Factors influencing organic honey production level and marketing: evidence from southwest Ethiopia

Benyam Tadessea a,*, Yaregal Tilahun a, Wondimu Woyamo b, Mekuanint Bayu b, Zelalem Adimasu b

a Department of Agricultural Economics, College of Agriculture and Natural Resources, Mizan-Tepi University, P.O.Box 260, Ethiopia
b Department of Animal Science, College of Agriculture and Natural Resource, Mizan-Tepi University, P.O.Box 260, Ethiopia

ARTICLE INFO

Keywords: Organic honey Beehives Marketing Production Constraints Assessment Multiple linear regression

ABSTRACT

The primary aim of this study was to identify factors influencing natural honey production and marketing constraints in Kafa, Sheka, Bench-Sheko, and West Omo zones which covered 23 woredas and 69 kebeles. Primary and secondary sources of data were utilized for this study. Both qualitative and quantitative data types were employed. Data were collected from 94, 134, 118, and 39 respondents that were selected randomly from Bench-Sheko, Kaffa, Sheka, and West-Omo Zones respectively, based on probability proportional to the sample size. The collected data were analyzed by using descriptive statistics and a multiple linear regression model. The dominant honey production practice in the study area was the use of traditional beehives. The productivity of traditional, transitional, and modern beehives was 9, 16, and 22 kg per hive. Major constraints that affect honey production include lack of modern technology (92.5%), absconding (69.5%), pests and predators (46.8%), lack of credit access (28.3%), poor extension service (57.4%), lack of beekeeping equipment's (45.2%) and death of colony (38.0%). Similarly, poor market linkage (84.1%), lack of market information (66.2%), poor infrastructure (61.5%), low price of product (60.7%), weak bargaining power of farmers (37.5%), long-distance to market (88.4%), shortage of packing and storage materials (57.6%), presence of illegal traders (53.5%) and absence of branding (60.3%) are factors that influence honey marketing in the study area. The econometric result showed that variable cost, age of the respondent, marital status, experience, and hive number owned influence the level of honey production. The policy should focus on creating access to modern honey bee technologies, providing capacity building for producers, organizing cooperatives, providing credit services, promoting the involvement of private sectors, establishing linkages among honey producers, researchers, and private sectors.

1. Introduction

In Ethiopia, honey production deeds are one of the ancient agricultural activities (Bekena and Greiling, 2017) that expedited with favorable natural resource endowment, distinctive agro-ecological conditions, and over seven thousand flowering species (Admassu et al., 2014; MoA and ILRI, 2013) and have a comparative advantage in honey and wax production (MoA and ILRI, 2013). The country is among the foremost honey producers in Africa and the world. There are over ten million bee colonies and one point eight million beekeepers exist in Ethiopia (Bekena and Greiling, 2017). It is the fourth largest honey producer next to the Republic of India, China, and Turkey in the world by having 6,958,004 beehives (CSA, 2020) which produced 53782 and 5790 tons of honey and beeswax respectively (FAO-STAT, 2021).

In Ethiopia, honey production is much less from grasping its potential for earning foreign currency generally and generating financial gain for honey producers specifically. The country has the potential of manufacturing up to five thousand tons of honey and fifty thousand tons of beeswax every year (Assefa, 2017). But the recent production level of honey and beeswax is a smaller amount than ten percent of its potential, exploitation of alternative high-value honeybee products is non-existent (MoA and ILRI, 2013) and also the gain from the subsector is not adequate (Beyene and David, 2010). Identifying the issues that hinder honey production, productivity and marketing is pivotal for further intervention and improving the subsector.

The dominant honey-producing regions in Ethiopia are Oromia, Amhara, and SNNPR (Southern Nations, Nationalities, Peoples Regional Government) that accounts for 54.3%, 19.5%, and 16.6% of the total...
production (CSA, 2020). The Southwestern part of Ethiopia which is endowed with dense natural forest, appropriate environmental conditions, and different species of flora and fauna has a prominent potential for honey production (Ito, 2014; Tarekegn et al., 2018). Different researchers like Tarekegn et al. (2017a,b); Tarekegn and Ayele (2020); Tarekegn et al. (2017a,b); Erkalo (2017); Belete (2015); Shenkute et al. (2012); Albore et al. (2019) conducted a study on the honey value chain, honey production systems, technology adoption and market outlet selections of honey in southwest Ethiopia. But none of these studies addressed factors affecting organic honey production level and marketing. Therefore, this study aimed to identify factors poigant honey production in the Bench-Sheko, Kafa, Sheka, and West-Omo zones of southwest Ethiopia. 

### 2. Research methodology

#### 2.1. Description of the study area

This study was conducted in Bench- Sheko, Kaffa, Sheka, and West Omo zones of SNPPR. The study was conducted in 23 woredas and 69 kebeles (Table 1). The detailed description was explained as follows:

#### 2.2. Research design

Both qualitative and quantitative data types were used in this study. Both primary and secondary data sources were used. Primary data were collected through a household survey by using questionnaires, focus group discussions, key informant interviews, field observations, and market assessment. In each woreda three focus group discussions were conducted. A total of 69 focus group discussions in which each composed of 8 honey producers were performed. In each woreda, 5 key informants were interviewed concerning honey production and marketing problems. Secondary data were collected from official reports and published documents.

In this study, a multi-stage sampling technique was followed. In the first stage, the four zones (Kafa, Sheka, Bench Sheko, and West Omo) and all 23 (twenty-three) woredas of the four zones were selected based on the recommendation of the SNPPR special support office. In the second stage, three kebeles1 from each woreda2 were selected purposively based on the production potential of honey. The sample size was determined by using the following formula of Morgan (1970) (equation 1).

$$n = \frac{Z^2P(1-P)}{D^2}$$

(1)

where, $n$ = sample size, $Z^2 = 95\% = 1.96$ & $e = level$ of precision (5%).

$P$ = the population proportion (assumed to be 0.5 for it provides the maximum sample size) and $q=1-p$. Based on the above formula, 94, 134, 118, and 39 producers and 14 traders, 10 cooperatives and unions, and 20 processors were selected randomly from Bench-Sheko, Kaffa, Sheka, and West-Omo Zones respectively, based on probability proportional to the sample size.

The collected data were examined by using descriptive and econometric methods. Descriptively, mean, percentage, and frequency were used and an econometrically multiple linear regression model was used to identify factors influencing the level of honey production. A highly skewed variable was converted into log form because logarithmic conversion is a suitable way to convert highly skewed into a more normalized dataset (Table 2).

