Evaluation of Beekeeping and Financial Benefits of Modern Beehive Adoption in Kitui County, Kenya

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ABSTRACT

Beekeeping has developed into a multimillion export earning activity in countries like China and USA. These countries have embraced modern apiculture where beekeepers use modern beehives. The adoption of modern beehives is still a new idea in Kenya as most beekeepers use traditional log hives leading to low economic benefits from the beekeeping sub-sector. Traditional beehives produce low amounts of honey that is of low quality. Kitui county is within the arid and semi-arid climatic region in Kenya where the regular crop husbandry agriculture fails most of the seasons. Apiculture has been proved to offer substantive livelihood diversification strategy in such places. However, most of the beekeepers in the region continue to use traditional hives resulting to little economic benefits. This study sought to evaluate the performance of beekeeping and the financial benefits of using modern beehives in Mwingi Central Sub-County of Kitui County, Kenya. The study objectives were; (i) to investigate bee farming (apiculture) in Mwingi Central Sub-County (ii) to evaluate the financial benefits of adopting modern bee farming in the study area. Data was mainly collected through administering questionnaires to 110 sampled beekeepers from Mwingi Central. The collected data was analyzed using the Statistical Package for Social Sciences version 25. The results proved that traditional log hives were the most common bee hives used in the area with quite few modern hives (langstroth hives) in use. Low honey bee occupation rate was observed in the log hives. Income from beekeeping was consequently low. The partial budgeting technique proved that adopting modern bee hives bring more financial benefits compared to use of log hives. The study recommends among other things; the county government should partner with non-governmental organizations to facilitate more adoption of modern bee hives by giving loans and donations and that there should be more training on modern apiculture to the beekeepers in the study area.

Key Words: Apiculture, Kitui County, Modern beehives, Partial budgeting techniques, Traditional bee hives

INTRODUCTION

Background to the study

Apiculture is considered one of the widespread economic activities in the world. By the year 2013 the estimated total number of bee hives in the world was 81,027,786. The number of hives varies from region to region with Asia having the largest number at 36, 635,897. The hive types also vary across the regions as each country has a wide variety of both traditional and modern hives. The global annual average honey production is about 1.6 million tons (FAOSTAT, 2015).

China is an all-time highest honey producer worldwide, with an overwhelming 300,000 metric tons of honey produced annually. In 2013 alone she produced 466,000 metric tons of honey. Approximately there are about 7 million honey bee colonies in China. Other hive products estimates are 3,000 MT of royal jelly, 500 MT of

pollen, 4,000 MT of bee wax and 350 MT of propolis. Annual revenue proceeds from export of hive products in China are estimated at US$ 100,000,000 (Research Gate, 2015).

Africa is also known for honey production where the largest honey producing and exporting counties include; Ethiopia, Tanzania, Angola, Central African Republic and Kenya. Ethiopia is the leading honey producer in Africa. Beekeeping has been a long-standing practice in Ethiopia and accounts for 1.3% of Agricultural GDP. There are approximately 5,250,000 bee hives in the country producing approximately 54,000 metric tons annually (Demisew, 2016).

Recent studies in Kenya show that there are about 90,340 beekeepers in the country owning about 2 million hives. Annual honey production is estimated at 25,000 metric tons contributing about KSH.4.3 billion, which is only a quarter of the country's potential of 100,000 metric tons (Kiptarus et al., 2015). It is also evident that little has changed especially on modernization of the sector in Kenya. According to Natural Resources Institute (2009) improving the living standards of rural people through modern beekeeping is a challenge despite the availability of new technologies in beekeeping as most farmers are yet to adopt modern apiculture. In Kitui County, there are 377,199 log hives, 1,674 Kenya Top Bar Hives -KTBH and 4,681 Langstroth hives (County Government of Kitui, CGoK, 2015). Given three quarters occupation rates, the hives should produce a total of 2,959,425kg of honey valued at Ksh. 887,827,500 when sold at Ksh. 300 per kilogram at the farm gate. However, the subsector contributes only Ksh. 543,124,800 to beekeepers in the county from the meager 1,810,416 kg of honey produced annually (CGoK, 2014). Therefore, income from apiculture is still low owing to the low amounts of honey produced. The low performance is due to the failure of beekeepers to adopt the more productive modern bee hives.

