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Major Plant and Flora Species Associated with Honeybee Production in Sub-Zoba Dbarwa, Eritrea

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ABSTRACT

The study was carried out in three administrative Kebabis of Adi Sherefeto, Temajila and Shketi in Sub-Zoba Dbarwa, to identify the major plants foraged associated with honeybees and to set a flowering calendar of honey plants. Structured and semi-structured questionnaires, group discussions, interviews with key informants and visual methods were used to collect information. A total of 53 plants belonging to 30 families with 31 major species, 13 secondary and 9 minor plants foraged by bees were identified. *Becium grandiflorum, Isoglossa solensis, Eucalyptus spp., Shinus molle and Vernonia abyssinica* were the five top bee forages. Most of the important bee flora bloomed from August to October and hence this was the peak period of honeybee foraging activity, strong colony strength and time of honey harvest. Therefore conserving and multiplying drought-resistant honeybee plants are needed to enhance honey production.

Introduction:

Eritrea is one of the tropical honey producing countries, which has about, 22,349 bee colonies of which 14,036 are in traditional hives and 8,313 are in modern hives (MoA, 2016). In Eritrea, beekeeping is believed to have started from honey hunting and then progressed to keeping bees in house yards in traditional hives. However, in the traditional system honey yield per hive and quality is low (MoA, 2016).

The bees are dependent on flowering plants for food in the form of pollen and nectar. Similarly, plants are dependent on the bees for pollination. The mutual interdependence of the anthrophilous insects and entomophilous angiosperms hastened their co-evolution (Suryanarayan, 1986). The flowering plants of several plant families blossom at different time intervals of the year. Pollen and nectar availability to foraging bees fluctuates with time of the year and flowering of different species of plants (Free, 1970). The phase of the blooming period does not commence simultaneously in the entire honey flora that make part of the main honey-flow. Depending on the soil type, climatic factors and the habitat of the vegetation, the time of blooming may change even for the same nectar plant (Rodionov and Shabanshov, 1986).

Beekeeping is a branch of agriculture and is a useful means for strengthening and creating different capital assets for people's livelihood. It is one of the most important agricultural sectors that enables human beings to utilize natural resources that otherwise would be wasted and contributes to the increase in the productivity or food products through pollination (Bradbear, 2009).

Bees live all over the world, from the tropics to the arctic, in rain forests as well as in deserts. There are over 20,000 species of bees, some of which are small, others are large, and each species has adapted to the specific conditions of their environment (Leen van't *et al*., 2005).

The vast majority of bees live a solitary way of life, but some species such as the honeybees and stingless bees live in colonies (Leen van't *et al*., 2005). Honeybees collect large amounts of food, which they store in order to survive when conditions are adverse. Man has harvested these stores of honey and pollen for thousands of years, and just like the honeybees, beekeepers live all over the globe, although the technology used varies with the region (Leen van't *et al*., 2005). Among the honey bees belonging to *Apis mellifera* found in Eritrea are *A. mellifera scutellata* and *A. melliferayementica* (Lorenzo and Yovan, 2013).

Modern beekeeping in Eritrea was first introduced during the Italian colonization by few Italian hobby beekeepers. Gradually the technique was transferred to Eritreans. Even though farmers were not well introduced with modern beekeeping system until after independence.

After independence, the Ministry of Agriculture first introduced modern beehives at demonstration level. In 1993, the Ministry of Agriculture established demonstration sites for beekeeping in Maekel, Debub and Northern Red Sea zones in order to increase farmers' awareness on beekeeping.

From 1991 to 2015, a total of 25,583 modern bee hives and 9,484 beehive accessories were distributed to farmers (MoA, 2016). While most of the hives were imported from Greece, some were locally produced in Dongolo. Beekeeping has now become an important income-generating activity besides other agricultural activities in Debub and Ma'ekel Zones and is spreading to other zones of the country.

Some of the major challenges mentioned which hinder the potential of beekeeping include lack of bee forage, shortage of rainfall, agro-chemical poisoning, pests and predators, absconding, lack of beekeeping equipment and accessories and extension services and training. Wrong beekeeping practices and timing in harvesting of honey and other hive products have led to severe unquantified losses in the beekeeping industry in the country. In order to avoid and come up with success in beekeeping activities, efforts should be geared to alleviate the main constraints that hindered beekeeping development.

In this study, important honeybee forages and their flowering periods were determined, to identify major plant species available in the area for sustainable beekeeping production and to establish a floral calendar of important plants for beekeeping.

Materials and Methods:

Description of the study areas: Sub-Zoba Dbarwa is located in Zoba Debub, about 30 km south of the capital; Asmara, on the road to Mendefera, at an altitude of 2100 meters above sea level. Annual rainfall ranges from 500 to 700 mm and the temperature varies from 0°C on the coldest days in January to days with up to 35°C in July and August (Brigitta, *et al*., 2003).

The study was carried out in three administrative kebabis of sub-zoba Dbarwa, namely, Temajila, Shketi and Adi Sherefeto that are located in the northern part of the Sub-zoba. The administrative kebabis were selected based on their accessibility and potential for beekeeping.