### Table 1. Study area description.

| Description | Former Bench- Maji (current Bench-Sheko and West-Omo zones) | Kaffa Zone | Sheka Zone |
|-------------|-------------------------------------------------------------|------------|------------|
| GPS location range | 5°30’–7°00’ N to 34°00’–36°00’ E | 6°24’–7°00’ N to 35°39’–36°30’ E | 7°24’–7°52’ N to 35°13’–35°35’ E |
| Zonal Towns | Mizan Aman and Jemu | Bonga | Masha |
| Annual Rainfall (mm) | 1500–1800mm | 1600–2200 | 1800–2200 |
| Temperature (°C) | 15 °C–29 °C | 18–21 | 15 °C–27 °C |
| Altitude (m.a.s.l) | 1200 to 1959 | 500 to 3350 | 900 to 2750 |
| Total population (2017) | 847,168 | 1,102,278 | 269,243 |

| Description | Bench-Sheko, on the northeast by Kaffa, on the northwest by the Oromia Region, and on the east by South Sudan, on the west by Bench Sheko, on the west by the Gambela Region, on the north by the Sheka, on the northeast by Kafa, and the east by Debub Omo | Bench-Sheko, on the northeast by Kaffa, on the northwest by the Oromia Region, and on the east by South Sudan, on the west by Bench Sheko, on the west by the Gambela Region, on the north by the Sheka, on the northeast by Kafa, and the east by Koteza | Bench-Sheko, on the northeast by Kaffa, on the northwest by the Oromia Region, and on the east by South Sudan, on the west by Bench Sheko, on the west by the Gambela Region, on the north by the Sheka, on the northeast by Kafa, and the east by Koteza |

### Table 2. Summary of variables and expected signs.

| Variable | Description | Type | Expected signs |
|----------|-------------|------|----------------|
| LnYield | Production level by the kilogram | Continuous | +/- |
| lnAge | Age of the respondents | Continuous | + |
| Education level | The education level of the respondents | Continuous | + |
| Marital status | Marital status of the respondents | Dummy | - |
| Family size | Family size of the respondents | Continuous | +/- |
| lnLabourage | Member of the family that exists in Working Age | Continuous | +/- |
| lnLivable price | The variable cost of honey production equipment's | Continuous | +/- |
| Hive number | Number of honey possessed by respondents | Continuous | +/- |
| Cooperative membership | Membership status of the respondents in cooperatives | Dummy | + |
| lnIncome | Income level of the respondents | Continuous | + |
| lnDistance | Distance from the nearest market center of the respondents | Continuous | - |
| lnExperience | Experience of the respondents in honey production | Continuous | + |
| Training | Access to the training of the respondents | Dummy | + |
| lnPrice | The selling price of honey | Continuous | +/- |

1 Kebele is smallest administrative unit of Ethiopia.

2 Districts in Ethiopia locally known as woreda which indicates the third level of administrative division of Ethiopia.
respondents in honey production, \( x_{13} = \) Access to the training of the respondents, \( x_{14} = \) The selling price of honey.

3. Results

3.1. Socio-demographic characteristics of respondents

In the study woredas, 95.7% of respondents were males and the rest of the respondents were females. It indicates that honey production is dominated by males and women’s participation was low. Regarding marital status, 94.65% of respondents were married while 5.35% of respondents were single (Table 3). The major occupation of the interviewed respondents was agricultural farmer which accounts for 95.7% of respondents. This result implies that since the majority of respondents depend on agriculture for their income, it creates a suitable condition for beekeeping as it can go side by side with other agricultural activities.

The mean age of the respondents was 42.5, education level (4 years of schooling), family size (7.15), working-age (3.14), and experience (18.8 years) (Table 4). The higher mean educational level (6.2) was obtained in Sheka zone whereas, the average education level in the West-Omo zone were (0.56).

From the total respondents, 27.7% reported that they had access to extension service and the rest 72.3% no access to extension service particularly in the honey sector, and 20.75% respondents reported that they had access to credit while 79.25% respondents had no access to credit service in the study area (Table 5).

Regarding cooperative membership, 69.85% of respondents said that they were a member of a cooperative whereas 30.15% were not a member of any cooperatives (Table 5).

3.2. Types of hives owned

The three hive types which are used by honey producers in the study area are traditional, transitional/intermediate, and modern/movable frame hives. Traditional hives are hives that are constructed from locally available materials by implementing indigenous knowledge and the experience of honey production. Transitional/intermediate hive types are also made from a wooden box and locally available material. Modern hives are hives that indicate the use of frame-hives and accessories. It contains bottom boards, boxes encompassing frames for brood and honey, and an inner cover and top cap providing shelter from the weather.

Many respondents own both traditional and transitional beehives. In the study area, 65 and 7.5% of respondents owned traditional and transitional beehives respectively whereas the rest of the respondents owned both traditional and transitional beehives (Table 6). From the respondents, 58.3% of respondents revealed that honey bees stay for a long time in modern beehives than traditional ones (Table 6). This might be due to the presence of a queen excluder and easiness for internal inspection of modern hives compared to traditional ones. The only mechanism in the traditional hive to harvest honey is by the destruction of combs and this, in turn, affects the stability of bees in the hives. Similarly, the occurrence of disease was highest in traditional hives. It implied that the use of modern and transitional hives is far better than traditional hives.

3.3. Price of hives

The cost of hives determines which types of hives could be used by the farmers in the study area. The average cost of a modern hive was 1581.20 ETB which is higher than the average cost of the transitional beehive (1140.00 ETB) (Table 7). The average cost of a traditional hive was 93.77 ETB and is obtained from the local market. According to the focus group discussion, traditional hives were prepared from locally available materials in a social group called ‘Debo’ by some farmers.

3.4. Productivity of honey

The productivity of traditional, transitional, and modern beehives was 9, 16, and 22 kg per hive (Table 8). The average selling price of a kilogram of honey was 92.2 Birr.

3.5. Challenges of honey production

Factors that affect the production and productivity of honey were discussed as follows:-

Lack of modern technology: - Of the total respondents, 92.5% of respondents reported that lack of modern technology affects honey productivity. The traditional method of honey production is dominant due to the lack of modern technology. It needs to be replaced by improved and modern scientific methods for better management.

