ASSESSING THE IMPACT OF TRAINING OF BEEKEEPERS ON THE PRODUCTIVITY OF THE APICULTURE INDUSTRY IN THE VOLTA AND OTI REGIONS OF GHANA

BY

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DECLARATION

I, Prince Dzorgbenyui Kwami Nyikplorkpo, do hereby declare that except for the references cited, which have been duly acknowledged, this work, "**Assessing the Impact of Training of Beekeepers on the Productivity of the Apiculture Industry in the Volta and Oti Regions of Ghana"** is the result of my research. It has never been presented either in whole or in part for any other degree of this University or elsewhere.

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Date 24TH OCTOBER, 2023

This thesis has been submitted for examination with our approval as supervisors.

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Rev. Dr. Edward Ebo Onumah (Principal Supervisor) Date 24/10/2023

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DEDICATION

I dedicate this work to my late father Mr. Herit Adolph Kwasi Nyikplorkpo, my mother Mrs. Praise Saviour Adzo Nyikplorkpo, my wife Peace Afriyie Ama Nyikplorkpo and my children Priscilla, Phebe, Perfect and Paulina Nyikplorkpo.

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ABSTRACT

This study sought to assess the impact of training of beekeepers on the productivity of the apiculture industry in the Volta and Oti Regions of Ghana. Specifically, the study analyzed the factors that influence participation in beekeeping training programmemes, evaluated the impact of training programmemes on the productivity of beekeepers and examined the strengths, weaknesses, opportunities and threats of beekeeping. The study used descriptive statistics to measure factors that influence participation in beekeeping training while propensity score matching was used to determine the productivity of beekeepers in the study area. The study further employed the SWOT analytical tool to evaluate the strengths, weaknesses, opportunities and threats of beekeeping. A structured questionnaire, interviews, field visits and focus group discussions were employed to gather data for the study. A multistage sampling technique was used to select two hundred and ten (210) respondents comprising ninety-eight (98) trained and one hundred and twelve (112) formally untrained beekeepers. The study was conducted in six districts/municipalities in the Volta region and two districts from Oti region. STATA Version 15 was used to analyse objectives one and two while a radar chart in excel was used to analyse objective three. It was observed that gender, educational level and number of members of household in beekeeping influenced participation in beekeeping trainings. Whereas males and those with high education were found to be less likely to participate in trainings, household members in beekeeping was found to increase participation in training. The result from the Nearness Neighbor Matching based on the ATT suggests that on average, participation in a beekeeping training programmeme increased productivity measured in gallons/beehives by 1471.96. However, by applying the same matching method (nearest matching method) on the ATE (i.e on the entire population comprising both trained and untrained groups), the productivity was

found to increase by only 0.421. This means that training programmemes in beekeeping drives an increase in productivity of beekeeping than other demographic characteristics such as age, gender, marital status, educational level and years of experience. The training programmemes afforded the beekeepers opportunity to enhance their knowledge, skills and attitudes towards the business. The study found that natural, human and economic resources that support beekeeping abound in the study area. Beekeeping is promoting the sustenance of biodiversity in the study area. Among the weaknesses of beekeeping is the absence of definite policy in place to guide and give direction to the beekeeping sector in the country in general and the study area in particular. Also, there are no well organized and strong beekeeping associations both at regional, district and local levels to help drive the beekeeping business. There is also a lack of institutional support for the beekeeping sector and this is a weakness to beekeeping. Among opportunities available for the development of beekeeping is the presence of some training institutions such as the Ohawu Agricultural College and the Adidome Farm Institute in the study area to offer training in beekeeping to interested people. Beekeepers have come out with improved *borrasus* hives fitted with topbars in place of the *borrasus* log hives. Threats identified included the continuous use of traditional honey extractors despite the benefits associated with improved beekeeping technology and the menace of bushfires that destroy beehives, bee habitat and fora. The study concludes generally that for the beekeeping sector to strategically function as a profitable venture, training programmemes in new methods of beekeeping should be made a topmost priority. More training programmemes for beekeepers is recommended for the enhancement of their skills, attitudes and competence.

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ACRONYMS

AdFI	Adidome Farm Institute
ATE	Average Treatment Effect
ATT	Average Treatment Effect on the Treated
ATU	Average Treatment Effect on the Untreated
BUSAC Fund	The Business Sector Advocacy Challenge Fund
COMDEKS	Community Development and Knowledge Management for the Satoyama Initiative Programmeme
EPA-	Environmental Protection Agency
EC	European Commission
EU	European Union
FAO	Food and Agricultural Organization
FC	Forestry Commission
FORUM	Forest Protection and Resource Use Management
GNA	Ghana News Agency
KSB	Kenyan Topbar Hive
MOFA	Ministry of Food and Agriculture
NBSSI	National Board for Small Scale Industries
NGOs	Non Governmental Organizations
OAC	Ohawu Agricultural College
PSM	Propensity Score Matching
SNV	Netherland Development Organization
SEM	Structural Equation Modeling

SWOT Strengths, Weaknesses, Opportunities and Threats

UCC University of Cape Coast

UNESCO United Nations Education, Scientific and Cultural Organization

UNDP United Nations Development Programmeme

UNTRAINED - Those beekeepers who did not have any formal training in beekeeping.

USA United States of America

USD United States Dollar

VORAB Volta Region Association of Beekeepers

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Beekeeping, also known as apiculture has been promoted by policymakers, non-government organizations (NGOs), and agriculturalists as an important tool for increasing incomes, reducing poverty and improving the livelihoods of many people across the globe (Tulu *et al*., 2020; Andaregie & Astatkie, 2021). Beekeeping has become a crucial agribusiness venture because its products including honey, beeswax, royal jelly, and propolis are in high demand internationally as well as in domestic economies (Tesfaye, Begna & Eshetu, 2017; Schouten & Caldeira, 2021). Aside the economic and social benefits, pollination by bees can stimulate food production, ensure food security, as well as contribute to the conservation of biodiversity in natural habitats (Olschewski *et al*., 2006; Schouten & Lloyd, 2019). Beekeeping also acts as a cultural heritage value for many communities (Schouten & Lloyd, 2019). In this regard, Hinton *et al*. (2020) specifically linked beekeeping to the three values of sustainable development: economic, social, and environmental concerns.

Beekeeping is a predominant venture across Africa particularly in Zimbabwe, Ethiopia, Kenya, Zambia, Cameroon and South Africa (Dietemann, Pirk & Crewe, 2000; Lowore & Bradbear, 2015; Yusuf *et al*., 2018). For example, the leading producer of honey in Africa is Ethiopia and only placed nineth position in the world (Andaregie & Astatkie, 2021). Ethiopia produced 163,257.42 tons of honey between 2007 and 2011, out of which 99.2% was consumed locally and 0.8 percent was exported. Ethiopian export of honey totaled 1,297,716 kg in 2007–2011, with a total value of US$4,066,528 (Miklyaev, 2013).

According to a research by the Central Statistical Agency (CSA), Ethiopia has approximately 10 million bee colonies, with roughly 4.6 million in hives and the remainder in forests (Tulu *et al.*, 2020). Nevertheless, Africa contributes the lowest to the world's honey trade market despite its potential (Amulen *et al.*, 2017). Indeed, there is a comparative advantage for African countries in the production of organic honey if critical attention is paid to the sector.

Although data on beekeeping in Ghana is scarce, there are however some studies made in various parts of the country that could be refered to. For instance there were 5,748 beekeepers in Ghana's former Brong Ahafo area, consisting of 2, 212 females and 3,536 males (Subbey 2009). In 2010, the region's average yearly honey production was 74,088kg. According to Akagaamkum *et al.* (2010), beekeepers in the Volta region of Ghana are among the best performing in the country with an annual production of 34 kg per beehive compared to the national average yield of 14 kg per hive. Several beekeeping projects have been executed with the goal of providing disadvantaged people across the country with an alternative source of income.

This is premised on the view that when beekeeping is made a profitable venture, new entrepreneurs will be attracted to the sector (Schouten *et al.*, 2020). Within this context, skills training is seen as productive means to optimize the beekeeping industry (Schouten & Caldeira, 2021). Moreover, because of the aggressiveness of tropical bees, venturing into beekeeping demands training, education, and other extensive services (Okpokiri *et al.*, 2015). According to Lynton and Pareek (1990), training is mostly made up of opportunities for participants to gain the requisite knowledge and abilities.

The goal of farmer training is to increase their farming productivity. It has been demonstrated that training farmers has a number of benefits. According to the findings of Murshed-E-Jahan and Pemsl's (2011) in a study on Bangladeshi small farmers, training farmers can increase their productivity and income levels more effectively than providing them with financial assistance. In a related study, Tripp and Hiroshimil (2005) validated the value of training that can help farmers improve their skills in farming tasks.

Qaiser *et al*. (2013) and Serda *et al*.(2015) maintained that specialized training in aspects such as the type of hives to use, when to set up the hives, management of pests and diseases of bee, repair and maintenance of beekeeping materials, bee season (period of nectar flow) as well as harvesting and quality control among others are required for optimizing gains in the sector. Thus, training in these areas will enhance the productivity of beekeepers and by extension ensure the production of quality honey for the local and international markets.

Several projects have been rolled out with the overall aim of promoting the Apiculture enterprise in the country (Hussein, 2000). Thus, Apiculture Promotion and the 7th National Workshop on Beekeeping organized in 1984 (Hussein, 2000) exemplified such projects. Furthermore, some organizations and associations have been established to promote the beekeeping industry in Ghana. The Progressive Beekeepers Association in Berekum, the Royal Bees Society in the Volta Region, Volta Region Association of Beekeepers, Beekeeping Learning and Marketing Center (BLHMC) in Twifo Praso and many others are some of them..

1.2 Statement of the Problem

Ghana's beekeeping sector can be traced back to the 1970s. Despite many years of operation and the potential benefits of beekeeping, the sector is saddled with many challenges, which limits its ability to act as an alternative livelihood strategy (Jeil *et al*., 2020a). One challenge has to do with the fact that many beekeepers in the country continue to use traditional beehives despite the benefits associated with improved beekeeping practices (Schouten 2020; Wakjira *et al*. 2021). It should be noted that where beekeepers use only traditional methods of beekeeping, low yields of hive products are recorded. Also, many practitioners of beekeeping drop out of the business after a few years of practice. According to Flottum (2018), beekeeping has the greatest dropout rates (50–80%) out of all agricultural commodities, which is consistent with this viewpoint. For instance, Sharma and Dhaliwal (2014) found that just 23% of 120 initial beekeepers in India sustained their business. A similar trend in dropouts is observed in South Africa (Yusuf *et al*. 2018) and Kenya (Musinguzi *et al*., 2018). The District Director of Food and Agriculture (MOFA) and the District Officer of the Business Advisory Center (BAC) of the Akatsi South Municipality in a personal communication, stated that they trained fifty beekeepers between 2016 and 2017. However, by September, 2019, only thirty (30) were in operation. Scholars including Aksoy *et al*. (2018) and Schouten & Caldeira (2021) have attributed the low uptake of improved beekeeping technology and high attrition rate among beekeepers to lack of or inadequate training and other extensive services.

Furthermore, most studies on beekeeping have focused on socioeconomic and environmental impacts (Abou-Shaara 2017; Aksoy *et al*. 2018; Schouten *et al*. 2020). In Ghana, however, the potential of beekeeping for livelihood security has also been examined (Jeil *et al*. 2020a; Jeil *et al*. 2020b). It is important that factors that influence beekeepers and other interested parties to participate in beekeeping training programmemes are documented to help stakeholders make informed decisions on future training programmemes. It is equally important for the positive impact of such trainings on productivity to be documented to inform potential investor in the sector. Unfortunately, such information on the factors that drivee participation in beekeeping training programmemes and how such training impacts on the productivity of beekeepers are lacking in Ghana as a whole and the Volta and Oti regions in particular. Nevertheless, some studies on the training programmemes in beekeeping have found the impact on honey productivity and incomes (Gemeda 2014; Fikru *et al*. 2015). At the contrary, evidence from other studies revealed that training as well as other extensive services in beekeeping have no implications on productivity, incomes and livelihoods (Wagner *et al*. 2019; Schouten *et al*. 2020).

Surprisingly, many organizations (AdFI, OAC, UCC, SNV, FORUM, BUSAC Fund) have implemented several training programmes at one time or the other for beekeepers in order to enhance output and revenue generation within Volta and Oti regions. Trainings were given in areas such as bee biology, bee seasons, deference between brood comb and honeycombs, how and when to set hives, how to get hives colonized, how to prevent "accordion beekeeping" and harvesting and extraction of honey and beeswax among other skills. These training programmes are expected to result in increased productivity of beekeepers. A review of the literature found that, despite such trainings, no research had been done to ascertain the characteristics that influence participation in beekeeping training programmes and how such training affects beekeeper output.

Despite the above efforts, beekeeping could not be deemed to have reached a desirable level of practice in Ghana. There are several grey areas needing consideration to improve practice. As a promising sector, it is crucial to examine and recommend the programmes that would enable Ghana to build a rewarding Apiculture industry towards poverty reduction and livelihood empowerment. Another issue that has not been adequately explored is the potentials and challenges of beekeeping in the study area.

Over the years, no study in terms of scanning the internal and external environments of beekeeping has been conducted to ascertain the potential strengths, weaknesses, opportunities and threats that exist in order to take advantage of them for the development of the beekeeping sector. Sammut-Bonnici and Galea (2015) indicated that a SWOT analysis of beekeeping could reveal the internal strengths and weaknesses, as well as the external opportunities and threats in the environment of a business or an organization. The internal scanning of beekeeping in the two regions could therefore be used to identify resources, capabilities, core competencies and competitive merits inherent to the sector.

On the other hand, external analysis could assist in identifying risks and market opportunities for beekeepers by examining resources available to competitors in the sector, and the overall environment. It is evident from the above that the impact of beekeeping training programmes on beekeepers productivity is still not clear. Therefore, this study seeks to examine the implications of beekeeping programmes on the productivity of beekeepers in the Volta and Oti regions of Ghana and the factors that drove participation in such programmes, while also determining the strengths, weaknesses, opportunities and threats of the sector in the study area.

Against the background information, the study proceeded by asking the following questions.

1. What are the factors which influence participation in beekeeping training programmes?
2. What are the impact of the training programmes on the productivity of beekeepers?
3. What are the strengths, weaknesses, opportunities and threats of beekeeping?

1.3 Main objective of the study

To assess the impact of training of beekeepers on the productivity in the apiculture industry in the Volta and Oti Regions of Ghana.

Specifically, the study:

1. Analyzed the factors influencing participation in beekeeping training programmemes in the Volta and Oti regions of Ghana.
2. Evaluated the impact of the training programmemes on the productivity of beekeepers in the Volta and Oti regions of Ghana.

3. Examined the strengths, weaknesses, opportunities and threats of beekeeping in the Volta and Oti regions of Ghana.

1.4 Justification of the study

The study will enable government and other stakeholders know what motivates people to participate in beekeeping training and to determine which people to invite for future trainings to improve upon the beekeeping industry.

The impact of past training programmemes if documented by this study, would help stakeholders determine the profitability of beekeeping and thus make informed decisions on future investments into the sector.

The findings of the SWOT (strengths, weaknesses, opportunities, and threats) analysis of beekeeping in the study region will help stakeholders make well-informed decisions about which areas to explore and which to focus on in order to advance beekeeping.

1.5 Outline of the Study

This study was organized under five chapters namely chapter one involving the introduction which delt with overview of beekeeping, the problem that was investigated, the objectives of the study as well as the importance of the study

Chapter two contains a review of various literature on the beekeeping and the methods of evaluation of the objectives.

The third chapter sort to ouline the methodology used in executing the study whci included the use of structured questionnaire to take data and tools such as Propensity score Marching, Binary Logistics and SWOT analysis. The population, sample, sampling and sample size determination was also captured in this chapter.

The results obtained from the study was analysed and discussed the fourth chapter while the fifth chapter, delt with the summary of results, conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter aims to analyze literature on a variety of beekeeping-related topics, such as the value of beekeeping, statistics on honey production, consumption, imports, and exports, as well as other hive products like beeswax. The influence of beekeeping on biodiversity, the productivity of beekeeping, the method of study, and the establishment of livelihoods were all reviewed.

2.2 Beekeeping and Hive Products

Bees are insects of the class insecta. There are over 20,000 species of bees in the world (Partel, *et al* 2021). Majority of the bee species are solitary in nature, living individually and raising their young, while others are social and semi-social in nature (Gentry, 1982, Adjare, 1984). The solitary bees are of two kinds, those that drill holes in dead wood and make their nest, referred to as carpenter bees, examples *Xylocopa spp* and leave cutter bee (*Megachile spp)*. Mason bees, example *Osmia spp*, build their nests in the soil. The semi-social bees may drill holes close to each other in the ground. Social bees however live together in colonies. They develop nests in cavities, logs or outside on tree branches, roofs or ceilings (Partel, *et al* 2021). Honey bees belong to a sub-family *Apinae* which comprises five (5) species. These are *Apis mellifera*, *Apis dorsata*, or Giant or rock honeybee, *Apis florae,* the little honeybee, *Apis cerana* and *Apis laboriosa*. *Apis dorsata and Apis florea* build single combed and exposed nest while the other three build multi-comb nests in enclosed cavities, (Gentry, 1982, Bradbear, 2009). Of the five species, *Apis mellifera* is used by beekeepers for commercial honey production throughout the world. There are races *of* the *Apis mellifera* located throughout the world some of which are: *Apis mellifera adansonii*, found in West Africa, *Apis mellifera Sahariensis* found in North Africa, *Apis mellifera capensis(*cape bee*)*, found in South Africa, *Apis mellifera monticola*, found in East Africa (around Mountain Kilimanjaro), *Apis mellifera mellifera*, found in Europe. The race found and kept by beekeepers in Ghana is the *Apis mellifera adansonii* (Gentry, 1982 & Bradbear, 2009).

According to Gentry (1982) and Bradbear (2009), beekeeping or apiculture is the management of an honeybee colony and this is reliant on some knowledge of the bee. Three distinguished basic stages in the historical development of the bee-human interaction, according to him, can be identified. Bee-killing (hunting), bee-having and beekeeping are the three types of beekeeping. The stage which is more developed is modern beekeeping. Bee-killing is the practice whereby fire is used to kill the honeybees in a colony in their cavity so that the combs containing honey and brood (larval and pupal stages) can be taken. Bee-having however involves keeping bees in hollowed sections of tree trunks, gourds or straw and mud containers as well as clay pots,. In this system, combs are fixed to the containers which does not permit easy inspection and management of the colony (Bradbear, 2009). Beekeeping however is the housing of bees in modern moveable comb hives which lends itself to easy inspection and management of the colony.

2.2.1 Hive Products

Honey is the most popular hive product, and it is used for both food and medicine. Beeswax is another important commodity, though its applications and value are not as well known as that of honey. In any beekeeping endeavor, these two are the most important hive products. Apart from honey and beeswax, other products that require unique expertise to obtain include pollen, propolis, royal jelly, and venom, as well as bee brood and bees (queen rearing), (Bradbear, 2009, & Akagaamkum *et al*. 2010). Harnessing these products according to these researchers will help rural folks to improve upon their livelihood.

2.2.1.1 Honey Production

The primary hive product is honey. It is made of nectar taken from trees out of which bees extract most of the water contained in it by evaporation. Nectar has about 80% water and 20% sugars. Bees use their long tongue to reach the nectaries, suck the nectar and fill the crop or honey stomach- a special structure on them- and fly it home. In the hive, nectar is put into the cells and enzymes are added, which work on it to transform it into honey. When the moisture content is right, the honey is caped or sealed. The final product is composed of 20% water, 75% glucose and fructose and 5% sucrose (Aksoy *et al*. 2018).

Aksoy *et al*. (2018) stated that honey is classified according to the source from which the bees gathered the nectar, with the flavor, colour and viscosity (thickness) of the honey being influenced by the source of the nectar. He further stated that honey collected between October and December for example may have an orange flavour, showing that most of the nectar were collected from citrus trees. When bees collect nectar from citrus (orange) plants, the viscousity of the honey is high with the colour been light or yellowish. Nectar from neem trees give light and umber coloured honey with very low viscousity (runs like water) while nectar from coconut gives a dark coloured honey with moderate viscousity (Aksoy *et al*. 2018). However, according to Gomes *et al.* (2010) and Kebede *et al.* (2012), the nectar types that honeybees employed, climate, soil type, and postharvest management procedures all have a significant impact on the physicochemical qualities of honey.

2.2.1.1.1 Uses of Honey to Bees and Man

Bees store honey in the cells of the combs they produce for their own use in times of dearth. It is the food that they feed on in the nest supplying energy and other nutrients.

Honey is used by man for various purposes including food sweetener, food, medicine (both human and veterinary) -wound dressing, ulcers, antibiotics, promotes hair growth, for cooking, seasoning meat, baking, drinks, and Vinegar (Stanley, 2019).

2.2.1.1.2 How Honey is Harvested

Harvesting usually takes place between November and February. However, not every bee colony is ready for harvesting at this time. Harvesting should be done after 5.30 pm or early in the morning. The bees will be more docile at that time. The following is the procedure in harvesting. (personal experience).

SON, (2001) and Nyikplorkpo (2008) states that to go into harvesting of honey, the beekeeper must first put on protective clothing carefully made up of overall suit, bee veil and a pair of hand gloves, not forgetting to protect the feet with a pair of wellington boots. Get your smoker, bee brush and knife (or hive tool) and rust – proof containers (preferably made of plastic) in which to place the honey combs when cut FAO (2020a). The smoker must be loaded with appropriate fuel (male inflorescence of the oil palm or cracked corn cob) and set it on fire to produce smoke. Using the smoker, some smoke must be puffed around the hive gently for a few minutes after which the beekeeper waits for a few more minutes, then puff smoke at the entrance hole.

According to FAO (2020a), if there is sufficient honey in the hive, the worker bees will instinctively feed heavily on the honey and become docile. (If the bees start to attack you, it means there is not much honey in the hive so it is not yet time to harvest and the hive should be left alone).

Open the lid after puffing the smoke, knock on the topbars with your knife or hive tool to determine which of them have combs, (the bars without combs will make more noise than those with combs). The first bar is removed from one end of the hive using your knife or hive tool and placed aside. If it has a comb, rest it across your container so that the comb is hanging down and will not be damaged. If you are unable to remove a topbar easily, it may be because it has become fixed by propolis or one comb has stuck to another or to the hive body. Use the knife/hive tool to separate them and take the topbar out. Gently puff smoke into the gap after removing the first topbar to cause the bees to move to the other side of the hive. Remove the topbars one after the other and cut the honey-filled combs into a container - replacing each empty bar and sliding it towards the end of the hive. Puff more smoke if the bees are coming out between the bars. Carry on until you find a topbar that has a brood comb attached to it (Nyikplorkpo, 2008).

You will find the first comb to be white and new. This may either be empty or contain some unripe honey. Put the new comb back into the hive for the bees to develop FAO (2020b). You should only remove the capped combs or those that are partly capped as these contain the ripe honey. Sweep the bees on the comb into the hive with the brush or feather. Cut the comb from the topbar, leaving about 2 centimeters length on the topbar for the bees to start building the next honeycomb. Put comb in the container and replace the topbar. Continue to harvest until you come across a brood comb, which will be dark in colour. You should stop here to ensure you have left enough honey for the bees to eat during the lean season.

Go to the other end of the hive and repeat the process until you reach the brood comb again. Now you have finished harvesting, close the hive carefully, making sure the lid is fitting properly. All the above procedure must be carried out swiftly, but quietly (Akukumah & Jezard, 1989 & Nyikplorkpo, 2008).

2.2.1.1.3 How Honey is Processed

When honey is harvested it must be graded, processed and packaged for sale or for home consumption. There is a number of processing equipment such as the manual or electric centrifugal honey extractor of different volumes of capacity and solar honey extractor. There is however a local extraction system described as follows:

Local honey processing equipment is made up of the following: Rubber bucket, Nylon mosquito net, rubber bowl, Cassava dough sieve (made from palm frond) and Containers into which to pour honey (Nyikplorkpo, 2008).

Extraction of honey is done as follows. Wash your hands thoroughly and wear clean surgical gloves. Select combs which are light in colour and which have mostly sealed honey (first grade) into one container and very dark combs containing plenty of pollen cells or unsealed honey (second grade) into a separate container (while harvesting). (Clauss & Clauss, 1991 & Nyikplorkpo, 2008). Pick off any bees and dirt while putting the combs into the separate containers. Honey from the second grade combs must be consumed immediately at home or sold at the local market as it cannot be stored for a longer period. The first grade combs are crushed with a spatula (akplẽ cooking stick) till you have a "honey–wax soup". The cassava dough sieve is then placed over the rubber bowl and the nylon net spread over the sieve. Pour the mashed combs onto the net, hold the ends of the net together and tie the crushed combs into a ball. Place weight over it and leave it over night. By the next day, the honey will drain out of the crushed combs into the bowl. You can now pour the honey into clean containers- gallons and/or bottles. Seal and place labels on containers and the product is ready for the market. The second grade honey should be processed the same way as the first grade one (Nyikplorkpo, 2008).

2.2.1.2 Beeswax Production

Beeswax, according to FAO (2021), is another hive product which is usually not recognized at all in some areas as having value, while it is valued in other areas more than honey. These are produced by the wax gland situated at the lower abdomen of the bees.

2.2.1.2.1 Uses of Beeswax to Bees and Man

The bees use the wax to build their combs while man uses it in the industrial production of cosmetics, pharmaceuticals, polishes, candles and many other products (FAO, 2021).

2.2.1.2.2 How Beeswax is Processed

Empty combs from which honey have been extracted are placed in a clean sack and the sack placed in a pot containing water. The pot is then placed over fire with a weight placed on the sack to hold it down under the water. As the water begins to heat up, the wax will begin to melt and float on the water. Either scoop it with a ladle into a clean container with water and leave to solidify or after all the wax melts, remove the pot and leave to cool. Scoop the solidified wax and mould it later into a solid mass (FAO 2021). As men are mostly engaged in beekeeping, women, who according to Jeil *et al*. (2019) are active in honey trade could also be involved in the processing of beeswax along the value chain.

2.2.1.3 Propolis and how it is Produced by Bees

Propolis is another valuable beekeeping product. It is used in the treatment of pulmonary tuberculosis, problematic ulcers and wounds, pharyngitis, bronchitis, chemical and temperature burns, , angina, tonsillitis, , pulmonary inflammation and digestive tract diseases. Because of this, special interest is shown in propolis by a lot of health institutions all over the world. It was found out by some scientists from the USA, propolis contained 10% of a unique antioxidant known as pinocembrin, antibacterial, antiviral anti-inflametory and anti-tumoral substances (Sloan, 2000; Sforcin, 2007). It serves as pesticides against parasites such as the verroa mite (Drescher *et al*. 2021; Pusceddu *et al*. 2021).

