ADOPTION OF MODERN HONEY BEE PRODUCTION AND PROCESSING PRACTICES AMONG FARMERS IN KANO STATE, NIGERIA

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA
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DECLARATION

I declare that the research work titled Adoption of Modern Honey Bee Production and Processing Practices among farmers in Kano State, Nigeria has been written by me under the supervision of Prof. B. I. Okeh and Dr. C. Uguru. The information derived from related literature has been duly acknowledged in the text and list of references. No part of this dissertation has ever been presented for award of degree or diploma at any other university.

_____ _____

NDU, Augustina Ukachi Date

CERTIFICATION

This dissertation titled ADOPTION OF MODERN HONEY BEE PRODUCTION AND PROCESSING PRACTICES AMONG FARMERS IN KANO STATE, NIGERIA by Augustina Ukachi, NDU meets the requirements governing the award of Master's Degree (Agricultural Education) of the Ahmadu Bello University Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This dissertation is dedicated to the memory of my beloved parents Mr. F.O. Ndu and Mrs. C. A. Ndu, who laid the good educational foundation on which I am building upon. May God grant your souls eternal rest.

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Abstract

This study assessed the adoption of modern honey bee production and processing practices in Kano State, Nigeria. Specifically, the objectives were to identify the socio-economic characteristics of the farmers, access their awareness and adoption of modern honey bee processing practices. Furthermore, the research sought to identify the benefits of and constraints to adoption of modern honey bee processing practices (MHBPPs) in Kano State. The study was a descriptive survey with a population of 1200 KNAP-trained bee farmers for the period 2010-2013.Ten (10) LGAs were randomly selected (to reflect all the senatorial zones) and all the 270 bee farmers in the 10 LGAs formed the sample size for the study. A structured and validated questionnaire was used to elicit relevant data from the respondents. Of the 270 administered questionnaires, 97.50% rate of return was obtained and the data was used for analysis. The result showed that majority of the bee farmers were males 94.30%, married 91.60%, and aged 45-55years 73.70% with all the participants having at least primary education with an average annual income of ₦200,000.00 from bee keeping business. The bee farmers were aware, adopting and benefiting from MHBPPs In terms of adoption, the most adopted practice was wearing bee clothes followed by sorting and grading and benefited most in quality products with increased income. The most severe constraints to adoption were high cost of equipment, scarcity of modern production and processing equipment and the least constraint was honey fermentation and crystallization. All the null hypotheses were rejected because significant relationship existed in the variables tested. Hypothesis one which stated that there is no significant effect of socio-economic characteristics on adoption of MHBPPP was significant at 0.05. This implies that there is a significant effect of socio-economic characteristics on adoption of MHBPPPs. Significant relationship was found between awareness and adoption of MHBPPs

since calculated r value of 0.637 was found at 0.05 level of significance. There was significant relationship between constraints and adoption as calculated r value of 0.673 at 0.05 levels of significance was obtained. This means that the higher the constraints the lower the adoption of MHBPPs. In conclusion, the study found that bee farmers in Kano State were aware and were adopting the MHBPPs, with benefits of higher quality products and increased income. However, the constraints encountered by the farmers led them to the use blends of local and modern tools in their production and processing. The study recommended that government should provide soft loans, remove duties on imported tools and equipment as well as create enabling environment for local fabrication of honey production and processing tools.

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LIST OF ABBREVIATIONS

Abbreviations		Full Meaning
AU	-	African Union
BES	-	Beekeeping Extension Society
BVT	-	Bee Venom Therapy
CDM	-	Cold Dripping Method
CEBRAD	-	Centre for Bee Research and Development
CRC	-	Community Orientation Committee
EU	-	European Union
FDG	-	Focus Discussion Group
FPT	-	Food Processing Technologies
IAR &T	-	Institute of Agricultural Research and Training
KNAP	-	Kano Afforestation Programme
KNARDA	-	Kano Agricultural and Rural Development Author
KTBH	-	Kenyan Top Bar Hive
LGA	-	Local Government Area
NAFDAC	-	National Agency for Food, Drugs Administration and Control
NEPC	-	Nigerian Export Promotions Council
NGO	-	Non-Governmental Organization
SOFT	-	Society of Facilitators and Training
SON	-	Standard Organization of Nigeria
SPSS	-	Statistical Package for the Social Science (computer software)
USAID	-	United States Agency for International Development
WADG	-	West African Dwarf Goat
WWW	-	World Wide Web

OPERATIONAL DEFINITION OF TERMS

Adoption: The acceptance and continuous use of learnt practices and skills in bee farming. It is the uptake and continuous use of such practices as extraction of honey and wax with centrifugal force and solar extractors, uncapping, filtering, dehumifying of honey and wax.

Adoption of Modern Production and Processing Practices in Bee Keeping: The acceptance and continued use of the skills and practices in the production and processing of hive products. These practices include use of appropriate hives and smokers, identification of bee plants, use of appropriate materials for baiting, ability to inspect and harvest without much disturbance to bees, proper strainers/filters for honey and wax, sorting and grading the products according to acceptable standards, proper packaging in labeled containers, use of protective bee clothes, use appropriate rooms for extraction and grading of honey and wax. Other modern processing practices include the use of centrifuge and solar extractors, avoidance of naked fire during harvesting among others.

Adulterated Honey: Honey that is contaminated with any foreign material like impurities wax/comb remains, crystallized particles of honey, particles from smoker etc; these particles reduce the quality and hence market value of honey.

Bee Brood: The young bees that have hatched and growing up.

Colonization: The situation where bees occupy and reside in a new or un-occupied hive and continue their activities of procreation and production of products.

Dehumification: a means of reducing the moisture content of honey. It involves the use of a device called dehumifier which rapidly decreases the relative humidity of honey (without damaging the quality of the honey).

Honey Bee Processing: This involves value addition to the bee products through extraction, sieving and straining, sorting/grading, bottling, labeling, packaging into cartons. Through these practices, dirt, all impurities and moisture are removed from honey and wax.

Honey Bee Processing Practices: These are skills, methods and techniques used in adding value to honey bee products. It includes ability to extract products using appropriate tools and equipment, identification of the good strainers from bad ones, sorting/grading based on quality, appropriate labels for their products.

Super: Extra/ new hive placed on top of another hive purposely for honey especially when the lower hive is full of honey. It helps in managing negative tendencies such as swarming and abscondment of bees.

Uncapping: The removal of the covering/ceiling of the comb so that the honey flows out into a waiting container. It can be done with knife, uncapping knife or automatically in automated extractors.

Queen Chamber: The queen's room/place where she lives and cared for by the workers in the hive. The queen leaves the chamber only during maiden flight, swarming or abscondment.

Queen Rearing: Raising young queen artificially by the bee farmer through providing the necessary environment for the workers and queen to prepare the cells for the queen.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Honey bees are social insects that belong to the family *Apidae,* genus *Apis* and species *Apis melifera*. These social insects visit approximately two (2) million flowers to make one pound of honey for human use. They live in colonies made up of only one queen, some few drones and thousands of workers. According to Mujuni, Natukunda and Kuzonga, (2012) a productive colony may have more than two- three million workers performing various duties (near perfect division of labour) and a co-ordinated lifestyle. Bees produce honey, wax, propolis, bee pollen, bee venom and royal jelly which are beneficial to man as food, medicine and materials for industrial use. The use of bee and its products through apitherapy and bee venom therapy (BVT) in the treatment of various human ailments and diseases abound in literature.

Stangaciu (2006) reports several uses and benefits of bee and its products in the treatment of various ailments and diseases. Richardson (2012) states that fresh raw honey is not only a sweetener, but has many wonderful anti-bacterial, anti-viral, and anti-fungal properties and hence used as a potent healing agent in many parts of the world. Apart from these products, honey bees contribute immensely in ensuring continued human existence through their activities in the pollination of plants. Food is cheaper in most developed economies due to the intense specialized agricultural system of which honey bees play key roles through colony renting for pollination in farms. Abebe, Puskur and Karippai, (2008) reports that honey bees increase the productivity of both food crops and forest trees and specifically increase the production of water melon by 100%, onions by 94%, and citrus fruits by 30%, and tomatoes by25%. In developed economies and places where bee keeping is commercialized, bee renting for pollination is another source of income to farmers (Kaiser

and Arnst 2013) and also leads to diversified agriculture as it can be integrated with other agricultural activities as well as agro-forestry (Shakib & Sayed, 2016).

Bee production or apiculture involves the use of modern artificial techniques of managing bees for honey, wax, pollen, propolis, venom and royal jelly. Since bees are naturally wild, what is done in bee farming is the use of appropriate management and modern practices to manipulate the environment (climate, soil, vegetation, equipment and other resources) to enhance production. Due to its role in employment, bee farming has become one of the major strategies of governments especially of East and South African countries at alleviating poverty and improving income of people. It is an enterprise that is not only beneficial through its products, but also its minimal start off capital, environmental friendliness and large market for products (Haftom-Gebremedhu, Tesfay, Murutse and Estifanos 2013).

There are different categories of honey bee practitioners especially in developing countries like Nigeria. These practitioners include honey hunters, hobbyists, careerists and professionals who engage in one aspect or the other in honey bee and other related products. Most times their production is of low quantity and quality due to use of local tools and poor practices (Fakayode, Babatunde, Olowogbon & Adesuyi 2010). These practices destroy not only the adult bees, but also the brood, combs, flowers/plants and contaminate the products harvested. Their bee production activities are not different from the honey hunters (poachers, thieves or vandalizers of hive products). These people 'fire and kill' bees, harvest matured and immature honey, vandalize the hives and waste many other products for lack of appropriate skills and practices. There are also the hobbyists who, for their love of the golden insect, keep a few hives in their environment but are usually scared even opening or harvesting the products.

On the other hand, commercial honey bee farmers keep a large number of modern hives and equipment in many different apiaries where they have managed the environment to suit the bees. The products of such commercial farms are usually more varied and qualitative due to better methods of production, harvesting, extraction, grading and packaging of the products. Although the bee farmers are categorized in these forms by different authors, most of them co-exist or use blends of both practices. This is to say that a farmer may have both local and modern apiary equipment depending on available funds, level of skill acquired and available technology. Therefore, there is need to create awareness among bee farmers on the need to adopt modern production and processing practices for the protection of the bees and production of high quality products.

Awareness is simply knowledge of the existence of something: practice, technology or an input, a skill, equipment or method of doing something. This knowledge may lead to adoption or non adoption of the innovation depending on the benefits derivable from its use. When a honey bee farmer learns of the existence of a modern practice (use of Langstrouth hive, safety bee kit or honey or wax extractor) and gains some understanding of its functions, such an individual is said to be aware. In bee farming, this knowledge includes information about modern skills, methods and practices of production, baiting, swarm management, harvesting and processing, sorting and packaging, identification of good marketing channels among others. Sources of this new knowledge or practices can be from the extension officer, fellow bee farmers, co-operative groups, nongovernmental organizations (NGOs), agricultural departments of tertiary institutions and government farms. The source of the information of the innovation may positively or negatively affect its use by the honey bee farmers. Awareness is the first stage in the adoption process. The level of awareness of the modern processing practices and the benefits derivable from their use will make farmers to adopt. However, with improved knowledge, skill, practices and

improved tools and facilities, the quality and quantity of produce will satisfy both local and export demands. Processing helps to increase and improve the quality and shelf-life of the hive products. The purpose of processing any product is to add value and increase the products' acceptance by the consumers. The processing stages for the production of marketable honey according to food processing technologies (FPT, 2000) include uncapping, extraction, settling, dehumification, filtering, grading, packaging and labeling.

Adoption is a complex process that requires time for decisions to be taken by the farmer. It implies the acceptance and continued use of a new and recommended idea or practice by individuals or groups over a reasonably long period. Tabinda, Murad, Sajida and Akmal, (2013) define adoption in bee farming as the development and use of new bee management techniques, production and distribution of genetically superior honey bee queens, appropriate skills for production and processing as well as marketing of produce. Adoption involves creating awareness of the innovation, building interest and evaluation of the idea by the farmer, trial and eventual adoption or rejection of the innovation. Adoption is made easier if the innovation has better advantages over the practices already in use.

One of the basic reasons for adoption of any innovation is due to the benefits accruable from such a venture by the prospective person or user. Roger's theory of adoption (1962) clearly agrees that new practices that have advantages are much more easily accepted by the prospective end-users. The adoption of the modern methods of processing hive products presents the bee farmer with a lot of benefits. Some of these benefits include ease of operation/work in the apiary, much more harvest of other products that were otherwise wasted due to poor skills and tools of processing them. Moreover the sustainability of bee farming is guaranteed since the bee brood (young bees), environment and the farmer are all preserved and protected when modern methods of both production and processing are

employed. This is because the farmer harvests only the ripe honey while leaving the immature ones to remain and complete their own life cycle

The use of modern methods in processing honey and wax reduces to the lowest level the incidences of adulteration of products. This is because the right type of hive and other hive tools that allows for proper inspection and or harvesting of products are put in place hence risks and some hazards of the job are reduced. This is in contrast to the use of local hives where all the contents of the hive (honey, wax, bee brood, and all the bees) have to be harvested at the same time. The sustainability of bee production business cannot be guaranteed in such a case.

Innovations that have made bee farming easier such as queen rearing cannot be practiced by bee farmers who do not have the right tools and practices. Through queen rearing, the farmer is able to determine the trait and characteristics of the colony, time and number of hives to establish since he no longer depends on chance for the colonization of his hives.

In order to achieve good success in honey bee production and processing, the farmer should have some personal qualities and skills that will enhance effective production. Some of these qualities according to Gregner, (2003) include interest in bees and their characteristics, love for good flowers, being a naturalist and biologist who uses good knowledge and skills learnt to harness the bee products. Also the intending honey bee farmers should relate well and have good interaction with experienced bee farmers as mentors. Through these interactions, the new entrants learn the basic modern skills and practices in the what, why, when and how of managing bees and their stings for good production. According to Abebe *et al.* (2008) in Ethiopia and Mujuni *et al.* (2012) in Uganda, bee farmers prefer to learn new techniques, skills and practices from their fellow farmers than from extension workers due to issues of trust.

Some of these skills and practices include the ability to open and inspect activities in the hive, ability to wear and use the bee clothes and remain calm especially when the bees are agitated in the course of inspection or harvest. It also includes ability to differentiate the various products through their color, scent or position in the hive and be able to harvest them. Other important practices and methods include the ability to use the modern processing machines, tools, equipment and other materials to harvest, uncap, extract, dehumify, sort/grade, package and load these products appropriately with minimal or no damage or contamination. Awareness and adoption of these modern practices are very important to every intending or practicing bee farmer in order to improve the quality of honey bee products in Kano State.

Kano State Government, in an effort at reducing the high rate of unemployment, security risks and youth restiveness, train and provide inputs to different people in the state. The Kano Afforestation Programme, (KNAP) a parastatal of the Ministry of Environment, under the Community Orientation Committee (COC) train people in various aspects of agriculture including bee farming. Records from KNAP shows that for some years now (2010-2013) a total of one thousand two hundred (1200) people were selected, trained and empowered with basic practices, skills and tools in honeybee farming They were also given 2 modern and one local hives, complete bee kits (boot, gloves, overall, goggles, hat), buckets, smokers, hive tools and a financial assistance of ₦5,000.00 per participant. Monitoring and evaluation of the activities of the trained bee farmers is carried out by the monitoring and evaluation unit of the parastatal. In order to reduce the problems of adulteration and marketing of their products, KNAP buys off the raw produce from some of the trained bee farmers, process and market the product in differently sized containers that are labeled.

1.2 Statement of the Problem

Honey bee production is an aspect of agriculture that has been described by many as a profitable venture due to its many benefits and opportunities. It has the potential of creating sustainable employment, alleviating poverty and improving the ecological condition of the environment where it is practiced. Despite all the benefits of bees to man coupled with the small 'take-off' funds, bee farming has not received the desired recognition by both government and the citizenry in Nigeria and in Kano in particular. Most of the honey consumed in Kano is produced by honey hunters whose production is low both in quality and quantity, due mainly to poor skills in processing the products. Even the traditional honey bee farmers also use crude tools and materials both in production and processing. These traditional tools and practices have detrimental effects on the environment, honey bee population (destroys the bee brood and combs), lowers quality and quantity of hive products, reduced economic gains of the farming community. These crude/traditional methods are a threat to sustainability of bee business.

However, with modern skills and practices in production and processing, many more and higher quality products are harvested from the hive. The modern box/framed hives are designed to make inspection and harvesting of products easier since the frames and hives are not attached by wax or propolis. Equally, the use of complete bee kit reduces bee stings on the farmer thereby allowing him to focus and complete his work (inspection of harvesting) without fear of being stung.

Due to poor processing and packaging of products in unlabeled containers, there is high level of adulteration, resulting to poor market at local and international levels. It is the quality of honey that has disqualified Nigeria from exporting hive products to the EU as a third world country ('third country'). Nigerian Export Promotion Council (NEPC, 2015), states that the non certification of Nigeria has affected Nigerian investors and exporters who

secure orders from EU importers for honey, propolis, wax and other products. This adulteration is costing Nigeria over US $200 million annually that would have been earned from export of honey bee products.

In addition, bee farming has not been accepted by many people as an income generating aspect of agriculture due to fear of bee stings (bee phobia) and poor knowledge of how to manage them. With the adoption of modern production and processing practices and facilities by farmers, honey bee production will improve to the level of export in the country. This study therefore, investigated the adoption of modern honey bee production and processing practices in honey bee farming in Kano State, Nigeria.

