Research Article

Identification, characterization and evaluation of honeybee floras in Kafa, Sheka and Benchi Maji Zones of Southern Nations Nationalities and Peoples Region (SNNPR), Ethiopia

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Abstract

The study was aimed at identifying and characterizing honeybee floras and their flowering seasons in south western parts of the country. Relevant data were collected through conducting questionnaire survey, focus group discussions, field observations and lab analysis of pollen and honey samples. In addition, seasonal performance of colonies in terms of brood area, adult population, pollen and nectar stores were evaluated. The obtained data were analyzed using SPSS-ver.20 and MsExcels. Accordingly, a total of 200 floral species categorized under 77 families identified. Of which, 26(13%) grouped under 16 families characterized as major bee floras. Seasons, January to February, July to August were considered as Dearth periods; March, September to October were brooding seasons, April, November to December were major nectar flow seasons. March to April and November to December were major honey flow seasons being the first for high land and mid land areas and the later for lowland areas whose major botanical origin was Schefflera abyssinica and Guizetia scabra respectively. However, in some areas with better forest covers, Manilkara bujji become a major honey source plant. Whereas, January, June to July, March (in low lands) were considered as minor/mini harvesting seasons whose major botanical origin was Vernonia species, Croton macrostachyus and Combretum species respectively. It was noted that there was a significant correlation among brood area, adult population, pollen store and nectar stores at p<0.01.

Introduction

Ethiopia is endowed with diverse agro climatic features which favors for the growth of diverse natural and cultivated floral species supporting huge number of bee colonies [1-3]. In the country, about 7000 floral species identified so far. Of which, about 400 were characterized as important honeybee plants [4,5]. The Southern Nations Nationalities and Peoples Region in general and the western parts of the region comprising Kafa, Sheka and Benchi Maji zones in particular are endowed with diverse floras potential for beekeeping activity [6,7]. Identification, characterization and evaluation of bee forage species of an area is a prerequisite for attaining a successful beekeeping. However, in spite of some endogenous knowledge on estimating the flowering seasons of some major bee plants by local beekeepers, the type of potential bee plants in the areas, their flowering seasons and contributions for honeybees are not clearly identified. A proper season-based colony management practices are imperative for maintaining the bees in their abodes and obtaining maximum rewards. However, the type and level of managements will vary based on seasons and colony status which in turn related with the abundance level of pollen and nectars sources, based on the abundance level of forage resources and colony status, there are three distinctive periods/cycles occurring once or more times a year; being the Dearth, the Buildup and the honey flow periods. The dearth periods, during which honeybees suffer from shortages of nectar and pollen sources mainly during dry season or excessive rainy seasons. The buildup periods, during which there are many bee forages and the weather is likely favorable for colony expansion. The honey flow periods, during which honeybees are more access for much pollen and...
nectar sources as a number potential plants flowering at a time \cite{8,9}. Timing of management operations corresponding to phonological patterns is very crucial in building up colonies prior to the commencement of major nectar flow seasons \cite{9}. Hence, the aim of this study was to identify and document the types of honeybee floras in the areas and their respective flowering calendars, their contribution for honeybees and proposing appropriate seasonal colony management practices to be pursued to maximize the production level from the untapped huge resources of the areas.

**Materials and methods**

**Description of the study areas**

The Kafa, Sheka and Benchi maji zones are found in Southern Nation Nationalities and Peoples Region, Ethiopia (Figure 1). The area receives maximum amount of rain falls ranging from 1000 to over 2200mm annually and the average daily temperature ranges from 17 to 21°C. Having long rainy seasons and favorable weather condition, the area is potential for the growth of diverse plant species flowering during various seasons of the year which intern are opportunities for the abundance of flowers nearly year-round; even some plants may have multiple flowering seasons which considered as golden opportunities for beekeeping. Most parts of the area are covered with intact natural forests which in some areas may exceed 70% of the total area covers \cite{10}. In addition to the abundance of huge natural forests, the area is also home for the growth of various crop species such as coffee, sorghum, maize, etc.; considered as potential sources for pollen and nectar. However, in spite of these potentialities, the overall beekeeping practices of the areas is mostly undertaken in traditional manner with very minimum or no colony managements characterized as low levels of product in terms both quality and quantity.

**Study site selection and data collection procedures**

The study was conducted in Kafa, Sheka and Benchi Maji Zones of the South Nations Nationalities and Peoples Region (SNNPR) of the country. After conducting a reconnaissance survey, study sites were selected using purposive sampling method based on their potentialities for beekeeping activity and their accessibilities. Accordingly, Chena, Gimbo and Gewata districts from Kafa zone; Guraferda and Debub Benchi districts from Benchi Maji zone and Masha district from Sheka Zone were selected. From each district, three Peasant Associations (PAs) were purposively selected based on their agro ecological variation and potentiality for beekeeping activity. From each PA, 15(�) beekeepers were randomly selected for collecting questionnaire data. All the relevant data were collected through conducting questionnaire survey, field observations, colony inspection and laboratory analysis of pollen and honey samples. The questionnaire survey basically includes about the types bee forages/their local names, honey harvesting seasons and types of plants having adverse effects on honeybees (if any), swarming seasons, types of management practices and so on. In addition, focused group discussions with key informants containing experts, community groups, development agents (DAs) and beekeepers were also undertaken to generate all the relevant information.

After the collection of survey data, nine colonies were assigned to each agro ecology (i.e., at Chena, Gimbo and Gewata districts) based on their accessibilities for regular follow-ups. From each nine colonies assigned at each site, one colony...
was used for pollen collection and the rest eight colonies for collecting their seasonal performance status in their pollens and nectar stores, brood areas and adult bee population trends. The pollen samples were collected by attaching a pollen trap at the entrance of hives making honeybees dislodging their pollen pellets from their pollen baskets while interring into their hives through the holes of pollen trap with 16% efficiency. The dislodged pollen pellets were collected weekly, dried in oven, sorted out by their color, location, collection dates and preserved in an oven maintained at 36°C. Each sorted pollen sample was weighed, identified under microscope using x40 magnification power after diluting with ether solution. The identification of plant types for each type of pollen was undertaken using the already prepared references slides; by comparing the size, shape and apertures of the pollens. Honey samples were also systematically collected from each location following their major and minor harvesting seasons to identify its botanical origin considering a pollen count in honey sample exceeding 45% is mono floral honey [11].

