu, Mwangi, Verkuijl and Wondimu (2022) assert that apiculture in Europe relies heavily on new technology to improve product quality and distribute products to various markets. Marketing innovation in the global scope has facilitated growth in apiculture through new distribution channels, improved product designs and innovative product placement and pricing strategies. According to Gaga and Esaulov (2022), use of technology in apiculture management was essential to improve honey yields and growth of the apiculture sector. According to Danieli et al. (2023) application of apiculture systems such as the application of software tools was associated with sustainable apiculture in Italy.

According to Ali and Jabeen (2020), adoption of modern apiculture practices is critical for growth of apiculture sector. According to Bekuma (2021) study on adoption of modern apiculture technology in Ethiopia, promotional activities and possession of adequate information on beehive technologies affected adoption. Affognon, Kingori, Omondi, Diiro, Muriithi, Makau and Raina (2020) posit that traditional apiculture methods had negative effects on product quality, alteration of production levels and effect on product development. Modern apiculture methods such as use of technology increase productivity levels. According to Renton (2021), Kenya is among the countries involved in developing apiculture to enhance agricultural biodiversity. According to Kiingwa, Muiruri and Mahiri (2020) adoption of technology can lead to significant improvement in productivity.

## Statement of the Problem

The apiculture sub sector in Kenya is performing below its optimal production capacity limiting productivity levels, growth of employment opportunities in the sub sector and contribution to the national revenue collection. According to Affognon et al. (2020), in Kenya, apiculture contributes only 1.89% to the gross domestic product. This is despite Kenya's beeswax and honey production potential estimated at 10,000 and over 100,000 metric tons respectively (Kiingwa, Muiruri & Mahiri, 2020). Only 20% of the production potential is exploited which reduces apiculture productivity levels (Espen, Williams, Alves, Hung, Graaf, & Verbeke, 2023). Majority of apiculture businesses in Kenya face increased challenges of low production and poor quality of products due to continued use of traditional apiculture practices which has negative impact on the performance of apiculture (Mukasa, 2019). A report by the Kitui County Government (2023) indicated that due to high dependence on the traditional technology, the County experienced a 38% reduction in honey production. According to Kiiti, Muiruri and Mahiri (2020), 62% of the apiculture enterprises in Kitui County use traditional apiculture

practices and outdated technology which limit production potential. Kitui County, Makueni County and Machakos County are among the areas where apiculture is common in Kenya (Kiiti, Muiruri & Mahiri, 2020). However, the activity has low economic impact and poor revenue generation among apiculture businesses due to failure to adopt modern technology and practices.

Yohana and Saria (2020) found that failed adoption of modern apiculture practices led to 33.1% decrease in apiculture productivity in Sub-Saharan Africa. According to Mcmenamin et al. (2020), only 35.1% have adopted modern apiculture practices in Kenya. According to Cullen (2019) traditional apiculture methods leads to poor quality products which reduces productivity. According to Lloyd (2021), adoption of innovative apiculture practices such as new technology and product value addition contributed to 70-80% improvement in product quality in Sub-Saharan Africa and increased yields by 40%. Chemwok, Tuitoek and Nganai (2019) found that adoption of modern apiculture methods had a significant impact on quality of honey produced in Mwingi District, Kitui County. According to Boncristiani, Prdic, Ignjatijevic, Vapa Tankosic, Lekic and Kostic (2023) adoption of innovations in apiculture leads to increased productivity and growth of apiculture related businesses such as food production industries and agriculture. Studies by (Affognon et al., 2020; Cullen, 2019) indicated that modern apiculture practices and innovations such as adoption of technology improved apiculture production. Lloyd (2021); Ali and Jabeen (2019) studies found strong correlation between adoption of modern and innovative apiculture practices and growth of apiculture. Renton (2021) conducted a study on apiculture sector in Kenya and showed that apiculture businesses were faced with increased low revenue generation, low honey production due to poor apiculture practices and lack of innovation.

Cullen (2019); Affognon et al. (2020); Ali and Jabeen (2019) and Lloyd (2021) studies above on apiculture found that modern and innovative apiculture practices have significant effect on growth of apiculture and apiculture-related businesses. These studies however, present conceptual gaps since they considered one or two elements of innovative practices. Majority of the studies assessed modern apiculture practices and apiculture in the global context hence, presenting contextual gaps. Studies conducted in Kenya assessed adoption of modern hives which represent only one innovative practice presenting conceptual gaps. Conducting this study was crucial in identifying constraints in innovative practices for growth of apiculture in Kenya. This study aimed to bridge the conceptual and contextual gaps by examining innovative entrepreneurship practices and performance of apiculture enterprises in Kenya.

**Main Objective**

The main objective of the study was to examine the relationship between innovative entrepreneurship practices and performance of apiculture enterprises in Kenya.

**Specific Objectives**

i. To establish the relationship between technology adoption and performance of apiculture enterprises in Kenya.
ii. To find out the relationship between market development and performance of apiculture enterprises in Kenya.

**Theoretical Review**

**Diffusion of Innovation Theory**

Rogers (1962) developed the diffusion of innovation theory to explain how, why, and at what rate new ideas and technology spread. According to Rogers (2003), diffusion is the process by which an innovation is communicated over time among the participants in a social system. He proposes four main elements influence the spread of a new idea: the innovation, communication channels, time and a social system. The innovation must be widely adopted in order to self-sustain. Rogers (2003) lists the categories of adopters as innovators, early adopters, early majority, late majority, and laggards. Adoption of a new idea does not happen

simultaneously rather it is a process whereby some people are more apt to adopt the innovation than others are.

According to Wayne (2016), the result of this diffusion is that people, as part of a social system adopt a new idea, behaviours, or product. Adoption means that a person does something differently than what they had previously. The theory is applicable to this study as it demonstrates the link between technology adoption and organizations' performance. Increased innovation in an organization through adoption of new technologies is expected to enhance performance.