Lack of Apiculture specialists: - In the whole study area, there was no specialized apiculture expert, therefore, the sector face the technical challenge to improve production and productivity. About 74.9% of respondents reported that poor extension service affects beekeeping practice in the study area (Table 9).

Absconding: - Absconding is a term used when all bees leave the hive. It can occur due to shortage of feed, disturbance, bud management, unfavorable weather condition, colony collapse disorder (CCD), and related factors. Absconding results in total loss of colony and by hive productivity reduced. From interviewed respondents, 69.5% of respondents faced absconding challenges (Table 9).

Absence of Input Suppliers: - Of the total respondents, 45.2% responded that lack input supply challenges beekeeping activities (Table 9). Lack of beekeeping equipment like bee suits can directly affect the management and inspection of the hives. In the study area, this equipment was not available for honey producers even to buy from the market. DAs (Development Agents) deeply regrettably mentioned that

**Table 3. Socio-demographic characteristics (Dummy variable).**

| S/N | Characters | Zones (Frequency/Percent) | Average (%) |
|-----|------------|---------------------------|-------------|
|     |            | Bench-Sheko | Kaffa | West-Omo | Shaka |
| 1   | Sex        | male         | 119  (96.7) | 116  (94.3) | 121  (99.2) | 114  (92.6) | 95.7 |
|     |            | female       | 4 (3.3)   | 7 (5.7)   | 1 (0.8)   | 9 (7.4)   | 4.3  |
| 2   | Marital status | single | 5 (4.1)   | 9 (7.4)   | 2 (1.7)   | 10  (8.2)  | 5.35 |
|     |            | married      | 118  (95.9) | 114  (92.6) | 120  (98.3) | 113  (91.8) | 94.65 |

Source: Authors computation, 2020.

3 ETB refers to Ethiopian Birr.
there was a lack of overall wear even for themselves, lack of queen excluder and the limited number of NGOs (Non-Governmental Organizations) that support cooperatives farmers was a critical challenge for beekeeping. NGOs simply distribute hives to farmers without support with technical training; therefore the use of modern hives is not as effective both at cooperatives and individual levels as the expected potential.

Lack of credit access: - Of the respondent, 28.3% responded indicated that lack of credit service was one of a challenge for beekeeping practice (Table 9). Discussion with government bodies and experts supporting in this area from kebele to Zonal level of whole study area raised that lack of credit service and lack of equipment and material supporting organization contributed for less production of honey as compared to the potential of the study area.

Poor pre and Post-harvest management: - Poor pre and post-harvesting management of products affect the quality and amount of honey produced from the hive. The volume of production is very small and needs routine collection from fragmented small-scale production. In the current study, 57.4% of respondents faced challenges in pre and post-harvest management (Table 9).

Deforestation: - Southwestern Ethiopia is naturally endowed with different bee forage species that make beekeeping pleasant activity in the study area. Of the total respondents, 53.5% and 25.6% mentioned

Table 5. Access to services (Dummy variables).

| S/N | Characters | Zones (Frequency/Percent) | Average (%) |
|-----|------------|---------------------------|-------------|
|     |            | Bench-Sheko | Kaffa | West-Omo | Shaka |           |
| 3   | Income source: | Agriculture | 115 (93.5) | 117 (95.1) | 120 (98.3) | 118 (95.9) | 95.7 |
|     |            | Trade | 5 (4.1) | 2 (1.6) | 2 (1.7) | 3 (2.4) | 2.45 |
|     |            | Gov’t worker | 3 (2.4) | 4 (3.3) | 0 (0) | 3 (2.5) | 2.03 |
| 4   | Extension service access | Yes | 40 (32.6) | 38 (30.8) | 24 (19.7) | 34 (27.7) | 27.7 |
|     |            | No | 83 (67.4) | 85 (69.1) | 98 (80.3) | 89 (72.3) | 72.3 |
| 5   | Credit access | Yes | 25 (20.4) | 34 (27.7) | 13 (9.7) | 31 (25.2) | 20.75 |
|     |            | No | 98 (79.6) | 89 (72.3) | 109 (89.3) | 92 (74.8) | 79.25 |
| 6   | Cooperative membership | Yes | 22 (17.9) | 58 (47.1) | 2 (1.7) | 47 (38.2) | 69.85 |
|     |            | No | 101 (82.1) | 65 (52.9) | 120 (98.3) | 76 (67.8) | 30.15 |

Source: Authors survey, 2020

Table 6. Types of hive owned, honeybee stay period, and disease occurrence in hives.

| S/N | Characters | Zones (Frequency/Percent) | Average % |
|-----|------------|---------------------------|-----------|
|     |            | Bench-Sheko | Kaffa | West-Omo | Shaka |           |
| 1   | Hive types owned by farmers | Traditional | 80 (65.0) | 67 (54.4) | 98 (80.3) | 76 (61.8) | 65 |
|     |            | Transitional | 5 (4.1) | 18 (14.6) | 3 (2.4) | 11 (8.9) | 7.5 |
|     |            | Modern | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0.0 (0.0) | 0 |
|     |            | Traditional & modern | 12 (9.7) | 14 (11.3) | 10 (8.2) | 14 (11.4) | 10.1 |
|     |            | Traditional & transitional | 18 (14.6) | 15 (12.6) | 8 (6.5) | 9 (7.3) | 10.2 |
|     |            | All hive types | 8 (6.5) | 8 (6.5) | 3 (2.5) | 16 (13.0) | 7.2 |
| 2   | Long stay | Traditional | 26 (21.2) | 33 (26.8) | 30 (24.6) | 42 (34.1) | 26.6 |
|     |            | Transitional | 19 (15.4) | 21 (17.1) | 21 (17.2) | 13 (10.6) | 15.1 |
|     |            | Modern | 78 (63.4) | 69 (56.1) | 71 (58.1) | 68 (55.3) | 58.3 |
| 3   | Disease occurrence | Traditional | 61 (49.6) | 43 (34.9) | 67 (54.5) | 68 (55.3) | 48.6 |
|     |            | Transitional | 14 (11.4) | 41 (33.3) | 18 (14.8) | 17 (13.8) | 18.4 |
|     |            | Modern | 48 (39.0) | 39 (31.7) | 37 (30.3) | 38 (30.9) | 33 |

Source: authors survey, 2020

Table 7. Price of hives in the study area.

| No | Types of hive | No of Hives | Minimum (ETB) | Maximum (ETB) | Mean (ETB) | Std. Dev. |
|----|---------------|-------------|---------------|---------------|------------|-----------|
| 1  | Modern hive   | 125         | 1200.00       | 3400.00       | 1581.200   | 219.11332 |
| 2  | Transitional hive | 110       | 250.00        | 1500.00       | 1140.00    | 209.49918 |
| 3  | Traditional hive | 380       | 30.00         | 450.00        | 93.77      | 105.10110 |

Source: Own survey data, 2020
3.6. Honey marketing challenges

Marketing here is defined as the movement of beeive products from the production area to consumers. Its major concern is the pricing and supply of honey bee products. **Poor market linkage** - According to information obtained from FGD, there was no market linkage of producers with traders; therefore, farmers sell their products to local traders and consumers at low prices. From the total interviewed farmers, 84.1% of respondents indicated that poor linkage of the market is the major factor that affects the benefit of honey production.