Performance trends of colonies was evaluated by measuring the frame area of stored pollen/bee breads, broods, nectar and adult bees each month using Delaplane et al., [12], standard methods for honeybees’ performance estimation as shown in Figure 2. In this method, an empty frame being divided into 8 grids of 10 cm by 10 cm areas vertically and a cross middle of the frame horizontally; However, the grids at the two (upper and lower) edges of the frame holds half of the areas of grids at middle (i.e. 5 cm by 10 cm) (Figure 2). Hence, a frame may hold 16 units of 10cm by 10 cm areas in both sides considered as one deep frame. Estimation of pollen and nectar stores and brood areas were done in deep frame based by overlapping the gridded frame over each frame of the hives; to hasten the task of estimation, a photo camera was used to capture and counting later. According, one deep frame may include 16(sixteen) units of 10cm-by-10cm areas, each may contain 400 cells or 125 adult bees. Hence, one deep frame is estimated to contain 6,400 cells (broods or pollen cells) or 2,000 adult bees [12]. Based on this, we interchangeably interpreting the areas in squared inch units (in2); one inch= 2.54cm. Similarly, the adult bees were estimated by summing up the comb areas covered with adult bees in deep frame bases considering the bees on combs, hive covers, as well as bees accumulated on the walls of hives and at the entrance into account. The study was conducted for two consecutive years (through 2018 and 2019GC).

During field observation, identification of the intensity of visits of honeybees to various flowers and type of forages (pollen, nectar) sources was undertaken. This could be done through observing the foraging activities of honeybees (i.e.honeybees sucking diving their heads into the flowers base when collecting nectar and observing for pollen pellets on their hind legs for pollen collection).

Plant abundances

The abundance of each honeybee plant was determined using Tesfaye et al., [13] plant density determination methods; by classifying the plants into three groups being the trees, shrubs and herbaceous with sampling plots of 50m by 50m, 20m by 20m and 1m by 1m respectively. The plots of 50m-by-50m areas were laid systematically considering the variability among land use patterns and vegetation covers; then small quadrants of 20m*20m and 1m*1m quadrants were laid out at different sites of larger plots. Accordingly, at least five small quadrants (1m*1m) and two medium quadrants (20m*20m) were considered. From each agro-ecology of selected sites, a minimum of 24 larger sampling plots were considered.

Density of plants (number of plants per unit area (hectare) of observation) was used to determine the abundance level of major bee plant species across each agro ecological zones.

Collection of reference materials

Palynologic analysis and establishment of flowering calendar requires good collection of reference materials. In order to get the preliminary materials, fully matured but, unopened flower heads were collected and preserved following the standard herbarium procedures for identifying the botanical origin of honey samples and pollen samples regularly collected from apiaries. Reference slides were prepared following the methods prescribed by the International Commission for Plant–Bee Relationship [11] by shocking down the pollen grains from anthers on the slides and placed on a watch glass and washed with ether; after the remaining ether has evaporated, the pollen picked up with a needle and a small fragment of glycerinated jelly was placed on a microscope slide and melted at 40°C. Then, the compound/specimen was covered with cover glass and diluted. Then the pollen slide prepared in this manner used as a pollen data base for palynologic analysis. The identified pollen samples on slides were labeled and put into slide box which then used as references.

Honey sample collection and Laboratory analysis

Fresh honey samples were collected from different agroecologies for laboratory analysis following harvesting seasons. From each agro-ecology, 4 to 6 samples were collected from different sites. The pollen analysis was undertaken following the methods elucidated by Louvuex, et al [11] for determination of botanical composition and frequency of pollen grains in the honey.

Data analysis

The obtained data were analyzed using SPSS-ver-20 and Microsoft excels. Descriptive statistic such as frequency and...
percent were used. The Analysis of variance (ANOVA) with GLM (Generalized Linear Model) at p<0.05 significance level with Mean + Standard Deviation (SD) of values considered. Pearson’s correlation model was used to identify the correlation among pollen and nectar stores with brood and adult bee population.

Result and Discussion

Honeybee plants identified in the area

A total of two hundred species of plants grouped under seventy sevenfamilies being Araceae, Asteraceae, Fabaceae, Labiatae, Myrtaceae, Phytolaccaeae, Pedaliaceae, Poaceae, Acanthaceae, Agavaceae, Anacardiaceae, Apiales, Apocynaceae, Aquifoliaceae, Araliaceae, Arecaceae, Basellaceae, Boraginaceae, Brassicaceae, Caricaceae, Celastraceae, Combretaceae, Dracaenaceae, Commelinaceae, Convolvulaceae, Crassulaceae, Capparidaceae, Cucurbitaceae, Cyperaceae, Ericaceae, Euphorbiaceae, Fabaceae, Polygonaceae, Gutierrezeeae, Icacinaceae, Moraceae, Lamiales, Lauraceae, Linaceae, Malvaceae, Meliaceae, Melianthaceae, Loganiaceae, Moraceae, Moringaceae, Annonaceae, Musaceae, Myrsinaceae, Myrtaceae, Oleaceae, Onagraceae, Piperaceae, Plantaginaceae, Poaceae, Proteaceae, Punicaceae, Ranunculaceae, Resedaceae, Rhamnaceae, Rosaceae, Rutaceae, Sapindaceae, Sapotaceae, Ulmaceae, Simaroubaceae, Solanaceae, Sterculiaceae, Sapotaceae, Thymelaeaceae, Tiliaceae, Urticaceae, Vitaceae, Verbenaceae, Annonaceae and Bignoniaceae identified to be important in contributing pollen, nectar, propolis or a combinations each for honeybees (Table 1).

Of the total 200 identified species, forty seven (23.5%) of them being Schefflera abyssinica, Crotonmacrostachyus, Cordia africana, Eucalyptus species, Polyscias fulva, Prunus africana, Combretumcollinum, Combretum brownie, Syzygium guineense, Desmodium species were climber; Euphorbia tirucalli, Hypericum revolutum, Lippia abyssinica, Ocimum species, Sesbania sesban, Maytenus gracilipes, Ipomoea tenuirostris, Premna schimperi, Jasminum abyssinicum, Galiniera saxifraga, Fuchsia hybrid, Euphorbia latifolia, Clausena anisata, Solanum incanum, Solanum dasyphyllum, Allophyllus macrobotrys, Plectranthus bursorum, Erica genus, Ilex mitis L., Dalbergia luteaL, Cajanus cajan, Rhusglutinosu, Phytolaccadecandra, Cleomegynandra, Solanecigogias, Ricinuscommunis, Morus L, Bersema abyssinica, Buddlejadaavidiiand Clerodendrumspicespecies were shrubs; fifty one (25.5%) of them being Guizotia abyssaca, Satureja paradoxa, Trifolium species, Vernonia leopoldii, Vernonia unionis, Bidentaprestinaria, Bident macroptera, Bident pachylophum, Cineraria abyssinica, Crossocephalummacropappum, Dicrocoehalachrysanthemifolia, Nicadra physalois, Lagger acrispata, Parthenium hysterophorum, Tagetes minuta, Pycnostachysemii, Xanthium spinosum L., Caylusea abyssinica, Hypericum species, Plectranthus bursorum, Plantago lanceolata, Datura stramonium, Cardusus species, Ipomoea species, Solanum nigrum, Galinsogaparfiflora, Bothriochloeschimeri, Bident spilosa, Justitia laiandolai, Phaolopsis imbricate, Cyperus species, Hypoestes forskaoli, Isoglossaspices, Zantedeschia anethifolia, Triumfettarhomboidae, Girar dinebullosu, Physalis lagascae, Salvia leucantha, Anethum graveolens, Ageratum houstonianum, Anthemisthiensis, Commelina benghalensis, Urta simensis, Clerodendron myricoides, Datura stramonium, Discodipodium penninervum, Kalanchoedensuflora, Crotalaria species, Rumex abyssinicus and Sparrmanniaricinocarpawere herbs; seventeen(8.5%) of them being Combretum paniculatum, Goania longiplicata, Paltohobiumstellatum, Mikania longisaitoides, Clematistaegiaca, Microglossypyrifolia, Clematis hirsuta, Gymnemayselvestre, Basella alba, Helinus mystacinus, Gouania longiplicata, Apomoea species, Curcubitapieces, Zeheria scabra, Mimosa invisa, Rhoicissus tridentata and Desmodium species were climber; fourteen(7%) of them being Guizotia abyssinica, Zeya mays, Coffee arabica, Oamiscus basilicum, Helianthus annuus, Brassica species, Sorghum bicolor, Vicia faba, Linumusitatis simumL., Pisum sativum, Sesamum indicum, Piper capense, Coriandrum sativum L. and Phaseolus speciesawere crops; Seventeen(8.5%) of them being Lycopersiconesculentum, Capsicum annuum, Solanum tuberosum, Mangifera indica, Persea americana, Citrus aurantifolia, Citrus simensis, Citrus medica, Citrus deliciosa, Annonaspecies, Musapices, Punica granatum L., Carica papaya, Curcubitapepo, Psidium guajava L. and Solanumcommuniswere fruits and vegetables (Table 1).