Statement of the problem

As reported by Mugendi (2011) most of the beekeepers in Kitui County exclusively use traditional beehives (log hives). The same trend exists in the selected study area. In Kenya, most of the studies on apiculture focus on factors influencing modern apiculture. However, in order to fully understand the adoption behaviour of the beekeepers, there is need to first evaluate the performance of the sub-sector and the benefits of using modern hives in comparison to traditional hives. To fill this gap, the study sought to; investigate bee farming and apiculture related institutions in Mwingi Central Sub-County, and evaluate the financial benefits of adopting modern beehives.

MATERIALS

Modernization of apiculture in Kenya

In Kenya beekeeping is as old as its history (Paterson, 2006). Forested areas such as around Mt. Elgon, Mau Escarpment and Aberdare Ranges were early beekeeping regions. Pastoralists also gathered honey from the plains and woodland regions in the country (JAICAF, 2009). In the early days, honey gatherers undertook what would be likened to robbing bees of their honey. The beekeepers collected the honey at night in a hurry using burning-straw torches to smoke out the bees thus killing almost the entire colony. Furthermore, the use of such torches often led to forest fires (FAO, 1986).

Efforts to improve and modernize the sub-sector in Kenya dates back to the colonial period when the government started to introduce modern apiculture to the already practicing beekeepers in the 1950's. Training programs were begun followed by establishment of honey refineries in a number of places. The initial refineries were established at Makueni, Baringo, Samburu and Tharaka Districts, and in Nairobi City. Similar factories had reached other places such Kakamega and Kitui Districts. Bee wax industries were set up in Elgeyo-Marakwet, Baringo, Kabarnet, Kapenguria and Eldama Ravine Districts (Kigatiira & Morse, 1979). These developments were important in promoting the sector. In 1971, the Government in collaboration with the Canadian International Development Agency (CIDA) established beekeeping cooperatives, undertook construction and equipping of more honey refineries and started distribution of KTBH hives. A few years later in 1982 the government made another milestone by setting up the National Beekeeping Station in Baringo District (USA-India-Kenya collaboration, USINKEN, 2010).

Years later, another major milestone in the sub-sector was realized when the government of Kenya drafted the National Beekeeping Policy of 2009. The major objectives of the policy were to heighten beekeeping contribution to food security, create more employment and enhance conservation of the environment (Government of Kenya, GoK, 2009). As it was noted by JAICAF (2009), the subsector had been operating without a working policy since 1950s.

In Mwingi Central sub-county, modernization of beekeeping begun after the beekeepers started forming small beekeeping groups and the subsequent creation of the Mwingi beekeepers CBO in 2002 with assistance from International Centre of Insect Physiology and Ecology (ICIPE). Later in the year 2004 to 2008 Kenya Forest Service (KFS) and ICIPE founded the Participatory Forest Management project in Mwingi District. The project was aimed at enhancing conservation of forests while promoting gainful utilization by the rural communities in Mwingi District. Later in 2007 ICIPE went on to implement Commercial Insect Programme (CIP) in selected parts of Mwingi to upscale apiculture as an income source for the individuals who had taken part in the earlier forestry conservation programmed. The programmer's activities included distribution of Langstroth hives, training on modern apiculture and introduction of stingless bees (Kioko, 2010).

