



Beekeeping practices: Opportunities and constraints in three different land use patterns in Sheko Woreda, South West Ethiopia

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Abstract

The present study was conducted to assess beekeeping management practice, its constraints and opportunity in three lands use pattern in Sheko Woreda from December 2013-october 2014. Stratified sampling was employed to select study sites and Sample size was determined using a standards formula and study participants were selected randomly. Data were collected using semi structured questionnaire; focus group discussion, and field observation. Data were analyzed by using SPSS software package version 20.0. The majority (97%) of the currently existing beehives were traditional while modern beehives account only 3% of the available hives. Sixty seven percent of the respondents had traditional bee hives, 15% had both transitional and traditional, 9% had both modern and traditional and 9% had all three types of beehives. Almost all respondents reported that they got beekeeping skills from their family through traditional method. Majority (80%) of the respondents in the area had no planned time for colony inspection and 90% of the respondents had no the idea of post and pre honey harvesting colony management practice and 80% of the respondents did not practice supplementary feed for their colony. The study also showed that 79% of the respondents had no training on the general principle of beekeeping and the modern technologies and 21 % of them were engaged in some training and they mentioned that training had significant contribution for the adoption of the modern technologies and seasonal colony management practice. Common beekeeping constraints cited by respondents included: honey bee diseases, migration and swarming, marketing problem, lack of skilled man power, shortage of training, lack of equipment, absence of agricultural extension service, lack of appropriate skills in honey harvesting and poor attention to the sector

Therefore, for sustainable beekeeping practice and to get maximum ecological significance of honey bees, beekeepers and agricultural workers need training on the modern technologies and general principle of beekeeping. Government and nongovernmental organization should give attention in the adoption of modern technologies equipment along with good market linkage for honey and its products. Besides beekeepers need to consider pre and post colony managements skills for better yield and quality of honey and for the safe life of bees. The issue of honey bee enemies and diseases need to be investigated further for developing effective prevention and control measures.

Keywords: Sheko, Bench Maji, Ethiopia Beekeeping practice Seasonal colony management, honeybees

1. Introduction

Africa is blessed with numerous types of wild honeybees (Adjare, 1990). Ethiopia is one of the countries of the continent which own big honey production potential. Its forests and woodlands contain diverse plant species that provide surplus nectar and pollen to foraging bees (Girma, 1998) [49]. Due to its wide climatic and edaphic variability the country has diverse and unique flowering plants of 6000 to 7000 species thus making it highly suitable for large number of colonies of honeybees and long practice in beekeeping industries (Bista and Shivakoti, 2001) [22]. The diversity of plants species comprises forest trees, bushes, grasses, and cultivated flowering plants that are actually and potentially useful for beekeeping. On the other hand, apiculture and traditional tree growing and management practice is deep-rooted in Ethiopian rural life. The mixed farming systems in Ethiopia possess indigenous and traditional on-farm trees growing practices, such as agro forestry, homestead tree planting, wood plot, and farm boundary tree planting, combined with apiculture (EFAP, 1994).

Ethiopia produces honey around 23.6% and 2.1% of the total African and world's honey, respectively. Ethiopia is

Africa's largest producer and ranks 9th in the world with a current national estimated honey production of 54,000 MT per year (FAO 2010) [40]. It is also one of the four largest beeswax producing countries in the world. In Ethiopia, beeswax is one of the 12 major exportable agricultural products and there are approximately 1.5 million beekeepers in Ethiopia and 8 to 10 million bee colony hives (FAO, 2011). The Oromia, Amhara and SNNP regions represent 46%, 24% and 22% of Ethiopia's honey production, respectively, and produce honey in colors ranging from light to dark amber. Tigray produces 5% of the country's honey, which is of a distinct white color. Beekeeping in Ethiopia plays an important role in income generation for beekeepers. Honey production of the country meets beverage requirements of the urban and rural population. It is also demanded for its nutritional and medicinal values. The other hive products such as beeswax, royal jelly, propolis, and bee venom have high demand globally (Amsalu, 2004) [12]. Ethiopia farmers keep about seven millions hives in local beehives, while the rest exist in the forest as wild colonies (EMA, 1981) which represent the highest bee density in Africa. There are also three types of beekeeping practice in Ethiopia traditional forest beekeeping, traditional backyard

beekeeping, and improved (modern) beekeeping. Majority of beekeeping that farmers practice in Ethiopia is traditional which does not consider seasonal colony management practice (Fichtl and Admasu, 1994) [43]. The country exported its first consignment of honey to the European Union (EU) in 2008 after a three year period of preparations towards attaining third Country listing status. This was the result of a deliberate set of interventions to help increase processing capacity in combination with an out-grower scheme to supply honey (Paulos, 2012) [72]. Honey and beeswax export marketing in Ethiopia has been started during the 1980s and the total annual honey production has been increased from 21,480 tons to 23,700 tons between the period 1984 and 1994. But, only 3.05 tons per annum has been exported during the specified period (ITC, 1996). Current honey production estimate represents only 8.6% of the country's production potential. Productivity from traditional hives is very low, with an average of 5-6 kg per year, while production from improved hives (including transitional hives) reaches levels of 18-30 kg per year. Beekeeping has been and still is very widespread, economically important and an integral part of the life of the farming communities of Ethiopia (Fichtl and Admasu, 1994 and Verma, 1990) [43, 89]. However, the products obtained from this sub sector are still low as compared to the potential of the country. Although thousands of tons of honey are produced every year it is usually poorly managed and unattractive in appearance. Because of this its place in the local market being taken by imported honey. Moreover, traditional hive honey is of good quality as long as it is in the hive. Faulty handling, from the time of its harvest until it reaches to market is responsible for its inferior quality. The type of hives used, extent seasonal colony management and the methods of removing and storage of honey play a vital role in the quality of honey (Crane, 1970) [29]. According to Shenkuta *et al.* (2010) beekeeping is practiced in three zone Keffa, Sheka and Bench maji by over 60% of the total household the practice is under taken by three types of bee hives: traditional, intermediate and modern bee hives. Sheko

Woreda is one of areas in the country known with its honey production potential. However to the best of knowledge there is lack of information about beekeeping practice, its opportunity and constraints in the area which can be used to scale up honey production and to intervene on the existing beekeeping constraints. Hence this research was conducted to assess the existing beekeeping practice, its opportunity and constraints in Sheko Woreda South West Ethiopia.