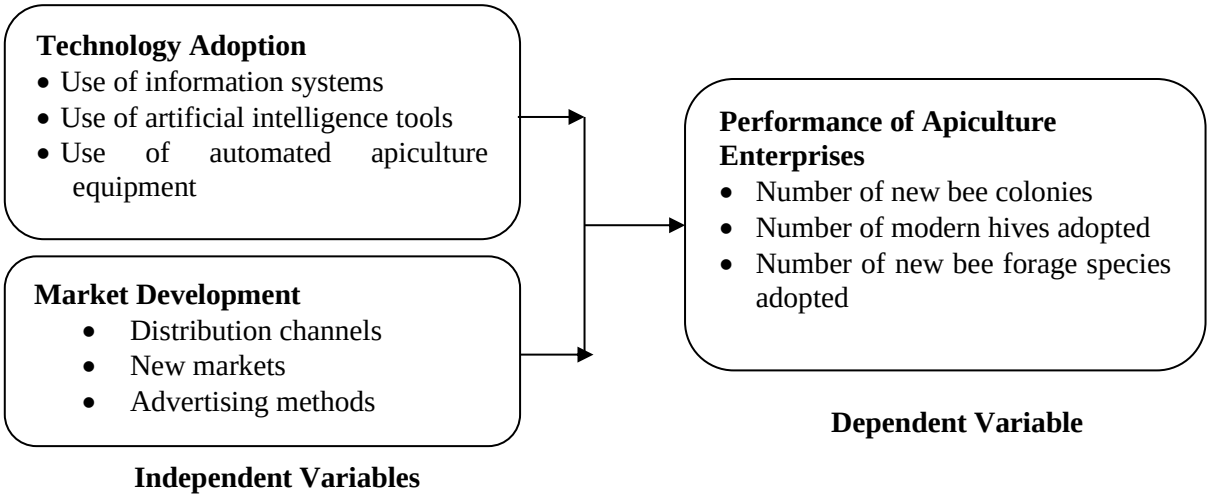
**Economic Entrepreneurship Theory**

Economic entrepreneurship theories were introduced by Richard Cantillon in the first half of the 1700s, who brought the idea of entrepreneurs as risk takers. The economic entrepreneurship theory has deep roots in the classical, neoclassical theories of economics, and the Austrian market process (AMP). The Austrian Market process (AMP) model which will be adopted in this study was influenced by Joseph Aloi Schumpeter (1934). Schumpeter (1934) described entrepreneurship as a driver of market-based systems. An important function of an enterprise according to this model was to create something new which resulted in processes that served as impulses for the motion of market economy. Fiet (2002) held that entrepreneurs are incentivized to use episodic knowledge (that is, possibly never seen before and never to be seen again), to generate value.

Casson (2005) contends that an entrepreneur is the prime mover in economic development, and one's function is to innovate, or to carry out new combinations. In the current study, as suggested in the economic entrepreneurship theory by, the performance of firms is largely influenced by such factors as innovation and risk-taking. The economic theory of entrepreneurship firmly states that the economy and entrepreneurial activity are intertwined, with entrepreneurs needing prosperous conditions to be able to thrive. Economic factors play an important role in the development of entrepreneurial activities. This concept asserts that entrepreneurs are motivated by economic incentives such as technological market knowledge and associated resources. Availability of markets can drive entrepreneurial growth. The absence of markets for products can also drive entrepreneurial activity through development of new markets and improvement of existing markets through innovation. Adoption of new ideas such as distribution channel innovations leads to improvements in products, processes and services. The model demonstrates the link between market development and performance of apiculture. Market development is expected to improve apiculture performance.

**Conceptual Framework**

The framework shows the dependent and independent variables utilized in a study. Hrebiniak (2021) defines it as a group of concepts, which are organized in a systematic manner to provide a tool for integrating and interpreting information. Figure 2.1 presents the conceptual framework that was used in this study.



## Technology Adoption

A new technology alone does not guarantee a wide spread adoption and efficient use. For efficient utilization of the technology, the fulfilment of specific economic, technical and institutional conditions are required. From the farmers' economic perspective, the new technology should be more profitable than the existing alternatives (Gikunda, Ooga, Okiamba & Anyuor, 2021). The Kenyan Top Beehive Bar (KTBH) is a modified Greek basket-basket with moveable, removable upper rods. The lid is built of a wooden frame with a galvanized sheet steel light meter on top. The comb can be simply removed for inspection and restored to the shelf, which gives the KTBH a variety of benefits over standard input components. Without harming the brood nest, the honeycomb can be removed. Modern honey extraction equipment utilizes automated processes to extract honey from frames, reducing labor and time (Alexandre, Vincent, Pacifique, Abias, Alexis, Francoise & Jacques, 2020). This helps maintain the quality of honey and minimizes stress on bees during the extraction process.

Smart sensors and artificial intelligence are used to monitor beehives. These sensors collect data on temperature, humidity, hive weight, and even sound, which can help beekeepers detect issues like swarming, disease, or temperature fluctuations. Artificial intelligence algorithms can analyze this data in real-time, providing beekeepers with insights into the health and well-being of their colonies. Artificial intelligence powered image recognition systems can identify common bee diseases, by analyzing images of bees or hive frames (Wakgari & Yigezu, 2021). Early detection allows for timely intervention. Artificial intelligence and machine learning can analyze environmental data and detect the presence of pesticides or other harmful chemicals in the vicinity of beehives. Beekeepers can then take steps to protect their colonies from exposure. According to Ngomo (2020) artificial intelligence can help optimize hive management by providing recommendations on when to inspect hives, when to harvest honey, and when to intervene if a hive is in distress. This can improve overall apiculture efficiency.

