Full Length Research Paper

Analysis of honey production systems in three agro-ecologies of Benishangul-Gumuz, Western Ethiopia

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The study was conducted in three districts of Benishangul-Gumuz Regional State, Western Ethiopia, to characterize honey production systems, identify major constraints limiting honey production and suggest the required development intervention options for future development. Purposive sampling technique was used to select the districts that represent the three agro-ecologies of the region. A total of 120 beekeeping households were selected and individually interviewed in their respective farms using pre-tested semi-structured questionnaire. Stratified sampling technique was used to select the households. Data was analyzed using descriptive statistics, chi-square test and one-way ANOVA of SPSS software. The results revealed that the number of bee colonies per household were not different across the districts. Honey yield from traditional and transitional hives varied across the districts, but not from modern hive. Beekeeping sector of the areas is constrained by high cost and limited availability of modern beekeeping equipments and accessories, inferior quality of honey, honeybee enemies, inadequate research and extension services, and shortage of skilled human power. Thus, to benefit beekeepers from the sector, alleviating the prevailing constraints and exploiting the available opportunities is important.

Key words: Honey production, Benishangul-gumuz, reproductive swarming, migration, beekeeping constraints.

INTRODUCTION

Ethiopia has a longer tradition of beekeeping than any country in the world even though the sector is still undeveloped sector of agriculture (Melaku et al., 2008a). The country is one of the major honey and beeswax producers in the world; the largest honey producer in Africa and the 10th largest producer in the world (Girma, 1998; Kerealem et al., 2009). Ethiopia possesses natural resources that are favourable to beekeeping activities. However, the contribution of the sector to the national economy is very low due to traditional honey production and wax extraction practices of beekeepers. In many regions of the country, beekeeping generates

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income for resource-poor farmers including women, youth and the unemployed sectors of the country (Melaku et al., 2008b). The sector also suits to areas where other agricultural activities are limited like harsh agro-systems where crop production is marginal and livestock cannot exist. Moreover, beekeeping stabilizes and protects fragile environments since it is environmentally sustainable activity and can be integrated with other agricultural practices. Honey bees are good pollinating agents thereby increasing crop productivity and conserving plant biodiversity (Teferi et al., 2011).

Assosa, Homosha and Mao-Komo districts of Benishangul gumuz regional state are believed to be potential areas for beekeeping development as they have good climatic conditions and diversified bee flora. But, there is no compiled and reliable information on honey production systems in the areas so far. The sector at country level is constrained by lack of knowledge, shortage of trained man power, shortage of beekeeping equipments, pests and predators, and inadequate research and extension services to support beekeeping development programmes (SOS-sahel-Ethiopia, 2006). Benishangul gumuz regional state cannot be exceptional from these constraints.

But, for any developmental strategies that intervene prevailing constraints, a full characterization and understanding of the production systems is very essential. Therefore, this study was conducted to characterize honey production systems, identify the major constraints limiting honey production and suggest the required development interventions for future improvement.

MATERIALS AND METHODS

Study area

This study was conducted in three districts of Benishangul gumuz regional state, namely Assosa, Homosha and Maokomo. The three districts were selected to represent the three agro-ecologies of the regional state. Maokomo represents highland, Assosa mid-altitude and Homosha represents lowland. Assosa town is located 670 km west of Addis Ababa. Maokomo is located about 105 km south of Assosa town and Homosha is located about 30 km west of Assosa town.

Benishangul gumuz regional state is located between geographical coordinates: 9°30’N-11°39’N latitude and 34°20’ to 36°30’ E longitude with altitude ranging from 1272 to 1573 m above sea level. Mean annual rainfall and temperature in the region range between 700 to 1450 mm and 21 to 35°C, respectively (AMS, 2008). Major crops grown in the areas are sorghum, maize, finger millet, soya bean and ground nut. Livestock species commonly kept are goats, cattle, chicken and donkeys in order of importance (AsARC, 2006).

Sampling method

The three districts were selected purposively based on their agro-ecology. Then stratified random sampling technique was used to select peasant associations (PAs) and the sample respondents. A total of 120 beekeepers were randomly selected for questionnaire interview and farm visit from the three districts.

