

Analysis of Honey Bee Production Opportunities and Challenges in Central Zone of Tigray, Northern Ethiopia

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Abstract- This study was conducted in three purposively selected districts of central zone of Tigray, namely, Kolla Tembien, Tanqua Abergelle and Weri'e Leke. The overall objective of the study was to analyze the major honey bee production opportunities and challenges in the study area. For this study a total of 135 beekeepers were randomly and proportionately selected from each study districts. The data collected was analyzed descriptive statistics and Musa et al rank index were employed to analyze the data on challenges and opportunities. According to survey result, the respondents of the study districts could harvest 1.83, 1.36 and 1 times per annum from traditional, modern and transitional hives respectively. The productivity of the traditional hive is significantly low ($p < 0.05$) in Kolla Tembien (16.6 kg) as compared to Tanqua Abergelle (29.7 kg) and Weri'e leke (21.5 kg) districts. 94% of the beekeepers daily followed the bee hives to check the presence of honey bee enemies. The honey bee production system of the study area has been reported to face with different major challenging factors such as water scarcity (96.5%), financial problem (91.1%), pests and predators (89.6%), poor extension services (65.6%), shortage of bee forages (56.2%) and high input cost (36.8%). Financial problem in Kolla Tembien is significantly higher ($p < 0.05$) than Tanqua Abergelle and Weri'e leke districts but input cost problem in Weri'e leke is significantly higher ($p < 0.05$) than Tanqua Abergelle district. Poor extension services related to beekeeping is more pressing factor in Weri'e leke ($p < 0.05$) than the other two districts. The households also listed the major pests and predators of honey bee and were captured using rank index; ants (0.3), death head hawk moth (0.23), birds (0.2), honey badger (0.08) and lizard (0.07). Despite these limitations, there are many opportunities for beekeeping in the study area; access of bee hives, sustainable honey market price, healthy bee colonies and good infrastructure. In order to sustain the beekeeping activities of the study area, it is recommended that there should be affordable and appropriate extension service, supplying cheap bee keeping inputs, capacitating to beekeepers i.e. pests and predators control mechanism, .

Index Terms- Beekeeping, challenges, Kolla Tembien, opportunities, Tanquaa Abergelle, Weri'e Leke

I. INTRODUCTION

Ethiopia is home to some of the most diverse flora and fauna in Africa. Its forests and woodlands contain diverse plant species that provide surplus nectar and pollen to foraging bees

(Girma, 1998). The country is the largest honey producer in Africa and 10th largest honey producers in the world (Rivera et al., 2007). Although thousands of tones of honey have been produced every year, the products obtained from the subsector have been observed to be still low as compared to the potential of the country (Edessa, 2005).

In Ethiopia, beekeeping is a promising non-farm activity for the rural households. It contributes to the incomes of households in particular and the economy of the nation in general. The direct contribution of beekeeping includes the value of the outputs produced such as honey, bee wax, queen and bee colonies, and other products such as pollen, royal jelly, bee venom, and propolis in cosmetics and medicine (ARSD, 2000 and Gezahegn, 2001). It also provides an employment opportunity in the livestock sub sector of the agricultural sector. The exact number of people engaged in the honey sub-sector in Ethiopia is not well known. However, it is estimated that around one million farm households are involved in beekeeping business using the traditional, intermediate and modern hives. It could also be observed that a large number of people (intermediaries and traders) participate in honey collection and retailing (at village, district and zonal levels). Thousands of households are engaged in Tej-making in almost all urban areas, hundreds of processors are emerging and exporters are also flourishing (Beyene and David, 2007). Honey and beeswax also play a big role in the cultural and religious life of the people of Ethiopia. Another very important contribution of beekeeping is through plant pollination and conservation of the natural environment. Beekeeping is environmentally sustainable activity that can be integrated with agricultural practices like crop production, animal husbandry, horticultural crops and conservation of natural resources. Thus, it would be one of the most important intervention areas for sustainable development of poor countries like Ethiopia (Gibbon, 2001). The contributions of beekeeping in poverty reduction, sustainable development and conservation of natural resources have been well recognized and emphasized by the incumbent government of Ethiopia and non-governmental organizations (NGOs). As the country is endowed with varied ecological zones and different flora, it has a huge potential for beekeeping. However, the roles of beekeeping as income generation or diversification for subsistent farmers and generating foreign exchange earnings have been very minimal.