Research has determined that while bees use wax or wax mixed with propolis to fill gaps of up to 3.5 to 10mm in their nests, only propolis are used to close gaps of 0.1 to 3.5 mm. (Simone-Finstrom *et al*. 2017). The bees are much more active in closing up smaller cracks of between 0.1 to 3 mm than the bigger ones of between 3 and 5 mm. Bees use more propolis in sealing upper parts of their nests than below the nest. Bees use propolis to reduce ventilation in order to conserve temperature (Conrad, 2016). The depth of closing cracks grows proportionally from below upwards as they could use 1 – 2 mm of propolis below the nest, 1 – 3mm in the nest, and 1 – 4mm above the nest. This behaviour can be explained by the fact that it is at the upper part of the hive that a lot of heat or temperature is lost for which reason bees fill the gaps there faster and most completely. Temperature loss is generally, a great motivation or stimulus for the collection and storage of propolis. The product also helps the bee's immune system by protecting against pathogens and parasites (Conrad, 2016 ; Simone-Finstrom *et al*. 2017; Hodges, Delaplane & Brosi 2018)

The majority of instruments used in propolis collection in the world are based on the instinct of bees to close gaps and openings in the hive which are smaller than 4mm. The quantity of this propolis in a hive varies and is dependent on many factors which include the breed of the bee, geographical and climatic conditions, type of hive, presence of sources of propolis in nature and bee colony strength in terms of population. Large amounts of propolis are collected by the Gray mountain bees from Caucasus. While the dark forest bees collect a lot of the propolis, Italian bees collect less, while very little is collected by bees from Ukraine and the far east. Different species of bees collect different amounts of this product and store it in different places in the hive under the same climatic conditions. Propolis is most often found in three places in the hive: on cover boards (or other types of covers) above the nest, on the sidebars of the frames in the nest, and at the hive entrances (FAO, 2021).

The quantity of propolis that can be collected from one hive varies. It ranges between 50 and 100g and 150 and 200g. Some beekeepers believe that a colony of bees could produce 400g of propolis and that this quantity could be increased to 2 kg and more using special procedures. (FAO, 2021), FAO (2021) indicated that when the factors that incite bees to collect propolis are taken into consideration, it is possible for the amount to be increased with success. Increased ventilation in the hive, irregular surfaces of cover boards and walls of hives, special types of hive entrance bars, and some kind of teasers for bees are favourable conditions to effect such increased production

2.2.1.3.1 How Propolis is Harvested

Propolis collection using wooden or plastic bar frameworks is often the practice. These bars are used to create temporary gaps of 3 to 4 mm apart, which makes it possible to harvest 250 to 400g of pure propolis within a season (Andrich *et al.* 1987). The bars are placed on the hive frames while cover boards and isolating materials are removed. The bees will fill the gaps between the bars with propolis within 6 to 7 days, after which new bars are used to replaced them. These bars with the propolis on them are placed in a rough cloth and wrapped in so that the bars are inside. They are then placed in a deep freezer for several hours. (Tsagkarakis *et al.*, 2017).

The bars are taken out of the freezer after some time and unrolled with bars turned down so that the propolis fall down on the table or bowl (Drescher, *et al.* 2017). For topbar hives, the topbars are spaced on the hive 3 to 4 mm apart with the hive cover removed. Bees will fill the gaps between bars with propolis in an attempt to close up the space. The topbars are replaced with new ones, wrapped in a cloth and placed in the refrigerator for several hours and then the propolis fall off the bars and are collected (Krell (1996); Tsagkarakis *et al.* 2017)

According to Tsagkarakis *et al.* (2017), 1kg of propolis may be obtained by placing bars of various heights on a mesh that is attached to each other. Instead of cover board and isolating materials, the mesh can be used to cover hive frames.

A perforated grid should be placed in the hive to assist bees to make propolis in manageable sizes. This is similar to a queen excluder, except the slots are smaller, measuring no more than 6 mm. Propolis will be used by the bees to fill in the gaps. Remove the grid and store it in the freezer. When the sheet is cool enough, flexing it causes the propolis bits to fall out. It's feasible to get 50 g of propolis per hive per season this way (Tsagkarakis *et al*,(2017).

Some beekeepers, according to the Bees for Development Journal (2016), employ cover boards with apertures that are screened with a network. They then apply 50 drops of mint and dill oil on a piece of gauze-coated cotton placed on the boards. Another teaser that can be used is formic acid. The sharp and strange smell produced will irritate the bees and cause them to close the openings of the network with pure propolis, which are occasionally taken off using a hive tool.

Tsagkarakis *et al.* (2017) stated that in Brazil, an innovative propolis harvesting technology was developed, allowing beekeepers to harvest 800g of the finest propolis from a single colony. On the side wall of the hive, a "window" is made and closed with bars. Specific ventilation is maintained by the bees in their nest and so when the beekeeper creates gaps (about 8mm) by removing a number of bars, they are filled with propolis. As Japan's demand for propolis grew, Brazil became its leading supplier of the substance.

Some beekeepers at times place special cassettes on hive entrances in place of entrance boards. Thus the cassette is used to close the large opening which is created. The bees would then put propolis on the cassette network in order to reduce the level of ventilation in the nest so as to optimize microclimatic conditions. The cassettes are removed from the hive after being filled with propolis and kept at a low temperature (-10 to 20°C). With light tapping, the frozen propolis may now be readily removed from the network, Tsagkarakis *et al.* (2017)

Propolis is also gathered from the walls of hives, around hive entrances, frame bars, isolating materials and cracks on the hive using a hive tool for scratching it. However, this method is not productive.

When a special two layer covers made of Capron network with 4 x 4 mm openings are used, it will result in 3-4 times increment in propolis production which requires automated gathering. During spring time, the network are placed on the frame of the topbars above the nest and below the isolating material. The covers are turned 90 degrees in the direction of the hive entrance during hive inspection . During winter, they are not left in the hive. This is to avoid their being contaminated with bee excreta and wax Tsagkarakis *et al.* (2017).

2.2.1.3.2 Processing of Propolis

In autumn when the bees are preparing to winter, the covers with the propolis are taken out of the hives. The propolis are either extracted or removed mechanically. SIP-II which is an electrical device is used to modify propolis after the first step of freezing the covers. The hardened propolis are grounded with a revolving shaft with cogs while a smooth shaft using a string pushes the cover towards the working shaft. Propolis is cleansed roughly and finely by this process (Tsagkarakis *et al.* 2017).

A centrifugal extracting machine CLK-1 is used to grind propolis pieces into powder and cleanse it of impurities which cannot be more than 20% of the propolis and at the same time make it ready for use. The powdered propolis is measured in quantities of 25 to 100g in retail trade and pressed in briquettes using a pressing machine (OKS-030 or P-6324) having 25000kg force. The powder is first kept under room temperature for about 4 hours before being pressed (Tsagkarakis *et al.* 2017).

Propolis will lose some of its characteristics if it is warmed, washed or melted. It should be kept in polyethylene bags and placed in a dark place. Propolis has a long shelf life and so could be safely used 10 years after it is harvested because it is a very stable matter.

2.2.1.4 Pollen

The pollen is the most significant component of blooming plants with unique structure and function (Stephen, 2014). Cone-bearing and blooming plants both produce it as a part of the reproductive process. Gymnosperm (cone-bearing) plants generate pollen in pollen cones. Pollen is made by flowering plants (angiosperms) in the anthers of the flower. Pollen grains are made up of one to several cells and have an outer and an inner wall. To aid in the identification of the pollen grains and to assist them stick to insects that visit the flowers, the outside wall may be smooth or covered in spines, warts, granules, or furrows. This knowledge is helpful in pollen research and studies on plant taxonomy. A pollen tube that delivers the sperm to the ovule (or female gamatetophyte) emerges when the pollen that fell on an appropriate pistil or female cone germinates after pollination has occurred (Stephen, 2014).

Bees consume pollen which they convert into bee bread (a mixture of honey and pollen) it is the main source of protein as well as fats/lipids, minerals and vitamins (Ellis *et al.,* 2010). Pollen, the honey bee's most nutrient-variable food source, is made up of water (7%–16%), crude protein (6%–30%), ether extract (19–14%), carbohydrates, comprising sugars (19%–41%), non-reducing sugars (0%–9%), and starch (0%–11%), lipids (5%), ash (1%–6%), and unknown (22%–36%). According to studies, not all pollen is equally nourishing to bees because it has various amounts of each component in it from different sources (Ellis *et al.*, 2010). A bee colony is thought to need between 15 and 55 kg of pollen per year. Pollen is necessary for the bees' growth and development. Bees that are still developing are fed a combination of royal jelly and bee bread. Bee bread is consumed by newly emerging bees to finish their development. For one worker larva to grow, 124–154 mg of pollen are thought to be needed. There are roughly 30 mg of protein in this amount. In forensics, climate change research, and other fields, pollen can be used to identify insect movement patterns, insect feeding sources, and varieties of honey. The use of pollen in these research is justified for a number of reasons. First, pollen grains stand out, are easily recognized, and may be classified according to family, genus, and frequently species rank. As a result, very precise information can be acquired. Secondly, sporopollenin, the component of pollen, is resilient and resistant to decomposition. Thirdly, the location of the plant from which the pollen originated can be identified based on the identification of the pollen. (Jones & Jones 2001).

2.2.1.5 Royal Jelly

Royal jelly is a yellowish-white, creamy, acidic secretion produced by the mandibular and hypophrangeal glands of juvenile worker bees, according to Kunugi and Ali (2019) and Collazo *et al.* (2021). This chemical is provided to all bee larvae for the first three days, including workers, drones, and queens. After three days, worker and drone larvae are fed worker jelly, which is composed of honey and pollen, while queen larvae are fed royal jelly continuously until they reach adulthood. The most important component of honeybee diet, royal jelly, is crucial for caste differentiation. (Pavel *et al.* 2011).

Fresh royal jelly contains water of between 60-70%, pH of 3.6-4.2. Royal jelly has pharmacological qualities as a result of its distinctive and rich composition, which includes proteins, carbohydrates, lipids, vitamins, minerals, flavonoids, and polyphenols in addition to various biologically active compounds (Kunugi & Ali, 2019). According to Kocot, *et al.* (2018), since royal jelly improves the general wellbeing and fertility of queen bees, who can lay up to 3000 eggs per day and live up to five years as opposed to infertile workers who live up to just 45 days, it is noted that royal jelly is a highly effective promoter of healthy ageing and longevity. Royal jelly, has been known historically to enhance memory, prevent senility, promote energy, lower anxiety, and calm hyperactive people, according to Pavel *et al*. (2011) quoting Mateescu (2005). Royal jelly is used in Chinese and Japanese medicine to treat diabetes and maintain normal blood sugar levels. Royal jelly stimulates and energizes the body by acting on the cardiovascular system and blood as a blood pressure regulator. Pavel *et al*. (2011).

2.2.1.6 Bee Venom

Bees frequently use bee venom (BV), an odorless, transparent liquid with an acidic pH of 4.5 to 5.5 that is a hydrolytic combination of proteins to defend themselves against predators (Lee *et al*., 2014). Only 0.1 g of dry venom makes up one drop of BV, which is made up of 88% water. The bee venom contains a highly complex mixture of peptides, including melittin, adolapin, apamin, and MCD-peptide, as well as enzymes, with PLA2 being the most important, and other compounds, such as low molecular weight bioactive amines such as histamine and adrenaline, as well as minerals. In order to treat rheumatoid arthritis and other rheumatic disorders, patients undergoing bee venom therapy (BVT) are given an injection of honeybee venom. Lee *et al.* (2014). According to Ali (2012), BV administration stimulates the immune system's operation and influences the release of cortisol, which is known to act as a natural anti-inflammatory agent. Melittin, the main component of BV, was discovered to reduce inflammation by enzymatically blocking the activity of the enzyme phospholipase (PLA) (Ali, 2012).

2.3 Economic Importance of Beekeeping

According to Klein *et al*. (2007); Kluser & Peduzzi (2007); Gupta *et al*. (2014); and Schouten, Lloyd & Lloyd (2019) beekeeping does not need large areas of land to start, while it improves crop yields, and is complimentary to most farming systems and also able to provide quick returns on investment.

In Ghana, the importance of beekeeping can be stated as:

1. Producing honey and beeswax at anytime of the year without spending time and energy to hunt for them.
2. Increasing crop yields through efficient pollination by the bees,
3. Discouraging people from wild hunting which mostly lead to bushfires, leading to destruction of bees, vegetation, life and property, and
4. It is a source of employment for many people.
5. Source of raw materials for industry and many others.

Beekeeping provides food, income, and employment to landless poor people in subsistence economies and therefore is a valuable self-help activity (Panda & Padhi, 1995).

The food, medicine, pharmaceutical and cosmetic industries have many uses for products from the bee such as honey, beeswax, pollen, propolis and royal jelly.

2.3.1. Pollination

It is commonly recognized that pollination, not honey, wax, or other bee products, accounts for 95% of the commercial value of beekeeping (Lindström *et al.* 2016). In other words, it would be worthwhile to keep and produce honeybees only for agricultural pollination even if we did not harvest bee products. Bees play a very significant role in the pollination of agricultural and horticultural crops such as mango, citrus, oil palm, cashew, coffee and pawpaw just to mention a few.

Bees help in biodiversity conservation through pollination, thus helping to maintain the ecosystem of the world. According to Gratzer, Susilo, Purnomo & Fiedler (2019), Kremen, Williams & Thorp (2002) and Partap (2011), it has been estimated that various species of bees, including solitary bees, bumble bees and honey bees pollinate about 66% of the world's crop species.

According to Gross (2020), the California almond industry employs approximately 1.5 million honey bee colonies. Due to the almond industry's reliance on honey bees for pollination, there has been lots of research on its impacts on honey bee health and the increasing demand for pollination services. Despite the fact that beekeeping does not only positively contribute to income gain but also plays a role in increasing food security, its potential receives only subordinate attention within Ghana. Beekeeping is hardly mentioned in Ghana when agricultural enterprises are been named.

Bees play a great role in food production in Ghana in particular and other countries in general. They are consistent in foraging thus remaining on the same plant for long. This makes them very effective as pollinators. In the United States, plantation farmers pay beekeepers to place their hives on their farms during flowering to pollinate their crops for them. In Ghana, the role of bees in pollinating agricultural and horticultural crops are not appreciated by farmers, thus they do not make efforts to protect them. According to Morse and Calderone (2000), pollination of crops by honeybees during the year 2000 in the USA resulted in increased yield and quality of crops. This pollination services achieved an estimated value of US$14.6 billion. Morse and Calderone (2000), added that information on the advantages of honeybees pollinating coffee was made public in June 2002, and that Panama saw a 50% rise in coffee bean production at the same time. (Roubik, 2002). The beneficial effects of honeybees pollination of many tropical crops is not evidently documented. It is therefore impossible to put a monetary value on pollination of indigenous plants by honeybee and its crucial contribution to biodiversity preservation. Although the other apiculture products, such as beeswax and honey, are significantly more tangible, their value- in comparison to the wealth generated by optimal plant pollination- must be less (Morse & Calderone, 2000).

2.3.2 Health Benefits of Bee Products

Honey bees, also known as the “Golden insects” produce honey and other vital hive products such as royal jelly, pollen, bee venom, propolis, queen bees and their larvae. These are marketable primary bee products. However, the best known primary products of honeybees are honey and beeswax (FAO, 2021).

The use of natural honey and other honeybee products as food and medicine by mankind has been in existence so many years. In fact, records have shown that raw honey is the oldest used sweetener and it was known to have been in use throughout the world for several years (FAO, 2021). Honey primarily is the food for the bees in the nest supplying energy and other nutrients. Honey is used by man for various purposes including as food sweetener, food, for cooking, seasoning meat, baking, drinks, and vinegar. It is also used as medicine (both human and veterinary) -wound dressing, ulcers, antibiotics and promotes hair growth.

According to Pasupuleti *et al.*(2017), raw honey contains 82.4 grams(%) of carbohydrates, 38.5g of fructose, glucose 31g, sucrose 1g, other sugars 11.7g, dietary fiber 0.2g, 22 amino acids, 27 minerals and 5,000 enzymes. Minerals include phosphorous, magnesium, zinc, iron, potassium, calcium and selenium. Vitamins that have been found in honey include riboflavin (Vit. B2), pantothenic acid, (Vit. B5), vitamin B6, thiamin, 0.038 mg, 0.068 mg and niacin. It contains 80 percent of natural sugars, 18 percent water and minerals, vitamins, pollen and protein 2 percent. It is not a surprise that honey is referred to as "the perfect running fuel." It provides a supply of liver glycogen which is an easily absorbed energy, making it ideal as a pre- and post-exercise energy source and for energetic morning starts. (Kumar, 2018). Pasupuleti, *et al.* (2017), asserts that propolis contains vitamins B1, B2, B6, C, and E, magnesium,(Mg), calcium (Ca), potassium (K), sodium (Na), copper (Cu), zinc (Zn), manganese (Mn) and iron (Fe). It also has a few enzymes such as succinis dehydrogenase, glucose-6-phosphatase, adenosine triphosphatase and acid phosphatase present in it (Lofty, 2006, Pasupuleti, *et al.* 2017) .

Aside pollination, bees are important for the production of hive products. These hive products are honey and beeswax (Pasupuleti, *et al.* 2017). Pasupuleti, *et al.* **(**2017) stated that in the developed countries where hi-tech beekeeping is practiced, pollen, propolis, bee venom, royal jelly as well as starter bees (queens, workers) are produced in addition for sale. Bradbear (2006) also adds apitherapy which is medicine using bees' products.

The name "apitherapy" is derived from the Latin terms "apis" for bee and "therapy" for treatment, according to FAO, IZSLT, Apimondia, and CAAS (2021). Apitherapy is a type of complementary medicine that uses bee products like raw honey, bee pollen and its natural derivatives, bee bread, and propolis, as well as bee secretions like royal jelly, beeswax, and bee venom, bee larva, and other products like the hive air and the sounds of the hive to promote health and prevent or treat a variety of medical conditions. FAO, IZSLT, Apimondia, and CAAS (2021) continued by stating that nearly all bee products can be used in medical care and that the cost of bee venom was USD 138 for a dosage of 25 mg compared to USD 748.38 for a milligram of pure bee venom peptide. Honey is very good for healing wounds (Stanley, 2019). Apitherapy is so developed in China to the extend that the Fugian Agricultural and Forestry University in the year 2001 produced the first apitherapy university graduates. Veterinary apitherapy is also reported in many countries. Honey is used in the treatment of bovine mastitis, otitis exerna, pyoderma, dermatitis, mouth ulcers and stomatitis among other animal diseases.

Propolis is reported by Sung *et al.* (2017) to be efficacious against diseases such as tinea capitis and tinea versicolour.

2.3.3 Beekeeping as an Income Generator

Additionally, beekeeping has been found to provide rural communities with significant, reliable, and stable sources of income (Amulen *et al.*, 2019; Bradbear, 2009; Schouten *et al.*, 2019; Schouten & Lloyd, 2019). According to Duah *et al.* (2017), beekeepers in the Berekum Municipality made an average total net income of one million, two hundred and ninety thousand, one hundred and fifty three Ghana cedis (Ghc1, 290,153) from honey sales of twelve thousand, seven hundred and twenty three (12,723) gallons per year between 2011 and 2015.

Apiculture, or beekeeping, is now one of the most widely practiced agricultural activity in the world. There are over 56 million bee hives on the planet, producing 1.2 billion tons of honey (Kizilaslan & Kizilaslan, 2007). About one quarter of all honey produced is traded, with about 20 countries accounting for 90% of all honey exports. With 65 million beehives and 306.000 tons of honey produced, China is the country with the most beehives. The EU produces approximately 11 to 13% of the global honey output (more than 204 to 220 tonnes) in the period 2010 to 2013, while China accounts for 27% of world production. The countries in the EU that are the leading honey-producers in 2013 included Romania, 26.6 Tonnes, Spain with 30.6 Tonnes, Germany 15.7 Tonnes, Hungary 18.5 Tonnes, and Poland 15.4 Tonnes, (Borowska, 2016).

The world produces 20 kilograms of honey per hive on average, with Mexico producing 27 kilograms. China produced 33 kg, Argentina 40 kg, Australia 55 kg, Canada 64 kg, Hungary 40 kg, and Turkey 16 kg. These nations also have the world's highest honey export rates. Austria, England, France, Germany, Italy, Japan, Switzerland, the United States, and other European countries are the top honey importers. Germany imports more honey than Turkey produces in its whole crop. Bee products such as beeswax, propolis, royal jelly and pollens, in addition to honey, play important roles in global trade. Bees, on the other hand, pollinate crops for farmers in nations with established agriculture, in addition to producing hive products. Crop growers in the United States, in 2017 for example, paid beekeepers a bee-rent of 320 million dollars to ensure the pollination of the plants they produce (USDA-NASS, 2017). In 2019, fees for pollination services were estimated to be $309 before falling to an estimated $254 million in 2020 with almond pollination fees accounting for the bulk of fees (USDA-NASS, 2020).

In order to determine the profitability of beekeeping in Ghana as a whole and for that matter, the Volta and Oti regions, it is important that records on production and finance are used. It is rather unfortunate that most beekeepers, like those engaged in other agricultural enterprises hardly keep records. Without good records of individual colonies and apiaries, in terms of numbers and amount of honey and other hive products harvested there is no way production can be analyzed accurately neither can profitability.

In a study conducted by Noah and Peter (2013) in Ghana's former Brong Ahafo region, they discovered that honey production is increasing in all municipalities and districts in the region. There are a total of 5,748 beekeepers in the region, with 2,212 being females and 3,536 being males (Subbey, 2009). Honey output averaged 74,088kg per year in 2010. Honey production accounts for a considerable portion of beekeepers' earnings (48.9%), followed by crop production. Duah *et al.* (2017) conducted a study on income sustainability and poverty reduction among value chain beekeeping industry actors in the Berekum Municipality in the former Brong Ahafo region of Ghana. It covered the period 2011 and 2015, and established the profitability of beekeeping. According to the findings, beekeeping might be a significant economic activity capable of supporting rural life and increasing the incomes of households. The study found that beekeeping has the ability to reduce economic stress and is a very sustainable value chain activity for participants. This is due to the fact that the income generated from beekeeping is far higher than the initial investment.

Three thousand, two hundred and forty three (3,243) liters of honey were generated by an average of 1,195 colonized colonies, according to the researchers. The average selling price per six-litre gallon was one hundred twenty Ghana cedis (GH120), resulting in an average total net revenue of three hundred eighty three thousand, one hundred and forty two Ghana cedis (GH383,142). Comparing this revenue from beekeeping to the then-current national minimum wage of GH 216, which equals GH 2,592 annually in 2015, according to Duah *et al.* (2017), beekeepers' lives can be improved as a result of the significant contribution that honey sales provide to the fight against poverty.

Beekeeping does not benefit only beekeepers economically but also other actors in the value chain. Duah *et al.* (2017), found out that carpenters gained a total net income of thirteen thousand, nine hundred and sixty Ghana cedis (GH₵13,960) in 2015 having produced one hundred and seventy-five (175) hives with an average expenditure of three thousand five hundred and forty Ghana cedis (3,540).

According to research by Duah *et al.* (2017), honey sellers sold an average of 2,247 liters of honey in 2015. The traders made a total net profit of five thousand, eight hundred and eighty nine Ghana cedis (GH 5, 889) at an average selling price of 140 Ghana cedis per gallon.

The above research by Duah *et al*. (2017) and Noah and Peter (2013) established the economic benefits of beekeeping beyond any doubts without even looking at income from the extraction of the other hive products- beeswax, pollen, royal jelly, propolis, as well as revenue from sale of bee queens, apitherapy (use of bee venom to treat diseases such as rheumatism) and pollination services as found in America and Europe.

2.3.4 Local and International Trade in Hive Products

2.3.4.1 Trade in Honey

In the EU, great importance is attached to the quality, purity, and safety of beehive products. Producers do their best to meet the requirements of the Good Production Practices and Good Hygien (FAO, 2021). Imports are used to complement native output when it is low (Semkiw, 2007). Exporting honey from less developed nations to more developed nations is part of international trade since these items can be sold for substantially more money than on domestic markets (Borowska, 2011). The European market (mainly EU countries) received over 53% of honey mainly in international trade, (European Commission, 2013a). The USA and Japan are the two countries that import the most honey globally today. The countries with the biggest volume of imported honey worldwide include sixteen (16) members of the European Community. Of this number, Germany imports approximately 100,000 tonnes, the United Kingdom and France approximately 30,000 tonnes, while Belgium, Spain and Italy import over 16,000 tonnes, (Borowska, 2016).

Borowska, (2016) went on to state that, in the years 2004-2009, Poland exported several hundred tonnes of honey on average every year whereas the export level exceeded 15,200 tonnes in 2014. China was the main trade partner of Poland in honey with a volume of over 10,100 tonnes. Nevertheless, its export share fell from 51% in 2010 to about 45% in 2014. With approximately 3,600 tonnes, the EU countries formerly held joint second place in the honey trade; but, in 2012 and 2013, the Ukraine overtook them with approximately 7,900 tonnes, which accounted for 30 to 39% of imported honey (Borowska, 2016). Romania, with 262-430 tonnes, Germany, 500 tonnes, Spain, 130 tonnes, and France were significant trading partners for imports from the EU between 2011 and 2016, while Bulgaria traded more than 1,000 tonnes in 2014. Italy having over 328 tonnes and the UK also with approximately 400 tonnes traded with the EU as well (Borowska, 2016).

The primary and most well-known hive product and a valuable source of both food and medicine is honey, which is produced by beekeeping. Another important hive output is beeswax. Any beekeeping project revolves around these two major items. Honey, the main product of the hive, is essentially nectar from flowers from which bees have mostly drained the water content. Honey provides energy and other nutrients to the bees in the nest. According to Stanley (2019) and FAO (2021), honey is used by man for various purposes including: Food sweetening, Food, Medicine (both human and veterinary) -wound dressing, ulcers, Antibiotics, Promotes hair growth, for cooking, Seasoning meat, Baking, Drinks, and Vinegar.

Beeswax and honey are traded widely both domestically and internationally. Many international corporations use honey in the pharmaceutical sector and to create goods like lip balms, soaps, and lotions for the skin. Since many individuals are concerned about their health, they substitute honey for sugar in their tea and other foods. Scanning through various documents such as *Investment Guide for the Agriculture Sector in Ghana, 2018, Agricultural Sector Progress Report, 2016 and the Planting for Food and Jobs* and other policy documents of the government of Ghana prepared by Ministry of Food and Agriculture, (MOFA) and other bodies, it was observed that beekeeping and trade in its products are not valued and for that matter, not mentioned by governmental organizations in these documents in Ghana.