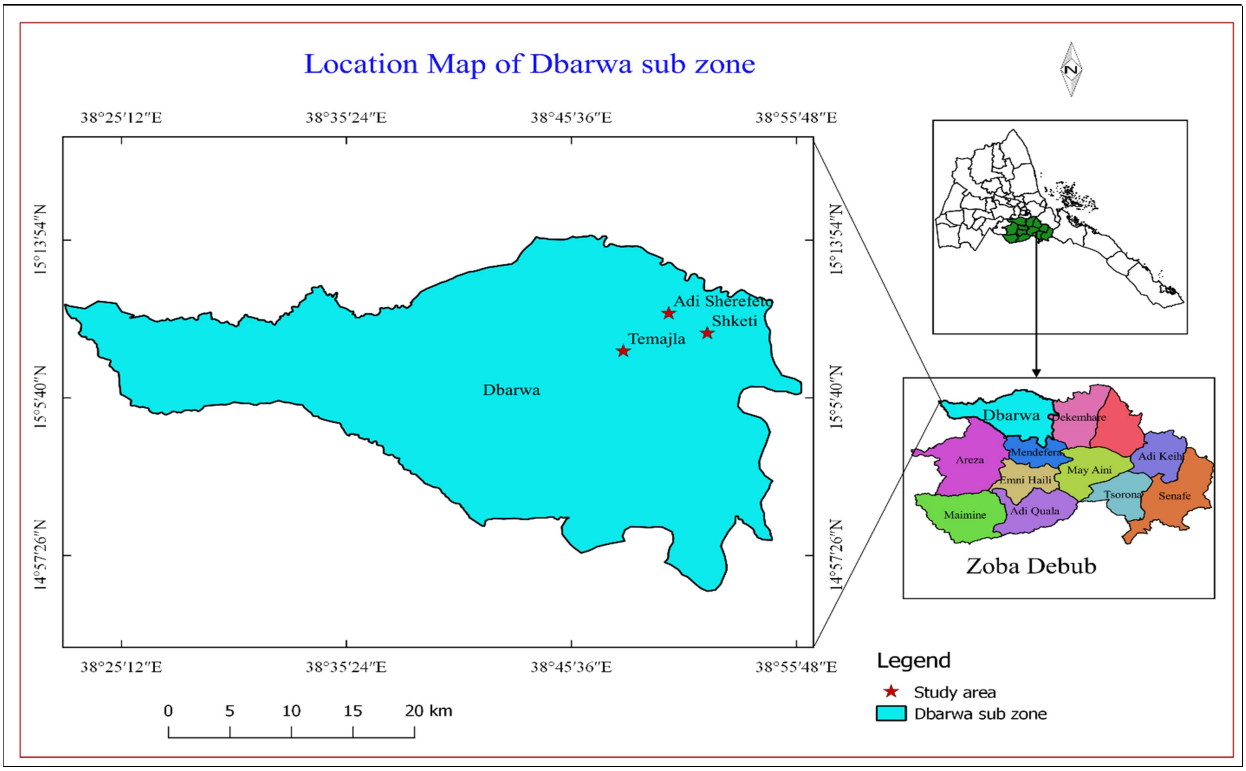

Figure 1: Map of the study area

Structured and semi-structured questionnaires were used for the study. Group discussions, interviews with key informants and visual observations were used as methods for seeking answers to research questions.

A questionnaire was prepared and interviewed to a total of 61 beekeeper farmers (17 from Temajila, 23 from Shketi and 21 from Adi Sherefeto) and the information on the present status of beekeeping in the sub-zoba was obtained from the individual beekeepers, beekeeping association and concerned departments of the government. The structured questionnaires were designed to obtain demographic information that included the following: age, sex, educational level, family size, occupation, and years of beekeeping experience.

Interviews and Participatory Rural Appraisal: The sampled beekeepers were individually interviewed with structured questionnaire at their homes. In the group discussion, the beekeepers, local leaders and representatives of the Ministry of Agriculture in the administrative kebabis were assembled as participants. There were about 13-16 people participated in each of the group discussion sessions. The discussion was carried out in local language (i.e. Tigrigna) therefore; the responses were translated and written in English. The discussions started with interacting with the beekeepers firstly to determine the general problems that limiting beekeeping production, such as trend of their colony number and honey yield, and problems they face in bee colony management, in order to understand the context of beekeeping in their agro-ecological zone. The second step involved gathering local knowledge about important sources of forage for honeybees, the flowering time of the forages and the factors that affect plant flowering. These steps involved Participatory Rural Appraisal tools (Gordon, et al., 1987).

Discussions with key informants: Key informant interviews were also used. The key informants were identified based on their community positions, reputations, and knowledge of the issues under study. Gender considerations were made while conducting the Participatory Rural Appraisal (PRA) exercises by including women's representatives in each PRA. The key informants included beekeepers, experts in beekeeping, local leaders, and elders. Discussions

focused on plants that considered as important sources of forage for honeybees, and when they flower, which plants give the best honey, the right months of the year to expect honey and the signs for harvesting.

Identification of bee-flora: The identification of bee flora in the study area was mainly carried out through interviewing the sampled beekeepers with a questionnaire and direct observation of foraging honeybee workers visiting flowers. These observations were made during field trips either at dawn or at dusk.