1.3 Objectives of the Study

The broad objective of the study was to assess adoption of modern honey bee production and processing practices in Nigeria. The specific objectives of the study were to:

1. describe the socio-economic characteristics of honey bee farmers in Kano State;
2. ascertain the awareness of MHBPPPs in the production and processing of honey and wax in the study area;
3. assess the level of adoption of MHBPPPs in production and processing of honey and wax in Kano State;
4. examine the benefits derived by the farmers in using MHBPPPs in production and processing of honey and wax; and,
5. identify constraints to adoption of MHBPPPs in production and processing of honey and wax in Kano State.

1.4 Research Questions

The following research questions were drawn up to answer the research questions:

1. What are the socio-economic characteristics of the honey bee farmers in the study area?

2. Are the farmers in the study area aware of MHBPPPs in production and processing of honey and wax?
3. What is the level of farmers' adoption of MHBPPPs in production and processing of honey and wax in Kano State?
4. What are the benefits derived by farmers from using MHBPPPs in production and processing of honey and wax in Kano State?
5. What are the constraints to the adoption of MHBPPPs in the production and processing of honey and wax in the study area?

1.5 Research Hypotheses

$Ho_{1:}$ There is no significant effect of socio-economic characteristics of honey bee farmers' on adoption of MHBPPPs in production and processing of honey and wax in Kano State.

$Ho_{2:}$ There is no significant relationship between farmers' level of awareness and level of adoption of MHBPPPs in the production and processing of honey and wax in Kano State.

$Ho_{3:}$ There is no significant relationship between the number of constraints and adoption of MHBPPPs in the production and processing of honey and wax in Kano State.

1.6 Significance of the Study

Every study or research is supposed to add new knowledge and information to the existing body of knowledge in the society. This study will be useful to a number of individuals and organizations. These include the honey bee practitioners, policy makers, educational institutions, Non-Governmental Organizations (NGOs), training consultants and others.

Honey bee practitioners will benefit from the findings of the study because it will provide them with modern skills in processing the hive products. The modern skills will

enable them to process the hive products to the level of getting the maximum benefits in both quality and quantity. More over none of the products will be wasted as the skills and methods needed to get all the products (honey, wax, propolis, bee bread, bee venom and royal jelly) will be known.

Policy makers of government will equally benefit from the study because it will provide the needed information on how to plan activities and projects that will help to improve the methods and skills of especially the unemployed and under employed people in the society.

Furthermore, the findings will be useful to planners in managing and making government programmes more focused and result-oriented. This will result to improved and increased production, more income generation as well as job creation for the teaming youths. Educational Institutions and other skills training and development outfits will use the identified methods, skills and practices on their trainees for improved productivity in bee keeping practices. The result of the work can be used as a guide by educational institutions where honey bee farming is taught like the universities, polytechnics, colleges of education and colleges of agriculture. These people will graduate with the needed methods, skills and practices necessary for starting up their own businesses. Honey bee farmers associations, bee farmer co-operatives and even young farmers club will benefit from the findings as it will help in training and retraining of their members.

1.7 Basic Assumptions of the Study

This study assumed that:

1. Honey bee farmers in Kano State are aware but are not adopting modern practices in production and processing the products of the hive.
2. Due to poor production and processing practices of the hive products, consumers' demands are not met, hence less benefits/income for the farmer.

3. Adoption of modern production and processing practices will lead to sustained honey bee production and the creation of gainful employment and income for farmers.
4. With improved practices and good standard of living of the current ageing bee farmers, the youths will be attracted to honey bee business.

1.8 Delimitations of the Study

The study was delimited to the assessment of the adoption of MHBPPPs in the production and processing of honey and wax among farmers in Kano State. It was also delimited to the objectives of the study and to Kano State as the study area. Furthermore, it was delimited to honey bee farmers who have been trained by KNAP and have their personal apiaries either at subsistence or commercial scale at any of the KNAP Forest Shelter Belts in Kano State. This was to avoid interferences from extraneous factors. The study was also delimited to the modern production and processing practices for honey and wax only as the other hive products are not part of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter reviewed of literature related to the study. The review was done under the following sub-headings:

2.1 Theoretical Framework of the Study

There are different theories available for the uptake of innovation by farmers. According to Botha and Atkins (2005) there are different theoretical frameworks in the uptake of innovation. This study however, was based on Rogers's diffusion of innovation theory propounded in 1962.

Diffusion of innovation seeks to explain how, why and at what rate new ideas and technologies spread through cultures. Rogers (1995) defines diffusion as a special type of communication or spread of ideas from one society or culture to another or from a focus or institution within a society to other parts of the society through different channels over time.

The messages are usually new ideas or practices being taken to farmers with the expectation that they (farmers) will adopt the innovation. Adams (1999) listed 4 elements that affect diffusion as the innovation, communication channels, time and the social system (individuals or groups to be served). This is to say that the package embedded in the innovation and the means of passing the information to the farmers affects its spread. Diffusion is not a single, all-encompassing theory, but made up of several theoretical perspectives that relate to the overall concept of diffusion. The innovation may have spread through cultures, however, Adams (1999) notes that its adoption is affected by many other factors. The decision to adopt an innovation, according to the author is based on time, awareness, persuasion, decision, trial and acceptance or rejection. The honey bee farmer that will adopt the framed hive for production or extracting machine for honey or wax processing must necessarily be aware of its existence and be convinced of its usefulness in the production. Potential adopters' decisions to accept or reject will be based on the results of trials of the innovation in terms of economic gains, compatibility with many factor around and within the farmer. This theory is suitable to the current study because it will guide the researcher on the strategies that can be adopted in convincing farmers to adopt the new innovation in honey bee production and processing.

Individual innovativeness theory in the view of Nutley, Davies and Walter in Botha and Atkins (2005) is based on an individual's inquisitiveness or desire to seek and know more about a new idea or innovation. It focuses on the abilities of a person that will spur him/her to come up with genuine ideas of doing things. In relation to innovation in honey production and processing, inquisitive people seem to be more eager to adopt innovation in queen rearing, use of centrifuge extractors and the packaging of products in labeled containers. The source and sender of innovation information counts so much in the acceptance or rejection of such innovation. Hence the channels of information (sender)

should be tested and trusted by the farmers in order to enhance adoption. In relation to this study, it is believed that if information of new techniques in honey bee processing is made available to farmers, there is every possibility that the rate of adoption will be higher among the inquisitive farmers who, in turn will make such information available to other farmers.

Theory of rate of adoption was propounded by Rogers (1995) and focuses on the rate at which different farmers respond to innovations. It usually starts slowly and gradually picks up as times progresses. The author identified that the adoption of innovations is best represented by an s-curve on a graph. It holds that adoption grows slowly and gradually in the beginning and then a period of rapid growth that will taper off and become stable and eventually decline (Rogers, 1995). Similarly, Adams (1999) used it to describe the relative time of adoption and categories of different farmers into innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34.0%) and the laggards (16.0%), Time is very significant in the diffusion of innovations among framers because they need to think through and make decision on the new skill or package This theory is useful to the current study in that if the technical steps involved in honey bee production and processing is sequentially arranged from simple to complex, highly inquisitive farmers can easily adopt and then replicate same among other farmers.

Theory of perceived attributes in the view of Rogers (1995) as reported by Botha and Atkins (2005) is based on the notion that individuals will adopt an innovation has benefits or advantages more than what is in use already in the farm. It discusses the advantages of the modern skills or tools over the traditional ones including its compatibility with other existing practices and resources (method of production, size of farm, available skills and cost). The new practice should not be too complex and should be tested and proved better with observable results. This aspect of the theory is relevant to the current study as it emphasizes the advantages of modern production and processing practices over

the traditional methods which if not checked can lead to the extinction of bees and destruction of the ecosystem. The new production and processing practices will enable farmers to harvest many more products (propolis, venom, bee pollen and royal jelly apart from honey and wax) which were before now wasted due to poor skills. The quality and quantity of these produce or crop yields through pollination should be evident as well as continues harvesting through proper de-queening and re-queening at appropriate times. This will mean more income resulting to better standard of living.

However, weaknesses of this theory as identified by Botha and Atkins (2005) are that it does not consider that some people may not adopt even after understanding the workings and benefits of the innovation. This rejection may be due to many reasons which may include poor skill needs, high cost of the innovation, size and ownership of farm land and compatibility with other operations already in existence in the farm. The theory also failed to give sufficient consideration to innovation characteristics, which according to Kole in Botha and Atkins (2005) assumed that all members of a group should adopt innovations and quickly too. Another demerit of the theory is that early diffusion studies assumed that adoption of an innovation meant the exact copying or imitation of how the innovation has been previously used in different settings. Innovation should rather be adapted or modified to suit particular new settings. However this research will develop strategies that will reduce to some extent some of the identified weaknesses of the theory in the course of adopting it as the theory for the current research.

2.2 Honey Bee Production

Honey bee farming is the practice of farming bees in managed environments in order to get economic benefits from them. Morse (1994) defined honey bee farming as the preservation of honey bee colonies through the use of sophisticated and artificial technologies (hives) for the production of desirable products. Ivbijaro (2012) named bees

as one of the beneficial insects that have many products which include honey, beeswax, bee pollen, propolis, bee venom and royal jelly. In the same vein, Ntege-Nanyeenya *et al.* (1997) and Ndu (2003) explained that honey bee production is the art, science and business of rearing, breeding and managing bee colonies (*Apis mellifera*) in hives for its products and benefits in crop pollination. Honey bee production includes all the practices that involve managing the environment (equipment, weather factors, soil and other resources) that enhances and enables bees to produce honey and other hive products as well as be involved in crop pollination. Honey bee production is different from honey hunting although the two involve honey production. While modern honey bee production enhances sustainability of bee keeping enterprises by protecting the bees from destruction, honey hunting by its practices kill the bees, destroy the brood and destabilize the ecosystem (Matanmi *et al.* 2008).

Honey bee production has lots of benefits both to mankind and to the environment. Ojeleye (2016) identified about eight products of bees as honey, beeswax, pollen, propolis, bee venom, royal jelly, apilarniril and apilarniprop each having its values either as food, medicine (apitherapy) or as ingredients for manufactured goods. In the same vein, Abebe *et al.* (2008) stated that farming communities benefit more from the honey bees in terms of improved nutrition, sustained income and pollination of planted crops. Tope, Fohouo and Bruckner (2012) reported that bees increased the fruit and seed yields of many plant species through pollination. This is the reason for honey bee renting in the developed economies and this is an added source of income to the bee farmer. Belewu (2015) and Ajao, Idowu and Oladimeji (2015) states that the value of honey bee pollination is 30-50 times the value of honey and the monetary worth of commercial pollination in the US is estimated to about 15-20 billion US dollars annually. This symbiotic relationship between plants and bees help in balancing the ecosystem and leading to sustainability of the environment.

In a research conducted by Yusuf, Lategun and Ayinde, (2010) in Kwara State, it found that honey bee farming has the potential of creating enough employment to absorb the teaming unemployed youths due mainly to the low start-up capital, small land requirement and minimal managerial needs. Some of these employments include hobbyists, small scale and commercial bee farmers, professionals, input providers and processors of the products. In a survey conducted by Salama and Matavele (2009) on the situation analysis of bee keeping industry in eight South African countries (Botswana, Lesotho, Malawi, Mozambique, South Africa, Swaziland, Zambia and Zimbabwe), it was found out that bee farming improved the income, livelihood and crop production of the people, even though they have not met their potential in production. In the same vein, Abebe *et al.* (2008) reported that bee farming has contributed about 20% of the Gross Domestic Product (GDP) and about 60-70% of the livelihood of the population of Ethiopia. The report further stated that Ethiopia is the leading honey producer in Africa and has beeswax as one of the 12 major exportable agricultural products with over a million people employed by bee farming.

The realization of the benefits of the hive has led to efforts by various agencies of both government and non-governmental organizations at improving production through trainings and retraining in modern production and processing practices. In Nigeria, as obtainable in other countries especially in Africa, government agencies at national, state and local governments are collaborating with national and international research institutes as well as other countries in seeking ways to improve and increase honey bee production for both local consumption and for export. The Oyo State Government and the Institute of Agricultural Research and Training (IAR &T) under the coordination of Centre for Bee Research and Development (CERAD) collaborated with Israeli Embassy and organized a 12- day modern bee production training at Moore Plantation, Ibadan and at the Nigeria National Park Service, New Bussa in August 1998.

In 2004 the Raw Materials Research and Development Council, Abuja sponsored the establishment of model apiaries for beekeeping and honey production in the 6-Geo-Political Zones of the Federation. In 2006, the European Union sponsored the procurement of technical support for the planning and implementation of capacity building on bee farming, honey production and processing under its Micro-Projects Program in Six States of Niger Delta (EU-MPP6). Also in 2013, the Centre for Entrepreneurship Development and Vocational Studies sponsored the establishment of honey factory/modern apiary for The Federal Polytechnic, Ado Ekiti, (Ojeleye 2013). The report further stated that the Leventis Foundation, Nigeria, has taken the initiative to include bee-farming in the curriculum of its agricultural schools in Ilesa Oyo State and Dogon Dawa in Kaduna State.

Furthermore, Akinnifesi and Setshwaelo, (2014) reports the South-South Cooperation in training beekeepers in technologies relating to wild bee harvesting, hive construction, production and processing of honey. According to them, this programme is an initiative of the China-Nigeria-FAO aimed at empowering people in various areas of agriculture.

In the same vein, the Kano State government has made efforts to improve honey bee production by training bee farmers in modern practices. The Afforestation Department, a parastatal of government under the Ministry of Agriculture and Environment has trained honey bee farmers from all the forty-four (44) Local Government Areas on various aspects of modern bee farming. They were equally empowered with some start-off equipment such two (2) Kenyan Top Bar Hive (KTBH), one (1) local hive, smokers and a small take-off grant. Also the Kano Agricultural and Rural Development Authority (KNARDA) engage in training and supervision of farming activities in the state including bee farming. An NGO known as Apicultural Society of Nigeria in the state train, coordinate and sensitize bee keepers with both local and modern practices of bee farming. However, most of these

keepers complain of poor forage, vandalizing of hives, and adulteration of products as well as poor input as major problems.

At the educational level, bee production is one of the courses taught at the tertiary institutes as a prerequisite for graduation at the colleges of education, colleges of agriculture, and universities of agriculture as well as in faculties of agriculture in regular universities. Many Non Governmental Organizations (NGOs) are organizing trainings, workshops, conferences, exhibitions and fares all aimed at making the bee farmers more aware of modern production and processing practices. This clearly shows that the future of bee keeping in the country is good as many more of these trainings are needed in all the local government areas of the nation. However, how much aware are the bee farmers of the innovations in bee farming and processing and how many of them adopt them?

2.2.2 Socio-Economic Characteristics of Bee Farmers

Bee farmers are people who engage in one form of apicultural production, processing or services or the other. They may own apiaries of different sizes, or buy products and process into finished products or they may be marketers of the products in or out of the country. These bee farmers have some peculiar socio-economic characteristics which include age, gender, marital status, educational qualification, major occupation, and years of bee production experience, farm size/number of hives, average annual income from bee business and source of bee production and processing tools, equipment and information.

The belief and classification of agriculture by many people as an occupation for the poor has been extended to bee farming, hence many young people do not get engaged in it. Several literatures show that majority of bee farmers' age about 50 years and above and they are mainly males with minimal or no education. Matanmi *et al.* (2008) shows that bee farmers in Oyo were mainly males aged 50 years and above. This was also reports that in Ethiopia by Abebe, *et al.* (2008) that 94% males, in Uganda 95% (Mujuni *et al.* 2012) and

they aged 55years and above. Also Abebe *et al.* (2008) reports that age, educational level, visits and convictions from others farmers affected adoption of innovation. Kebebe (2011) reports that Silti Wereda bee farmers in Ethiopia were mainly males 96.25%, married 93.75%, and 77.5% of them were 21-50 years of age and they had literacy level of 60%. This literacy level differed from the earlier findings of Abebe *et al.* (2008) who observe that literacy among bee farmers in Ethiopia was seventy six percent (76.7%). It is a fact that High literacy level of respondents enhances adoption of innovations. In a similar vein, Onwumere, Onwukwe and Alamba (2012) reports that bee farmers in Abia State, Nigeria, were mainly males (75%) 50% married with 43% having secondary education. Also 56% of them had farm size of 5-9 hectares and 56% has had 6-10 years bee keeping experience and they reported that the younger generation were adopting the modern innovation more the older farmers who stock to the traditional methods. In Nigeria according to Adamu (2014) most bee farmers are above fifty years of age, mostly illiterates and are majorly males. Hippolyte, *et al.* (2015) found out that Kenyan bee farmers adoption of innovation is significantly affected by gender, educational level attained, off-farm income and number of apiaries visited.

The nature of bee production (stings, night activities of harvesting, tasking jobs of carrying hives and some cultural beliefs) is a factor to women participation. In a study in Pakistan by Quiser *et al.* (2013), they found that women's participation in bee keeping is poor due to some cultural beliefs (housewife to do only domestic jobs as well as pudah system,) and the tasking jobs are hindrances to their participation. Kebebe (2011) found out that women participation is affected by traditional bee keeping, psychological fear of bee stings, time of major activities and household workloads. This implies that improved production and processing practices may enhance women participation in bee farming. These socio-economic characteristics should be improved in order to increase and improve

the productivity of the hive in quality and quantity. Through good education of the benefits of the innovation, awareness of the sources of supply and good channels of marketing their products as well as the removal of the constraints, bee farmers' adoption of modern production and processing practices will be improved.