Traditional bee hives in Kenya include the hollow log hive, pot hive, basket and the bark hive made of bark peeled off from a tree trunk. The log hive is the most common traditional hive in Kenya (Cramb, 2003). The log hives are constructed from indigenous hard wood trees and comprise of logs measuring between 1.0 to 1.5 metres and have thin walls to reduce the overall weight of the log hive. The attractiveness of the log hive to swarming bees may be enhanced by placing two dry honey combs in the hive. In other communities such as the Kamba, the inner wall of the log is rubbed with the leaves of an Ocimum species plant (mutaa) which has an aromatic scent to attract a swarming bee colony. The prepared log hive is usually placed between branches of a tree for a swarming bee colony to occupy (Carroll, 2006). During harvesting, the honey mixes with the brood, pollen and wax since they are all removed and wrinkled together thus interfering with the honey quality and quantity. Another disadvantage of these hives is that mature hard woods are felled to make the hives. Furthermore, since the hives are placed on trees, bees' attacks by insects such as the safari ants are common (JAICAF, 2009).

Modern beehives

Modern hives are also becoming popular in Kenya. There are two categories of the modern box hives: the movable comb hives and movable frame hives. The fundamental concept behind the modern boxes is the reutilization of bee colonies since bees are not killed during honey harvesting. They are also easier to manipulate and manage compared to the log hives (JAICAF, 2009). The other equipment used in modern beekeeping include the bee brush, protective clothing, catcher box, hive tool, smoker and the honey extracting centrifugal equipment.

The movable comb hives were first created by the Greek beekeepers when they fitted bars on the top part of a basket hive (Mann, 1976). The KTBH of Kenya is constructed based on a similar design. The hive was designed by Prof. G. Townsend in Canada purposively to be used in East Africa (FAO, 1990). The bars can be removed by lifting allowing the beekeeper to easily inspect the hive for ripe honey (FAO 1986). An important feature of the KTBH is the queen excluder. This is a wire mesh held in place six bars from the entrance of the hive. The wire mesh divides the hive into two, the section with brood combs where the queen lays eggs, and the other section with honey combs where the worker bees make honey (Rangoma, 2011). After the necessary preparations the hive is hung 1m from the ground between two posts where it can swing freely. The KTBH has several advantages compared to the traditional log hive including that it is easy to check for ripe honey since one can remove each bar at a time and inspect the comb. During harvesting only honey combs are removed leaving behind the brood nest hence ensuring cleanliness of the honey is maintained. Honey quality is high since pollen and brood combs are separated from the harvested honey. Furthermore, the hives are hung 1m above the ground hence it is easy to harvest honey, control ants' attack and perform other hive management activities (Carroll, 2006).

The other category of modern box hives is the movable frame hives and are the most preferred hives for commercial honey production worldwide (Paterson, 2006). The hives have frames within which the bees establish honey combs. The design was invented by Revered Lorraine Langstroth in 1851. His model is known as the langstroth. These hives greatly revolutionized beekeeping making it a commercial activity. Other frame

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hive models include the Dadant hive of USA and the Smith hive of UK (Mann, 1976).

The langstroth is the widely used modern hive in Kenya. It has frames which can be removed for inspection to identify those full of honey. The langstroth consist of two boxes, one at the top (super chamber) and another at the bottom (brood chamber). The two boxes are separated horizontally by a wire mesh known as a queen excluder. The queen bee lays eggs within the brood chamber where she is restricted from moving to the super chamber by the queen excluder. The workers bees stay in the honey super chamber where they form honey combs in the fixed frames and not on bars as in KTBH (Carroll, 2006; JAICAF, 2009).

During harvesting, frames with honey filled combs are removed and the honey extracted using the centrifugal honey extractor equipment. Once the honey is extracted, the combs (within their frames) are returned to the hive since they are not destroyed. However, the langstroth is quite expensive to acquire compared to the log hives. In addition, much more technical and management skills are required (Paterson 2006).

METHODS

Study Area

The study was conducted in Mwingi Central Sub- County which is one of the 8 Sub-Counties of Kitui County. The sub-county covers an area of 4,141.4 km^2 and lies between latitudes 0°48ˈS to 1°12ˈS and longitudes 38°0ˈE to 38°48ˈE. It is an area of tropical climate that is hot throughout the year with most of the months dry. Annual temperatures range from 21°C–34°C. The area receives annual rainfall ranging between 500–700 mm. The altitude ranges from 860m in the lower areas to 1090m in the hilly sections. Natural vegetation mainly comprises of the thick thorn-bush type with scattered trees due to the low rainfall experienced (County Government of Kitui, CGoK, 2014).