The flower species were identified as a bee plant only after visual confirmation and collection of food by honeybees (Sivaram, 1995; Naim and Phadke, 1976). Some of the plants were photographed and documented. The scientific names of the important plants for honeybees were recorded using earlier studies carried out on Eritrean plants (Bein *et al*., 1996; Hiyoba *et al*., 2005). The family name of bee forages was recorded according to floristic survey carried out by Ryding and Nemomissa (1990) of three areas along the escarpment road from Asmara to Massawa.

Ranking of the plant species, if three or two of the administrative kebabis reported as very important (1), it was considered as a major plant species. However if a plant was reported as important (2), and as less important (3), it was considered as a secondary and minor plant species, respectively. Plants of major, secondary and minor sources of nectar and pollen of honeybees were identified based on the view of the majority during the discussion sessions. The remainder, which could not be in the range of the categorical system, were classified with the help of experts and key informants.

Secondary data on important plant species for honeybees was collected from individual beekeepers, key informants, and Ministry of Agriculture offices in order to supplement the information the present status of beekeeping in the sub-zoba.

Observations: Observations during the field visits to confirm and crosscheck information from other sources were carried out. Plant species that flowering was observed and noted.

Before conducting a field survey, a discussion was conducted with the head of sub-zoba Ministry of Agriculture and bee experts to select sites and respondents. Based on the information of the sub-zoba department head and bee experts, beekeepers were selected from the study area to collect the required information. Interviews were conducted with the selected respondents and key informants to generate the relevant data by using structured and semi-structured questionnaires; in addition, surveys; checklists; and visual observation was part of data collection.

Sampling Techniques and Sample Size: In this study, a reconnaissance survey was used to select the administrative kebabis and the beekeepers. Out of the 28 administrative kebabis in the sub-zoba Dbarwa, three administrative kebabis namely Shketi, Temajila and Adi-sherefeto were selected for this study. According to the data obtained from the sub-zoba Ministry of Agriculture, using the population list of beekeepers in the sample administrative kebabis, all (a total of 61) beekeeper households (HH's) having traditional and/or modern beehives were interviewed. The list of beekeeper households that obtained from the sub-zoba for each of the administrative kebabis was used as a guiding frame. Furthermore, purposive sampling method was used for the selection of key informants and focus groups from the selected administrative kebabis (Figure 2).

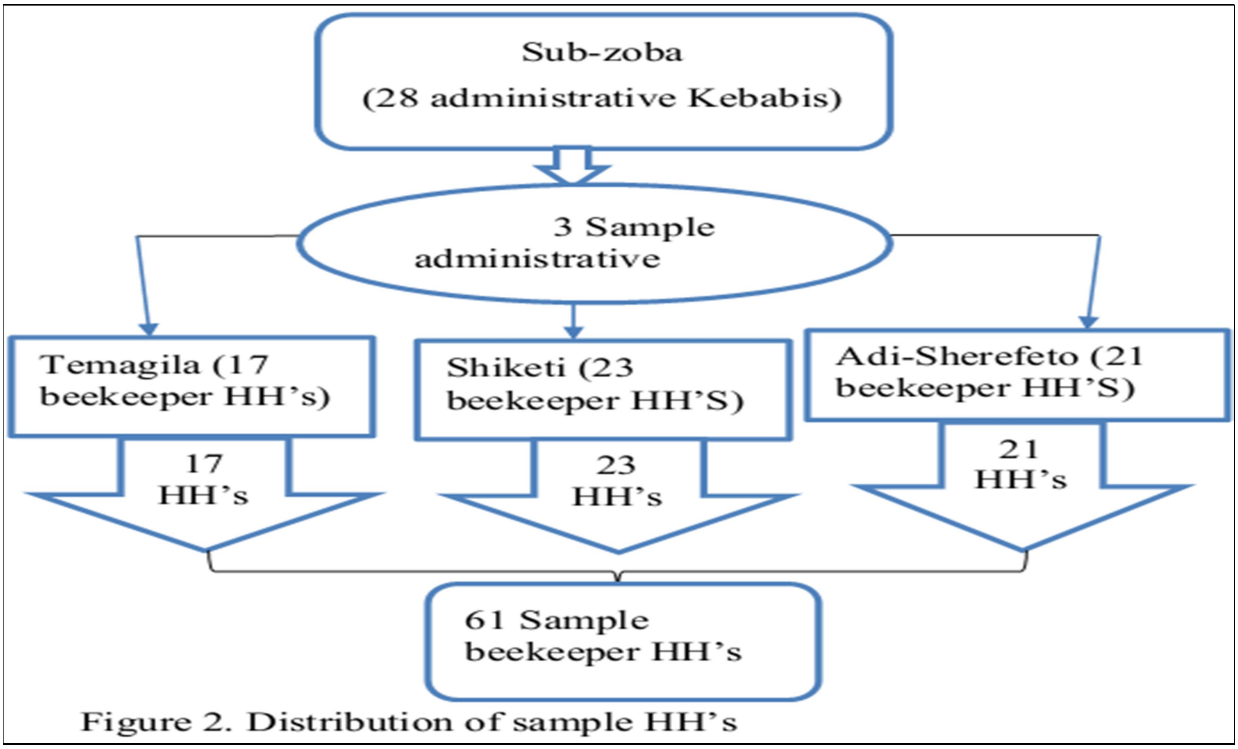

Figure 2. Distribution of sample HH's

Method of data analysis: Primary data such as the major bee forage species and their flowering time were collected through structured questionnaire. The collected data were coded and tabulated for analysis. Appropriate Statistical Packages for Social Sciences (SPSS) software Version 21 and descriptive statistics (such as frequencies, percentages and averages) were used for analysis. On the other hand, data collected through interview were analyzed through narration and interpretation.