2.3 Production, Management and Harvesting of Hive Products

Apiary, bee-yard or bee farm is a place where colonies of bees are kept in hives for proper management and productivity. A good apiary site is the one that provides the optimal conditions for the bees to live and produce maximally. Haftom-Gebremedhn, Girmay and Awet (2013) states that since apiculture are a floral-based-business, bee farmers should have good understanding of the type and duration of the floral calendar with consideration to the climatic condition and farming system practiced in the area. Such a place should be secluded, have good sunlight with abundance of floral plants. According to Ayodele and Onyekuru (1999) and Cramp (2008) a good apiary site should be close to a multitude of flowering plants, good source of clean water and be far from heavy human and vehicular movement to avoid noise vibrations. Noise irritates bee especially African bees and causes them to sting. The area should also be free from high tension wires, flooding, and pest and disease incidences. Akhaluola, (2011) adds that a good apiary should have good access road and be protected from honey hunters and wild animals that vandalize the hives. The use of gentle stingless bees can also be used in the urban areas as it can reduce stinging and phobia of people.

Although bees can travel several miles in search of pollen and nectar, however, the abundance of nearby floral plants within a range of 2 miles or even less leads to a good crop of honey and other apiary products (Ojeleye, 2014). These can be planted orchards, crop lands or forested areas and even weeded lands as long as they have flowers. Bees identify good flowers according to Abdulazeez, (2013) by colour, shape, pattern and odor or scent.

The bee farmer should be able to identify and plant different honey bee plants which flower at different seasons of the year in and around the apiary. This provides an all-year-round food for bees. Some of these honey bee plants include citrus spp, mango, guava, avocado, cowpea, groundnut, sunflower, tomatoes, cotton, soya bean, castor, eucalyptus, pride of Barbados, rose and many other plants.

Supplemental Food: This is necessary at periods when flowers are not available. Haftom-Gebremedhn, *et al*. (2013) states that during periods of food scarcity, alternative food should be made available for the bees. The supplemental food can be in forms of sugar syrup, pollen supplement; dried soya bean mixed with honey and melted wax. Akinwade and Badejo, (2009) found out from their research that banana paste can be fed to bees to increase the population of the worker bees for more honey production. Whatever is to be fed to the bees must meet up with the colour, taste, scent and at a soluble level that the bees can readily use. Clean fresh water should be made available at all times to enhance their proper health and production.

Equipment and Tools: Having identified the appropriate site for the apiary, the next most important duty is to provide the equipment and tools most especially the hive. Several literatures have shown that in most countries there is a mix of both traditional and modern equipment in use. In researches conducted in Ethiopia and Kenya by Abebe *et al.* (2008) and Hippolyt *et al.* (2015) respectively, it was found that both traditional and modern tools and practices were adopted in both production and processing. However, there should be caution in the use of traditional equipment and tools (especially local hive) as it does not easily give in favorably to work of inspection and harvesting of products. Oyerinde and Ande, (2006) warned that using traditional tools and practices have detrimental effects on the environment, honey bee population, quality and quantity of hive products, reduced economic gains of the farming community. Some of these traditional hives, according to

Gregory (2011) are made from straw, calabash, hollow tree trunks, clay pots and wooden materials of various shapes and sizes.

In terms of processing, Kaiser and Arnst (2013), Akhaluola, (2011) and National Beekeeping Training and Extension Manual (2012) identifies some of the modern tools, materials and equipment to include decapers, decantation facilities, honey press, centrifugal extractor, solar extractor, humidifier, labeled containers, strainers of different sizes, different sizes of bottles, buckets and basins with covers. Others, according to Morse (1994), Cramp (2008), Gregory (2008) and Onabe (2011) includes stainless containers of diverse sizes and shapes, small plastic containers for wax, knives and sieves of different mesh sizes. uncapping knife or capping scratcher, capping trays, settling tanks, honey filters or sieves, plastic or stainless basins or buckets with lids, jerry cans, bottles of various sizes. Pot of different sizes, and pans, bowls, plastic moulds of varying sizes, clean white clothing materials for straining, solar wax extractor, steam wax extractor as well as heat source, soap for smearing wax moulds, strong sticks for applying pressure to the straining bag.

Management: Management in honey bee production involves all the efforts and practices made by the farmer to ensure that the bees are comfortable and hence are able to produce and store surplus honey for man. The practice adopted in a particular apiary is determined by the production type of the farmer (queen rearing, honey producer, beeswax producer or one that is more interested in bee renting for pollination). Management in bee farming according to Randy (2013) involves basically obeying these three rules, bees' need for a warm and dry bedroom (brood chamber), abundance of flowers so that they can store surplus (harvestable) honey and the need to manage parasites. Healthy colony that has large population requires a queen that has good capacity to lay eggs, availability of nectar and pollen. There is need also for adequate space in the hive as well as honey storage for the dearth period. A good worker bee population is necessary to look after and feed the brood,

forage and maintain temperature control in the hive. Good management of these factors in terms of enhancing and improving them are important. The level of sophistication of the enterprise determines the extent to which management can affect these factors. Some of the practices that affect all types of enterprises include ensuring that the hive condition is optimal to weather factors, level of ventilation in the hive should be adequate and the colony should be protected from pollution, pests and diseases.

Baiting: This is a practice in honey bee farming aimed at attracting bees to the hive. Several cultures use different things to attract the bees which may include honey itself, wax, local scent made from a combination of leaves, barks, roots and other materials that has been dried and ground together. The burning of this material in an un-occupied hive attracts swarming or absconding bees, which comes, inspects and colonize if the place is conducive. Other materials include perfume; wax and honey, which according to Morse (1994) and Mujuni *et al.* (2012) which have strong scent and lasts longer in the hive.

Swarming: This is one of the natural tendencies of bees and occurs at particular periods in a year. Swarming involves the splitting of the colony with the younger queen leaving the old hive for another place. Un-conducive hive conditions such as congestion (with brood and honey), poor ventilation and feeding or pest and disease attack or even over population. Through adequate management and practices of the colony, the farmer can use swarming to his advantage. In order to prevent swarming according to Gregory, (2011), Kaiser and Ernst (2013), Randy, (2013) and Ojeleye (2014), the bee keeper should de-queen and or re-queen colonies if the brood nest is crowded, keep young queens, harvest ripe honey, add supers, give plenty of storage and brood space, equalize or divide the colony by placing another baited hive nearby so that the young queen move in and colonize it. The bee farmer can do any of these when he observes the swarm cells starting or the worker bees' activities tending towards swarming.

Management of Pests and Diseases: Honeybees like every other living thing are affected by pests and diseases. Randy (2013) stated that bees can handle pathogens effectively if they are not stressed through some of their natural activities which include cleanliness, grooming activities for the young and swarming. Moreover, many of the products especially honey, royal jelly, bee venom and propolis has high medicinal qualities that help reduce the incidence of diseases in the colony (Onabe 2011 and Belewu 2015.). Honey is slightly acidic with a high osmotic pressure which does not allow the growth of pathogens and propolis is an antibiotic. The bee farmer should ensure good health of the bees through proper management of the environment (hive) that should be dry, warm and ventilated. Damp environment encourages the growth of pathogen leading to diseases in a colony. Bees may be affected by pests, predators, diseases and especially pesticides.

Harvesting of Hive Products: The benefits derivable from bees through their surplus harvestable products are the main reasons for bee production. These products include honey, beeswax, propolis, bee pollen, bee venom and royal jelly and they are all useful to man in several ways. However this study will focus on production and processing of only honey and beeswax. Depending of floral quantity and quality in and around the apiary, two or three honey crops can be made in a year from a hive. Cropping in bee production is the term used for harvesting of honey. There are some basic guidelines in honey harvesting that enhance harvesting and reduce bee stings. Some of these guidelines, according to Hussein (200), Ndu (2003), Cramp (2008), Abdulazeez, (2011), Onabe (2011), Richardson (2012) and Wambua, (2015) include proper dressing in complete bee kit, use of smokers and harvesting only ripe and fully capped combs either early in the morning or evening. Campbell, Kenealy and Campbell (2003) states that combs should be capped to about 80% before harvesting to enhance the quality of product (less moisture content levels of about 18.6-17% reduces crystallization and fermentation of honey). Weather factors are

also important factors considered during harvesting. Cramp (2008) and Mujuni *et al.* (2012) warns that bee farmers should avoid harvesting their products during damp weather (honey is hygroscopic and will absorb water from the surroundings) and at night. In the same vein, Kebebe (2011) states that the ideal moisture content of honey for good processing and storage is 18%, however, timeliness of extraction of honey from comb as well as seasonal nectar conditions are factors that should be taken care of. Bees are disturbed during harvesting and they tend to be aggressive, however, they should not be killed but gently brushed off using bee brush or the use of harmless organic repellants.

Type of equipment used in harvesting also affects quality of produce. The local farmers use different local tools and equipments but in semi-modern and modern bee farms, they make use of most of the following equipment and tools as identified by Cramp, (2008), Akhaluola (2011), Onabe (2011) and Abdulazeez, (2013) include hive tool, uncapping knife or capping scratcher, capping trays, honey extractor, settling tanks, honey filters or sieves, plastic or stainless basins or buckets with lids, jerry cans, bottles of various sizes. All these tools and equipment should be properly cleaned, dried and placed in the facility where the extraction is to be done. The tools and equipment for wax extraction include different sizes of pots and pans, bowls, plastic moulds of varying sizes, clean white clothing materials for straining, solar wax extractor, steam wax extractor as well as heat source, soap for smearing wax moulds, strong sticks for applying pressure to the straining bag. Harvesting and processing procedure is usually determined by the method of production especially the type of hives.

Local harvesting involves the use of naked fire to "smoke/kill" the bees to death or force them to swarm. It occurs mostly in farms where local hives were used. The local farmer empties the content of the hive into a container for onward processing. In this method everything suffers the effects of the fire (unripe combs, ecosystem with other

beneficial organisms are killed or disorganized as well as stings on the farmer himself). Moreover the product is adulterated with different materials (pieces of wood, ash, leaves and other materials and the smell of smoke). It should be discouraged by all who desire sustained apicultural production.

Modern Harvesting of Bee Products: This involves the collection of only ripe combs from supers usually during dry evenings (not damp) by a well dressed bee farmer (full kit) and armed with a lit smoker. Hive types here include Langstroth, Kenyan top bar and other improved hive types. The farmer smokes the hive gently with a lit smoker and brushes the bees away. Only capped combs are removed. If the hive is KTBH, then the combs are cut with the knife into a bucket with cover. The covering of the bucket reduces water absorption from the environment by the honey. In the case of Langstroth hives, the frames with ripe combs are collected into a covered container leaving the ones with brood (unripe/ immature). A few combs are also left especially during dearth periods so that the bees can feed. All harvests are then taken to the processing room that should be warm and hygienically clean. The use of smoker and kit helps the farmer to manage stinging by bees, ensures quality products safety of the farmer and the environment Honey and wax are together when harvested until after extraction.

Extracting Honey and Wax: Honey that is intact in the comb, according to Ayorinde (2015) and Belewu (2015) is pure and unadulterated weather it is in the hand of the honey hunter, local farmer or the most sophisticated bee farmer. The difference in their final product is determined by the harvesting and processing adopted. It is also true that honey and wax are all together until after extraction. Therefore proper care and hygienic principles is needed for good end product. The type of farm enterprise, knowledge and skills of the farmer, available resources and volume of produce are some of the determinants of the extraction method that can be used.

Extraction in apiculture is the separation of honey and comb from each other and from dirt and impurities. It will be discussed according to the style used by the bee farmer as local, semi-modern and modern methods. Cramp (2008) and Gregory (2011) states that it is better to extract honey soon after harvest in a clean and warm room in order to improve quality and reduce losses. Local Methods Depending on the locality, knowledge and skill available to the bee farmers, Onabe (2011), Oyerinde (2015) identifies the following methods: hand squeezing, spinning, boiling, floating, solar wax meter. Hand Squeezing Method; the comb is squeezed between the hand to release the honey. Although the practice may seem easy to carry out, Onade, (2011) notes that it is wasteful and prone to adulteration with dirt and impurities. Floating Method; the comb is chopped into pieces and allowed to stay in a covered bucket/container so that the honey will settle below. Then the pieced comb and other floating material are scooped out. The honey is then passed through a clean white cloth to stain filter out the honey into clean container. It may be allowed to drain for at about 24 hours or more. Boiling Method; in this method the harvested comb is put in a pot and boiled to release the honey. The melted honey is drained off after separating from the comb.

Although some of the local methods may give quick extraction, however, the produce is usually poor both in quality and quantity with a lot of losses. Matanmi, Adesiji and Adesoji, (2008) reports that local bee farmers in Oyo State normally threw away the uncapped and brood combs as well as wax due to poor skill or ignorance of its value. Destroying the uncapped combs and broods indicates no future for bee keeping and honey production.

The Semi- Modern Methods: Common methods used in semi modern methods of honey processing include pressing of combs, use of honey press, **Cold Dripping Method** (CDM) **Pressing Method**; the harvested combs are placed into a straining bag and tied.

Then pressure is applied and this forces the liquid honey to drain through the tiny openings into a waiting tank/bucket underneath. Another method is the use of Cold Dripping Method (CDM) in which the sliced combs are filtered over night through a mesh or net. Salama and Matavele (2009) observe that although CDM is easy to use and may be cost effective, it also leads to loss of substantial quantity of honey which remains in the comb. The method used by most semi commercial farmers in Uganda according to Gregory, (2011) is the straight-sided metal bucket that has holes in the bottom with another bucket put underneath to collect the honey. There is a central presser made from a circle of wood that presses the honeycomb in mesh cloth or sieving bag to squeeze out the honey. **Solar Meter**; this equipment is made of wood and galvanized metal placed inside a glass or clear plastic cover. On a sunny day, solar radiation is trapped by the galvanized metal which increases the temperature inside the enclosure. The increased temperature melts the comb and honey flows out into a waiting bucket/container.

Modern Methods of Extracting Hive Products in large apiaries, the supers of honey are brought into the extraction room that has been properly cleaned for quality and hygienic standard. Cramp, (2006) states that to enhance extraction and slightly reduce honey moisture, commercial bee keepers place supers in warm rooms at about 95^{o} F or warm air be forced through the supers. Centrifuge Extractor In modern commercial bee farms, honey extraction is usually done with extractors which may be manual or automated. In the manual type, the frames (Langstroth hives) are placed individually over a large bowl and hot knife is cleanly run up the combs on both sides of the frame to slice off the capping. The frames are then place in the extractor till it is full. The machine handle is turned so that the honey flows into the base of the extractor and to the strainer buckets for further processing.

In the case of automated centrifuge, combed frames are placed into the extractor until it is full and the machine turned on. As the machine rotates with centrifugal force, high quality and quantity honey and comb is released into honey tank. The facilities for slicing, filtering and straining the honey are all embedded in the machine. The capping is collected into a muslin bag or sieve to drain the remaining honey into a container. This method gives very high quality and quantity of the honey crop and very effective in harvests from frame hives. However, due to the high cost of purchase, maintenance and skills required, Onabe (2011) and Randy (2013) states that local farmers do not use it.

Types of Honey in the Market

There are different types of honey in the market based on processing, packaging and the taste of consumers. Some of these types according to Killion (1981) and Kaiser and Ernst (2013) include comb honey, extracted honey, chunk honey, strained honey and blended honey among others. Comb honey according to is honey that is sold with portions of cut comb. They contain only sealed and undamaged honey-comb, which is neatly cut in portion and packed for sale. This type of honey is eaten with the comb and since the consumers see it in its natural unadulterated form, it fetches much more money. Due to the fact that it has not been opened to the air, it has finer flavor than the one that has been processed in any way.

Strained Honey: This is one that all the particles of comb, bee materials, pollen or any foreign matter has been carefully removed. It goes through the process of uncapping, filtering and straining in order to remove any debris. Gregory (2011) and Oyerinde (2015) states that the colour and flavor of honey may differ due to the source or age of honey, but strained honey should be clear from any extraneous materials and colour range from golden to amber and dark.

Blended Honey: This is one that mixes honey from different sources together. This is more common with large scale apiarists who have honeybee farms in different locations that have varying floral types and patterns. The farmer may also decide to blend the honey if some of the honey has more moisture than others (Morse, 1994). The blending in a warm room will help to harmonize to get a unique quality honey. Magaji, (2012) reporting the workings of Bee keepers Extension Service (BES) in Kaduna states that they intend to buy off produce from their accredited producers and eventually blend to give their packaged honey. Another type of honey processed by A and Shine Abuja and some other apiaries is the value added to honey by blending in other healthy medicinal plant parts such as ginger, garlic and *moringa*. This of course attracts extra cost from the consumers.

Depending on the requirement of consumers (local or international) the bee farmer may leave some little quantity of pollen in the processed honey to increase the protein content. However it should not be much in order not to ferment the honey. Whatever type of honey that has been produced, proper packaging into clean, dry and transparent containers as well as labels are very important. These containers should have light weight, of low and affordable price and be transparent. The packaging should be air-tight and in a very hygienic environment.

2.4 Processing the Hive Products (Honey and Wax)

Processing of any product aims at value addition to the end produce making it more acceptable to the prospective buyers and consumers. The farm level processing of hive products after extraction according to Wambua (2015) involves purification through further straining and filtration, sorting/grading, packaging and labeling. Just like in extraction, processing of honey should be done in a clean warm room and hygienically kept specifically for that purpose. Management practices and technologies in honey and wax processing aim at reducing fermentation and crystallization. These practices include

sorting/grading, bottling, labeling and packing of products into cartons or other containers. Due to the peculiar nature of processing these products (very sticky and attraction for insects), ample time and patience is a requirement of the bee farmer for best results. The farmer should protect products against contamination by ants, flying insects, and tools or from moist environment at all important for quality products.