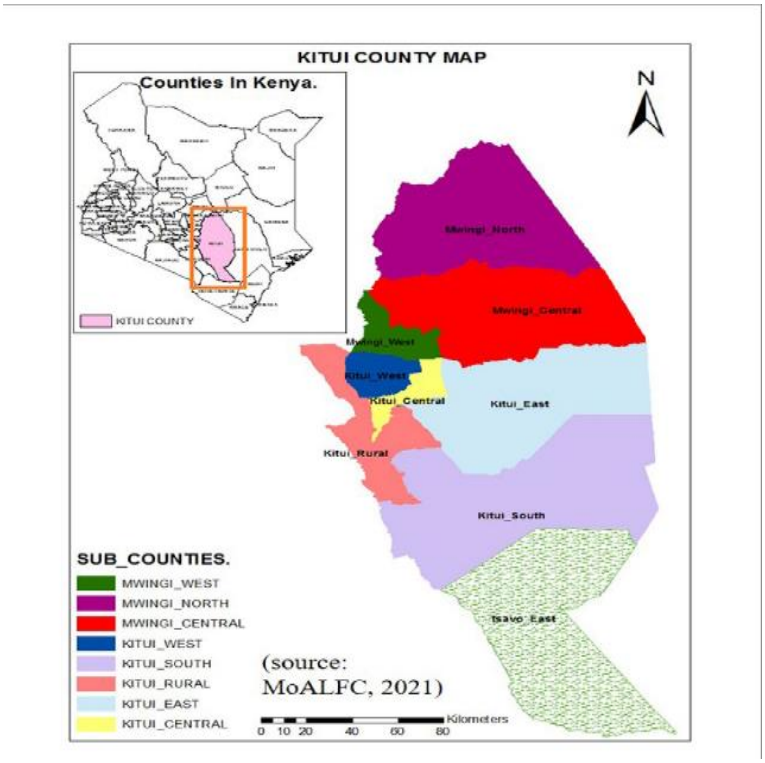

Figure 1 Map of Kitui showing Mwingi Central, study location.

Target population and Sample Size

According to Kenya National Bureau of Statistics, KNBS, (2010) the area had a total of 141,207 inhabitants (67,397 male and 73,810 female) in the 2009 census distributed in 29,672 households. Crops grown include maize varieties, millet, sorghum, cow peas, green grams and pigeon peas. Mango and watermelon are grown is some regions (CGoK, 2014). Livestock kept are goats, beef cattle, donkeys and chicken. Beekeeping is also a

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common economic activity in the area and has been an important economic activity in since time immemorial with most beekeepers using traditional log hives (Nightingale, 2006).

The sample size was determined by applying the formula developed by Cochran (1963):

$n = \frac{z^2pq}{e^2}$. The sample size was computed as follows:

$$\frac{1.96^2 \times 0.9 \times 0.1}{0.05^2}$$

The formula gives 138 which was further adjusted (finite population correction for small populations) using the formula below:

$$n_1 = \frac{n_\theta}{1+(n_\theta/N)}$$

This is computed to give a sample size below:

$$\frac{138}{1+(138/522)} = 109.1 \approx 110$$

Sampling Procedure and Data Collection Instruments

The study used both probability and non-probability sampling techniques. Mwingi Central Sub- County was the area of study selected purposively because of presence of the Mwingi beekeepers CBO from where beekeepers get training on modern apiculture therefore increasing their probability of adopting modern box hives. Five out of the 16 locations of Mwingi Central Sub- County were purposively selected since they had the highest proportion of registered beekeepers in Mwingi Central (522 out of 785). The beekeepers were stratified into adopters and non-adopters proportional to their approximated population in the area.