**Lack of market information and access** - Averagely, 66.2% of respondents in the study area confirmed that the lack of market information is a problem while 84.2% of respondents confirmed that the lack of market access is one of the major challenges for selling the product (Table 9). This result is in agreement with the finding of Tadesse (2001) and Gebrehiwot (2015).

**Poor Infrastructure** - Infrastructure (road) problems were another factor, farmers carry their product and walk a long distance to market access (Table 10). From the total respondents, 61.5% of respondents revealed that poor infrastructure is a problem in honey marketing.

**Presence of illegal traders** - Presence of illegal trade directly and directly affects legal traders’ competence in the market. According to the discussion held with traders, illegal traders buy honey at a high price and adulterate with other substances then sell at a lower price. This affects the quality as well as the price of the honey market; therefore, consumers and other traders raise serious problems of adulteration of the produce. As traders’ information, farmers store honey for a better price but due to extraction and storage problems, honey quality deteriorates, it also

deforestation and the shortage of bee forage influencing beekeeping (Table 9). According to FGD (Focus Group Discussions) discussion with farmers and stakeholders, there was no attempt done for plantation of bee forage by the government or any other body.

**Pesticide and herbicide threats** - From the total respondents, 47.6% of respondents replied the effect of pesticide and herbicide on honey was crucial (Table 9). This might be due to a lack of knowledge in content, dose, and application time of chemicals in the study area.

**Death of Honey bee** - Death of honey bees occur in the study area, from respondents 38.1% revealed the death of honey bee colony reduces hive productivity (Table 9). The death of the colony might be due to lack of inspection for disease, might be an inappropriate application of chemical in the surrounding farm, might be pest and predator or some poisonous plants and majorly due to ants in all study area.

### Table 10. Marketing challenges at farmers, cooperatives, traders, and union level.

| S/N | Marketing Constraints | Zones (Frequency/Percent) | Average Freq (%) |
|-----|-----------------------|---------------------------|------------------|
|     |                       | Bench-Sheko | Kaffa | West-Omo | Sheka |          |
| 1   | Poor market linkage   | 75 (79.7)   | 109 (82.1) | 31 (81.1) | 105 (93.5) | 81 (84.1) |
| 2   | Lack of market access | 80 (85.4)   | 102 (77.2) | 35 (91.8) | 96 (82.1) | 78 (84.2) |
| 3   | Lack of market information | 66 (69.9) | 88 (66.6) | 25 (64.7) | 74 (63.4) | 63 (66.2) |
| 4   | Poor infrastructure   | 60 (63.4)   | 72 (54.4) | 28 (72.1) | 66 (56.1) | 57 (61.5) |
| 5   | Low price of product  | 57 (60.9)   | 115 (62.6) | 25 (64.7) | 64 (54.4) | 77 (60.7) |
| 6   | Long distance to market | 32 (91.1) | 115 (86.9) | 34 (88.5) | 102 (86.9) | 70 (88.4) |
| 7   | Weak bargaining power of farmers | 32 (34.1) | 51 (39.0) | 14 (35.2) | 49 (41.5) | 36 (37.5) |
| 8   | Lack of packing and storage facility | 43 (46.3) | 96 (72.4) | 19 (47.5) | 75 (64.2) | 58 (57.6) |
| 9   | Lack of cooperatives and institutional linkage | 52 (55.3) | 85 (64.2) | 22 (56.5) | 82 (69.9) | 60 (61.5) |

Source: Own survey data, 2020
affects the market price of honey but adulteration with external substances is not a factor of farmers rather it is of illegal traders. Regarding illegal traders, 53.5% of respondents responded that illegal trade affects critically the honey market and 60.3% of respondents responded the adulteration is among the other problems which affect the honey market (Table 10).

**Absence of branding and legal policy:** - The discussion with unions and cooperatives showed that there was an absence of branding and legal policy for illegal trade. For example, in Sheka zone there was honey production by Haile Gebresilas and exported by the name of Haile honey. Therefore, the source of honey can’t be recognized in the world market. There was no rule and regulation of the marketing of Haile honey. Therefore, the source of honey can’t be recognized in the market. Hence, the region producing honey does not benefit from honey marketing. There was no licensing system for honey traders in the domestic market, therefore, any person can simply open the shop and start honey trading, and no criteria are set to be a honey trader (Table 10). The other challenge raised by the Bonga forest honey union was that since the export price of honey is lower than the local market price, unions are forced to sell their product to local and illegal traders and, facing a great challenge to get sufficient and reasonable profit which helps them to compete in the international market.

**3.7. Econometric result of factors influencing honey production in the study area**

**Variable cost:** - this variable is continuous and measured by the amount of money spent on variable inputs. The result implied that there is a positive relationship between variable cost and quantity of honey produced. This is because that the cost incurred for honey production was small. The increase in one birr for honey production will increase the quantity of honey produced by 9% (Table 11).

**Education level:** - It is a continuous variable and positively related to honey output as hypothesized. The result indicated that the increase by 1% of age of the respondent will increase honey production by 33%. This indicates that most honey producers are older peoples which possess skills and better management practices.

**Age of the respondent:** - It is a continuous variable and positively related to honey output as hypothesized. The result indicated that the increase by 1% of age of the respondent will increase honey production by 9% (Table 11).

**Marital status:** - it is a dummy variable and has a negative relationship with honey production. It indicates that single honey producers are more technically efficient than honey producers who are married. The coefficient indicates that if the number of married households increases by 1 unit, honey production will be reduced by 34 kg.