Honey Processing: The strained honey is kept in covered stainless or rubber buckets in order to properly melt the contents for further processing to enhance quality product. Cramp, (2008) suggests that the honey be passed through heaters or bottled honey heated to 66^0C for 30 minutes. In the same vein, Leister (2013) states that warm water bath at temperature of 110^o F is necessary to enhance floating of debris and other contaminants which are easily scooped off. The honey is then strained through differently sized meshes or clean white clothing material. This straining is done severally until the right quality honey is obtained. All the capping and wax got from honey processing are kept in separate containers awaiting wax rendering. The filtered quality honey is poured into a honey tank, bucket or any container meant for that purpose.

Grading/Sorting: This is another major work in processing honey. Sorting is placing honey according to their quality based on laid down standards. According to Ambrose (2013) in Leister (2013), honey is defined as:

....the natural sweet substance produced by honey bees from the nectar of plants or from secretion of living parts of plants or the excretions of plant sucking insects on the living parts of which the bee collect, transform by combining with specific substances of their own; deposit,, dehydrate, store and leave in the honey comb to ripen and mature.

Except by straining and filtering, any product that has more or less of this definition is not honey.

Magagji (2012), reports that a model honey processing plant is being proposed by Beekeeping Extension Society (BES) in Kaduna State, Nigeria. Magaji further states that filtered honey will be bought from participating bee farmers and transported to the processing centers and poured into collection and filtering tank. The honey is passed into the settling tank and then processed further to improve its moisture and pollen content, colour, aroma and other desirable qualities. The final product will then be packaged in containers of various sizes including sachets and finally sealed. In order to reduce adulteration of the product, Akinlabi (2015) states that proper packaging in labeled sachets, bottles and jerry cans are ideal as this make marketing easy. The bottles could be of various sizes 1liter, 1.5, 2 or 3 liters. Plastic jerry cans of 5, 10, 15 or 20 liters can also be used to serve different consumer

Honey grading is the practice of arranging honey based on certain pre-determined characteristics. Although a number of authors and even practitioners argue that quality and type of honey is dependent on the type of flowers and age of honey, they however agree that grading/sorting should be based on colour, aroma/taste, moisture content and quantity of pollen grains in the honey. This is in line with the findings of Ige and Olugbenga (2010) who states that proper analysis of pollen type and source is of great importance for honey quality control and identification of adulterated honey, Campbell, Kenealy and Campbell, (2003) states that quality honey should contain about 17% moisture with colour that ranges between white and dark amber. In most South and East African countries bee farmers were taught to grade their honey into grades one, two and three based on the identified characteristics (Maavele and Salama 2009). The symbol for grading may differ according to countries and may be the use of alphabets or numerals depending on the regulating agency. In Nigeria, some of the regulating agencies for quality standards of products include Standards Organization of Nigeria (SON), National Agency for Food Drug Administration

and Control (NAFDAC), Export Promotion Council of Nigeria (NEPC). At the international level, the European Union (EU) Council gives the guidelines and standard for honey meant for the EU nations and also the "third country listing"(NEPC 2015). Grade One honey is made from new wax combs, medium light colour, very little pollen, few uncapped honey (80% capped) and acceptable flavor/aroma. Grade two honeys is from new wax combs, medium light colour, very little pollen, few uncapped honey, acceptable flavor/aroma and low moisture content. The third grade is mostly new wax combs, light brood combs with dark honey, acceptable flavor/aroma and low moisture content. What remains may be graded as the fourth with old brood combs, dark honey with pollens and doubtful flavor The moisture content is higher than all the others hence the least in quality and may serve better as a bait material (Leister 2013 and Belewu 2015).

Packaging of honey can be done in various sized packs, bottles, tins, drums and tanks. (Gregory (2011) and Wambua (2015) notes that honey can be preserved in containers after heating over certain temperature levels or frozen in cold rooms for a long shelf life without fermentation or crystallization. Morse (1994) noted that honey that is packed in jar and properly cocked while hot will rarely ferment or crystallize. Strict adherence should be paid to the quality standard as stipulated by the regulating agencies in the country and other international bodies if the products are for export. Another method of preserving is by freezing and this increases the shelf-life of the product. Leister (2013) states that honey standard should be maintained whether they are for direct consumption and those intended for sale in bulk containers as honey that may be repacked for retail sales or use as an ingredient in other foods for human consumption.

Labels are used to identify source and quality and producer of honey. Most local farmers do not bother about labels for their products due to the cost of producing the labels. The labels should give information of the quality, quantity, date of production, plant nectar

and pollen source, name and address of the producer as well as phone numbers and other contact addresses. Such information as meeting up the quality standards set by nation's regulatory bodies (in Nigeria NAFDAC and SON, Export Promotion Council of Nigeria) and other international bodies such as African Union, European Union and other bodies (export). The label could also contain other necessary information that consumers might want to know about the product such as floral type, appropriate temperature for storage in order to avoid crystallization of honey.

Beeswax Rendering/ Processing

Beeswax is one of the major economic products of the hive second to honey in quantity. It is the melted comb after honey harvest and an important industrial raw material for many natural products such as cosmetics, candles, shoe and furniture polish, lip gloss, textiles, printing, medicine, finishing for guns and many other products. Most local bee farmers do not regard wax as a product that can add to their income due to the stress involved in the processing. Ojeleye (2016) reports what he observed in Cross River State in 2002 of how bee farmers were using the wax as fire wood due to poor knowledge of its economic benefits. Similar cases were observed by the researcher during visits to apiaries and honey markets. Due to poor skills, many of the bee farmers hire people who extract the honey and then take for their payment, the wax. Some other farmers mould the wax in small sizes and sell it off to children at give away prices. Rendering is the term used to describe the processing of wax and it is a tedious job even with experienced bee keepers. Honey bee practitioners have advised that capping and combs from harvested honey give the best quality wax and therefore should be processed separately from old or dark ones.

Beeswax can be processed through various ways which may include use of electricity, solar energy and heat from cooking pots. Caution should be taken when processing wax especially with fire because it is highly inflammable. Gregory, (2011),

states that beeswax extraction involves a variety of tedious activities including washing, straining, gentle heating in low temperature to melt (not boil) and the removal of dirt.

Locally, the crushed honey comb is washed in warm water to remove dirt and any remaining honey and this makes the beeswax to float. The floating beeswax is scooped into a cloth sack and tied with a strong string. Heat good quantity of water in a bigger pot and the sack of honey comb immersed inside the pot until it is completely covered with the warm water (boiled water destroys the wax so avoid it). Keep heating gently until all wax has melted out from the sack and rise to the surface of the heated water.

Squeeze out all the wax from the sack by placing it between two sticks and apply pressure. As the water cools, the wax solidifies on the water surface and scooped. Break the dirty wax into smaller pieces; melt the wax in a pan placed inside a second bigger pan of boiling water. Heat gently until all the wax is melted. The dirt will settle at the base of the pan. Pour the melted wax through a clean clot strainer to remove the dirt. This heating and straining can be repeated until a clean wax is obtained. Depending on the shape desired, plastic moulds of different sizes and shapes can be used. Smear the mould with soap to stop the wax from becoming sticky as it hardens. As the wax cools it hardens and takes the shape of the mould.

Solar extractor is another method of extracting wax. The wax is put into a filtering bag and placed on a metal tray in an insulated box under a glass cover and set in the sun. A metal lip directs the melting wax into a container. Over-heating should be avoided to prevent burning or darkening of the wax. Steam wax extractor is a more modern machine for processing wax or capping. A sack of wax is hung above a metal container floating on boiling water in a pot. Melting wax drips from the bag to collect in the container. Take care that the water does not boil dry (top-up water in the pot if necessary). The whole container may be covered with a lid or left open. The wax should be graded, packed and labeled

appropriately based on their quality. Higher quality attracts better price So good skills and techniques of harvesting and processing should be taught ant learnt by the farmers as this will help improve their produce, increase their income and enhanced standard of living.

2.5 Awareness of Modern Processing Methods in Honey Bee Farming

Hornsby (2010) defines awareness to mean having knowledge or perception or a state of knowing about something. Awareness of anything is the knowing or being conscious about the existence of something and understanding its functions and uses. It is the first step in adoption process in agricultural extension. The farmer may casually know about an innovation, but it takes the understanding of its function and benefits to be persuaded to try it out. The success or otherwise of the trial will determine its continued use in the farm. Extension workers usually play vital role in creating awareness of agricultural innovation to farmers. Although bee farming has a long history in Nigeria, practitioners were mainly honey hunters and a few others that used local tools and practices that are rather detrimental to the bees, environment and sustainability of the bee farming enterprise.

There is need to create the needed awareness about the health and economic benefits of honey bee farming, the low start-off capital, and the innovations in its production and processing that reduced the hazards of stinging. Farmers need to have good information about the best sites for apiaries, identify honey plants, how to catch swarm and hive them. They should also be able to identify when bees are stressed, diseased or preparing to swarm and the appropriate clothing needed for any work/operation in the apiary. The use and skill needs of modern framed hive, extracting machines, processing tools and packaging materials, their advantages over the local types should be made known to them. The high quality and quantity products from innovators and research institutes that used these modern machines should be shown to them at meetings and exhibitions. However, the farmers should also be aware of the cost implications of these innovations and possible sources of

credits/loans. It has been reported by Adams (1999) that access to these incentives help adoption of innovation by farmers. The farmers equally need to know where training and reliable information about the innovation can be got from.

Sources of Information of Modern Honey Practices

Information of improved methods of processing of hive products can get to the farmers through many sources which include extension workers, fellow farmers, mass media (radio, newspapers, and television), journals, books, workshops, farmers' day and demonstration plots. Mujuni *et al.* (2012) reports that farmer to farmer source of information was the preferred choice due to the trust and confidence the farmers put in each other compared to the trust in extension workers. This is similar to the bee farmers in Kano who rely more on information from fellow farmers than the extension workers who they assume may not be very knowledgeable in the skills needed in bee farming (Adamu, 2014). Literacy level, age and general exposure of a farmer affects adoption of modern practices especially those from the mass media. An educated farmer can easily access and analyze innovation information; with good experience in bee business a farmer can identify the activities of moth from that of bees.

2.6 Adoption of Modern Honey Bee Production and Processing Practices

Adoption is an extension term used to describe the acceptance and use of a new idea, plan or practice by the farmers to whom it has been presented. It usually involves new innovation that improves and increases both quality and quality of production. It is a complex process that requires time for decisions to be made by the farmer on whether or not to accept the innovation. Hornsby (2010) defines adoption as the decision to start using something such as an idea, plan or new technology. In the same vein, Abebe *et al.* (2008) explains that adoption implies the continued use of a recommended idea or practice by individuals or groups over a reasonably long period. Adoption therefore is not a one stop

affair, but one that requires time for the farmer to assess the compatibility of the innovation with his values, existing level of farm technology, level of farm development as well as the relative advantage in economic terms.

Adoption in this study is the acceptance and continued use of improved methods of honey bee production, processing and marketing of products for better and higher production and improved income. This means that the bee farmers will start using framed hives, bee suits/kits, honey extracting machines, and process the hive products in standards that meet hygienic levels acceptable by government agents. The farmers need to fully understand these innovations and the steps involved in adopting. Framed hives are quite different from local hives that are made from clay, straw, hollows of tree trunks, pots and other such materials that do not allow the farmer to inspect or crop the honey conveniently. The farmer should understand and use smokers and bee kit when inspecting or harvesting due to the benefits they have in reducing stinging and destruction of the bees and other useful organisms in the ecosystem. Abebe *et al.* (2008) reports that 71.1% of adopters of box hive had opportunity of visiting other apiaries indicating that "farmer-to-farmer" exchange of experience and knowledge sharing influences adoption. Farmers take the pain to try out all these options in order to convince themselves of the workability or otherwise of the innovation and their decision to adopt or not.

The use of extracting machines and its accessories leave the honey harvested in good quality and quantity. It also reduces the challenges of bee stings that farmers face during extracting in unprotected areas from bees that come to attack. Cramp, (2006) observes that a farmer packing supers may be surrounded by millions of bees that are on a revenge mission for their honey especially on a hot sunny day. At such times a trained bee farmer will keep the supers in a safe place and suspend extraction for that day and manage the situation without damage to anything including himself. Adjare, (1990), reporting bee revenge in a

community in Cameron, states that all the villagers had to vacate for a whole day because bees took over their homes.

Through the use of extracting machines, nothing is lost. Even the capping of the comb is separated and used as a high quality wax and Roger (1994) advises that it should not be mixed with old wax due to its high market value. Cramp, (2006) states that honey processed with modern equipment is less prone to fermentation and crystallization due to the management measures put in place This measures may include, properly warming the extraction room, passing hot air through the supers, pasteurization as well as the use of honey hydrometer that checks the moisture content of honey. Proper packaging of hive products helps to increase and improve its quality and market value. Magaji (2012) suggests that proper packaging of honey in labeled containers be done in order to make the product both accessible and more importantly to reduce adulteration, a common occurrence in Nigeria. Adams (1999) identifies the stages of adoption as awareness, interest, evaluation, trial, adoption. Many of the honey bee farmers in Kano State are aware of modern processing but adoption may be affected by many other factors which may be within or outside the farmer's control.

Rate of adoption of innovation differs among people, while some adopt innovations as soon as they are aware and convinced, others would want to see evidence of the practice in other peoples' farms before they can accept. Some of the personal characteristics that affect adoption of any innovation include level of education, age, financial level, ideas and general exposure. Sabo and Dia (2009) find that the minimal level of education of the vegetable farmers in Adamawa State enabled them to adopt vegetable technology information to improve their production. In a research conducted in Uganda by Mujuni *et al.* (2012) it was found that many bee keepers were reluctant to adopt modern techniques and practices due to the age, level of education, access to extension service, experience,

farm size and access to credit. In the same vein Adamu, (2014), reports that most bee farmers in Nigeria are above fifty years of age, mostly illiterates and are majorly males. Socio-cultural factors affect women participation in bee keeping as reported in Pakistan by Quiser *et al.* (2013) and in Nigeria by Adamu (2014).

However, some farmers device ways of overcoming these challenges by starting the enterprise on a small scale, belonging to co-operatives or by hiring some of such tools from neighbors or corporative. When these trials bring conviction, efforts are then made to acquire the technology into their farm practices.

Agricultural projects have measurable impact when beneficiaries gain from the outputs generated through project resources. These areas of assessing can be in the change in their living standards due to increased income, quantity and quality of produce for local or international market, education of their children to good schools and hospital services. It can also be measured in terms of increase in the farm size, number of skilled labour employed and quality of packaging of finished products. Ntege-Nanyeenya *et al.* (1997) states that it is important to recognize that beneficiaries (honey bee farmers) will adopt only technologies that meet their needs and circumstances; be they technical, social, economic and agro-ecological. This is to say that the technology must necessarily fit into their production process, be affordable and the materials needed at easy reach (accessibility). The incentives to support its use should be made available and affordable.

2.7 Benefits of Modern Honey Bee Production and Processing

Bee farming, whether at local or modern levels, is loaded with many benefits. These benefits include the harvesting of products such as honey, wax, propolis, bee venom, bee bread, royal jelly and other minor items that are useful to man. These products bring in income, foreign exchange, raw materials for industries as well as medicine for ailments.

The National Export Promotions Council (2015, NEPC) states that Nigerian honey has a distinctive flavor that distinguishes it from other honeys from other places. However, due to adulteration of the products (poor processing) Nigeria lost about 19,300,495.4 US dollar worth of honey sales in 2013 to other African countries of Ghana, Cote des'Ivoire, Liberia, Gabon and Senegal. Some of the specific benefits of modern processing of hive products include, ease of operation, high quality and quantity of produce, improved income and standard of living, improved environmental friendliness, increased crop harvests as well as the use of apitherapy among others.

Traditional honey processing and wax rendering are two tedious and time consuming aspects of bee farming which many bee farmers are afraid to do, hence they rather hire it out for others to do for them. Ojeleye (2016) states that some bee farmers in Cross River State were using the wax as fire wood and others just wasted it. The researcher also observed that in some communities in Kano, wax is given out as compensation for honey extraction. However, with the modern extractors and practices (centrifugal, solar and other automated extractors) these jobs are done smoothly, neatly and with much ease and less time consumed. Furthermore, Meagy, Rashid, Ilam and Islam (2013) and Hyppolyte *et al.* (2015) reports that farmers who adopted the modern equipment attained high efficiency of production in both quality and quantity of their produce.

With improved production and processing practices, bee sting, which used to be a challenge to bee production and processing, is now an advantage to health and income source of the farmer. The innovation of using bee stings and other products in handling and treating human health (Apitherapy) is helping to improve health and longevity of humans. The author of Journal of the American Apitherapy Society (2010) reports several findings of the use of bee products in treating human ailments. Some of the diseases handled through apitherapy include, according to them wounds, arthritis, back pain, diabetes, ulcers and

tumors and infertility among others. Oyerinde (2015) states that bee venom therapy should be learned and combined with the knowledge of acupuncture as practiced in the Republic of China and other countries in bringing about relief of some ailments. Stangaciu, (2006) in Romania and many other doctors in Egypt use apitherapy and Bee Venom Therapy in treating many different diseases and wounds.

Another important aspect of modern processing practices of the hive products is the addition of some medicinal plant parts (leaves, barks, roots) to honey. In Nigeria, according to Adeshina (2016) some bee farmers blend honey with other medicinal herbs (ginger, garlic, moringer) to increase the health benefits of such products. This increases the monetary value of such honey. Furthermore, fermentation and crystallization of honey (major challenges) has been overcome through modern processing practices and equipment. Cramp, (2006) states that honey processed with modern equipment is less prone to fermentation and crystallization due to apprpriate management measures (warmth and dehumification of the room) put in place.