According to the records at the Mwingi beekeepers Community Based Organization (CBO), 198 (38%) of the registered beekeepers in the sub-county possessed and had been using modern box hives at least two years prior to the study. The remaining 324 (62%) exclusively used the log hives during the same period. Based on this proportion, 42 adopters and 68 non-adopters were sampled. Selection of the individual beekeepers for the two strata involved two stages. First 68 non-adopters were selected using random sampling technique from the stratum of 324 non-adopters. Secondly, 42 adopters were selected using the same technique from the stratum of 198 adopters. At the same time, the proportional allocation technique developed by Mead & Curnow (1983) was applied to establish the number of respondents per location to be included for each stratum. This was necessary since the beekeeper's numbers vary across the five locations thus ensuring better representation.

$$n_i = \frac{n \times p_i}{N}$$

Where: n_i is the desired sample size in each stratum; N = total population size (522); pi = the proportion of the population in each stratum; n = sample size for the study (i.e. 110 beekeepers). The sample size for each stratum (location) has been summarized in the Table 3.1 below.

Table 1 Sample size tabulation per location.

Location	Registered Beekeepers	Sample size	Adopters	Non adopters
Mwingi	131	28	10	18
Nuu	102	21	8	13
Mui	85	18	7	11

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Waita	145	31	12	19
Kivou	59	12	5	7
Total	**522**	**110**	**42**	**68**

Source: Survey data.

The main instrument used to collect primary data was the questionnaire. The questionnaire comprised of both closed and open-ended questions and a copy was administered to each of the 110 beekeepers. The units of study were the registered beekeepers and in their absence the spouse of the beekeeper or a close and mature relative.

An interview guide facilitated collection of more information from the key informants through interviews. The in-depth information obtained complimented the information gathered using questionnaires. Secondary data was obtained from research reports and journals, Community Based Organization records, national and county government publications and other relevant written materials.

Triangulation was the method used to detect and correct wrong responses (data verification). Triangulation in research is the use of more than one data source with the aim of increasing confidence in the findings through confirming of a proposition (Tashakkori and Teddle, 2003). As such the qualitative data collected was used to triangulate the quantitative data. The collected data was analyzed both quantitatively and qualitatively. Qualitative data was categorized, cleaned and coded to fit their respective themes. SPSS-20 was employed in analyzing data quantitatively. Descriptive statistics such as cross-tabulations and means were utilized to describe and summaries the types of hives and honey production levels in the study area.

A partial budget is a simple technique for assessing the benefits and costs of a new innovation or change, relative to not using it (Lessley et al., 1991) (Equation 4). It focuses only on revenue and expenses affected by a change such as an adoption of a given technology. According to Kentucky University (2009) the changes are divided into four categories; additional revenue, reduced expenses, reduced revenue and additional expenses.

An adoption may bring additional income if there is increased production following the adoption. For instance, it is expected that the modern bee hives produce more honey. The income from the modern bee hives is the additional revenue. Reduced expenses are the expenses not incurred because of not using the log hives for example, transport cost since modern box hive are placed in one place (apiary).

Additional expenses include costs on equipment, fences, bee feed and labor. There is reduction of wax produced when modern bee hives are used. Such lost value is considered reduced revenue. Estimates for the four categories in monetary value were obtained through questionnaires and secondary data analysis before running the calculations to determine the profitability of each kind of hive. Since the KTBH was not in use in the area, partial budgeting was done for only langstroth versus log hives. Following Kentucky University (2009) the simple equation for partial budgeting is specified as follows:

$$\{\text{Additional revenue} + \text{Reduced expenses}\} - \{\text{Additional expenses} + \text{Reduced revenue}\} = \text{Profitability of adoption} \quad \text{(Equation 4)}$$

Adoption of modern beehives will have financial benefit if the value obtained is positive.