2. Materials and Methods

2.1 Description of the study area

2.1.1 Preliminary Survey

Reconnaissance survey was conducted in January, 2014 to gather relevant information about the study area. During this survey, an overall view of beekeeping, (apiary site, types of beehives used etc.) topographical features and vegetation cover of the area were assessed. All the available information about the vegetation and land-use pattern was collected from concerned governmental, non-governmental organization and local people living around the study area and direct observation also dominant plant communities were documented. According to WCC-PFM project report (2011); forest, agriculture and Human Settlement are vegetation structure of the study areas. Sheko forest, the subject of the present study is among the remnant natural forest in Ethiopia where an indigenous wild coffee (*Coffea arabica*) grows naturally. Hence, the Ethiopia government designated the Brehankonter forest project in Sheko Woreda as a special reserve of wild *Coffea arabica* comprising 12 kebeles (10,000 hectares) of total forested area comprising 24 kebeles.

2.1.2 Physical description of the study area

A. Geographical description of the area

The present study was carried out in Sheko district Bench Maji Zone, South west Ethiopia. The area is located at 6°58' N and 35°45' E, 705 km south-west of Addis Ababa. It is drained by the Upper Akobo River which joins the Baro River at the border with Sudan.

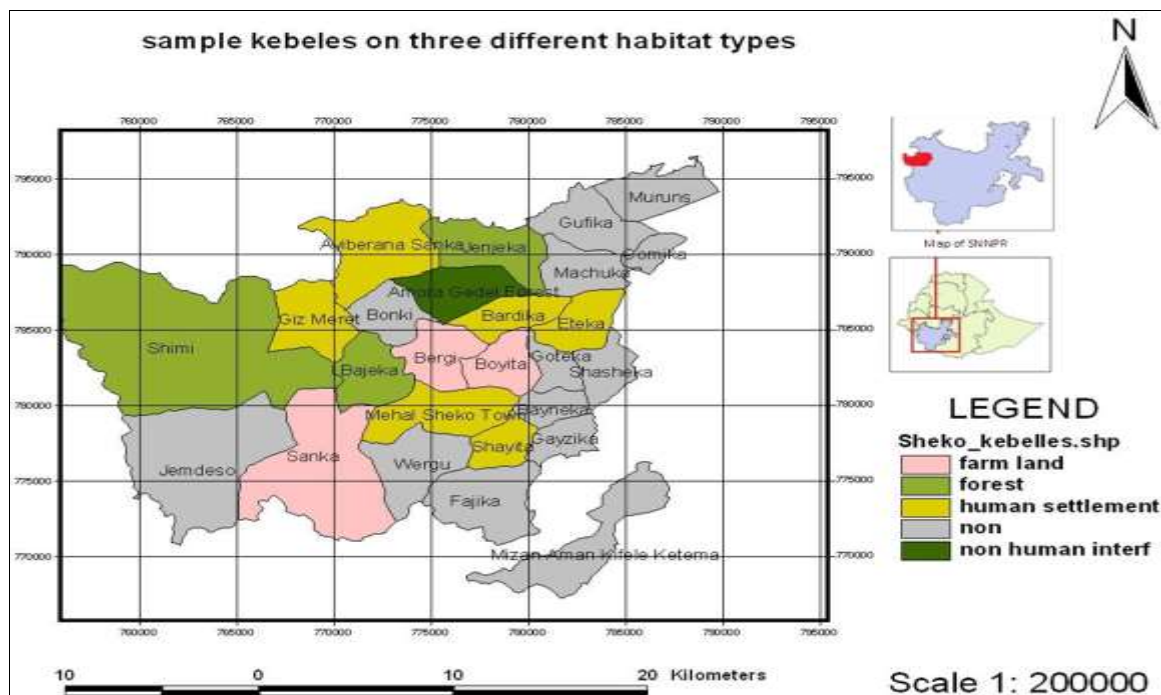


Fig 1: Map of Sheko Woreda with different land use patterns (Source: WCC-PFM, 2011).

B. Climate of the area

The rainfall and temperature data collected by Ethiopian National Meteorological Service Agency at Tepi station were used to describe the climate of the study area. The study area has unimodal rainfall distribution (having one long rainy season between April and September with a peak in September). The 10 years rainfall data (2001-2011) shows that the average mean monthly maximum rainfall is 290.03 mm in September and the average mean monthly minimum rainfall is 31.08 mm in January. The mean annual rainfall of the area is 1850.55 mm/year. The 10 years temperature data from the year 2001-2011 of the area, the average maximum monthly ranges from (27.8°C) in December to (33.37°C) in March The average minimum monthly temperature ranges from (11.68°C) in April to (22.01°C) in May. The mean minimum temperature of the coldest month of the area was 15.23°C per year. The mean maximum annual temperature of the warmest month is 30.17°C per year.

2.2 Study design

The design of the study was community based cross-sectional study house-to-house survey conducted between Semi-structured interview, group discussion, and personal observations were used to gather the required data and analyzed to draw a conclusion about the existing beekeeping practice.

2.3 Sampling techniques and Sample size

Stratified sampling technique was employed to select study site, in which the study sites are defined and classified based on different land use patterns into three strata (three study site). Sample sizes of the study were determined by using standard formula single population proportion and with regard to the sample size of each farmer’s groups or stratum proportional allocation was made under which the sizes of the samples from the different strata are kept proportional to the sizes of the strata. Finally respondents were selected based on the allocated sample by simple random method using lottery method.

Therefore, according to Sheko Woreda Agricultural Office, the total numbers of kebeles in the study area were 24. Based on the different land use pattern four kebeles that are categorized into three study site were selected. This means that out of four kebeles that were found in three study sites, two of them found in agro forest study site (Shimmy & Sanka) were named land use pattern “A” the second study site is in human settlement under Shaytakebele named land use pattern “B” and the third study site belongs in non-human settlement Jemdosekebele and named land use pattern “C”. The total number of beekeepers in three study sites was 164. Land use pattern A has 86 beekeepers, land use pattern B has 37 beekeepers and land use pattern C has 41 beekeepers.

Reliable sample size determined by standard formula single

population proportion formula (Cochran, 1977) by assuming 0% confidence level with marginal error 0.10 and $p= 0.5$ Single population proportion formula reduce the sample size into 78 out of the representatives beekeepers in three study site were represent the whole study population and based on the number of beekeepers found in each land use patterns proportional allocation was made in considering the determined sample size and total number of beekeepers in each study sites. So that the sample size from each studies sites were land use patterns-A 44 (agro forest) Finally respondents were selected from the three study site based on the allocated proportion by using simple random method using lottery method in their actual residents and the prepared questionnaire papers were interviewed. Besides the beekeepers data were collected from agricultural worker from Woreda as well as developmental agent working on the selected kebeles. Therefore, 12 Agricultural experts and expertise along with 78 beekeeping farmers a total of 90 represent study population was examined.

