International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

Socio-Economic Factors Influencing Adoption of Modern Bee Keeping Technologies in Baringo County, Kenya

Bunde A.O[1], Kibet K.[2]

[1]ChukaUniversity, Faculty of Business Studies, Department of Business Administration, P.O. Box 109 - 60400, Chuka, Kenya

[2]Moi University, School of Business and Economics, Department of Economics, P.O. Box 3900 – 30100, Eldoret, Kenya

Abstract: ***Bee keeping improves livelihood of rural communities due to its low capital requirement, low technical knowhow and the fact that it is amenable to existing land use in the rural areas. The county is designated as Arid and Semi-Arid Lands (ASALs) which is characterized by high incidence of drought, poor infrastructure, and high levels of poverty. The purpose of this study was to determine factors that affect the adoption of modern Bee Keeping Technology in Baringo County. The study specifically investigated; the levels of modern bee keeping technologies, ' challenges facing modern bee keeping farmers, the level of household income from bee keeping in comparison with other farm enterprises and socio-economic factors that influence the adoption of modern bee keeping technologies. The target population for this study was the entire population of households of Baringo County. The researcher adopted a combination of cluster, purposive and random sampling technique. The sample size was 294 bee keeping farmers. The questionnaires were used for gathering primary data. The data gathered was analyzed using descriptive statistics such as frequency, means and percentages with the aid of SPSS. Bee keeping was practiced by (29.9%) of the respondents and (70.1%) farmers do not practice. The challenges facing Bee farmers were ranked in a descending order. The main challenges being: lack of Bee keeping materials, extension support, lack of capital among other challenges. The income from bee keeping and other sources of farm enterprise indicated that the sale of cereals was ranked highest and the sale of bee products was ranked fourth. The results showed that the adopters mean age was smaller than the non adopters and negatively correlated with p= 0.010. From the logistic regression model on factors affecting adoption of modern bee keeping indicated that gender (β=0.252, p=0.1), age (β=0.017, p=0.05), family size (β=1.656, p=0.05) and education (β=0.446, p=0.01) were significant. Farm size and livestock as variables in the logistic model were not significant. The modern bee keeping farming contributes significantly to households' income. The ministry of livestock development and fisheries and other development agencies working in the area should promote modern bee keeping by availing bee keeping materials such as smokers, protective gears, and train farmers on modern bee keeping practices to enable them improve their yields as part of the strategies to alleviate poverty.***

Keywords: Adoption, Modern Bee Keeping, Technology

1. Introduction

Apiculture is one of the most widespread agricultural activities that are practiced all over the world. The place of origin of 70 % of the honeyed plants that grow in the world is, Anatolia (Tzob, 2006). Today, 56 million bee hives exists in the world and 1.2 million tons of honey is produced from these hives. ¼ of produced honey is subject to trade and 90% of the exports come from nearly 20 honey producing countries (FAO 2005). World honey production per bee hive is around 20 kg and this amount is 33 in China, 40 in Argentina, 27 in Mexico, 64 in Canada, 55 in Australia, 40 in Hungary and approximately 16 kg in Turkey. Although the other countries have neared their full capacity in terms of Colony number and honey production. In Turkey, 200,000 agricultural organizations have activities in apiculture. But, only 20,000 of these organizations deal with apiculture as their main source of income. Honey production had rapid increase in between 1936-2005 and reached to 82.336 tons in 2005 (Tuik, 2005).African production represents only 9.8 per cent of the world production of honey and 23.5 per cent of beeswax. Exports of honey from sub-Saharan Africa countries some of which was intra-African trade in 2004 were 184 metric tonnes (MT) valued at US$ 469 000 whereas in the same year there were imports of 874 MT valued at US$ 2 708 000. Exports of beeswax from sub-Saharan Africa in 2004 were 721 metric tonnes (MT) valued at US$ 465 000 but in the same year there were imports of 255 MT valued at US$ 224 000 (FAO, 2005). These amounts of exports and imports are minimal in world trade figures. They show, however, that African honey is sold on the world market at a price of US$ 2549/MT whereas imports are valued at US$ 3098/MT and beeswax is sold at US$ 645/MT and bought at US$ 878/MT. There thus seem to be considerable opportunities not only for increasing the quantity of Africa's major hive products but also for improving their quality.

Kenya, like other East African countries relies heavily on agriculture. Seventy-five percent (75%) of its people live in rural areas and sixty percent (60%) of these live in absolute poverty (Ravallion, 2005). Kenya is a nation of small holders with over five million small-scale farmers and pastoralists. Cut backs in public services and the free market philosophy of recent years have hit rural communities very hard. As this is unlikely to change, the future of such rural communities will depend on developing their capacities from within to meet the development challenge. Beekeeping is an opportunity to harvest and add value to a local resource (floral nectar) to generate wealth and employment and beat poverty. The Kenyan Ministry of Agriculture estimates that current production levels of honey are less than $1/5^{th}$ the potential production level which is estimated at 100,000 metric tones per annum. The sector is potentially worth US$100 million (111 Million Euros) or more to the Kenyan

economy, (Kerio Valley Development Authority Reports, Unpublished). Beekeeping as an activity complements existing farming systems in Kenya. It is simple and relatively cheap to start, enhances the environment through the pollinating activity of bees, is completely sustainable, generates income and requires a very low level of inputs (land, labour, capital and knowledge in its simplest form). It is therefore an ideal activity for small scale, resource poor farmers. Traditionally, however, beekeeping in Kenya has been more akin to honey robbing rather than honey harvesting. Wild bee nests and traditional log hives are plundered through smoking the hives or killing many bees. Due to the lack of market knowledge and local outlets for honey, sales have usually been to producers of local liquor and the beekeeper is prone to exploitation by more knowledgeable middlemen. In Nairobi and other urban centers there is a strong market for high quality honey, and supermarket shelves are stocked with expensive imported honey from Mexico and Australia. These sell alongside locally produced varieties which tend to be adulterated, poor quality honey.