**Experience:** - the coefficient of experience indicates that a 1% increase will decrease honey output by 9%. The reason for this is that when producers are experienced agricultural production increase, they turn and focused on the production of cash crops.

**Hive number owned:** - it is a continuous variable and was measured by the total number of hives owned. As it was hypothesized, the variable has a positive relationship with the quantity of honey harvested and is significant at a 1% significance level. The increase in one number of hives will increase the quantity harvested by 4 kg (Table 11).

### 3.8. Summary of constraints along with honey value chain actors

The constraints that affected honey production were summarized in Table 12.

### 4. Discussion

The socio-demographic conditions of beekeepers were seen to play an important role in the adoption of technologies in beekeeping activity (Abuje et al. 2017; Kiros and Tsegay, 2017). Honey production is mainly dominated by males. The result agreed with that of Alemu (2010), Kebede and Adgaba (2011), and Abebe (2011), who reported a low level of women’s participation in honey production. The research by Hartmann (2004) confirmed that honey production is mainly men’s job in Ethiopia. This is due to the characteristics of beekeeping activities that involve climbing the tallest trees to hang beehives and later transferring them into the backyard. Honey Production is dominated by males and women were not inspired to participate in these activities (Dinka and Kumsa, 2016).

More educated farmers are believed to adopt typically new technologies more than uneducated farmers (Ekwe and Nwachukwu, 2006). Honey producer's education level may have affected their probability of shifting from traditional to the modern honey production system (Dinka and Kumsa, 2016). The descriptive result indicated that the producers were existed in active and productive age group. This result is in line with the finding of Kinati and Tolemariam (2012), Dinka and Kumsa (2016), and Kiros and Tsegay (2017) however it disagrees with Duguma and Janssens (2016) finding who reported that 51.26 ± 10.99 years of mean age recorded in Jimma town.

### Table 11. Factors influencing natural Honey production level.

| Factor                        | Coef.  | Std. Err. | T     | P > t | R2     | Root MSE | Prob > F |
|-------------------------------|--------|-----------|-------|-------|--------|----------|----------|
| Yield                        | 0.33   | 0.16      | 2.08  | 0.038 | 0.638  | 0.60051  | 0.0000   |
| Education level              | 0.04   | 0.01      | 4.3   | 0.000 |        |          |          |
| Marital status               | -0.34  | 0.06      | -5.26 | 0.000 |        |          |          |
| Family size                  | -0.02  | 0.02      | -1.29 | 0.199 |        |          |          |
| Workage                      | -0.01  | 0.02      | -0.4  | 0.692 |        |          |          |
| Sex                          | -0.08  | 0.3       | -0.27 | 0.789 |        |          |          |
| variable cost                | 0.09   | 0.02      | 4.94  | 0.000 |        |          |          |
| Hive number owned            | 0.04   | 0.01      | 18.32 | 0.000 |        |          |          |
| Cooperative membership       | 0.04   | 0.07      | 0.6   | 0.55  |        |          |          |
| Income                       | -0.02  | 0.04      | -0.59 | 0.553 |        |          |          |
| Distance                     | -0.04  | 0.05      | -0.85 | 0.397 |        |          |          |
| Experience                   | -0.09  | 0.05      | -1.96 | 0.051 |        |          |          |
| Training                     | -0.08  | 0.06      | -1.26 | 0.21  |        |          |          |
| Lagged price                 | -0.12  | 0.12      | -0.97 | 0.333 |        |          |          |
| cons                         | 2.87   | 0.94      | 3.06  | 0.002 |        |          |          |

Source: Own survey data, 2020
Poor access to extension services made problems for honey producers that adopt modern technologies (Dinka and Kumaa, 2016). Lack of extension service leads producers to follow traditional management practices instead of modern technologies (Gichora, 2003). Extension service avails information regarding improved technology usage that will increases honey production level (Nigussie, 2011; Samuel 2014; Tarkegn et al., 2017a,b). As the farmer becomes more experienced in agricultural production it will have a higher knowledge to identify challenges and coping mechanisms, therefore, they turn and focused on the production of cash crops rather than beekeeping activity. These results agree with the findings of Gebrehiwot (2015).

A majority of the respondents (69.85 percent) seem to be members of cooperatives. This result is in agreement with the finding of Arage (2018), Gebrehiwot (2015) reported that there was poor participation of honey producers in cooperatives. In Ethiopia, 6,958,004 hives existed. From this, 96.02% were traditional hives while the rest 1.35 ad 2.63% were intermediate and modern beehives, respectively (CSA, 2020). Traditional beehives dominate honey production practice. These hive types are dominant hive types used by beekeepers in developing countries especially in Africa (Schmolke 2009) as cited by (Kasangaki et al., 2014). CSA (2020) indicated that 96% of honey production in the country was from traditional hives, whereas the rest 1.4% and 2.6% were from intermediate and modern hives, respectively. The major advantage of traditional beehives is the local availability of materials for construction of the hives, which needs less capital and fewer skills for making the hives, while its disadvantage is removal and replacement of combs and examination and manipulation of hives are also impossible. And also bee brood will be destroyed and honey quality is low because of the mixing of pollen, brood, and other materials of the combs (Kasangaki et al., 2014).

Tulu et al. (2020) revealed that high yield, simplicity of examination, ease of harvesting of honey products, and high-quality honey are the main advantages of improved beekeeping technology while high cost, the need for high skill, the need for accessories, and unavailability as disadvantages of modern beehives. Similar results were reported by Yehuala et al. (2013) and Affognon et al. (2015).

The cost of a beehive is higher than the finding of Sahle et al. (2018), who found the cost of a modern hive between 900-1000 ETB in the Tigray Region. These types of hives are further costly than traditional hives. Its advantage is possibility to harvest honey without damaging the bee colony, durable, high yielding, and simple to check and perform any management activities (Kasangaki et al., 2014). Therefore, the transitional hive is relatively affordable for farmers than that of the modern hive. Transitional hive types were designed to allow easy manipulation (Kasangaki et al., 2014). The productivity of traditional, transitional, and modern beehives was 9, 16, and 22 kg per hive, respectively. This study agrees with the finding of Kiros and Tsegay (2017) which showed that 16.2 ± 4.12 kg of honey from transitional hives were harvested. The present result was greater than the result implied by Getu and Birhan (2015) and Kinati and Tolemariam (2012) who found that the mean yield per year/colony was 7.20 ± 0.23, 14.70 ± 0.62, and 23.38 ± 0.73 kg for traditional, transitional, and modern hives respectively. However, the mean output found from transitional hives in this study area is higher than the result indicated by Yemane and Taye (2013) which is 14.07 kg per hive/year.