2.2 Beekeeping practices

2.2.1 Beekeeping experience and Honey Production

Majority of the respondents had about 15 years of beekeeping experience. The average years of experience for the entire respondents were about 13 years, the minimum and maximum years of experience 5 and 25 years. The annual crude honey produced in 2012/13/2014 per traditional box beehives was 18.33 Kg and that of improved one was 33.75 Kg. Depending on seasonality and size of the beehives, some farmers indicated that a well-managed traditional beehive can produce up to 20 kg of honey per hive. About 316.38 kg of honey is reported to be produced per year per household in average.

2.2.2 The type & number of beehives used by Beekeepers

According to Sheko Woreda Agricultural office information the total number of beehives in the study sites were 3276 in the years 2012 and 2014. From this number 3209 (96.4%) of the hives are totally traditional and the rest (1.8 %), 54 (1.6%) account transitional (Chefeka,) and modern beehives respectively. The number may be very low compared to the expected hives used by the farmers because most of them are not interested to register the exact number of their beehives due to various reasons such as poor activities of agricultural office and forest beekeeping is difficult to access the information.

Table 1: The different types of bee hives owned by respondents in study area

Types of beehives	Frequency (n)	Percent
1. Traditional beehives	52	66.1
2. Traditional and transitional	12	15.4
3. Modern and traditional	7	9.0
4. All three types	7	9.0
Total	78	100.0

Table 2: Number of beehives in by kebele of Sheko Woreda in the year 2012/13 and 2014

Land use patterns	Traditional beehives	Transitional beehives	Modern beehives	Total
A	1951	52	18	2024
B	380	11	32	423
C	878	-	4	882
Total	3209	63	54	3326

Table 3: Distribution of respondents in terms of types of beehives in Land use patterns

Study sites	Total no of beekeepers	Sample respondents	Traditional only user	Traditional & transitional	Traditional & modern	All type
A	90	57%	70%	25%	28%	44%
B	34	20%	5%	58%	58%	28%
C	39	23%	25%	17%	16%	28%
Total	163	100%	100%	100%	100%	100%

Evidence from the respondents 67% owned only traditional beehives followed by both traditional and transitional (Chefeka) 15% (but with this proportion majority of them is still traditional) (Table-5). They reason out that majority being relay on the traditional hives includes absence of extension program for the adoption modern technologies; Shortage of professional (experts) to the sector, lack of NGO’s working on the adoption of modern beekeeping, poor attention given by the local government in supporting

beekeeping and farmers attitudes towards the modern technologies. The adoption of modern box beehives (plate-1c) in the area is mainly practiced by the transitional beehives (plate-1a) which are replaced by locally prepared material as part of adoption of the modern technologies which is called” Chefeka “beehive (plate -1b). It is very cheap compared to the modern transitional beehives and constructed by locally available material and have equal production potential with the modern transitional beehives.



A

b

c

Plates 1: Locally prepared Transitional, Chefeka and modern beehives in sampled kebele(a) Transitional beehives (b) Chefeka beehives and (c) Modern box beehives



a

b



c

Plates 2: Apiary site with Chefeka (a) and transitional beehives (modern hives) (b) in Shytakebele of the study area

Table 4: Honey production by types of beehives in selected study site for the year 2012/13

Land use patterns (Study site)	Average product per hives (kg) Traditional	Average product per hives(kg) Transitional	Average product per hives (kg) Modern
A	19	30.5	34
B	16	26	28
C	15	27	29
Average	16.6	27.8	30.3

As observed during data collection it is too difficult to get the exact information about the amount of honey produced per year because of various reasons such as poor communication of the office with kebeles and they have no well-organized planned activities on documenting honey production as well as no professional expertise working on beekeeping. However from different source honey production potential of the Woreda from the year 2012-2013 is organized below. Annual honey production potential of the area seems increasing from the year 2012 to 2014 however if we compare the newly added individual farmers to the industries as well as honey production potential of the area the increasing number is insignificant.

Table 5: Honey production potential in selected study sites for the year 2012-2013

Roll	Land use patterns	Production potential
1	A	58%
2	B	16%
3	C	26%
4	Total	100%

2.2.3 Colony inspection

Respondents were interviewed the frequency of inspecting their colony and 44% of the respondents had no regular time of inspection, 33% do not take look their hives completely externally except chalking repining of honey, and 20% of them take look every around 2-3 months. So generally 80% of respondents did not inspect their colony and some of the inspection practice common in case of human settlement area that are currently using modern and Chefeka beehives. From the result land use pattern-C beekeepers had better and improved practice of inspection of their colony which associated with the modern beekeeping technologies.

2.2.4 Honey harvesting, method its potential and income from the sale of honey

Majority (91%) of the respondents harvest honey two times per year and the rest (9%) harvest honey even three times. honey harvesting amount and the quality is not as much similar than before as a result of different internal and external factors such as poor colony strength, shortage of bee, and bee flora common to the area. October, November and December are regarded as the main honey flow season and harvesting period of the year as this period is the main flowering season of the year; whereas, May, April and June were regarded as the second honey flow season/ harvesting period of the year.

The amount of honey yield per hives in harvesting season varies from places to places, which in most cases is determined by the existences of plenty pollen and nectar source and the level of colony management & input. The maximum and minimum amounts of honey harvested from traditional beehives were 20 kg and 10 kg respectively. The average honey yield obtained per hives from Chefeka hives made from locally available materials and modern hive is 27.8kg and 30.3kg, respectively. Concerning annual income from the sale of honey majority respondents (72.5%) their annual income 50% covered by the production and sale of honey and the rest (27.7%) about 60-75% annual income covered by honey production (Figure- 14). If we convert the annual gross income of respondents from the sale of honey output in the study area, ranged from 10400 to 10500Birr. This is calculated by considering average number of

beehives, harvesting season, the amount of honey produced per year and per hives and the average cost of honey per kg. Which indicates beekeeping are the main economic resource and the possibility of scaling up honey production.