Beekeeping is a very long-standing practice in the farming communities of the Tigray region and it plays a significant role as source of additional cash income and nutrition for many subsistence farmers. It is an integral part of the smallholder

farming system. In Tanqua Abergelle, Kola Tembien and Werie lekes districts, Central zone Tigray, Northern Ethiopia, apiculture is a good source of income for smallholder farmers, as both honey and bee colonies are in high demand. Despite the significance of bee keeping, there is little empirical evidence on the potentials and challenges of bee keeping for income generation and forest management in the study districts. There is limited information currently available on the constraints of bee keeping in the honey bee sub-sector. The objective of the study, therefore, was to analyze the major honey bee production opportunities and challenges in the central zone of Tigray regional state, Ethiopia.

II. METHODOLOGY

2.1. Study area

The study was conducted in Kolla Tembien, Tanqua Abergelle and Werie leke districts of the central Tigray, Northern Ethiopia. The latitude and long of the districts is N 13° 37' 6.24" and E 39° 0' 6.84" (Kolla Tembien), N 13° 14' 06" and E 38° 58' 50" (Tanqua Abergelle) and N 14° 00' 00" and E 39° 10' 1.2" (Werie leke).

2.2. Sample size and sampling techniques

The three districts were selected for the study following purposive sampling approach considering potential in honey bee production. A multi stage sampling technique was used in this study. In the first and second stage, honey bee potential districts have been identified purposively and a sample size of 135 was set for this study using quota method. In the third stage, 42 beekeepers from Tanqua Abergelle, 58 beekeepers from Kolla Tembien and 35 Werie leke were selected randomly and proportionately.

2.3. Data type, source and Data collection Techniques

For this study, both primary and secondary data have been relied on. Primary data was collected from sample household heads, beekeepers while secondary data was collected from office of agriculture and rural development of respective study districts. Both formal and informal survey methods have been used to collect the required data. Semi structured questionnaire was used to collect the primary data.

2.4. Data analysis

The data collected from 135 beekeepers were analyzed using descriptive statistics in such as mean and standard deviation and is presented in tables. Musa et al (2006) rank index calculation was also employed to put the order of importance of pests and predators, which are challenges for honey bee production in the study area. The rank index can be calculated as follows.

Rank index= $\frac{\text{sum of } (3 \times \text{number of household ranked first} + 2 \times \text{number of household ranked second} + 1 \times \text{number of households ranked third}) \text{ for individual reason, criteria or preference}}{\text{sum of } (3 \times \text{number of household ranked first} + 2 \times \text{number of household ranked second} + 1 \times \text{number of households ranked third}) \text{ for over all reason, criteria or preference}}$

III. RESULTS AND DISCUSSIONS

2.5. Demographic characters of the respondents

The respondents were selected from Tanqua Abergelle (31%), Kolla Tembien(43%) and Werie Leke(26%) districts. Most of the interviewee household heads were male (89%) and the rest were female headed households (11 %). Regarding to the marital status, 89.7% of the respondents were coupled and the rest 10.3% fall under the category single, widowed, widower, divorced and never married). Based on the survey result, the educational status of the household heads was 32.9%, 14.1%, 35.3%, 15.3% and 2.4% for illiterate, read and write, elementary school completed, high school completed and church schooled respectively. The minimum and maximum age of respondents was 23 and 70 respectively while the mean age was 44. The average family size of the study area was 6 heads per household and the minimum and maximum households' family size was 2 and 12 heads respectively. The average beekeeping experience of the respondents was 11.1±9.3 (mean + SD) years.

2.6. Land holding and land allocation Practices for bee keeping

According to the survey result, farm size of the respondent varies across the study districts. Averagely the land holding size of Tanqua Abergelle, Kolla Tembien and Werie Leke farmers (mean±SD) is 1.3 ±0.73, 0.84±0.53 and 0.72±0.45 hectare respectively. But the average farm size of the farmers in the study area is 0.94± 0.62 hectare per household. Most of the farmers (62.7%) did not allocate land for bee farming properly but only 37.3% have a separated land for bee keeping.