About 92.5% of respondents mentioned lack of technology is one of the challenges for the sector. This result is in agreement with the finding of Tadesse (2001); Kerealem et al. (2009); Yirga and Tefere (2010) and Sahle et al. (2018a,b). The use of old technology outcomes in truncated honey supply and reduced quality of yield (Beyene and David, 2010). According to Gebrehiwot (2015), the use of modern style beehives is still at a very low level in Ethiopia.

In the whole study area, there was no specialized apiculture expert, therefore, the sector faces the technical challenge to increase production and productivity. According to Johannes (2005), the major honey production problems are the lack of knowledge and shortage of trained manpower. Due to poor extension service, farmers lack knowledge on how to obtain better products (quality and quantity). In all study sites, poor extension service and lack of experts specialized in apiculture were raised as a great challenge for beekeeping activities as explained in the focus group discussion and key informant interview. This result is in line with the finding of Kerealem et al. (2009); Gebrehiwot (2015) and Sahle et al. (2018a,b).

The absence of beekeeping equipment (input supply) is another challenge that hinders the productivity of the beekeeping business. According to the focus group discussions and key informant interview, not only the lack of input supply but also the cost of inputs especially of the modern hive is a great challenge in the study areas. This result is in line with the finding of Sahle et al. (2018a,b). Development Agents (DAs) in the discussion also raised a similar challenge to farmers regarding the lack of beekeeping equipment. This finding is in line with that of Terefe (2018) at Chiro district of East Oromiya Region, who reported that NGOs distribute hives with no demonstration on the management of the hive. Shortage of credit access to buy inputs including modern hive for farmers, cooperatives and unions involved in honey production and marketing affect the production level as well as the quality of honey as indicated by focus group discussion. Kerealem et al. (2009) supported this finding.

The limitations of apiculture know-how especially the method of harvest and lack of proper apiary tools are causing the honey to be with a high moisture content which may be conducive for some pathogens. Similarly, FGD (Focus Group Discussion) report indicated that due to improper handling, honey lacks quality in its stay. Modern honey production that includes the use of modern style beehives is still in Ethiopia at a very low level. Of 4,993,815 beehives available in Ethiopia during
2011, only 139,682 were modern beehives (CSA, 2012). The majority of respondents in the study area own traditional hives and harvesting from traditional hives does not allow total inspection for ripening honey. Therefore, the honey may contain some broods and also there was no extractor for farmers, which affects the quality of honey. According to Beyene and David (2010), the extensive use of traditional beehives results in relatively low honey supply and poor quality of honey harvested when compared to the potential honey yields and quality gains associated with modern beehives. Modern beehive produces more than 20kg of higher quality honey. This situation results in growing domestic prices of table honey and poor perspectives for reaching export markets. The benefit from the sub-sector to the nation as well as to the farmers, processors, and exporters is not satisfactory.

Deforestation of the area for different agricultural activities results in the shortage of bee forage in the study areas. Deforesting the forests as means of survival seriously affects honey production (Gebrehiwot, 2015). In line with agricultural activities, the use of pesticide and herbicide also affects beekeeping activities. This finding is in agreement with the finding of Johannes (2005); Kerealem et al. (2009); Arage (2018) and Sahle et al. (2018).

The death of bee colonies highly influences honey production. In agreement with the present study, Shenkute et al. (2012) reported that flowers of some plants were poisons to honey bees, and flowers of Croton macrostachyus cause the death of honey bees in Kaffa and Sheka zones. Arage (2018) reported that the death of a colony was a key constraint faced by beekeepers at the farm level.

The major factors affecting the income of farmers from honey production were poor market linkage, lack of access to market, lack of market information, poor infrastructure, low price of the product, long-distance to the market, weak bargaining power of farmers, and lack of cooperative and institutional linkage. Tadesse (2001) confirmed the absence of organized market channels as marketing constraints. This finding was in agreement with that of Beyene and Verschuur (2014) and Sahle et al. (2018a,b). This result agrees with that of Yeserah et al. (2019) who found that licensing procedures, access to credit, market transparency, and experience in honey trading affect honey marketing.

The Econometric result revealed that variable cost, education level, age of the respondent, marital status, experience, and hive number owned. Famuyide et al. (2014) revealed that the higher the educational status, the higher the productivity and better management. This result is in line with the finding of Najafi (2003); Gebrehiwot (2015); Dinka and Kumsa (2016); Abuje et al. (2017). Most honey producers are older peoples which possess experience and better management practices. This study is in line with the finding of Karadas and Kadirhanogullari (2017). Single producers are more efficient than married ones. This result is in line with the finding of Olarinde et al. (2008) implied that married honey producers are more technically inefficient than single honey producers. Gebrehiwot (2015) reported that high experience has no value in increasing honey production. The larger the number of hives owned, the higher the quantity of honey harvested (Dinka and Kumsa 2016). A producer with more beehives can harvest more volume of honey (Tarekegn et al., 2018). The finding is in line with the finding of Nigussie (2011); Kerealem et al. (2009); Abuje et al. (2017) and Kizilaslan and Kizilaslan (2007).

5. Conclusion

This study was designed with the general objective of identification of challenges that affect the production, productivity, and marketing of honey in the Kaffa, Sheka, Bench Sheko, and West Omo zones of SNNPR. A total of 23 woredas and 63 kebeles were involved in the study. Based on the survey, major constraints that affect honey production include lack of modern technology, absconding, disease, and pests as well as predators, lack of credit access, poor extension service, and the like affect honey production in the study area. Lack of technology, high cost of technologies, and lack of practical-based training for farmers as well as DAs made the farmers stick with traditional hives using their indigenous knowledge. Even though there is potential in the study area, due to these challenges the benefits farmers get out of beekeeping are not much as have to be.