Sources and methods of data collection

Pre-tested semi-structured questionnaire was used to interview the selected beekeepers. The interview was held in their respective farms using a local language. Then, group discussions with key informants and local administrators were held in each PA. The questionnaire covered a large range of variables which include demographic characteristics, resource holdings, beekeeping management practices, honey marketing and constraints of beekeeping.

Focus group discussions were primarily on ranking of constraints, diseases, pests and predators of beekeeping in the areas. Secondary data such as number of bee colonies, amount and type of bee hives, honey marketed per year were collected from agricultural offices of the districts.

Data analysis

Data collected was managed in such a way that the qualitative as well as quantitative variables can be analyzed. Data were entered into SPSS (version 20) and coded for analysis. Descriptive, one-way ANOVA and chi-square test were used for data analysis. Districts representing the three agro-ecologies (highland, mid-altitude and lowland) were used as fixed factors for most of dependent variables in one-way ANOVA model. The model used for the analysis was:

\[ Y_i = \mu + D_i + \epsilon_i \]

Where, \( Y_i \) is dependent variable, \( \mu \) is overall mean; \( D_i \) is the fixed effect of districts; \( i = \) Assosa, Homosha and Maokomo; \( \epsilon_i \) is a random error. Chi-square test was used to determine differences in percent frequencies of nominal data. For all analysis, the level of significance was set at 5%.

RESULTS

Demographic characteristics

The mean age of household head and family size of the sample households are presented in Table 1. Age of household heads was not significantly (P>0.05) different among the districts. However, family size of Assosa was significantly (P<0.05) less than family size of Homosha and Maokomo districts. The sample respondents from Assosa and Maokomo districts were better educated than that of Homosha (Figure 1). About 95% of the sample households were male headed and majority of them (88.3%) were married.

Land and livestock holdings

Land and livestock holdings of the sample respondents are shown in Table 2. The sample respondents of Assosa had significantly (P<0.05) larger land size than that of Maokomo. Number of cattle, sheep, goat and equines kept per household were significantly (P<0.001) different...
Table 1. Age and family size of the sample households.

<table>
<thead>
<tr>
<th>Variable</th>
<th>District</th>
<th>Assoa; N=40</th>
<th>Homosha; N=40</th>
<th>Mokomo; N=40</th>
<th>P-value</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SEM</td>
<td>Mean</td>
<td>SEM</td>
<td>Mean</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>37.8</td>
<td>2.19</td>
<td>39.4</td>
<td>1.70</td>
<td>36.4</td>
</tr>
<tr>
<td>Male family size</td>
<td></td>
<td>2.4a</td>
<td>0.17</td>
<td>3.1b</td>
<td>0.34</td>
<td>3.7a</td>
</tr>
<tr>
<td>Female family size</td>
<td></td>
<td>3.3</td>
<td>0.23</td>
<td>4.0</td>
<td>0.34</td>
<td>4.0</td>
</tr>
<tr>
<td>Total family size</td>
<td></td>
<td>5.6b</td>
<td>0.32</td>
<td>7.0b</td>
<td>0.62</td>
<td>7.6a</td>
</tr>
</tbody>
</table>

ns: Non-significant, *P<0.05, **P<0.01, ***P<0.001; means with the same letters across rows are not different at 0.05 level.

Figure 1. Education status of sample respondents.

Table 2. Land and livestock holdings of the sample respondents.