Modern honey bee production is not only a noble and economically rewarding vocation, but also a very viable economic pursuit undertaken all over the world with many benefits. However, with improvement in the methods of production and processing, many more products are harnessed for man's use. The value of beekeeping could be described as sweet as honey itself, not minding other valuable products such as beeswax, pollen (bee bread), propolis, royal jelly, bee venom which are derivable due to the improved methods of production adopted by the bee farmer.

The pollinating activity of honey bees is also of great value to food production, as it is directly responsible for 80 percent insect pollination in plants such as cereals, pulses, fruits, horticultural as well as tree plants. According to Kiesha (2014), there are at least 10 crops that would disappear without the honeybee and these includes apples, almonds,

blueberries, cherries, avocados, cucumbers, onions, grapefruit, oranges, and pumpkins. In support of the benefits of bees in pollination, Abebe *et al.* (2008) reports that bee farming community benefits more from the honey bees in terms of improved nutrition, sustained income and pollination of planted crops. Furthermore, Miklvaev, Jenkins, and Barichelle, (2012) and Belewu (2015) states that the pollinating benefit of bees is about 25-35% more than the products of the hive.

The global demand for all bee products cut across religious and cultural lines. The domestic demand for quality honey remains amazing as, nearly every family is becoming interested in pure honey consumption; even at high prices. At the international market, quality standards have to be met in order to market the bee products across countries.

Nigeria can access the European Union market for hive products if the quality of produce is improved through modern methods of production. Nigeria Beekeeping News (2016) reports that five agricultural products namely honey, rice, cocoa, beans and melon has received codes of practice in processing and packaging (devoid of impurities), ensuring labeling on packaged products as well as effective enforcement of mandatory standards. This move may possibly open the international market for honey especially to the European Union countries (EU) for better income.

Modern honey bee production /keeping and processing is seen and valued as a sustainable form of agriculture for environmental preservation and conservation of bee brood and other organisms in the ecosystem. Modern practice helps in the regeneration of forest resource, reclamation of eroded land and pasture improvement. Disease and pest management is made easier in modern bee farms. This is because of proper ventilation of the hive and early detection of disease signs due to the bee farmer's improved methods and practices of production and processing.

Another major benefit of modern practices includes the innovation of queen rearing and breeding. This practice allows the bee farmer to choose and determine the stock and trait of bees to keep, when and how to de-queen and re-queen and number of hives to keep. Ojeleye (2014) states that queen rearing is important because young queens are more prolific and has less swarming tendencies. Queen rearing helps the farmer to have a few spare young queens for use in emergencies as well as saving time waiting endlessly for swam that may never detect and colonize the baited hives.

In order to reduce the high cost of adopting improved technologies of extracting machines, Gidney and Mekamen (2010) states that in Northern Ethiopia, local engineers were adapting and producing the Italian honey extractor. However, it was not effective in extracting honey. The Das Bee Technology (a registered private firm) Danbatta Kano State, has to a reasonable extent, infused the improved technologies into the local equipment and tools, making them function as the improved ones. They have been able to construct local straw hive with queen excluder and also having two stairs for higher and better yields.

2.8 Constraints to Adoption of Modern Honey Processing Practices

Constraints to the adoption of modern honey bee production and processing practices can be from the farmer's socio-economic characteristics, the technology/practice itself and conformity of the new practice with the farming practice already in use, knowledge and skill of the farmer and weather factors. Abebe *et al.* (2008) and Mujuni *et al.* (2012) identifies other constraints as technical, economic and social factors, fear of bee stings, inadequate start-up capital and safety equipment as well as availability of flowering plants. In addition, Haftom-Gebremedhn, Girmay and Awet (2013) states that inadequate flowers at some seasons of the year affect yield of bees.

Economically, the equipment or practice may be too expensive for farmers to buy or the practice not in line with their social and cultural beliefs. Tewodros, Eyassu and Amsalu

(2015), Belewu, (2015), Onabe, (2015) and Ojeleye, (2016) states that most bee farmers in Nigeria do not adopt modern practices due to high cost of purchase and maintenance of the equipment and practices. In Kenya, Hippolyte *et al.* (2015) reports that although there is favorable natural environment for good crop of honey, however, the farmers lack necessary financial and technical support to adopt modern practices. Some of these challenges may include available number of extension workers with requisite knowledge in the particular skill or technique, resources (capital, land, equipment, labour and skill) available at the disposal of the farmer, proximity of the farmer to other farmers in the same enterprise as well as beliefs and traditions of the area. In the same vein, a study on the situation analysis of bee industry in eight South African countries by Salama and Matavele (2009) found out that most of the farmers had problems with bee abscondment, fragmented production sites resulting to poor collection and marketing, deforestation, poor standardization of produce.

In addition to these constraints, Wilson (2006) further stated that high aggressiveness and low productivity of most strains of native bees, poor honey processing and downstream factors which affects the potential increase in market supply as well as lack of coordination among the institutional bodies concerned with the various honey production, processing, trading and consumption were affecting quality and quantity of hive products in Sub-Saharan Africa. Other constraints to adoption include drought (about 70% of forage is from natural forest), absconding of bees, diseases and pests, lack of bee farming equipment and lack of adequate extension support among others. Other constraints include cultural beliefs and costumes. In an impact assessment study on bee keeping on sustainable rural livelihood among women in Pakistan, Quiser *et al.* (2013) found out that social and cultural barriers affected women participation in bee farming. The Pudah system which is practiced in Kano is one of such barriers.

Alkali *et al.* (2013) and the communiqué of the Nigerian Beekeeping Conference (NIBEECON, 2015), identifies many constraints to honey bee keeping in Nigeria as: poor data base, no standards of various hive products (except for honey which is obsolete 2003), poor synergies between researchers and practitioners, high rate of vandalism of hives and; no deliberate or national policy for research, training and extension services. In the same vein, Ugandan bee keeping equally has similar constraints which Dathine Agricultural Consult Limited (2006) identifies as political interference which encourages large production without addressing quality and market problems, low processing practices due to low skill and high cost of equipment and uncoordinated activities of stakeholders. Other constraints according to Abebe *et al.* (2008) and Saheed, (2013) include poor access to credit and inputs, low level of education, old age, gender, fermentation and crystallization of the honey crop and marketing, pesticides use in crop lands and bee stings and allergies.

2.9 Empirical Studies

In the course of this study, some relevant completed research works were consulted to act as guide in the various areas of the research. It is also intended that the gap existing between the current study and the reviewed work will be clearly seen. Some of them are presented in this section.

Oyerinde and Ande (2006) carried out a survey research titled a ‘preliminary assessment of modern apicultural practices in Kwara State, Nigeria’. Fourteen bee farms were identified in the state and were all adopted for the study. Structured questionnaire was used to get responses from respondents and data were analyzed using frequency tables and percentages. The findings indicated that awareness of modern apicultural techniques and practices were still low resulting in low production despite the favorable climatic and environmental features of the state. The bee farmers preferred Kenyan Top Bar hives though the government apiaries had the Langstrouth hive but colonization was poor

probably due to poor management. With regards to shade trees for the hives, cashew had the highest number due to its high preponderance as orchard crop in the state. The findings also revealed that bee keeping was new in Kwara State since all the hives were less than six years old coupled with the higher number of hives in the first and second years (63.84% and 28.26% respectively) of apiary operation.

The current study is similar to the work of Oyerinde and Ande in the areas of design and instrument for data collection. However, some of the differences are in the location of the study, while the reviewed work was carried out in Kwara State, North Central Nigeria, the current research was in Kano State in North Western Nigeria.

Matanmi *et al.* (2008) conducted a descriptive research in Oyo State on the topic 'analysis of the activities of bee hunters and bee keepers.' The study did not indicate population and hypotheses; however snowball technique was used to sample 50 respondents (20 bee hunters and 30 bee farmers). Instruments for gathering data were questionnaire and oral interview and analyses was done with frequency tables and percentages. The findings showed that majority of the respondents were males aged 50 years and above with the bee hunters being of lower educational level than the bee keepers. The bee keepers used protective coverings and had up to 37 hives, the hunters did not protect themselves and the highest numbers of hives were thirteen per person per year. The major challenges experienced by both groups were poor access to good information, inadequate land and training programs among others.

The current research is similar to the reviewed work in the areas of research design, instrument used which was questionnaire and interview as well as in methods of analyses adopted. However the differences are in the areas of study location Oyo (South West) and Kano (North West) respectively and in the respondents (hunters and bee farmers). The

findings of Matanmi *et al.* (2008) identify differences between the quality of honey from the hunters and that of bee farmers. These findings are relevant to the current research.

Abebe *et al.* (2008) carried out a descriptive survey in Ethiopia on the 'determinants and benefits of adopting improved box hive among bee farmers.' Two specific objectives were stated with no hypothesis and research questions. The total population was not indicated, but purposive sampling was used to identify four peasant bee keeping groups/communities where bee hive activities were high. 130 (Adopters and Non-Adopters) respondents were purposively sampled made up of 8 females and 122 males. Data collection was through personal observations, interviews and focus group discussion and analyses was done using percentages, frequency tables, mean, mean deviations, t-test and Chi-square.

The findings indicated that age, educational level and visits and conviction from friends and neighbors affected the adoption of box hives in the area. The adopters of box hive had better yields 64 kg (about three times of what was obtained from local hives) and more income than non adopters. However, some of the major constraints of bee farming in the area included drought (about 70% of the forage came from natural forests), abscondment of bee, pests and diseases and lack of bee keeping materials.

Similarity that existed between the current work and the reviewed one were the areas of research design which is descriptive survey, purposive sampling of respondents and methods of analysis which includes frequency tables, percentages. The differences were in location of study which was in Eastern Zone of Tigray Region of Ethiopia and Kano State in Nigeria as well as in the stratification of respondents into Adopters and Non Adopters which is not applicable in the current study. Contributions of the reviewed work to the current study are in the areas of literature reviewed, research design adopted, sampling method, instrumentation and method of analyses.

Mujuni *et al.* (2012) conducted a research titled 'factors affecting the adoption of bee keeping and associated technologies in Bushenyi District, Western Uganda'. From a population of 100 bee farmer households in two counties, 30 bee keepers and adopters and 20 non- bee keepers and non- adopters were purposively sampled. Structured questionnaire, personal observation and visits to the apiaries were all used for information gathering. Data were analyzed using, correlation and regression and findings showed that 95% were males, 55% aged 50years and above. It was also found that respondents had some level of education and also had at least 5 years of bee keeping experience. Although 56% used the traditional hive with only 1% having the modern Langstrouth hives, they recognized the better yield in quality and quantity of both honey and beeswax from the latter.

The adoption of the modern Langstrouth hive was low due to high cost of purchase but other technologies adopted are hive baiting (90%), weekly inspection of hives (70%) and record keeping. Record keeping was highest in Kyamuhunga District because it was a requirement for members of their association. The major constraints faced in bee keeping as reported by respondents were inadequate and high cost of equipment, bad weather, pests and diseases, transportation and thieves (poachers). Information about innovation was mainly from fellow bee farmers, extension workers, books, radio and newspapers. Factors affecting adoption of the modern technologies included phobia of bee stings, lack of start-up capital, inadequate skills, poor access to land and no protective covering and suggested that if government could provide capital, training, strong extension service and price control, the adoption of modern technologies will improve. Despite the fact that the study was carried out in Uganda, it contributed to the current research in the areas of literature review, design of work, sampling methods, instrument used and methods of analyses.

Quiser, Ali, Tag and Akmal (2013) carried out a research study on the topic 'impact assessment of bee keeping in sustainable rural livelihood in Pakistan'. The main objective

of the study was to determine the real benefits of bee keeping training given to the rural females. Of a population of about 7000 bee keepers rearing exotic breeds of bees in about 300,000 colonies, purposive sampling was used in selecting the towns and villages where large numbers of apiaries were situated. Random sampling was used in selecting 15 bee farmers from each district where training had been carried out by Society of Facilitators and Trainers (SOFT). Instruments used were structured questionnaire and supplemented with interview to elicit data from respondents. Frequency distribution, percentages, mean, standard deviation and regression were used for analyses, Findings showed that social and cultural barriers restricted women from fully participating in the field (open farmlands) for management practices of bee keeping. The younger ladies found it difficult to carry out many of the management practices such as handling bees, movement of hive, and honey extraction among others. It was also found out that bee keeping improved the keepers' income although the ratio was low among the respondents.

Similarities of this reviewed work with the current study are in respondents who are bee farmers as well as the topic that is bee keeping and purposive random samplings. The findings provided a good basis for comparing male and female participation in bee keeping in Kano State, Nigeria. Some of the differences include the location of study and respondents. While the former study was in Pakistan with only women as respondents, the current one is in Nigeria with both male and female bee farmers.

Kumsa and Takele (2014) carried out a research titled 'assessment of the effect of seasonal honey bee management on honey production of Ethiopian honey bee in modern bee keeping in Jimma Zone'. It was a descriptive survey and the respondents were purposefully sampled, contacted and interviewed with structured questionnaire and observations. The sample size was seventy-five (75) with twenty-five (25) from each district. The findings showed that 62.7% of bee keeping in the area was based on

inappropriate colony and characterized predominantly by high absconding and low quality produce. Some of the similarities of this reviewed study and the current one was in the areas of type of study, sampling method and type of research instrument. However, differences include the location of the study area Ethiopia and Nigeria. The current work did not carry out inspection of bee colonies as did the former study.

2.10 Summary of Reviewed Literature

This chapter reviewed the available related literature to the topic. The study adopted Rogers's diffusion theory as the theoretical framework for the study based on the fact that it supports improved awareness of innovation. It is the person (farmer) that is informed about an innovation that will think of adopting and continue its use in his/her production. The basic features of diffusion theory such as innovation decision process, individual decision theory, theory of rate of adoption and theory of perceived attributes were well discussed especially as they relate to adoption of modern production and processing practices in honey bee production.

The concepts of bee keeping and its production processes including locating apiary and other management practices were properly discussed. This became necessary because the honey and wax has to be produced before processing can take place. This chapter also discussed the feeding procedures, swarm control, measure to control bee stings through the use of protective clothing and smoker while working in the hive were all necessary information. The harvesting procedure, equipment and materials needed, precautionary guidelines and other information about harvesting of honey and wax were also explained. Modern processing techniques of honey and wax, sorting, grading and labeling of products were explained. Awareness and adoption of agricultural innovation especially as they affect honey bee production and processing were discussed. Effect of different sources or channels

of information on adoption of modern honey bee innovation were highlighted. Other factors affecting adoption of modern honey bee processing in Kano were also discussed.

Finally, six empirical studies reviewed indicated that although adoption of modern skills and equipment by farmers help increase and improve quality and quantity of produce of honey and wax, however many factors around the farmer affects it. The studies found out that some of these factors include economic level of the farmer, educational qualification, age, skill acquired and compatibility of the innovation with social norms and cultures of the areas and the scale of farmers' production. This study is different from the reviewed literatures in that none of the studies assessed the three variables of awareness, adoption and benefits in one study. Moreover, some of the studies were in other countries or other states and not in Kano. The absence of such a study in Kano State is a gap this research desires to fill. Hence the current study is assessing the awareness level and the rate of adoption as well as benefits of modern processing equipment and skills in honey bee keeping in Kano State.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter dwelt on the methods and procedures used in carrying out this study under the following sub-heading:

3.1 Research Design

The design for the study was descriptive survey research. Descriptive survey research design according to Olaofe (2010) is a study that uses the investigation of a sample of a population to document, describe and explain what is in existent or non-existence on the present status of phenomenon being investigated. In survey study, views and facts are collected from respondents through questionnaire, interviews among others, analyzed and used for answering research questions.

3.2.1 Area of Study

Kano is one of the seven (7) states of the North-West Zone of Nigeria and was created out of the defunct Northern Region in 1976. It borders with Jigawa State to the north and east, Bauchi, Plateau and Kaduna States to the south, Katsina State to the west

and northwest. According to the 2006 census, Kano State has a population of about nine million (9,000,000) inhabitants. The indigenes are mainly Hausa-Fulani with a large number of other Nigerians and foreign nationals residing in the state. As a commercial center of the nation, Kano State has a lot of businesses, commercial and educational activities with four (4) universities, three (3) colleges of educations, a polytechnic and some monotechnics, as well as thousands of secondary and primary schools.

The state has more than 18,684 square kilometers (7,214 sq miles) of cultivable land and is the most extensively irrigated state in the country (Adisa, 2011). Rivers and dams crisscross most parts of the state including the Kano-Challawa-Hadejia river system. Most inhabitants of the rural areas are farmers producing crops such as millet, rice, cassava, date palms, fruits, vegetables, sorghum, wheat, sweet potato, sugarcane, groundnut, cotton and livestock (cattle, goat, sheep, poultry and rabbits) and some add bee keeping as an added source of income. The vegetation consists of wooded savanna in the south and shrub vegetation in the north with a mean annual rainfall ranges of over 1,000mm in the extreme south to a little less than 800mm in the extreme north. The rains usually last about three to five (3-5) months with mean temperature ranges from 26°C to 33°C.

Due to the Kano State's proximity to the Sahara Desert, both the Federal and State governments established a number of forest shelter belts at different locations. Some of the major ones according to KNAP, (2015) are located at Gaya, Gezawa, Karaye, Kura, Bebeji, Bichi, Dambatta and Falgore. These environments provide the needed flora, good water source and cool abode for bees and hence house a large number of apiaries of both local and modern facilities.