2.7. Honey bee production, productivity and management

Most of the households (94%) responded to have regularly and daily followed and checked their beehive against bee enemies while the rest (6%) check their bee hives only during honey harvesting season. According to similar research conducted in Adami Tulu Jido Kombolcha district by Tesfaye K and Tesfaye L (2007) from the sample households, 53.5% of the beekeepers visit their beehives every day 30.2% of them visit their beehives every three days and the rest visit their beehives to check if the beehive was occupied with bee colonies and during honey harvesting season, which indicates a bit different habit from the study areas' practice. This difference might be due to difference in beekeeping experience. In beehive management (follow up, checking against enemy, cleaning the environment, supplying additional feeding, watering and honey harvesting) gender role may or may not be equal. Of the total respondents, 44% responded that both husband and wives to have equal hands in the beehive management, but the rest 41% and 15% of the household replied that the beehive management is mainly on the shoulder of male and female respectively.

The study has also tried to reveal that the type of beehive being used in honey production in the study area. Of the total sample households, 41% household heads did own both traditional and modern beehives and the rest 27.7%, 30.1% and 1.2% owns traditional, modern and transitional beehives only respectively (table 1). This finding is definitely different from national beehive usage status i.e. 95% of the beekeepers are traditional beehive owners but the rest are modern and transitional beehives owners (CSA, 2013).

Depending on the study finding, the traditional beehive users harvest honey 1.83 times per annum but the modern and transitional beehive owners is harvesting honey 1.36 and 1 times per year per hive accordingly. Regardless of the type of beehive used, the overall harvesting frequency of the study area is 1.59 times per annum per hive (table 1). This finding is almost in line with the national harvesting frequency which is 1.61 times per annum (CSA, 2013).

Based on the survey data analysis, the average productivity of the beehives per harvesting period was 22.6 (traditional), 20 (transitional) and 31.2 (modern) kilo grams (table 2). Productivity of traditional beehive in Kolla Tembien is significantly lower ($p < 0.05$) as compared to Tanqua Abergelle and Weri'e Leke districts (table 2).

2.8. Opportunities of Beekeeping

According to the survey data analysis result, Most of the beekeepers of the study area, 92.5% and 97.2% have reported that they have no problem with access to all types of beehives and bee colony respectively (table 3). On the contrary, a study conducted in Adami Tulu Jido Kombolcha district in mid rift valley of Ethiopia by Tesfaye K. and Tesfaye Lemma, (2007) indicated that lack of beehives to be one of the major constraints of beekeeping in the study area. . The study result indicated that sustainable market for honey and its byproducts to be one opportunity in the study districts. All of the respondents (100%) explained that the price of honey to have been increasing from time to time and to have been facing honey price fluctuation (table 3). This may be due to the existence of good accesses to market information, market infrastructure, particularly road and mobile telephone networks, in the study districts. Unlike to this finding, Tolera and Dejene (2014) indicated that price fluctuation

to be the most pressing factor of beekeeping in Jimma zone of Oromia region of Ethiopia. No problem related to honeybee diseases, pesticides and herbicides, and behavior of the honeybee (aggressiveness) has been reported in all the study districts (table 3)

2.9. Challenges of Beekeeping

Based on the survey data analysis most of the beekeepers in the study area, Kolla Tembien (92%), Tanqua Abergelle (88.1%) and Weri'e Leke (90%) districts reported to have faced different challenges in relation to beekeeping. Taking all the study areas, on average, (90 %) of the beekeepers reported different challenges in beekeeping. Though the challenges reported indicated variation across the study districts drought/ water scarcity/, financial problem, pests and predators, poor extension services, shortage of bee forage and high input cost are the most economically important challenges in their decreasing order of importance (table 3) in the study districts in common. The households also listed major pests and predators observed in the study area in their decreasing order of importance; amongst include ants, death head hawks moth, birds, honey badgers, lizard, wax moth and spider (table 4).

Drought or water scarcity was reported as one of the top challenging factors which 95.2%, 92.0 % and 100% of the beekeepers from Kolla Tembien, Tanqua Abergelle and Weri'e Leke districts mentioned to be challenging respectively (table 3). In favor of this finding, study by Adeday *et al.*, (2012) conducted in Wukro district Eastern Zone of Tigray indicated that water scarcity or drought to be one of the main problems of beekeeping.