## Market Development

According to Wakgari and Yigezu (2021) market access is critical for beekeepers to sell their products. It has a significant effect on growth of apiculture. Market development involves development of marketing channels and partnerships with industry players to produce and sell bee products. According to Mulatu, Marisennayya and Bojago (2021) availability of markets affects adoption of apiculture practices and apiculture growth. Establishment of promotions to enhance market access and financing of market development is critical in apiculture development

Nzula (2020) posits that lack of information on market access affected apiculture productivity. It is essential to sensitize beekeepers on effective apiculture practices through trainings on effective marketing initiatives. According to Kathila (2019) factors such as access to markets have significant impact on apiculture. In addition, institutional support in market development has significant impact on apiculture. Therefore, there is a need for partnerships to provide funding and market access for beekeepers and improve apiculture productivity.

## Empirical Review

### Technology Adoption and Performance

Danieli et al. (2023) studied the application of apiculture systems in apiculture in Italy. The study assessed the application of software tools for sustainable apiculture. They found that tools such as precision apiculture technologies and systems improved performance of apiculture. The study concluded that tools such as sensors, apiculture systems have a positive impact on performance of apiculture. The study recommended that adoption of precision apiculture technologies to improve apiculture productivity.

Wakjira et al. (2021) examined smart apiculture in Indonesia. The study assessed smart apiculture systems in and sustainable apiculture and found that apiculture innovations led to improved operations and productivity. The study concluded that apiculture technologies led to

significant improvement in productivity. They recommended adoption of smart apiculture systems to improve apiculture performance.

Vapa-Tankosi´c et al. (2020) examined technology adoption and sustainability of apiculture sector in Serbia. The study assessed the impact of technology adoption and research and found that technological adoptions had a positive impact on apiculture performance. The study concluded that research and development and innovations were critical in improving apiculture practices. They recommended adoption of technology in apiculture to enhance sustainability.

Bekuma (2019) assessed the adoption of modern apiculture technology in Ethiopia. The study examined the factors affecting adoption of modern beehive technologies and found that promotional activities and possession of adequate information on beehive technologies affected adoption. The study recommended the dissemination of information on modern beehive technologies to facilitate adoption.

Wambua (2019) studied apiculture technologies in Kenya. The study assessed the factors affecting adoption of apiculture technologies in Kitui County, Kenya and found that factors such as the cost, the quality of products and productivity levels affected the adoption of apiculture technologies. The study concluded that adoption of apiculture technology had positive impact on productivity and recommended use of modern hives.

Chemwok, Tuitoek and Nganai (2019) studied factors influencing honey production in Kenya. They found that honey production had reduced due to economic, technological and social factors. The study found that technology adoption had significant and positive impact on honey production. They concluded that modern apiculture methods were essential in meeting the increased demand for honey and recommended utilization of modern technology in honey production to increase productivity.

**Market Development and Performance**

Wakgari and Yigezu (2021) conducted a study on factors affecting apiculture in Spain. The study found that factors such as adoption of modern apiculture practices and market access had a significant effect on apiculture. The study recommended development of marketing channels and application of modern apiculture technologies to improve apiculture performance. Mulatu, Marisennayya and Bojago (2021) examined adoption of modern apiculture technologies in Ethiopia. The study assessed the factors affecting adoption of modern apiculture technologies and found that factors such as access to finance and markets affected adoption of apiculture technologies. They concluded that providing links to financial enterprises was critical to enable beekeepers access finance before adoption of technologies. They recommended establishment of promotions to enhance market access and financing of modern apiculture technologies.

Kathila (2019) examined the factors affecting apiculture in Makueni County, Kenya. The study found that factors such as training, funding and access to markets had significant impact on apiculture. In addition, institutional support was found to have a positive and significant impact on apiculture. The study recommended partnerships to provide funding and market access for beekeepers and improve apiculture productivity.

Signore (2022) conducted a study on the barriers to apiculture development in Kenya. The study found that lack of trainings and access to markets for beekeepers affected apiculture development. The study concluded that education had a significant and positive impact on apiculture and technology adoption rates. The study recommended increased trainings to equip beekeepers with knowledge and skills on modern apiculture practices.

## RESEARCH METHODOLOGY

**Research Design**

The study adopted descriptive research survey design. According to Niyonambaza et al. (2019), in a descriptive survey method research, participants answer questions administered through interviews or questionnaires. After participants answer the questions, researchers describe the responses given. A survey research design describes the characteristics of a large

population(Niyonambaza et al., 2019). One reason for the choice of the survey research design was its usefulness in describing the characteristics of a large population.

**Target Population**

A population refers to the entire group of persons or elements that have at least one thing in common. According to Kothari (2014), the target population is defined as a physical representation and includes all the units that are possible members of the sample. According to statistics by Ministry of Agriculture, Livestock and Fisheries Development (2023), there are 1969 beekeepers who are members of the five bee farmers cooperatives in Kitui County, 816 beekeepers who are members of the Makueni beekeepers and 500 beekeepers in Machakos County. The study population was 3285 beekeepers from the eight bee farmers cooperatives in Kitui County, Makueni County and Machakos County due to high apiculture activities in the Eastern Kenya region. Data was collected from beekeepers from the eight bee farmers cooperatives in the counties. The unit of analysis was eight bee farmers cooperatives in Kitui County, Makueni County and Machakos County. The unit of observation was beekeepers from the eight bee farmers cooperatives in counties.