Similar to the production challenges, there was poor market linkage and market access, low bargaining power of farmers, long-distance to market, shortage of packing and storage materials, and the like affect marketing in the study area. The presence of illegal traders, lack of brand, the problem of licensing, and lack of trade policy on honey marketing challenges the legal traders and exports and unions in the study area. In general, the beekeeping practices in the study area were facing complex challenges in both production and marketing. Therefore, remedial actions should be taken both by the government and NGOs working around honey production and productivity. To improve and expand beekeeping activities, it is necessary to solve the above-mentioned problems through the involvement of all stakeholders including the farming community, government, non-government organizations, and the private sector. In this regard, it is recommended that increasing accessibility to modern beehives, enhancing the skill and knowledge of the producers through training on the management of beekeeping activities, organizing honey marketing cooperatives, promoting the involvement of the private sector in the provision of apicultural tools, establishing linkages among apiculture farmers, research institutions and the private sector.

Declarations

Author contribution statement

Benyam Tadesse; Yaregul Tilahun; Wondimu Woyamo; Mekuuntzint Bayu; Zelalem Adimasu:-Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Funding statement

This work was supported by Southern Nations, Nationalities, and People's regional government special support office and Miza-Tepi University.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgment

The researchers acknowledge Southern Nations, Nationalities, and People's regional government special support office and Miza-Tepi University for their technical contribution.