The different indicators that the beekeepers use for identifying honey harvesting season includes: counting the beginning of flowering time to forward, smelling of honey, decrease honey bees activities, and end of flowering season. Some beekeepers identify honey season honey bees become more aggressive during the time of honey season and still others identify by inserting a thin piece of stick into the hives and if the honey is ripe the stick come with some honey as the traditional beehives is not suitable for inspection hence some of them mentioned that collection of unripe honey is common. Almost all respondents during harvesting of honey use similar practice that is the use of different smoke commonly at night such as animal dung, *teff* straw etc. for the same purpose but most bees die during harvesting as poor insertion of the smoke and they cannot give time for the bees to live the hives hence most will be die during harvesting mechanically and smoke as poor harvesting practice.

Respondent's also mentioned that during honey harvesting season they do not take care for the safe life of honey bees and majority of them (79%) do not take measure for the life of honey bees. Evidence from the respondent specially those beekeepers that are currently using traditional beehives (forest beekeeping) the degree of taking care for honeybees during harvesting is very low because the large tree and the traditional beehives are not comfortable for handling the life of honeybees. Besides the respondents mentioned during harvesting majority of them collect the entire honey comb from the hives. However relatively beekeeper that owned Chefeka beehives (transitional beehives) in human settlement and very few modern box beehives had some improvement practice in careful harvesting of the honey from the hive which is related with modern beekeeping practice.

2.2.5 Supplementary feed and best honey flora

About 90% of the respondents believed that honey bee flora shortage is common during some season of the year. The peak months in which feed shortage occurs are April and March. These months are indicated as dearth period because there was no much flowering plant. However as a result of poor seasonal colony management practice respondents were mentioned lack of supplementary feed during feed shortage and about 80% of respondents had no practice supplementary feed to their colony during bee flora shortage and the rest 20% had some activities of supplementary feed specially apiary site that are found in human settlement (land use patterns -B) that are currently using Chefeka beehives. Concerning knowledge of the respondents about the best flora of the area about 80% of them well know the best flora of the area and the rest 20% did not have that much understanding common bee flora of the area.

2.3 Beekeeping Constraints

2.3.1 Beekeeping training and its interest

Concerning Farmers' training on general principle of beekeeping and on modern technologies, 79% beekeepers did not take any training. But 21% beekeepers have taken some training on modern technologies of beekeeping. Majority (79%) of the beekeepers lack the knowledge of appropriate principle of beekeeping activities. According to respondents

(21%) that engaged training helped them to know basic improved beekeeping technologies and general principle of beekeeping. However, even if they trained still there are various problems in adoption of the modern technologies. Respondents mentioned adoption of improved beekeeping technologies to the area is beyond the buying capacity of the farmers and it is not easily accessed for those who can afford it. All respondents including those who had no chance of visiting beekeeping center are interested to be train about the modern beekeeping and basic of beekeeping. Besides during group discussion the entire participant both beekeepers and agricultural expertise mentioned the most critical problems of beekeeping activities in the study area is lack of appropriate skills about the modern technologies and general principle of colony management practice such as transferring colony, apiary sites selection, colony feeding, honey harvesting method, transferring colony etc. These issues should be addressed for development of beekeeping in the area.

2.3.3 Honeybee enemies & traditional controlling methods

Table 6: The most common honeybee enemies ranked in order of decreasing importance in the study sites

R. No	English Name	Scientific Name
1	Wax moth (both size)	<i>Galleria mellonella</i>
2	Different kinds of ants	<i>Dorylus fulvus</i>
3	Death head hawk moth	<i>Daphnis ner</i>
4	Different beetles	<i>Aethinatumida</i>
5	Lizards	<i>Hemidactylus frenatus</i>
6	Birds	<i>Serinus canaria</i>
7	Spider	<i>Theraphosabloni</i>
8	Wasps	<i>Vespula vulgaris</i>
9	Bee lice	<i>Braula coeca</i>
10	Honey badger	<i>Mellivoracapensis</i>

The results from respondents, majority (69%) and during group discussion honeybee enemies are causing losses both the quality and amount of honey by affecting the life of honeybees. Honey bee's enemies are causing bees to migration, decreasing colony strength, and some honey bees dies in the hives after fighting with their enemies. During discussion participant point out those bees after fighting they tend to migrate from their hives some may die inside the hives in which dead bees observed. In addition according to Tepi research center report and respondent's description Nosema and Chalk brood disease which caused by fungus (*Ascosphaera apis*) are the most common honeybee diseases observed in the hives producing severe damage to the beekeeping sector in the study area.

2.3.4 Honey flora and its shortage

Most probably the main reason for honey yield difference in the different harvesting time was due to the different availability of bee flora species. Respondents and participants from focus group discussion and expertise on apiculture and related professions were asked to list

2.3.2 Incident of Swarming, absconding and migration

Regarding season of colony swarming during group discussion all participants mentioned that sources of colony for their traditional beehives were swarming that are constantly emerges from different colony. Also 93% of the respondents reported swarming is common to most part of the study area and they also mentioned that September, October and November are the main swarming months of the year. According to the principle of honeybees' seasonal colony management practice if bees face different environmental hazard both the strength and the number of colony tend to decrease. 60% of respondents believe decreasing, colony become common in the study area. In addition 94% of respondent believe that migration of colony is common to the area as a result of different driving factors such as poor managements of beekeepers, shortage of flora and other environmental factor. Beekeepers indicated that colony migration occur mainly January-March up to flowering time which is associated with lack of seasonal management.

common bee flora of the area includes Girawa - *Vernonia amygdalina*, Sesa-*Cordia africana*, Avocado-*Persea americana*, Mango-*Mangifera indica*, Coffee - *Coffea arabica*, Maize - *Zea mays*, Banana - *Musa paradisiaca*, Geteme - *Schefflera abyssinica* are some of the most common flowering plant. According to respondents and all FGPs mentioned there are two flowering season of the year are September - October and May - June

All respondents mentioned that after harvesting shortage of honey bee forage is common as majority of the plant has the same flowering season but almost all of them underlined that from year to year flowering period and short duration of flowers and fluctuation become common in the area. They also mentioned that the main reason for unusual fluctuation of flowers are climate change, shifting agricultural practice, huge deforestation and no at all practice of bee forage development by beekeepers and other concerned organization. Here are some of the most common honey bee plants and their flowering period in the study area which is obtained from beekeeping farmers and Woreda agricultural worker as well as volunteers.