This indicates being the area receiving ambient rain falls throughout most seasons; it creates an opportunity for the growth of diverse floral species. Perhaps, this creates an opportunity for honeybees to access for ample forage sources during most seasons the year. Similarly, Siya [10] also indicated that even though there is an ever increasing rates of deforestation due to over population and resettlements resulting for the depopulation of major bee plants including Chordia africana, Olea species and Prunus africana, the area is still known for its more diverse plant species and coverage compared to most parts of the country.

Number of Honeybee plant species flowering each season

Availability of diverse floral species during particular season creates a good opportunities for the bees in obtaining substantial amount of nectar through full day foraging by adjusting their foraging times as each plant species has its own time schedules for attaining its optimum nectar secrections [14]. Though each plant species has its own requirements for the amounts of rain falls, temperature and sun light intensities for
| Habit | Local Name | Scientific Name | Family Name | Flowering seasons | No. of days | Utility |
|-------|------------|-----------------|-------------|-------------------|-------------|---------|
|       | Buto       | Schefflera Abyssinica | Araliaceae  | March-April       | 60          | HL; ML; LL | N       |
|       | Wago       | Croton macrostachyus | Euphorbiaceae| April-July        | 98          | HL; ML; LL | P,N     |
|       | Di'o       | Cordia africana    | Boraginaceae | May-Sept.         | 150         | HL; ML; LL | N       |
|       | Bahirzaf   | Eucalyptus species | Myrtaceae   | Nov.-Dec.; Mar.- June | 150         | HL; ML; LL | N       |
|       | Keresho    | Polyscia fulva     | Araliaceae  | Mar.-April        | 60          | HL; ML; LL | P,N     |
|       | Omo        | Prunus africana    | Rosaceae    | Oct.-Nov.         | 50          | HL; ML; LL | P,N     |
|       | Tikurabalo | Combretum collarum | Combretaceae | -                 | -           | HL; ML; LL | P,N     |
|       | Wonbela    | Combretumbrownie   | Combretaceae | -                 | -           | HL; ML; LL | P,N     |
|       | Yino       | Syzygium guineense | Myrtaceae   | Dec.-Janu.        | 30          | HL; ML; LL | P,N     |
|       | Shedo      | Sapium ellipticum  | Euphorbiaceae| Dec.-Janu.        | 55          | HL; ML; LL | P,N     |
|       | She'o      | Allophylus abyssinicus | Asteraceae  | May-Nov.          | 86          | HL; ML; LL | P,N     |
|       | Gacho      | Euphorbia abyssinica| Euphorbiaceae| Nov.-Dec.         | 52          | HL; ML; LL | N, P     |
|       | Wogammo    | Ehractiocymosa     | Borraginaceae| Nov.-Janu.        | 75          | HL; ML; LL | N       |
|       | Bazragrar  | Acacia abyssinica  | Fabaceae    | Dec.-May          | 162         | HL; ML; LL | P,N     |
|       | Gerbi/girar| Acacia lahai       | Fabaceae    | March-May         | 85          | HL; ML; LL | P,N     |
|       | Alaro      | Acacia niloticus   | Fabaceae    | Mar.-May          | 85          | HL; ML; LL | P,N     |
|       | Tukur girar| Acacia mellefers   | Fabaceae    | Mar.-May          | 85          | HL; ML; LL | P,N     |
|       | Ohiyo/sesas| Albizia species    | Fabaceae    | April-May         | 38          | HL; ML; LL | P,N     |
|       | Digitta    | Calpurnia aurea    | Fabaceae    | Nov.-Janu.        | 50          | HL; ML; LL | P,N     |
|       | Lukina     | Leucaena leucocephala | Fabaceae  | Sept.-Dec.        | 110         | HL; ML; LL | P,N     |
|       | Kelewa     | Maesalanceceolata  | Myrsinaceae | Aug.-Sept.        | 55          | HL; ML; LL | P,N     |
|       | Charo      | Ficus sur          | Moraceae    | May-June          | 35          | HL; ML; LL | P,N,pnr  |
|       | Nugehso    | Bruceaentidysenterica | Simaroubaceae| Sept.-Nov.        | 75          | HL; ML; LL | P,N     |
|       | Mielo      | Ficusvasta         | Moraceae    | May-June          | 35          | HL; ML; LL | P,N,pnr  |
|       | Yekolawanza| Pilostigmamonningii | Fabaceae    | -                 | -           | HL; ML; LL | P,N     |
|       | Yaho       | Olea welwitschii   | Oleaceae    | Dec.-Janu.        | 30          | HL; ML; LL | N       |
|       | Wulkifa/Shewuko/ | Dombeya torrid | Sterculiaceae | Oct.-Dec.       | 80          | HL; ML; LL | N       |
|       | Buti'l     | Manilkara butugi   | Sapotaceae  | Nov.-Janu.        | 45          | HL; ML; LL | P,N     |
|       | Adsesse    | Veprisdainelli     | Rutaceae    | Nov.-January      | 90          | HL; ML; LL | P,N     |
|       | Kondo bereberie | Piper nigrum    | Piperaeae   | Sept.-Oct.; Jan.-Mar. | 85          | HL; ML; LL | P,N     |
|       | Koso       | Hagenia abyssinica | Rosaceae    | Oct.-Dec.         | 90          | HL; ML; LL | P,N     |
|       | Beye       | Olivia rochetiana  | Oliniaceae  | Janu.-May         | 135         | HL; ML; LL | P,N     |
|       | Bosoka     | Eriobotrya japonica| Rosaceae    | Sept.-Dec.        | 90          | HL; ML; LL | P,N     |
|       | Gravillia  | Grevillea robusta  | Proteaceae  | Oct.-Janu.        | 115         | HL; ML; LL | P,N     |
|       | Chewie     | Dracaena steudneri | Dracaenaceae| Oct.-Dec.         | 75          | HL; ML; LL | P,N     |
|       | Luiya      | Trichilidregeaana  | Meliaceae   | Nov.-Mar.         | 130         | HL; ML; LL | P,N     |
|       | Ororo      | Ekebergia capensis | Meliaceae   | March-June        | 100         | HL; ML; LL | P,N     |
|       | Boko       | Bersema abyssinica | Meliantheae | Janu.-May         | 130         | HL; ML; LL | P,N     |
|       | Bibiro     | Millettia fusiformis | Fabaceae  | Mar.-May          | 70          | HL; ML; LL | P,N     |
|       | Shifieraw  | Moringa oleifera   | Moringaceae | Feb.-May          | 92          | HL; ML; LL | N       |
|       | Keero      | Anigeriaitissima   | Sapotaceae  | Nov.-Feb          | 100         | HL; ML; LL | N       |
|       | Shishu     | Celtis africana    | Ulmaceae    | May-June          | 43          | HL; ML; LL | P       |
|       | Aroressa   | Grewia species     | Thymelaeaceae| -                 | -           | HL; ML; LL | P       |
|       | Nukseso    | Bruceaentidysenterica | Simaroubaceae| Sept-Nov.        | 45          | HL; ML; LL | P,N     |
|       | Korch      | Erythrina abyssinica| Fabaceae    | Nov.-Janu         | 90          | HL; ML; LL | P,N     |
|       | Tsedaki    | Spathodeanlotica   | Bignoniaceae| April-Aug.        | 140         | HL; ML; LL | N       |
|       | Wondifo    | Apodytesdimidiata  | Icacinaceae | Dec.-Mar.         | 115         | HL; ML; LL | P,N     |