Financial shortage was one of the pressing factors that affect the beekeeping activity of the study districts. Depending on the survey data most of the farmers of the study districts i.e. Kolla Tembien (100%), Tanqua Abergelle (83.3%) and Weri'e Leke (90%) reported financial problem to be a challenge in the beekeeping business (table 3) and it was observed to be significantly ($p < 0.05$) pressing factor for beekeeping business in Kolla Tembien than Tanqua Abergelle.

Furthermore, respondents of the study area indicated that the presence of pests and predators to be among the major challenges to honey production in the study districts. These might be

happening due to the nature of the agro ecological set up of the study districts. According to the information extracted from this survey, presence of pests and predators ranked to be the third important challenge for beekeeping in the study districts (table 3). Different pests and predators which include ants, death head hawks moth, birds, honey badgers, lizards, wax moth and spider in decreasing order of their importance were listed by the respondents (table 4). A study by Tesfaye K. and Tesfaye L., (2007) indicated that the prevailing pests and predators observed in Adami Tulu Jido Kombolcha district include ant like insects, birds, spiders, monkey or apes, honey badger and lizard. A recent study by Adeday *et al.*, (2012) conducted at Wukro district of Tigray regional state also revealed that honey badger, ants, wax moth, bee-eater birds, lizards, snake and spider to be the most devastating challenges in the study area. Regardless of the order of importance, most of the pests and predators mentioned by respondents of the study area were similar to Wukro and Adami Tulu Jido Kombolcha districts findings. Ants were among the most common predators of honeybees in the study area with rank index of 0.3 and it is ranked first (table 4). In line with this finding, ants were placed at the top rank in Wukro district as reported by Adeday *et al.* (2012). Based on the beekeepers response, death head hawks moth (0.23) was also put in the second rank in the study area. In addition, birds were placed as the major factor that affect honey production and the rank index result was found to be 0.2 (table 4). This finding is also similar with the research finding by Adeday *et.al.* (2012) conducted at Wukro district, birds are observed as one of the top ranked predators of bee. When put by rank index, small number of beekeepers also reported the presence of honey badger (0.08), lizards (0.07), wax moth (0.06), spider (0.04) and hamagot (0.02) to be more challenging in the study area. Prevalence of beetles, snake, mice and wasp were not reported as challenges for beekeeping in the study area (table 4).

Moreover, survey result indicated that poor extension services were ranked fourth. Of the total respondents, 65.6% were not satisfied with extension services delivered beekeepers in relation to beekeeping development in the study districts (table 3). A study by Gidey and Kekkonen, (2010) also indicated inadequate

extension coverage to be one source of challenge for beekeeping business development in Tigray region which is in favor of this study's findings. This problem might be happening mainly due to limited number of development agents (DAs) in kebelles¹ and beekeeping technicians at district level.

Furthermore, shortage of bee forages and inflated cost of improved inputs were mentioned as constraints to the beekeeping business of the study area. Of the total sample household heads, 56.2% and 36.8% of the beekeepers put lack of adequate bee forages and high input cost to be pressing factors for the beekeeping business respectively (table 3). In line with this finding, research findings on the similar area of study by Gidey and Kibrom (2010) and Adeday *et al.* (2012) conducted in Saese Tsaeda Emba and Wukro districts of Tigray regional state respectively also indicated that shortage of bee forage to be the main challenge for beekeeping development. The shortage of bee forages existed might be due to erratic and unpredictable nature of rainfall, deforestation and application of agrochemicals (pesticides and herbicides) that are observed in the study districts. Furthermore, some beekeepers of Kolla Tembien (35.6%), Tanqua Abergelle (20%) and most beekeepers of Weri'e Leke (60 %) reported that the ever increasing cost of improved beekeeping inputs to have its own effect on the successful operation of the beekeeping business (table 3). Ever increasing input cost problem is significantly higher ($p < 0.05$) in Weri'e Leke than the other two study districts. A similar study by Nebiyu and Mesele (2013) reported that most of the beekeepers of the Gamo Gofa zone of Southern Ethiopia preferred traditional beehives over transitional and modern beehives. The main reason for this was because of the cost of constructing materials of transitional beehives and unaffordable cost of modern and transitional beehives. Besides, lack of adequate supply beekeeping equipments and cost of harvesting and processing equipments for using modern and other improved beehives, transitional beehive.