Data on production and trade in agricultural products in Ghana does not include those from beekeeping. In a Ghana News Agency (2009) article titled "SNV to facilitate honey making business in the Volta Region," published on 14th Aug 2009, Ms Cassandra Okudzeto of SNV, was reported as saying that Ghana currently consumed 340 metric tonnes of honey annually, 300 metric tonnes of which was produced locally while the 40 metric tonnes shortfall was imported.- published by GhanaWeb News on 28th July, 2017.

In Ghana, honey is sold in jerry cans, discarded plastic bottles of all sizes, gallons, and used beverage bottles (including bottled water, whiskey, and other types). In 2016, the global honey market was worth US$2.2 billion. When compared to 2012, when shipments of natural honey were valued at US$1.8 billion, this climbed by 27.1 percent on average for all exporting countries (Borowska, 2011). In terms of exports of natural honey, Europe led all other continents in 2016, with shipments totaling US$825.3 million, or 36.8% of all honey sales worldwide. In comparison, Asian exporters received 23.5 percent, 14.5 percent for Latin America and the Caribbean (excluding Mexico), 10.6 percent for Oceania (mainly New Zealand, followed by Australia), and

7.8 percent for North America. African countries contributed a respectable 6.8% of all natural honey exports.

China topped the list of nations exporting natural honey in 2009, according to the Ghana News Agency, with US$276.6 million, or 12.3 percent of all exports. New Zealand came in second with US$206.7 million, or 9.2 percent. With a value of US$142.4 million, or 6.4 percent of global exports, Sierra Leone is the only African nation among the top five exporters. According to Ghana News Agency (2009), the top 15 countries sent 77.2 percent of all natural honey exports in 2016, accounting for more than three-quarters of all natural honey exports (by value).

In locations with a lot of melliferous plants, beekeeping can be a lucrative business. The potential for beekeeping development in Ghana in general, and in the Volta and Oti regions in particular, is immense due to the country's varied environment and infinite floral resources gathered from cultivated crops and wild vegetation. The production of honey for both domestic and international markets has been seen as a key step in generating money. As a result, chemical analyses of honeys from various parts of the country have been conducted in preparation for their usage in the food business (Doddo & Aidoo, 1999). According to Ms Okudzeto of SNV, Ghana currently consumed 340 metric tonnes of honey annually, 300 metric tonnes of which was produced locally while the 40 metric tonnes shortfall was imported, 14th Aug 2009 .-GNA, (2009), according to a news item carried by GhanaWeb News on 28th July, 2017 titled, “SNV to facilitate honey making business in the Volta Region”-

In a 2019 report by COMTRADE on honey trade of Ghana, a total of six thousand, four hundred and five kilograms (6,405) of honey worth two hundred and eighty thousand dollars ($280,000) was exported to various countries in the world including Canada ($159,000), United States

($5,800) and the United Kingdom ($3,400) while seventy thousand dollars ($70,000) worth of honey was imported within the same year of 2019.

2.3.4.2 Trade in Beeswax

Beeswax, according to Gentry, (1982) and FAO (2021), are produced by the wax gland situated at the lower abdomen of the bees. The bees use the wax to build their combs. Beeswax is used by man industrially to produce cosmetics, pharmaceuticals, polishes, candles, comb foundation sheet, as well as for a variety of other purposes such as polish, grafting waxes, lubricants, and electrical insulations (Bradbear, 2009 & FAO, 2021).

In an Egyptian papyrus made around 1550 BC, beeswax was mentioned in 32 prescriptions. It is lauded for its positive effects on the energy and blood systems as well as the body's general equilibrium (Bogdanov, 2016). Ancient Egyptians, Greeks, Romans, and the Chinese people all utilized beeswax candles. Since the birth of Christianity in Europe, it has been used in churches. Natural beeswax of high grade is required by all businesses. Beeswax is commonly priced between $4 and $10 per kilogram around the world. Beekeepers in industrialized countries use the majority of locally produced beeswax to make comb foundation sheets.

Ethiopia produces around 4300 tons of beeswax annually, ranking first in Africa and third globally, according to Johannes (2005). However, the yearly production of beeswax would probably exceed 5000 tons given the current growth in honey production, which is anticipated to reach over 54,000 tons. France, Germany, and Greece are the next three biggest beeswax importers into the EU, together making up 39% of all beeswax imports. Between 2003 and 2007, imports climbed by 5.4% annually in terms of volume and by 14% annually in terms of value, which was a significant growth when compared to other major importers. The value of imports in 2007 was € 9.4 million per 2.9 thousand tonnes. There are no data on the German beeswax market, which is unfortunate, but given that imports far outweigh exports, it may be presumed that Germany has a sizable beeswax industry. Beeswax is utilized for a variety of uses, including comb foundation sheets for frame hives in modern times. Cosmetics consume twenty-five to thirty percent of it, pharmacy consumes 25-30 percent, candles consume 20 percent, while 10-20 percent goes for other purposes. Beeswax is a highly stable and oxidation-resistant material. The chemical makeup of beeswax is quite complex, and the industry has yet to develop a counterpart with comparable qualities (Bogdanov 2016). Beeswax remains irreplaceable in many industrial applications although many synthetic waxes are available today (Krell, 1996).

Ethiopia produced 163,257.42 tons of honey between 2007 and 2011, with 99.2 percent used domestically and 0.8 percent exported. Ethiopian honey exports totaled 1,297,716 kg in 2007–2011, with a total value of US$4,066, 528 (Miklyaev, 2013). Sudan, Ethiopia's northwest neighbor, was Ethiopia's single greatest honey importer in terms of volume and monetary value. Despite a little increase in honey exports between 2007 and 2011, Ethiopia's honey exports remain small in relation to its total honey production (Miklyaev, 2013).

Data gathered by Miklyaev (2013) indicated that the majority of honey produced in Ethiopia is consumed locally while small amounts are exported. For instance in 2007-2008, forty two million, one hundred and eighty thousand, three hundred and forty six (42,180,346) kilograms of honey was produced by Ethiopia. Out of this number, forty one million, nine hundred and sixty thousand, four hundred and fifty seven (41,960,457) kilograms was consumed while two hundred and nineteen thousand, eight hundred and eighty nine (219,889) kilograms were exported. Then in 2010-2011, one hundred and sixty three million, two hundred and fifty seven thousand, four hundred and twenty (163,257,420) kilograms of honey was produced out of which one hundred and sixty one million, nine hundred and fifty nine thousand, seven hundred and three (161,959,703) kilograms were consumed while five hundred and twenty thousand and, three hundred and one (520,301) kilograms were exported (Miklyaev, 2013 & Bogdanov 2016).

Comparing the percentage domestic consumption with that exported, the researchers came out with the following that in 2007-2008, 99.5% of honey was consumed as against 0.5% exported while 99.6% was consumed as against 0.4% exported in 2008-2009. In 2009-2010, 99.6% was consumed as against an export of 1.0% and lastly, 98.7% of honey was consumed as against 1.3% exported in 2010-2011. The above shows that the Ethiopians consumed more of what they produced and exported less (Miklyaev, 2013 & Bogdanov, 2016).

2.3.5 Beekeeping and its Influence on Food Production

Bees are important in food production and sustenance of the environment. It is therefore important that they are conserved and protected. Unfortunately, a number of human activities have affected bees and caused the destruction of bee habitats. Bushfires, the incessant and uncontrolled use of pesticides in agriculture has led to the destruction of bee habitats. For life to exist on our planet, pollination is essential.

Bees and other pollinators have sustained biodiversity and thriving ecosystems for plants, humans, and bees for millions of years. They also provide food security and nourishment (FAO, 2021). Pollinators are necessary for the growth of many of the micronutrient-rich fruits, vegetables, nuts, seeds, and oils that people consume. In nearly 75% of the world's crops, bee pollinators are crucial for the ongoing production of high-quality fruits and seeds for human consumption. Animal pollinators and for that matter bees, are responsible for a huge portion of the world's diversified food resources.

According to the FAO (2021), bees either directly or indirectly pollinate close to one third of all plants and plant products consumed by humans. Unfortunately, pollination services by the bees are on the decline in a number of areas. Previously, nature offered this service at no apparent expense. Agricultural techniques have altered as farm fields have grown larger, with an emphasis on a smaller number of crops and more pesticide use. According to FAO (2021), accumulating data refers to these issues as potential reasons of a major drop in bee population and activity. The reduction is projected to have a negative impact on the production and pricing of vitamin-rich foods like fruits and vegetables, leading to increasingly unbalanced diets and health problems including malnutrition.

In order to safeguard biodiversity and increased food production and security, efforts must be made to protect bees. Most of the pollinators are wild, including over 20 000 species of bees. Crop yields could be raised by as much as 25% with better pollination management. Pollinators would greatly contribute to world nutrition and food security for an increasing global population, as well as eradicating poverty and hunger, by ensuring increased yields and successful agricultural production (FAO, 2021).

2.3.6 Beekeeping and Biodiversity

Bees play major roles in maintaining biodiversity. They are involved in pollination of many plant species. Their constancy (their continuous stay and foraging of a particular plant species until nectar is exhausted before moving to another species) makes them the most important pollination agent. According to Bradbear (2006), beekeepers that practice beekeeping in a forest will be concerned about forest protection, particularly the large trees that bees enjoy. He went on to remark that when a forest has more bees, the pollination is better, which leads to more tree regeneration and biodiversity protection. Bushfires have destroyed the habitat of bees that pollinate Brazilian nuts (Bertholletia excelsa), and this is considered to be one reason why the production of Brazil nuts in the Amazon has decreased (Mori & Prance, 1990). Pollinator shortage, deterioration of bee habitat, and resulting decline in plant reproduction have all been extensively documented (Roubik, 1995).

A survey found that beekeepers in Zambia's North West Province played a key role in promoting forest conservation because they value dense woods and want to prevent damaging late fires (Clauss, 1992). According to Clauss (1992), "beekeepers are frequently concerned about late fires between August and October," which "scorch the flush and, above all, the blooms of the most significant nectar plants like *Cryptosepalum exfoliatum pseudotaxus, Brachystegia spp*., and *Copaifera*." According to available data, beekeepers who stand to financially benefit from the preservation of bee habitat are motivated to safeguard forests. The degree to which other beekeepers around the world care about and are prepared to invest in forest conservation is not known.

Lumbering, illegal gold and other minerals mining and sand winning are among human activities that is in recent times, threatening the existence of our forests and other vegetation types. Beekeeping projects can be adopted to conserve forests and for that matter, the ecosystem thus conserving biodiversity. It follows that areas with high beekeeping potential will have virgin woods and low human population densities, both of which are conducive to beekeeping.

Bees are essential pollinators, and many ecosystems depend on them to reproduce and diversify their genetic makeup (cross -pollination). Therefore, the viability of plant species that depend on bee pollination may be impacted by declining bee colonies and species. Some types of plants need bee pollination to live (FAO, 2007). According to Mau-Mandela (2010), ecologists predict that over 100,000 species will go extinct if bees are not used to fertilize plants. Additionally necessary for pollinating food crops are bees. Bees pollinate a third of all plants and plant-based foods consumed by people, either directly or indirectly (FAO, 2021). In the United States of America, bees are anticipated to assist in pollinating more than 90 crops valued at more than USD 15 billion annually (Berenbaum, 2007). Bee pollinated crops are shown to have higher yields and better quality, at no additional expense to the farmer. Regardless, many farmers consider bees and other pollinators to be pests.

2.3.7 Honey Production and Livelihood

Rural communities can obtain livelihood security by managing bees and boosting income access at the same time (Ali & Jabeen, 2015). According to Jaffe' *et al.* (2015), when low-income communities keep bees, they can gain additional revenue from trade in bee products, which would reduce their need to exploit other natural resources. It will also provide incentives for beekeepers to conserve natural ecosystems like food sources and nesting places. Beekeeping has the potential to increase crop yields and offer quick returns on investment. It is suitable with most farming techniques and does not require very large amounts of land (Klein *et al.*, 2007; Kluser & Peduzzi, 2007; Gupta *et al.*, 2014; Schouten, Lloyd & Lloyd, 2019). Equipment required for beekeeping could be accessed locally as a number of local materials could be used as beehives. Some of these are pots, baskets, old metal trunks, barrels and wooden boxes among others which could be used to keep bees. Many women in Berekum Municipality and Nkwanta South were active in honey trade as a source of income, according to Jeil *et al.* (2019). Aside beekeepers who make a living from honey production and sales, those who work in the industry include carpenters who build beehives, welders who build smokers, and tailors who create bee suits. Beekeeping programmes are becoming more popular in developing countries, with the goal of providing rural impoverished people with alternative sources of income (Crane, 1999, Bradbear, 2009, Lloyd, Somerville & Schouten, 2016 & Gratzer, *et al.*, 2019). The benefits of beekeeping programmes may not always be realized, despite their exceptional attributes. According to Otis and Bradbear (2003) and Narayan (2018), despite the greatest efforts of development organizations, many beekeeping programmes have offered the intended recipients few, if any, favorable livelihood advantages and in other cases have made things worse for the poor.

2.4 The Impact of Training on the Development of Beekeeping

Rahman and Islam (2016) define training as the process of enhancing employees' aptitudes, skills, and competencies to carry out particular occupations. They asserted that training supports both the acquisition of new skills and the updating of existing ones. Training, according to Srirekha and Rao (2017), is a critical component for enhanced performance since it can increase individual and organizational capability. Unlocking the potential for growth and development and creating a competitive advantage requires training. As a result, beekeeper training is likely to improve their aptitudes, talents, and capacities to do beekeeping more efficiently.

Training, according to Lynton and Pareek (1990), consists mostly of carefully planned opportunities for participants to acquire the knowledge and skills they need. Beekeepers are given training to help them become more efficient at their jobs. Farmers, and beekeepers for that matter, have been shown to produce a variety of outputs. Murshed-E-Jahan and Pemsl (2011) discovered that improving farmers' (beekeepers') abilities through training is more beneficial than providing financial aid in terms of raising output and income levels. This finding was based on their study of small farmers in Bangladesh. Similar to this, a study by Tripp and Hiroshimil (2005) affirms the value of training and claims that it can aid farmers' (beekeepers') improvement of their skills in their farming (beekeeping) activity. In fact, beekeeping training would go a long way toward improving the skills of beekeepers.

According to Pocol and McDonough (2015), Mburu *et al.* (2017), and Ekele *et al.* 2019, vocational training for beekeeping can improve equal employment possibilities. In India, Kumar (2018), in a research involving 196 participants on the impact of training on beekeepers' knowledge found out that 65.81% had low knowledge level, 26.53% (Low-Medium) knowledge level, 7.65% (High-Meduim) knowledge level and 0.00% (high) knowledge level before the training programmeme. At the end of training, the results drastically changed to Low knowledge level 0.00%, Low-Medium knowledge level, 18.36% High-Medium knowledge level 67.85% and high knowledge level 13.77%.

The above results from Kumar indicated that training of beekeepers is very important in enhancing their knowledge in beekeeping. This acquisition of knowledge could have rippling effect on their skills and attitudes to beekeeping. According to Kher *et al.* (2004), beekeepers' training needs are critical for upgrading and developing their knowledge and abilities. Both Kumari (2005) and Singh (2005) reported similar results, concluding that skilled beekeepers had a higher level of knowledge than inexperienced beekeepers. According to Srinivas and Sailaja (2013), after a training programme run by Krishi Vigyan Kendra (KVK), a "farm science center," participants showed greater understanding after being exposed to the scientific beekeeping training. Additionally, it was discovered to be consistent with Lal and Tandon's (2011) research. Just like many crop and animal farmers go into production without any formal training, and treat their work not as a business but as a pastime, many beekeepers are into the industry as a result of following their parents to harvest honey for a number of times in the wild and not because they have undergone any training. Beekeeping, like any other enterprise needs training to enhance effectiveness and efficiency.

In Ghana, beekeeping inputs such as beehives, bee suit, smoker and hive tools are not readily available on the market for one to walk in and buy. Management of bees in terms of type of beehive to use, when to set beehives, most appropriate place to set them, how to determine maturity of honey, determining the difference between honey comb and brood combs and hygienic way of harvesting honey all demand training. Other skill sets such as how to determine signs of imminent swarming and how to prevent it, identifying queenlessness in a bee colony and how to rectify it and various methods of colonization of beehives needs to be imparted to beekeepers through training. Due to lack of training therefore, many beekeepers use equipment that does not permit efficiency while their management of bee colonies is very poor. It is therefore important that beekeepers are trained in the production of some, if not all the equipment needed as well as management practices in beekeeping.

2.5 Training in Beekeeping

Any country's most valuable resource is its human capital. However, it is a nation's qualitative strength—not its numerical—that drives it toward development and prosperity. The main driver of every society's socioeconomic or political-cultural transformation is human resource development. Training is one of the most important components of human resource development (Srinivas & Sailaja 2013).

According to Srinivas & Sailaja (2013), training increases knowledge, a cognitive aspect of a person's thinking that is important for both overt and covert conduct; persons with a stronger understanding of the technical nature of improved farm methods would have a higher adoption rate. Inadequate and wrong understanding leads to either insufficient or excessive acceptance of innovation, which is disastrous for the farming industry.

Training, according to Adisa and Okunade (2005), is an age-old idea that has the therapeutic function of moulding people's knowledge, abilities, and attitudes that are essential for effective performance of responsibilities and or assignments. Raab (1991) asserts that training agricultural and community development programme participants attempts to impart information, knowledge, and skills while also replacing outdated attitudes with more positive ones, exchanging ideas, and removing uncertainties and barriers.

Training in beekeeping has been going on in various parts of the world to equip beekeepers with requisite aptitudes, attitudes, knowledge and skills to enhance their performance and productivity. "The use of both formal and informal ways to communicate knowledge so that people gain the required abilities to deliver," according to Drummond (2000), is what training is. According to Aswathappa (2000), training is the process that equips workers with the skills, abilities, and aptitudes necessary to carry out certain tasks. Armstrong (2003) defines training as "the formal and systematic adjustment of behavior through learning that occurs as a result of education, instruction, development, and planned experience."

Despite the importance and benefit of participating in training programmemes, beekeepers may refuse to take advantage. A number of reasons may account for this. Agricultural programmes that involve farmers and, for that matter, beekeepers have a direct impact on livelihoods, the environment, technology adoption, nutrition, poverty, agricultural sector performance, and the macroeconomy. In a research, titled "Major factors influencing farmers' participation in skill training programme in Assosa Zone", Telayneh (2010) found out that centralized programmeme planning is one of the structural obstacles that affect farmers' participation. If the target groups are not involved in planning a process, they may think that the programmeme planners have no interest in serving their needs and interests and therefore will refuse to attend the training programmeme (Gboku & Lekoko, 2007). Treunicht, Steyn, and Loots (2001) also underlined the necessity to empower local interest groups to determine needs in accordance with their own beliefs and customs.

Many interventional projects and programmemes for the rural people and for that matter, farmers usually have the "top-down" approach to planning instead of a "down-top" approach. It is important that needs assessments are done involving the people to identify felt needs which should be addressed. When the people who are affected by the intervention are involved, they would own it and so lend every support for its success. It has long been understood that top-down approaches to development with minimal involvement and input from intended beneficiaries are an unsustainable and ineffective way to empower and develop beneficiaries. A push for bottom-up efforts that consider beneficiaries as partners, draw on local expertise, and seek to empower target recipients has emerged in recent decades.

Farming systems research and extension was advocated by Chambers (1983) as a model for agricultural development. Farmers play a vital role in the success or failure of an agricultural enterprise, according to the farming systems and extension concept. It recognizes farmers' contributions to the identification of agricultural concerns as well as long-term development solutions (Kumba, 2003).

The Ghanaian Savanna Agricultural Research Institute (SARI), a branch of the Council for Scientific and Industrial Research (CSIR), has reportedly embraced the concept of farming systems research, according to Etwire *et al.* (2013). They claimed that the bulk of Ghana's agricultural programmes employed a bottom-up method of development. Instead of teaching farmers, the emphasis is now on collaborating with them and providing them with mentoring in order to jointly identify and overcome regional agricultural challenges.

Other factors could have an impact on involvement. The sex of a farmer may influence his or her decision to join in an agricultural project in a positive or negative way. Female farmers have greater social connections than male farmers, making them more inclined to participate in agricultural ventures. On the other hand, male farmers usually have more access to and control over resources. Men are better prepared to work in agricultural operations since they frequently make the majority of the decisions. Nxumalo and Oladele (2013) assert that male farmers are more likely than female farmers to participate in agricultural projects. Nnadi and Akwiwu (2008) claim that there is no strong correlation between sex and farmers' participation in agricultural initiatives.

According to Nnadi and Akwiwu (2008), Farid *et al.* (2009), and Nxumalo & Oladele (2013), younger farmers are more likely to take part in agricultural projects because they are more creative, risk-takers, and open to trying new things. The advantages of participating in a farming project, however, may have been seen or personally experienced by older farmers because they are more experienced and equipped. A lack of resources may also prevent older farmers from participating in an agricultural programme. Numerous writers have found a correlation between age and participation in an agricultural endeavor.

According to Kahn *et al.* (2012), a woman's physical strength deteriorates as she ages, limiting her ability to participate in agricultural projects. However, Oladejo *et al.* (2011) found no evidence of a connection between age and involvement in agricultural projects. Married farmers are more likely to take part in agricultural projects than farmers who are not married since they may have access to their spouse's knowledge and resources. Marriage, in the opinion of Nnadi and Akwiwu

(2008), makes a farmer more concerned about the welfare and food security of his or her family, which is likely to have an impact on the decision to take part in an agricultural project.

2.6 Impact Analysis, and Productivity of Beekeeping

Impact evaluation often aims to either "prove" the intervention's effectiveness (the accountability agenda) or "improve practice" (the lesson learning agenda) (Herbert & Shepherd, 2000). According to Duy *et al.* (2014), a range of factors, including technological innovation, corporate strategy, or other beneficial externalities, could increase productivity. Increased productivity might result from instruction in the use of modern beehives, knowledge of the best times to establish hives and gather honey, and application of cutting-edge honey extraction technologies. Profitability is easily determined by the gap between cost and income. Hives, protective clothing, buckets, smokers, extractors (which can be bought or rented), and, in some situations, feed and medicines are all costs involved with beekeeping. Revenue is generated by the sale of bee products or pollination services. An indigenous Ugandan hive costing US$8 was compared to a top-bar hive costing US$38 in a recent study conducted by SNV in Uganda. The local style hive was determined to be more profitable with an output of 10 kg of honey per year, providing that a kilogram of honey sells for the same price regardless of hive type.

The profit from the sale of 15kg of honey produced by the top bar hive annually is still lower than what is realized from cheaper traditional hive. By having more of these low-cost hives, the beekeeper can increase his or her revenue (Lowore & Bradbear, 2013a). Because a beekeeping system rarely consists merely of a hive, taking a systems approach to beekeeping is essential. Labor is a cost, but the overall number of honey bees is a gain. Fixed-comb hives will have higher labor costs than top-bar and frame hives, which are designed to entail beekeeper management methods.

Pollination services rendered by beekeepers to crop farmers could also result in increased production and be a source of income to the beekeepers. In 2019, beekeepers earned approximately $309 million from pollination income as crop farmers paid beekeepers to place their hives on their farms for the bees to pollinate the crops (USDA-NASS, 2020).

Productivity is a metric that measures the amount of output per unit of production and has a lot to do with scale and efficiency. The ideal system is when productivity and profitability coincide, but this is not always the case.

According to Lowore and Bradbear (2013a), there are numerous techniques for calculating productivity in beekeeping. They suggested that we must first dispel the notion that a hive is a factory or merely a container that produces nothing. In beekeeping, the exact units of production differs in relation to the system: an honey bee colony, an apiary, or a population of several honey bee colonies making up the bees. Nectar will be abundant in natural settings with a large population of large flowering trees, such as mango, citrus, or African black berry fields.

Lowore and Bradbear (2013a), stated that one hectare of these resources will be exceedingly productive if it is well-stocked with a significant number of colonies. According to them, while 500 kg of honey can be produced from a two and a half acre field of mature chestnut trees in a year for instance, a two and a half acre field of mature lime trees will produce a thousand kilograms of honey per year.

Productivity would be boosted by increasing the density of good nectar-producing plants. Some of the numerous factors that determine the quantity of honey realized each year by honey bee colonies are genetics composition , the age of the queen, the species of bees, the environment or climate, size of the bee colony, and inclination to swarm. Some of these elements could be controlled by the the beekeeper, while the interest of the beekeepers and their capability to manage bees to maximize honey yield differs based on their expertise and talents. Management is a delicate art of balancing profit and production and this can be better achieved if local beekeepers are trained for instance in colony and apiary management.

2.6.1 Impact Assessment Models

There are a number of impact assessment models among which are the propensity score marching and binary logistic regression models that are used to estimate the effect of training programmemes on productivity.

2.6.1.1 Propensity Score Matching

The employment of microeconometric techniques such as Propensity Score Marching in estimating the impact of developmental policies and programmes has become a common approach not only for scholars, but also for policy-makers engaged in projects in different fields (Heinrich, Maffioli & Vázquez, 2010). Fundamentally, the interest in all programme evaluation efforts is to ascertain whether a particular intervention as designed, is effective in accomplishing its primary objectives. In the view of Heinrich, Maffioli and Vázquez, (2010), a well-designed intervention is usually supported by research or theory that demonstrates how the intervention's scoring mechanisms will function to meet its objectives and bring about the desired results.

An evaluation model called Propensity Score Matching (PSM) is used to examine how training programmes affect productivity. The PSM employs an experimental methodology in which one group is treated, while a second group is left untreated (Caliendo & Kopeinig 2008). By taking into consideration the factors that determine whether a person will receive a treatment, policy (in this example, beekeeping training), or other intervention, the PSM aims to assess the effect of such a measure (Rosenbaum & Rubin, 1983). To run the PSM model, some steps has to be followed as recommended in literature. First, the propensity scores has to be calculated. Secondly, the matching logarithm is decided to determine the region of common support. Third and final step is the assessment of treatment effects, and their standard errors been subsequently calculated. The propensity score can be estimated by using the Probit or logistic model where the covariates are regressed on the treatment variable. Therefore, the propensity scores of the respondents can be estimated by using training (treatment) as the dependent variable and gender, age, marital status, educational level, and years of experience as covariates or independent variables. Probit regression is then used to estimate the model to get propensity score. This would mean that the respondents share similar characteristics apart from the training. After the Probit regression model was estimated to determine the propensity scores, five blocks will be selected. The blocks ensure that the mean propensity score is not different for treated and controls in each block (Rosenbaum & Rubin 1983).