**Sample and Sampling Techniques**

Sample refers to a part of or fraction of population that is being investigated upon. It can The study adopted stratified random sampling technique to pick respondents from the bee farmers cooperatives in counties. Stratified sampling was used to determine the number of respondents from each cooperative since the beekeepers is located in different geographical areas within the County. Yamane 1967 formula was used to calculate the sample size where:

$n= \frac{N}{1+N(e)2}$

n= sample Size, N= Total Population (1969), e= 0.05 significance

$\mathbf{n= \frac{3285}{1+3285(0.05)2}}$

$\mathbf{n= \frac{3285}{9.2125}}$

**n=357 respondents**

**Table 3.1 Sampling Frame**

| Cooperative | Population size | Sample size |
|---|---|---|
| Mukali Beekeepers | 250 | 27 |
| Kioko Beekeepers | 400 | 44 |
| Mwingi Beekeepers | 269 | 29 |
| Gategi Beekeepers | 100 | 12 |
| Kamaki | 950 | 103 |
| Makueni Beekeepers | 316 | 34 |
| Kibwezi Beekeepers | 500 | 54 |
| Machakos Beekeepers | 500 | 54 |
| **Total** | **3285** | **357** |

**Data Collection Instruments**

The primary data was collected using questionnaires. According to Kowalczyk (2015), questionnaires are free from any interviewer's bias and errors, which may undermine reliability and validity of the results emerging from the survey. In addition, a large number of people can be reached relatively easily and economically. The researcher developed a questionnaire to collect data from the beekeepers. The questionnaire adopted close-ended questions. Secondary data on growth of apiculture was collected from reports, government publications and scholarly journals. Data was recorded in data entry tables.

### Data Collection Procedure

The researcher sought a letter of research approval from the university to conduct research. Permission to collect data from all the eight bee farmers' cooperatives in Kitui County, Makueni County and Machakos County was sought. Questionnaires were administered to beekeepers in the County.

### Pilot Test

Seltman (2014) argue that a pilot study is crucial in assessing the reliability and validity of an instrument to answer research question. A pilot study is defined as small-scale preliminary research that is conducted to evaluate time, cost, and feasibility to improve on the design of a particular study before conducting the actual one or full-scale research project (Kultar, 2017). The researcher carried out a pilot study to ensure the data collection tool is reliable and valid. The pilot test helped to correct some of the challenges encountered before undertaking the final study. The pretesting sample was made up of 36 respondents, representing 10% of the sample size. The pilot study was conducted at Mwingi District within Kitui County. The respondents included beekeepers registered with the bee farmers cooperatives. The results from the pilot test will not be used in the main study. In addition, the respondents will be excluded from the final study.

### Data Analysis and Presentation

Seltman (2014) posits that data collected should be interpreted and presented to draw conclusions. Data was analyzed using descriptive statistics to produce percentages and means and frequencies. The tool used for analysis was SPSS version 25. Data was also analyzed using inferential statistics which are regression and correlation analysis. Analyzed data was presented in form of tables and diagrams prepared from SPSS.

ANOVA was used to determine the significance of the analysis model. In addition, the relationship between innovative practices and performance of apiculture was checked using a multiple regression analysis. The relationship between the study variables was tested using multivariate regression models.

## PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

### Descriptive Statistics Analysis

### Technology Adoption

The first specific objective of the study was to establish the relationship between technology adoption and performance of apiculture enterprises in Kenya. The respondents were asked to indicate the extent to which the agree with the statement on technology adoption based on a Likert scale where Strongly agree -5, Agree -4, Moderate -3, Disagree -2, Strongly disagree -1. The results of the study were as shown in table 1.

The findings revealed that 44.2% of the respondents strongly agreed that beekeepers have adopted modern systems, 30.8% agreed while 6.7% disagreed. The study findings also showed that 80.8% of the respondents strongly agreed that beekeepers use artificial intelligence tools to manage hives while 85% strongly agreed that Use of advanced technology has increased honey production. Moreover, 50% of the respondents strongly agreed use of smart hive management tools have improved production while 45% agreed. Further, the results of the study revealed that 70% of the respondents strongly agreed beekeepers use automated honey production equipment. Further, 80.8% of respondents strongly agreed that use of automated apiculture equipment has increased production.

The implication of the results is that majority of the respondents indicated that they agree with the statements on technology adoption as shown by a mean of 4.10. The responses given by the respondents had little variation (standard deviation=0.88). The findings of the study are

consistent with the results of a study by Danieli et al. (2023) which found that adoption of technology tools and systems improved performance of apiculture.

**Table 1: Technology Adoption**

| Statements | Strongly disagree | Disagree | Neutral | Agree | Strongly agree | Mean | Std Dev |
|---|---|---|---|---|---|---|---|
| Many beekeepers have adopted modern systems in apiculture | 0.0% | 6.7% | 18.3% | 30.8% | 44.2% | 4.13 | 0.94 |
| Many beekeepers use artificial intelligence tools to manage hives | 0.0% | 0.0% | 19.2% | 0.0% | 80.8% | 4.62 | 0.79 |
| Use of smart hive management tools have improved production | 0.0% | 0.0% | 5.0% | 45.0% | 50.0% | 4.85 | 0.36 |
| Use of advanced technology has increased honey production | 0.0% | 0.0% | 5% | 10% | 85.0% | 3.28 | 1.16 |
| Many beekeepers use automated honey production equipment | 0.0% | 0.0% | 10% | 20% | 70% | 3.11 | 1.26 |
| Use of automated apiculture equipment has increased production | 0.0% | 0.0% | 19.2% | 0.0% | 80.8% | 4.62 | 0.79 |
| **Average** | | | | | | **4.10** | **0.88** |

## Market Development

The second specific objective of the study was to find out the relationship between market development and performance of apiculture enterprises in Kenya. The respondents were asked to indicate the extent to which the agree with the statement on technology adoption based on a Likert scale where Strongly agree -5, Agree -4, Moderate -3, Disagree -2, Strongly disagree -1. The results of the study were as shown in table 2.