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Table 1: Lists of honeybee plants and their flowering seasons.

| Habit          | Local Name | Scientific Name | Family Name | Flowering seasons | No. of days | Utility |
|----------------|------------|-----------------|-------------|-------------------|-------------|---------|
| Shrub          |            |                 |             |                   |             |         |
| Dengerito      | Vernonia auriculifera | Asteraceae | January - March to June - March | 310-50 | P,N     |
| Grawo          | Vernonia amigdalina | Asteraceae | January - March to June - March | 50-70 | P,N     |
| Yeferes Zeng   | Vernonia adenosia | Asteraceae | September - December | 50-75 | P,N     |
| Tambora        | Vernonia congoensis | Asteraceae | October - December | 70-90 | P,N     |
| Hamaka         | Vernonia filigera | Asteraceae | October - December | 70-90 | P,N     |
| Gujo           | Vernonia rueppellii | Asteraceae | October - February | 120-130 | P,N     |
| Soyoma         | Vernonia thomsoniana | Asteraceae | October - December | 80-90 | P,N     |
| Yeebooo        | Phoenix reclinata | Arecaceae | November - January | 50-55 | P,N     |
| Agam           | Carissa spinarum | Apocynaceae | February - March | 45-50 | P,N     |
| Tumoga/sensel  | Justicia schimperi | Acanthaceae | October - December | 70-70 | P,N     |
| Njorie          | Robus species | Sapindaceae | December - February | 50-65 | P     |
| Dorjeit/chiffrig | Sidarhombifolia | Malvaceae | September - December | 100-100 | P     |
| Gaaqoo         | Hibiscus berberidifolius | Malvaceae | October - November | 60-60 | P     |
| Sansuri        | Hibiscus ludwigii | Malvaceae | October - November | 60-60 | P     |
| Kontir         | Caesalpinia decapetala | Fabaceae | October - January | 110-110 | P,N     |
| Bottel brush   | Calistemon cinctus | Myrtaceae | September - September | 135-135 | N     |
| Tushimo        | Pavetta abyssinica | Rubiaceae | October - December | 90-90 | P,N     |
| Digissie       | Combretum collinum | Combretaceae | - | March - April | 45 P,N     |
| Yudo           | Dracaena steudneri | Dracaenaceae | December - January | 105-105 | P,N     |
| Geisho         | Rheumus prioides | Rhamnaceae | Year round | 365-365 | P,N     |
| Maccarikitta   | Dodonaea angustifolia | Sapindaceae | - | September - | 115 P,N     |
| Mogneabba      | Brugmansia evoluta | Solanaceae | Year round | 365-365 | P,N     |
| Yewofkolo      | Lantana camara | Verbenaceae | Year round | 350-350 | P,N     |
| Kincib         | Euphorbia tirucalli | Euphorbiaceae | October - November | 30-40 | N     |
| Amija          | Hypericum revolutum | Guttiferae | October - January | 110-110 | P,N     |
| Koseret        | Lippia abyssinica | Verbenaceae | February - March | 45-45 | P     |
| Damakiesie     | Ocimum species | Lamiaceae | September - December | 105-98 | P,N     |
| Suspansia      | Sesbaniasp | Fabaceae | January - March | 63-63 | P,N     |
| Alatshiko      | Maytenus gracilipes | Celastraceae | August - November | 110-110 | P,N     |
| YavitKareg     | Ipomea teniurostis | Convolvulaceae | December - January | 60-60 | P,N     |
| Tumbo/Chocco   | Premnaschimperi | Verbenaceae | March - December | 275-275 | P,N     |
| Tembelet       | Jasminum所以他 | Oleaceae | December - January | 60-60 | P,N     |
| Didoo          | Galinierasaxifraga | Lamiaceae | December - February | 50-50 | N     |
| Key aebba      | Fuchsia hybrid | Onagraceae | September - January | 150-150 | N     |
| Limmich        | Clusiana hispida | Rutaceae | May - May | 90-90 | 73 N     |
| Emibayo        | Solanum incanum | Solanaceae | March - December | 300-305 | P,N     |
| Geber embay    | Solanumumumsporphyr | Solanaceae | March - December | 300-305 | P,N     |
| Tatesa/Emibus  | Allophyllum macrobotry | Sapindaceae | May - November | 80-80 | 80 P,N    |
| Embusbusie     | Plectranthusbusunom | Lamiaceae | February - March | 50-80 | 40 P,N    |
| Chiffrig       | Erica genus | Ericaceae | October - November | - | 40-35 | P,N     |
| Ketto          | Ilex mitis | Aquifoliaceae | October - December | 90-90 | 80 N     |
| Yagbero        | Dalbergia lentea | Fabaceae | September - December | 120-120 | P,N     |
| YergibAter     | Cajanus cajanes | Fabaceae | September - December | 100-100 | P,N     |
| Embus           | Rhusglutinosa | Urticaceae | May - November | 85-85 | 80 P,N    |
| Mut ansa       | Spermacion cinconar | Lamiaceae | October - November | 50-60 | 50 P     |
| Endod           | Phytolacca dodecandra | Phytolaccaeae | November - May | 200-200 | P     |
| Awkobekel      | Cleome gynandra | Capparidaceae | October - December | 120-120 | P,N     |
| Yeshikokogomen | Solanaceo gigas | Asteraceae | October - March | 180-180 | 150 P     |
| Gulo           | Ricinus communis | Euphorbiaceae | October - November | 65-65 | 50 P,N    |
| Yeferenjirji   | Morus alba | Moraceae | October - December | 70-70 | 60 P     |
| Azamir          | Bersema abyssinica | Melianthaceae | October - December | 60-60 | 60 P,N    |
| Ataro           | Buddlejajadavidi | Loganiaceae | November - January | 75-70 | 60 P,N    |
| Misiritch       | Clerodendrum species | Lamiaceae | October - December | 50-52 | 60 P,N    |
| Habit | Local Name | Scientific Name | Family Name | Flowering seasons | No. of days | Utility |
|-------|------------|----------------|-------------|-------------------|-------------|---------|
|       |            |                |             | HL | ML | LL | HL | ML | LL | P,N |