Over the years numerous attempts have been made to develop beekeeping in Kenya with limited success. This limited success is due in part to poor information on the realities of beekeeping from producer level right through to the market. What we want to understand through this study is where beekeeping in Kenya is now so that we can design effective interventions to develop it to where we would like it to be (realize the potential of the sector to beat poverty). In Kenya three systems of beekeeping are said to exist, namely honey hunting, forest bee keeping and backyard beekeeping (FAO,1990). Honey hunting is a system of looking for honey without taking care of the bee colonies. Honey hunters search for honey in caves, crevices of stones and hallow trunks of wood using fire flame, hot water and other crude materials to displace the colony. Forest beekeeping is hanging of hives on tree branches for harvesting honey during the honey flow period without taking care of the bees. This is not also widely practiced by farmers. The hives are hung on trees to catch swarms and taken home when occupied by bees. Backyard beekeeping is a system of beekeeping where the beekeepers take care of their bees providing with shelter, water, and feeds and also protect them from bee enemies. This is the most advanced system of beekeeping in the region. In this system, bees are managed in hives either in door or out door apiaries and several million bee colonies are managed with the same traditional beekeeping methods in almost all parts of the country.

1.3 Statement of the Problem

Baringo County covers the current Baringo, North Baringo, Marigat, Mogotio and Koibatek districts. These are districts that were designated as Arid and Semi-Arid Lands (ASALs), characterized by high incidence of drought, poor infrastructure, and high levels of poverty. In this region, 65% of the population lives below poverty line (spend less than a dollar per day). A country's economic development depends on the proper utilization of resources and involvement of various sectors in the economy. Bee keeping is one of the sub-sector supporting the livelihood of many households given that two thirds of Kenya's total land area is arid and semi –arid (ASAL) where bee keeping can be an option to diversify the livelihood of the people. The Government of Kenya (GoK) increasingly acknowledges the special attention the ASALs need in order to achieve sustainable poverty reduction and economic growth, as expressed in its Investment Program for Economic Recovery Strategy (IP-ERS) 2003-2007 and its successor the Vision 2030. Despite many intervention programs that have been established in this region, poverty levels have remained high because most of these programs cease at the end of funding period due to many reasons which include high maintenance cost, and lack of skilled personnel. Experience has proved that the success of any project depends on the extent that the project utilizes locally available resources both material resources and indigenous knowledge of the local community. Traditionally communities in this region were bee keepers since they utilized the honey to prepare local brew and for medicinal purpose. The region is endowed with vegetation that is known to produce high quality honey. Economic importance of beekeeping in improving household income makes it one of the options available for reducing poverty levels in the area.

1.4. General Objective

The general objective was to examine the factors affecting adoption of modern bee keeping technology in Baringo County

1.4.1 Specific Objectives

The study was guided by the following specific objectives:

1) To investigate the levels of modern bee keeping technologies within Baringo County
2) To investigate challenges facing modern bee keeping farmers in Baringo County
3) To examine level of household income from bee keeping in comparison to other farm sources of income in Baringo County.
4) To investigate factors that influenced adoption of modern bee keeping technologies in Baringo County.

1.5 Research Questions

These are the issues that the researcher seeks to answer and they are related to research objectives.

i) What is the level of modern bee keeping technologies in Baringo County?
ii) What are the challenges facing modern bee keeping farmers in Baringo County.
iii) What is the level of income from bee keeping compared to other sources of farm income in Baringo County?

Hypothesis

H_{O1}: There is no influence of personal and socio-economic factors on adoption of modern bee keeping technologies in Baringo County.

1.6 Justification of the Study

Poverty index results released by the government in the year 2011 indicated that 65% of the households in Baringo region lived below poverty line (live on less than a dollar per day). The condition has deteriorated due to severe drought that has

been experienced in the region in the past three years that has affected crops and livestock in the area which are the livelihoods of the communities in the area. Bee keeping is not affected much by drought, it is not labour and capital intensive and does not require a lot of technical knowledge, hence the government through the Ministry of Agriculture should promote bee keeping as an option for the community to diversify and improve their household income. In Kenya, the potential of the bee keeping sub-sector has not been fully exploited, which is evident by the fact that the sector is not recognized in sessional paper on poverty reduction of 2008-2012. The study indicated that bee keeping has significant economic impacts on household especially in arid areas. The study will benefit several stakeholders; Ministry of special program and planning in coming up with interventions to mobilize people to adopt to modern beekeeping technologies in the area, Nongovernmental organizations(NGOs), Community Based Organization (CBOs), Faith Based Organizations (FBOs) and other agencies working with the community in the region to improve their livelihoods. The results from this study will provide the stakeholders with an intervention option that is sustainable, amenable to other economic activities and utilize the indigenous knowledge of the community. This is suitable for ecologically fragile area like Baringo County. The study will also be used as a base for further investigation by other researchers on related topics.