To estimate the PSM model, the propensity scores variable would have to be created first and then matched with the respondents based on their respective propensity scores. The propensity score is the probability that someone has received the treatment or has taken part in the beekeeping training programmes. By comparing the characteristics of respondents within the treatment (with training) and control groups (without training) that have similar propensity scores, the effect of the treatment on the outcome variable can then be ascertained. Pan and Bai (2015) provide four steps to estimating PSM; 1) estimate propensity score; 2) matching, 3) evaluate quality of the matching, and 4) evaluate outcomes.

One important component of PSM is the balancing of covariates between the treated and the untreated groups. It should be noted, however, that a critical component of the PSM is the balancing of the covariates between those who received the training programmes and those without the training programmes.

The average treatment effect on the treated (ATT) and the average treatment effect are the two approaches for measuring PSM (ATE). The ATT represents the impact of the treatment on the population, as opposed to the ATE, which represents the average of individual treatments (those who received the treatment). It is very neccessary to note that where the covariates between the two groups are not balanced, ATT and ATE cannot be computed (Rosenbaum & Rubin 1983)

There are four main balancing methods in the PSM: 1) Nearness neighbor matching; 2) Radius matching; 3) Kernel matching; and 4) stratification matching. The propensity score p (Z) is defined as the conditional probability of impact of training on production and income of beekeepers. It is mathematically represented as:

$$P(Zi) = Pr[(Li= IZi)] = E(LiIZi) = F\{h(Zi)\}$$

Where: Li = (0, 1) is the indicator of the impact of training and Zi denotes a vector of pre-training characteristics, and F{.} can be a normal or logistic cumulative distribution.

2.6.1.2 Binary Logistics Regression

There are several estimation techniques that can be used to analyze survey data: multiple regression, structural equation modeling, and logistics regression.

Multinomial logistic regression, according to Starkweather and Moske (2011), is used to forecast categorical placement in or the likelihood of belonging to a category on a dependent variable based on numerous independent variables. The independent variables may be continuous, interval, ration, or dichotomous, or binary in nature. The dependent or outcome variable can be divided into more than two categories, which is an extension of binary logistic regression. Similar to binary logistic regression, multinomial logistic regression evaluates the likelihood of categorical membership using maximum likelihood estimation.

According to Arewa (2019), structural equation modeling (SEM) is a type of second-generation multivariate analysis that has the potential to reveal relationships between or among latent variables and the indicators that correspond to them. According to him, SEM can be constructed using cross-sectional data such as questionnaires or cross-sectional data or structured with time series. SEM, is used when a researcher's construct variables are interrelated or at least related by theory. There must also be an underlying theory providing a causal link.

When estimating the association between a dichotomous dependent variable and a dichotomous-interval or ratio-level independent variable, binary logistic regression is frequently used. Using a set of predictor variables, logistic regression is used to forecast a categorical (often dichotomous) variable, according to Wuensch (2014) and Berger (2017). They claimed that if all of the predictors are continuous and appropriately distributed, discriminant function analysis is often utilized with a categorical dependent variable. Logit analysis is usually utilized when all of the predictors are categorical; logistic regression is frequently used when the predictor variables are a mix of continuous and categorical variables or if their distribution is not uniform (logistic regression does not make any assumptions about the distributions of the predictor variables). The predicted dependent variable in a logistic regression is a function of the likelihood that a given subject would fall into one of the categories.

It is important to keep in mind that the choice of statistical or estimating approaches is based on a number of fundamental presumptions regarding the variables used in the study. The regression findings can be false if these conditions are not met (Osborne & Waters 2002). Generally, multiple regression or estimation techniques must meet the assumptions of linearity, reliability, measurement, homoscedasticity, and normality (Lindley, 1968; Hoyt *et al*. 2006).

Aside these assumptions, multiple regressions including structural equation modeling are used when there is one metric dependent variable and two or more metric and/or nonmetric independent variables (Osborne & Waters 2002). However, multiple regressions may produce misleading results when the outcome variable is nonmetric, dichotomous, categorical or binary (Roediger *et al*. 2001).

There are two types of logistics regressions: multinomial and binary logistics regressions. One advantage of using logistics regression is that the data must not necessarily meet the assumptions of normality, linearity, and homoscedasticity (Lindley, 1968). The multinomial regression is an extension of binary logistics regression that requires more than two categories or responses of the dependent or outcome variable (Goeman & le Cessie 2006).

Binary logistics regression is flexible and lends itself to easy interpretation (Gujarati, 1970). In a binary logistics regression model, the response or dependent variable is binary or dichotomous with two responses (Horowitz & Savin 2001). In this regard, binary logistics regression is used when there is dichotomous or binary outcome variable and several independent variables either categorical or dichotomous (Hosseinian & Morgenthaler 2011). The outcome variable usually has two responses: 1 = YES and 0 = NO with 1=YES serving as the reference variable. The logistics regression uses maximum likelihood ratio to calculate the odd ratios (Hosseinian & Morgenthaler 2011). Moreover, the use of marginal effects in logistics regression can examine the extent to which the average predicted probability of a binary outcome changes with a change in independent variables (Norton *et al.*, 2019). Therefore, marginal effects are often reported in logistic regression to show and quantify the incremental impact on the outcome variable with respect to each of the predictor factors.

2.7 Review of Empirical Works

Bees have been with mankind for centuries providing hive products such as honey, beeswax, propolis, pollen and royal jelly among others to man. Bees also have been pollinating various plants thereby aiding in the maintenance of the ecosystem and supporting biodiversity. Beekeeping has been the livelihood of many people the world over. With the upsurge of global food insecurity, unemployment and poverty in several areas of the world especially the rural areas, means of alternative livelihood are being sought and beekeeping is one area that have been identified to be able to bring relief to the rural poor (Schouten 2020).

The most valuable resource in every nation is its human capital. However, it is a nation's qualitative strength—not its numerical—that drives it toward development and prosperity. The main driver of every society's socioeconomic or political-cultural transformation is human resource development. One of the most crucial elements of human resource development is training.

According to Srinivas and Sailaja (2013), training improves learners' knowledge of improved agriculture practices. This is due to the fact that knowledge is a cognitive component of an individual's thinking that plays a significant influence in both covert and overt action. Individuals having a better understanding of the technical nature of improved practices would be more likely to adopt them. Inadequate and incorrect understanding leads to under or excess adoption of innovation, which is devastating to the farming industry.

Adisa and Okunade (2005) state that training is an established idea with the therapeutic purpose of forming people's knowledge, skill, and attitude—all of which are important for the effective performance of duties and/or assignments. Raab (1991) also stated that training persons involved in agricultural and community development projects aims to communicate information, knowledge, and skills, as well as to replace old attitudes with new ones, exchange opinions and experiences, and remove uncertainties and challenges.

Beekeepers have been receiving training in various regions of the world in order to equip them with the necessary aptitudes, attitudes, knowledge, and skills to improve their performance and productivity. It is "the use of both formal and informal ways to impart knowledge so that people gain the required talents to deliver," says Drummond (2000). According to Aswathappa (2000), training is the process that equip workers with the skills, abilities, and aptitudes necessary to carry out certain tasks. According to Armstrong (2003), "Training is the formal and systematic transformation of behavior through learning that occurs as a result of education, instruction, development, and planned experience."

Kumar (2018) took up a study of some 196 beekeepers in Bihar IndiaThe goal was to ascertain how beekeepers responded to training. Before and after training, the study's participants were assessed. This was done to observe the effects of training on a single individual and to see whether there were any differences between the behavioral components (i.e., knowledge) of trainees who had undergone scientific beekeeping training and those who had not. He conducted personal interviews by contacting the subjects to gather some personal information about them. He found out at the end of the study that while 129 (65.81%) of the subjects initially had low knowledge level, 52 (26.53%), Low-medium knowledge level, 15 (7.65) high-medium knowledge level and zero (0.00%) with high knowledge level before going into the training. Data taken after the training however showed that substantial change in gain of knowledge was recorded as follows: low knowledge level reduced to zero (0.00%), low-medium knowledge level rose to 36 (18.36%), high-medium knowledge level was attained by a higher number of 133 (67.85%) participants while 27(13.77%) attained high knowledge level which was zero before the training. The researcher had a pre-training knowledge mean of 29.63% which was far lower than the post-training mean value of knowledge of 68.36%. This study underpinned the importance of training for beekeepers.

Kumar (2018) discovered in a study that beekeeper training was important in obtaining information, changing attitudes, and acquiring skills, as the chosen students' average knowledge, attitude, and ability scores all rose after receiving scientific beekeeping training. The training also improved the trainees' socioeconomic situation.

Yusuf *et al.* (2014) found in a study that because of training they had, beekeepers increased the number of hives they had three years after the training. He also found that there was an increase in the number of times the beekeepers made harvest in a year. The number of times harvesting was done in 2007; the year the training took place was zero. However, by 2010, it increased to four times in the year. This shows that the training the beekeepers had, brought about changes in their knowledge, attitudes and skills which would also translate into increased productivity and by extension, income.

While many of researchers quoted above outlined the importance of beekeeping training programmemes in improving the aptitudes, attitudes, knowledge and skills of beekeepers which in effect would result in increased productivity and income, other studies also found out that beekeeping incomes or profitability is unaffected by access to extension services and beekeeping instruction. A number of studies have made note of this, including those from Papua New Guinea (Schouten *et al.* 2020), Tanzania (Wagner *et al.* 2019), Ethiopia (Gebeyehu *et al*. 2010), sub-Saharan Africa (Amulen *et al.* 2017), and Pakistan (Qaiser *et al.* 2013). This is corroborated by Schouten and Caldeira (2021) who found in a study of a number of beekeeping trainers in Fiji, that a number of factors could limit the effectiveness of beekeeping training. These factors among others include theorethical classroom based training instead of outcome based, practical apiary training, few trainers as against large numbers of trainees as well as few beehives for large numbers of participants which does not permit practical skills development, low interest levels of the trainees in beekeeping and methods used to choose trainees, isolation in remote areas, low levels of literacy and language comprehension, and a lack of suitable beekeeping teaching and educational resources are a few more factors.

They claim that Fiji faces similar issues because rural development initiatives have increasingly pushed beekeeping's acceptance as a viable source of revenue for farmers.

Schouten and Caldeira (2021) also discovered that training alone could not lead to higher productivity, but that nine elements were discovered to have a substantial impact on beekeeping achievement in terms of honey production, hive counts, and beekeeping revenue. A few examples include owning the land where apiaries are located, having several apiaries, years of beekeeping experience, protective gear, the ability to perform colony splits, net beekeeping income, investing it back into beekeeping operations, having access to a vehicle or honey collection services, and knowing when and why to supplementary feed bees.

2.7.1 What Others Have Done With Propensity Score Matching

Numerous circumstances have been assessed using propensity score marching. Propensity score marching was used by Biewen *et al.* (2014) to assess public training initiatives including "short-term activation and reemployment" and "complete classroom further training." They assessed the contrast between training and not taking part in any job market programmemes. According to the estimated effects of short-term training, they discovered negative effects shortly after the programmeme's start in the range of -5 percentage points, indicating that participants have a 5 percentage point lower monthly employment rate while enrolled in the programme than they would have if they did not.

In order to assess the findings of an inquiry into the drivers of human capital investment in formal training (short-term off-the-job training), Loan *et al.* (2014) employed the propensity score matching method. They found out that the productivity of household business was positively impacted by training. However, they discovered that neither training activities nor enterprises in the formal sector had any impact on productivity in the near future (one or two years). Dearden *et al.* (2006), found in their study titled "The impact of training on productivity and wages: evidence from British panel data", considerable effects of training on productivity. Despite the above positive findings using the PSM, In their study, Black and Lynch (2001) found no evidence that training had any effect on production.

2.8 SWOT Analysis

SWOT stands for strengths, weaknesses, opportunities, and threats. While the possibilities and threats are part of the external environment, which the entity has no influence over, the strengths and weaknesses are internal aspects of the sector under review. SWOT is a good tool for strategic planning for any entity.

Strengths are features of a corporation or an individual that provide them an advantage over their competitors, according to Gürel & Tat, (2017). Strengths identifies the assets that must be maintained and expanded in order to compete (Sammut-Bonnici & Galea, 2015). They are constructive tangible and intangible characteristics that are inherent to an organization or individual. Organizational advantages or capabilities include things like process capabilities, financial resources, goods, and services, as well as customer goodwill and brand loyalty.

Gürel & Tat (2017) continued by stating that a company's or a person's flaws are characteristics that make them inferior to others. Weaknesses are characteristics that fall short of the standards we think should be met; they restrict an organization's ability to accomplish its primary objective and have an impact on its growth. However, defects can be controlled. They must be limited and ultimately stopped. Examples include a lack of funding, a small product offering, inadequate distribution, higher costs, a negative brand image, poor marketing abilities, insufficient management capabilities, and poorly trained staff.

Opportunities are externally appealing characteristics that demonstrate why a firm is likely to succeed (Bekuma, 2018). Opportunities to produce more money in a more environmentally friendly way are externally appealing components that determine the reason for an organization's existence and development. Such opportunities exist when a business can make use of its surroundings to create and put into action plans that will increase its profitability.

Companies should keep an eye out for chances and seize them when they present themselves. Examples include things like quick market growth, complacent rivals, shifting consumer preferences, the discovery of new uses for products, economic booms, government deregulation, and sales decreases for competing goods.

According to Gürel & Tat (2017) and (Sammut-Bonnici & Galea 2015), threats are environmental factors that are outside of an organization's control and could harm its operations. Threats appear when conditions in the external environment endanger the organization's business's dependability and profitability. Foreign competitors entering the market, the introduction of new replacement products, the fall of the product life cycle, changing customer requirements or tastes, rival enterprises adopting new tactics, more government regulation, and eventually, the economic slump are all examples.

Strengths of beekeeping therefore are such favourable internal environmental conditions that beekeepers could manipulate or exploit. The weaknesses are those unfavourable internal environmental conditions that the beekeepers could work on to improve the business. The opportunities are the favourable external conditions over which the beekeeper has no control while the threats are those unfavourable external situations that the beekeeper again has no control. The first phase of SWOT, according to Ommani (2011), is the external factor evaluation matrix, which entails looking outside the firm at situations that cannot be controlled but may be handled to improve or lessen their impact on the business.

The existence and abundance of honeybee colonies, the socioeconomic value of honey, the availability of potential flowering or melliferous plants, the availability of water resources, market demand for honey bee products, and beekeeper experience (engagement period)were all mentioned by respondents in an Ethiopian study by Shibru *et al.* (2016). The respondents cite inadequate bee colony inspection and management techniques, bee pests, drought and bushfires, colony absconding and migration, poisonous plants in the region, and farmers' use of poisonous agro-chemicals as barriers to or threats to beekeeping in the Abol and Godere Wereda areas.

Bekuma (2018) also in another study identified constrains of beekeeping as improper application of agro chemical inputs by crop farmers, problem with honeybee diseases, pests and predators and also damaged bee forages like herbs and shrubs and high cost of modern hive and equipment. He got the following as opportunities from the respondents- availability of melliferous plants and water, the availability of large bee populations, high demand by consumers and traders for locally produced honey as well as support from government and non-governmental organization. Bekuma

(2018) also reported that according to Central Statistics Agency of Ethiopia, the country's annual production of honey stands at 47.71 million kilograms with the majority being harvested from traditional hives. He however stated that about 86.54% (135) of the beekeepers studied indicated that as a result of wrongfulr application of agro-chemical , bee disease outbreaks that occrs seasonally, and problems with predators, honey yield was decreasing.

Garabedian (2021) in his study titled "Identification of strength and weaknesses, opportunities and threats for the development of beekeeping in Bulgaria" found that because bee farms are tiny, they can respond to market situations more rapidly, demonstrating flexibility in business management, which he recognized as a strength of beekeeping. He also noted the high degree of control over the activity, the high motivation for apiary development, and the combination of the owner, the entrepreneur, and the worker in one person (the beekeeper), which are all strengths of beekeeping. The small size of the apiaries allows for higher degree of control over the activity. He claims that these are the primary determinants of a beekeeper's motivation to grow his business.

Weaknesses identified by him are lack of control over the selling price. Apiaries' primary flaws are a lack of control over the selling price of bee products and high production costs, despite the fact that the farm is relatively small. The small size of the farm is the element that most deters investment in the acquisition of equipment, according to farmers, who believe they are unable to properly plan, control their costs, and be competitive in terms of market prices and low levels of modern mechanization in production (Garabedian, 2021).

Opportunities for beekeeping in Bulgaria were found in the study to include the trend of rising food prices, which is a global trend of steadily rising food and beverage prices (including honey), as well as the creation of local brands of high-quality bee products, which were imposed on the market as a result of unique customs in the production of honey in the various rural areas of the nation. The market is seeing an increase in demand for organic products, and the potential demand in Bulgaria outpaces the supply by a wide margin (Garabedian, 2021).

Threats include variable market prices—high price dynamics for a brief period of time influence the market for bee goods. escalating input costs – in recent years, the cost of fundamental production tools like beehives and honey pressers has skyrocketed. Last but not least, there is the issue of climate change, which places Bulgaria in a region where there is a risk of drought and other natural disasters (Garabedian, 2021).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The methodologies used in the work are covered in this chapter. Additionally, it emphasizes the theoretical foundation, production theory, profit maximization theory, study areas, research design, sampling strategy, and associated data collection and analysis methods.

3.2 Conceptual Framework

The conceptual foundation for this work is depicted in Figure 3.1. Drummond (2000) defined training as the process of transferring knowledge so that individuals can develop the delivery-related skills.

Training of practitioners of beekeeping (mostly farmers by occupation) involves institutions such as nongovernmental organizations (NGOs), the Ohawu Agricultural College and Adidome Farm Institute among others. These institutions offer training in various aspects of beekeeping to enhance practitioners' knowledge and skills in the vocation.

Studies conducted at various times by Dunkan (2004); Adgaba (2007); Nnadi and Akwiwu, (2008); Mujuni *et al.* (2012); Noah & Peter (2013) and Duah *et al.* (2017) all showed that demographic characteristics influence participation in beekeeping trainings by practitioners. While older people of fifty (50) years and above and the married were found to have interest in and undertook training in beekeeping more than the young and unmarried, higher education was found to inhibit participation in the training programmes. Crop farmers were found to be involved in beekeeping training programmes than other professions such as civil servants, carpenters, masons and teachers. According to a study by Tripp and Hiroshimil (2005), training is important because it can help farmers (for that matter, beekeepers) improve their farming (beekeeping) skills. The training of beekeepers (thick line with two-arrows) is very important therefore in enhancing their aptitudes, attitudes, knowledge and skills in beekeeping, which will lead to efficient and effective operations such as keeping to timelines in harvesting of honey, maintenance of good bee populations at the time of flower blooms and colony management among others. These would in turn result in increased productivity and income of the beekeepers. With the increase in productivity and income, beekeepers will be encouraged to seek more knowledge and skills in order to be more efficient and effective. Those beekeepers who do not participate in any formal training (indicated by broken line with two arrows) would lack such skills and knowledge and so may not be able to properly manage their beekeeping business and thus experience low productivity as indicated by the broken line on the diagram. The low productivity will result in low motivation to seek training.

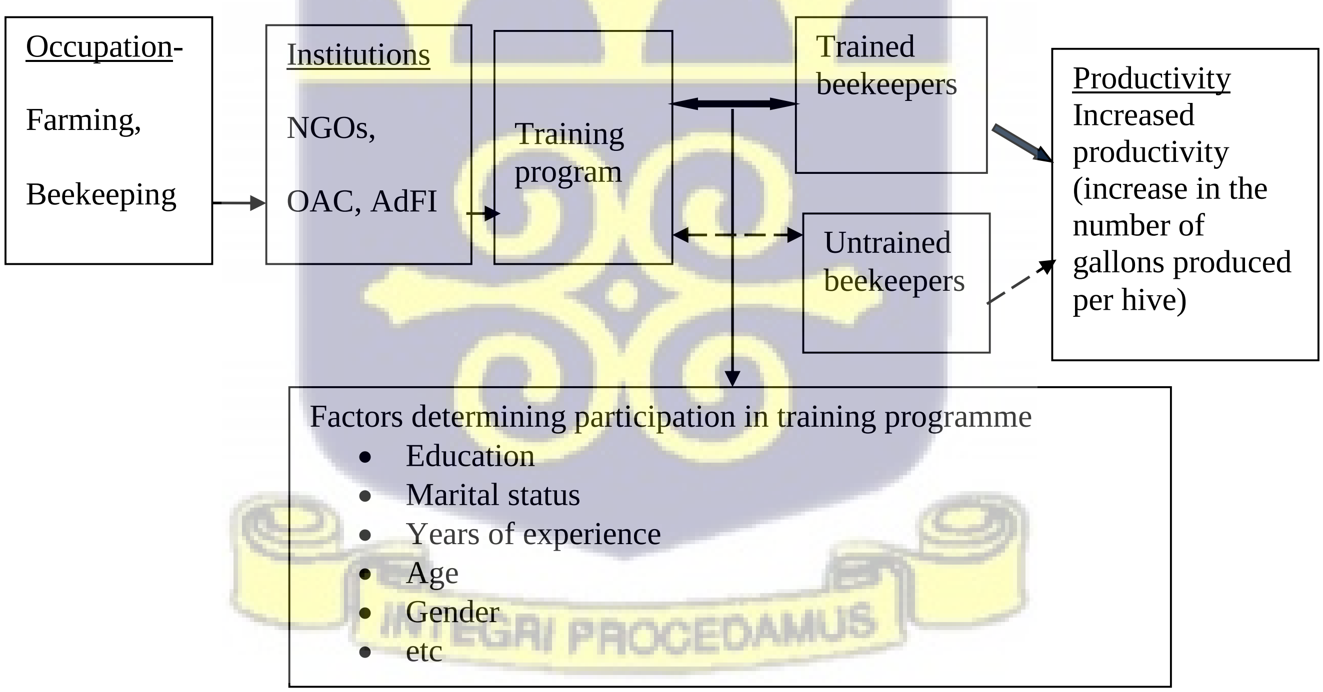

Figure 3.3: Conceptual framework of beekeeping training

Source: Adapted from Nyikplorkpo, (2008).

3.3 Theoretical Framework

Aswathappa (2000) defined training as the process of enhancing an employee's aptitudes, abilities, and talents to enable them to perform specific duties. According to Armstrong (2003), "Training is the formal and systematic transformation of behavior through learning that occurs as a result of education, instruction, development, and planned experience". According to Kher *et al.* (2004), apiculture training is critical for beekeepers to upgrade and update their expertise. Both Kumari (2018) and Singh (2005) reported similar results, concluding that trained beekeepers had a higher level of knowledge than untrained beekeepers. Srinivas and Sailaja (2013) also reported that after a programme of training conducted by Krishi Vigyan Kendra (KVK) which means "farm science center", an increase in knowledge was observed as a result of participants being exposed to the scientific beekeeping training.

3.4 Theory of Production

The notion by which a business must choose how much of each commodity it produces and sells is outlined by production theory in economics. Additionally, it specifies the quantity of manpower, fixed capital, and raw materials it will use. The idea by which a business must choose how much of each commodity it produces and sells is laid out in economics via the concept of production theory. Along with stating how much it will use, it also specifies how much labor, fixed capital, and raw materials it will use. Production is the process of combining numerous inputs to create a consumable result. The act of producing an output in the form of a good or a service that makes people's lives more useful. To put it another way, it is a process for transforming inputs into outputs,. (1995; Kurz & Salvadori).

The production function establishes a technical connection between the firm's physical inputs and physical outputs for a given technological state.

Q = f (a, b, c, d,,,,,,z)

In apiculture or beekeeping the above is represented thus,

The variables a, b, c, d, ….z are the various inputs such as beehives, hive stand, bee suits, bee veil, wellington boot, smoker, hive tool or knife, plastic harvesting containers, packaging containers and honey extracting devices, land and labour among others while Q is the output of hive products (honey, beeswax etc). Most of these inputs could be in use for about ten (10) years and remain constant or fixed if properly handled and so can be classified as fixed inputs while the plastic harvesting and packaging containers could be regarded as variable inputs.

The unit of production is the beehive. Productivity per bee colony (per beehive) in beekeeping is dependent on a number of factors. These include the number of bees present during the nectar flow, the presence of melliferous plants to provide an adequate supply of nectar for them to forage, prompt honey harvesting to prevent bees from consuming honey, and colony management.

3.5 Profit Maximization Theory

A firm's goal is supposed to be to maximize short-run profits in the classic economic model of a firm, which is based on the assumption that the present period is typically taken to be a year. Tripathi (2019) asserts that the standard microeconomics theory assumes that a firm's goal is to maximize present or short-term profits in order to explain how prices and output are determined. This is true for all types of market structures, including monopolies, ideal competition, and monopolistic competition. The firm's current short-run profit maximization model has given decision-makers a beneficial foundation for effective resource management and allocation.

The distinction between total expenditure and total revenue is referred to as profit. The concept of cost employed in managerial economics and economic theory, according to Tripathi (2019), is distinct from the concept of accounting cost used by accountants. The concept of profit utilized in economic theory and that employed in its computation by the accountant are different due to the way costs are conceptualized.

Economic profit is the difference between total revenue and total cost, so π =TR-TC, where TR stands for total revenue, TC for total costs, and π stands for total economic profits. When businesses decide how much output to generate and how much to charge for a product, they aim to maximize economic profits.

According to Tengku (2007), perspective and emergent theories are the two main categories relevant to corporate strategy. The perspective theories include resource-based theories, game-based theories, profit maximization/competition-based theories, and socio-cultural theories of strategy. He added that there are a few other ideas that can be included, such as survival-based theories, theories based on uncertainty, and theories of corporate strategy based on human resources.The agency theory and the contingency theory according to Khairuddin (2005) are two other theories which are relevant to strategic management.

According to Tripathi (2019), a business firm's primary goal under the neo-classical theory of the firm is profit maximization. Profit maximization is attained when the company complies with the two rules: MC=MR and the MC curve cuts the MR curve from below. Maximum profit is the amount of pure profits that is over and above the average cost of production. The sum that is left over after all expenses, including management salaries, have been paid, is what the investor or business owner calls the profit. To put it in another way, it is an additional source of income to regular profits.

Profit maximization of the firm can be expressed as:

Maximize p(Q) where p(Q) = R (Q) – C (Q)

Where p(Q) represenst profit, R (Q) is revenue, C (Q) represents costs, while the units of output sold are represented by Q. A perfectly competitive firm and a monopoly firm are affected byn the two marginal rules and the profit maximization conditions stated above (Tripathi, 2019).