| Herb  |            |                |             |                |             |         |
| Tufo  | Guizotia scabra | Asteraceae | Oct.-Jan. | Oct.–Janu. | Oct.-Janu. | 110 | 110 | 105 | P,N |
| Neddo | Satureja paradoxa | Lamiaceae | July-Oct. | July –Oct. | July –Oct. | 120 | 120 | 110 | N   |
| Magoshimo | Trifolium species | Fabaceae | Sept.-Nov.; Apr.-May | Sept.–Nov.; Apr.-May | Sep.-Nov.; Apr-May | 115 | 115 | 115 | P,N |
| Chibo | Vernonia leopoldii | Asteraceae | Oct.–Nov. | Oct.-Nov. | - | 52 | 50 | - | P,N |
| Silliche | Vernonia unionis | Asteraceae | Oct.-Dec. | Oct.-Dec. | Oct.-Dec. | 90 | 85 | 85 | P,N |
| Adey abeba | Bidens predastaria | Asteraceae | Sept.–Nov. | Sept.–Nov. | Sept.–Nov. | 75 | 75 | 70 | P   |
| Meskel abeba | Bidens macroptera | Asteraceae | Sept.–Dec. | Sept.-Dec. | Sept.-Dec. | 115 | 115 | 110 | P   |
| Meskel abeba | Bidens pachylophama | Asteraceae | Oct.–Dec. | Oct.-Dec. | Oct.-Dec. | 115 | 115 | 110 | P   |
| Noophoo | Cineraria abyssinica | Asteraceae | Oct.-Dec. | Oct.-Dec. | Sept.-Dec. | 95 | 90 | 90 | P   |
| Mandallo | Crassocephalummacropappum | Asteraceae | Sept.-Jan. | Sept.-Janu. | Sept.–Janu. | 140 | 140 | 130 | P   |
| Hramo  | Dicrococephal Chrysanthemifolia | Asteraceae | Sept.-Nov. | Sept.-Nov. | Sept.-Nov. | 85 | 85 | 70 | P   |
| Etsetfaris | Nicradaphyaloideae | Solanaceae | April-Dec. | April-Dec. | April-Dec. | 270 | 270 | 270 | P,N |
| Huphicho | Lagrea crispate | Asteraceae | June-Nov. | June-Nov. | June-Nov. | 157 | 150 | 143 | P   |
| Partinum | Parthenium hysteroxerus | Asteraceae | Year round | Year round | Year round | 365 | 350 | 355 | P   |
| Yahiya shitto | Tagetes minuta | Asteraceae | Sept.-Nov. | Sept.-Nov. | Sept.-Oct. | 72 | 70 | 58 | P   |
| Ye’ero  | Pycnostachysneminii | Lamiaceae | June-Dec. | June-Dec. | June-Dec. | 180 | 180 | 60 | P,N |
| Yesietnas | Xanthium spinosum L | Asteraceae | Year round | Year round | Year round | 365 | 365 | 365 | P,N |
| Yanno  | Caylusea abyssinica | Resedaceae | Mar-Dec. | Mar-Dec. | Mar-Dec. | 300 | 300 | 280 | P   |
| Amja  | Hypericum species | Guttiferae | Nov.–Dec. | Nov.–Dec. | Nov.–Dec. | 40 | 40 | 35 | P   |
| Motijo | Pleotrichus species | Lamiaceae | Sept-Nov. | Sept-Nov. | Sept.-Nov. | 70 | 70 | 55 | P   |
| Korkeb  | Plantagelanceola | Plantaginaceae | Nov.–Jan | Nov.-Janu | Nov.-Janu | 80 | 80 | 75 | P   |
| Guccino | Carduus species | Asteraceae | Jan–Feb | Janu-Febr. | Janu-Febr. | 40 | 40 | 40 | P   |
| Ye’ayit Hareg | Ipomeoae species | Convolvulaceae | Octo-Dec. | Oct.-Dec. | Oct.-Nov. | 80 | 80 | 65 | P,N |
| Tikurawat | Solanum nigrum | Solanaceae | Sept.–Dec. | Sept.-Dec. | Sept.-Nov. | 100 | 95 | 90 | P   |
| Yeshewa Arem | Galinsoga parviflora | Asteraceae | Augt-May | Aug.-May | Aug-May | 260 | 250 | 235 | P,N |
| Yamesho | Bottrivioclinechimeri | Asteraceae | Sept.-May | Sept.-May | Sept.-May | 240 | 240 | 210 | P,N |
| Chogogit | Bidens spilosa | Asteraceae | June-Dec. | June-Dec. | June-Nov. | 210 | 210 | 190 | P   |
| Chingrech | Justitia ladanoides | Acanthaceae | Oct.-Janu. | Oct.-Janu. | Oct.-Janu. | 115 | 115 | 110 | N   |
| Liketi  | Phaulopsis imbricate | Acanthaceae | Sept.-Dec. | Sept.-Dec. | Sept.-Dec. | 120 | 120 | 105 | N   |
| Englica | Cyperus species | Lamiaceae | Mar – Apr | Mar. -April | Mar- April | 45 | 45 | 45 | P,N |
| -      | Hypoestesforskaloii | Acanthaceae | Oct.-Janu. | Oct.-Janu. | Oct.-Janu. | 120 | 120 | 110 | N   |
| Dergu  | Isoglossaspecies | Acanthaceae | Aug.-Nov. | Aug.-Nov. | Aug.-Nov. | 120 | 120 | 100 | N   |
| Turumbaabeba | Zantedeschia ethiopica | Araceae | Sept.-Dec. | Sept.-Dec. | Sept.-Dec. | 120 | 120 | 110 | P,N |
| Doro   | Triumfettarhomboida | Tilliaeae | Sept.-Dec. | Sept.-Dec. | Sept.-Dec. | 105 | 105 | 105 | P   |
| Dobbi  | Girardinia bullosa | Urticaceae | Sept.-Dec. | Sept.-Dec. | Sept.-Dec. | 115 | 115 | 100 | P   |
| Awut   | Physalis lagascae | Solanaceae | Sept.-Dec. | Sept.-Dec. | Sept.-Nov. | 100 | 95 | 90 | N   |
| Sage(Eng) | Salvia leucaantha | Lamiaceae | Year round | Year round | Year round | 365 | 365 | 305 | N   |
| Enselal | Anethum graveolens L | Apiaceae | Sept.-Dec. | Sept.-Dec. | Sept.-Nov. | 110 | 100 | 90 | P,N |
| Kefo   | Ocimumamericanum | Lamiaceae | Year round | Year round | Year round | 210 | 210 | 210 | P   |
| Blue mink(Eng) | Ageratum houstonianum | Asteraceae | Sept.-Mar. | Sept.-Mar. | Sept.-Mar. | 192 | 190 | 178 | P,N |
| Chedramo | Rutachalaeopsis | Rutaceae | Oct-Dec. | Oct-Dec. | Oct-Dec. | 90 | 90 | 90 | P   |
| Shukido | Anthemistogetnest | Asteraceae | Sept.–Janu | Sept.-Janu | Sept.–Janu | 140 | 140 | 120 | P,N |
| Shato   | Commelinabahengiensis | Commelineae | Sept.-Oct. | Sept.-Oct. | Sept.-Oct. | 55 | 50 | 45 | P   |
| Samma  | Urtica simensis | Urticaceae | Sept.-Dec. | Sept.-Dec. | Sept.-Dec. | 120 | 120 | 100 | P   |
| Aghio  | Clerodendronmyricoides | Verbenaceae | Sept.-June | Sept.–June | Sept.-June | 300 | 300 | 280 | P,N |
| Astenagir | Datura stramonium | Solanaceae | Aug.-Febr | Aug.-Febr. | Aug.-Janua. | 205 | 200 | 185 | P   |
| Aluma  | Discopodiumpennerivnium | Solanaceae | June-Dec. | June-Dec. | June-Dec. | 210 | 200 | 200 | P   |
| Ndhahulla | Kalanchoe densiflora | Crassulaceae | Oct.–Nov. | Oct.-Nov. | Oct.--Nov. | 50 | 50 | 45 | P   |
| YaitMisir | Crotalaria species | Fabaceae | Sept.-Nov. | Sept.-Nov. | Sept.-Nov. | 75 | 75 | 70 | P   |
| Megmecho | Rumex abyssicus | Polygonaceae | Mayjuly-Oct. | May-july-Oct. | May-June-Oct. | 75 | 75 | 75 | P   |
| Moggecco | Sparmannia ricinocarpa | Tiliaceae | Oct.-Dec.; May-June | Oct.-Dec.; May-June | Oct.-May; May-June | 85 | 85 | 70 | P   |