References

Abbebe, W., 2011. Adoption of modern beekeeping and its impact on honey production in Kenya; case of baringo county. Afr. J. Agric. Environ. 3, 1–14.
Admasu, A., Kibebeew, W., Amsalu, B., Eneremru, K., 2014. Honeybee Forages of Ethiopia. United Printers, Addis Ababa.
Affognon, H.D., Kingori, W.S., Omondi, A.I., Diro, M.G., Muriithi, B.W., Makanu, S., Raina, S.K., 2015. Adoption of modern beekeeping and its impact on honey production in selected districts of Ethiopia. J. Agric. Ext. Rural Dev. 3 (5), 82–87.
Abuje, V., Nyangweno, P., Mwakobo, S., Cheping’eno, W., 2017. Determinants of honey production in Kenya; case of baringo county. Afr. J. Agric. Environ. 3, 1–14.
Affognon, H.D., Kingori, W.S., Omondi, A.I., Diro, M.G., Muriithi, B.W., Makanu, S., Raina, S.K., 2015. Adoption of modern beekeeping and its impact on honey production in selected districts of Ethiopia. J. Agric. Ext. Rural Dev. 3 (5), 82–87.
Affognon, H.D., Kingori, W.S., Omondi, A.I., Diro, M.G., Muriithi, B.W., Makanu, S., Raina, S.K., 2015. Adoption of modern beekeeping and its impact on honey production in selected districts of Ethiopia. J. Agric. Ext. Rural Dev. 3 (5), 82–87.
production in the former Mtiriri District of Kenya: assessment using theory-based impact evaluation approach. Int. J. Trop. Insect Sci. 35 (2), 96–102.
Albores, A., Arehino, D., Abraham, G., 2019. Adoption and intensity of adoption of beekeeping technology by farmers: the case of Sheko woreda of bench-Maji zone, South west Ethiopia. Ukrainian J. Ecol. 9 (3).
Alemu, T., 2010. Assessment of Honeybee Production Practices and Honey Quality in SekotoWoreda of Waghima Zone, Ethiopia. Doctoral dissertation, Haramaya University.
Asfaha, G., 2017. Livestock and Fisheries Research Strategies: Poultry, Fisheries, Apiculture and Sericulture (2016-2030).
Bekena, N., Grefling, J., 2017. Quality focused apiculture sector value chain development in Ethiopia. J. Agric. Sci. Technol. A. 7, 107–116.
Belete, M., 2015. Value Chain Analysis of Organic Honey: in Sheka Zone of Southern Ethiopia; Case of Masha Woreda. Doctoral dissertation.
Beyene, T., Verschuur, M., 2014. Assessment of constraints and opportunities of honey production in Wonchi district south west Shewa zone of Oromia. Am. J. Res. Commun. 2 (10), 342–353.
Beyene, T., David, P., 2007. Ensuring small-scale producers in Ethiopia to achieve sustainable and fair access to honey markets. In: Paper Prepared for International Development Enterprises (IDE) and Ethiopian Society for Appropriate Technology (ESAT), Addis Ababa, Ethiopia. BoAĐ (Bureau of Agriculture and Rural Development) 2010 Annual Report of Tigray Region Ethiopia.
CSA (Central Statistical Agency of Ethiopia), 2012. Agricultural Sample Survey, CSA (Central Statistical Agency of Ethiopia), 2020. Federal Democratic Republic of Ethiopia Central Statistical Agency: Agricultural Sample Survey, Livestock and Livestock Characteristics (Private Peasant Holdings).
Dinka, J., Kumsa, T., 2016. Factors affecting honey production in Ambo district, west Shewa zone, Oromia regional state, Ethiopia. Int. J. Econ. Busin. Manag. 2, 170–182.
Duguma, B., Janssen, G.P.J., 2016. Assessment of feed resources, feeding practices, and coping strategies to feed scarcity by smallholder urban dairy producers in Jimma town, Ethiopia. SpringerPlus 5 (1), 1–10.
Ekwe, K.C., Nwachukwu, I., 2006. Inflence of household factors on the utilization of improved Gari processing technology in Southeastern Nigeria. J. Agric. Ext. 9.
Erkalo, K.T., 2017. Structure and conduct of honey market in Chena district Kaffa zone, southern Ethiopia. World J. Agric. Sci. 13 (1), 45–52.
Famuyide, O.O., Adebayo, O., Owese, T., Azeez, F.A., Arabomen, O., Olugbire, O.O., Ojo, D., 2014. Economic contributions of honey production as a means of livelihood strategy in Oyo State. Int. J. Sci. Technol. 3 (1), 7–11.
FAO-STAT, 2021. Global Production Data on Honey and Beeswax. FAO. http://www.fao.org/faostat/en/#data/QH. (Accessed 9 March 2021).
Gebrhiwot, N.T., 2015. Honey production and marketing: the pathway for poverty alleviation the case of Tigray Regional State, Northern Ethiopia. Zenith Int. J. Bus. Econ. Manag. Res. 5 (6), 342–365.
Getu, A., Birhan, M., 2015. Chemical Analysis of Honey and Major Honey Production Challenges in and Around Gondar, Ethiopia.
Gichora, M., 2003. Towards Realization of Kenya’s Full Beekeeping Potential: A Case Study of Baringo District. Caviller Verlag.
Hartmann, I., 2004. The management of resources and marginalization in beekeeping Societies of South West Ethiopia. In: Paper Submitted to the Conference: Bridge Scales and Epistemologies, Alexandria, 1.
Ito, Y., 2014. Local honey production activities and their significance for local people: a case of the mountain forest area of Southwestern Ethiopia. Afr. study Monogr. Suppl. issue 48, 77–97.
Johannes, A., 2005. Strategic intervention plan on honey and beeswax value chains. In: Agric & Horticultural Economists—Local Consultant, SNV Support to Business Organizations and Their Access to Markets (Boam).
Kanadas, K., Kadihanagullari, L.H., 2017. Predicting honey production using data mining and artificial neural network algorithms in apiculture. Pakistan J. Zool. 49 (5).
Kasangaki, P., Chemurot, M., Sharma, D., Gupta, R.K., 2014. Beehives in the world. In: Beekeeping for Poverty Alleviation and Livelihood Security. Springer, Dordrecht, pp. 125–170.
Kebede, A., Adgaba, N., 2011. Honey Bee Production Practices and Honey Quality in Silit Wereda Ethiopia. Doctoral dissertation, Haramaya University.
Kerealem, E., Tilahun, G., Preston, T.R., 2009. Constraints and prospects for apiculture research and development in Amhara region, Ethiopia. Livot. Res. Rev. Dev. 21 (10).
Kisitu, C., Tolemarium, T., 2012. Opportunities and Challenges of Honey Production in Gomma District of Jimma Zone, South-West Ethiopia.
Kiros, W., Tesgay, T., 2017. Honey-bee production practices and hive technology preferences in Jimma and Bihabur zone of Oromiya regional state, Ethiopia. Acta Univ. Sapientiae Agric. Environ. 9 (1), 31–43.
Kizilaslan, H., Kizilaslan, N., 2007. Factors affecting honey production in apiculture in Turkey. J. Agr. Sci. Res. 3 (10), 983–987.
MoA, ILRI, 2013. Apiculture Value Chain Vision and Strategy for Ethiopia. Addis Ababa, Ethiopia. Ministry of Agriculture and International Livestock Research Institute.
Morgan, K., 1970. Sample Size Determination Using Krejcie and Morgan Table. Kenya Univ. Sapientiae Agric. Environ. 9 (1), 65–69.
Nahapiet, J., K, K., 2002. An overview of current land utilization systems and their contribution to agricultural productivity. In: Report of the APO Seminar on the Impact of Land Utilization Systems on Agricultural Productivity. Productivity Organization, Islamic Republic of Iran Asian.
Nigumie, G., 2011. February. Honey market chain analysis the case of Burie woreda, West Gojam Zone, Amhara national regional state. In: Conference of Jimma University, p. 247.
Olariinde, L.O., Ajo, A.O., Okonkwa, S.O., 2008. Determinants of technical efficiency in bee-keeping farms in Oyo State, Nigeria: a Stochastic production frontier approach. Res. J. Agric. Biol. Sci. 4 (1), 65–69.
Sahle, H., Ensiyaye, G., Negash, A., Neges, T., 2018a. Assessment of honey production system, constraints, and opportunities in Ethiopia. Pharm. Pharmacol. Int. J. 6 (2), 67–2379.
Sahle, H., Ensiyaye, G., Negash, A., Neges, T., 2018b. Assessment of honey production system, constraints, and opportunities in Ethiopia. Pharm. Pharmacol. Int. J. 6 (1), 42–47.
Samuel, S., 2014. Market Chain Analysis of Honey Production in Sods Zurie District, Southern Ethiopia (Doctoral Dissertation, MSc Thesis. Haramaya University, Haramaya, Ethiopia).
Shenkute, A.G., Getachew, Y., Asfaha, D., Adgaba, N., Ganga, G., Abebe, W., 2012. Honey production systems (Apis mellifera L.) in Kaffa, Sheka, and bench-Maji zones of Ethiopia. J. Agric. Ext. Rural Dev. 4 (19), 528–541.
Tadesse, G., 2001. Marketing of honey and beeswax in Ethiopia: past, present, and future perspectives. In: Proceedings of the 3rd National Annual Conference of Ethiopian Beekeepers Association, Addis Ababa, Ethiopia, pp. 78–88.
Tarekegn, K., Ayele, A., 2020. Impact of improved beebees technology adoption on honey production efficiency: empirical evidence from Southern Ethiopia. Agric. Food Secur. 9 (1), 1–13.
Tarekegn, K., Girma, G., Assefa, A., 2017a. Value chain analysis of honey in Kaffa and Sheka zones of SNNP, Ethiopia. Int. J. Res. Agric. Sci. 4 (3), 142–148.
Tarekegn, K., Haji, J., Tegegne, B., 2017b. Determinants of honey producer market outlet choice in Cheni District, southern Ethiopia: a multivariate probit regression analysis. Agric. food Econ. 5 (1), 1–14.
Tarekegn, K., Haji, J., Tegegne, B., 2018. Factors affecting the market supply of honey in Cheni district, Kaffa zone, Southern Ethiopia. J. Dev. Agric. Econ. 10 (3), 99–109.
Terefe, T., 2018. Practices and challenges of beekeeping in Chiro district of west Hararghe zone, Eastern Oromia, Ethiopia. East Afr. J. Sci. 12 (2), 127–136.
Tulu, D., Aleme, M., Mengistu, G., Bogale, A., Bezabeh, A., Mendesil, E., 2020. Improved beekeeping technology in Southwestern Ethiopia: focus on beekeepers’ perception, adoption rate, and adoption determinants. Cogent Food Agric. 6 (1), 1814070.
Yehuala, S., Birhan, M., Melak, D., 2013. Perception of Farmers towards the Use of Modern Beehives Technology in Amhara Region, Ethiopia.
Yemane, N., Taye, M., 2013. Honeybee production in the three Agro-ecological districts of the Gamo Gofa zone of southern Ethiopia with emphasis on constraints and opportunities. Agric. Biol. J. N. Am. 4 (5), 560–567.
Yeserah, S., Jenberie, A., Begna, D., 2019. Honey marketing, structure, and conduct of honey market in Gozamen district, East Gojjam zone, and Amhara region. Cogent Food Agric. 5 (1), 1620153.
Yirga, G., Teferi, M., 2010. Participatory technology and constraints assessment to improve the livelihood of beekeepers in Tigray Region, northern Ethiopia. Momona Ethiop. J. Sci. 2 (1).