2. Bee Keeping in Africa

Beekeeping is an important component of agriculture and rural development programmed in many countries. Beekeeping provides nutritional, economic and ecological security to rural communities at the household level and is an additional income generating activity. This being a non-land-based activity does not compete with other resource demanding components of farming systems. Enormous agricultural & agro-based opportunities exist in the rural areas to generate income and employment. In Nigeria, beekeeping is a useful means of strengthening livelihoods and has been identified as a viable agricultural practice that could alleviate poverty and sustain rural employment (Messely 2007). The environmental benefits of African beekeeping according to Bee for Development Journal (2006) include: Bees are indigenous and a natural component of the local ecosystem, and they contribute to biodiversity through pollination. Bees in most of Africa are disease free, which means that no medicines are used to maintain bee health - quite apart from the fact that poor people could not any way afford to treat them. Beekeeping causes no disturbance to the natural environment. Compare this to a tea estate, which even if certified organic, has involved replacement of natural vegetation with an imported monoculture; Beekeeping creates an economic incentive for rural African people to conserve natural vegetation. Apiculture Trade Africa believes that African honeys are special products. They are produced in the “last frontier”, with indigenous bee stocks and no introduced bee diseases or predators, therefore enabling bee colonies to survive without the use of medicines to maintain bee health. African honey is harvested by small holder farmers, many of whom are the poorest in society. Selling bee products can provide a feasible way out of their poverty. Beekeeping is the ultimate environmentally sustainable activity. The indigenous species of honey bees contribute to biodiversity through pollination and provide economic incentive for rural African people to conserve natural forests, which provide an abundance of excellent bee forage (Tilahun 2006).

2.1 History of Beekeeping in Kenya

In many countries in the world where honey bees (*A. mellifera*) naturally occur, some Kenyan communities have had a long history of harvesting honey from the wild or in traditionally managed colonies. The most well known of these communities include those living in and around key forests found on Mt. Elgon, Mt. Kenya, Aberdare ranges and Mau Escarpment. Others live in the plains as pastoralists and gather honey from extensive woodlands. Honey has always been the most important hive product in all cases. By 1982, the tropics produced 13% of honey in the world market, the subtropics 30%, mostly from Argentina, China and Mexico while temperate regions produced 57% (Bradbear, 1985). The beekeeping industry in Kenya first received the attention of the British colonial government in 1950s (Min. of Agriculture 1967). A memorandum was signed then for the development of the bee industry, establishing the position of a full-time bee officer and instructors. Four key outputs were expected out of this initiative, namely: provision of marketing facilities particularly in areas where trade in bee products was not already properly developed; improvement of quality and total quantity of wax produced; introduction of more suitable equipment to modernize operations, including double chamber hives and fireless smokers to reduce fire risks, thereby minimizing fatalities of bees when harvesting honey and increasing honey quality development of honey refineries for extraction

2.2 Beekeeping Practices and Equipment in Kenya

In the most basic traditional set up, honey gatherers endured much stinging as they robbed bees of their honey in the wild. They usually did so at night and used live torches as smokers, working hurriedly and without protective clothing. The result was that they burnt and killed many bees in the process and there was always danger of setting vegetation on fire in this quest for honey. By the stage when hives were introduced, they were simply made from a hollow log, bark or clay. The hive was not destroyed during harvesting but the equipment used in harvesting honey was just as in robbing. The crude product of comb and honey crushed together was mostly consumed as food or fermented into a traditional beer. In this scenario, all wax was lost (FAO, 1986). This was the situation in Kenya by the time a Canadian funded beekeeping project was initiated in 1971. There was little or no table honey in local shop outlets except that which was imported from Australia. Most of the honey produced in East Africa by then was unfit for use on the general markets but was well suited for making beer. The most surprising finding was that this beer industry consumed the bulk of honey at above normal prices. In modernizing operations, it was desirable to move from this stage to a situation whereby the bee colony would be preserved and not driven off during honey collection.

2.3 Modern Beekeeping Methods

The approach recommended and the principle behind operating a modern hive is to make it possible to move individual combs for inspection or honey collection, then replace them without damage to the colony. In transitional hives which constitute a stage between primitive and modern beekeeping, long top bars provide all the support combs need under normal circumstances. An exception is where hives must be moved, as happens in migratory bee keeping, for then combs may break unless they receive additional support incorporated in the design of the top bar. Such hive equipment is further enhanced with in-built queen excluders that confine the queen bee to a brood area while giving workers access to the hive area beyond. This makes it possible to harvest honey and beeswax by simply removing the combs containing fully capped honey, but no pollen or brood (FAO 1986). Gichora (2003) found that beekeepers in Baringo District of Kenya had continued to practice traditional methods of beekeeping despite the introduction of modern beekeeping methods in Kenya nearly thirty years before her study. The Tugen people could count on one another to keep traditional beekeeping practices alive since all of them had either received instruction from a family member or a local beekeeper. It is how they learnt to manage colonies in traditional hives. 92% of 224 beekeepers interviewed had not received any training in modern methods. In exceptional cases, 4.5% of respondents in this household survey had encountered extension agents of modern beekeeping and learnt to keep bees in modern hives during a short course. The amazing finding was that people exposed to such short courses did not internalize the training and continued to depend on extension agents to manage bee colonies for them afterwards, or else they reverted to traditional management of modern hives!