The profit maximization theory is based on a number of assumptions such as:

1. The objective of the firm is to maximize profits where profits are the difference between the firm's revenue and costs.
2. The entrepreneur is the sole owner of the firm.
3. Tastes and habits of consumers are given and constant and
4. Techniques of production are given among others.

With these presumptions, the firm's profit maximization model may be demonstrated under conditions of perfect competition and monopoly (Tripathi, 2019).

According to Tengku (2007) and Tripathi (2019), the firm is just one of many producers under perfect competition. While the company has some control over the market price of the product, it also sets prices and manages quantities. When there is perfect competition, a firm's MR and AR curves coincide, leaving it with little choice but to decide on the products to be sold at the going rate. Because the market sets the price and the firm sells its goods at that price, the MR curve is parallel to the x-axis.

Therefore, the firm is considered to be in equilibrium when MC=MR=AR (Price). This meets the criteria that MC = MR, however point A, where the MC curve dives below the MR curve, is not the point of maximum profitability. When a company can generate greater profits by creating more than the OM, it is not in its best interest to create the OM. When the company's output reaches the

OM_1 level, where it meets both conditions for equilibrium, it will nevertheless stop producing. Any plans to manufacture more than OM_1 would incur losses since, past the equilibrium point B, the marginal cost exceeds the marginal income. As a result, the firm maximizes its earnings at the M_1B price and at the output level OM_1 (Tripathi, 2019).

Because it is the sole seller in a monopoly, the monopoly firm is the industry as a whole. As a result of its customers' tastes and financial situations, the demand curve for its products is downwardly sloping to the right. It can set the price to its greatest advantage because it is a price maker. However, the company cannot, control both output and price. Either of the two things is possible. When a company chooses its output level, the price of the product is defined by the demand for it on the market. The quantity of the product that consumers will buy at that price, however, will determine its output if it decides on the price for its product.

While Marshalllian and Cournot-Nash, two theories of competition between profit-maximizing firms in Neo-classical economics, start from different premises regarding the levels of strategic interaction between firms, they both arrive at the same conclusion—namely, that market prices decline as the number of firms in an industry rises—Keen and Standish (2006).

The management theory of the firm is based on the understanding that when ownership and control are separated, the power of control is transferred from the owners to the managers. As a result of this separation, managers who do not bear liabilities are given authority, which gives rise to the bureaucratic power that has developed as a result of efforts to manage organizational resources (Toveda, 2007).

Managers can decide whether to pursue strategies that maximize their personal utility rather than trying to generate revenues that maximize the utility of owners or shareholders (Williamson, 1985). This managerial behavior is restrained by profit since the financial market and shareholders want a minimum profit to be paid out as dividends in order to protect managers' jobs.

Williamson claimed that managers exercise discretion while formulating and carrying out policies in order to maximize their own utility as opposed to attempting to maximize profit, which ultimately maximizes own utility subject to minimum profit.

The behavioral theory of the firm, as described by Toveda (2007), combines a number of ideas that have arisen in economics, sociology, business, and management. It addresses the questions of how businesses behave in a market space and what influences the inter-firm connections. She asserts that the firm is viewed under the economic theory of the business as a "black box," or a component that converts inputs into outputs. This theory examines what occurs within the organization, how the output occurs as economic activity, and how decisions regarding production, scheduling, and inventory are decided in an effort to counteract this limited viewpoint (Toveda (2007).

The behavioral theory, also referred to as a decision theory, describes the circumstances around operational decisions and the results that add value. Ownership rights, obligations, control over resources, and authority are all factors that have an impact on decisions. Decisions are seen as a sequential process that includes both rational and non-rational parts.

The behavioural theory emphasizes the organizational internal processes and characteristics such as decision-making processes, information processing constraints, power and coalitions, and hierarchical structures (Hoskosson, Hitt & Wan Daphne Yiu, 1999).

The Structure-Conduct-Performance Paradigm (S-C-Pis a method of analysis used to investigate how market structure and seller behavior impact market performance. (Haji, 2014).

In the topic of industrial organization, the relationship between business conduct and market structure has taken center stage (Bin *et al.*, 2018). Emphasis on market structure and corporate behavior is largely influenced by the work of a group of economists in the 1930s. Between the early 1950s and the early 1980s, the SCP paradigm dominated the framework for empirical studies of industrial organization. The 1930s work of Harvard economist Edward Mason is where the SCP first emerged. (Bin *et al.*, 2018).

The market structure is made up of the comparatively stable aspects of the environment that affect the conduct of and competition between buyers and sellers operating in a market. Only a few traders might be able to sustain their business activities profitably, for example, if the market structure is defined by significant entry barriers. (Lelisa & Kuhil, 2018 and Haji, 2014). This could result in the few traders engaging in non competitive behaviour. The non-competitive behaviours can lead to excessive profits and widened marketing margins for traders. Low producer shares for farming households brought on by concentration may have a substantial impact on the income of farmers and their purchasing power, which is reliant on the market as a supplier of food. (Haji, 2014). Some features of market structure include the number of buyers and sellers of food commodities, the number of suppliers of agricultural inputs like fertilizer and veterinary medicines, entry barriers, and the kinds of trade rations (vertical coordination mechanisms) among market participants. (USAID, 2008).

The term "conduct" relates to how businesses operate in a particular situation, and it is typically influenced by an industry's structural traits. Market conduct refers to the behavior patterns that businesses use to adapt or change to the markets in which they operate. Despite the fact that industry conduct cannot be directly and precisely measured, some variables can be utilized to measure different latent variables' features more precisely. Bin *et al.* (2018). Collusion, pricing strategies, research and development, capacity investment, and promotion are some of the variables that are frequently used to measure corporate behavior.

Performance is defined as the output results and their outcomes from processes, goods, and services that allow evaluation and comparison in relation to objectives, benchmarks, prior performance, and other companies. Performance can be described both financially and non-financially. (Baldrige, 2010). In a different vein, market performance can be viewed as an assessment of how much an industry's market behavior diverged from the best contribution it could have made to the accomplishment of some specific economic goals. (Bin *et al*., 2018).

According to the SCP paradigm, there are precise causal links between market structure behavior and performance. In particular, market structure influences behaviour, and behaviour affects performance: structure- conduct- performance (Bin *et al.*, 2018).

When we conduct economic transactions for the purpose of purchasing goods and services, we incur costs known as transaction costs. Transaction costs may include expenses for using the internet and telephone for communication, paying for legal services, buying and maintaining a car, and using public transportation, among other things. Transaction costs are essentially the expenses associated with participating in the market. According to this definition, a transaction cost is a cost imposed when making an economic bargain Haji (2014). For instance, commission is a transaction cost associated with the marketing of coffee that coffee farmers in poor nations pay to brokers when purchasing or selling coffee.

According to Haji (2014), transaction costs may be divided into three categories: search and information costs, which are expenses incurred to find out if the desired good is accessible on the market and who has the best deal, among other things. The second expense is monitoring fees, which are incurred when checking to see if the other party is abiding by the contract's terms and, if necessary, initiating legal action (frequently). The third expense is the cost of the negotiations, which includes the expenses incurred to reach an agreement with the other party to the transaction, design a suitable contract, and so on.

3.6 Research Design

The study adopted a multistage method of sampling to get subjects for the study. This involved the selection of eight (8) districts/municipalities purposively from the Volta and Oti regions. The districts and municipalities selected in the two regions were noted to have beekeeping activities going on there. These are Ho, Ho West, Kpando, Adaklu, Agortime-Ziofe, Central Tongu in the Volta Region and Nkwanta South and Kadjebi districts in the Oti Region. Ho Municipality, Ho West, Kadjebi and Nkwanta South districts were deliberately chosen as they had a lot of trained beekeepers while Agortime-Ziope, Kpando, Central Tongu and Adaklu districts were selected for having untrained beekeepers. After the districts were selected, a snowballing method was used to select nine (9) communities where the beekeepers are located. These are Shia, and Dzolo-Gborgame in the Volta region and Nkwanta, Kuru and Dodo-Tamale in the Oti region where beekeepers had training. For those who did not receive any training, Kpando-Dafor, Helekpe, Ziofe, Mafi Adanu in the Volta region were selected. Within the communities, purposive sampling was again adopted to select the individual beekeepers who participated in the study. In all ninety-eight trained and one hundred and twelve untrained beekeepers were enrolled onto the study.

The approaches used to gather data for the study included a structured questionnaire, interviews, field observations, and focus group discussions (FGD).

The focus group was made up of seven members drawn from NGOs engaged in beekeeping activities, the regional umbrella body of beekeepers, leaders of some local beekeeping associations and an environmental journalist also involved in beekeeping activities.

Assisted by some Regional Executive members of the Volta Region Association of Beekeepers (VORAB), I undertook trips to the various communities to meet with the beekeepers and to administer the questionnaire and visiting some of the apiaries (beekeeping sites) to familiarize myself with what they were doing and make observations. Some of these executives were also part of the Focus Group Discussion.

3.7 Data Analysis

The empirical data that were acquired from the distributed survey questionnaires were analyzed using STATA software (version 15). Descriptive statistic was used to identify the basic characteristics of the data. This took in the form of mean and standard deviation. Moreover, a correlation matrix was used to examine intercorrelation between and among the variables. Two statistical techniques were used to analyze the quantitative data: binary logistics regression and Propensity Score Matching (PSM). Objective 1 was analyzed using binary logistics regression whereas objective 2 was analyzed with the aid of PSM. However, with regard to the qualitative data (objective 3), the Radar Chart in Excel was used to assess the data while the SWOT analysis was utilized to develop themes from the responses to the strengths, weaknesses, opportunities, and threats of beekeeping within the research locations.

3.8 Estimating Techniques

3.8.1 Binary Logistics Regression

There are two types of logistics regressions: multinomial and binary logistics regressions. One advantage of using logistics regression is that the data must not necessarily meet the assumptions of normality, linearity, and homoscedasticity (Lindley 1968). A variation of binary logistic regression known as multinomial regression calls for more than two categories or answers for the dependent or outcome variable. (Goeman & le Cessie 2006), and this condition makes it not suitable for this study. Therefore, binary logistics was used.

Binary logistics regression is flexible and lends itself to easy interpretation (Gujarati 1970). In a binary logistics regression model, the response or dependent variable is binary or dichotomous with two responses (Horowitz & Savin 2001). In this regard, binary logistics regression is used when there is dichotomous or binary outcome variable and several independent variables either categorical or dichotomous (Hosseinian & Morgenthaler 2011). The outcome variable usually has two responses: 1 = YES and 0 = NO with 1=YES serving as the reference variable.

The logistics regression uses maximum likelihood ratio to calculate the odd ratios (Hosseinian & Morgenthaler 2011). In this study, “participation in beekeeping training” was used as the outcome variable and serves as a dichotomous dependent variable coded with the reference category 1 = “participation in beekeeping training” and 0 = “no participation in beekeeping training”. Moreover, the use of marginal effects in logistics regression can examine the extent to which the average predicted probability of a binary outcome changes with a change in independent variables (Norton *et al.*, 2019). Therefore, marginal effects are often reported in logistic regression to show and quantify the incremental impact on the outcome variable with respect to each of the predictor factors.

Additionally, eight (8) independent variables (both categorical and continuous) were used with a set of dummies. Following the recommendation by Gujarati (1998), it is possible to define the logistic probability function of the association between a dichotomous outcome variable and a number of independent variables as:

The binary logistic regression can be expressed as:

$$p_1=E(Y=^1/_{X1})=1//(1+e^{-(\beta 0+\beta 1}X_1) \quad (1)$$

This can further be expressed as:

$$p_1=1/(1+e^z)=e^z/(1+e^z) \quad (2)$$

Where p_1 is the probability of 'participation in beekeeping training', $X_{1's}$ are the explanatory or independent variables, the standard irrational number of e is e^z, $(1 + P_1)$ is the probability of "no participation in beekeeping training", and $\beta_{0+\beta_1}$ are the logit parameters to be estimated or slopes of the equation.

$$1-P_1=1/(1+e^z) \quad (3)$$

Hence, the expression $P_1/(1-p_1)$ is the odd ratio which can further be expressed as:

$$P_1/1-P_1=[(e^z/1+e^z)/1+e^z)] \quad (4)$$

Applying the natural log on the equation (4) yields:

$$L_1 = Ln (P_1/1-P_1) = Z_1 = \beta_0 + \beta_1 X_1 \quad (5)$$

Where L_1 denotes the natural log of the odd ratio which is both linear in x and in parameters. Finally, we can obtain the theoretical logit model by adding the error term as follows:

$$Z_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots \beta_n X_7 + U_1 \quad (6)$$

where, Z_1 is the dependent variable (participation in beekeeping training or non participation), X_1 ...X_k denote the predictor variables (gender, age, marital status, educational background, full-time participation in beekeeping, years of experience, and association one belongs to), $\beta_{0 \ldots}$ β_n are the parameters to be estimated, and U_1 is the error term.

Table 3.1: Explanatory Variables for Binary Logit Regression and a Priori Expectation

Variable	Description	Measurement	A priori Expectation
Gender	Gender of beekeeper	Dummy 1=Male 0=Female	+/-
Age	Age of beekeeper	Years	+
Training	Whether a respondent took part in beekeeping training	Dummy 1= participation in beekeeping trg. 0 = No participation in beekeeping training.	+/−
Household members in beekeeping	Number of members in beekeeping	Continuous	+
Education	Level of education attained by beekeeper	Years	+
Experience	Number of years of beekeeping experience	Years	+
Members of Association	Whether a respondent belongs to an association or not	Dummy 1= yes 0= No	+
Productivity	Total harvest (quantity of honey harvested in gallons/number of hives)	Continuous	+/-

Source: Author's own construction based on an extensive literature review

3.8.2 Propensity Score Matching

3.8.2.1 What Propensity Score Matching Does

The propensity score is the likelihood that a treatment will be assigned subject to baseline characteristics, according to Austin (2011) and Granger *et al.* (2020). Propensity scores are an alternative method for assessing the effects of receiving treatment when random assignment of treatments to treatments is impractical. Propensity score marching is the process of pairing treatment and control units with comparable propensity score values after eliminating all unpaired units and maybe adding other factors (Rubin, 2001). Although it can be applied to studies of more than two groups, its main usage is to compare two groups of topics.

According to Austin (2011), one can plan and carry out an observational (nonrandomized) study that imitates some of the distinctive characteristics of a randomized controlled trial using propensity score. Specifically, the propensity score is a balancing score because, subject to the propensity score, the distribution of observed baseline covariates across participants who received treatment and those who did not will be comparable.

The conditional probability of being assigned to a treatment group given a vector of observable covariates is how Hullsiek and Louis (2002) defined PSM.

3.8.2.2 The Importance of Propensity Score Matching

Propensity score matching, according to Rosembaum and Rubin (1983) demonstrate how covariance correction on propensity scores, pair matching, and subclassification all contribute to an accurate calculation of the treatment impact. Granger *et al.* (2020) claim that propensity scores are useful for situations with unusual binary outcomes because accounting for the propensity score alone is sufficient to enhance balance on the measured covariates. In situations when the relationship between covariates and treatments is better understood than the relationship between covariates and outcome, they are also useful since treatment is modeled rather than result. According to Granger *et al.* (2020), areas of non-overlap in the covariate distributions that are typically ignored when using conventional regression approaches can be found by comparing the propensity score distributions of the treatment groups.

3.8.2.3 Marching Techniques

There are a number of matching techniques used in PSM, among them are nearest neighbor matching, radius matching, kernel matching and stratification matching. (Thavaneswaran & Lix (2008).

Nearest Neighbor Matching Method

The predicted propensity scores for the control and treatment groups' absolute differences are as close to one another as possible using the nearest neighbor matching method. Ordering of the control and treatment subjects is random. The following step is to pick a control subject whose propensity score is most comparable to that of the first treated subject.

Where: $$C(P_i) = \min_j |P_i - P_j|$$

C (P_i) represents the group of control subjects j marched to treated subjects I (on the estimated propensity score)

P_i is the estimated propensity score for the treated subjects i

P_j is the estimated propensity score for the control subjects j

Radius Matching Method

The radius matching method pairs each treated subject with a corresponding control subject that is within a predetermined range of the propensity score of the treatment subject. Only a set number of comparisons will be possible because each treatment participant must be marched with a control subject at a specific interval.

The Kernel Matching Method

Every treated subject is marched with the weighted average of the control subjects in the kernel matching approach. The weights are inversely related to the difference in propensity scores between the treatment and control groups.

Stratification Matching Methods

Interval classification based on the propensity scores' range of values is used in stratification matching algorithms. Participants in the treatment and controls are split up into intervals that, on average, have equal propensity ratings. The discrepancies between the treatment group's findings and those of the control group are calculated to establish the average treatment effect. Based on the number of individuals who received the therapy in each block, it is a weighted average of the findings for that block. Cochran (1968) asserts that stratification into quintiles or the use of five strata will eliminate more than 90-95% of the covariate bias.

The PSM employs an experimental methodology in which one group is treated, while a second group is left untreated (Caliendo & Kopeinig 2008). By taking into consideration the factors that determine whether a person will receive a treatment, policy (in this example, beekeeping training), or other intervention, the PSM aims to assess the effect of such a measure (Rosenbaum & Rubin 1983). To run the PSM model, some steps must be followed as recommended in the literature. First, the propensity scores must be calculated. Secondly, the matching logarithm must be decided on to determine the region of common support. The evaluation and computation of treatment effects and associated standard errors will be the third and last step. By regressing the covariates on the treatment variable in a Probit or logistic model, the propensity score may be calculated. Therefore, the propensity scores of the respondents were estimated by using training (treatment) as the dependent variable and gender, age, marital status, educational level, and years of experience as covariates or independent variables. Probit regression was used to estimate the model to get propensity score. This means that the respondents share similar characteristics apart from the training. After the Probit regression model was estimated to determine the propensity scores, five blocks were selected. The blocks ensure that the mean propensity score is not different for treated and controls in each block.

To estimate the PSM model, the propensity scores variable would have to be created first and then match with the respondents based on their respective propensity scores. The propensity score is the probability that someone has received the treatment or has taken part in the beekeeping training programmemes. By comparing the characteristics of respondents within the treatment (with training) and control groups (without training) that have similar propensity scores, the effect of the treatment on the outcome variable can then be ascertained. Pan and Bai (2015) provide four steps to estimating PSM; 1) estimate propensity score; 2) matching, 3) evaluate quality of the matching, and 4) evaluate outcomes.

One important component of PSM is the balancing of covariates between the treated and the untreated groups. It should be noted, however, that a critical component of the PSM is the balancing of the covariates between those who received the training programmemes and those without the training programmemes.

The average treatment impact on the treated (ATT) and the average treatment effect are the two approaches for measuring PSM (ATE). Consequently, the ATE is the treatment effect on the population, as opposed to the ATE, which is the average of the individual treatments (those who received the therapy). It is significant to note that ATT and ATE cannot be calculated when the variables between the two groups are not balanced (Rosenbaum & Rubin 1983).

There are four main balancing methods in the PSM: 1) Nearness neighbor matching; 2) Radius matching; 3) Kernel matching; and 4) stratification matching. The conditional likelihood of the effect of training on beekeepers' output and revenue is what is meant by the propensity score, or propensity score p (Z). It is denoted mathematically as:

$$P(Zi) = Pr[(Li= IZi)] = E(LiIZi) = F\{h(Zi)\}$$

Where: Li = (0, 1) is the indicator of the impact of training and Zi denotes a vector of pre-training characteristics, and F{.} can be a normal or logistic cumulative distribution.

Formula for determining productivity:

Total quantity of honey harvested = $\frac{TQHH}{TNBH} = P$

Where TQHH is Total quantity of honey harvested and

TNBH is Total number of beehives harvested, whilst

P = Honey in gallons /hive

3.8.3 SWOT Analysis

The third objective was to examine the industry's SWOT analysis, which identifies its opportunities, threats, and strengths. Utilizing a qualitative approach, the pros, cons, opportunities, and threats of beekeeping are discussed. Strengths, Weaknesses, Opportunities, and Threats, or SWOT, analysis, is a systematic planning technique that assesses those four components of a project or business endeavour. A SWOT analysis can be performed on a business, product, location, sector, or individual.

A SWOT analysis is used to evaluate an organization's internal strengths and weaknesses as well as external opportunities and threats. By using a functional approach, one can identify resources, capabilities, core competencies, and competitive advantages in the areas of finance, management, infrastructure, procurement, production, distribution, marketing, reputational considerations, and innovation. For the purpose of finding sources of competitive advantage, internal analysis is crucial. (Sammut-Bonnici & Galea 2015). In other words, beekeeping's strengths are traits that give it an edge over other businesses or sectors, while its weaknesses are features that put it at a disadvantage in comparison to others. Furthermore, beekeeping opportunities are those factors in the environment that beekeepers may employ to their benefit, and beekeeping risks are those elements in the environment that can cause problems for beekeepers.

In another vein, Ommani (2011) states that "population growth is the major reason for increased food demands and it puts additional pressure on the natural resource. Countries with rapid population growth face especially difficult challenges in ensuring food security. As such, SWOT analysis is used to identify strategies for agricultural development, especially in farming systems ans for that matter beekeeping, and they help the researchers or planners to manage and prioritize them for achieving food security."

The SWOT analysis of beekeeping was investigated therefore to provide beekeepers, future researchers and planners information necessary to manage and prioritize them for the sector's development. It was arrived at using focus group discussion. A seven member group was constituted made up of representatives of NGOs engaged in beekeeping activities, the regional umbrella body of beekeepers, leaders of some local beekeeping associations and an environmental journalist also involved in beekeeping activities (see appendix 2). This group met on the 2nd day of September, 2021 at the offices of the Greenglobe, Ghana office in Ho to have the focus group discussion of the strengths, weaknesses, opportunities and threats of the beekeeping industry in the Volta and Oti regions of Ghana. After brainstorming and coming out with the SWOT of beekeeping in the Volta and Oti regions as a whole, the team went on to suggest what in their opinion could be done to develop beekeeping in these regions.

SWOT was analyzed using an Excel Radar Chart. A built-in type of chart in Excel is the Radar Chart, often known as Polar Charts, Spider Charts, Spider Web Charts, or Star Charts. Radar charts, sometimes known as spider charts, have one axis for each category, all of which utilize the same scaleThe axes of a radar chart radiate from the center of the chart, and data points are plotted on each axis using a similar scale. This results in a geometric shape that quickly summarizes performance across all areas. Radar charts can be used to visualize the performance of individuals, teams, products, and companies across a variety of categories. They can be used in performance appraisals and customer satisfaction surveys. The advantages of this analytical tool include a concise display, the ability to highlight strength or weakness at a look, and the ability to handle multiple data series. Its negatives include the possibility of audience confusion due to the uncommon chart form, as well as the fact that it is more difficult to read for most individuals. (Murray, 2019; Ireson, Hixon, & Tippie, 2021).

The Spider Web Chart, also known as the Radar Chart, is used to compare two or more goods or groups on numerous attributes or characteristics. The qualities or factors to be compared are usually somewhat distinct from one another. Frequently, the scores assigned to each component are scaled from 0 to 10, with higher scores indicating greater performance or lower risk on the factor in question. From a central zero hub, scores on each factor or feature extend outwards on spokes. The "radar image" or "spider web" pattern is formed by connecting the scores for each group's factors (SWOT). Because the patterns for each group frequently overlap, translucent shading of the group patterns and group sorting of the scores will be required to aid in the visual display of the group "webs" or "radar sweeps." Excel Radar Charts are used to display a twodimensional multi-variate comparison. It's a graphical representation of data that can be used to condense a large amount of data into a single image. It's also known as a spider or star chart. Each spike in the graph represents a data point, and the length of the spike denotes the data point's magnitude. Plot Area, Chart Title, and Legend are the three primary elements of a Radar Chart (Ireson, Hixon, & Tippie, 2021).

3.9 Data Sources and Measurement of Variables

In order to acquire the data for this study, both primary and secondary sources were used. Additionally, techniques for gathering both quantitative and qualitative data were used. The quantitative data was collected using a survey method. Questionnaires were sent to the field and administered by the researcher with support from some research assistants who were trained by the researcher. The questionnaire contained questions that covered the research questions of the study; including socio-demographic characteristics, training received in beekeeping, training in quality, value addition and sale of honey and beeswax, influence of training on farmers' production, and of beekeepers.

3.10 Study Area

As shown in Figure 3.2, the study was carried out in the Volta and Oti regions of Ghana. Ho serves as the capital of the Volta Region, one of Ghana's sixteen (16) administrative regions. There are seventeen (17) Districts and Municipal Assemblies in it. It is located to the east of Lake Volta and west of the Republic of Togo. The region is made up of the Oti Region to the north, the Gulf of Guinea to the south, the Eastern Region to the west, and the Republic of Togo to the east. It is situated between the latitudes of 60 15'N and 80 45'N and the longitudes of 00 15'W and 10 15'E.

Ho, the regional capital, is located about 175 kilometers to the northeast of Accra, the Ghanaian capital.

The Oti Region is one of Ghana's sixteen (16) regions. The 10 regions of the nation include six that have just been established. A Constitutional Instrument (C.I.) that was passed on February 15th, 2019, divided the northern half of the Volta Region into a new region with Dambai as its capital. There are eight (8) Municipal and District Assemblies in Oti (MDAs). The Northern Region is to the north of the Oti Region; Togo is to the east; the Volta Region is to the south; the Bono East Region is to the west; and the Savannah Region is to the north-west.

The Volta and Oti regions, which span around 500 kilometers from south to north, are covered with deciduous forest, woodland savannah, savannah grassland, coastal strand mangrove swamps, and woodland savannah. The terrain is low-lying, with the highest point, Mount Afadza, rising 855 meters above sea level, which is less than 15 meters above sea level near the coast. More than half of the area is covered by the Volta River Basin, and the Volta Lake drains a sizable portion of the two regions. There is also the world's largest constructed lake, as well as the rivers Dayi, Oti, and Daka, as well as other seasonal streams such as Aka, Agali, and Kplikpa.

The region experiences a tropical environment for the majority of the year, with temperatures ranging from 12°C to 32°C. There are two distinct rainfall regimes throughout the year, one from March to July and the other from August to October, according to the bi-modal rainfall pattern. The Sahel-savannah region in the north receives the least rainfall, compared to the region's highlands and forest zone. Between 513.9 and 1099.88 millimeters of rain fall each year.

Forest reserve/watersheds (732.30 sq km), Volta Lake and water bodies (3360.00 sq km), and Lagoon Areas are the three primary land use types in the area (330.00 sq.km). There are 1250.00 square kilometers of tree crops, 1870.00 square kilometers of arable crops, 350.00 square kilometers of partially mechanized commercial farms, and 15.00 square kilometers of rice and vegetable irrigation on cultivated fields.