Table 8: Common bee floras in the study area of Sheko Woreda

Botanical name	Common name	Flowering period
<i>Cordia Africana</i>	Wanza Wadessa	May-Sept
<i>Hygenia abyssinica</i>	Kosso, Hexxo	Sept-Oct
<i>Euphorbia sp.</i>	Kulkual Adami	Sept-Oct
<i>Ficus vasta</i>	Warkaharbu (Oromifa)	Oct-Dec

<i>Erythrinaabyssinica</i>	KorchWalanso	Sept-Dec
<i>Scheffleraabyssinica</i>	Geteme	March-May
<i>Anigariaaltisma</i>	Keraro	March-April
<i>Pterolobiumstellatum</i>	Kontir (Ah); Haragma (Oromifa)	Sept-Dec
<i>Vernoniasp</i>	GrawaEbicha (Oromifa)	Dec-Feb
<i>Zea mays</i>	Maize	June -Oct
<i>Bidensklp</i>	MeskelAbabaomekala	August-Oct
<i>Sidasp</i>	Chiferge	Sept-Oct
<i>Helianthsanmus</i>	Sun flower	Variable
<i>Rutachalopensis</i>	Tenaadem	Sept
<i>Lippiaadoensis</i>	Kessie	Sept-Oct
<i>Persea Americana</i>	Avocado	Sept-Dec
<i>Mangifraindica</i>	Mango	Sept-Dec
<i>Papaya carica</i>	Papaya	Sept-Nov
<i>Musa paradisca</i>	Banana	Sept-Oct
<i>Coffee arbica</i>	Coffee	April-May

2.3.5 Marketing problems and practice of processing beeswaxes

Another critical issue for the development of beekeeping is market condition of its product honey and 81% respondents believe stable marketing problem is common to the area. Beekeepers also administered that the practice of processing beeswaxes and majority (94%) respondents mentioned they never process beeswaxes for better benefit. The respondents reported that they have good interest to improve the practice of wax processing if these all issues are accessed in relation to waxes processing skills and material.

Table 7: Reason for poor processing of beeswaxes in the study area

Reason for poor waxes processing	n	%
Lack of awareness	19	24.5
Lack of processing skill	43	55.1
Lack of processing material	5	6.4
All of the reason	11	14.1
Total	78	100

2.3.6 Practice of seasonal colony management

From the different inputs for effective and productive beekeeping activities seasonal colony management is vital for sustainable beekeeping. So that respondents interviewed that in their honey production practice weather they have planned time for pre and post season colony management and majority (90%) of them had no even knows the practice and its components. Besides during the discussion the participant mentioned that they do not have any idea about the significance of selecting apiary site as well as the practice of supplementary feed for their colony during feed shortage. Besides during the discussion majority of them accepted lack of management practice is critical problem for their beekeeping activities. So that according to respondents and expertise on apiculture one of the major constraints to effective beekeeping activities were inadequate skills of seasonal colony management.

2.3.7 Common problems associated with beekeeping mentioned by beekeepers

According to respondents and group discussion participant common problem associated with honey production practice in the study area includes the use of totally traditional practice and traditional beehives, lack of skilled manpower, appropriately skilled trainers, and the availability of modern beehives, training materials and training institution, lack of support from different organization, relatively high price of

the modern beehives, high risk of hanging beehives and harvesting honey in large tree which is life treating practice, shortage of bee-flower because of shifting agricultural system of the area, huge deforestation practice, increasing population, climate changes, poor adaptation of honey bees in human settlement from their wild area and lack of NGOs working on beekeeping development are some of critical beekeeping constraints.

They also underline that the key issues associated to the improvement of the current status of beekeeping industries to the existing huge potential of honey production and maximum ecological benefit of honeybees depend on solving the existing problems. Every problems associated with beekeeping in the study area is the use of traditional practice that does not give opportunity of seasonal colony management as well as caring the safe life of honey bees. Therefore most respondent's, expertise from SWRDAO and researches center and the group participants suggested that the existing beekeeping challenges can be improved by accessing training opportunity for beekeepers and expertise as well as the concerned stakeholder should do hand in hand in the adoption of the modern technologies along with beekeeping equipment.

2.5 Statistical analysis of different variable

One of the objectives of the study was to compare honey production difference in three land use pattern. So that to determine significance production different among the three study sites the following variable were analyzed such as the types of beehives used by beekeepers, annual honey production variation, yielding potential per hives, the adoption of the modern technology, beekeepers preference of the agro-ecology, and bee forage shortage. Honey yield variation per hives in modern hives in three different land use pattern observed 36kg, 24kg and 29kg in A, B and C land use patterns respectively and annual honey production variation in three land use patterns found that 38 tons, 10 tons and 16 tons in A, B and C land use patterns respectively. To determine the effect of land use patterns on honey production variation we use hypothesis and null hypothesis test. So that the production difference between the three study sites probably as a result of the real effect of the different land use patterns (hypothesis) or absence of difference land use patterns impact on honey production different (null hypothesis). If the likely range of variation of the average yield and annual honey production are due to land use patterns difference the null hypothesis become wrong. This is tested by the standard deviation of the

estimated mean formula called Standard deviation of estimated mean and sample mean by the formula:

SD of estimated mean = $\sigma/N^{1/2}$ (Snedecor and Cochran, 1980) [78]

Yielding difference in three land use patterns

S.D of estimated mean = $\sigma/N^{1/2}$

Where σ = Standard deviation of all yield

N = number of agro ecology $\sigma = 5$
 $N = 3$

S.D of estimated mean = $\sigma/N^{1/2}$
= $5/3^{1/2}$
= 3.33

Annual production potential difference

S.D of estimated mean = $\sigma/N^{1/2}$

σ = Standard deviation of all annual production

N = number of land use patterns $\sigma = 14.72$
 $N = 3$

S.D of estimated mean = $\sigma/N^{1/2}$
= $14.72/1.5$
= 9.8

From the result if we compare both honey yield per hives and annual honey production potential variation between the three land use pattern their means of standard deviation result is significantly larger than standard deviation of estimated mean (5 with 3.33 and 14.72 with 9.8) Therefore we have evident that the null hypothesis is not correct instead the different land use patterns has an effect on both honey yield per hives and annual honey productions potential between the three land use patterns (study site).

• Training involvement

From 21% respondents who engaged training on the modern technologies and on the basic principle of beekeeping from the three lands use patterns Majority (62%) are from land use patterns – B. The report show that land use patterns- B which is human settlement beekeepers relatively a better training engagement and hence better adoption of the modern technologies as well as good practice of seasonal colony management specially colony inspection and deliberate feeding of colony during feed shortage.