Results and Discussion:

The practice of cultivating bee forages: The survey showed that, from the total interviewed households, the majority of the respondents (59 %) planted bee forages (Table 1). The bee forages that were commonly identified and planted by the respondents included Shinus molle, Eucalyptus spp., Opuntia ficus-indicaand Vernonia amygdalina. These plant species, which are cultivated by the beekeepers, are exotic but have been naturalized over time; and nowadays part of the landscape and foraged by honeybees as reported.

Table (1) Planting habit and the types of plant species commonly planted by respondents

Description	Response	n	%
Planting Habit	Yes	36	59.0
of Bee Forages	No	25	41.0
	Total	61	100.0
Plant Species Planted	*Shinus molle*	22	31.4
	Opuntia ficus-indica	21	30.0
	Vernonia amygdalina	17	24.3
	Eucalyptus spp.	10	14.3
	Total	70	100.0

A number of responses were allowed

As reported by Alemtsehay (2011) in addition to the supply of artificial food, beekeepers in the beekeeping area should grow different bee forages in order to cope up with shortage of forage during dry seasons. While planting bee forages would be good if the plants had both nectar and pollen sources. An area could be improved by selecting good melliferous plants for other primary purposes such as reforestation, windbreaks, cover crops, firewood crops or

forage crops for livestock. Similarly, Carroll (2006) reported that, it was necessary to supplement the bee's source of nectar by planting certain plants around the apiary such as eucalyptus, sunflower, passion fruits, acacia, bottlebrush etc.

Trees would also give shade to the bees and provide a screen between them and people and animals nearby. While planting emphasis should be given to conserving the already existing bee forages and then planting new ones in order to supplement the native bee floras.

Bee forage and floral calendar: A list of some commonly-known honey plants that determined for their respective areas in terms of their rank (major, secondary and minor), relative abundance and their flowering months in the study areas are recorded below in Tables (2, 3, 4, 5, and 6).

Some of the plant species in the area are highly important for bees as reported by respondents, such as '*tahbeb*' (*Becium grandiflorum*) that need protection and reproduction by individuals or by other concerned governmental personnel. Beekeepers may find this information useful to exploit the potential resources in their areas instead of migrating to other places that demand expenses.

Floral species: Some of the honeybee forages of the study area are shown in Figure 3. According to the respondents, the identified major nectar and pollen producing plants in the study area were: Acacia etbaica, Agave sisalana, Aloe elegans, Becium grandiflorum, Bidens pachyloma, Cordia africana, Cynodon dactylon, Dodonaea angustifolia, Eucalyptus spp., Euclea schimperi, Euphorbia abyssinica, Euphorbia nubica, Isoglossa solensis, Leucas abyssinica, Mimusops kummel, Ocimum hadinse, Olea europaea subsp. africana, Opuntia ficus-indica, Oxygonum sinvatum, Plantago lanceolatal, Psiadia punctulate, Pterolobium stellatum, Rumex usambarensis, Shinus molle, Sorghum bicolar, Syzygium guineense, Vernonia abyssinica, Vernonia amygdalina, Vicia faba, Zea mays and Ziziphus spina-christi.

Honeybee plants that identified as important honey sources: As the respondents were asked to list up honey bee plants in their order of importance, their relative abundance for honeybees and potential to give good honey yield in the area, 53 flowering plants belonging to 30 families were identified in the three administrative kebabis and are presented below in Tables (2, 3, 4, and 5). Accordingly, the most abundant common bee flora species include Acacia etbaica, Cynodon dactylon, Eucalyptus spp., Euclea schimperi, Isoglossa solensis, Plantago lanceolatal, Rumex usambarensis, Vernonia abyssinica and Sorghum bicolar. Sub-Zoba Dbarwa is one of the areas having high potential for bee forage with different bee flora species being commonly grown. The major honey flow season of the study areas was indicated to be from October to November and the minor flow season from May to June depending upon the availability of bee forage, that in return depends on the amount of rainfall.