RESULTS AND DISCUSSIONS

During the study two types of hives were observed, the traditional log hive and the langstroth modern beehive. The most common hive type was the log hive since all respondents possessed at least one. There were 3,432 log hives distributed among the 110 beekeepers in the area. However, only 1,160 log hives had honeybee colonies translating to a meager 33.79% occupation rate. Hence a total of 2,272 log hives were unoccupied during the study period (Table 2). The low occupation rate was due to the honeybee absconding problem occasioned by drought, lack of feed, honey bee enemies (e.g. safari ants) and honeybee diseases such as the European foul

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brood and foul brood.

The langstroth hive was the only actively used modern bee hive observed in the area. The number was however too low as only a handful 118 box hives of langstroth type were found among the respondents. Despite this, the occupation rate in bee hives was notably high at 75.42%. Only 26 langstroth hives lacked bee colonies (Table 2).

Table 2. Number of hives per type and occupation rate.

Hive type	Beehives with colonies	Beehives without colonies	Total beehives	Occupation rate
Log hive	1,160	2,272	3,432	33.79%
Modern hive	89	26	118	75.42%
Total	1,249	2,298	3,550	35.18%

Source: Survey output.

Others such as the KTBH were not in use despite being possessed by some of the respondents owing to the high rate of absconding of bees from them.

The paper revealed that the beekeepers in Mwingi harvest their honey at least thrice per year from the log hives and four times from the modern hives. The harvest seasons mainly come in May, September and December. One log hive produces between 8-10 kg of honey per season. The langstroth on the other hand produces between 20-24kg of honey per season. On average 32,480kg of honey was produced from the 1,160 traditional log hives in the years 2014 and 2015 (Table 4.2). Average annual harvest from a single log hive was therefore 28kg. The price of a kg of honey at the farm gate is Ksh. 250 at lowest. Proceeds from the sale were therefore at least Ksh. 8,120,000 per year from all the log hives.

An average total of 6,675 Kg was obtained from the 89 langstroth hives in the two years. Average annual harvest from a single langstroth hive was therefore 75kg. Honey production from the modern hives therefore earned income of Ksh. 1,668,750 per year. In summary therefore, the average income from the beekeeping enterprise among the 110 beekeepers was Ksh. 9,788,750 per year. This is against an estimate of Ksh. 20,989,200 assuming 80% occupation rate in both hive types. These figures prove that the beekeeping sub-sector is still underperforming despite the high potential.

Table 3 Honey production and income per hive type.

Type/Year	2014 (Kg)	2015 (Kg)	Average in the 2 years (Ksh)	Average annual harvest per single hive (Kg)	Average total income per hive type (Ksh)
Log hive	31,320	33,640	32,480	28	8,120,000
Langstroth	6,586	6,764	6,675	75	1,668,750
Total	37,906	40,404	39,155	103	9,788,750

Source: Survey output.

The study showed that the active apiculture related institution in the study area is the Mwingi Beekeepers and Food Crops Cooperative Society. It is a farmers' cooperative located in Mwingi town and is mainly aimed at processing and marketing honey from small scale farmers in Mwingi. The initial title for the organization was 'Mwingi Beekeepers Community Based Organization (CBO) which was set up in 2002. It became a cooperative in June 2015. The earlier Mwingi Beekeepers CBO was established in the year 2002 by six registered groups through the support of International Centre of Insect Physiology and Ecology (ICIPE). By 2010 the CBO had 55 registered groups with a total of 2,360 farmers from all over Mwingi (the former Mwingi District). However,

some of the groups were not fully active. The main aim of setting up the CBO was to have a common market through which beekeepers would avoid selling their honey to brokers who were buying the product at a very low price. Mwingi beekeepers CBO started buying comb honey from its registered farmers then process, package and market it (Mwingi beekeepers CBO, 2013). With the vision to diversify the main products handled in the organization the farmers changed and registered it as a cooperative under the name; Mwingi Beekeepers and Food Crops Cooperative Society which continues to serve the beekeepers.