• Beekeepers land use pattern preference and occurrence of feed shortage

87% respondents prefers honey production in terms of supporting huge number of beehives and the quality of honey, land use patterns- A is better followed by non-human settlement (C- land use patterns). Evidence from the study feed shortage during some season of the year is common to the study area and the shortage is critical in land use patterns -B followed by land use patterns -C and land use patterns -A. Flora shortage is sever in human settlement in both honey season. Finally important variables also tested using

SPSS software package version 20.00, Anova one way test between different dependent and independent variable (Table 13). The relation between colony management practice of beekeepers and educational back ground and training on beekeeping were related. The result of the analysis show that, training has significant contribution on the tendency of adopting modern beekeeping and increasing productivity of honey from different beehives, that means those beekeepers who had good practice of seasonal colony management activities such as occasionally visiting their apiary, chalking bee enemies and disease and taking care during honey harvesting for their colony has better experience and they have relatively better educational back ground.

Therefore from the analysis it possible to conclude that training on beekeeping has significant contribution for the development of beekeeping and the adoption of the modern technologies. The other situation in relation to educational back ground of beekeepers is the tendency of processing bees' waxes for better income, removal of all honey combs during harvesting and identifying the best bee flora of the area. This also significant contribution to the educational back ground of beekeepers $P < 0.5$ or $P < 0.01$ for this analysis.

Discussion

The present study was conducted to assess beekeeping practice, opportunity and its constraints in three land use pattern of Sheko Woreda. According to the result of the study 97% of the honey production practice and the types of beehives used in the study Woreda were completely traditional. Besides, respondent's 67% of them currently owned only traditional beehives. The traditional beekeeping system has many disadvantage in management of beehives as well as the amount and quality of honey produced. This study is in line with the Survey conducted by Dereje *et al.* (2003) in seven beekeeping potential zones of Oromia (west and east Wollega, Ilubabor, Jimma, Bale, Guji, and Borana) from 2002-2003 in view of assessing honeybee management practices and post-harvest handling of bee products, the analysis showed that traditional beekeeping system ranges from 89.3% (in Jimma) to 99% (in Borena) with overall average of 95.2% and only 4.8% of the beekeepers are exercising improved beekeeping, which ranges from 1% (Borena) to 10.7% (Jimma, 3.1% intermediate (top-bar) and 7.6% framed box hive). According to respondents majority of the traditional beehives are found in the forest (both densely and agro forest). In this study, the sex of the interviewed beekeepers except a single female all was males. This is in line with the report of Hartmann (2004) [54] as cited by Solomon who noted beekeeping as the men's job in Ethiopia. Almost all of the respondents mentioned beekeeping activities like hanging traditional beehives in large tree, collecting honey during honey season, preparing traditional beehives etc. are mainly male responsibility. However a study conducted in Alaba Woreda by Shiferaw *et al.* (2010) on indigenous beekeeping knowledge found that the good involvement of female in various activities in beekeeping. Such as, honey harvesting, colony inspecting, apiary sanitation and honey marketing. This shows Poor understanding of the community about beekeeping potential that can be performed by all individual without sex reference.

During the survey period it has been also observed that the

adoption of intermediate (Chefeka beehives) and improved box hives (modern beehives) is very low. This shows that large proportion of the respondents had little exposure to improved beekeeping practices as well as according to information from Sheko Woreda agricultural report less than 3% Of currently available beehives in the Woreda are modern and from the respondents 9% both modern and traditional, and 15% both Chefeka and traditional beehives owned by the farmers (still under this proportion 90% of the beehives are traditional). Information from Woreda Agricultural expertise (DA-worker), during the group discussion and respondents mentioned that the adoption of the modern beehives and supporting beekeeping by the local government is very low compared to the existing potential. Farmers' training is one of the essential inputs in beekeeping sector in order to increase yield, to attain good management practice, to sustain business, appropriate input utilization, honey quality maintenance and handling bee forage development, and pest and disease control (FAO, 2010) [40]. Of the total 78% farmer did not take any training and 21% beekeepers have taken some training on modern technologies. According to respondents training has helped them to know basic improved beekeeping practices and principle of colony management but they reported that difficulties of implementing their skill because of many constraints due to little attention in adopting the modern beekeeping technologies by concerned body in the area. A study conducted by Workneh Abebe (2007) on farm demonstration of improved beekeeping technologies in Ejere district of west Shoa zone, Oromia the accessories are cost effective when it is used in group and beekeeping training is also needed for enhancing the technology promotion which, in turn, increases the productivity of the beekeepers and utilization of the technology. This show that a big need of beekeeping training and the adoption of modern technologies in improving honey production system. This finding is not in line with, a study conducted by Gidey (2009) in Northern part of the country about various efforts done by the government for the adoption of the new technology (91%) in respect to honey production and improved honey production system. Also, Great effort has been made by government extension package and Relief Society of Tigray (REST) to adopt movable frame hive technology to the region to increase quantity and quality of honey production and for better management of bees. The study also noted that this recently introduced new technology has shown significant improvement in the management of hives, bees and production of honey and wax and the beekeepers were mentioned that technology/innovations are available to improve the production of honeybee in Tigray.

According to the respondent estimate, maximum and minimum amount of honey harvested amount in Kg taken per hive 14-20, 18-28 and 20-35 of crude honey for traditional, transitional and modern bee hive respectively. This is not similar with a study by Greener Journal of Business by Chala *et al.* (2013) mentioned the national honey production result was average of 5 kg 12-15 kg and 15-20kg for traditional intermediate and movable frame hives (modern) respectively. Moreover, according to the survey conducted in West Showa Zone, average honey yield of traditional hive is 6.1 kg per hive per annum (Edessa, 2002). Therefore honey production per hives compared to the national standard as well as in different area the study

area has better yield which show the possibility of planning large scale beekeeping activities in the area.

The objective of colony seasonal management is to insure colony development with all the natural plant resources available in order to have the maximum number of foraging bees and every colony will have maximum population and production level in all season. However evidence from the present study found that 90% of the respondents had no practice of seasonal colony management in order to increase product of honey and for the safe life of honey bees which is one of fundamental beekeeping constraints in the area. This finding is similar with a survey conducted in Jimma zone by Tolera and Dejene (2010) on Seasonal honeybee management practices result, most of the beekeepers (86%) did not practice seasonal bee management activities. About 41% of the respondents did not reduced supers and not withdraw queen excluder during dearth periods. Likewise, due to lack of skill on seasonal bee management, they practiced bee colony transferring during inappropriate time and with poor techniques. Moreover, according to a study by Gidey and Mekonen (2010) [47] in northern part of the country reported the higher adoption rate of improved beekeeping technologies and significant increment of honey production in northern Ethiopia. Practical based beekeeping training, apiary visit and education could increase promotion of improved beekeeping technologies in order to obtain the intended amount of hive products as diagnosed; the development of improved apiculture was severely hampered by the lack of knowledge and skills at Woreda level.