According to the respondents, 31 flowering plants were identified as major honeybee plants in the study area and are presented in Table 2 and some of the bee forage plants are shown in Figure 3. The plants identified as natural indigenous plant species include: Becium grandiflorum, Aloe elegans, Cordia africana, Cynodon dactylon, Eucalyptus spp., Euclea schimperi, Isoglossa solensis, Leucas abyssinica, Ocimum hadinse, Olea europaea subsp. africana, Oxygonum sinuatum, Plantago lanceolatal, Pterolobium stellatum, Rumex usambarensis, Shinus molle, Vernonia abyssinica and Ziziphus spina-christi. Agave sisalana, Opuntia ficus-indica, Ocimum basilicum, Casimiroa edulis, Moringa oleifera and Vernonia amygdalina were exotic (not native) plant species. Some plants like Brassica napus, Cucurbita pepo, Guizotia abyssinica, Lathyrus sativa, Ocimum basilicum, Sorghum bicolar, Vicia faba, and Zea mays were cultivated plants and are important bee flora of the study area.

The respondents indicated that even though there were different types of bee plants in honey flow (production) seasons, there was a shortage of bee food during the dry season. They also

indicated that bee forages were declining as compared with the past due to forest degradation and expansion of cultivated lands in the area.

Figure 3 Some of the honeybee forages in Shketi, Temajila and Adi-sherefeto

Table (2) Major honeybee plants as identified by the beekeepers

S. No.	Scientific name	Family name	Vernacular name	Temajila	Shketi	Adi Sherefeto
1	*Agave sisalana*	Agavaceae	Eka	1	1	1
2	*Aloe elegans*	Asphodelaceae	Ere	2	1	1
3	*Becium grandiflorum*	Lamiaceae	Tahbeb	1	1	1
4	*Brassica napus*	Brassicaceae	Adri	1	1	1
5	*Casimiroa edulis*	Rutaceae	Cazmir	1	2	1
6	*Cordia africana*	Boraginaceae	Awhi	1	2	1
7	*Cucurbita pepo*	Cucurbitaceae	Zucchini (Duha)	2	1	1
8	*Cynodon dactylon*	Poaceae	Romadi	1	1	3
9	*Eucalyptus spp.*	Myrtaceae	Kelamitos	1	1	1
10	*Euclea schimperi*	Ebenaceae	Kiliaw	1	1	1
11	*Guizotia abyssinica*	Asteraceae	Nihug	NA	1	NA
12	*Isoglossa solensis*	Acanthaceae	Mehtsebi-geni	1	1	1
13	*Lathyrus sativa*	Fabaceae	Sebere	1	1	1
14	*Leucas abyssinica*	Lamiaceae	Tsaeda encheyti	1	1	1
15	*Moringa oleifera*	Moringaceae	Moringa	1	NA	NA
16	*Ocimum basilicum*	Lamiaceae	Seseg	1	1	1
17	*Ocimum hadinse*	Lamiaceae	Chemor	2	1	1
18	*Olea europaea subsp. africana*	Oleaceae	Awliie	3	1	1
19	*Opuntia ficus-indica*	Cactaeae	Beles	1	1	1
20	*Oxygonum*	Polygonaceae	Chew mrakut	2	1	1

	sinuatum					
21	*Plantago lanceolatal*	Plantaginaceae	Mendelto mesel	2	1	1
22	*Pterolobium stellatum*	Fabaceae	Konteftefe	1	1	1
23	*Rumex usambarensis*	Polygonaceae	Hihot	3	1	1
24	*Shinus molle*	Anacardiaceae	Berbere tselim	1	1	1
25	*Sorghum bicolar*	Poaceae	Meshela	1	1	1
26	*Verbascum ternacha*	Verbenaceae	Zengi-adgi	1	2	1
27	*Vernonia abyssinica*	Asteraceae	Sigemo	1	1	1
28	*Vernonia amygdalina*	Asteraceae	Grawa	1	1	1
29	*Vicia faba*	Fabaceae	Baldenga	1	1	1
30	*Zea mays*	Poaceae	Efun	1	1	1
31	*Ziziphus spina-christi*	Rhamnaceae	Gaba	3	1	1

(1= very important; 2= important; 3= less important) NA= Not Available

As indicated in Table 3, the beekeepers identified 13 flowering plants as secondary source of food plants for honeybees in the area.

Table (3) Secondary honeybee plants as identified by the beekeepers

S. No.	Scientific name	Family name	Vernacular name	Temajila	Shketi	Adi Sherefeto
1	*Acacia etbaica*	Fabaceae	Seraw	3	1	2
2	*Argemone Mexicana*	Papaveraceae	Tsaeda dander (Akoma)	2	1	3
3	*Capparis tomentosa*	Capparaceae	Andel	2	2	1
4	*Carissa edulis*	Apocynaceae	Agam	3	2	2
5	*Cyperus bulbosus*	Cyperaceae	Kuenti	2	2	3
6	*Dodonaea angustifolia*	Sapindaceae	Tahsos	2	1	2
7	*Euphorbia nubica*	Euphorbiaceae	Halegi hibey (Elip)	2	NA	1
8	*Gymnema sylvesta*	Asclepiadaceae	Shakuk	3	2	2
9	*Lactuca taraxifolia*	Asteraceae	Tselam dander(Mofoz)	2	NA	NA
10	*Linum usitatissimum*	Linaceae	Entatie	3	1	2
11	*Maerua angolensis*	Capparidaceae	Koromo	1	NA	2
12	*Mimusops kummel*	Sapotaceae	Kummel	NA	2	2
13	*Salvia schimperi*	Lamiaceae	Aba hadera	2	NA	1

(1= very important; 2= important; 3= less important) NA= Not Available

As shown in Table 4, the beekeepers identified nine flowering plants as minor source of food plants for honeybees in the area.