<table>
<thead>
<tr>
<th>Variable</th>
<th>District</th>
<th>Assoa (N=40)</th>
<th>Homosha (N=40)</th>
<th>Mokomo (N=40)</th>
<th>P-value</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SEM</td>
<td>Mean</td>
<td>SEM</td>
<td>Mean</td>
</tr>
<tr>
<td>Total land (ha)</td>
<td></td>
<td>2.1a</td>
<td>0.23</td>
<td>1.7ab</td>
<td>0.17</td>
<td>1.45b</td>
</tr>
<tr>
<td>Grazing land (ha)</td>
<td></td>
<td>0.5a</td>
<td>0.12</td>
<td>0.1b</td>
<td>0.04</td>
<td>0.1b</td>
</tr>
<tr>
<td>Cultivated land (ha)</td>
<td></td>
<td>1.6</td>
<td>0.90</td>
<td>1.5</td>
<td>0.17</td>
<td>1.4</td>
</tr>
<tr>
<td>Apiary site (ha)</td>
<td></td>
<td>0.03</td>
<td>0.02</td>
<td>0.03</td>
<td>0.02</td>
<td>0.0</td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td>2.3b</td>
<td>0.32</td>
<td>0.9c</td>
<td>0.32</td>
<td>3.5a</td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
<td>0.7a</td>
<td>0.16</td>
<td>0.1b</td>
<td>0.07</td>
<td>0.9a</td>
</tr>
<tr>
<td>Goat</td>
<td></td>
<td>3.6b</td>
<td>0.54</td>
<td>5.2a</td>
<td>0.69</td>
<td>0.6c</td>
</tr>
<tr>
<td>Equines</td>
<td></td>
<td>1.0a</td>
<td>0.12</td>
<td>0.4b</td>
<td>0.12</td>
<td>0.5b</td>
</tr>
<tr>
<td>Chicken</td>
<td></td>
<td>8.4a</td>
<td>0.99</td>
<td>10.3a</td>
<td>1.74</td>
<td>3.9b</td>
</tr>
<tr>
<td>TLU</td>
<td></td>
<td>2.9a</td>
<td>0.25</td>
<td>1.6b</td>
<td>0.25</td>
<td>2.7a</td>
</tr>
</tbody>
</table>

ns: Non-significant, *P<0.05, **P<0.01, ***P<0.001; means with the same letters across rows are not different at 0.05 level.

among the districts. Larger number of cattle and sheep per household were kept in Maokomo district than others. The sample respondents in Homosha used to keep more number of goats compared to the rest districts. Whereas, the sample respondents in Assosa possessed more number of equines than the sample respondents in
Homosha and Maokomo. The assessment also showed that more number of chickens was kept per household in Assosa and Homosha than Maokomo.

Hive types, colony distribution and honey yield

There were 43201 traditional, 273 intermediate and 2079 improved box hives in the study areas (BOARD, 2011). The traditional hives are made of bamboo and grass. Most beekeepers hang their traditional hives upon trees in the forest or homestead until honey harvesting season. Transitional hives are not widely used in study areas.

The number of colonies owned per household were not significantly (P>0.05) different across the districts. However, the sample households in Maokomo had significantly (P<0.01) larger number of bee colonies in traditional hive compared to the sample households in Assosa and Homosha. Contrary to this, the number of bee colonies in modern hives were significantly (P<0.001) larger in Assosa than Homosha and Maokomo (Table 3). Estimates of honey yield varied across the districts as well as hive types. Modern hive yielded more honey followed by transitional hive. Honey yield from traditional hive per year was significantly (P<0.001) higher in Maokomo than Assosa and Homosha. Honey yield from transitional hive was significantly (P<0.01) higher in Homosha than Assosa. The sample households from Maokomo did not use traditional hive at all. Modern hive yielded comparable amount of honey across the districts (Table 3).

Honeybee management practices

In the study areas, colony is usually obtained by trapping swarm which is done by hanging traditional hives upon trees. Colonies are trapped twice a year, first from September to November and then from February to March. However, the sample respondents reported that honeybee population is declining over the years in the study areas. The sample respondents indicated that they smoke the traditional hives on average for 1.6 h with cow dung, wax, or bark and leaf of some trees together or separately to attract swarm.

Traditional hives are hanged on trees either at homestead or forest whereas modern and transitional hives are usually put at backyard under shade. Traditional hives were inspected externally by the sample respondents and internal inspection was unknown unless it is for honey collection. From 83 sample respondents having modern box hive, it was indicated that 73.5% of them make an external inspection on daily basis whereas the rest inspect their box hives externally once a week. Internal inspection was made only at a time of honey harvest. During honey collection from traditional hive, the sample respondents indicated that they remove all combs destroying a colony.