Majority (80%) of the respondents reported the occurrence of feed shortage following harvesting time mainly in February and March and July and August both in the first and second harvesting season of the year. Besides, majority 90% respondents and during the focal group discussion participant indicated that there is no provisions of supplementary feeds in spite of sever feed shortage. This is relating with the traditional practices of forest beekeeping and lack of completely seasonal colony management practice which show most beekeepers has no the expected beekeeping skills. This result is not similar with a study conducted by Shiferaw *et al.* (2010) [2] revealed that deliberate feeding of bees in Alaba farmers is relatively common, some farmer have the practice of feed flour of pea, boiled pumpkin and provide solution of sugar in dry season when there is feed shortage. They also provide that they avail water for their honey bees. Besides a report by Solomon (2009) who stated that during dearth period when there is little honeybee forage, beekeepers provided supplementary feeds. Beekeepers give additional feed for their honeybees when they think the time is dearth period (when there is no enough pollen and nectar source).

The study also revealed that more than 90% the farmers annual income 50% and some of them 75% annual income by the production and sale of honey. This result is in line with a study conducted by Shenkuta *et al.* (2012) in three zone of KaffaSheka and Bench maji honey production contributes about 50% to the total household cash income of small scale farmers involved in beekeeping. According to the present study more than 60% of the respondents know the best honey bees' flora common to the area. A beekeeper needs a good knowledge of plants and their flowers, an understanding of honey plants, the plants that produce nectar used by honey bees to make honey, helps a beekeeper

know where to put the hives According to a study conducted by Almtseay (2010) on seasonal availability of common bee flora in relation to land use and colony performance in Gergera watershed AtsbiWembwrta District, eastern zone of Tigray, Ethiopia, the main reason for increasing trend of honey production was improvements in bee forage next to hive management (like use of modern bee hive) in the recent years.

According to the present study beekeepers reported about colony inspection: 33% of do not take look their hives completely as well as 44% of inspect occasionally both internally and externally. Farmers need regularly inspect their colony. This result is in line with a study conducted by Shenkutea *et al.* (2012) in three zone of south west part of the country on assessment of beekeeping found that 80% respondents do not inspect their bees both internally and externally and in both study associated with lack of training on beekeeping technologies. This result is not in agreement with a study conducted in eastern and northern Tigray by Gidey and kibrom (2010) on beekeeping for rural development. Its potentiality and constraints found that 91% of the sampled population practice adoption of the modern beehives with its training which is associated good practice of colony seasonal management and very good inspection of their hives frequently in well planned manner as a result significant increase in honey production.

Concerning colony migration majority (64%) of respondent believe that problem of honey bees migration become common that seems to be like real absconding and more than half (60%) respondents also mentioned colony decreasing observed in the area. The current decrease colony is not similar with CCD(colony collapse disorder) and past losses in that colony loss are occurring mostly because bees are failing to return to the hive (which is largely uncharacteristic of bee behavior) (Bradbear, 2004)^[20] According to beekeepers, report the main reasons behind migration of bees are shortage of feed, lack of skill in managing hives (in proper transfer of colony), poor adaptation of wild bees, increased intensity of deforestation, Shifting agricultural practice, bee enemies, increasing use of pesticides, protection against bad weather as a result of climate changes and poor management practices of the modern beehives(few of them). This is similar with a study conducted in Jimma zone by Chala *et al.* (2012)^[26] who reported honeybees migrate in response to resource depletion as a result of environmental degradation and poor management practice of beekeepers. This result also revealed that beekeeper has no any activities of planting any bee flora to overcome the current problems associated with bee forage which is not similar with a study conducted in Burie District of Amhara Region by Tessega (2009), beekeepers try to overcome the problem of reduction of honey bee plants hence beekeepers grow different local bee forage plants near by the apiary site Despite these local efforts, the national beekeeping resource base is deteriorating at a faster rate warranting sustainable intervention progress (Melaku *et al.*, 2008)^[63]. Hence, to address environmental problems as well as to improve household food security, a number of interventions have been made in Ethiopia. Migration mostly takes place in dry season (January to February) and main rainy season (July to August) following honey harvesting periods and lower flowering plants available. The colony strength as well as honeybee products mostly depend on the availability and

type of bee flora next to level of seasonal colony management practice (Bista and Shivakoti, 2001)^[22].

According to the present study 84% of them replay that swarming is common in the study area. The productive of honey bees colonies and the quality of honey greatly influenced by reproductive swarming it greatly reduces hive strength, is most often associated with overcrowding in the hive. This result is in agreement with a study conducted by Shenkuta *et al.* (2011) in three zones ShekaKeffa and Bench 89.3% mentioned that reproductive swarming of honeybee colonies is a frequent phenomenon. An increase in the number of colonies during a honey flow, whether through swarming or division is usually made at the expense of the honey crops. This study similar to a study conducted by DerejeWoltedji (2010) in North Shewa zone found that the effects of hive volume and management on reproductive swarming intensity and honey yield of local honeybee colony found that the effect of frequent swarming tendency of the colony resulted in reduction of colony work force and less collection of nectar and honey yield on the colonies, which faced shortage of space. Regarding season of colony swarming, beekeepers of the survey area indicated that September, October and November were the main months in which colony swarming occurs because of availability of plenty flower (pollen) increase vegetation coverage and instinct behavior of bees; while, March, April, July, and December were months in which there was no record of incidence of reproductive swarming so beekeepers should consider swarm cache season and the management of swarm as important components of seasonal colony management. Swarm control is part of proper Seasonal colony management practices which is the combination of activities which are undertaken by beekeeper(s) such as hive inspection, building up of the colonies, adding or reducing supers, inserting queen excluder. While they may look frightening, bees that are swarming and carrying honey from their old hive are much less defensive or likely to sting than they would be if they were protecting brood (immature bees) at the old hive.