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| Habit       | Local Name | Scientific Name       | Family Name | Flowering seasons | No. of days | Utility |
|------------|------------|-----------------------|-------------|-------------------|-------------|---------|
| Climbers   |            |                       |             |                   |             |         |
|            | Beggo      | Combretum paniculatum | Combretaceae| Oct – Mar.         | 170 170 165 | N       |
|            | Achbeno    | Goania longiplicata    | Rhamnaceae  | Oct.- Janu.       | 87 87 80    | N       |
|            | Kentaffa   | Ptilobiumstellatum    | Fabaceae    | Oct.- Janu.       | 100 100 85  | P,N     |
|            | Haddi      | Mikaniosisclematoides  | Asteraceae  | Oct.- Mar.         | 160 160 130 | P,N     |
|            | Yazhoareg/ Kacho | Clematis longicaula | Ranunculaceae| Oct. – Mar.       | 160 155 135 | P,N     |
|            | Hareg      | Microglossaprynolia   | Asteraceae  | Sept.- May         | 250 250 220 | P,N     |
|            | Nechye'azohareg | Clematis hirsuta | Asteraceae  | Dec. – Mar.        | 125 120 105 | N       |
|            | Qombo      | Gymnemaicyrnestre     | Asteraceae  | Oct.-June          | 260 260 250 | P,N     |
|            | Nopho      | Basella alba          | Basellaceae | Sept.- Nov.        | 75 72 60   | P       |
|            | Xaro       | Heliniumystacinus     | Rhamnaceae  | Sept. – Dec.       | 115 115 110 | N       |
|            | Hareg      | Gouaniumlongispicata  | Rhamnaceae  | Sept. – Janu.      | 135 135 135 | N       |
| Fruits     | Morning glory(Eng) | Apomoeaspecies | Convolvulaceae| Nov.-Febr.        | 115 115 110 | P,N     |
| Fruits     | Yemdr'Babuy | Cucurbita species     | Cucurbitaceae| Aug.– Nov.         | 88 85 70   | P       |
| Fruits     | HaregResa  | Zeheria scabra         | Cucurbitaceae| Sept.-Nov.        | 80 70 60   | P       |
|            | -          | Mimosa invisa         | Fabaceae    | May.-Dec.          | 215 210 180 | P,N     |
|            | Wodel asfes | Rhiosissus tridentata | Vitaceae    | Mar.- Apr.         | 60 60 50   | N       |
|            | Desmodium | Desmodiumspecies      | Fabaceae    | Sept. – Nov.       | 60 60 50   | N       |
| Fruits     | Nugo       | Guizotia abyssinica   | Asteraceae  | Oct. – Dec.        | 60 60 55   | P,N     |
| Fruits     | Baaroo     | Zeya mays             | Poaceae     | May – July         | 60 60 45   | P       |
| Fruits     | Buno       | Coffee arabica        | Rubiaceae   | Janu. – Feb.       | 35 35 30   | P,N     |
| Fruits     | Besobila   | Ocimumsambusilicum    | Labiatae    | April – June       | 60 60 60   | P       |
| Fruits     | Yefemjisuf | Helianthus annusus    | Asteraceae  | Oct. – Dec.        | 70 67 55   | P,N     |
| Fruits     | Shaaichofo | Brassica species      | Brassicaceae| Sept.-Nov.         | 70 70 65   | P,N     |
| Fruits     | Yango      | Sorghum bicolor       | Poaceae     | May-July; Oct.- Nov.| 145 145 120 | P       |
| Fruits     | Bakelo     | Vicia faba            | Fabaceae    | June – July        | 40 40 -    | P       |
| Fruits     | Mutto      | Linumusitsitsizim L   | Linaceae    | Sept.-Nov.         | 70 65 50   | P,N     |
| Fruits     | Atero      | Pismum sativum        | Fabaceae    | June – July        | 40 -       | P       |
| Fruits     | Selt       | Sesamum indicum       | Pedaliaceae | -                 | -          | 45 P     |
| Fruits     | Timiz/Turfo | Piper capense         | Piperaceae  | March-June         | 75 75 62   | P       |
| Fruits     | Debo/dimbil | Coriandrum sativum L  | Apiaceae    | May – Dec.         | 230 230 215 | N       |
| Fruits     | Goobbo     | Phaseolus species     | Fabaceae    | April-May          | 30 30 25   | P       |
| Fruits     | Timatam    | Lycopersiconesculcenten | Solanaceae | July – Aug         | 45 45 40   | P       |
| Fruits     | Barberie/baro | Capiscum annum  | Solanaceae  | Aug.– Oct.         | 55 55 50   | P       |
| Fruits     | Dinnich/Doko | Solanum tuberum    | Solanaceae  | May-Aug            | 56 56 50   | P       |
| Fruits     | Mango      | Mangifera indica      | Anacardiaceae| Oct.-Janu, May-June| 145 145 140 | P,N     |
| Fruits     | Avocado    | PerseaAmericana       | Lauraceae   | Oct.-Dec., May-June| 135 135 125 | P,N     |
| Fruits     | Lomi       | Citrus aurantifolia   | Rutaceae    | Dec.-Janu, May-June| 80 80 75   | P       |
| Fruits     | Bertukan   | Citrus sinensis       | Rutaceae    | Dec.-Janu, May-June| 80 80 75   | N,P     |
| Fruits     | Tiringo    | Citrus medica         | Rutaceae    | Dec.-Janu, May-June| 80 80 75   | N,P     |
| Fruits     | Menderine  | Citrus delicosia      | Rutaceae    | Dec.-Janu, May-June| 80 80 75   | N,P     |
| Fruits     | Gishta     | Anonna species        | Annonaceae  | Oct.-Janu, May-June| 75 75 70   | P       |
| Fruits     | Muz        | Musa species          | Musaceae    | May-July           | 75 75 75   | N       |
| Fruits     | Roman      | Punica granatum      | Punicaceae  | Oct.-Dec., May-June| 90 90 75   | P,N     |
| Fruits     | Papaya     | Carica papaya         | Caricaceae  | Dec.-Janu, May-June| 115 115 115 | P       |
| Fruits     | Dubba/Buqo | Cucubita pepo         | Cucurbitaceae| May – Dec.         | 240 240 210 | P       |
| Fruits     | Apple      | Malus sylvestris      | Rosaceae    | Oct.-Nov.          | 45 -       | P       |
| Fruits     | Zeytun     | Psidium guajava       | Myrtaceae   | May-July, Oct.-Jan.| 210 210 210 | P       |
| Fruits     | Kokke      | Solanummunicatum     | Solanaceae  | Mar-June           | 120 120 105 | P       |