2.4 Determinants of Adoption of New Technologies by Small Scale Farmers

In Kenya, empirical studies on adoption of farm technology mainly concentrated on the investigation of crop, soil and water conservation and dairy technologies (Itana, 1985), (Getachew, 1993), (Chilot, *1994)*, (Lelisa, 1998), (Shiferaw and Holden, 1998), (Kidane, 2001), (Berhanu, 2002), (Endries, 2003), (Habtemariam, 2004), (Million and Belay, 2004). With regard to beekeeping technology adoption (Melaku, 2005) is the only one to mention. It confirms that study on beekeeping technology adoption is found are still few. However, related research materials to the selected explanatory variables for the study have been reviewed as follows: Voh's, (1982) research report on factors associated with the adoption of recommended farm practices in a Nigerian village also explained that extension contact, socio economic status, access to market, education and leadership role have positive relationship with the adoption of new technologies. According to Feder *et al*, (1985) in their study of adoption of agricultural innovation in developing countries, factors that influence technology adoption are credit, farm size, risk, labor availability, and human capital and land tenure. The same authors stated that farmers' awareness about the technology can increase, if they have access to education. Education can also directly facilitate technology adoption, by increasing access to information about alternative market opportunities and technologies. Legesse, (1992) revealed that extension contact, poor distribution of inputs and technical assistance, socio psychological variables such as farmers' ability, belief, habit and customs, and expectations affect the technology adoption. Itana, (1985) showed that literacy, farm size and adequacy of rainfall affect the adoption decision of farmers positively, while unavailability of cash for down payment and price of farm inputs affect farmer's adoption decision negatively.

3. Materials and Methods

3.1 Theoretical and Conceptual Framework

The study adopted the Sustainable Livelihoods Approach proposed by U.K Department for International Development, 2000 version, which allows appreciation of how capital assets (Human, physical, social, and financial) fit into the Sustainable Livelihoods Framework. The Framework assists with consideration of the various factors that constrain or enhance the livelihood of the household. In the Framework, the understanding of sustainable livelihoods is separated into five parts: the vulnerability context; people's livelihood assets; policies, institutions and processes; livelihood strategies, and livelihood outcomes. Beekeeping is a useful means of strengthening livelihoods because it uses and creates a range of assets. Successful beekeeping draws upon all categories of capital assets. The study conceptualizes that; if modern bee keeping technologies are promoted in Baringo County, and challenges facing modern bee keeping farmers addressed (such as provision of extension support, access to financial support, marketing of bee products, and provision of bee keeping materials, coupled with favourable factors that influence adoption of modern bee keeping technology) there will be increased output in production. The adoption of improved bee hive technology was the dependent variable of the study, while the independent variables comprised of factors that influence the adoption of improved technology. The factors considered during the study include family size, gender, age, land size, education and livestock. During the study the adoption of a beekeeping technology was hypothesized to be influenced by personal attributes (gender, age, education, family size) and socio- economic factors (Livestock holding and land size).

4. Procedures

This study was done in Baringo County. Survey research design was employed as the data gathering technique. The population of study constituted household heads that were either male or female and practiced bee keeping. The population of study was rural based and made up of smallholder farmers. The study used a sample size of 294 bee keeping farmers; simple random sampling procedure was then employed before actual interviews in the field. The study used questionnaire and interview schedule to collect data from the respondents. The validated interview schedule was pilot tested with a sample of 30 household heads within the County. The completed study instruments were serialized, coded and double checked to ensure quality control. Data was analyzed using SPSS where inferential statistics and descriptive statistics were applied in data

analysis. Frequency distribution tables were used for descriptive presentation of the data.

4.1 Logistic Regression Models

The central mathematical concept that underlies logistic regression is the logit the natural logarithm of an odds ratio. The Logit Model is also called logistic regression or logistic model. The model is more relevant for prediction of the probability of occurrence of an event by lifting data to a logistic curve. This is a more generalized linear model that is used for binomial regression. Like other forms of regression analysis, it makes use of several predictor variables that may either be numerical or categorical. For example the probability that a small holder farmer adopted modern bee keeping technologies was predicted by taking into consideration on the factors that influence adoption of new technologies by small holder farmers. The logistic function was used to test on whether small holder farmer adopt or do not adopt modern bee keeping technologies is based on cumulative probability fraction as indicated below.

$$F(z) \text{ or } y_1 = \frac{1}{1 + e^{-z}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.1$$

Where;

$e \simeq 2.718$ - represents the base of natural logarithm.

$$z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots + \beta_n X_n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.2$$

Where β_0 is called the "intercept" and $\beta_1, \beta_2, \beta_3, \ldots\ldots$ and β_n are called the regression coefficients of $X_1, X_2, X_3, \ldots\ldots\ldots$ and X_n respectively. The intercept is the value of z when the values of all the factors that affect X is zero. To illustrate further, Consider use of Logit model in predicting adoption of modern bee keeping technologies. A positive regression coefficient is an indication that the factors that affect adoption of modern bee keeping technologies increases the probability that a small holder farmer would adopt modern bee keeping while a negative regression coefficient means that variables used in the model decrease the probability of adopting modern bee keeping. To identify the model that was used in the start let us defined the logit model as

$$Pi = f(z) = \frac{1}{1 + e^{-z}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.3$$

Where

P_1= Probability that farmers adopt modern bee keeping technologies and hence

$$(1 - P_i) = 1 / 1 + e^{-z} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.4$$

is the probability of not adopting to modern beekeeping technologies

In the above model, the values of P_i ranges from 0 to 1 while; Z_1 ranges from $-\infty$ to ∞.