The findings revealed that 25% of the respondents strongly agreed that beekeepers use wholesalers to sell products, 28.3% agreed while 22.5% disagreed. The study findings also showed that 24.1% of the respondents strongly agreed that beekeepers use retailers to sell products, 455 agreed while 11.7% disagreed. Moreover, 57.5% agreed that beekeepers have easy access to markets to sell products while 8.3% strongly disagreed. Besides, 20.9% of the respondents strongly agreed that there is high development of new markets while 13.3% disagreed. The results also revealed that 13.4% of the respondents strongly agreed that beekeepers use online platforms to advertise products while 13.3% strongly disagreed. The findings showed that 15.6% of respondents agreed that advertising on online platforms has increased sales while 10.3% disagreed. Moreover, 26.8% of the respondents strongly agreed that there is high market demand for bee products while 7.3% disagreed.

Majority of the respondents agreed with the statements on market development as shown by a mean of 3.51. The responses given by the respondents had little variation (standard deviation=1.36). The findings are of the study are consistent with the results of a study by Wakgari and Yigezu (2021) which found that factors such as adoption of modern apiculture practices and market access had a significant effect on apiculture.

**Table 2: Market Development**

| Statements | Strongly disagree | Dis Agree | Neutral | Agree | Strongly agree | Mean | Std Dev |
|---|---|---|---|---|---|---|---|
| Beekeepers use wholesalers to sell products | 12.5% | 22.5% | 11.7% | 28.3% | 25.0% | 3.31 | 1.39 |
| Beekeepers use retailers to sell products | 0.0% | 11.7% | 19.2% | 45.0% | 24.1% | 3.43 | 1.53 |
| Beekeepers have easy access to markets to sell products | 8.3% | 13.3% | 8.3% | 57.5% | 12.1% | 3.98 | 1.40 |
| There is high development of new markets | 10.0% | 13.3% | 27.5% | 28.3% | 20.9% | 3.24 | 1.41 |
| Beekeepers use online platforms to advertise products | 13.3% | 3.3% | 29.2% | 40.8% | 13.4% | 3.38 | 1.17 |
| Advertising on online platforms has increased sales | 5.3% | 10.3% | 7.3% | 61.5% | 15.6% | 3.88 | 1.30 |
| There is high market demand for bee products | 5.0% | 7.3% | 27.5% | 33.4% | 26.8% | 3.34 | 1.31 |
| **Average** | | | | | | **3.51** | **1.36** |

**Performance of Apiculture Enterprises**

The study established the percentage changes in the number of new bee colonies, number of modern hives adopted and number of new bee forage species adopted. Results indicated that there was gradual improvement in performance of apiculture between 2020 to 2024.

In 2020, the modern hives adopted increased by 1.01% while new bee colonies increased by 0.8% compared to previous years. Adoption of new bee forage species was stagnant in 2020, 2021 and 2022 and increased slightly in 2022, 2023 and 2024 as shown in figure 4.1. Adoption of modern hives and new bee colonies increased gradually from 2020 to 2022 and increased by a higher percentage in 2023 and 2024. The changes were attributed to more collaborations between apiculture enterprises and the County governments which offered grants and training to improve apiculture methods.

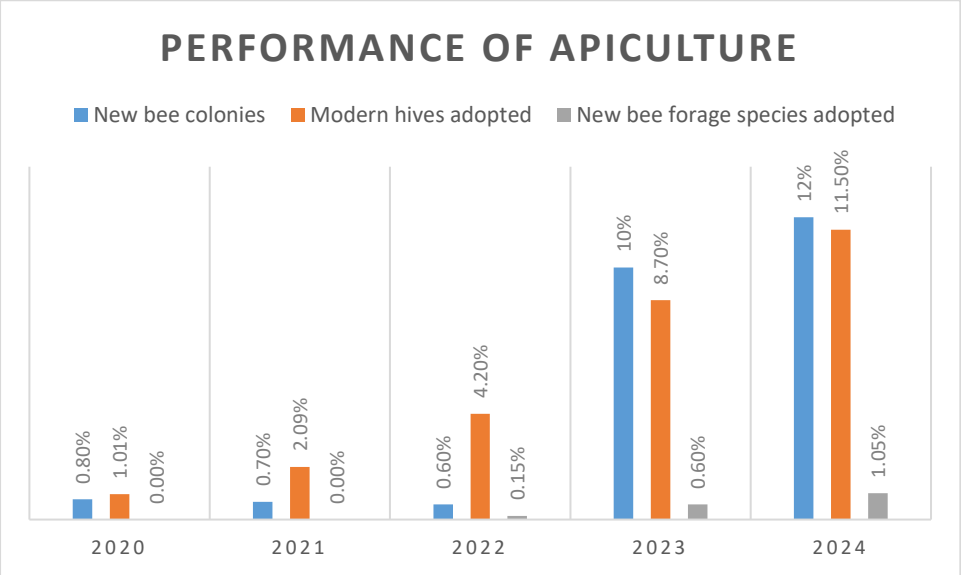



**Figure 1 Performance of Apiculture**

Further, the respondents were asked to indicate the extent to which they thought technology adoption, market development, affected performance of apiculture enterprises in Kenya. The results showed that 70% of the respondents agreed to a very great extent that technology adoption affected performance of apiculture enterprises while 25% agreed to a great extent. Moreover, 75% of the respondents agreed to a very great extent that market development affected performance of apiculture enterprises while 20% agreed to a great extent. The results

imply that many beekeepers associated to the apiculture enterprises believed that innovative entrepreneurship practices influenced performance of apiculture enterprises. The results are shown in figure 2. The results agree with findings by Gaga and Esaulov (2022) study, which found that innovative technologies improved apiculture productivity and recommended adoption of innovative methods to improve apiculture practices and sustainability.