NB: P= Pollen, N= Nectar, Pr= Propolis, - = not available

Table 1: Lists of honeybee plants and their flowering seasons.

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its proper growth and setting flowers, the ideal requirements of most species for the above conditions are almost similar. In this regard, some plants such as Combretum species, Schefllera abyssinica, Polyscias fulva and Croton microstachys will bloom during the onset of minor rainy seasons (March to May). While the higher number of species are blooming following the heavy rainy seasons through September to November. However, the number of flowering plant species is highly declining during heavy rain seasons occurring through June to August and dry seasons occurring through December February (Figures 3-5).

**Major honeybee plants**

Blooming of plants is a continuous process throughout the year, while major bee plants blooming during certain seasons providing excess amounts of pollen and nectars [15]. According to Nuru et al [4] and Demissew [5], Ethiopia has an estimate of 7000 floral species. However, only few of which are identified as major bee plants in their contribution for honeybees. Identification of major bee plants in the study areas was undertaken through two methods; one is through prioritizing them from survey data and secondly through conducting field observation on the foraging intensities of foraging bees on each plant and their contribution for colonies performance. Accordingly, a total of twenty six species classified under seventeen families were identified/ranked as major bee plants (Table 2).

**Abundance of major honeybee plants**

The profitability of beekeeping does not merely depend on the availability of diverse floral species; rather it relies on the abundance of few but potential bee plant species [16,17]. The plant abundance/density/value of each plant species in Table 3 were rounded to 1.

![Figure 3: Number of flowering bee plant species.](image)

![Figure 4: Pollen Collection.](image)

Pollen grain of some major bee plants (a. Guizetia; b. Croton macrostachys; C. Vernonia species).
Table 2: Major Honeybee forages prioritized based on frequency of respondents.

| S.N | Local Name | Scientific Name | Family | Frequency of respondents (%) | Percent of respondents |
|-----|------------|-----------------|--------|------------------------------|------------------------|
| 1   | Buto       | Schefflera abyssinica | Araliaceae | 268                          | 99.25                  |
| 2   | Tufo       | Guizotia scabra   | Asteraceae | 263                          | 97.22                  |
| 3   | Wago       | Croton macrostachyus | Euphorbiaceae | 260                          | 96.11                  |
| 4   | Adey abeba | Bident species    | Asteraceae | 255                          | 94.44                  |
| 5   | Grawo      | Vernonia amygdalina | Asteraceae | 251                          | 92.78                  |
| 6   | Dengerito  | Vernonia auriculifera | Asteraceae | 226                          | 84.44                  |
| 7   | Di'o       | Chordia africana  | Boraginaceae | 225                          | 83.33                  |
| 8   | Yaho       | Olea welwitschii | Oleaceae | 218                          | 80.56                  |
| 9   | Yino       | Syzygium guineense | Myrtaceae | 210                          | 77.78                  |
| 10  | Bahiraf    | Eucalyptus species | Myrtaceae | 207                          | 76.67                  |
| 11  | Buna       | Coffee arabica   | Rubiaceae | 203                          | 75                     |
| 12  | Mogneabebe | Brugmansiasuaveolens | Solanaceae | 195                          | 72.22                  |
| 13  | Acibano    | Goania longiplicata | Rhamnaceae | 150                          | 55.56                  |
| 14  | Tikurabalo | Combretum collinum | Combretaceae | 135                          | 50                     |
| 15  | Wonbela    | Combretum brownie | Combretaceae | 135                          | 50                     |
| 16  | Butij      | Manilkara butugi | Sapotaceae | 132                          | 48.89                  |
| 17  | Wulkifa    | Dombeya torrid   | Sterculiaceae | 116                          | 42.78                  |
| 18  | Omo        | Prunus africana  | Rosaceae | 102                          | 37.78                  |
| 19  | Shedo      | Sapium ellipticum | Euphorbiaceae | 98                           | 36.11                  |
| 20  | YeferenjiNug | Helianthus annuus | Asteraceae | 96                           | 35.56                  |
| 21  | Nugo       | Guizotia abyssinica | Asteraceae | 93                           | 34.44                  |
| 22  | Dido       | Galiniera saoxifraga | Lamiaceae | 90                           | 33.33                  |
| 23  | Shachiao   | Brassica species | Asteraceae | 84                           | 31.11                  |
| 24  | Wondifo    | Apodytesdimidiata | Icacinaceae | 75                           | 27.78                  |
| 25  | Kentafa    | Pterolobiumstellatum | Fabaceae | 65                           | 24.07                  |
| 26  | Kacho      | Clematis longicauda | Ranunculaceae | 38                           | 14.07                  |

Report from the respondents indicated that though the area is endowed with diverse floral species, the abundance level of major bee plants is declining from time to time due to various anthropological factors which might be one of the cases for the reduction trends of colonies population. Similarly, Reichmann [18] also reported that deforestation has a noticeable impact on forest coverage of the areas from time to time. For instance, only in Kafa zone, annually an estimate of 22,500 hectares of forests will be distracted for the purpose of human settlements, agricultural expansion and fuels. According to various literatures acknowledged that integration of beekeeping with forest conservation practices found to be one of best mitigation options to boost the species richness and coverage through maximizing cross pollination services [19-21]. Hence, measures taken in scaling up the sub sector into a full time business for small scale farmers accompanied with appropriate market chain accesses is very crucial issue to restore the distraction of natural resources and related consequences.