Table (4) Minor honeybee plants as identified by the beekeepers

S. No.	Scientific name	Family name	Vernacular name	Temajila	Shketi	Adi Sherefeto
1	*Bidens pachyloma*	Asteraceae	Gelgele meskele	2	3	3
2	*Euphorbia abyssinica*	Euphorbiaceae	Qolqaul	1	3	3
3	*Euphorbia tirucalli*	Euphorbiaceae	Kenchibi	3	NA	NA
4	*Gomphocarpus purpurasceus*	Asclelpiadaceae	Demayto	3	NA	NA
5	*Jasminum floribundum*	Oleaceae	Habi-tselim	3	NA	3
6	*Meriandra bengalensis*	Lamiaceae	Nihba	3	3	1
7	*Parkinsonia aculeata*	Fabaceae	Shewit Hagay	3	3	3
8	*Psiadia punctulate*	Asteraceae	Tsehay ferhet	3	1	3
9	*Syzygium guineense*	Myrtaceae	Liham	NA	NA	3

(1= very important; 2= important; 3= less important) NA= Not Available

Table (5) Local flora species that give good honey yield and their relative abundance

S. No.	Scientific name	Family name	Vernacular name	Temajila	Shketi	Adi Sherefeto
1	*Acacia etbaica*	Fabaceae	Seraw	1	1	1
2	*Agave sisalana*	Agavaceae	Eka	5	5	5
3	*Aloe elegans*	Asphodelaceae	Ere	5	1	3
4	*Argemone mexicana*	Papaveraceae	Tsaeda dander (Akoma)	2	4	4
5	*Becium grandiflorum*	Lamiaceae	Tahbeb	5	2	1
6	*Bidens pachyloma*	Asteraceae	Gelgele meskele	4	3	2
7	*Brassica napus*	Brassicaceae	Adri	4	4	5
8	*Capparis tomentosa*	Capparaceae	Andel	5	2	5
9	*Carissa edulis*	Apocynaceae	Agam	5	4	4
10	*Casimiroa edulis*	Rutaceae	Cazmir	5	5	5
11	*Cordia africana*	Boraginaceae	Awhi	5	5	5
12	*Cucurbita pepo*	Cucurbitaceae	Zucchini (Duha)	5	5	5
13	*Cynodon dactylon*	Poaceae	Romadi	3	1	1
14	*Cyperus bulbosus*	Cyperaceae	Kuenti	1	2	1
15	*Dodonaea angustifolia*	Sapindaceae	Tahsos	5	1	2
16	*Eucalyptus spp.*	Myrtaceae	Kelamitos	2	1	1
17	*Euclea schimperi*	Ebenaceae	Kiliaw	3	1	1
18	*Euphorbia abyssinica*	Euphorbiaceae	Qolqaul	5	5	1
19	*Euphorbia nubica*	Euphorbiaceae	Halegi hibey (Elip)	5	NA	5
20	*Euphorbia tirucalli*	Euphorbiaceae	Kenchibi	5	NA	NA
21	*Gomphocarpus purpurasceus*	Asclelpiadaceae	Demayto	4	NA	NA
22	*Guizotia abyssinica*	Asteraceae	Nihug	NA	5	NA
23	*Gymnema sylvesta*	Asclepiadaceae	Shankuk	5	4	3
24	*Isoglossa solensis*	Acanthaceae	Mehtsebi-geni	1	1	1

25	*Jasminum floribundum*	Oleaceae	Habi-tselim	5	NA	4
26	*Lactuca taraxifolia*	Asteraceae	Tselam dander(Mofoz)	2	NA	NA
27	*Lathyrus sativa*	Fabaceae	Sebere	2	3	4
28	*Leucas abyssinica*	Lamiaceae	Tsaeda encheyti	5	2	5
29	*Linum usitatissimum*	Linaceae	Entatie	5	3	4
30	*Maerua angolensis*	Capparidaceae	Koromo	5	NA	5
31	*Meriandra bengalensis*	Lamiaceae	Nihba	5	4	4
32	*Mimusops kummel*	Sapotaceae	Kummel	NA	5	5
33	*Moringa oleifera*	Moringaceae	Moringa	5	NA	NA
34	*Ocimum basilicum*	Lamiaceae	Seseg	5	5	5
35	*Ocimum hadinse*	Lamiaceae	Chemor	4	1	1
36	*Olea europaea subsp. africana*	Oleaceae	Awliie	5	1	1
37	*Opuntia ficus-indica*	Cactaeae	Beles	4	5	1
38	*Oxygonum sinvatum*	Polygonaceae	Chew mrakut	3	2	1
39	*Parkinsonia aculeata*	Fabaceae	Shewit Hagay	5	5	5
40	*Plantago lanceolatal*	Plantaginaceae	Mendelto mesel	2	1	1
41	*Psiadia punctulate*	Asteraceae	Tsehay ferhet	5	2	1
42	*Pterolobium stellatum*	Fabaceae	Konteftefe	5	3	5
43	*Rumex usambarensis*	Polygonaceae	Hihot	3	1	1
44	*Salvia schimperi*	Lamiaceae	Aba hadera	5	NA	5
45	*Shinus molle*	Anacardiaceae	Berbere tselim	5	4	4
46	*Sorghum bicolar*	Poaceae	Meshela	1	1	5
47	*Syzygium guineense*	Myrtaceae	Liham	NA	NA	5
48	*Verbascum ternacha*	Verbenaceae	Zengi-adgi	5	5	5
49	*Vernonia abyssinica*	Asteraceae	Sigemo	1	1	1
50	*Vernonia amygdalina*	Asteraceae	Grawa	5	5	5
51	*Vicia faba*	Fabaceae	Baldenga	1	3	5
52	*Zea mays*	Poaceae	Efun	3	3	3
53	*Ziziphus spina-christi*	Rhamnaceae	Gaba	5	4	5