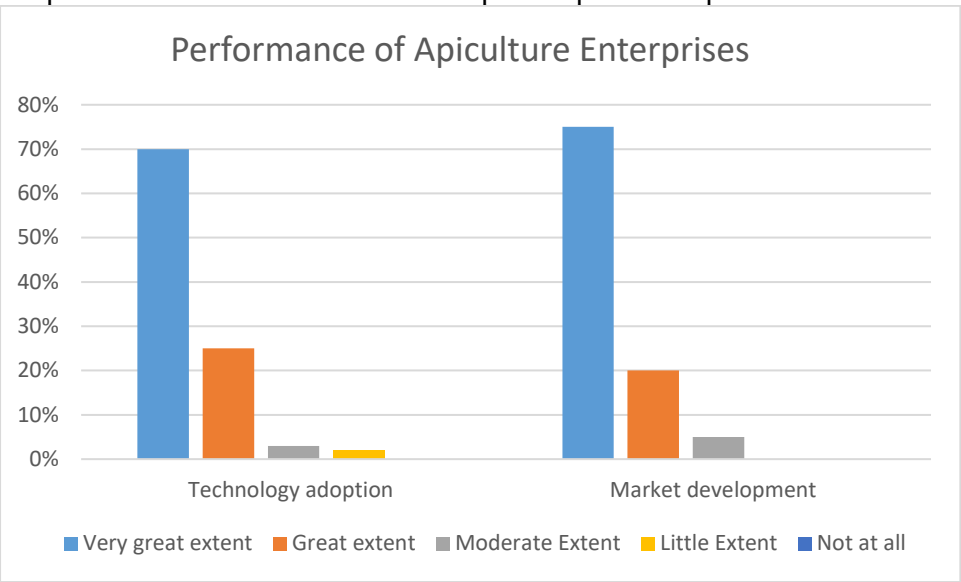



**Figure 2 Performance of Apiculture Enterprises**

## Correlation Analysis

The study carried out correlation tests to determine the strength of the relationship between the independent variables (technology adoption and market development) and dependent variable (performance of apiculture enterprises in Kenya). Pearson correlation, which ranges between -1 and +1 was used because the data was discreet. A positive Pearson correlation value indicates a positive relationship while any negative Pearson correlation value indicates a negative relationship. The association between the variables becomes stronger as the Pearson correlation value approaches either +1 or -1. The results of the correlation analysis are shown in table 4.3.

**Table 3: Correlation Coefficients**

| | | Technology adoption | Market development | Performance |
|---|---|---|---|---|
| Technology adoption | Pearson Correlation | 1 | | |
| | Sig. (2-tailed) | | | |
| | N | 281 | | |
| Market development | Pearson Correlation | .335** | 1 | |
| | Sig. (2-tailed) | 0 | | |
| | N | 281 | 281 | |
| | Sig. (2-tailed) | 0.063 | 0.001 | |
| | N | 281 | 281 | |
| Performance | Pearson Correlation | .582** | .441** | 1 |
| | Sig. (2-tailed) | 0.000 | 0.000 | |
| | N | 281 | 281 | 281 |

The results of the correlation showed that technology adoption had a positive and significant relationship with performance of apiculture enterprises (Pearson Moment Correlation = 0.582, Significance = 0.000<0.05). Adoption of technology tools and systems can lead to significant improvement in performance of the apiculture sector. These findings are consistent with Chemwok, Tuitoek and Nganai (2019) who found that technology adoption had significant and positive impact on honey production.

Further findings revealed that market development had a positive and significant relationship with performance of apiculture enterprises (Pearson Moment Correlation = 0.441, Significance

= 0.000<0.05). These results shows that development of new markets, improved distribution channels and advertising methods lead to a significant improvement in performance. The findings of the study are consistent with the findings of a study by Signore (2022) found that lack of trainings and access to markets for beekeepers affected apiculture development.

**Regression Analysis**

The multiple linear regression analysis was carried out to determine the relationship between innovative entrepreneurship practices and performance of apiculture enterprises in Kenya. Multiple regression analysis helped to find out the best predictor variable or the strength of relationship of each independent variable (technology adoption, market development) on the dependent variable thus resulting into an optimal model. The results from the regression model were used to establish the coefficient of determination analysis, model fitness analysis and model coefficients.

**Table 4: Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .745 | 0.552 | 0.547 | 0.1777 |

a Predictors: (Constant), technology adoption, market development

The findings showed that innovative entrepreneurship practices which comprises technology adoption, market development had a high positive correlation with performance apiculture enterprises as shown by a joint Pearson Correlation value of 0.745. On the other hand, the results showed that innovative entrepreneurship practices had a coefficient of determination value of 0.552. This shows that innovative entrepreneurship practices accounts for up to 55.2% of the variations in performance of apiculture enterprises. The regression results show that R was 0.745 which shows that the correlation between the independent variables and the dependent variable is positive.

**Table 5: Analysis of Variance**

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 11.836 | 2 | 2.959 | 38.377 | .000 |
| | Residual | 8.867 | 278 | 0.077 | | |
| | Total | 20.704 | 280 | | | |

a Dependent Variable: Performance

b Predictors: (Constant), technology adoption, market development

The results of the study also showed that the overall regression model linking technology adoption, market development and performance of apiculture enterprises was significant as indicated by F calculated value of 38.377 at 5% level of significance as shown by a significance level of 0.000., this showed that the overall model was statistically significant at 5% significance level.