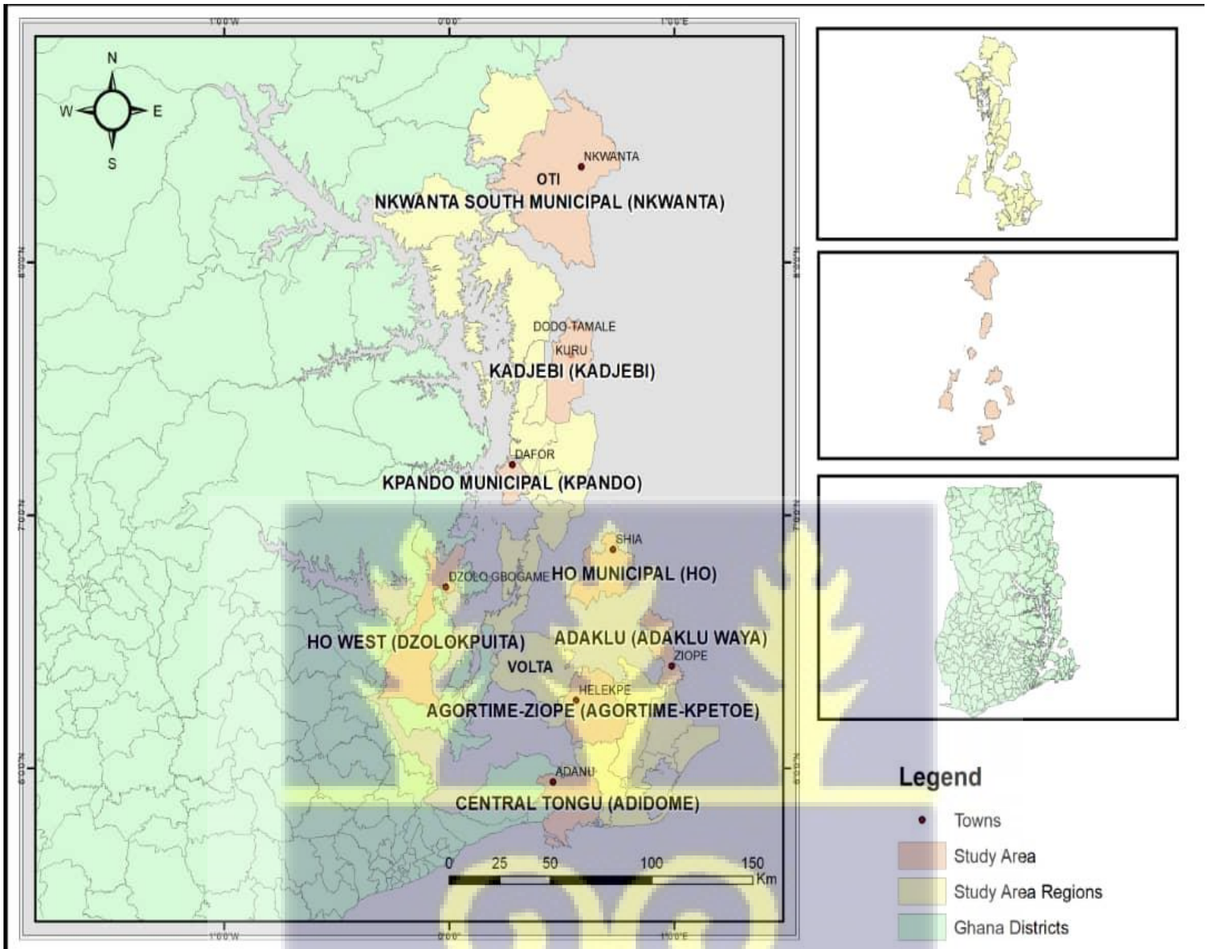

Figure 3.4: Map showing the study area in the Volta and Oti regions
Source: Geography Department of the University of Ghana

3.11 Study Population

The study population for this study is people involved in beekeeping in Volta and Oti regions. According to the Volta Region Association of Beekeepers (VORAB), the two regions (Volta and Oti) have an estimated number of 1,500 beekeepers in 2014, made up of 100 females and 1,400 males). Since there is no single data base of beekeepers, the list of beekeepers was obtained from various sources and contacted/included in the study. The reference period was only considered based on difficulty of getting organizations beyond 20 years period since the knowledge about beekeeping training was clear that it involved some local project based NGOs which might no longer exist after the end of their projects.

According to Taherdoost (2016), sampling for research can be done by either using formulae to calculate or using A Sample Size Table. Gill *et al.(*2010), indicated that for a population of 1500, the sample size based on a confidence level of 95% and a margin of error of 5% would be 306. This was adopted for the study. However, a lot of the beekeepers targeted did not agree to participate in the study and so, the final number of respondents came to 210 beekeepers for the study.

3.11.1 Sampling Techniques and Sample Size

Primary data were used for the study. As regards the qualitative data, an interview guide was developed with open-ended questions. More so, one focus group (with seven (7) members) was constituted made up of representatives of NGOs engaged in beekeeping activities, the regional umbrella body of beekeepers, leaders of some local beekeeping associations and an environmental journalist also involved in beekeeping activities. Therefore, focus group discussion (FGDs) was the main instrument of data collection for objective three. The study employed a multi-stage sampling technique.

According to Ackoff (1953) and Taherdoost, H. (2016), multi-stage sampling is the process of shifting from a large to a narrow sample in a step-by-step manner. In the first stage, eight districts/municipalities were purposively selected from the Volta and Oti regions. These are districts where a number of beekeepers are known to exist. These are Ho, Ho West, Kpando, Adaklu, Agortime-Ziofe, Central Tongu in the Volta Region and Nkwanta South and Kadjebi districts in the Oti Region. Ho Municipality, Ho West, Kadjebi and Nkwanta South districts were purposively selected because they had a lot of trained beekeepers while Agortime-Ziope, Kpando, Central Tongu and Adaklu districts were selected for having untrained beekeepers.

This was followed by the second stage where Snowball was used in selecting 9 communities – Shia, Dzolo-Gborgame, in the Volta Region and Nkwanta, Kuru and Dodo-Tamale in the Oti Region where beekeepers in these communities had training from SNV, FORUM, BUSAC Fund and the EP Church farms at one time or the other. Kpando-Dafor, Helekpe, Ziofe and Mafi-Adanu in the Volta Region were also selected because the beekeepers there were reported not to have received any training in beekeeping. The snowballing enabled the researcher to locate beekeepers that were trained in various aspects of beekeeping and those who were not trained. Two hundred and ten (210) beekeepers that were willing to take part in the study were then purposely selected. With an estimated population of 1500 beekeepers in the two regions, the sample size was determined using sample size determination table of Gill *et al.(*2010). According to this table, the sample size for a population of 1500 at a confidence level of 95% and a margin of error of 5% will be 306 and this was adopted for use. However, going into the study, only 210 beekeepers in the study area were willing and actually participated in the study.

Table 3.2: Sample Size Selection

District/Municipality	Community	No. of beekeepers
	Trained Beekeepers	
Ho Municipality	Shia	10
Ho West	Dzolo-Gborgame	12
Kadjebi	Kuru	13
Kadjebi	Dodo-Tamale	15
Nkwanta South	Nkwanta	48
Sub total	-	98
	Untrained Beekeepers	
Central Tongu	Mafi-Adanu	20
Agortime-ziope	Ziope	10
Adaklu	Helekpe	52
Kpando	Dafor	30
Sub total	-	112
Grand Total		210

Source: Field data (2021)

The Table 3.2 above shows the sample population that was used for the study. The trained beekeepers are those beekeepers who had some formal training organized by NGOs and are regarded as the treatment while untrained beekeepers are those who, although might have received education from other practicing beekeepers to ply their trade, did not receive any formal training and are regarded as the control of the study.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

In this chapter, the descriptive statisctics of the raw data is presented. It captures the mean,standard deviation, and the minimum as well as the maximum. Moreover, the empirical findings and discussions are presented in accordance with the objectives of the study: 1) analyze the factors influencing participation in beekeeping training programmemes; 2) evaluate the impact of the training programmemes on productivity, and examine the 3) the beekeeping industry's advantages, disadvantages, possibilities, and threats.

4.2 Descriptive Statistics

The descriptive findings are presented in Table 4.1 below.

Table 4.1: Descriptive Statistics

	Trained		Untrained		Pooled	
Variables	Mean	Dev.	Mean	Dev.	Mean	Dev.
Gender	0.72	0.45	0.8	0.40	0.73	0.44
Age	51.32	14.97	42.1	17.25	49.97	15.62
Marital status	0.75	0.43	0.83	0.38	0.76	0.42
Education	0.71	0.46	0.63	0.56	0.69	0.47
Full-time Participation	0.51	0.50	0.53	0.51	0.51	0.50
Household members in beekeeping	2.58	2.51	1.59	0.98	2.43	2.37
Years of experience	12.54	10.67	7.87	8.33	11.84	10.47
Member of Association	0.82	0.38	0.63	0.49	0.79	0.40
Productivity	227.46	652.50	64.8	85.35	894.68	1136.02

Source: Field data, 2021

In this Table 4.1 above is found descriptive statistics showing means for the trained and untrained beekeepers as well as the means of the two combined.

"Gender" for the trained respondents has a mean of 0.72 and a deviation of 0.45 while the mean for the untrained respondents recorded 0.8 and a deviation of 0.40 with the pooled recording 0.73 mean and 0.44 deviation. This means that there were more males who had training in beekeeping than females in the study. Bees are feared by a lot of people especially women while beekeeping activities are normally carried out in the evenings or night. Because of this, a lot of women are not involved. This confirms the findings of Mujuni *et al.* (2012) and Yusif *et al.* (2014) who recorded 93% and 95% beekeepers being males respectively. Again, a study by Claire *et al.* (2005) indicated that beekeeping has historically been a male-dominated profession due to a combination of cultural, societal, and practical issues that restrict women's participation. However, Lalika (2008) discovered that beekeeping activities encompassed both sexes at various phases of the production and sale of honey and beeswax (the value chain). Women are involved in taking the harvests home, the extraction, packaging, and marketing of the products. Men are often in charge of honey harvesting, which is typically done at night. According to Jeil *et al.* (2019), women have greater equipment challenges, which contributes to the low number of women who work in beekeeping.

The mean "age" of the trained respondents is 51.32, the standard deviation of 14.97 with the mean for the untrained been 42.1 and 17.25 respectively while the mean for the pooled is 49.97 and deviation 15.62. This is consistent with research by Mujuni *et al.* (2012), who discovered that half of participants were over 50 years old. Many people, especially the youth fear bees because of their propensity to sting. According to Borst (2018), many people shy away from beekeeping because of the fear of being stung. Also, the youth are not interested in farming related business such as beekeeping, Kodom *et al.* (2022). This therefore results in mostly the aged being involved in beekeeping as identified by the study. Contrary to this however, Islam *et.al.* (2015) found in their study that young people are mainly associated with beekeeping.

The "marital status" for the trained has a dispersion of 0.75 and a standard deviation of 0.43 and for the untrained the mean was 0.83 and deviation 0.38 while the mean for both is 0.76 and a deviation 0.42. This is in line with Duah *et al.* (2017) who had forty-eight out of fifty respondents in their study being married. Beekeeping involves a lot of drudgery- harvesting the honey and other products, extracting, packaging and finally marketing (the value chain). It therefore requires much labour. The married could get their spouses to assist them carry out these activities with much ease than the unmarried and hence the number of married in the business.

The "educational level" of the trained has the mean of 0.086 and the deviation of 0.46. For the untrained, the mean is 0.63 and a deviation of 0.56 with the mean for the pooled being 0.69 and a deviation of 0.47. This is in accord with the work of Gemeda (2014). The various means signals that few educated people tend to engage in beekeeping. According to Khalida *et. al.* (2015), most educated groups permanently and continuously seek to get the best information and from multiple sources. For this reason, they went on, continuing education to higher levels reduces the need for training. Many educated youth migrate into the cities to seek "white -colour jobs" instead of getting onto the land and into agriculture. This has led to the low number of the educated found by the study in beekeeping. This finding is also supported by Islam, *et.al.*(2015) who in a research, found that most people who are into beekeeping have low education.

The 'full-time participation in beekeeping" recorded the dispersion of 0.51 and the standard deviation of 0.50 for the trained and 0.53 mean and 0.51 deviation for the untrained with a mean of 0.51 and deviation of 0.50 for the pooled. This is consistent with the work by Gemeda (2014) who observed that active or engaging in Apiculture farming as a full-time business has the prospect for growth of the industry than the part-time. The full-time practitioner, is more likely to see his life dependent on beekeeping and so would strive to improve upon its performance in terms of productivity by participating in training..

With respect to the 'number of people in the respondent's household involved in beekeeping" the mean of 2.58 was recorded and the deviation of 2.51 for the trained. For the untrained, the mean is 1.59 and a deviation of 0.98 while the mean and deviation for the pooled are 2.43 and 2.37 respectively. The finding show that as more people in a household are engaged in beekeeping, productivity increased. This confirms the study by Fikru *et al*. (2015) who found that sometimes more people from a household engage in beekeeping.

The trained respondents' "years of experience" in beekeeping recorded the mean of 12.54 and the deviation of 10.67. The untrained has a mean of 7.87 and a deviation of 8.33 with the pooled having a mean of 11.84 and a deviation of 10.47. This finding likely explains the fact that performance improves with experience which is enhanced by formal training, and this has a significant effect on beekeeping performance. A beekeeper tends to get more familiar with operating methods, processing, marketing techniques, and coping with livelihood strategies during times of bad harvests as time goes on when formally trained (Kumwenda, 2016). This is further supported by Rahman (2016) who postulated that experience helps an individual tothink in a better way and make a erson more matured to take right decision.

The "association one belongs to" has the mean of 0.82 and the deviation of 0.38 for the trained with the untrained recording a means of 0.63 and deviation of 0.49 while the mean and deviation for the pooled is 0.79 and 0.40 respectively. This shows that belonging to a beekeeping association resulted in greater participation in the beekeeping training programmes than non-membership of a an association. Participating in a beekeepers organization could result in peer-to-peer knowledge sharing that develops inclusive environmental management strategies, encourages the application of best practices, and enhances the social capital and food security of honey producers (Manson *et al*. 2016 & Sumane *et al.* 2018). According to Hassenien and Kloppenburg (1995), disseminating knowledge through social interactions promotes the adoption of sustainable practices by fostering credibility, trust, and empathy.

Pooling the trained and the untrained together, a mean productivity of 894.68 gallons of honey with a deviation of 2236.02 was recorded. The trained had a mean of 999.24 gallons of honey and a deviation of 2386.43 in a year while the untrained had 267.33 and a deviation of 636.92. This means the group with training has a higher outcome variable than the one without training. Productivity is a measure of yield per unit of production. From the result, it can be asserted that training, has impacted increased productivity. This is in line with Ishmaeel *et al.* (2019) who also found in a study that training have a positive effect on productivity of beekeepers by enhancing their production level. In beekeeping, the unit of production could be a colony (beehive), a population of honey bees or a hectare of forage (Lowore & Bradbear, (2013b). Increased sustainable apiculture or beekeeping productivity contributes directly to food security through enhanced availability, access and utilization of safe nutritious food and indirectly through additional income to the beekeeper (FAO, 2019). From the discussion, it will be noted that training of beekeepers realized increased productivity which will contribute to improving the livelihoods of practitioners.

4.3 Comparison of Means of Productivity (t-test)

Moreover, a t-test (two sample) was conducted to ascertain whether there is a significant difference between trained and untrained groups in terms of productivity.

Table 4.2: Comparison of means of Productivity (t-test)

Group	Obs	Mean	Std Dev.	t-stat
Trained	98	0.704	0.459	-7.356
Untrained	112	0.250	0.435	
Combined	210	0.462	0.499	
Difference		-0.454	0.062	

Source: Author's Computation

NB: H_0: diff = 0 H_a : diff < 0 H_a: diff = 0 H_a: diff > 0

The results from Table 4.2 suggests that there is a significant difference between the means of productivity of the two groups of respondents. Thus, the mean productivity of the respondents who received beekeeping training (trained) is 0,704 which is greater than the mean productivity of 0.250 which is recorded by the respondents who did not receive beekeeping training (untrained). The result shows that training resulted in higher yields of honey as a result of the beekeepers acquiring new skills , attitudes and knowledge while those who did not receive training had a lower productivity and hence the smaller mean. The null hypothesis, which claimed there was no difference between the two sets of respondents, was thus disproved. According to Adisa and Okunade (2005), training is a tried-and-true concept with the therapeutic benefit of shaping people's knowledge, skills, and attitudes that are necessary for successfully carrying out of tasks and/or responsibilities. Raab (1991) asserts that the purpose of agricultural and community development programmeme participants' training is to impart information, knowledge, and skills while fostering new attitudes, sharing ideas, and removing uncertainties and barriers. For this reason, the beekeepers who received training had the higher mean of productivity because of their knowledge, skills, abilities and attitudes moulded such that some old perceptions, uncertainties and obstacles to production were eradicated giving way to higher productivity. The untrained however had the low mean productivity because of not having the opportunity for change in attitudes, skills and knowledge which could have brought about the neded increase in productivity. Khalida *et. al.* (2015), in their research found that the relationship between productivity and beekeepers was not significant. They attributed this to the fact that beekeepers need to use modern methods of production and thus concluded that the lower the productivity is the more training needed by beekeepers. Therefore, the study argues that training in beekeeping drives the difference in productivity levels between the trained and untrained groups.

4.4 Factors Influencing Participation in the Beekeeping Training Programmes

Tables 4.3 display the results of the binary logistic regression (mean marginal effect) for the variables influencing the enrollment in beekeeping training programmes within the study areas.

Table 4.3: Binary Logistic Regression Results

Explanatory Variables	Average marginal Effects (dy/dx)	Std. Err.	P-value
Gender	-0.043	0.060	0.472
Age	-0.004**	0.002	0.027
Marital Status	-0.056	0.061	0.359
Educational level	-0.031***	0.050	0.001
Full-time Participation	0.008*	0.048	0.087
Household members in beekeeping	0.035*	0.019	0.066
Years of experience	0.006	0.004	0.147
Association belongs to	0.131**	0.052	0.011
Constant	-1.441	1.162	0.232

*** p<0.01, ** p<0.05, * p<0.1

Source: Field data, 2021

Significant findings are discussed in this section. The marginal effect of age is negative and statistically significant at the 5% level, as shown in Table 4.3, demonstrating that involvement in beekeeping training declines with age. Thus, on average, when a beekeeper's age increases by a year, the probability of participating in beekeeping training will marginally decrease by -0.004. This implies that beekeepers who have advanced in age are less likely to take part in beekeeping training programmes compared to the youth or young beekeepers. This is because the aged usually think because they are old, they do not need to receive training as that would be a waste of their time. Tulu *et. al.* (2020) and Abebe *et. al.* (2011) in their studies reported that the age of beekeepers negatively influenced the adoption of beekeeping technology and for that matter, participation in training programmes.

The finding is consistent with the work of Schouten and Caldeira (2021) who observed in Fiji that the age of respondents has a negative impact on the decision to participate in beekeeping training. Similarly, Abebe and Puskur (2011) and Abebe, Ranjan and Puskur (2011). found evidence that the age of respondents negatively impacts on the ability to adopt beekeeping technology in Ethiopia.

The findings also revealed that educational level is negative and statistically significant at 1%. This implies that as the educational level of a beekeeper increases, the probability of participating in beekeeping training will reduce. An increase in educational level is more likely to reduce the probability of participating in beekeeping training. Thus, on average, a one level increase in the educational background of a beekeeper will marginally reduce the probability of participating in beekeeping training by 0.031. The plausible reason may be that people who have attained higher formal education may consider beekeeping training unnecessary. It may also be that people who climb higher in formal education may not even think about engaging in beekeeping as a venture let alone participating in the beekeeping training programmes. Some, who may be interested in beekeeping, may decide to source for needed resources or information on the internet.

This is consistent with the argument by Schouten *et al.* (2020) that beekeeping is usually undertaken by uneducated people in Papua New Guinea. The reason is that people who have attained formal education tend to search for formal jobs (white collar jobs) and do not venture into beekeeping let alone undertaken a training programme in beekeeping. Also, considering that they have attained formal education, educated people may not see a need to undertake a training programme in beekeeping. According to Khalida *et. al.* (2015), most educated groups permanently and continuously seek to get the best information and from multiple sources. For this reason, they went on, continuing education to higher levels reduces the need for training. Therefore, higher education level negatively relates with the probability of participating in beekeeping training as unearthed in this study.

Moreover, the result with respect to full-time participation in beekeeping shows that the coefficient is positive and statistically significant at 10%, suggesting the likelihood of participation in beekeeping training programmes. On average, as the number of full-time beekeepers increase by one (1), the probability of participating in beekeeping training will marginally increase by 0.008. This implies that as more people become fulltime beekeepers, there is more likelihood of them taking part in the beekeeping training programme. The plausible reason may be that new entrants into beekeeping will increase competition, which will drive people to improve on their skills or adopt new methods of beekeeping to remain competitive. This result corroborates with the work by Lal *et al* (2012) in Kullu and Mandi districts of Himachal Pradesh that most beekeepers engage in beekeeping as a full-time business venture, and that they are mostly active in taking part in activities related to beekeeping. Similar finding is observed in South Africa by Yusuf *et al.* (2018) on the importance of undertaking beekeeping as a full-time business venture.

Furthermore, with respect to the number of household members into beekeeping, the results reveal that having more household members in beekeeping is most likely to increase participation in beekeeping training programmeme given that the coefficient is positive and statistically significant at 10%. This suggests that increasing the number of household members in beekeeping is more likely to lead to 0.035 increase in the participation in beekeeping training programmemes.

Therefore, having more household members in beekeeping is likely to be a significant predictor of participation in beekeeping training programmeme. The finding corroborates with the works of Andaregie and Astatkie (2021) and Mulatu *et al*. (2021) in Ethiopia that family size and the number of members of the family who are into beekeeping determine the extent to which beekeepers adopt modern hive beekeeping technology.

Additionally, the coefficient of beekeeper association membership is statistically significant at the 5% level and is positive. Thus, on average, as people join beekeepers' associations, the probability of them participating in beekeeping training will also increase by 0.131. Therefore, having beekeepers in associations is a good step to increase their participation in beekeeping training. In fact, membership in associations accrues several benefits to individual members as it engenders a collective action or voice to champion the interest of the group. It also affords each individual an opportunity to learn from colleagues and peers as well as encourages participation in collective actions and programmemes, including participation in beekeeping training.

However, gender, marital status, and years of experience do not show any significant impact on the participation in beekeeping training programmeme. It is imperative to emphasize that since new and modern technologies in agriculture particularly in beekeeping continue to evolve and beekeepers need to update their knowledge in beekeeping very regularly in order to stay competitive.

4.5 Impact of Beekeeping Training Programmes on Productivity

4.5.1 The Matching Methods

Having calculated the propensity score and satisfied the balancing condition, the next step is to match the propensity score with the respondents' characteristics. The goal of matching technique is to achieve a balance between the treatment (those who received the training) and the untreated group (those without training) based on the observable characteristics. Four matching techniques exist: nearest neighbor matching, radius matching, kernel matching, and stratification matching. In each of these techniques, the matching is conducted on the treated group known as the average treatment effect on the treated (ATT). The results are presented in Table 4.4 below.

Table 4.4: Matching methods (Average Treatment Effect on the treated (ATT)

Matching Methods	TRAINED	UNTRAINED	ATT	STD. ERR	t-Value
NearestNeighbor Matching	98	112	1471.96	322.06	4.57
Radius Matching	98	112	1469.39	311.94	4.71
Kernel Matching	98	112	1499.57	303.82	4.83
Stratification Matching	98	112	1497.82	343.94	4.65

Source: Author's computation

To calculate the matching scores for Table 4.4, the other independent variables were matched on the outcome (total harvest after training) variable, which is an increase in productivity. Training, gender, age, marital status, educational attainment, and years of experience are additional factors that are taken into account when matching candidates.

From the Table 4.4., the values of ATT are positive across the four matching techniques. The result from the Nearness Neighbor Matching suggests that if a respondent has received beekeeping training programme, productivity which is measured by the "quantity of honey harvested in gallons" (total harvest after training) will increase by 1471.96. With respect to Radius matching, training will increase productivity by 1469.39, Kernel matching will be 1499.57, and Stratified matching will be 1497.82. This indicates that beekeeping training programmes have a greater impact on beekeeping output than other demographic factors including age, gender, marital status, level of education, and years of experience (Murshed-E-Jahan and Pemsl, 2011; Qaiser *et al*., 2013; Serda *et al*., 2015).

Generally, the findings from the PSM revealed that the group that participated in the training programmes (Trained) had increased productivity compared to the group without the training (Untrained). This is particularly true when the average treatment effect was applied on the treated (ATT) variable over the nearest matching method. These findings are consistent with existing literature (Murshed-E-Jahan and Pemsl, 2011; Qaiser *et al*., 2013; Serda *et al*., 2015). Training improves learners' knowledge of improved agriculture (and for that matter beekeeping) practices (Srinivas & Sailaja 2013). This is because knowledge, a cognitive element of a person's thinking that has a big impact on both covert and overt action, is the reason why. Individuals having a better understanding of the technical nature of improved practices would be more likely to adopt them resulting in increased productivity. Inadequate and incorrect understanding leads to under or excess adoption of innovation, which is devastating to the farming industry. Through training, the beekeepers' aptitudes, talents, and abilities were enhanced resulting in increased productivity (Aswathappa, 2000)

According to Rahman and Islam (2016, training supports both the acquisition of new skills and the updating of existing ones. According to research by Murshed-E-Jahan and Pemsl (2011), improving farmers' (beekeepers') skills through training has a greater impact on raising productivity and income levels than financial assistance. Once more, Kumari (2005) and Singh (2005) discovered that output rose because trained beekeepers had a higher level of knowledge than untrained beekeepers. In fact, within the field of Apiculture, training of beekeepers in specialized aspects such as type of hives to use, when to set up the hives, timely harvesting, prevention of swarming, avoidance of "accordion" beekeeping, honey and beeswax extraction, packaging, management of diseases and pests, repair and maintenance as well as training in new technology related to beekeeping is important. The training in these areas will stimulate the efficiency and enhance the effectiveness of ensuring quality honey production as well as generally optimize the gains with respect to beekeeping production.

4.6. Strengths, Weaknesses, Opportunities, and Threats (SWOT) of Beekeeping

The Excel Radar Chart results for the internal strengths and weaknesses are presented in this section. The external opportunities and threats are further revealed. The result is shown in Figure 4.1.