Honeybee swarming and migration

The sample respondents mentioned that reproductive swarming is a frequent phenomenon in the study areas. Majority of the sample households did not use either to prevent or control a reproductive swarming. But, some households had prevention and control methods of reproductive swarming as indicated in Table 4. The prevention and control methods varied significantly (P<0.001) across the study districts. Colony migration was also mentioned as one of the top problems in the study areas. The major reasons mentioned for migration were lack of feed, pests and predators, human interference especially at a time of honey collection, and wind in order of importance.

Provision of supplementary feeds, water and shade

More than half of the sample respondents used to provide supplementary feeds and water to their colonies in modern and transitional hives in dearth periods (Figure
Table 4. Prevention and control practices of reproductive swarming and migration by the sample households.

<table>
<thead>
<tr>
<th>Variable</th>
<th>District</th>
<th>Assosa (N=40) %</th>
<th>Homosha (N=40) %</th>
<th>Maokomo (N=40) %</th>
<th>X²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you prevent reproductive swarming? (Yes)</td>
<td></td>
<td>62.5</td>
<td>40</td>
<td>12.5</td>
<td>23.191***</td>
</tr>
<tr>
<td>Do you control reproductive swarming? (Yes)</td>
<td></td>
<td>20.0</td>
<td>45.0</td>
<td>12.5</td>
<td>17.347**</td>
</tr>
</tbody>
</table>

Prevention methods for reproductive swarming

<table>
<thead>
<tr>
<th>Method</th>
<th>Assosa (N=40) %</th>
<th>Homosha (N=40) %</th>
<th>Maokomo (N=40) %</th>
<th>X²</th>
</tr>
</thead>
<tbody>
<tr>
<td>No prevention</td>
<td>40</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Removing supersidures</td>
<td>17.5</td>
<td>25.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Supering/providing more space</td>
<td>12.5</td>
<td>0.0</td>
<td>0.0</td>
<td>42.650***</td>
</tr>
<tr>
<td>Use of queen excluder</td>
<td>17.5</td>
<td>10.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Removing supersidures and use of queen excluder</td>
<td>12.5</td>
<td>5</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

Control methods for reproductive swarming

<table>
<thead>
<tr>
<th>Method</th>
<th>Assosa (N=40) %</th>
<th>Homosha (N=40) %</th>
<th>Maokomo (N=40) %</th>
<th>X²</th>
</tr>
</thead>
<tbody>
<tr>
<td>No control</td>
<td>80</td>
<td>55</td>
<td>87.5</td>
<td></td>
</tr>
<tr>
<td>Killing queen of swarm</td>
<td>12.5</td>
<td>45</td>
<td>0.0</td>
<td>41.645***</td>
</tr>
<tr>
<td>Transferring swarm to another hive</td>
<td>7.5</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Putting traditional hive around</td>
<td>0.0</td>
<td>0.0</td>
<td>12.5</td>
<td></td>
</tr>
</tbody>
</table>

*, ** and *** are significant at P=0.05, 0.01 and 0.001, respectively.

2). Commonly used feeds reported were flour of cereals and sugar. However, colonies in traditional hives are not given a supplementary feeds and water in the study areas. Concerning shade for hives, the sample respondents used thatched roof and trees for modern and transitional hives. Traditional hives were hanged upon trees primarily in the forests and collected after honey harvest (Figures 3 and 4)

Honey management practices

February, November, and December are the major honey harvesting periods in Assosa, Homosha and Maokomo districts, respectively. But, honey management practices are not different across the districts. Beekeepers in the study areas collect honey by removing all the combs from traditional hives thereby discarding their colonies and starting with new colonies each year. Honey collected from traditional and transitional hives is usually inferior in quality compared to honey collected from modern hives. The sample respondents having modern and transitional hives use protective clothes and smoke during honey collection. Beekeepers with only traditional hives do not use protective clothes, but some reported that they smear honey on their hands and work naked to protect themselves.