**Table 6: Regression Coefficients**

| Model | Variables | B | Std. Error | t | Sig. |
|---|---|---|---|---|---|
| 1 | (Constant) | 0.118 | 0.058 | 2.037 | 0.044 |
| | Technology adoption | 0.523 | 0.065 | 8.025 | 0.000 |
| | Market development | 0.469 | 0.064 | 7.269 | 0.000 |

**Dependent Variable: Performance**

**Optimal Regression Model**

**Performance = 0.118 + 0.523 (technology adoption) + 0.469 (market development)**

The results of the study indicated that technology adoption had a positive and significant relationship with performance of apiculture enterprises (β = 0.523, Sig = 0.000). This implies that increasing technology adoption rates leads to a significant improvement in performance. The findings agree with the findings of a study by Vapa-Tankosi´c et al. (2020) which found that technological adoptions had a positive impact on apiculture performance.

Moreover, the findings of the study also indicate that market development had a positive and significant relationship with performance of apiculture enterprises (β = 0.469, Sig = 0.000). This implies that improving access to markets, development of distribution channels and advertising methods leads to a significant improvement in performance of apiculture enterprises. The findings agree with Kathila (2019) study, which found that factors such as training, funding and access to markets had significant impact on apiculture.

## Conclusions

The study concluded that technology adoption has the most positive significant influence on performance of apiculture enterprises This shows that when apiculture enterprises focus on using information systems, automated equipment and tools and adoption of artificial intelligence tools in apiculture management, , there will be a significant improvement in performance. Another conclusion is that market development had the second most significant influence on performance of apiculture enterprises. Utilization of various advertising methods, improving market access and development of distribution channels lead to a significant improvement in the performance.

## Recommendations

Since technology adoption has the most significant effect on performance of apiculture enterprises, the study recommends that apiculture enterprises through their members should consider increased adoption of technology tools such as information systems, artificial intelligence tools to manage apiculture practice and improve performance. There is a need to adopt new technologies such as modern hives, sensors and process automation systems to improve performance of apiculture.

In order to have an improvement in performance of apiculture enterprises, there is a need for beekeepers and apiculture associations to improve marketing through use of various advertising channels, adoption of online advertising platforms, development of distribution channels through use of wholesalers and retailers and improving access to market. Beekeepers should join cooperatives for market development collaborations to increase sales and improve performance of apiculture.

## References

Affognon, H. D., Kingori, W., Omondi, A., Diiro, M., Muriithi, B., Makau, S., & Raina, S. (2020). Adoption of modern apiculture and its impact on honey production in the former Mwingi district of Kenya: Assessment using theory-based impact evaluation approach. *International Journal of Tropical Insect Science*, *35*(02), 96-102.

Alonso, A., O'Shea, M., Kok, S., & Bressan, A. (2021). Entrepreneurs' impact on the wider community: A comparative study of commercial beekeepers through the lens of social role theory. *Society and Business Review*, *16*(3), 459-475.

Bedraoui, O., & Ait Lhassan, I. (2022). The effect of innovation practices on the performance of moroccan hotels: An empirical study. *International Journal of Research in Business and Social Science (2147- 4478), 11*(9), 13-23.

Bekuma, A. (2019). Review on Adoption of Modern Beehive Technology and Determinant Factors in Ethiopia. *Journal of Natural Sciences Research*, *8*(3), 24-29.

Bislimi, K. (2020). Determinants of family entrepreneurship in the apiculture sector. *Journal of Family Business Management*, *12*(1), 106-119.

Boncristiani, M., Prdic, N., Ignjatijevic, S., Vapa Tankosic, J., Lekic, N., & Kostic, S. (2023). Research on the determination of the factors affecting business performance in apiculture production. *Agriculture*, *13*(3), 686.

Čavlin, M., Prdić, N., Ignjatijević, S., Vapa Tankosić, J., Lekić, N., & Kostić, S. (2023). Research on the determination of the factors affecting business performance in apiculture production. *Agriculture*, *13*(3), 686.

Chemwok, C., Tuitoek, D., & Nganai, S. (2019). Factors Influencing Honey Production in Marigat, Baringo County - Kenya. *International Journal of Research and Innovation in Social Science, 3*(2), 2454-6186.

Cullen, G. (2019). Evaluating cover crops as a climate change adaptation strategy. *International Journal of Environmental Studies*.

Danieli, P. P., Addeo, N. F., Lazzari, F., Manganello, F., & Bovera, F. (2023). Precision apiculture systems: State of the art, pros and cons, and their application as tools for advancing the apiculture sector. *Animals*, *14*(1), 70.

Degu, G.W., Mwangi, H., Verkuijl. L. & Wondimu A. (2022). An assessment of the Adoption of seed and fertilizer packages and the role of credit in smallholder maize production in Sidama and North Omo Zone, Ethiopia.

Espen, M., Williams, J. H., Alves, F., Hung, Y., De Graaf, D. C., & Verbeke, W. (2023). Apiculture in Europe facing climate change: A mixed methods study on perceived impacts and the need to adapt according to stakeholders and beekeepers. *Science of The Total Environment*, *888*, 164255.

Faruk Fuad, M. A. (2019). Potentials and prospects of apiculture entrepreneurship in Dinajpur region: A participatory analysis. *Agricultural Research & Technology: Open Access Journal*, *21*(5).

Freixanet, J., Braojos, J., Rialp-Criado, A., & Rialp-Criado, J. (2020). Does international entrepreneurial orientation foster innovation performance? The mediating role of social media and open innovation. *The International Journal of Entrepreneurship and Innovation*, *22*(1), 33-44.

Gaga, V. A., & Esaulov, V. N. (2022). Innovative technologies and modern facilities in apiculture. *IOP Conference Series: Materials Science and Engineering*, *142*, 012022.

Gikunda, R. M., Ooga, D. M., Okiamba, I. N., & Anyuor, S. (2021). Cultural barriers towards women and youth entry to apiculture production in Maara Sub-County, Kenya. *Advancements in Agricultural Development*, *2*(2), 73-85.

Hosni, E. M., Al-Khalaf, A. A., Nasser, M. G., Abou-Shaara, H. F., & Radwan, M. H. (2022). Modeling the potential global distribution of honeybee pest, Galleria mellonella under changing climate. *Insects*, *13*(5), 484.