4.6.1 Strengths of Beekeeping

The strengths of beekeeping in the Volta and Oti regions were identified as natural endowment, , availability of human capital, presence of agro-ecological zones conducive to beekeeping, low or no negative impact of beekeeping on the environment as well as beekeeping been a means of livelihood for some people in the regions among others.

The Volta and Oti regions are rich in natural resources, including bees, bee flora (melliferous plants) that bloom throughout the year to provide bees with year-round foraging opportunities, and water bodies that, if harnessed, would enhance the livelihood of many people.

There is readily available human capital to go into beekeeping with even a lot of the people who did not receive any formal education not only interested but involved in the industry. According to Gershon Amaglo, (personal communication, 2021), a participant in the focus group discussions stated that SNV (2012) reported that the two regions has the largest number of beekeepers as well as large number of female beekeepers in Ghana. A number of beekeepers were trained in the study area over the years by organizations such as SNV, FORUM, BUSAC fund VORAB, OAC and AdFI to enhance their efficiency while a lot other untrained keepers are also into the business.

Quality of Honey: According to Wisdom Otoo (personal communication, 2021), it is reported that honey from the Volta and Oti regions are of great medicinal value. Honey is valued for medicinal uses as antiseptics and wound dressers. According to Basa *et al*. (2016), honey has antibacterial and immunomodulatory properties which aid in wound repairs. According to them antimicrobial agents are essentially important in reducing the burden of global infectious diseases. Laboratory examination is necessary to ascertain the medicinal properties of honey produced in the Volta and Oti regions and to determine whether it has superior properties to those from other regions. If this is done and a superior quality honey is determined, it could result in pharmaceutical industries coming in to exploit the product for the manufacture of various drugs.

Agro-ecological zones: It was found out that all the agro-ecological zones of Ghana are found in the two regions. This is corroborated by MOFA on their website which listed them as the coastal savanna, forest, transitional and guinea savanna zones which are all conducive to beekeeping. The Kalakpa Resource Reserve (KRR) located near Ho and Kyabobo National Park in the Nkwanta South district, all have flowering plants conducive for beekeeping (FC & SNV 2007; van Raamsdonk, Odoom & Linden, 2008).

These various agro-ecological settings produce various bee flora that blooms at various times of the year and is very suited to beekeeping. It will afford the study area the opportunity to enhance the development of beekeeping to create employment for the people and ensure an all- year-round honey production. According to Mushonga *et al*. (2019), vegetation comprising of forest savannah made up mostly of flowering plants with national parks full of various flora and fauna is ideal for beekeeping.

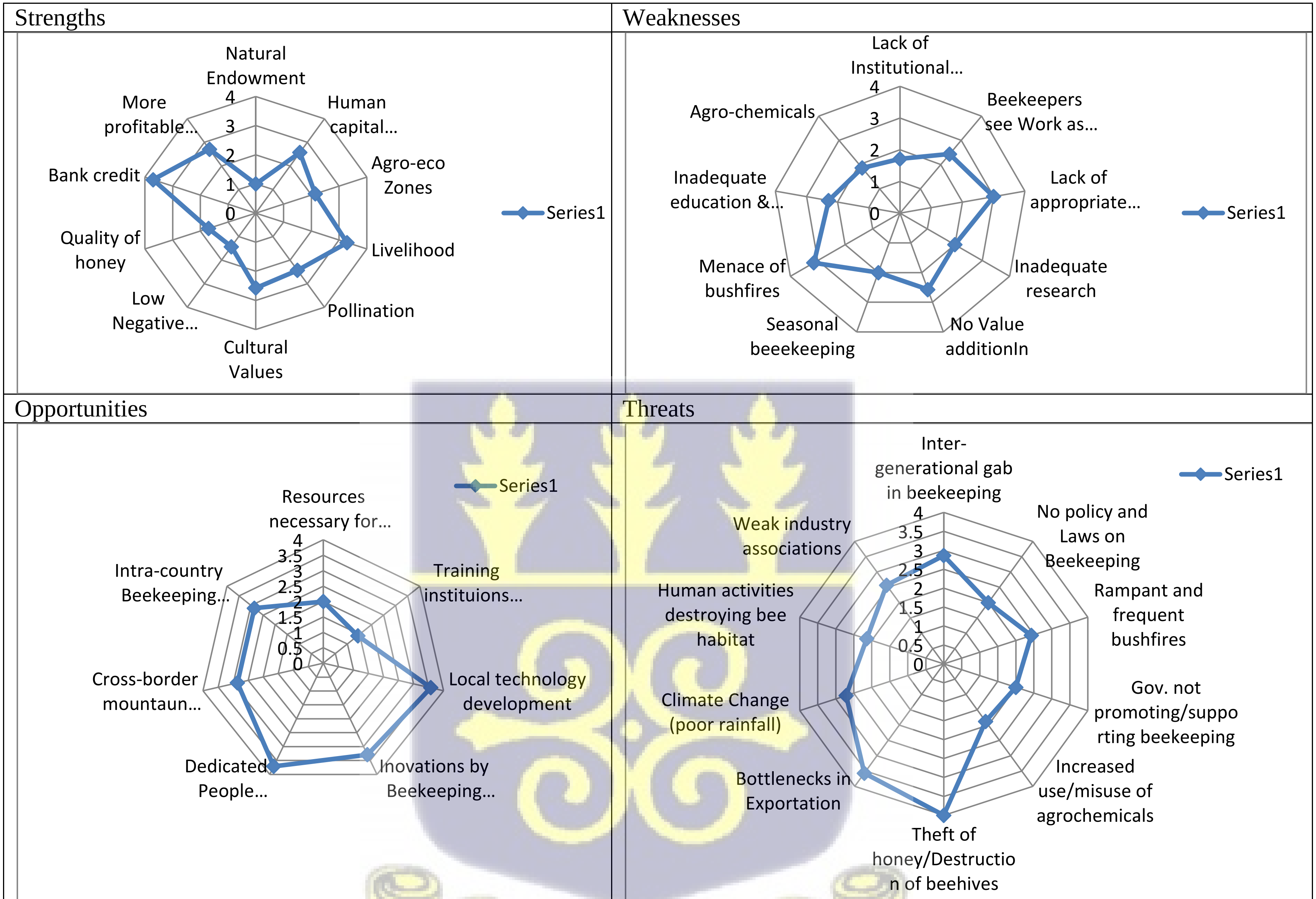

Figure 4.1: SWOT Analysis

Source: Survey data, 2021

Livelihood: Divine Odonkor, (personal communication, 2021), indicated that beekeeping in the two regions serves as means of livelihood which provides employment and income to many. The crop and animal farmers engaged in beekeeping make a lot of income from the sector to supplement their income. In the view of Mushimba *et al.*(2001), beekeeping is a versatile profession that may be easily pursued by individuals of both sexes on a full- or part-time basis. Beekeeping is simpler to begin than other agricultural livelihood options, (Hecklé *et al.*, 2018).

Pollination: More than 80% of all kinds of flowering plants and more than 75% of all primary crops in the world depend on animal pollinators (Nabhan & Buchamann 1997; Kevan *et al.* 2002). According to reports, domestic bees pollinate 15% of them, while wild bees and other species pollinate the remaining 80% (Freitas *et al.*, 2004). The constancy of bees ensures effective pollination of many species of crops and plants thus resulting in the production of crops such as pear, mangoes cocoa, oil palm and other fruits and vegetables in the Volta and Oti regions. Pollination by bees results in the maintenance of biodiversity and honey production.

No or low negative impact on the environment (degradation): Another strength of beekeeping identified is the fact that unlike crop and animal production which results in the degradation of the environment through the use of agrochemicals, over cropping, bush burning and overgrazing, keeping bees does not in any way cause environmental degradation. It rather enhances the development of the environment through biodiversity conservation. This is achieved through pollination services rendered by the bees to cultivated crops and wild plants (Nabhan & Buchamann 1997; Kevan *et al*. 2002 & Freitas *et al*., 2004).

Gershon Amaglo, (personal communication, 2021) in comparing the price of honey to fuel (petrol) and the possible cost of developing both products posited that whereby a 4.5 liters of petrol costs GHS30.00, the same volume of honey costs GHS 150.00. Again, unlike petroleum exploration which involves enormous capital, ($125 per foot onshore and about $300 per foot offshore), According to the Ghana Beekeepers Association (GBA), Ghana could become a major producer of honey in the world with an investment of GHS1.62 billion in the first year of production and earn GH2 billion yearly for the following ten years (Jeil, Segbefia, Abass & Adjaloo (2019).

4.6.2 Weaknesses of Beekeeping

The weaknesses of beekeeping identifies are lack of institutional support, use of agro-chemicals, seasonality of beekeeping, menace of bushfires, lack of value addition among others.

Institutional support: No organization is actively supporting beekeeping in the two regions and for that matter Ghana as a whole- some beekeepers' associations are there, but they lack the capacity in terms of resources to develop the industry.

According to Oppong *et. al.*(2021) indicated in a research that over the years, the government of Ghana have rolled out programmes to boost productivity levels of agriculture to reduce poverty, organizations, such the Ministry of Food and Agriculture, do very little to promote beekeeping, if anything at all. Scanning through various documents such as *Investment Guide for the Agriculture Sector in Ghana, 2018, Agricultural Sector Progress Report, 2016 and the Planting for Food and Jobs, 2017-2019* and other policy documents of the government of Ghana prepared by Ministry of Food and Agriculture, (MOFA) and other bodies, it was observed that beekeeping and trade in its products are not valued and for that matter, not mentioned by governmental organizations in these documents. The Forestry Commission which depends on working on trees for their salaries although produce honey, do not actively support training in beekeeping.

Some of the beekeepers when asked corroborated what the Focus Group Discussants said when they said the extension agents of MOFA do not communicate to them on beekeeping neither do they visit their apiaries to give advice to them on their beekeeping operations.

Nongovernmental organizations that seem to be involved only train people within a short time and leave without putting in place any plans of sustainability. Mention can be made of organizations such as Heifer international, SNV, FORUM and GreenGlobe Ghana who after training people in beekeeping do no follow-ups due to lack of funds. Beekeepers mentioned that they have not heard of these NGOs who trained them for a long time. In the views of Manish and Sanjay (2013), the beekeeping industry is one that has received the least attention from government probably due to the lack of Wreness of the economic and biologivcal potential that it offers.

How Beekeepers regard the industry: They are not ready to pay to attain further skills training in the business. Beekeepers handle the sector as any other farming business whereby they do not attach business acumen to their work. This was observed in interviews conducted by the researcher in the course of data collection. Bradbear (2009) asserts that beekeeping is typically regarded as a hobby or a secondary activity. Beekeepers fail to invest funds into the business and always look to philanthropists to donate beekeeping equipment to them.

One beekeeper at Kpando- Dafor remarked "we do not have beehives, neither beesuits and smoker. You must try and arrange some for us." They do not harvest on time so that by the time they visit their hives, the bees might have consumed the honey thus efficiency of the beekeepers is low. Even though the research location has a high potential for producing honey, Tarekegn and Ayele (2020) found that beekeeper efficiency is only 9.8 kg per hive per year, which is lower than the national average of 12.5 kg per hive per year from traditional hives. Training enhances the aptitude, skills and abilities of beekeepers and making them more effective and efficient. (Aswathappa 2000).

Training would lead to change in world view of beekeepers and thus make them to see the sector as a business rather than a hobby. Operating the sector as a business would result in beekeepers seeking training on their own in areas where they find themselves handicapped.

Lack of appropriate technology: There is the lack of appropriate technology in use in beekeeping in the study area. Some beekeepers still use naked fires in honey harvesting. Some still use log hives that are difficult to manage. Modern honey extractors are also lacking in the study area. When asked in an interview how they extract the honey, some of the beekeepers at Adaklu said they use their hands to squiz the honey from the combs. The use of the hand is unhygienic as if tends to contaminate the honey while unripe honey gerts fermented within a few days after extraction FAO (2020).

The implementation of better beehive technology has a good and considerable effect on honey output, according to the literature. Affognon *et al.* (2015) found out in a study that beekeepers with modern hives got higher yields of honey than those with traditional hives. Many beekeepers - it was observed after being interviewed- also need further training.

Inadequate research: There is inadequate research into beekeeping and bee products such as beeswax, pollen, propolis as well as their value addition in Ghana as a whole and the Volta and Oti regions in particular. No literature on such research was sited by the student researcher after several searches.

A search on the website of the Forestry Research Institute of Ghana (FORIG), a research tinktank established to research into forest products of which beehive products (non timber-forest products (NTFPs) is part (Lowore & Wood, 2014), has nothing to show on beekeeping. Most of the beekeepers who were interviewed knew only about honey and beeswax being hive products, even with the beeswax, a lot of them are not able to extract it. They usually throw the combs away after extracting the honey. They have no idea about the other hive products let alone how to extract themContrary to popular assumption, honey, beeswax, and pollination services are not the only products or services that bees may provide, claim Hans, *et al.* (2018).

Despite being marketable, other hive products like pollen, peopolis, royal jelly, venom, queens, bees, and their larvae are still not acknowledged by beekeepers as a source of revenue. This has resulted in them losing income they should hitherto have gained from such products. Beekeepers at the moment sell their honey and beeswax in their raw states instead of adding value to them. They or other industries could produce candles from the beeswax and drugs for cough and asthma from the honey thereby gaining extra revenue from the sector.

No value addition: A raw agricultural product is transformed into something new through packaging, branding, processing, chilling, drying, extracting, or any other type of process that distinguishes the product from the original raw commodity, according to Matthewson (2007). Apart from honey, which might sell for more than twice as much, there are no initiatives to promote value addition to bee products (Nkwele Agribusiness Planning and Investment (Pty) Ltd, (2016) & Omari, (2010). This has resulted in beekeepers depending solely on honey and beeswax as the only hive products harvested (to which no value addition is done before been sold) while losing the opportunity to harness others as pollen, propolis and royal jelly.

Value could be added to the honey to produce honey wine, drugs and pomades while candles could be produced from beeswax to generate additional income. The key benefits of adding value to bee products include giving small-scale beekeepers more products to offer, enabling them to tap into new and diversified markets, and giving them greater control over the manufacturing processes they choose for their goods, among other things (Hilmi *et al*. 2011).

Inadequate education and networking: among beekeepers in the study area. Farmers and for that matter, beekeepers rely on a variety of resources to learn about management techniques, financial management, and marketing in order to remain viable and competitive in the production market (Velardi *et al.* 2021). These types of knowledge can be shared through both formal and unofficial networks. Sharing, building trust, and assisting one another in achieving goals are all part of networking. Gaining new insights, advancing one's business, and strengthening business relationships are all benefits.

The network of the beekeeper might be a great place to find fresh viewpoints and business-related ideas. A major advantage of networking for beekeepers is the sharing of issues, successes, and goals as doing so can help them discover new perspectives they might not have otherwise. In formal networks, according to Velardi *et al.* (2021), agricultural extension agents disseminate knowledge in a top-down approach. Peers are involved in informal networks, which typically develop from beekeepers' social interactions. Researchers like Manson *et al.* (2016) and Sumane *et al.* (2018) have found that these peer-to-peer knowledge exchange networks are crucial for creating inclusive approaches to environmental management, encouraging the adoption of best practices, boosting social capital, and increasing the yield of honey and other hive products. Despite the advantages of networking that have been mentioned above, the majority of beekeepers in the research region operate independently of one another and are therefore unable or unwilling to exchange ideas and experiences (Velardi *et al.* (2021),. This was collaborated by some of the beekeepers in interviews conducted during the period of study. This is hampering the development of the industry in the study area.

Seasonal beekeeping: Beekeeping at the moment is only seasonal when it could be developed to an all year round business. There are various bee flora spread all over the regions which come to flower at different times of the year. Migratory beekeeping could make effective use of the blossoms throughout the year thereby producing honey throughout the year. According to FAO (2020), regions with perennially flowering plants like coconuts can produce honey all year round. In order to assure year-round harvesting, beekeepers could either plant additional or conserve the present plants in their localities. Mesele (2001) asserts that migrating honey production is a widespread practice in Africa. He continued by saying that migratory beekeepers move their hives at specific seasons. And this is frequently a profitable practice. Unfortunately, most of the beekeepers interviewed said at the moment beekeeping is only sedentary and restricted to November to February each year.

The menace of bushfires: that rampage the vegetation in the two regions is a big problem resulting in loss of bee flora, bee habitat and sometimes, the burning of beehives and bee colonies. Despite the existence of PNDCL 299 (1999) which proscribed the indiscriminate setting of bushfires, the incidence of bushfires is an annual phenomenon. The law is not specific on what should be done when beehives are destroyed by bushfires. Bushfires are caused as farm lands are being prepared; cattle herders burn the dry grasses with the view of getting grasses to grow soon after the first rains so that their animals could get forage, careless disposal of fire by palm wine tappers as well as bee hunters among others. . In their studies, Shibru, Asebe and Megersa (2016) reported that drought and wild fires accounted for 13.1% of the reported constraints of beekeeping in Ethiopia.

Agro-chemicals: The use of agro-chemicals by crop farmers in the study area, is a problem to beekeeping. Agro chemicals such as pesticides destroy bee habitats, bee flora as well as killing of the bees. Labour for farming is now become difficult to find. This has led to many farmers resorting to the use of herbicides to control weeds on their farms.

According to Hald (1999) and Hyvonen and Salonen (2002), the excessive and ongoing use of herbicides results in a decreased variety of flowering plants, which in turn has an impact on bee colonies and productivity. The incidence of insect pests of crops and animals has also led to the dependence of farmers on the use of insecticides to control such insect pests. These chemicals end up polluting the environment rendering it harmful to the bees and other useful insects. In the view of Hooven, *et al*. (2013 The bulk of bee poisoning incidents are brought on by extremely toxic insecticides with long-lasting toxicity. Neonicotinoids such as clothianidin, imidacloprid, and thiamethoxam, organophosphates such as acephate, azinphosmethyl, chlorpyrifos, diazinon, dimethoate, malathion, and methamidophos, N-methyl carbamates such as carbaryl, and pyrethroids such as deltameth are among the harmful substances named. According to Hooven *et al*. (2013), the majority of bee poisoning incidents take place when insecticides are applied while bees are foraging, during bloom on crops that are pollinated by bees, when bees collect pollen, nectar, or other materials contaminated with insecticide from treated crops that do not need bee pollination, and when bees collect insecticide-contaminated nectar from plants treated with systemic pesticides. The combination of various fungicides and insecticides has been shown to be more lethal to bees than either chemical alone, according to Johnson, *et al*. (2013).

4.6.3 Opportunities of Beekeeping

Among opportunities identified were presence of traini9ng institutions, intra-country beekeeping between Ghana and Togo, availability of resources that support beekeeping, and cross-border mountain beekeeping.

Resources necessary for beekeeping: All the conditions necessary for beekeeping (natural, human, and economic conditions) abound in the Volta and Oti regions. Apiculture is a floral-based industry, and bees are entirely plant-dependent (Crane, 1990). Bees populations, vegetation with varieties of trees that bear flower at different times of the year (allowing for possible all year round migratory beekeeping), vast water bodies- rivers, dams, streams, and local and intra-border markets as well as enthusiastic farmers ready to ply the beekeeping business abound. Plants such as *Sapotaceae/ Meliaceae, Anacardiaceae,Gynandropsis gynandra, Burkea Africana* among other plants which bees forage, abound in the study area, (Letsyo & Ameka, 2019).

Training institutions: The most valuable resource for every nation is its human resources, claim Srinivas and Sailaja (2013). According to these scholars, a nation's progress and wealth are driven more by the quality of its people than by its sheer population size. In essence, any society undergoes socioeconomic or politicalcultural revolution as a result of the growth of its human resources. Training is one of the key methods for developing human resources. There are two training institutions – the Ohawu Agricultural College and the Adidome Farm Institute – that have been training their students in beekeeping and could train more (they also offer demand driven short duration courses in beekeeping to interested applicants). The Evangelical Presbyterian University is also beginning to go into beekeeping training. These trqinings will afford beekeepers qualitative training which will enhance the beekeeping business.

Local beekeepers are developing local technologies and innovations in beekeeping: Innovation, according to Roger 2003, is the perception of an idea, practice, or thing as novel by a person or other unit. Field visits and interviews revealed that beekeepers and . Beekeeping associations are developing and coming out with new technologies and innovations. Beekeepers are improving on the use of *borassus* hives by using topbars with it (Adaklu and Mafi areas) in housing bees while water instead of fire is used to prevent bee stings during the harvesting of honey. This is an improvement on the traditional log hives.

VORAB has developed an honey extractor that could help extract honey in a more hygienic way. Unfortunately, due to lack of funds, it could not produce it for use by the beekeepers.

Dedicated individuals: and institutions such as Ohawu Agricultural College, the Adidome Farm Institute and Evangelical Presbyterian University, Non-Governmental Organizations championing the course of beekeeping in the two regions-VORAB, SNV, Eximbank, African Union Beekeeping Programmeme in terms of mobilizing, training people to go into beekeeping and improving practice.

Intra-country beekeeping: With the proximity of the two regions to Togo (the whole lengths of the Volta and Oti regions, about 500 kilometers share boundaries with Togo), there is the potential to develop and promote cross border beekeeping and trade in bee products - both local and international market. There are people along the border whose homes for instance, are situated in Ghana while their farms (beehives) are located in Togo and vice versa. For instance in Batume Junction, a community located in the Akatsi North district of the Volta region, on the Ho-Aflao road, a street in the town serves as the boundary between Ghana and Togo. It is interesting to note that the people in this community use both the Ghana cedi and CFA franc, the currencies of Ghana and Togo respectivley. This could facilitate easy trade between both sides. Morris and Dadson (2000), posited that trans-border trade between Ghana and Togo illustrates the importance of socio-economic relashtionships among trans-border traders. They further indicated that when the border between Ghana and Togo was drawn by the colonial administrators, it split the Eʋe tribe between the two countries. This artificial border has not prevented continued commerce and personal interactions among the Eʋes from the two countries. These interactions continue to be important in trans-border trade between the two countries. Beekeepers in other regions such as

Central and Greater Accra regions for instance, cannot boast of easy cross-border trade in hive products and they need to travel long distances to achieve this.

Cross-border mountain ranges: The Ghana-Togo- Atakora mountain ranges (the Weto range) can promote intra-country beekeeping and mountain beekeeping. The UNDP Global Environment Facility Small Grant Programmeme (2017) has promoted beekeeping along the Ghana -Togo ranges in both countries for which reason some NGOs from both countries have corroborated in beekeeping since 2012. The UNDP in another project under the name Community Development and Knowledge Management for the Satoyama Initiative Programmeme (COMDEKS), has sponsored beekeeping projects in the Weto Range (UNDA, 2017).

4.6.4 Threats of Beekeeping

Inter-generational gap in beekeeping, lack of policy backing beekeeping, weak industry associations, rampant and frequent bushfires, destruction of bee habitat through human activity, as well as increased use and/or misuse of agrochemicals were some of the threats.

There is an inter-generational gab in beekeeping: The involvement of the youth in beekeeping is very low, threatening the future of the industry. It was noted that, despite the fact that beekeeping might be a very good source of work and subsistence for a lot of the teaming unemployed youth, most of the beekeepers are elderly people (average age of respondents been 50 years) engaged in crop and animal farming in the regions with just a few young ones being involved. This is not a very good situation as it creates a situation which if not addressed would bring about the extinction of beekeeping.

It was suggested that organizations such as MOFA be tasked through its extension department to make the education of the youth a priority so as to encourage them to take up beekeeping. A slot could be created in the annual Farmers Day Awards scheme to honour the best district, municipal and metropolitan beekeepers. This could stem the spate of rural – urban migration of the youth.

Rampant and frequent bushfires: Bush burning either for land clearing for farming purposes or hunting for wild games are a common and yearly occurrence in the study area. This results in the destruction of bee habitats, bee flora and beehives of beekeepers. These were collaborated by beekeepers in interviews. This phenomenon largely affects productivity of bees within the study area as bee habitats and bee flora are destroyed.

In their studies, Shibru, Asebe and Megersa (2016) reported that drought and wild fires accounted for 13.1% of the reported constraints of beekeeping in Ethiopia. Measures needed to be put in place by the local authorities such as the district, municipal and metropolitan assemblies, the Fire Service and other stakeholders to check this menace.

Increased use/misuse of agro chemicals: Crops such as maize, cowpea, vegetables, yam, plantain, and cocoa are cultivated by farmers who use a lot of pesticides for the control of weeds, insect pests and diseases. Kuwenda (2016) indicates that the use of pesticides by crop farmers will result in bee populations declining as bees abscond due to their sensivity to such chemicals. The use of weedicides leads to the destruction of bee flora and thus reduction in the availability of nectar flow. This is collaborated by Bekuma (2019) in a study he conducted in Ethiopia on the Challenges and Opportunities in Beekeeping.

Agrochemicals can directly reduce food availability to honey bees, by either contaminating floral resources with insecticides (Decourtye, Mader & Desneux 2010) or by reducing the quantity of available floral resources (Donkersley *et al*. 2014). The use of insecticides on crops also results in the killing of the bees. Tessega (2009) and Serda (2015) also reports that there was a decreasing trend of hive products in parts of Ethiopia as a result of the shortage of bee forages caused among others by the use of pesticides and herbicides.

Theft of honey and destruction of beehives: Burning of beehives go on in the study area and there beekeepers find it difficult to identify the culprits in order to bring them to justice.. Thieves go to still honey from hives of beekeepers and in order to cover up burn the hives. This causes a lot of financial loss to the beekeepers. A number of the beekeepers interviewed confirmed this. One beekeeper at Kpando claimed about 50 of his hives were burnt as a result of theft.

Kuwenda (2016) asserts that theft makes some beekeepers decide not to continue their trade. Several beekeepers lose their colonies because thieves don't have time to follow honey harvesting protocols. He suggested that removing a queen bee, all of the honey and brood combs, and worse yet, failing to replace the topbars, could force the bees to flee in response to a low crop.

Policy on beekeeping: There are no laws and policies on beekeeping for the protection and development of bees and beekeeping as we have for other agricultural commodities. If anyone is caught causing bushfire, he would not be charged for destroying the habitat of bees or bee flora but the destruction it may cause to life and property –crops and trees is the only thing the existing laws are concerned with. Although P.N.D.C. Law 229 proscribes the setting of bushfires, there is no specific mention of sanctions that should be meted out to anyone who causes the burning of beehives or bee flora.

Beekeeping is not been promoted and supported by governmental agencies. A district Director of Agriculture was reported by one of the participants to have said that beekeeping is not a national priority and that beekeeping does not need associations.