Honey is collected when beekeepers expect it is ready for harvesting without checking its ripeness. Thus, beekeepers are often not aware of differences in honey
quality due to water content. Beekeepers in the study areas detect honey harvesting time by observing bees accumulated on the entrance of hive, movement of bees, season, honey smell and sound of bees.

About 90% of interviewed beekeepers used to store honey from 1 month to 1 year for profit maximization (88%), for medicinal value, as a saving account and for continuous consumption. Few respondents indicated that storing honey for certain period increases its weight and this benefits them. Various types of plastic containers and sacs which are available in local markets are used for honey storage. Few beekeepers use plastic cups to store pure honey from modern hives as they are lacking in the local markets as mentioned by most of the sample respondents.

**Honey marketing**

Majority (95%) of the sample respondents in the study areas produce honey primarily for market (Figure 5). The average price of crude honey in local markets per kg was...
$1 in Assosa, $1.2 in Homosha and $1.3 in Maokomo. Whereas, the average price of extracted honey in local markets was $2.2 in Assosa, $1.9 in Homosha and $2.4 in Maokomo per kg. The price of traditional hive made of locally available materials was $0.5. The sample households put up for sale on average 58.49 kg of extracted and 80.69 kg of crude honey each year and had revenue of $139 per household per year.

Honey bee flora

Based on findings from the sample respondents and field observations, there were diversified types of bee flora in the study areas. Many of cultivated crops in the areas serve as pollen, nectar, or both pollen and nectar sources. Mainly shrubs, cultivated crops, forbs, herbs, weeds and some woody plants were used as a main bee forages for the first honey flow season (October - December) whereas woody plants were the main source of pollen and nectar for the second honey flow season (February to May). For this study, honeybee flora of the study areas was not investigated in detail. The sample respondents indicated that the availability of bee forages is seasonal and hence, feed shortage occurs in some months of a year, especially in dry period. It was also indicated that the distribution of bee forages in the study areas is declining over time due to deforestation and expansion of cultivated lands.

Pests and predators

Economically important pests and predators of the study areas are indicated in Table 5. The rankings were made based on focal group discussions in each districts. This study showed that ants, honey badger, wax moth, small hive beetle and spider were frequently occurring pests and predators of the three districts. Whereas, bee-eater birds, head hawks, bee lice, and premantides were found to occur rarely. Beekeepers in the study areas have their own mechanisms to prevent honeybee pests and predators. For instance, to protect ant, they put ash and burned fuel around hive stands; to prevent honey badger, they fix smooth iron sheet on trees that traditional hives are hanged, or put fences around the tree, and select trees that are not conducive for honey badger to climb. Bee diseases of the study districts were not covered in this study since it needs diagnostic survey and the sample respondents had limited knowledge to differentiate diseases. However, some of the sample respondents indicated that sometimes they face honeybee deaths in and around hives.

Constraints

The major constraints of beekeeping in the study areas mentioned by the sample respondents and key informants include:

1. High cost and limited availability of modern beekeeping equipments and accessories: These include box hive, casting mould, frame wires, honey extractor, and containers. The sample respondents reported that modern hive constructed by some private companies and cooperatives in the study areas are of poor quality, that is with wrong dimensions and made of poor quality timber. As a result, migration rate of honey bees in modern hive is very high in the areas.
2. Inferior quality of honey due to poor management: Majority of honey in the study areas comes from
Table 5. Rank of economically important pests and predators in the study areas.

<table>
<thead>
<tr>
<th>Pest/predator</th>
<th>Hive type (Rank)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traditional</td>
</tr>
<tr>
<td>Ant</td>
<td>6</td>
</tr>
<tr>
<td>Wax moth</td>
<td>3</td>
</tr>
<tr>
<td>Honey badger</td>
<td>1</td>
</tr>
<tr>
<td>Spider</td>
<td>4</td>
</tr>
<tr>
<td>Birds</td>
<td>2</td>
</tr>
<tr>
<td>Mice</td>
<td>8</td>
</tr>
<tr>
<td>Lizard</td>
<td>7</td>
</tr>
<tr>
<td>Small hive beetle</td>
<td>5</td>
</tr>
<tr>
<td>Wasp</td>
<td>9</td>
</tr>
<tr>
<td>Snakes</td>
<td>9</td>
</tr>
<tr>
<td>Head hawks</td>
<td>10</td>
</tr>
</tbody>
</table>

traditional hives and consequently, this honey contains beeswax debris and other non honey impurities. Due to limited knowledge, there is mishandling of honey after harvest which includes use of inappropriate storage materials and wrong storage places.