3.2.2 Population of the Study

The population for the study was one thousand and two hundred (1200) honey bee farmers (not hunters) that have been trained and equipped by Kano State Government under

their empowerment programme. Information from Kano Afforestation Programme (KNAP 2015) indicates that every year, different people are sorted from all the 44 LGAs and trained in different trades including bee production. Between 2010 and 2013, 1200 people were trained in bee keeping at the rate of 300 trainees per batch. After the training, each participant was equipped with two Kenyan top bar hives (KTBH) and one local hive, bee kit, smokers, buckets, hive tool/knife, sieves as well as five thousand naira as take off assistance. However, due to beaureucracy in governance, this programme of training bee farmers by KNAP was done for only three years (2010-2013). Hence the population of the study is 1200 trained and equipped honey bee farmers. Kano State has three senatorial districts namely Kano North, Kano South and Kano Central made up of 44 LGAs. The information is presented in Table 1.

Table 1: Population of the Study

Senatorial Districts	**No. of LGAs**	**No of Trained Bee Farmers**
Kano North	13	27 x 13 LGAs
Kano South	16	27 x 16 LGAs
[Kano Central	15	27 x 15 LGAs
TOTAL	**44**	**1200**

Source: KNAP, 2015

3.3 Sample Size and Sampling Procedure

Three (3) LGAs were randomly selected from each senatorial district in order to have a fair representation of the entire state. The sampling was done by writing the names of all the LGAs in each senatorial district on pieces of paper, and placing same in three different bags, (one bag for each senatorial zone) and the bags thoroughly shaken. Three pieces of paper were randomly picked from each bag, and one extra paper from Kano South because of the higher number of LGAs in the zone. Each LGA has 27 KNAP trained and

equipped bee keepers between 2011 and 2013. All the trained bee farmers from each of the randomly selected LGAs were taken as sample for that LGA. Therefore the 27 honey bee trained farmers in the ten sampled LGAs (270) formed the sample size for the study. This is presented in Table 2

Table 2: Sample Size for the Study

Senatorial Districts	LGA/ Location of Shelter Belts	Sample Size of Trained Bee Farmers
Kano North	Karaye	27
	Danbatta YANBAWA	27
	Dawakin Tofa -ROMI	27
Kano Central	Dawakin Kudu	27
	Gezawa	27
	Kura – GAFAN	27
Kano South	Gaya	27
	Bebeji (TIGA)	27
	Sumaila – SITTI	27
	Garko - DARKI	27
Total	**10 LGAs**	**270**

Source: KNAP, 2016

3.4 Instrument for Data Collection

The instrument for data collection was a structured questionnaire titled Farmers' Questionnaire on Adoption of Modern Honey Bee Production and Processing Practices (FQAMHBPPPs). The instrument had two sections: A and B with a total of fifty-eight (58) question items. Section A dealt with the socio-economic characteristics of the respondents, while section B which contained forty-eight (48) honey bee production and processing practices, were meant to gather data for answering the research questions and testing the null hypotheses.

Items under research questions 2 were scored as: aware =2, while not aware = 1. The mean and decision rule becomes 1.500. Hence any item that scores 1.500 and above is accepted as aware while scores below 1.500 is seen as not aware. The scoring for adoption (research question 3), fully adopted = 3, partially adopted = 2 and never adopted =1. This gave a decision rule of 2.00. Any item that scored 2.00 and above was accepted as adopted while any score below was taken as not adopted. Research question 4 required the respondents to rank their benefits in order of priority between 1^{st} and 10^{th}. Rankings from 1^{st}-5^{th} were accepted as very beneficial while 6^{th}-10^{th} were taken as less beneficial. The research question 5 required respondents to use the Likert Modified Rating Scale (LMRS) four points to indicate opinion on the severity of the constraints to adoption. Strongly Agree = 4, Agree = 3, Disagree = 2; and Strongly Disagree = 1. The mean was 2.500.

3.4.1 Validation of the Instrument

In order to ensure that the instrument meets the expected standard, copies of the questionnaire along with the title of the study, specific objectives, research questions and null hypotheses were scrutinized by five (5) experts from the Department of Vocational and Technical Education of Faculty of Education, Ahmadu Bello University, Zaria. The purpose was to ensure that the items in the measuring instrument meet up with the research objectives. After vetting, the corrections and suggestions were incorporated into the final copy of the questionnaire. Olaofe (2010) stated that face validity of a survey instrument of this nature is considered adequate.

3.4.2 Pilot Study

In order to test the reliability of the instrument, a pilot study was conducted in Bichi LGA of Kano State using two trained research assistants and the agricultural extension officer of the local government. Twenty (20) copies of the research instrument were distributed to the respondents in the Yakassai Afforestation Site. The choice of the LGA

was because it shares similar characteristics in terms of weather, beliefs of the people, social life, business ventures and soil conditions with the sampled LGAs. The data obtained from the completed questionnaire instrument was collected and analyzed using Cronbach's Alpha Reliability statistics.

3.4.3 Reliability of the Instrument

To test the reliability of the instrument, it was administered twice (test-re-test) t the respondents at two weeks interval. The data obtained was analyzed for reliability using Cronbach's alpha reliability statistics. A reliability co-efficient of 0.86 was obtained which is enough for this study (see appendix III). The result obtained assisted the researcher to clarify the items, remove ambiguities about statements and identify difficulties faced by respondents in completing the questionnaire.

3.5 Procedure for Data Collection

An introductory letter from the Head of Department (HOD), Vocational and Technical Education, Faculty of Education, Ahmadu Bello University Zaria was used to obtain permission from relevant authorities and farms that were visited for data collection. The researcher hired, trained and co-opted four (4) enumerators and ten extension staff of the ten sampled LGAs to assist in interpreting the questionnaire items into Hausa for the respondents that are unable to read. The researcher, enumerators and the extension workers proceeded to each of the 10 sampled LGA for administration of the instrument. After sorting the trained bee farmers by the help of the extension workers in the sampled LGAs, the instrument were administered, and where necessary interpreted to the respondents. The enumerators retrieved the completed questionnaire from the respondents and submitted to the researcher.

3.6 Procedure for Data Analyses

Socio-economic characteristics of the respondents were analyzed using frequency tables and percentage; while answers to the five research questions were through percentages and mean scores as higher or lower decision mean. The awareness and adoption were measured with a list of production and processing practices (MHBPPPs). The respondents were to indicate their awareness level aware = 2 while not aware =1. From these responses any mean score below 1.5 was regarded as not aware while scores above were regarded as aware. The mean scores were for adoption 2.00, was obtained by adding fully adopted = 3, partially adopted =2 and never adopted as = 1 and dividing by 3. The decision means for benefits and constraints were all obtained in like manner. Hence the decision means for benefits was (5.5) while that of constraints (2.50)

The three null hypotheses were tested using multiple regression statistics and PPMC at 0.05 ($P<\mu$) level of significance. Multiple regression statistics was used for H_{O1} while PPMC was used for Ho_2 and Ho3. If calculated r value is greater than or equal to the table value, the null hypotheses will be rejected. But if the calculated value is less than the critical value, the null hypotheses will be retained. The regression mode was specified as follows:

Model specification

$Y= \alpha + \beta_1X_1 +\beta_2X_2……..B_nX_n + e$, Where:

Y= Dependent variables (adoption of MHBPPPs)

$B_1 –\beta_n$ = Co-efficient of the independent variables

$X_1 –X_n$ = Independent variables

X_1 =Educational qualification

X_2 = Years of bee production experience

X_3 =Major occupation

X_4 = Total number of hives in apiary

X_5 = Total number of modern hives in the apiary

X_6 = Average annual income from bee business

X_7 = Sources of bee production and processing tools

E = error term which is independent and identically distributed.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The study was designed to assess the adoption of MHBPPPs among farmers in Kano State. The instrument was a structured questionnaire made up of 2 sections A and B. Section A had ten questions on socio-economic characteristics of the respondents while part B contained 48 practices on awareness, adoption, benefits derived and the constraints to the adoption of MHBPPPs in Kano State. A total of 262 out of the 270 items administered, representing 97.5% were returned and used for analyses. All hypotheses were tested at 0.05 levels of significance.

4.2 Answering the Research Questions

The data obtained from socio-economic characteristics were analyzed with frequency tables, percentages and means/averages based on the specific objectives of the study. The analyses are presented below. The results from table 3 showed that male were 94.3% meaning that majority of the honey bee farmers were males. 73.7 % of the respondents were aged between 46 – 55 years with a mean age as 52 years and 91.6% were married. On educational qualification 45.41% had primary education as almost all the respondents had one form of education or the other which is a good factor that enhances adoption of innovation.

On respondents' years of experience in bee keeping, 51% had between 11-15 years and the mean years of bee keeping experience was 12 years Major occupation was crop farming with 50.8% followed by bee farming with 22.1%. Furthermore, 46.5% of the bee farmers had 15 hives. With regards to ownership of modern hives, the findings showed that 38.2% had 10. The findings also showed that 79.9% earned about ₦200, 000 with a mean annual income of ₦200, 000. On respondents' source of production and processing tools

and equipment, 80.2% got their equipment from KNAP, while the least was from importation. This shows that most of the farmers got their honey bee processing tools and equipment from KNAP. However, the bee farmers were trained by KNAP.

Question 1: What are the Socio-Economic Characteristics of Honey Bee Farmers?

Table 3: Socio-Economic Characteristics of the Honey Bee Farmers (n=262)

Socio Economic Characteristics	Frequency	Percentage
Gender		
Male	247	94.3
Female	15	5.7
Age (Years)		
16 – 25	2	0.8
26 – 35	5	1.9
36 – 45	56	21.4
45 – 55	193	73.7
Above 55	6	2.3
Educational Qualification		
Primary	119	45.41
Secondary	81	30.9
NCE/ND	38	14.50
Bachelor's Degree/HND	22	8.39
Post Graduate Degree	2	0.8
Years of Experience in Honey Bee Business (years)		
1-5	4	1.5
6-10	32	12.2
11-15	135	51.5
16-20	61	23.3
Above 20	30	11.5
Major Occupation		
Crop farming	133	
Livestock farming	48	18.32
Civil servant	13	4.96
Bee farming	58	22.1
Trading/business	10	
Number of Hives in Apiary		
Equal to or less than 15	122	46.6
6-30	31	11.8
31-45	79	30.2
46 and above	30	11.5
Number of modern hives in apiary		
10 or less	120	45.8
11-20	89	34.0
21-30	2	.8
31-40	20	7.6
above 40	31	11.8
Income from Honey bee business (₦)		
200,000 and below	207	79.0
200,001 - 400,000	51	19.5
400,001 - 600,000	4	1.5
Sources of your honey bee Processing Tools and Equipment		
KNAP	210	80.2
Importation	1	.4
Local fabrication	21	8.0
Farmers c-operative	30	11.5

Table 4 showed the level of respondents' awareness of modern honey bee processing practices in Kano State. The average awareness mean of 1.76 was obtained which is higher than the decision mean of 1.500 which implied that bee farmers were aware of modern honey production and processing practices. The findings showed the level of awareness were as follows: use of separate rooms for extracting and sorting 99.2% wearing of protective bee clothes 98.1% and avoidance of naked fire 96.95%.

Table 4: Awareness of modern honey bee production and processing practices

S/No.	Modern Honey Bee Production and Processing Practices	Awareness			
		Freq	%	$\bar{X}$	Ranking
1.	Use separate rooms for extracting and sorting.	260	99.2	1.99	1st
2..	Wearing protective bee clothes.	257	98.1	1.98	2nd
3.	Avoids naked fire during harvesting.	254	96.90	1.97	3rd
4.	Baits new hives before installing	252	96.18	1.96	4th
5.	Use of warm and clean environment for extraction.	250	95.42	1.95	5th
6.	Maintains quality standard in processing.	228	87.0	1.87	6th
7.	Products packed in labeled containers.	208	79.39	1.79	7th
8.	Harvests in the evening or early morning.	202	77.1	1.77	8th
9.	Solar extractor for wax rendering.	171	65.3	1.65	9th
10.	Use dehumifiers for honey.	170	65.3	1.68	10th
11.	Planted new bee plants in apiary	169	65.3	1.65	11th
12.	Inspects colonies for pests and diseases	158	60.31	1.60	12th
13.	Use centrifuge extractor for honey only.	109	41.6	1.42	13th
14.	Separates capping from wax.	108	41.22	1.41	14th
	Average Mean			1.76	

Decision mean = 1.5

Table 5 showed that the respondents' average mean of adoption of 2.48 was higher than the decision mean of 2.000. Wearing of protective clothes had the highest awareness of 98.5% followed by use of warm and clean environment 87.00% while the least adopted MHBPPs was the use of centrifuge extractor 22.51% .

Table 5: Level of adoption of *MHBPPs* in Kano State

S/No.	Modern Honey Bee Processing Practices	Adopted Freq	%	$\bar{x}$	Ranking
1.	Wearing protective bee clothes.	258	98.47	2.98	1st
2.	Use of warm and clean environment for extraction.	228	87.02	2.86	2nd
3.	Products packed in labeled containers.	227	86.64	2.74	3rd
4.	Use separate rooms for extracting and sorting.	219	83.59	2.80	4th
5.	Baits new hives before installing	208	79.39	2.78	5th
6.	Harvests in the evening or early morning.	202	77.09	2.54	6th
7.	Avoids naked fire during harvesting.	200	76.33	2.65	7th
8.	Maintains quality standard in processing.	198	75.57	2.65	8th
9.	Separate capping from wax.	196	74.81	2.74	9th
10.	Inspects colonies for pests and diseases	139	53.05	2.41	10th
11.	Solar extractor for wax rendering.	91	34.73	1.81	11th
12.	Use dehumifiers for honey.	61	23.28	1.88	12th
13.	Planted new bee plants in apiary	60	22.90	2.11	13th
14.	Use centrifuge extractor for honey only.	59	22.52	1.80	14th
Average Mean				2.48	

Decision mean= 2.000

Table 6 showed ranking of respondents' perception of benefits derived from the use of modern honey bee production and processing practices. High quality of products ranked highest with 76.72%, increased income 64.12%, and ease of introducing other medicinal materials 61.06% in order of their benefits to the farmers. The least of the benefit was less time consuming in operations 23.28%.

Table 6: Ranking the benefits of MHBPPPs in Kano State

S/No.	Benefits derived from adopting MHBPPPs	F	%	$\bar{x}$	Rank
1	Higher quality of produce	201	76.72	8.618	1st
2	Increased income	168	64.12	8.466	2nd
3	Ease of introducing other medicinal materials to honey	160	61.06	8.095	3rd
4	Reduced drudgery	150	57.25	7.782	4th
5	High value of output	140	53.44	7.771	5th
6	Ease of operation	130	49.62	7.756	6th
7	Safety from bee stings	120	45.80	7.156	7th
8	High value of bulk sales	105	40.07	7.134	8th
9	Creates more value chain of products	81	30.91	6.771	9th
10	Less time consuming in operations	60	23.28	5.458	10th
	Average Mean			7.477	

Decision Mean 5.500

Table 7 showed that the major constraints to the adoption of MHBPPs were high cost 95.41%, scarcity of modern equipment 94.66% and poor information of quality standards93.81%. However the least of the constraints to the adoption of MHBPPs was honey crystallization and fermentation 89.31% which is still higher than the decision mean of 2.500. It can also be observed that the average mean of the constraints were all higher than the decision mean and implies that the farmers actually have constraints.

Table 7: Constraints to Adoption of *MHBPPs* (include Standard Deviation)

S/No.	Constraints	freq	%	$\bar{x}$	Rank
1.	High cost of equipment/tools	250	95.41	3.526	1st
2.	Scarcity of modern processing equipment and tools	248	94.66	3.320	2nd
3.	Poor information of quality standards	246	93.81	3.244	3rd
4.	Inadequate market	245	93.51	3.129	4th
5.	Poor linkages/assess to extension staff	243	92.75	3.122	5th
6.	Inadequate extracting and straining skills	241	91.98	3.118	6th
7.	Poor pricing of products	240	91.60	3.106	7th
8.	Non availability of subsidy	237	90.46	3.068	8th
9.	Poor co-operation among bee business stakeholders.	235	89.69	3.011	9th
10.	Honey fermentation and crystallization	234	89.31	3.007	10th
	Average Mean			3.165	

Decision mean =2.500

4.3 Null Hypotheses Testing

Null Hypothesis One: There is no significant effect of the socio-economic characteristics of farmers on adoption of MHBPPPs in Kano State

Table 8: Regression Analysis Showing Effects of Socio-Economic Characteristics of Respondents on Adoption of MHBPPPs

S/No	Variable	β	SE	t	Sign
1	Educational Qualification (X_1)	0.844	0.146	5.783	0.000
2	Years of Experience (X_2)	0.442	0.128	3.457	0.001
3	Major Occupation (X_3)	0.406	0.129	3.139	0.002
4	Total No. of Hives in Apiary (X_4)	2.126	0.155	13.679	0.000
5	Total No. of Modern Hives in Apiary(X_5)	-0.878	0.111	-7.705	0.000
6	Average Annual Income (X_6)	-0.614	0.211	-2.916	0.004
7	Sources of Honey Bee Processing Tools (X_7)	-0.680	0.122	-5.595	0.000

N = 262

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin Watson
1	.776a	.601	.590	1.36860	.601	54.751	7	254	.000	1.899

$R^2 = 0.601$

R^2 Adjusted = 0.590

Table 8 showed result from multiple regression analysis of the effect of socio-economic characteristics on adoption of MBHPPPs among farmers in Kano State. The R2 value of 0.601 and adjusted R2 of 0.590 indicating that about 59% of variance in dependent variables was explained by the independent variable in the model. Educational qualification, year of bee keeping experience, major occupation, total number of hives in the apiary, number of modern hives, average annual income and sources of honey production and processing tools were significant. This means that a unit increase in (each) of these variables result in increase in adoption of MHBPPPs. Thus, the null hypothesis that states that there is no significant effect of socio-economic characteristics of farmers on adoption of MHBPPPs is hereby rejected at 0.05 significant levels. By implication, there is a significant effect of socio-economic characteristics on adoption of MHBPPPs in Kano State.