Jabeen, A. (2019). Impacts of climate variability and climate change and adaptation strategy among small scale farmers of Kurfa Chele district, east Hararghe zone, Oromia Region, Ethiopia. *Journal of Biology, Agriculture and Healthcare*.

Kathila, G. (2019). *Factors Influencing The Uptake Of Apiculture As An Economic Activity In Kenya: A Case Of Farmers In Makueni County* [Unpublished master's thesis]. The University of Nairobi.

Kiingwa, K., Muiruri, P., & Mahiri, J. (2020). Determinants of modern box hives adoption in Kitui County, Kenya. *International Journal of Education and Research*, *8*(10), 121-132.

Kiiti, K., Muiruri, P., & Mahiri, J. (2020). Determinants of modern box hives adoption in Kitui County, Kenya. *International Journal of Education and Research*, *8*(10), 121-132.

Kingori, W., Omondi, A., Diiro, M., Muriithi, B., Makau, S., & Raina, S. (2018). Adoption of modern apiculture and its impact on honey production in the former Mwingi district of Kenya: Assessment using theory-based impact evaluation approach. *International Journal of Tropical Insect Science*, *35*(02), 96-102.

Kothari, C. R. (2014). *Research Methodology: Methods and Techniques*, 2nd Edition. New Delhi: AGE International.

Kowalczyk, D. (2015). *Survey Research: Definition, Methods & Types*. Retrieved from http://www.study.com

Lloyd, K. (2021). Apiculture Adaptations in A Shifting World: The Beekeeper's Experience across the Globebeekeeper's Experience Across The. *Capstone Collection*.

Martinus, K. (2021). Informal groups, disruptive innovations, and industry change in low-tech peripheries. *Geographical Research*, *60*(2), 256-268.

McMenamin, A., Mumoki, F., Frazier, M., Kilonzo, J., Mweu, B., Baumgarten, T., Patch, H., Torto, B., Masiga, D., Tumlinson, J., Grozinger, C., & Muli, E. (2019). The impact of hive type on the behavior and health of honey bee colonies (Apis mellifera) in Kenya. *Apidologie*, *48*(5), 703-715.

Mukasa, M. (2019). Research on the determination of the factors affecting business performance in apiculture production. *Agriculture*, *13*(3), 686.

Mulatu, A., Marisennayya, S., & Bojago, E. (2021). Adoption of modern hive apiculture technology: The case of kacha-birra Woreda, Kembata Tembaro zone, Southern Ethiopia. *Advances in Agriculture*, *2021*, 1-20.

Mwaka, C., & Karugu, J. (2023). Entrepreneurial innovation strategies and performance of dairy micro and small enterprises in Nyeri County, Kenya. *International Journal of Business Management, Entrepreneurship and Innovation*, *5*(1), 77-92.

Ngomo, L. (2021). *Determinants Of Production And Performance Of Honey Processing Projects: The Case Of Kitui County* [Unpublished master's thesis]. The University of Nairobi.

Niyonambaza, S. D., Kumar, P., Xing, P., Mathault, J., De Koninck, P., Boisselier, E., ... & Miled, A. (2019). A review of neurotransmitters sensing methods for neuro-engineering research. *Applied sciences*, *9*(21), 4719.

Novelli, S., Vercelli, M., & Ferracini, C. (2021). An easy mixed-method analysis tool to support rural development strategy decision-making for apiculture . *Land*, *10*(7), 675.

Strong, M. (2020). *The Effect of farmer characteristics on entrepreneurial behavior of beekeepers in Kibwezi West Sub County, Makueni County* [Unpublished master's thesis]. Strathmore University.

Tola, Y. H., Waweru, J. W., Hurst, G. D., Slippers, B., & Paredes, J. C. (2020). Characterization of the Kenyan honey bee (Apis mellifera) gut microbiota: A first look at tropical and sub-saharan African bee associated microbiomes. *Microorganisms*, *8*(11), 1721.

Valido, A., Rodríguez-Rodríguez, M. C., & Jordano, P. (2019). Honeybees disrupt the structure and functionality of plant-pollinator networks. *Scientific Reports*, *9*(1).

Vapa-Tankosić, J., Miler-Jerković, V., Jeremić, D., Stanojević, S., & Radović, G. (2020). Investment in research and development and new technological adoption for the sustainable apiculture sector. *Sustainability*, *12*(14), 5825.

Vercelli, M., Novelli, S., Ferrazzi, P., Lentini, G., & Ferracini, C. (2021). A qualitative analysis of beekeepers' perceptions and farm management adaptations to the impact of climate change on honey bees. *Insects*, *12*(3), 228.

Wakgari, M., & Yigezu, G. (2021). Honeybee keeping constraints and future prospects. *Cogent Food & Agriculture*, *7*(1).

Wakjira, K., Negera, T., Zacepins, A., Kviesis, A., Komasilovs, V., Fiedler, S., Kirchner, S., Hensel, O., Purnomo, D., Nawawi, M., Paramita, A., Rachman, O. F., Pratama, A., Faizah, N. A., Lemma, M., Schaedlich, S., Zur, A., Sperl, M., Proschek, K., … Brodschneider, R. (2021). Smart apiculture management services for developing countries—the case of SAMS project in Indonesia. *PeerJ Computer Science*, *7*, e484.

Wambua, B. (2019). *Assessment of Performance Indices of Frame Hive Apiculture and the Traditional Technology in Kenya a Case Study of Kitui County* [Unpublished master's thesis]. South Eastern Kenya University.

Yohana, Z., & Saria, J. (2020). Assessment of Apiculture as an Adaptation Strategy to Climate Change in Iramba District. *Huria Journa*, *27*(1).