3. Theft, pests and predators: The sample respondents of this study indicated that theft (human pest) is one of major problems in the study areas. The major pests and predators reported include ants, wax moth, honey badger, spider, honey hunter birds, mice, lizards, small and large hive beetles, honeybee lice, wasps, snakes and head hawks.

4. Lack of honey processors: There were neither large-scale nor small-scale honey processors in the study areas. This in turn, leads to poor quality honey consequently with low price for the producers.

5. Inadequate research and extension services: The districts where this study has been conducted are one of the remotest areas of the country. Thus, the areas were lacking adequate research and extension services in areas of modern beekeeping. This was manifested in this study that majority of the sample respondents had only traditional hives and the way they handle honey bees is backward.

6. Shortage of skilled human power: Benishangul-Gumuz region is one of emerging regions of the country. As a result, it is constrained by trained human power to assist beekeepers in the areas of modern beekeeping. The sample respondents and key informants also noted that they do not get sufficient technical assistances in order to improve their current way of honey production.

Opportunities

Based on group discussion and personal observations, the major opportunities to improve and expand the beekeeping sector in the study areas are:

1. Availability of honeybee colony in huge amount;
2. Diversified honey bee flora.
3. Tourists as the study areas are in proximity to Ethiopian Grand Electric Dam.
4. Attention given by the government to the sector.
5. Environmental friendliness of the sector.

DISCUSSION

The significantly larger family size in Maokomo and Homosha is likely related with polygamy marriage in the areas. Better education level of household heads in Assosa and Maokomo could be attributed better access to education in the areas. The likely reason behind differences in number of livestock species owned by the sample respondents among the districts is agro-ecological differences. Maokomo is highland and trypanosomiasis free area and thus, it’s more conducive to sheep and cattle. Homosha is lowland and this favors more likely goat production.

The availability of significantly greater number of honeybee colonies in traditional hives in Maokomo district is related with availability of dense forest, and lack of access to transitional and modern box hives. In contrary, the sample respondents in Assosa district possessed significantly greater number of honeybee colonies in modern hives which is related with availability of modern hive production centers in Assosa town.

The average honey yield in the study areas from traditional hive (5.2 kg/colony/year) is comparable to national average (5-8 kg/colony/year); from transitional hive (8.9 kg/colony/year) is less than the national average (20 kg/colony/year) and from modern hive (14.9kg/colony/year) is also less than the national average (30 kg/colony/year) (MOARD, 2007). The lower honey yield in transitional and modern hive could be likely attributed to higher absconding rates of honeybee race of the study areas (A. mellifera scutallata) and poor management practices due to skill gaps in modern beekeeping. The sample respondents reported that
colonies in transitional and modern hives usually abscond after honey harvest. This might be due to mishandling of colonies during honey harvest which include use of too much smoke and removing all honey combs. The incidence of honeybee enemies could be also a reason for higher absconding rates. Majority of the visited beekeepers do not use partition in transitional hive and queen excluder in modern hive. This leads to lower number of honey frames in the hives subsequently with lower honey yield per hive. Thus, these and similar skill gaps of beekeepers in modern beekeeping should be narrowed with extensive trainings.

This study revealed that the honey bee population in the study areas is in decreasing trend. The likely reasons behind are: deforestation due to increasing human population and agricultural investments, destruction of bee colonies by wild fire, wide use of pesticides for crop farming and mismanagement of colonies during honey harvest especially in traditional hives which include a total burning of colony.