There are no policies in place to promote and protect beekeeping in the country as a whole. No punishment for people who destroy bee habitats and beekeepers.

A lot of bottlenecks exist for the exportation of bee products: People are aware of large market opportunities outside the country but cannot export because of such bottlenecks. The process of certification is cumbersome and not easily accessible to many beekeepers. For any individual or company to export any product (including bee products), according to the Ghana Revenue Authority website https://gra.gov.gh/customs/export-procedures/, They must obtain a tax identification number (TIN) from the Ghana Revenue Authority or a GhanaCard Pin and register with the Registrar General's Office and the Ghana Export Promotion Authority. When the customs declaration is properly approved by customs, the exporter must electronically submit it and include all pertinent documentation, such as certifications and permits. Any person may export goods from Ghana for commercial use in accordance with the Export and Import Act 1995 (Act 503), provided the person, among others, completes a Ghana Export Form in the case of non-traditional export commodities. When exporting non-traditional export commodities, the exporter must provide the Commissioner with a completed Ghana Export Form. All these are cumbersome procedures which the ordinary beekeeper cannot afford to undertake.

Climate change resulting in poor rainfall and long spells of droughts affect the flowering of crops and plants on which bees depend for nectar In contrast, a study by Vercelli *et al.* (2021) discovered that Italian beekeepers' associations ascribed a fall in nectar, pollen, and honeydew supplies, as well as a reduction or absence of specific types of honey and a decrease in stocks kept in the nest, to climate change. These changes threatened a successful winter's survival. That report also mentioned nectar was also often unavailable in the flowers. This in turn affects productivity of bees and the beekeeping industry.

A number of human activities are causing destruction to bee habitat in the region. Such activities as urbanization, road construction works, quarrying, lumbering, sand wining, and use of agro-chemicals are having a great toll on beekeeping in the two regions. Beekeeping is impacted by agrochemicals in some places of Ethiopia, according to studies by Degu and Megerssa (2020) and Mekonnen *et al.* (2018) in West Shoa of OromiaAccording to studies, agricultural farms use a variety of insecticides, including malathion, diazinon, chlorpyrifos, lambda cyhalothin, propiconazole, baylathone, herbicides (45-OD (Pallas), 2, 4-D, and U-46) roundup, and fungicides (ridomil). The results of the survey indicate that pesticide spraying is considerably reducing the number of honey bee colonies. According to Malede *et al.* (2015), agrochemicals that have negative environmental effects and reduce the production of honey bee colonies in the region are also having an impact on beekeeping in and around Gondor, Ethiopia.

Weak industry associations which affect the development of beekeeping. In the studied area, there are numerous beekeeping associations. Unfortunately, some only exist in name as they are not organized. In interviews conducted by this research across the study area, most of the beekeepers confirmed that they were in an association having regular meetings but as at the time of this research,they hadly meet to discuss anything. Producer organizations can be formal or informal (Hilmi *et al.,* 2011). These could benefit by pooling resources, obtaining better financing terms from financial institutions, finding and purchasing equipment more affordably, and being in a stronger position to negotiate trade agreements with rural traders, bee product processors, wholesalers, retailers, and exporters (Hilmi *et al.,* 2011). The Volta Region Association of Beekeepers, (VORAB), which seem to serve as a regional umbrella body for all beekeeping associations in the Volta and Oti regions also lack funding and other resources and so are not able to rally the other smaller groups into a formidable body to promote beekeeping in the two regions.

4.6.4 The Way Forward

Members of the focus group discussion after brainstorming and coming out with the SWOT of beekeeping, also tried to come out with what they think needed to be done to help grow the beekeeping industry in the two regions. These are also presented as follows:

The Volta Regional Association of Beekeepers (VORAB) which at the moment stands out as the umbrella body of beekeepers in the Volta region (before the split of the region into the Volta and Oti) has been working to network all beekeepers in the two regions but lacks the resources to achieve its goals. It was therefore suggested that they liaise with various development partners to source for funding in order to carry out their objectives.

Fredericks *et, al.* (1980), Rural institutions represent a welcome decentralization and diffusion of planning and decision making prerogative to the grass-roots. Such an involvement is felt to be conducive to the creation of a dynamic and resilient farming community capable of building upon the technical and other resource inputs provided by government instead of being passive recipients of government aid and subsidies. There is the need therefore to revamp VORAB by organizing meetings to share ideas and develop the beekeeping sector. Due to the non availability of funds, VORAB became inactive and seem to be comatose. It was therefore suggested the present executives reorganize themselves to revamp it so that the various local associations – most of which are also weak could be reorganized. This it is believed would lead to a strong beekeeping body that would bring about a push for the sector.

There is the need to improve upon information sharing with beekeepers in the region. At present, it was observed that most beekeepers in the region are not in contact with each other both within the same locality and with those in other parts of the districts and regions. There was therefore the need to scale up communication and working together (Rwelamira, 2015) between and among them using modern social media channels such as Facebook, WhatsApp and others.

VORAB is working closely with the Evangelical Presbyterian University College (EPUC) to set up a Beekeeping Research Center to promote beekeeping. This has been ongoing for some time now and VORAB was tasked to impress upon their partners (EPUC) the urgency of this project to help develop the beekeeping sector in the two regions.

Need to revisit what stakeholders were doing previously to promote beekeeping. There was a multi-stakeholder platform on beekeeping that must be revived. That platform went to several places including to the regional minister's office, and made up of EPA, Wildlife, Fire Service, Forestry Commission, environmental NGOs, Ghana Export Promotion Council (now Ghana Export Promotion Authority), Ghana Tourist Board, NBSSI, MOFA, The Development Institute, the African Union Integrated Bureau of Agriculture and the University of Cape Coast. This was a group put in place to promote beekeeping in the Volta (former) region. This group has drafted a Beekeeping Policy for the entire country.

Step up literary work on beekeeping. It was agreed by consensus for beekeepers to be encouraged to write children's books on beekeeping, write on beekeeping from the angle of production, business, the environment and other areas. This it is believed would inform a lot of people on beekeeping in the regions and whip up interest in the sector.

Need to encourage more people to go into research into beekeeping. At the moment, there is a great gap between beekeeping and research in Ghana as a whole. The participants of the FGD were of the view that if research could be done on various aspects of beekeeping such as the best equipments that would suit beekeeping in Ghana, it will go a long way to help beekeepers perform better. For example at the moment, beekeepers mostly rely on the Kenyan topbar hive which was developed in Kenya. This may not be very suited for our environment but because no research has been conducted apart from the one by Dr Kwame Aidoo of the Department of Entomology, University of Cape Coast which came out with the Saltpond hive (this is bigger in volume than the Kenyan topbar), most beekeepers continue to use the Kenyan topbar hive.

CHAPTER FIVE

SUMMARY OF MAJOR FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter covers the summary of major findings of the study, conclusion, and recommendations. These were carried out in accordance with the study's objectives, which included analyzing the factors influencing participation in beekeeping training programmes, assessing the effect of those training programmes on beekeeping productivity, and examining the opportunities, threats, and weaknesses of beekeeping.

5.2 Summary and Major Findings

The study sought to assess factors which influence participation in beekeeping programmes, evaluate the effect of training on beekeeping output, and identify the strengths, weakness, opportunities and threats. Binary logistic regression model was used to analyse objective one whilst propensity score marching and SWOT metrics were used for objectives two and three respectively. Primary data was gathered from ninety- eight (98) trained beekeepers and one hundred and twelve (112) untrained beekeepers using a structured questionnaire, interviews, field observations and seven expects in focus group discussion. Six (6) communities were selected from five districts and municipalities in the Volta region and three from two districts in the Oti regions of Ghana. STATA version 15 was used for the analysis of objective one and two while radar chart in excel was used to analyse objective three.

The findings from the binary logistics regression revealed that gender and the educational level of respondents reduce the beekeepers' ability to participate in beekeeping training programmes. Moreover, the study further revealed that the number of members into beekeeping, years of experience of beekeepers, age of beekeepers, full-time participation in beekeeping, and membership of associations have the potential to stimulate participation in the training programmes for beekeepers. However, marital status was found to have no impact on the beekeepers' capacity to participate in beekeeping training programmes within the study areas.

Descriptive statistics revealed that the average mean of productivity (209.098 gallons) of the respondents who have undergone training in beekeeping is higher than the average productivity (198.663 gallons) of those who did not receive any formal training programmes in beekeeping. Moreover, by applying the PSM estimation, the results from the matching methods, thus, nearness neighbor matching, radius matching, kernel matching, and stratified matching suggests that the higher productivity recorded by the trained is as a result of the training programmes they received. As found by Kumar, (2018), training enhances knowledge. In a research, he found which will impact productivity. According to him, beekeeping training offer excellent opportunity to beekeepers to gain knowledge of new technology of obtaining high honey yields per colony. The results also showed that demographic factors or confounders including gender, age, marital status, educational attainment, and years of experience do not account for the difference in productivity between the trained and untrained.

The values of ATT and ATE are positive, which suggest the potential to increase productivity. The result from the Nearness Neighbor Matching based on the ATT suggests that, on average, if a respondent has participated in beekeeping training programme, productivity which is measured by the "quantity of honey harvested in gallons" (total harvest after training) will increase by 1471.96. This implies that training in beekeeping increases productivity.

However, by applying the same matching method (nearest matching method) on the ATE (i.e on the entire population comprising both trained and untrained groups), the productivity will increase by only 0.421. This indicates that beekeeping training programmes are more effective at boosting production than other demographic factors including age, gender, marital status, amount of education, and years of experience.

The study found a number of factors that constitute the internal strengths and weaknesses as well as external opportunities and threats of beekeeping within the study areas.

Natural, human and economic resources such as bees, bee flora that come to flower at different periods of the year, water bodies and both internal and external markets in neighboring Togo were found to abound in the study area. These if harnessed, would result in much income for the resource-poor rural folks. There is a lack of institutional support for the beekeeping sector. The Ministry of Food and Agriculture and the Forestry Commission, two official organizations that ought to be leading the charge in promoting beekeeping operations, are regrettably not doing much as expected, and this was noted as a weakness. The Ohawu Agricultural College and the Adidome Farm Institute continue to provide training in beekeeping. Bushfires and use of agrochemicals need to be regulated to save the beekeeping industry. The lack of a national policy for beekeeping negatively affects the sector.

5.3 Conclusion

Participants in beekeeping training programmes have the mean age of 50 years which indicate that the future of beekeeping is not very bright unless the youth are encouraged to go into the business, as it is mostly the elderly who are into beekeeping. The beekeeping sector is dominated by men as only few women are engaged in it. Men therefore participated more in beekeeping training programmes than women. The findings from the marginal effect of the logistic regression with regard to the variables that affect participation in beekeeping training programmes revealed that the age of respondents, full-time participation in beekeeping, number of household members into beekeeping, and membership of beekeepers' association positively influence the participation in beekeeping training programmes.

Furthermore, while an increase in the respondents' education levels tend to reduce the probability of their participation in beekeeping instruction, their gender, marital status, and years of experience have no appreciable influence on their capacity to do so.

The training programmes exerted positive effects on productivity as the beekeepers who undertook training were recorded as having higher productivity in terms of quantity of honey produced as compared with those who did not have training. The result from the Nearness Neighbor Matching based on the ATT suggests that, on average, if a respondent has participated in beekeeping training programme, productivity which is measured by the "quantity of honey harvested in gallons" (total harvest after training) will increase by 1471.96. This implies that training in beekeeping increases productivity.

However, by applying the same matching method (nearest matching method) on the ATE (i.e on the entire population comprising both trained and untrained groups), the productivity was found to increase by only 0.421. This indicates that beekeeping training programmes are more effective at boosting production than other demographic factors including age, gender, marital status, amount of education, and years of experience.The training programmes afforded the beekeepers opportunity to enhance their knowledge, skills and attitudes towards the business. As a result, they were more productive than individuals who did not receive training because they were more effective and efficient in their daily duties. By these outcomes of the study, it is observed that the main objective of this study which aimed at assessing the impact of training of beekeepers on the productivity of the apiculture industry in the volta and Oti regions found that training indeed influenced productivity positively.

On the strengths of beekeeping, the study found that natural, human and economic resources that support beekeeping abound in the study. Beekeeping is promoting the sustainance of biodiversity in the study area. Among the weaknesses of beekeeping is the absence of definate policy in place to guide and give direction to the beekeeping sector in the country in general and the study area in particular. Also, there are no well organized and strong beekeeping associations both at regional, district and local levels to help drive the beekeeping business. There is also a lack of institutional support for the beekeeping sector and this is a weakness to beekeeping. Among opportunities available for the development of beekeeping is the presence of some training institutions such as the Ohawu Agricultural College and the Adidome Farm Institute in the study area to offer training in beekeeping to interested people. Beekeepers have come out with improved *borrasus* hives fitted with topbars in place of the *borrasus* log hives. Threats identified included the continuous use of traditional honey extractors despite the benefits associated with improved beekeeping technology and the menace of bushfires that destroy bee habitat abd fora.

Therefore, this study sought to explore the opportunities and challenges with respect to training in beekeeping. The study concludes generally that for the beekeeping sector to strategically function as a sustainable livelihood strategy, training programmes in new methods of beekeeping should be made a topmost priority.

5.4 Recommendations

Based on the above major findings and conclusion, the following recommendations are offered:

To encourage participation in beekeeping training, attention should be paid to the educational background since this factor was found to negatively affect the respondent's participation in beekeeping training. Women should be encouraged and resourced to go into beekeeping training and practice. Moreover, the number of household members into beekeeping, years of experience of beekeepers, age of beekeepers, full-time participation in beekeeping and membership of beekeepers' associations should be considered since these factors have the potential to stimulate participation in the training programmes for beekeepers. Educated people should be encouraged to go into beekeeping

Training of beekeepers led to the enhancement of their skills, attitudes and competence. More training programmes should therefore be organized for beekeepers and those interested in going into beekeeping to constantly upgrade and update their skills and knowledge in beekeeping in order for them to have increased production.

Beekeepers in the study area of the Volta and Oti regions should be encouraged and assisted with resources to tap the various bee flora that blooms at various times of the year and is very suited to beekeeping so as to have an all-year round honey production. The Forestry Commission and the Ministry of Food and Agriculture should take the lead in promoting beekeeping operations across the nation. Training institutions such as the Ohawu Agricultural College and the Adidome Farm Institute that have been giving training in beekeeping should be well resourced so they could give more training especially in value addition to hive products in order to develop the sector. Intense education of the population by MoFA, the Fire Service and other stakeholders should be done to help curb the menace of bushfires and misuse of agrochemicals. Government should as a matter of urgency come out with a comprehensive policy to promote and develop the sector.

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APPENDICES

Appendix 1:

UNIVERSITY OF GHANA - LEGON

INTEGRI PROCEDAMUS

QUESTIONNAIRE

CONFIDENTIAL

ASSESSING THE IMPACT OF TRAINING OF BEEKEEPERS ON THE PRODUCTIVITY OF THE APICULTURE INDUSTRY IN THE VOLTA AND OTI REGIONS OF GHANA.

PRINCE D. K. NYIKPLORKPO, A POSTGRADUATE STUDENT, DEPARTMENT OF ECONOMICS AND AGRIBUSINESS, UNIVERSITY OF GHANA, LEGON

This questionnaire is being used to collect data for an academic study at the University of Ghana, Legon, to assess the impact of training of farmers on the productivity of the apiculture industry in the Volta and Oti Regions of Ghana. This interview is basically for academic purpose and respondents are assured of privacy and confidentiality.

(Please indicate your response by ticking (√) or writing where appropriate):

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS

1. Name of respondent……………………………………………………
2. Mobile no. ……………………………………
3. Gender: Male{ }   Female{ }

4. Age of respondent: ……………..years.

5. Marital status of respondent:

   a) Single { } b)Married { } c) Divorced { } d) Windowed { } e) Separated { }

6. Resident of ………………………….. in the ………………………….district/Municipality.

7. Main occupation ……………………………………………………………………………

8. What is your level of education? No formal education{ } Primary School { } JHS { } SHS { } MS { } Diploma { } B.Sc. { } MSc { } PhD{ }

9. Are you a full time or part-time beekeeper? ………………………………………………….

10. How many persons are in your household? . ……………………..

11. How many members of your household are into beekeeping? …………………..

12. How long have you been keeping bees? ……………….

13. Do you belong to any beekeeping association/group? Yes { } No { }. If no, then jump to Section B

14. Which one do you belong to? ……………………………………………………………

15. What is the total membership of your beekeeping Association/group? …………………

SECTION B: TRAINING RECEIVED IN BEEKEEPING

1. Are you aware of training opportunities for beekeepers? Yes { } No { }

2. Have you ever participated in any beekeeping training programmeme? Yes { } No. { }

3. If yes to 2 above, then when did you have the training? ....

	Year	Training organization	Date of training	Location of training	Duration
3.1					
3.2					

3.3					
3.4					
3.5					

4. What motivated you to get trained in beekeeping?

i. I had interest in beekeeping { }

ii. I saw it as a means of livelihood { }

iii. It was because I belong to an association that was trained. { }

5. If you have not received any training, then what was the reason?

i. I did not have any opportunity to be trained { }

ii. I was sick at the time of the training { }

iii. I was not available at the time of the training { }

iv. I do not see it necessary for success { }

6. If you answered question (5) then how did you get to know how to keep bees? Learnt from: (can tick more than one option) Family { } Friends { } Videos { } TV { } Magazine/Newspapers { }

7. In which aspect of beekeeping were you trained? (can tick more than one option)

S/N	Item	Date training received	Organization	Location	Duration
7.1	Construction of beehives				
7.2	Sewing of Bee suit				
7.3	Moulding of Smoker				

7.4	Honey extractor construction				
7.5	Swarm catcher construction				
7.6	Setting of beehives				
7.7	Baiting of beehives				
7.8	Management of bee colonies				
7.9	Feeding of bees				
7.10	Identification of matured honey for harvesting				
7.11	Identifying difference in honey and brood combs				
7.12	Honey processing				
7.13	Queen rearing				
7.14	Swarm catching				
7.15	Any other (specify)				

8. Were you trained to identify melliferous plants (plants bees like and visit) in your area?

   Yes { } No { }

9. If yes, what are some of them you have identified?

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

ii. Training in processing

10. Fill the table below if you had received training in processing.

S/N	Item	Date training received	Organization	Location	Duration
10.1	Harvesting of honey				

10.2	Honey extraction				
10.3	Production of Mead (honey wine)				
10.4	Beeswax extraction				
10.5	Packaging of honey				
10.6	Record keeping				

iii. Training in colonization

11. Did you receive training in colonization of beehives?

12. Do you use swarm catcher? Yes { } No{ }

13. How many swarm catchers do you have? ………………..

14. Which baiting materials do you use? ……………………………………………

15. How do you get bees into your hives? By baiting { } By colony division { } By use of swarm catcher {} By capturing a swarm { } By capturing established colony { }

16. How soon are beehives colonized after they have been set? ....

17. How many of your hives are colonized? ....

18. How long does it usually take after colonization to do first harvest?..

iv: Training in record keeping

19. In which of the following areas of record keeping did you receive training?

1. Inventory records { }
2. Production records { }
3. Records on colonization { }
4. Records on sales { }
5. Any other(s)……………………………………………………………………………………

………………………………………………………………………………………………

…………………………………………………………………………………………

SECTION C: BEEKEEPING EQUIPMENT IN USE

1. Which beekeeping equipment do you have? (you may select more than one) Beehive { }
   Bee suit { } Smoker { } hive tool/knife { } Torchlight { } Plastic containers { }
   Honey extractor { } other(s) (Specify)……………………..……………………………..
2. Which type of hives do you have? Kenyan Topbar { } Saltpond { } Borasus { } Frame { }
   Other(s) (Specify)……………………………………………………………………..
3. Are you able to produce your own beekeeping equipment? Yes { } No { }
4. If answer to question (3) is no, then where do you buy the following from and what are their prices?

S/N	Equipment	Source	Quantity	Unit Price ₵
4.1	Beehive			
4.2	Bee suit			
4.3	Smoker			
4.4	Swarm catcher			
4.5	Hive tool/knife			
4.6	Honey Extractor			
4.7	Torchlight			
4.8	Plastic containers			
4.9	Other(s)			

SECTION D: TRAINING IN QUALITY, VALUE ADDITION AND SALE OF HONEY AND BEESWAX

i. Production information

1. How do you identify mature honey?..
2. Do you mix mature and immature honey when harvesting? Yes { } No { }
3. Do you have containers you use only for harvesting honey? Yes { } No { }
4. What are the containers you use made of? plastic { } aluminum { } others (specify)……………
5. How do you extract the honey?...
6. Do you produce mead (honey wine)? Yes { } No { }
7. What quantity of the mead (honey wine) do you produce? …………………..

ii. Output information

8. What quantity of honey and beeswax do you get per harvest before and after the training?

S/N	Harvest/year	No of hives	Honey Quantity (lt)		Beeswax Quantity (kg)	
			Before	After	Before	After
8.1	First Harvest					
8.2	Second harvest					
8.3	Third harvest					

iii. Marketing Information

9. Did you receive training in packaging of honey and beeswax?
10. How do you package your honey for sale? ………………………………………………
11. How do you package your beeswax for sale? ………………………………………………
12. Is there ready market for honey? Yes { } No { }
13. Where do you sell your honey? ....

14. Do you have any difficulty selling your honey? Yes { } No { }

15. If yes to (18) above, what are the difficulties? ……………………………………………….

16. Do you sell your honey by wholesaling or retailing? ………………………..

17. Is there ready market for beeswax? Yes { } No { }.

18. Where do you sell your beeswax? ....

19. Do you sell the mead (honey wine) that you produce? Yes { } No { }

20. If yes, then how do you package your mead for sale? ………………………………………

…………………………………………………………………………………………

…..

21. What are the prevailing prices for the following bee products?

S/N	Bee product	Measure (kg, lt, etc)	Price GhC
21.1	Honey		
21.2	Beeswax		
21.3	Mead		
21.4	Propolis		
21.5	Royal jelly		

22. Please indicate the type and quantity of containers you use in packaging/selling honey and how much you sell each as well as price for beeswax in the table below?

S/N	Type of container	Quantity	Unit Price GhC
22.1	Empty beer bottle (6.25mls)		
22.2	Empty bottled water (500mls)bottle		
22.3	Empty bottled water (700mls)bottle		
22.4	Empty bottled water (1lit)bottle		
22.5	Empty alomo bitters bottle		
22.6	Empty 4,5lit gallon		
22.7	Empty 25 lit jerry can		
22.8	Pet plastic bottle (250mls)		
22.9	Pet plastic bottle (500mls)		
22.10	Pet plastic bottle (1lit)		
22.11	Beeswax (kg)		

iv. Compliance to quality assurance

23. Which the following organizations are you aware of as having some authority on beekeeping and bee products?

S/N	Organization	Role in beekeeping	Registered with it? Yes/No
23.1	Ministry of Food and Agriculture (MOFA)		
23.2	Food and Drugs Authority (FDA)		
23.3	Department of Cooperatives		

23.4	National Board for Small Scale Industries(NBSSI)		
23.5	Ghana Export Promotion Authority (GEPA)		
23.6	Registrar General Department (RGD)		
23.7	Ghana Standards Authority (GSA		
23.8	Ghana Consumer Protection Agency (GCPA)		

SECTION F: INFLUENCE OF TRAINING ON FARMERS' PRODUCTION

1. What are you doing differently after undergoing the training? You can choose (tick) more than one

S/N	Item	Training	
		Before	After
1.1	I could construct my own bee hive		
1.2	I could set up my own apiary		
1.3	I could determine the right time for setting hives		
1.4	I could bait my hives		
1.5	I could perform colony division		
1.6	I could merge weak colonies		
1.7	I could detect colonies without a queen and rectify it		
1.8	I could extract quality honey and in a more hygienic manner		
1.9	I could extract beeswax		
1.10	identifying difference between brood and honey combs		
1.11	Prevent harvesting of brood (eggs, larvae, pupae).		
1.12	Better evaluation of beekeeping as a business		
1.13	Increase in shelf life of honey		
1.14	Better assessment of colonies		
1.15	Retain bee colony after harvest		
1.16	Natural biodiversity conservation		
1.17	Early discovery of swarming		

2. Did the training result in your increase in honey production and income? Yes { }No{ }

S/N	Question	Before training	After training
2.1	Income from honey sales	Gh₵	Gh₵
2.2	Income from beeswax	Gh₵	Gh₵
2.3	Production expenses	Gh₵	Gh₵

ii. Self assessment of the impact of training

3. Indicate whether you strongly agree strongly agree, agree, neutral, disagree; strongly disagree by a tick (√)

SECTION G: CONSTRAINTS OF BEEKEEPERS

S/N	Question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
3.1	I need more training					
3.2	I am satisfied with the content of the training I had					
3.3	I did not have any training but I am satisfied with my beekeeping business					
3.4	Beekeeping does not require training					
3.5	Training I received were entirely free					
3.6	I am ready to pay for any training programmeme that can improve my beekeeping business					
3.7	Duration and length of training programmemes were adequate					
3.8	Training programmemes were effective					
3.9	Training programmeme(s) offered me the exact skills I needed					
3.10	I have been trained and can count myself among beekeepers in Ghana					
3.11	I feel very adequate with my current beekeeping skills level from training					

Rank the following issues/challenges that are currently affecting your beekeeping enterprise (***Rank with most pressing = 1 to 11)***

No.	Constraint	Rank
1	Lack of right and adequate education/information/skills	
2	Pest and disease incidence	
3	Absconding and swarming of bees	
4	High costs, and lack of modern apiculture equipment.	
5	Lack of Credit facilities	
6	Theft of honey	
7	Poor pricing of honey and beeswax	
8	Lack of market for honey and beeswax	
9	Lack of extension support	
10	Spraying of pesticides by crop farmers	
11	Hostile attitude of persons close to apiary	

THANK YOU

Appendix 2

PARTICIPANTS IN THE FOCUS GROUP DISCUSSION

	NAME	DESIGNATION
1	Prince D. K. Nyikplorkpo	Student researcher
2	Tordey Gershon Amaglo	Forestry Commission/Volta Region Association of Beekeepers-VORAB
3	Divine Odonkor	Regional Executive Director-VORAB
4	Rev Mawuli Kumah	Secretary ,VORAB, Ho Municipal
5	Wisdom Otoo	Victorious Queen Foundation- Kpando
6	Kafui Gali	Environmental journalist-GreenGlobe Ghana (NGO)
7	Samuel Dei	Executive Director, GreenGlobe, Ghana
8	Henry Anderson	Managing Director, MASCOT FARMS

Appendix 3:

GOOGLE MAP SHOWING GHANA-TOGO BOUNDARY LINE PASSING THROUGH BATUME JUNCTION