Null Hypothesis Two: There is no significant relationship between farmers' awareness and adoption of MHBPPs

Table 9: Pearson's Product Moment Correlation Statistics Relationship between Farmers' Awareness and Adoption of MHBPPs

Variables	N	$\bar{x}$	STD	Df	Correlation index	P
Awareness of modern honey bee processing practices	262	25.8626	1.32621			
				260	0.637**	0.001
Adoption of modern honey bee processing practices	262	35.0382	2.13852			

***. Correlation is significant at the 0.05 level (2-tailed).*

Results of the PPMC statistics showed correlation index r value of 0.637 was significant at 0.05 significant levels. This means that significant relationship exist between farmers' awareness and adoption of MHBPPPs in Kano State. Therefore the stated null hypothesis that there is no significant relationship between farmers' awareness and adoption

of MHBPPPs in Kano State is rejected. This implies that there is significant relationship between awareness and adoption of MHBPPPs in Kano State.

Null Hypothesis Three: There is no significant relationship between constraints and adoption of MHBPPPs

Table 10: **Pearson Product Moment Correlation Statistics between Constraints and Adoption of *MHBPPs* in Kano State**

Variables	**N**	$\bar{x}$	**STD**	**Df**	**Correlation index**	**P**
Constraints of modern honey bee processing practices	262	25.7137	3.55662			
				260	0.673**	0.001
adoption of modern honey bee processing practices	262	35.0382	2.13852			

***. Correlation is Significant at the 0.05 level (2-Tailed).*

Results from the analysis revealed a correlation index of - 0.0673 at 0.05 significant levels. This means that significant relationship exist between farmers' adoption and the constraints to the adoption of *MHBPPs* in Kano State. However, the relationship between these two variables is inversely proportional, that is the higher the constraints of MHBPPs, the lower the adoption and vice versa. Therefore the null hypothesis which states that there is no significant relationship between constraints and adoption of *MHBPPs* in Kano State is rejected. By implication, there is significant relationship between constraints and adoption of MHBPPPs.

4.4 Summary of Major Findings

The purpose of the study was to assess the adoption of MHBPPPs in Kano State. A structured questionnaire containing 58 practices in MHBPPPs in production and processing was the instrument. Results and findings from the research questions and statistical testing of the null hypotheses are presented as follows:

1. The socio-economic characteristics of bee farmers had significant effect on the adoption of *MHBPPPs* in the study area.
2. There is significant relationship between awareness and adoption of *MHBPPPs* in Kano State. This means that the more the awareness, higher the adoption.
3. There is an inverse relationship between adoption of *MHBPPPs* in Kano State and constraints to it. This is to say that the higher the militating constraints, the lower the level of adoption of the modern practices.
4. Bee farmers in Kano State were benefiting from the adoption of MHBPPPs in production and processing in terms of quality and quantity of produce, higher income as well as ease of introducing medicinal materials to honey.
5. The socio-economic characteristics of honey bee farmers in Kano State was found to be similar with other bee keeping communities in Nigeria and other parts of Africa.
6. Males dominated honey bee production in the study area as females participation was 5.7%

4.5 Discussion of Findings

The results on the socio-economic characteristics of the respondents agreed with the findings of other authors. Beekeeping is an agricultural enterprise that has more males (94.3%) with age range of 46-55 (73.7%, mostly married (91.6%) with about 10-15 (51%) years of beekeeping experience. In the same vein, Agwu, Ekwueme and Anyanwu (2008) and Matanmi *et al*. (2008) reported that bee farmers in Enugu and Oyo States were mainly males aged 50 or more years. The probable reason for higher number of males in bee keeping may be due to the tasking jobs and the timing of major operations (in the late evenings or early mornings). Quiser *et al*. (2013) found out that women participation in bee keeping is low due to cultural beliefs and tasking jobs. In some cultures and religious beliefs, women's duty and movement is restricted within the home (Pudah) hence bee

keeping may not be the preferred job for female. However, Adjare (1990) reported that in Ghana, housewives were very active in bee keeping. He further reported a case where a woman drove her bees several miles into her farm unprotected. This shows that bee keeping can be an occupation for everyone except those with bee allergy problems. On the account of age, some cultural beliefs could be factors to why young people are not active in bee keeping. Adjare (1990), reports that in most places in East Africa, bee keeping is associated with mystic powers and witchcraft activities. These beliefs discourage the younger generation thereby leaving beekeeping to the aged.

It was further found that all the respondents had one form of education or the other (probably a condition for selection for training). In line with this finding, Adams (1999) states that level of education attained, exposure and availability of finance are some socio-economic characteristics that help adoption process especially if such a person is inquisitive. Furthermore, Hyppolyte, (2015) reported that educated household heads were more likely to have more access to information (of innovation). However, Adamu (2014) reports high illiteracy is a challenge to adoption of modern honey bee practices in Nigeria.

The major occupation of the respondents was crop farming (50.8%). Bee and plants have symbiotic relationship each benefiting from the other (pollination and nectar). Abebe et al. (2008) reports that bee farmers were benefiting in terms of good nutrition, increased income and good crop pollination. Furthermore, Kiesha (2014) states that about ten crops would have gone into extinction without bees. This is to say that crop, agro forestry and bee farming enterprises are good combination as confirmed by Orisakwe and Agumuo (2012).

The study showed that 46.6% of the bee farmers had 15 hives with 38.2% having 10 modern hives in their apiaries. There is a good positive association between farm size and adoption of new technologies (Hyppolyte *et al*. 2015). Although the adoption of modern equipment was not high in the current study, however Abebe *et al*. (2008) reports that bee

farmers were reaping increased yield of about three times from the use of modern tools than what was obtained from local tools. Also, 70% of the respondents reported an annual income of ₦200,000.00 and got their processing equipment (80.2%) from KNAP. Income is one of the major reasons why people engage in business, hence it should be increased. In terms of equipment and tools, it was earlier reported that KNAP gave each of the trainees two KTBH, one local, bee suite, smokers and other accessories with five thousand naira take-off assistance. There was no mention of any modern processing tool given them. However, the researcher found out from the KNAP staff that through the monitoring arm of the unit, KNAP buys off the raw produce from their trained farmers, process, sort, pack, label and market. This may possibly be a way of helping in processing and marketing the produce. In line with this, Magaji (2012) suggests the establishment of collection points (at strategic places of honey production) and buy off the produce of their accredited producers, these raw honey will be processed and blended to give packaged honey ready for market.

Furthermore, with regards to awareness of MHBPPs, it was found that respondents had an average mean of 1. 76 as against the decision mean/rule of 1.500. For each of the practices, the mean awareness recorded were all higher than the decision mean except for the use of centrifuge extractor (1.42).The practice they were most aware of was the use of separate rooms for sorting (99.20%) and wearing protective bee clothes (98.10%). The bee farmers were aware of MHBPPPs in honey and wax production and processing.

Analysis on adoption of *MHBPPs* revealed that decision mean of 2.00 was exceeded since an average mean of 2.48 was obtained. The most adopted practices were wearing of protective clothes (98.5%) and use of warm and clean environment for extraction (87.00%) while the least adopted practice was use of centrifuge extractor of honey (22.50%). Onabe, (2011) and Randy (2013) states that one of the most important tools in bee keeping after the hive is bee kit since it protects both the farmer and the bees. Fear of bee stings is one of the

constraints of some people to honeybee farming, hence its proper management through protective wears, will encourage more of such persons into the bee business. In a related finding, Cramp (20008) and Wambua (2015) recommends that inspection, harvesting and extraction of honey should not be done with naked fire, at night or during damp weather as such activities at such times reduce the honey quality and quantity. However, the adoption of centrifuge extractor could be low due to high cost, unavailability or poor skill for its use. Contrary to this, Salama and Malavele (2009) and Gregory (2011) stated that bee farmers in their areas adopted CDM and improved solar meter for honey and wax processing.

On the benefits derived from the use of modern practices, bee farmers were benefiting from the adoption of MHBPPs. The ranking indicated high quality products (1^{st},) and increased income (2^{nd}) while the least benefit was less time consuming of activities (10^{th}). This agreed with the findings of Hyppolyte *et al*. (2015) who reports that bee farmers enjoyed improved and increased quality and quantity of hive products. It is worthy to note that one of the major problems of honey export from Nigeria to the EU, according to Belewu (2015) and NEPC (2015) is adulteration of products. This then means a brighter future for bee production business and higher income for the farmers. Furthermore, Salama and Matavele (2009), Ige and Olugbenga (2010), Yusuf *et al.* (2010), Tope *et al.* (2012) and Adeshina (2016) reports other benefits to include improved income and nutrition through good sales and exports of quality products, increased crop production through bee pollination, easier detection of adulterated products, good employment opportunities, apitherapy and BVT. Although bee farmers in the study area benefited from the identified practices, they were not the most important benefits. In the same vein, Abebe *et al.* (2008) reports that bee farming has contributed about 20% of the Gross Domestic Product (GDP) and about 60-70% of the livelihood of the Ethiopian population. In like manner, NEPC (2015) states that with proper production and processing practices, coupled with the

abundant bee potentials, Nigeria stands to earn great benefits of diverse types (income, foreign exchange, employment, improved health and high standard of living) from apiculture. Other innovations in bee keeping in recent times include apitherapy and queen rearing.

In terms of production in bee, queen rearing is a new technique that has helped the bee farmer to determine the trait and character of his colony Production of good quality queens, according to Ojeleye (2014), is a factor to improved efficiency in bee keeping. Through queen rearing, farmers can increase the number of productive colonies, de-queen, re-queen and reduce swarming and abscondment of colonies. A strong and viable queen breeds workers that are strong and productive.

Analyses of the major constraints to adoption of MHBPPPs indicated that the decision mean/rule of 2.500 was exceeded by the average mean of 3.165. In order of their rankings, it was identified that high cost of equipment 95.41%was first followed by scarcity of modern processing equipment94.66% and poor sources of information93.81. The least cost was honey fermentation and crystallization89.31%. In like manner, Campbell, Kenealy and Campbell (2003), Saheed (2013) and Belewu (2015) reports that high cost of equipment and inadequate modern equipment are constraints to high quality and quantity of hive products. Many of the modern equipment and tools are imported, expensive and rarely affordable by the average bee farmer. Due to these constraints, many bee farmers resort to the use of blends of both local and modern equipment (Abebe *et al. 2008*) as well as patronizing locally fabricated equipment. In Kano, like in many other places, local fabricators (DAS Bee Technology, Dambata) fabricate many of the modern equipment and tools for bee farming. In addition to high cost of equipment, most South and East African countries have major challenges of drought, vandalism of hives, bad weather and deforestation (Abebe *et al. 2008,* Salama and Matavale 2009, Mujuni *et al.*2012).

Proper and timely information dissemination is keys to success in any endeavor including bee production. The respondents identified poor information as the third most pressing constraint. Information is needed on sources of equipment, loan, intervention agencies, and marketing channels among others. Information about an innovation brings awareness. However, the source of information has to be acceptable as most farmers are skeptical about the source of their innovation information. Fabiyi (2015) reports that farmers in Bauchi State preferred innovation information from their fellow farmers than other sources. In the same vein, Mujuni *et al.* (2012) and Adamu (2014) reports that bee farmers in Western Uganda and Nigeria preferred farmer - to- farmer information due to trust and confidence.

Although fermentation and crystallization of honey is the least of the constraints of the bee farmers, however due to unfolding climatic issues especially as it relates to beekeeping, it had to be discussed. Many bee farmers in Nigeria have been reporting recent events in their honey crop. Nigeria Beekeeping News (2016) reports various cases of low yield and the advent of crystallization of honey in several states. Crystallized honey is difficult to harvest and process thereby leading to low quality and quantity of produce. Crystallization of honey in the very recent past has been reported in Ekiti, Anambra and Cross River States which bee farmers reported that they have never seen in all their years of beekeeping. In a study titled Assessment of the impact of climate change on honey and propolis production in Nigeria (reported in Nigeria Beekeeping News, 2016), the authors confirmed the progressive reduction in the volume of honey produced due mainly to reduced nectar and pollen. This situation, according to them is attributed to varying changes in rainfall pattern and distribution due to climate change.

Furthermore, three null hypotheses were tested with regression statistical analysis and PPMC and the results showed significant effects. The regression analysis showed R

value of 0.776 and the adjusted R value of 0.590 at 0.05 significant level, which were each higher than the standard R value of 0.400. This implies that a unit increase of the socio-economic characteristics of farmers (in terms of educational level, bee production experience), the better the adoption of MHBPPPs. This finding is supported by the study of Ntege-Nanyeenya et *al* (1997), Orisakwe and Agomuo (2011) and Hyppolyte *et al*. (2015) who reports that educated farmers are more eager and willing to adopt innovations in MHBPPs than illiterates.

Hypothesis two stated that there is no significant relationship between awareness and adoption of MHBPPPs in the production and processing of honey and wax in Kano State. The hypothesis was tested using PPMC and the result obtained indicated a significant relationship between awareness and adoption. The relationship between the variables is directly proportional, which is the higher the awareness, the better the adoption of innovation. A similar finding by Nutley, Davies and Walter in Botha and Atkins (2005) states that knowledge (awareness) and inquisitiveness of a person affects adoption of innovation. Several factors affect the adoption of an innovation among which, according to Rogers in Botha and Atkins (2005) are benefits accruable, compatibility of the practice with existing technology in the farm, level of complexity of the innovation, finance and the knowledge base of the farmer. If these variables are in their good working agreement with the new practice, then adoption is likely to be high.

The analysis of the relationship between constraints and adoption was significant at 0.05 significant levels. However, the relationship was inversely proportional, i.e. the higher or stronger the constraint, the lesser the adoption and verse versa. High cost of equipment made some of the farmers to use blends of modern and local processing equipment and engage in the use of locally fabricated equipment.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary of the entire research work and conclusions drawn as well as recommendations and contribution to knowledge. It also contained the suggestions for further studies.

5.1 Summary of the Major Findings

The study titled adoption of modern honey bee production and processing practices among bee farmers in Kano State, Nigeria was carried out with a structured questionnaire with 58 bee items. A study sample of 270 was randomly selected from a population of 1200 KNAP trained honey bee farmers. The study had five research objectives, five research questions and three null hypotheses and data were obtained with a structured questionnaire. In analyzing data, frequencies and percentages were used for the socio-economic characteristics, while mean, standard deviation and ranking were used for the research questions. Of the three null hypotheses, H_{O1} was tested with regression statistics while Ho_2 andH_{O3} were tested using PPMC. All hypotheses were tested at 0.05 levels of significance.

All three null hypotheses were rejected because significant relationship existed between the variables under investigation. From the analysis of hypothesis 1, significant effect was found to exist between socio-economic characteristics of bee farmers and adoption of MHBPPPs. This implies that education, good experienced in bee production and availability of funds had effect on adoption of MHBPPPs. Hence the null hypothesis one was rejected.

Hypothesis two which stated that there is no significant relationship between awareness and adoption of MHBPPPs in production and processing of honey and wax in Kano State was also rejected. This was because significant relationship was found to exist, that is the higher the awareness the higher the adoption of the practices. Hypothesis three was

rejected because significant (inversely proportional) relationship existed between adoption and constraints. The higher the constraints, the less the adoption of modern honey bee processing practices in the study area.

It was also found that the bee farmers were benefiting from the use of modern practices in diverse forms, hence they adopted despite the constraints. Many of them devised other means of overcoming the constraints (blending the use of local and modern as well as the use of locally fabricated equipment).Chapter five presents the summary of the entire work with conclusions drawn from the study, recommendations based on the findings, contributions to knowledge and suggestions for study.

5.2 Contributions to Knowledge

This study made the following contributions to knowledge:

Some of the socio-economic characteristics such as education, years of bee production experience and availability of funds are some of the factors that affect adoption of MHBPPPs in Kano State.

This study identified several constraints confronting bee farmers in Kano State among which were high cost of equipment, scarcity of modern equipment and poor information about quality standards in production and processing of honey and wax.

Poor participation of women in bee business, according to the study, is caused by cultural and religious beliefs as well as the tasking nature of jobs in production and processing of honey and wax.

Due to the benefits enjoyed by farmers in the use of MHBPPPs, bee farmers has devised means of using blends of both local and modern practices and equipment in production and processing of honey and wax in Kano State.

5.3 Conclusion

Based on the findings of the study, the following conclusions were made:

1. Farmers in Kano State are aware but not adopting all the MHBPPPs in production and processing of honey and wax. The farmers' participation in bee training may have exposed them to this high level of awareness.
2. Constraints faced by bee farmers in Kano State has affected adoption of some of the MHBPPPs. Constraints such as scarcity and high cost of available tool and equipment, poor information dissemination were high among the constraints.
3. Due to the benefits derived from adopting the MHBPPPs, most farmers use blends of local and modern tools and practices in their production.
4. Socio-cultural barriers and the tasking nature of most bee keeping activities has made
5. women participation in production and processing to be low, leaving the business as men's affair.

5.4 Recommendations

Based on the findings from the study, the following recommendations were made:

1. Farmers should form co-operatives that can assist them in assessing interest-free loan facilities, access to hiring unit of government farms as well as access trainings and conferences that will enhance and improve their production and processing. Government should also provide incentives through the co-operatives to its members.
2. Government should create appropriate linkages through which farmers can access the right information about loans, trainings, places for hiring tools and equipment. Major processing plants should be established by government so that farmers can easily process their products properly thereby improving the quality of produce.