If we divide eq. (3) by eq.(4) we obtain

$$\frac{P_i}{(1\text{-}pi)} \quad \ldots\ldots\ldots\ldots\ldots\ldots 3.5$$

The Eq. (3.5) above is the odd ratio in favour of adopting modern bee keeping technologies. The odd is the ratio of probability that something is true divide by that it is not true.

The eq. (3.5) is linearized by taking natural logarithms, (adopted from Mukras 1993):

$$Li = \ln \frac{Pi}{(1\text{-}Pi)} = Z_i = \beta_0 + \beta_i X_i + e_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.6$$

The equation shown above (6) is the logit model.

Where X_i are independent variables such as:

X_1 = Sex of household head (1 if male, 0 otherwise)
X_2 = Age of the household head.
X_3 = Education level of household head.
X_4 = Farm size (Hectares).
X_5 = Livestock holding
e_i = Error term

The above variables are considered independent and were analyzed in relation to how they influenced adoption of modern bee keeping technologies by small holder farmers in Baringo County. The choice of the variables was based on literature about adoption of new technologies by small holder farmers available from past studies. The study hypothesized that adoption of modern bee keeping technology is significantly influenced by personal and socio-economic factors.

5. Results and Discussions

5.1 Descriptive Statistics of the Respondents

Table 4.1: Descriptive Statistics of the Respondents

Description	Variables	f	%
Gender	Male	235	79.9
	Female	59	20.1
	Total	**294**	**100**
Age	18-25	61	20.7
	26-30	59	20.1
	31-35	60	20.4
	36-40	88	29.9
	Above41	26	8.2
	Total	**294**	**100**
No. of HH members	Below 5	58	19.7
	8-Jun	89	30.3
	10-Sep	30	10.2
	Above 10	117	39.8
	Total	**294**	**100**
Education Level	No school	45	15.3
	Primary 1-4	101	34.4
	Primary 5-8	30	10.2
	Secondary	60	20.4
	Post Sec	58	19.7
	Total	**294**	**100**

Source: Research Data (2011)

Section A of the questionnaire sought to find out the background information of the respondents. The results indicated that majority of the household head were males at (79.9%) while (20.1%) were females. The age distributions of the respondents were: (20.7%) were within the age of 18-25 years, (20.1%) within 26-30 years, (20.4%) are between the ages of 31-45 and (29.9%) aged 36-40, while (8.2%) are above 40 years. Majority of the respondents (39.8%) had

household members above ten, (30.3%) had between 6-8 members, (10.2%) had 9-10 members and (19.7%) had household members below five. It was found that (33.8%) of the respondents could not read and write. The remaining (38.5 %) and (27.7%) of the respondents attended formal education up to the level of 1-4 and 5-8 years of schooling respectively. Majority of the respondent (34.4%) and (10.2%) attained primary education of between standard 1-4, and 5-8 respectively, (20.4%) had secondary education, (19.7%) attained post secondary education, while (15.3%) had no formal education. The information is summarized in table 4.1. 4.3 Status of Modern Bee Keeping Technologies within Baringo County

Table 4.2: Levels of Modern Bee Keeping Technologies within Baringo County

Status of modern bee keeping technologies	*Variables*	*F*	*%*
Bee keeping	Yes	88	29
	No	206	70
	Total	**294**	**100**
Type of bee keeping	Modern	31	35
	Traditional	53	60
	Mix of both	4	4
	Total	**88**	**100**
Number of modern bee hives	None	206	70
	Below 5	51	17
	6-10	30	10
	Above 10	7	2
	Total	**294**	**100**
Number of traditional bee hive	None	206	70
	Below 3	38	12
	3-5	20	6
	6-10	23	7
	Above 10	7	2
	Total	**294**	**100**

Source: Research Data (2011)

The study sought to establish the status of modern bee keeping in Baringo County. From the results, (29.9%) of the respondents practice bee keeping while (70.1%) of the respondents did not practice bee keeping. Among the bee keepers (35.1%) have adopted modern bee keeping technologies and (59.9%) adopt traditional bee keeping while a minority (5.0%) practiced both modern and traditional bee keeping technologies. The study also sought to find out the number of modern bee hives of which (17.3%) of the respondents had less than five modern bee hives, (10.2%) had between 6-10 modern bee hives, while (2.4%) had above ten modern bee hives. Traditional bee hives in the study area were as follows; (12.0%) of the respondents had less than three bee hives, (6.8%) had between 3-5 bee hives, (7.8%) had between 6-10 bee hives and (2.4%) of the respondents had above ten traditional bee hives. The above information is summarized in table 4.2.

5.2 Challenges Facing Bee Keeping Farmers in Baringo County.

Table 4.3: Challenges Facing Bee Keeping Farmers in Baringo County

Challenge facing bee keeping	Frequency	Rank
Lack of bee keeping materials	41	1st
Lack of extension support	39	2nd
Lack of capital	27	3rd
Lack of bee keeping skills	23	4th
Marketing problem	19	5th
Absconding of honey bees	18	6th
Pest and diseases	11	7th
Drought	8	8th
Shortage of bee forage	6	9th
Reduction of honey bee colonies	3	10th

Source: Research Data (2011)

In order to utilize the beekeeping sub sector, identifying the existing constraints and searching for solutions was of paramount importance. During data collection, the respondents were asked an open ended question to list one major challenge that he/she faced in bee keeping. During data analysis, the challenges were ranked. The findings in the descending order are as follows: Lack of bee keeping materials, lack of extension support, lack of capital, lack of bee keeping skills, marketing problem, absconding of honey bees, pests and diseases, drought, shortage of bee forage and reduction of honey bee colonies. The results are as shown in table 4.4 above.