According to the beekeepers response and during the group discussion all of them mentioned common honey bees' enemies that are currently affecting honey bees in the area by disturbing colony, eating honey and brood killing and making the bees to migration. They mentioned common honey bee pests including *YesemEtchi* (Wax moth) the (greatest enemies), and enemies like ants (both black and red), birds, spiders honey badger, snake and lizards. Honeybee pests and diseases cause high mortality rates and severe economic loss. The existence of pests and predators were additional nuisances to the honeybees and beekeepers. Similar threats were reported from a study conducted in Tigray region by Gidey (2010) on bee lice found that Pests and predators that cause devastating damage on honeybee colonies and ranked in order of two decreasing importance were honey badger, ants, wax moth, bee-eater birds, lizard, snake and spiders. The needs for effective honeybee health delivery service and appropriate control methods in order to reduce diseases, pests and predators constraint remain very important and investigation and diagnosis of factors that endanger the health of local honeybees in different agro ecology zones and establishing ways of prevention and control measures need to addressed.

Bees waxes processing is the major activities to maximize income from beekeeping and majority (94%) of the

respondents never process bees waxes for better benefit because of the following reasons such as majority (55%) lack of processing skill followed by 24% lack of awareness about bees waxes and 11% of them that lack of processing skill, lack of awareness and lack of processing material. According to a study conducted by Yohannes Agonafir (2005) Intervention plan on honey & beeswax valuechains beeswax largely collected from traditional hives rather than the modern hives, which presently promoted by the Ministry of Agriculture and several NGOs. The wax yield from traditional hives is 8-10% of the honey yield, compared to 0.5-2 % from modern hives. The bulk of the supply of beeswax obtained as residual from “Tej” production, a mild alcoholic beverage popular throughout.

This study also found that marketing problem is common to the area which is in most case the price of honey changes widely based on the good will of buyers thus absence of grading systems does not encourage farmers to produce high quality products, in which most of the local markets are far away from the beekeepers and are inaccessible. This is similar with a study conducted by Gezahegne, (2001) discussed the constraints to marketing of honey and beeswax in the country and these include low and discouraging price of honey and beeswax in local markets, lower quality of products, lack of market information, absence of organized market channel, transportation problem, lack of appropriate technologies for collecting, processing, packing and storage of honey to keep its natural quality, lack of government support in promoting market development, and low involvement of private sector. Most honey come to market is un-extracted, and poorly managed therefore marketing interventions have to be introduced in local area for better production.

According to the present study the most common beekeeping constraints cited by respondents included: honey bee diseases, migration and swarming, marketing problem, lack of skilled man power, shortage of training, lack of equipment, absence of agricultural extension service, accessibility of skilled man power in the field of apiculture, and shortage of beekeeping equipment shortage of bee forage and environmental impact The finding similar with a study conducted by Workneh Abebe 2010 on the Adoption of improved box hive in Atsbi Wemberta District of Eastern Zone, Tigray Region: determinants and financial benefits It was also shown that credit, knowledge, education level of household head, perception and visits to demonstrations positively and significantly influenced adoption of improved box hive. Ranking showed that drought; honeybee pests and diseases; lack of beekeeping materials; death of colony; lack of adequate extension support; marketing problem; shortage of bee forage; lack of adequate beekeeping skill and reduction of honeybee colonies were the major constraints in the beekeeping development in their order of importance.

3. Conclusions and Recommendations

3.1 Conclusions

Southwest parts of Ethiopia are well known with very diverse and dense natural forests that favors for the existence of dense honeybee population and high potential of honey production. Therefore this study was conducted with the objective of understanding beekeeping practice and its constraints and opportunity in three different land use pattern in Sheko Woreda.

- The study revealed that beekeeping in the area common

traditional practice in which about half of the house hold get their income from the sale of honey and they get the practice of beekeeping from their family through traditional method hence, more than 97% of the hives in the area and 67% of respondents owned only traditional beehives along with traditional management system, with very low (3%) adoption rate of the modern technologies.

- Majority (90%) of beekeepers have no practice of pre and post-harvest management hence 80% of the respondents had no practice of supplementary feeding for their colony and 44% of the beekeepers inspect their colony occasionally and 33% do not inspect their colony totally but majority (95%) of respondents believed feed shortage is common following harvesting season.
- The result also indicates lack of training on modern technologies and basic beekeeping skills were critical constraints. Therefore all of the respondents has no the idea of seasonal colony management and waxes processing skill. The study also showed that there is significant difference honey production between the beehives found in three difference land use patterns in terms of the amount of honey produced per colony per year and the number of colony supported in each land use patterns as well as the extent of beekeeping constraints hence, most respondents prefer agro-forest land use patterns.
- The study also found that as a result lack of general principle of beekeeping critical problem in honey harvesting which does not consider the safe life of bees and collection of quality honey
- The study also revealed that training on general principle of colony management and modern technologies has significant contribution in maximizing honey production and safe life of honey bees as well as the tendency of adoption of modern technologies.

Generally beekeeping is a well-established practice in the farming communities of Sheko district and it plays a significant role as source of main cash incomes and nutrition for many farmers.

However, in spite of its significant economic contribution and its great potential for sustainable development for the area attention is not given to the sector by concerned stakeholder. Totally traditional beekeeping practice, lack of appropriate seasonal colony management skills, absence of colony inspection, lack of skilled manpower and institution, marketing problem, shortage of records and up-to- date information, poor extension program me, lack of NGOs working on adoption of the modern technologies are the major challenges facing beekeeping activities in the study area.

3.2 Recommendations

Possible recommendations on the basis of the study so as to be considered in the future intervention strategies which are aimed at the promotion of honey production practice and to get possible ecological benefit of honey bees without harming their life include:

- Both the local and regional government need to revised their extension program in relation to beekeeping and take in to consideration as one of the strategies for reducing poverty and ensuring household food security

with existing huge beekeeping potential.

- Every pre and post honey harvesting constraints associate with lack of proper seasonal colony management skills and lack awareness about general principle of beekeeping These indicate the importance of institutional support in the form of adequate and practical based training; improved beekeeping technologies, credit and marketing linkages need to be addressed simultaneously.
- Integration of beekeeping to other development activities such as conservation of natural resources, income generation, promote the sowing of multipurpose plant that can provide ample nectar and pollen for bees need to be practiced and encouraging more farmers to participate in beekeeping.
- Sheko district has huge beekeeping potential and many opportunities to scale up honey production. Therefore the possibility of extensive beekeeping and a room in increasing production by adoption of the modern technologies. So concerned body, educational institution and developmental organization should look for different option in introducing NGOs working on beekeeping and work hand in hand to change the life of beekeepers as well as to exploit the existing apiculture potential.

The impact of honey bees enemies and diseases increasing from time to time especially for the last five years So colony inspection and control of honeybee disease are important phases of colony management which must not be neglected by the beekeepers and further deep investigation (research) should be needed by concerned body to control the various honey bees enemies especially the newly emerging.

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