The processed honey is packaged in plastic containers of various sizes and has a label 'Eco Honey'. The processing, packaging and marketing is done at the Mwingi Honey Market Place, a facility belonging to the cooperative. Apart from being a honey processing and marketing place, it is also a training and demonstration center on modern beekeeping. This takes place in a workshop within the compound of the cooperative. The beekeepers get Ksh. 300 per kilogram of honey. Despite being pivotal in modernizing and promoting the sub-sector in the region, the CBO faces serious challenges. For instance, in 2015 the CBO was closed for several months due to mismanagement and misappropriations of funds.

When financial benefit of modern bee hives was examined, the study findings revealed that farmers were likely to adopt a new technology only if it was profitable. This finding is similar to the findings by Schultz (1995) who argued that probability of adoption depends on the difference in profitability between the modern and traditional technologies. The average annual honey harvest is 28kg from log hive and 75kg from a langstroth hive. The average price of a kilogram of honey is Ksh. 250 at the farm gate. Deduced from the partial budget in Table 4 below, the profit earned from a single modern bee hive was found to be Ksh. 17,857 (i.e., 18,750 - 893) while from a log hive was Ksh. 6,443 (i.e., 7,000 - 557) on average. The difference in profitability is therefore Ksh. 11,414 (US Dollar 110.82). The results proof that modern bee hives are of higher financial benefits compared to the log hives as hypothesized. The results concur with those of Workneh (2007) who found that adoption of improved box hives in Atsbi Remberto District, Ethiopia was financially beneficial to the beekeepers. The extra income resulting from the adoption was 489.11 Birr (US Dollar 21.61). The KTBH was not analyzed for financial benefit since only a few beekeepers owned some and which were not in use during the study period.

Table 4 Financial benefits of modern box hives.

Expenses (in Ksh)			**Returns (in Ksh)**		
	Langstroth	Log		Langstroth	Log
Average additional expenses			**Average additional revenue**		
Transport	200	179	Honey sales	18,750	7,000
Feed cost	192	157			
Labor cost	213	131			
servicing cost	138	90			
Reduced revenue **Bee wax**	150	00	**Reduced expenses**	0.00	0.00
Average total expenses	**893**	**557**	**Average total returns**	**18,750**	**7,000**

Source: Survey output.

CONCLUSION

The study concludes that traditional log hives is the most common hive, with low occupation rate of 33.79% and remarkably higher occupation rate in the modern bee hives (75.42%). This implies that total honey production would increase with more adoption due to the likeliness of higher occupation rate. The outcome of partial budgeting revealed that modern bee hives (langstroth) gave extra returns of Ksh. 11,414 (US Dollar 110.82)

annually when compared with log hives. Modern box hives are therefore, financially beneficial.

RECOMMENDATIONS

The paper recommends that the County Government of Kitui in collaboration with Non-Government Organizations initiate programs to promote more adoption of modern beehives. This can be done through direct donation of modern beehives to farmers or provision of affordable long-term loans. The paper further recommends that the County Government of Kitui work closely with Mwingi Beekeepers and Food Crops Cooperative Society to offer more training on modern apiculture. With more adoption of modern beehives, the overall income to the beekeepers would increase enabling them to improve their living standards.

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Conflict of Interest

The author(s) declares no conflict of interest.