5.3 Comparison between Bee Keeping and Other Farming Enterprises

Table 4.4: Comparison between Bee Keeping Incomes and Other Farming Enterprises

HH income from different farming enterprises		*f*	*%*	*Mean*
Sale of Milk	None	29	9	
	Less than 5000	104	35	
	5000-10,000	102	34	12415
	11,000-20,000	59	20	
	Total	294	100	
Sale of Cows	None	94	32	
	Less than 5000	89	30	9528
	5000-10,000	49	17	
	11,000-20,000	60	20	
	Total	294	100	
Sale of sheep	None	177	60	
	Less than 5000	117	39	2500
	Total	294	100	
Sale of goats	None	147	50	
	Less than 5000	87	29	2500
	Total	294	100	
Sale of vegetables	None	177	60	
	Less than 5000	117	39	2500
	Total	294	100	
Sale of Cereals	None	29	9	
	Less than 5000	117	39	
	5000-10000	83	28	15209
	11,000-20000	65	22	
	Total	294	100	
Sale of wood products	None	236	80	2500
	Less than 5000	58	19	
	Total	294	100	
Sale of bee products	None	206	70	
	Less than 5000	14	4	
	5000-10,000	34	115	
	11,000-20,000	23	7	
	Above 20,000	17	5	8943
	Total	**294**	**100**	

Source: Research Data (2011)

The study also sought to establish the relationship in household income between bee keeping and other farming enterprises. The finding indicated that income from sale of cereals ranked the highest at an average of Kshs. 15,209 per annum followed by sale of milk at Kshs.12, 415 and sale of cows ranked third at Kshs. 9,528 while sale of bee products was fourth in the rank at Kshs. 8943. Other farming enterprises contribute an average of Kshs. 2500 as summarized in table 4.4

4.6 Factors that Affect Adoption of Improved Bee Keeping Technologies by Small Scale Farmers

Table 4.5: Factors Affecting Adoption of Modern Bee Keeping Technologies

Variable	Adopter	Non adopter	t	sig	p
Male	30(10.2%)	241-81.9%			
Female	1(0.34%)	22-7.5%			
Age	M-42.2 SD-8	M-47.2 SD-6	2.6	0.2	0.2
Family size	M-6.6 SD-1.6	M-5.9 SD-1.6	2.0	0.1	0.1
Education	M-2.7 2.3	M-1.8 SD-1.9	4.2	0.3	0.3
Land size	M-2.55 SD-0.45	M-2.59 SD-0.35	0.4		
Livestock holding	M-4.4 SD -2.6	M-3.9 SD-1.8	0.4		

Source: Research Data (2011)

The total families of the respondents consist 79.9 % male and 20.1% female. Among the respondents 10.2% were male adopters of modern beekeeping technologies and 81.9% of the male were non adopters. The balance 0.34% and 7.5% are female in that order. Similar to other parts of Kenya, male-headed households dominated the area. The mean age of household head for adopters and non-adopters was 42.2 and 47.2 years, respectively. It has significant mean difference at P<0.01. The result shows that the adopters' mean age is smaller than non adopters. It is negatively correlated at P=0.010. It implies that beekeepers are reluctant to adopt new technology as they get older. The results indicated that age of the household head negatively influenced adoption. The respondents mean family size was 6.6 and 5.9 for adopters and non-adopters, respectively. The result shows that the mean family sizes of adopters are greater than non adopters. There is also significant mean difference between adopters and non adopters at P<0.05. This indicates that beekeepers with large family size opt more for technology adoption. This in turn implies technology adoption increases hive products which contribute to satisfy the need of their family. It is also positively associated with modern bee keeping technologies.

Comparison was done between adopters and non-adopters in relation to their mean educational level. It has statistically significant mean difference at P<0.01. This shows that the education level of adopters of improved box hive is higher than non-adopters of the technology, implying the influence of the variable in making adoption decisions. The variable is also positively associated with adoption of modern bee keeping technologies. Farm size was thought to be a good proxy indicator of wealth. The size of land distribution between adopters and non-adopters is on average 2.55 hectares and 2.59 hectares for adopters and non adopters, respectively. The findings did not indicate significant mean difference between both categories. The result shows that both categories have nearly equal size of land and implying that farm size did not affect adoption of modern bee keeping technology in Baringo County. The above information is summarized in table 4.5 above. Livestock holding was thought to be a good proxy indicator for wealth. The major livestock reared in the area are cattle (ox, cow), sheep, goat, poultry, and donkey. Mean comparison was made between adopters and non-adopters using t-test and the result is provided in Table 4.5 the mean livestock holding for adopters and non-adopters is 4.4 and 3.9, respectively. It has no significant mean difference. It reveals that there is no significant difference in the wealth status of both categories measured by livestock holding.

4.6.1 Logistic Regression for Factors Influencing Adoption of Modern Bee Keeping Technologies

The variables subjected to econometric logit model and the logistic results are as shown in table 4.6. The explanatory variables that fitted the model and were significant were: Gender, Age, Education level of household head and family size were significant while farm size and livestock holding were insignificant.