(1= highly abundant, 2= abundant, 3= medium, 4= rare, and 5= very rare) NA= Not Available

Flowering time of the common honeybee flora: The flowering time of common bee flora in the study area, that were identified by the beekeeper respondents, and key informants during focus group discussion are presented in Table 6.

The flowering time of these common bee floras in the study area varies according to the different periods of the year.

For instance, the majority of about 30 plants out of 53 plants flowered from August to November, giving good honey yield. Some of these were: Aloe elegans, Bidens pachyloma, Brassica napus, Capparis tomentosa, Cordia africana, Cynodon dactylon, Euphorbia abyssinica, Guizotia abyssinica, Gymnema sylvesta, Isoglossa solensis, Lathyrus sativa, Linum usitatissimum, Mimusops kummel, Ocimum basilicum, Ocimum hadinse, Olea europaea, Plantago lanceolatal, Pterolobium stellatum, Rumex usambarensis, Shinus molle, Salvia schimperi, Sorghum bicolar, Verbascum ternacha, Vernonia abyssinica, Vicia faba, Zea mays and Ziziphus spina-christi. These are a combination of trees, shrubs, herbs, cultivated field and horticultural crops used as important bee floras of the study area.There were some species of plants, which flowered during the dry season.

Generally, honeybee plants such as Acacia etbaica, Carissa edulis, Eucalyptus spp., Euphorbia tirucalli, Gomphocarpus purpurasceus, Lactuca taraxifolia, Maerua angolensis, Opuntia ficus-indica, Psiadia punctulate, and Vernonia amygdalina are well known for their dry period flowering and serve as subsistence forage to bees in the study area. Apart from these, there are some plant species, which flower throughout the year such as Cucurbita pepo, Eucalyptus spp., Moringa oleifera and Parkinsonia aculeate.

Some plants like Acacia etbaica, Agave sisalana, Becium grandiflorum, Euphorbia nubica, Meriandra bengalensis, Opuntia ficus-indica, Psiadia punctulate and Syzygium guineense that flower from April to June enable beekeepers to harvest hive products in addition to the peak of honey production season.

Table (6) List of common important forage plants for honeybees and their flowering period in Sub-Zoba Dbarwa (Temajila, Shketi and Adi Sherefeto administrative kebabis)

S. No.	Scientific name	Family name	Vernacular name	Flowering period
1	*Acacia etbaica*	Fabaceae	Seraw	April-June
2	*Agave sisalana*	Agavaceae	Eka	May-June/December
3	*Aloe elegans*	Asphodelaceae	Ere	September-October
4	*Argemone mexicana*	Papaveraceae	Tsaeda dander (Akoma)	October-February
5	*Becium grandiflorum*	Lamiaceae	Tahbeb	May-October
6	*Bidens pachyloma*	Asteraceae	Gelgele meskele	September
7	*Brassica napus*	Brassicaceae	Adri	September-October/year round
8	*Capparis tomentosa*	Capparaceae	Andel	June-August
9	*Carissa edulis*	Apocynaceae	Agam	February-March
10	*Casimiroa edulis*	Rutaceae	Cazmir	October-December
11	*Cordia africana*	Boraginaceae	Awhi	October-November
12	*Cucurbita pepo*	Cucurbitaceae	Zucchini (Duha)	Throughout the year
13	*Cynodon dactylon*	Poaceae	Romadi	September-October
14	*Cyperus bulbosus*	Cyperaceae	Kuenti	June-August
15	*Dodonaea angustifolia*	Sapindaceae	Tahsos	July-September
16	*Eucalyptus spp.*	Myrtaceae	Kelamitos	January-June/year round
17	*Euclea schimperi*	Ebenaceae	Kiliaw	November-December
18	*Euphorbia abyssinica*	Euphorbiaceae	Qolqaul	October-November
19	*Euphorbia nubica*	Euphorbiaceae	Halegi hibey (Elip)	May-June
20	*Euphorbia tirucalli*	Euphorbiaceae	Kenchibi	February-March and November
21	*Gomphocarpus purpurasceus*	Asclelpiadaceae	Demayto	January