Disclaimer Statement

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REFERENCES

1. Food and Agriculture Organization Corporate Statistical Database, FAOSTAT. (2015). Prod STAT Database. Retrieved April 6, 2016 from
2. Demisew, W.A. (2016). Beekeeping in Ethiopia, Country situational paper. Paper presented at 5th ApiExoAfrica 2016- Kigali Rwanda. Retrieved September 17, 2017 from
3. Kiptarus, J., Asiko, G., Muriuki, J., Biwott, H. (2015). Beekeeping situation in Kenya; the current situation. A paper presented at the 42nd International Apicultural congress, APIMONDIA, Buenos Aires, Argentina. Retrieved April 7, 2016 from
4. Natural Resources Institute. (2009). Agricultural Marketing in Developing Countries: The role of NGOs and CBOs. New York: Author.
5. County Government of Kitui, (2015). Summary of beekeeping report, Kitui [Pamphlet]. Kitui, Kenya: Author.
6. County government of Kitui, CGoK. (2014). Kitui county integrated development plan 2013–2017. Nairobi, Kenya: Author.
7. Mugendi, K. (2011). Adoption of Bee Farming as an adaptation strategy for rainfall variability effects on food security among the vulnerable communities in Kenya: Case of Kitui County. (Master's Thesis). Retrieved March 24, 2015 from
8. Paterson, P. D. (2006). The tropical agriculturist. London, England: Macmillan Publishers limited.
9. Japan Association for International Collaboration of Agriculture and Forestry, JAICAF. (2009). Development of Beekeeping in Developing Countries and Practical Procedures: Case Study in Africa. Nairobi, Kenya: JAICAF.

10. Food and Agricultural Organization of the United Nations, FAO. (1986). Tropical and sub-tropical apiculture: FAO Agricultural Services Bulletin No. 68. Brooklyn, New York: Author.
11. Kigatiira, K., & Morse, R.A. (1979). The construction, dimensions and sittings of log hives near Nairobi. Beekeeping in rural development. London, England: IBRA
12. USA-India-Kenya collaboration, USINKEN. (2010). Beekeeping in Kenya. Retrieved August 12, 2015 from
13. Government of Kenya, (2009). Sessional Paper No. 6 on National Beekeeping Policy June 2009. Nairobi, Kenya: Author.
14. Kioko, E. (2010). Reporting science in Africa. Retrieved January 26, 2015 from
15. Cramb, R. A. (2003). Processes affecting the successful adoption of new technologies by smallholders. In: B. Hacker (Ed.), Working with farmers: The key to the adoption of forage technologies: ACIAR proceedings No. 95 (pp. 11–22). Canberra, Australia: Australian Centre for International Agricultural Research.
16. Carroll, T., & Kinsella, J. (2013). Livelihood Improvement and Smallholder Beekeeping in Kenya: The Unrealized Potential. Development in Practice, 23, 332–345.
17. Mann, I. (1976). Bees are wealth. Nairobi, Kenya: Kenya Literature Bureau.
18. Food and Agricultural Organization of the United Nations, FAO. (1990). Food and Agriculture Organization of the United Nations Agricultural Bulleting 68/6. Retrieved January 8, 2017 from
19. Rangoma, M. (2011). Constructing a Kenya Top Bar Hive. Retrieved June 19, 2015 from
20. Nightingale, S. (2006). Bees and beekeeping: Science, practice and world resources. New York, Comstock publishing associates Ithaca.
21. Kenya National Bureau of Statistics, KNBS. (2010). KNBS 2009 population census report. Nairobi, Kenya: Author.
22. Cochran, W. G. (1963). Sampling Techniques (2nd ed.). New York: John Wiley and Sons, Inc.
23. Mead, R., & Curnow, R. N. (1983). Statistical methods in agriculture and experimental Biology. London, England: Chapman and Hall.
24. Tashakkori, A. & Teddle, C. (2003). Handbook of mixed methods in social and behavioral research. Thousand Oaks, CA: Sage
25. Kentucky University (2009). The power of partial budgeting. Retrieved January 8, 2017 from
26. Lessley, B. V., Johnson, M. D., & Hanson, C.J. (1991). Using the partial budget to analyses farm change. Retrieved from March 19, 2016 from
27. Mwingi Beekeepers Community Based Organization. (2013). Mwingi Eco Honey CBO profile [Brochure]. Kitui: Author.
28. Schultz, T.W., (1995). The value of the ability to deal with disequilibrium. J. Econ.Liter.13, 827–846.
29. Workneh, A. (2007). Determinants of adoption of improved box hive in Atsbi Wemberta District of Eastern zone, Tigray region Ethiopia. (Master's Thesis). Retrieved January 20, 2016 from
30. Research Gate. (2015). Beekeeping in China. Retrieved January 20, 2016 from