¹ Kebele is the smallest administration unit in both rural and urban areas with its own jurisdiction

Beekeepers of Tanqua Abergelle district reported that poor management (13%), honeybee and absconding (8.7%) to be challenging factors for beekeeping business. In addition to the finding in Tanqua Abergelle district, poor management and absconding problem were observed in Kolla Tembien district as well, but poor management and absconding problem were not reported for Weri'e Leke district. The presence of market fluctuation, honeybee diseases, and pesticides and herbicides were not reported from all districts (table 3).

IV. CONCLUSIONS AND RECOMMENDATIONS

Given the existing natural base of the country, Ethiopia, the incumbent government has given due attention on apiculture development as one of the strategies to reduce poverty and diversify the national exports. The study area, central zone of Tigray, is known for its potential honeybee production. It has many opportunities for honeybee development; more or less stable market price of honey, good infrastructure, healthy honeybee colonies, and good accesses to beehives are amongst the others.

On the contrary, The major constraints hindering for beekeeping business development in the district includes water scarcity, financial problem in relation to beekeeping, pests and predators, poor extension services in relation to beekeeping, shortage of bee forage, and high cost of improved inputs for beekeeping. Improved beekeeping technologies have been introduced to Tigray regional state in general and the study districts in particular by the bureau of agriculture and rural development at district and kebele level. However, majority of the beekeepers in the study area follow traditional way of colony management, harvesting and processing methods to produce honey, put another way round, most of the introduced modern ways of beekeeping are not in use to the desired extent. Based on the study's result, the following policy implications have been forwarded for the study districts.

Most sampled beekeepers responded that extension services delivered to them in relation to their

beekeeping business not to be as such satisfactory to the desired extent. Hence, the administrative body and office of agriculture and rural development of the study districts in particular and the region in general has to strive more towards improving the quality and adequacy of extension services in relation to beekeeping in the study districts. And other interested nongovernmental institutions should give attention on investing on this issue. Particularly, increasing the number of qualified developmental agents (DAs) at kebele and district level, awareness creation programs and capacity building to beekeepers should be focused on. Moreover, increasing the number of professionals like veterinarians and honeybee technicians and capacitating them all in all is also inevitable issue that shall be given weight too. Awareness creation and training need for beekeepers may include beehive management (follow up, checking against enemy, cleaning the environment, supplying additional feeding, watering and honey harvesting) market oriented production of honey.

Production, productivity and quality of honey shall be also increased by improving the management of the traditional beehives and introducing improved beehives and beehive accessories. Besides, honeybee productivity in the study area shall be enhanced through improving the availability of bee forages through introducing improved bee forage varieties.

Absconding problem, running way of bee colony from its beehive, was also reported to be cumbersome both in Tanqua Abergelle and Kolla Tembien study districts. This invites for a research on factors behind this problem to be conducted in the study area. To this end, responsible bodies have to search for factors behind the problem.

Most sample household heads, beekeepers, reported lack of adequate financial resources to invest on improved honey production technologies, storage, processing facilities and packaging to be challenging for their beekeeping business development. Thus, credit

services should be available to individuals who are willing to be involved in the production, collection, processing and packaging of honey and honey byproducts. This necessitates for appropriate credit system to be developed. Since adequate, quality and affordable credit system could contribute a lot towards improving the performance of beekeeping business.

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Table1: Honey harvesting frequency by beehive type in Tanqua Aberegel, Kolla Tembien and Wer'e Leke districts

Name of Districts	Traditional owners		Transitional owners		Modern owners	
	Farmers (%)	Frequency \pm SD	Farmers (%)	Frequency \pm SD	Farmers (%)	Frequency \pm SD
Tanqua Abergel	41.7%	2.1 \pm 0.57	4.2%	1.0 \pm 0.00	16.7%	1.75 \pm 0.96
Kolla Tembien	28.2%	1.55 \pm 0.52	NA	NA	25.6%	1.40 \pm 0.52
Weri'e Leke	10.0%	2.0 \pm 0.00	NA	NA	55.0%	1.18 \pm 0.40
Total	27.7%	1.83 \pm 0.58	1.2%	1.0 \pm 0.00	30.1%	1.36 \pm 0.57