Table 4.6: Logistic Regression Model output on Factors Affecting Adoption of Modern Bee Keeping Technologies

Variable	*B*	*S.E*	*Wald*	*Sig.*	*Exp(B)*
Gender	0.252	0.134	3.523	0.061**	1.287
Age	0.017	0.045	0.150	0.699*	0.983
Fam size	1.656	0.603	7.549	0.006**	5.239
Educ.	0.446	0.172	6.729	0.009***	1.562
Farm size	0.382	0.257	2.211	0.137	1.466
Livestock	1.257	0.789	2.538	0.111	3.515

, **, **-Significant at P<0.1, P<0.05 and p< 0.01

Source: Research Data (2011)

Gender difference is found to be one of the factors influencing adoption of new technologies. Due to many socio-cultural values and norms, males have freedom of mobility and participation in different meetings and consequently have greater access to information. So, gender was found to influence adoption of modern bee keeping in favour of male headed household. As described in Table 4.5, male adopters were 97.8% while 2.2% were females. The result of this study is in agreement with many of previous researchers who have reported positive effect of gender with adoption of agricultural technologies. Taha (2007), in his study on determinants of intensity of adoption of improved onion production package in Dugda Bora district found that male households are more likely to adopt onion production package at 1% significance level.

The role of age in explaining technology adoption is somewhat controversial. It is usually considered in adoption studies with the assumption that older people have more farming experience that helps them to adopt new

technologies. On other side, because of risk averting nature older farmers were more conservative than the younger ones to adopt new technology. The risk of modern bee keeping arises from high cost of production, and bee products market price fluctuation. The results indicate that age has negative relationship with the adoption of modern bee keeping technology. As portrayed from Table 4.5, the average age of adopters was, 42.2 while that of non adopters was 47.2 years. As shown in Table 4.5, the average family size of adopters was 6.6 members while for non adopters were 5.9. The logit model results show that family size has significant effects on adoption of modern bee keeping technologies. Though bee keeping is not a labour intensive activity, the relationship can be attributed to demand for more resources to meet the needs of the larger family. Education level of the household head was found to have positive and significant relationship with the intensity of adoption of modern bee keeping technologies. This explanatory variable accounts for 0.45 % of the variation in adoption of modern bee keeping technologies**.** This shows that being literate would improve access to information, capability to interpret the information, easily understand and analyze the situation better than Illiterate farmers. So, farmer who are literate were likely to adopt modern bee keeping than illiterate farmers. Land is the main asset of farmers in the study area. Farmers in the

study area use both their own land and also rent farm land for crop production .All the sample households own land. The distribution of land holding of the sample households is illustrated in Table 4.5. The average total land holding of the sample households were an average of 2.55 hectare for adopters and 2.59 hectares for non adopters. Logit model show no significant relationship on land holding and adoption of modern bee keeping. The residents of Baringo County are mixed farmers in practicing crop and livestock production. Each household owns at least one or more types of livestock and a piece of land for crop and livestock production. Ownership of livestock is an indicator of wealth status of a household, as confirmed by many studies; those farmers who have better livestock ownership status are likely to adopt improved agricultural technologies because they can take risk. Logit model results indicate that livestock holding has no significant effects on adoption of modern bee keeping.

4.6.2 Hypothesis Testing

The study hypothesized that adoption of modern bee keeping technology is significantly influenced by personal and socio-economic factors. This was achieved by using the binary logistic results to establish the influence of each variable on the adoption of modern bee keeping technology at 5% level of significance. The probability of the Wald statistic for the independent variable gender (χ^2 (1, N = 294) = 3.52, p =.061) was greater than the level of significance of .05. The null hypothesis that the b coefficient for survey respondents gender was equal to zero was not rejected. Gender of respondents does not have an impact on the odds that survey respondents adopt the modern bee keeping. The analysis does not support the relationship that gender of the respondents was 28.7% more likely to adopt the modern bee keeping technologies compared to those who use traditional beehives.

The probability of the Wald statistic for the independent variable farm size (χ^2 (1, N = 294) = 2.21, p =.137) was greater than the level of significance of .05. The null hypothesis that the b coefficient for respondents farm size was equal to zero was not rejected. Farm size does not have an impact on the odds that respondents adopt the modern bee keeping. The analysis does not support the relationship that farm size was 46.6% more likely to adopt the modern bee keeping technologies compared to other farming practices. The probability of the Wald statistic for the independent variable livestock holding (χ^2 (1, N = 294) = 2.54, p =.111) was greater than the level of significance of .05. The null hypothesis that the b coefficient for respondent's livestock holding was equal to zero was not rejected. Livestock holding does not have an impact on the odds that respondent adopt the modern bee keeping. The analysis does not support the relationship that livestock holding was 2.5 times more likely to adopt the modern bee keeping technologies compared to livestock farming.

The probability of the Wald statistic for the independent variable age (χ^2 (1, N = 294) = .150, p =.699) was greater than the level of significance of .05. The null hypothesis that the b coefficient for respondent's age was equal to zero was not rejected. Age does not have an impact on the odds that respondents adopt the modern bee keeping. The analysis does not support the relationship that age was 1.7% less likely to adopt the modern bee keeping technologies. The probability of the Wald statistic for the independent variable education (χ^2 (1, N = 294) = 6.729, p < .001) was less than or equal to the level of significance of .05. The null hypothesis that the b coefficient for education was equal to zero was rejected. The value of Exp (B) for the variable education was 1.56 which implies an increase in the odds of 56.2%. For each unit increase in education respondents were 56.2% more likely to adopt the modern bee keeping technologies.