22	*Guizotia abyssinica*	Asteraceae	Nihug	September
23	*Gymnema sylvesta*	Asclepiadaceae	Shakuk	August-November
24	*Isoglossa solensis*	Acanthaceae	Mehtsebi-geni	September-October/June
25	*Jasminum floribundum*	Oleaceae	Habi-tselim	October-November and May
26	*Lactuca taraxifolia*	Asteraceae	Tselam dander(Mofoz)	January
27	*Lathyrus sativa*	Fabaceae	Sebere	October-November
28	*Leucas abyssinica*	Lamiaceae	Tsaeda encheyti	October-November
29	*Linum usitatissimum*	Linaceae	Entatie	September-October
30	*Maerua angolensis*	Capparidaceae	Koromo	December
31	*Meriandra bengalensis*	Lamiaceae	Nihba	May/October
32	*Mimusops kummel*	Sapotaceae	Kummel	September-November
33	*Moringa oleifera*	Moringaceae	Moringa	Throughout the year
34	*Ocimum basilicum*	Lamiaceae	Seseg	September/year round
35	*Ocimum hadinse*	Lamiaceae	Chemor	September-October/May
36	*Olea europaea subsp. africana*	Oleaceae	Awliie	September-October/March-May
37	*Opuntia ficus-indica*	Cactaeae	Beles	April-June
38	*Oxygonum sinvatum*	Polygonaceae	Chew mrakut	June-September
39	*Parkinsonia aculeata*	Fabaceae	Shewit Hagay	Throughout the year
40	*Plantago lanceolatal*	Plantaginaceae	Mendelto mesel	September-October/year round
41	*Psiadia punctulate*	Asteraceae	Tsehay ferhet	April-June and November
42	*Pterolobium stellatum*	Fabaceae	Konteftefe	September-November/June
43	*Rumex usambarensis*	Polygonaceae	Hihot	September-November and April
44	*Salvia schimperi*	Lamiaceae	Aba hadera	October-November
45	*Shinus molle*	Anacardiaceae	Berbere tselim	September-November/January/May-June/year round
46	*Sorghum bicolar*	Poaceae	Meshela	September-October
47	*Syzygium guineense*	Myrtaceae	Liham	May
48	*Verbascum ternacha*	Verbenaceae	Zengi-adgi	October-November/August
49	*Vernonia abyssinica*	Asteraceae	Sigemo	September-November
50	*Vernonia amygdalina*	Asteraceae	Grawa	January-February
51	*Vicia faba*	Fabaceae	Baldenga	August-September
52	*Zea mays*	Poaceae	Efun	August-September/year round
53	*Ziziphus spina-christi*	Rhamnaceae	Gaba	October-November

Conclusion:

Generally, the area has a high potential for beekeeping and there are many households who keep bees. Beekeeping can contribute a considerable amount of income to the households of the majority of the rural communities in the area.

Though beekeeping is not new to the area it has not achieved the expected progress due to various reasons. Some of the most important constraints were lack of modern equipment, financial problems, lack of training, loss of bee forage due to deforestation, changing climatic conditions and lack of rainfall, incidence of pests and predators, and application of chemicals on field and horticultural crops.

Existence of different types of flora throughout the year, suitable agro-ecology for apiaries, availability of natural forest in almost all the study areas are some of the major potential resources that encourage every citizen in the sub-zoba.

From this study, it was learnt that knowledge on flora resources and their flowering time (establishing floral calendar) was important and was more appropriate to local conditions to maximize honeybees' management and productivity. It was noted that there were many plants visited by honeybees. Fifty-three common bee flora species representing 30 families were recorded in the three administrative kebabis. Some of these were dominant included: Acacia etbaica, Becium grandiflorum, Euclea schimperi, Opuntia ficus-indica, Eucalyptus spp., Agave sisalana, Vicia faba, Vernonia abyssinica and Shinus molle.

In the study area Becium grandiflorum, Isoglossa solensis, Eucalyptus *spp.,* Shinus molle and Vernonia abyssinica were the five top important bee forage species for honeybees as main source of pollen and nectar. Most of the important bee flora bloomed from August to October and hence this was the peak period of honeybee foraging activity, strong colony strength and time of honey harvest.

The identification of important honeybee plants in the development of beekeeping has positive impact. This in turn requires the proper identification of honeybee plants and establishment of a floral calendar.

Recommendations:

The respondents in the study area suspected some common plants of being not favoured by bees or claimed to be poisonous to bees. However, further studies are required to confirm if the plants are truly bee-poisoning species or not.

To alleviate the shortage of honey flora, protection and conservation of natural vegetation and planting of bee forages in farm boundaries and homesteads, using multipurpose bee forage species should be well promoted. In addition, the positive impact of grazing area enclosures should be encouraged.

It is necessary to conduct further research on beekeeping sub-sector at country level to assess the major flora for honeybees and prepare floral calendar on agro-ecological basis.

Generally, the experiences of the sub-zoba with good bee flora availability and the practice of enclosure activities should be introduced to other areas to improve forage availability as well as honeybee productivity. Major honeybee plants that can resist drought and bear (set) flowers for a long season should be selected and established on a large scale in nurseries and distributed to farmers of the area.

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