Survey data, 2014, SD= standard deviation, NA= not applicable

Table2: Honey productivity in Tanqua Abergelle, Kolla Tembien and Weri'e leke districts

Districts name	honey yield per harvest season to each beehive type (Kg) of the districts		
	Traditional \pm SD	Transitional \pm SD	Modern \pm SD
Tanqua Abergelle	29.7 ^a \pm 18.1	20.0 \pm 0.0	35.0 ^a \pm 14.8
Kolla Tembien	16.6 ^b \pm 7.3	NA	29.1 ^a \pm 13.4
Weri'e leke	21.5 ^a \pm 10.4	NA	29.5 ^a \pm 12.3
Average	22.6 ^a \pm 13.2	20.0 ^a \pm 0.0	31.2 ^a \pm 13.3

Survey data, 2014

Different letters in columns and rows indicate significant mean differences between districts and types of beehive respectively at P < 0.05. NA= not applicable, SD= standard deviation

Table3: Response proportions of major challenges of beekeeping in Tanqua Abergelle, Kolla Tembien and Weri'e Leke study districts

List of honey production factors	Number of farmers responding yes/no by district (%)						pooled responses		overall rank
	Kolla Tembien		TanquaAbergelle		Wrei'e Leke		Yes %	No%	
	Yes %	Rank	Yes %	Rank	Yes %	Rank			
Poor extension service related to beekeeping	58.5 ^a	5	54.2 ^a	5	84.2 ^b	4	65.6	34.4	4
financial shortage related to beekeeping	100 ^b	1	83.3 ^a	3	90 ^{a,b}	2	91.1	8.9	2
Market/price fluctuation of honey	-	-	-	-	-	-	-	100	-
Beehive accesses problem	-	-	-	-	-	-	7.5	92.5	9
Shortage of Bee forage	63.9 ^a	4	69.6 ^a	4	35.0 ^a	6	56.2	43.8	5
Pests and predators	95.2 ^a	3	88.0 ^a	2	85.7 ^a	3	89.6	10.4	3
Water scarcity	97.6 ^a	2	92.0 ^a	1	100 ^b	1	96.5	3.1	1
Absconding	7.3 ^a	8	8.7 ^a	7	0.0 ^b	-	8.0	92.0	8
Poor management	4.9 ^a	7	13.0 ^a	8	0.0 ^a	-	9.0	91.0	7
Diseases	-	-	-	-	-	-	-	-	-
Bee colony accesses problem	-	-	-	-	-	-	2.8	97.2	10
Pesticides and herbicides	-	-	-	-	-	-	-	-	-
High costs of improved inputs for beekeeping	35.7 ^{a,b}	6	20.0 ^a	6	60.0 ^b	5	36.8	63.2	6

Survey data, 2014. Values in the row not sharing the same subscript are significantly different across study districts (columns) at p<0.05 for two sided test of equal proportions

Table4: Rank index for major pests and predators of beekeeping in the study area

Lists of Pests and predators	Local name	Relative degree of importance of pests and predators			Index	Percentage (%)	Overall rank
		1 st	2 nd	3 rd			
Ant	Tsatse	27	23	13	0.30	30	1
Wax moth	Tsimbilali'e	3	6	5	0.06	6	6
Spider	Saret	2	4	5	0.04	4	7
Beetles	Hinziz	-	-	-	-	-	-
Hama got	Slihlot	3	1	-	0.02	2	8
Lizard	Tebeq	1	7	15	0.07	7	5
Wasp	E'cot	-	-	-	-	-	-
Bird	E'uf	22	8	14	0.20	20	3
Death head hawks moth	Anbesa nihibi	17	24	8	0.23	23	2
Snake	Temen	-	-	-	-	-	-
Mice	Enchiwa	-	-	-	-	-	-
Honey badger	Titgi	6	5	8	0.08	8	4

Survey data, 2014

Rank index=sum of (3*number of household ranked first +2*number of household ranked second + 1*number of households ranked third) for individual reason, criteria or preference divided by sum of (3*number of household ranked first +2*number of household ranked second + 1*number of households ranked third) for over all reason, criteria or preference