The probability of the Wald statistic for the independent variable family size (χ^2 (1, N = 294) = 7.55, p < .001) was less than or equal to the level of significance of .05. The null hypothesis that the b coefficient for family size was equal to zero was rejected. The value of Exp (B) for the variable education was 5.24 which imply an increase in the odds of 4.24 times. For each unit increase in family size respondents were 4.24 more likely to adopt the modern bee keeping technologies. From the findings the adoption of modern bee keeping technology is significantly influenced by personal factors such as family size and education at 5% level of significance.

6. Summary of Findings Conclusions and Recommendations

6.1 Summary of findings

The findings revealed that majority of the households (70.1%) do not practice bee keeping and only 29.9% practice beekeeping. Among the bee keepers only, (35.1%) have adopted modern bee keeping technologies while 59.9% practice traditional bee keeping and 5.0% practice both modern and traditional beekeeping methods. Farmers who have adopted modern bee keeping technologies are (17.3 %)

have less than five bee hives, 10.2% had between 6-10 bee hives and 2.4% had above ten modern bee hives as from table 4.2. For farmers owning traditional bee hives, 12.0% had less than three bee hives, 6.8% had between 3-5 bee hives, 7.8% had between 6-10 bee hives and 2.4% had above ten traditional bee hives as shown in table 4.2. The information above reveal that for the fewer farmers who have adopted modern bee keeping technologies have a higher number of bee hives compared to those that own traditional bee hive, this shows that modern bee keeping is a viable venture in the region. The results also show that status of modern bee keeping technologies in Baringo County is still low. The study also sought to establish challenges facing modern bee keeping farmers; the challenges were ranked as summarized in table 4.3, the most common challenges in the descending order were; lack of bee keeping materials, lack of extension support, lack of capital, lack of bee keeping skills, marketing problem, absconding of honey bees, pest and diseases, drought, shortage of bee forage and lastly reduction of honey bee colonies.

The study also compared household income between bee keeping and other farming enterprises. The finding indicated that income from sale of cereals ranked the highest at an average of Kshs. 15,209 per annum followed by sale of milk at Kshs.12, 415 and sale of cows ranked third at Kshs. 9,528 while sale of bee products was fourth in the rank at Kshs. 8943 per annum. Other farming enterprises contribute an average of Kshs. 2500 as summarized in table 4.5. The last objective of the study was to establish factors influencing adoption of modern bee keeping technologies. The logistic regression model was used to predict the factors that affect adoption of modern beekeeping technology. From the results gender, age, family size and education level of the household head were found to influence adoption of modern bee keeping technologies, while farm size and livestock holding did not, as summarized in table

6.2 Conclusions

The results revealed that the level of adoption of modern bee keeping in Baringo County is low; the results indicated 35.1% for adoption. The challenges facing bee keeping in Baringo County were ranked in a descending order and lack of bee keeping materials ranked 1st and reduction of honey bee colonies was last. Comparison of income from bee keeping to other farming enterprises were found to be; income from sale of cereals ranked the highest, followed by sale of milk, sale of cows ranked third while sale of bee products was fourth at an average of Kshs. 8943 per annum, other farming enterprises (wood products, goats, Sheep and vegetables) contribute an average of Kshs. 2500 per annum. Factors influencing adoption of modern bee keeping technology were found to be; gender, age, Family size and education level of the household head were found to influence adoption of modern bee keeping technologies, while land size and livestock holding does not.

6.3 Recommendations

From the study the following recommendations were made; The findings indicated significant contribution of bee keeping on household income, yet the level of bee keeping in the area was found to be low. The Ministry of Livestock Development and Fisheries and other development agencies working in the area should promote modern bee keeping as part of the strategies in the adoption of modern beekeeping technologies in Baringo County.

1) Lack of extension support was found to be the major challenge to modern bee keeping farmers in the area. The government through the Ministry of Livestock Development and Fisheries should train

a. farmers on modern bee keeping practices to enable them improve their yields. They should also avail bee keeping materials such as smokers, protective gears, and bee hives at subsidized rates.

2) Lack of capital was also found to significantly affect adoption of modern bee keeping since its capital intensive as compared to traditional technologies, hence the government and Non Governmental Organizations' working in the area to provide affordable credit to beekeeping farmers.
3) Bee keeping farmers should be encouraged to form Societies to enable them process, package and market their products jointly to allow them reap maximum returns.

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Author Profile

Bunde Aggrey Otieno received B.Sc. Degree and M.A. Degree in Economics from Moi University in the year 2007 and 2013, respecti vely. He has served as a Research Associate with Kenya Institute fo r Public Policy Research and Analysis (KIPPRA), Kenya National Bureau of Statistics (KNBS), Centers for Disease Control and Prevention(CDC KEMRI/CDC Atlanta Georgia), Insurance Regulat ory Authority (IRA) and as an Economist with State Department of Agriculture, he has taught as a part time lecturer in the department o f Economics of Moi University, Kenya, Department of Managemen t science, University of Eldoret, Kenya and Faculty of Commerce, Kisii University, Kenya. In July 2014 he was appointed as a Young Professional by the Kenya Institute for Public Policy Research and Analysis (KIPPRA). Currently he is a lecturer in Economics in the Department of Economics of Chuka University, Kenya. He is currently pursuing his PhD in Economics. He is a member of the African Finance and Economics Association (AFEA). He has published articles in a number of International Journals that includes the African Journal of Education Science and Technology (AJEST) the International Journal of Sciences Basic and Applied Research (IJBAR) and International Journal of Economics and Sustainable Development (IJESD). His research interests are in the field of Public sector Economics, Monetary Policy economics, Energy Economics and Agricultural value chains.