3. Government should create enabling environment to encourage local fabrication of some of these needed items. Also duty free tolls can be applied to the importation of honey production and processing equipment.
4. The government should train, retrain and employ more agricultural extension workers in modern methods of beekeeping and honey processing. The curriculum of their training should include but not limited to methods of adapting and technology transfers and improvement of resources needed for effective teaching. These steps will help the extension staff to reach out to the farmers with modern practices of MHBPPS.
5. The government and non-governmental organizations should organize more bee keeping

   and processing trainings at a larger scale as to accommodate more people especially females.
6. Stakeholders in honey bee business (producers, processors, marketers, exporters and researchers) should form a common forum and create the needed awareness of the benefits of modern practices in honey bee processing.
7. Special training should be mounted just for females in the areas of processing which seem to be less tasking than production. Moreover, lectures on some of the outdated cultural beliefs should be mounted so that women can be allowed to participate effectively in bee business.

5.5 Suggestions for Further Studies

The researcher suggested that further study be conducted in the following areas:

1. Assessment of the adoption of modern production practices in honey bee keeping in Kano State.
2. Effects of socio-economic characteristics on adoption of modern honey bee production and processing practices in Kano State.
3. Assessment of the adoption of modern honey bee processing practices in Imo State.

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APPENDIX I

DEPARTMENT OF VOCATIONAL & TECHNICAL EDUCATION

AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA.

FACULTY OF EDUCATION

VICE CHANCELLOR: Prof. Ibrahim Garba (B.Sc., M.Sc. (A.B.U.); Ph.D. (London) D.I.C.) Telephone: 069-51755, 50692

HEAD OF DEPARTMENT: Professor A. A. Udoh (B.Ed. (Hons) Nsukka; M. Ed. & Ph.D. Bus Edu. [A.B.U.])

Your Ref: _____ Date: 30th July, 2015

Our Ref: M.Sc/Educ/24437/2012-2013

Letter of Introduction

AUGUSTINA NDU – M.SC/24437/2012-2013

This is to certify that the above mentioned name is a Postgraduate student (M.Sc Agric Education) in the Department of Vocational and Technical Education, Ahmadu Bello University, Zaria carrying out a research topic: ***Assessment of the Awareness, Adoption and Benefits of Modern Honey Bee Processing Skills Among Farmers in Kano State.***

Please, kindly give her every assistance she may require.

Professor A.A. Udoh
HEAD OF DEPARTMENT

APENDIX II

REQUEST TO COMPLETE QUESTIONNAIRE

Dept. of Voc. and Tech. Edu
Faculty of Education
Ahmadu Bello University,
Zaria.

16/03/2016

Sir,

REQUEST TO FILL QUESTIONNAIRE

I am a Postgraduate student in the above mentioned Department, conducting a research study on *Adoption of Modern Honeybee Production and Processing Practices among Farmers in Kano State*. The questionnaire is designed to obtain data for the research work. Please fill the questionnaire as objectively as possible. All information supplied will be treated as confidential, and used only for the purpose of this study. Hence the researcher counts on your co-operation.

Thank you.

Yours faithfully

Augustina NDU
MSC/EDUC/24437/2012-13

APPENDIX III

QUESTIONNAIRE

Farmers Questionnaire on the Adoption of Modern Honey Bee Production and Processing Practices (FQAMHBPPs)

I am a final-year student of the Department of Vocational and Technical Education, Faculty of Education, Ahmadu Bello University, Zaria, conducting research on "Adoption of Modern Honey Bee Production and Processing Practices in Kano State, Nigeria". You are kindly requested to sincerely complete this questionnaire. Please be assured that all information given will be used for the purpose of this research alone.

Name: Augustina NDU

Matric Number: MSc/EDUC/24437/2012-2013 // P16EDVE8189

Section A: Socio-Economic Characteristics of Respondents

Please tick [√] the option that agrees with your opinion

1. Sex: Male [ ] Female [ ]
2. Age (in Years): 16- 25 [ ] 26-35 [ ] 36-45 [ ] 46-55 [ ]
   56 and above [ ]
3. Marital Status: Single [ ] Married [ ] Divorced [ ]
   Separated [ ] Widow/Widower [ ]
4. Educational Qualification: Primary [ ] Secondary [ ] NCE/ ND [ ]
   Bachelor Degree [ ] Post Graduate [ ]
5. Years of Experience in Bee Keeping: 1-5yrs [ ] 6-10yrs [ ] 11-15[ ]
   16-20 [ ] above 20[ ]
6. Major Occupation: Crop farming [ ] Livestock farming [ ]

Civil servant [ ] Bee farming [ ] Trading / business [ ]

7. Total Number of Hives in Apiary:

   Equal to or less than 15 [ ] 16-30 [ ], 31-45 [ ]

   46and above (large scale)[ ]

8. Number of Modern Hives in Apiary: 10 or less [ ] 11-20[ ]

   21-30[ ] 31-40 [ ] above 40 [ ]

9. What is the Average Annual Income from Bee Business: ₦200,000 and below [ ]

   ₦200,001-400,000 [ ] ₦400, 0001- 600, 0000 [ ] ₦600, 0001-800, 000 [ ]

   800,001-1m [ ] Above ₦1,000,000 [ ]

10. What are the sources of your honey bee processing tools and equipment?

    KNAP [ ] importation [ ] local fabrication [ ] farmers' co-operatives [ ]

SECTION B

RQ (1): Are you aware of Modern Honey Bee Processing Practices?

S/No.	Awareness of Modern Honey Bee Processing Practices	Aware	Not aware
1.	Inspects colonies for pests and diseases		
2.	Wearing protective bee clothes.		
3.	Baits new hives before installing		
4.	Solar extractor for wax rendering		
5.	Products packed in labeled containers.		
6.	Avoids naked fire during harvesting.		
7.	Maintains quality standard in processing.		
8.	Use centrifuge extractor for honey only.		
9.	Use dehumifiers for honey		
10.	Separate capping from wax		
11.	Harvests in the evening or early morning.		
12.	Planted new bee plants in apiary		
13.	Use separate rooms for extracting and sorting.		
14.	Use of warm and clean environment for extraction.		

TOTAL			
%			

RQ (2): To what Extent did you Adopt the Modern Honey Bee Processing Practices?
Please tick appropriately

S/No.	Adoption of Modern Honey Bee Processing Practices	Fully Adopted	Partially Adopted	Never Adopted
1.	Inspects colonies for pests and diseases			
2.	Wearing protective bee clothes.			
3.	Baits new hives before installing			
4.	Solar extractor for rendering wax.			
5.	Products packed in labeled containers.			
6.	Avoids naked fire during harvesting.			
7.	Maintains quality standard in processing.			
8.	Use centrifuge extractor for honey only.			
9.	Use dehumifiers for honey			
10.	Separate capping from wax			
11.	Harvests in the evening or early morning.			
12.	Planted new bee plants in apiary			
13.	Use separate rooms for extracting and sorting			
14.	Use of warm and clean environment.			
TOTAL				
%				

RQ (4): What are the Benefits Derived from the use of Modern Honey Bee Processing Practices?

Rank the following benefits on their order of importance, 1st is the most important benefit, while 10th is the least benefit derived. Please no two (2) items should be in one rank.

S/No.	Benefits / Ranking	Responses 1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1.	Ease of operation										
2.	Reduced drudgery										
3.	Less time consuming										
4.	High volume of output										
5.	Increased income										
6.	Higher quality of products										
7.	Safety from bee stings										
8.	High volume bulk sales										
9.	Creates more value chain of products										
10.	Ease of introducing other medicinal materials.										
TOTAL											

%											

RQ 5: What are the Major Constraints to the use of Modern Honey Bee Processing Practices?

Please tick the opinion that matches your constraints to adoption of modern practices

S/No.	Constraints Ranking	Strongly Agree	Agree	Disagree	Strongly Disagree
1.	High cost of equipment/tools.				
2.	Scarcity of modern processing equipment and tools.				
3.	Inadequate extracting and straining skills.				
4.	Poor linkages/assess to extension staff.				
5.	Honey fermentation and crystallization.				
6.	Poor co-operation among bee business stakeholders.				
7.	Poor pricing of products.				
8.	Poor information of quality standards.				

9.	Inadequate market.				
10.	Non availability of subsidy.				
TOT AL					
%					

APPENDIX IV

RELIABILITY CO-EFFICIENT OF PILOT STUDY

Variables =agree or disagree

Scale (all variables) all

Model alpha.

Reliability analysis

Scale: all variables15

Processing summary

	N	%
Valid	20	100.0
Excluded cases	0	0
Total	20	100.0

List wise deletion based on all variables in the procedure

Reliability statistics

Cronbach's alpha	No of items
.86	2

APPENDIX V

DETAILED SPSS RESULTS FOR RESEARCH QUESTIONS & HYPOTHESES

Descriptive Statistics

	Mean	Std. Deviation	N
ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	35.0382	2.13852	262
education qualification	3.79	1.049	262
years of experience in bee keeping	3.31	.884	262
Major occupation	2.4046	.92871	262
total number of hives in apiary	2.0649	1.10709	262
Number of modern hives in apiary	2.0573	1.35633	262
Average annual income from bee business	1.2252	.45365	262
sources of your honey bee processing tools and equipment	1.5076	1.04951	262

Correlations

		ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	education qualification	years of experience in bee keeping	Major occupation	total number of hives in apiary	Number of modern hives in apiary	Average annual income from bee business	sources of your honey bee processing tools and equpment
Pearson Correlation	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	1.000	-.334	-.241	.118	.583	.184	.070	.131
	education qualification	-.334	1.000	.351	.429	-.245	.025	-.085	-.637
	years of experience in bee keeping	-.241	.351	1.000	-.111	-.498	-.258	.131	-.488
	Major occupation	.118	.429	-.111	1.000	.228	.140	.265	-.003
	total number of hives in apiary	.583	-.245	-.498	.228	1.000	.766	.123	.377
	Number of modern hives in apiary	.184	.025	-.258	.140	.766	1.000	.016	.200
	Average annual income from bee business	.070	-.085	.131	.265	.123	.016	1.000	.097
	sources of your honey bee processing tools and equipment	.131	-.637	-.488	-.003	.377	.200	.097	1.000
Sig. (1-tailed)	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	.	.000	.000	.029	.000	.001	.129	.017
	education qualification	.000	.	.000	.000	.000	.346	.084	.000
	years of experience in bee keeping	.000	.000	.	.037	.000	.000	.017	.000
	Major occupation	.029	.000	.037	.	.000	.012	.000	.480
	total number of hives in apiary	.000	.000	.000	.000	.	.000	.023	.000
	Number of modern hives in apiary	.001	.346	.000	.012	.000	.	.396	.001
	Average annual income from bee business	.129	.084	.017	.000	.023	.396	.	.059
	sources of your honey bee processing tools and equpment	.017	.000	.000	.480	.000	.001	.059	.
N	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	262	262	262	262	262	262	262	262
	education qualification	262	262	262	262	262	262	262	262
	years of experience in bee keeping	262	262	262	262	262	262	262	262
	Major occupation	262	262	262	262	262	262	262	262
	total number of hives in apiary	262	262	262	262	262	262	262	262
	Number of modern hives in apiary	262	262	262	262	262	262	262	262
	Average annual income from bee business	262	262	262	262	262	262	262	262
	sources of your honey bee processing tools and equipment	262	262	262	262	262	262	262	262

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.776[a]	.601	.590	1.36860	.601	54.751	7	254	.000	1.899

a. Predictors: (Constant), sources of your honey bee processing tools and equpment , Major occupation, Number of modern hives in apiary, Average annual income from bee business, years of experience in bee keeping, education qualification, total number of hives in apiary
b. Dependent Variable: ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	717.860	7	102.551	54.751	.000[b]
	Residual	475.758	254	1.873		
	Total	1193.618	261			

a. Dependent Variable: ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES
b. Predictors: (Constant), sources of your honey bee processing tools and equipment , Major occupation, Number of modern hives in apiary, Average annual income from bee business, years of experience in bee keeping, education qualification, total number of hives in apiary

Co-efficients[a]

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	34.991	.783		44.694	.000		
	education qualification	-.844	.146	-.414	-5.783	.000	.306	3.267
	years of experience in bee keeping	.442	.128	.183	3.457	.001	.561	1.781
	Major occupation	.406	.129	.176	3.139	.002	.498	2.010
	total number of hives in apiary	2.126	.155	1.101	13.679	.000	.242	4.125
	Number of modern hives in apiary	-.878	.111	-.557	-7.905	.000	.316	3.161
	Average annual income from bee business	-.614	.211	-.130	-2.916	.004	.786	1.273

	sources of your honey bee processing tools and equipment	-.680	.122	-.334	-5.595	.000	.441	2.266

a. Dependent Variable: ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions							
Model	Dimension	Eigenvalue	Condition Index	Variance Proportions							
				(Constant)	education qualification	years of experience in bee keeping	Major occupation	total number of hives in apiary	Number of modern hives in apiary	Average annual income from bee business	sources of your honey bee processing tools and equpment
1	1	6.967	1.000	.00	.00	.00	.00	.00	.00	.00	.00
	2	.459	3.895	.00	.01	.01	.00	.02	.03	.01	.09
	3	.286	4.937	.00	.00	.00	.00	.01	.12	.01	.24
	4	.112	7.884	.00	.00	.08	.34	.01	.06	.01	.01
	5	.098	8.436	.00	.03	.00	.04	.02	.00	.67	.10
	6	.047	12.111	.02	.00	.01	.05	.58	.56	.12	.07
	7	.022	17.656	.04	.34	.67	.40	.00	.01	.16	.01
	8	.008	30.090	.94	.62	.23	.18	.35	.22	.02	.48

a. Dependent Variable: ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES

Casewise Diagnostics[a]

Case Number	Std. Residual	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	Predicted Value	Residual
121	-3.760	29.00	34.1457	-5.14571

a. Dependent Variable: ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES

Residuals Statistics

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	30.2262	38.7375	35.0382	1.65844	262
Residual	-5.14571	3.77377	.00000	1.35012	262

Std. Predicted Value	-2.901	2.231	.000	1.000	262
Std. Residual	-3.760	2.757	.000	.986	262

a. Dependent Variable: ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
AWARENESS_OF_MODERN_BEE_PROCESS_PRACTICES	25.8626	1.32621	262
ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	35.0382	2.13852	262

Correlations

		AWARENESS_OF_MODERN_BEE_PROCESS_PRACTICES	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES
AWARENESS_OF_MODERN_BEE_PROCESS_PRACTICES	Pearson Correlation	1	.637**
	Sig. (2-tailed)		.001
	N	262	262
ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	Pearson Correlation	.637**	1
	Sig. (2-tailed)	.001	
	N	262	262

**. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			AWARENESS_OF_MODERN_BEE_PROCESS_PRACTICES	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES
Spearman's rho	AWARENESS_OF_MODERN_BEE_PROCESS_PRACTICES	Correlation Coefficient	1.000	.683**
		Sig. (2-tailed)	.	.000
		N	262	262
	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	Correlation Coefficient	.683**	1.000
		Sig. (2-tailed)	.000	.
		N	262	262

**. Correlation is significant at the 0.05 level (2-tailed).

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
CONSTRAINTS_TO_USE_OF_MODERN_BEE_PROCESS_PRACTICES	25.7137	3.55662	262
ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	35.0382	2.13852	262

Correlations

		CONSTRAINTS_TO_USE_OF_MODERN_BEE_PROCESS_PRACTICES	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES
CONSTRAINTS_TO_USE_OF_MODERN_BEE_PROCESS_PRACTICES	Pearson Correlation	1	-.573**
	Sig. (2-tailed)		.000
	N	262	262
ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	Pearson Correlation	-.573**	1
	Sig. (2-tailed)	.000	
	N	262	262

**. Correlation is significant at the 0.01 level (2-tailed).

Nonparametric Correlations

Correlations

			CONSTRAINTS_TO_USE_OF_MODERN_BEE_PROCESS_PRACTICES	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES
Spearman's rho	CONSTRAINTS_TO_USE_OF_MODERN_BEE_PROCESS_PRACTICES	Correlation Coefficient	1.000	-.085
		Sig. (2-tailed)	.	.168
		N	262	262
	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	Correlation Coefficient	-.085	1.000
		Sig. (2-tailed)	.168	.
		N	262	262

Correlations

Descriptive Statistics

	Mean	Std. Deviation	N
ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	35.0382	2.13852	262
CONSTRAINTS_TO_USE_OF_MODERN_BEE_PROCESS_PRACTICES	25.7137	3.55662	262

Correlations

		ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	CONSTRAINTS_TO_USE_OF_MODERN_BEE_PROCESS_PRACTICES
ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	Pearson Correlation	1	-.673**
	Sig. (2-tailed)		.000
	N	262	262
CONSTRAINTS_TO_USE_OF_MODERN_BEE_PROCESS_PRACTICES	Pearson Correlation	-.673**	1
	Sig. (2-tailed)	.000	
	N	262	262

**. Correlation is significant at the 0.05 level (2-tailed).

Nonparametric Correlations

Correlations

			ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	CONSTRAINTS_TO_USE_OF_MODERN_BEE_PROCESS_PRACTICES
Spearman's rho	ADOPTION_OF_MODDERN_BEE_PROCESS_PRACTICES	Correlation Coefficient	1.000	.085
		Sig. (2-tailed)	.	.168
		N	262	262
	CONSTRAINTS_TO_USE_OF_MODERN_BEE_PROC	Correlation Coefficient	.085	1.000

	ESS_PRACTICES	Sig. (2-tailed)	.168	.
		N	262	262