Reproductive swarming has a negative effect on honey production since it decreases the honeybee population in the hive. It occurs either due to low space available for bees in the hive or low egg production performance of queen. In the former case it can be easily prevented by adding supers in modern hive and providing additional space by removing honey combs in traditional and transitional hives prior to colony produces queen cells. Queen cells can be also removed during internal inspection. Majority of beekeepers in the study areas, however, do not put any effort to prevent or control reproductive swarming which seeks due attention by development organizations to create awareness. In fact, it’s difficult to prevent and control reproductive swarming in traditional hives hence internal inspection on tall trees is cumbersome for a beekeeper. Similar scenario has also been reported in honey production systems in southwest Ethiopia (Shenkute et al., 2012).

Migration of honeybee colonies occurs in honey harvesting and dearth periods in the study areas. According to the sample respondents, the possible reasons behind could be feed shortages, bee enemies, human interference and wind, which is in line with findings of Chala et al. (2012); Amsalu (2006) and Shenkute et al. (2012).

Honey harvesting system from traditional hives revealed in this study is similar to Kafra and Sheka zones of south-western Ethiopia where beekeepers damage brood, discard their colonies after honey harvest and always start from new swarm every year (Shenkute et al., 2012). Some beekeepers also mentioned that they burn colonies to protect themselves from bees attack which in turn has negative implication on the colony population of the areas. Majority of beekeepers in the study areas store honey to sell it when the market price is high, but few indicated that honey storage increases its weight. This increase in weight is due to hygroscopic nature of honey and it has negative effect on quality. Some of other quality related effects of honey storage mentioned in the study areas were spoilage of crude honey, crystallization, loss of natural flavour and attacks by rodents and ants. This has an indication that beekeepers in the study areas should be given with appropriate honey storage equipments coupled with the necessary trainings.

Higher market prices of honey in Makomko and Homosha compared to Assosa could be related with the availability of huge refugee camps in the two districts. Generally, honey price of the areas is lower than some other parts of the country which could be due to absence of honey businesses operating on a larger scale.

Pests and predators cause a serious damage on bee colonies within short period. Economic importance of pests and predators varied with hive types which is mainly associated with the locations where beekeepers put their hives. For instance, ante is the top ranked pest in transitional and modern hives but not in traditional hive. Since the later is hanged on tall trees, ants cannot easily access it.

On the other side, being in the forest and far from residential areas, traditional hives are more exposed to honey badger, bee-eater birds and theft in contrary to transitional and modern hives. The later hive types are often kept at backyard. Some of the major pests and predators identified in this study like ant, wax moth and spider could be prevented by an appropriate apiary management. Similar bee enemies were identified in previous studies in the other parts of the country (Shenkute et al., 2012; Taye and Marco, 2014; Keralem, 2005).

**Intervention options**

1. Practical based trainings on modern beekeeping is an important step forward to narrow prevailing gaps in areas of honeybee management and honey handling processes;
2. The accuracy of modern box hives produced by private organizations should be monitored and controlled;
3. Beekeepers should be linked with suppliers of modern beekeeping equipments and accessories;
4. Beekeepers should be organized in associations to be benefitted from their products and for easy access to modern beekeeping technologies
5. Beeswax and other bee products should be promoted in order to provide beekeeper with further income.
6. The diversified bee flora of the area should be documented and conserved.

**Conclusion**

From this study it was realized that the study areas are potential for beekeeping development, but yet little
interventions were made to improve the existing very traditional honey production system. Modern beekeeping equipments and their accessories are not easily accessible and unaffordable to the beekeepers. There are huge knowledge and skill gaps among beekeepers on modern beekeeping which needs extensive practical based trainings. The beekeepers are not getting attractive money for their produces and this needs mechanisms to link them with central markets. Yet, the region is not supported with beekeeping researches to generate new technologies pertinent to the area and thus, concerned bodies should work more on establishing and strengthening apiculture research. In general, to be benefited from the sector, alleviating the prevailing constraints and exploiting the available opportunities is important.

Conflict of Interest

The authors have not declared any conflict of interest.

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