Evaluation of seasonal performance of honeybee colonies

Pollen stores: Pollen is one of bees’ products regarded as valuable special food rich in proteins and other essential elements serving as crucial food sources for bees [22]. It is known for its various therapeutic effects for human beings [23]. The nutritive content of pollen varies based on the plant types it is collected revealing that pollen from multi floral sources can increase its nutritional competencies [24]. Honeybees collect pollen from the anthers of flowering plants, store it by adding small amounts of honey and enzymes which then will ripen to form beebread used as a main food sources for adult bees as well as rearing their broods [25]. Even though pollen collection is a continuous process, honeybees intensively collecting it during early flowering times of active seasons to build up their population prior of peak nectar collection. A colony with 10,000 - 15,000 population needs an estimate of 13.4 to 17.8 kilograms of pollen annually [26]. This revealed the sustainability of a colony is highly relying on the availability of ample pollen sources. Mostly, the pollen intake of colonies is subject to considerable fluctuation during the course of the year. Commonly, one or two distinct peak pollen collection seasons occurring a year which is highly determined with the flowering of potential locally abundant plants [27].

The pollen stores of colonies for each month was estimated in squared inch units (in²) considering the number of comb cells filled with pollen or beebread. The average pollen stores of the areas were found to be 186.68in², 179in² and 177in² ranging from 95.88in² to 338 in², 77in² to 351in² and 79in² to 417in² in high land, midland and low land areas respectively. The Overall annual pollen store of the study areas was found to be 180.81in² ranging from 84in² to 369.02in² (Table 4). The annual pollen store potentials of A.m. scutellata in the current study was found to be somehow greater than the result of A.m.

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jementica recorded to be 103.68in² [28] and the same race (A.m. Scutellata) studied in Guji Zone which was found to be 117.12in² [29]. The pollen store of Guji Zone which was found to be 244.64in². However, less brood area (149.12in²) was recorded for Carniolan bees (A.m.carnica) evaluated in sub-tropical environment [17]. The maximum brood areas were recorded during September to November followed by during March to April. However, the peak brooding season will be attained during October (Table 5).

Nectar stores: Nectar is an aqueous solution secreted from flowers of plants profoundly containing sugars mainly glucose, fructose and sucrose with traces of minerals and proteins. It serves as a floral reward for pollinators which is considered as plants’ adaptation to promote cross pollination [34-36]. There is significant variation of nectar in terms of its quality and quantity based on plant species. Honeybees are selective to forage from plants with good quality (high sugar concentration) and quantity of nectar which is highly determined by weather condition and rain fall patterns [16,37,38]. Honeybees collect nectar, reducing its moisture contents and undertaking some enzymatic actions to ripen it and storing for their later uses. Honeybees actively collecting nectar during peak flowering seasons and the amount they store will also vary based on the availability of nectar source plants in their surroundings [9]. The mean annual nectar store of the study areas were found to be 326.76in³, 304.71in³ and 298.58in³ ranging from 218.71in³ - 736in³, 192.36in³ - 545.05in³ and 161.57in³ - 599.4in³ for high land, mid land and low land areas respectively. The Overall average annual nectar store of the study areas was found to be 309.84in³ ranging from 193 in³ – 504.72in³ (Table 6). The current result was found to be somehow greater than the result of A.m. scutellata obtained in Guji Zone which was 262.28in³ [28] which could be varying due to abundance level of potential nectar source plants compared to the study areas. The peak nectar store of the area was recorded during March to April and October to November. Seasons from January to

Table 3: Abundance of Major bee plants.

| SN | Local name | Scientific name | Density |
|----|------------|----------------|---------|
|    |            |                | High lands | Mid lands | Low lands | Over all |
| 1  | Buto       | Schefflera abyssinica | 6 | 5 | 0 | 4 |
| 2  | Tufo       | Guizetta scabra  | 28,333 | 47,083 | 69,321 | 48,246 |
| 3  | Wago       | Croton macrostachyus | 3 | 4 | 3 | 3 |
| 4  | Adey abebe | Bidens species | 20,052 | 21,564 | 35,642 | 25,753 |
| 5  | Grawo      | Vernonia amygdalina | 10 | 12 | 10 | 11 |
| 6  | Dengerito  | Vernonia auriculifera | 6 | 8 | 9 | 8 |
| 7  | Di'o       | Chordia africana | 2 | 4 | 3 | 3 |
| 8  | Yaho       | Olea welwitschii | 4 | 3 | 1 | 2 |
| 9  | Yino       | Syzygium guineense | 1 | 2 | 2 | 2 |
| 10 | Bahiraz    | Eucalyptus species | 8 | 5 | 3 | 5 |
| 11 | Buno Buna  | Coffee arabica | 18 | 109 | 88 | 72 |
| 12 | Mogneabba  | Brugmansiasauvolens | 40 | 18 | 18 | 25 |
| 13 | Acibano    | Gounalionigispicata | 6 | 5 | 1 | 4 |
| 14 | Tikurabalo | Combretum collinum | 0 | 0 | 4 | 1 |
| 15 | Wonbela    | Combrum bronze | 0 | 0 | 2 | 1 |
| 16 | Butij      | Manilkara butigi | 2 | 1 | 1 | 1 |
| 17 | Wulkifa    | Dombeya torrid | 2 | 1 | 1 | 1 |
| 18 | Omo/ tikuricet | Prunus africana | 2 | 2 | 1 | 2 |
| 19 | Shedo      | Sapum ellipticum | 3 | 3 | 2 | 3 |
| 20 | Yeferenjilug | Helianthus annus | 1 | 1 | 2 | 1 |
| 21 | Nugo       | Guizotia abyssinica | 0 | 0 | 83,333 | 27,778 |
| 22 | Dido       | Gallinerassaxifraga | 7 | 5 | 2 | 5 |
| 23 | Shachiao   | Brassica species | 11,223 | 18,740 | 15,254 | 15,072 |
| 24 | Wondfo     | Apodytestesidimatale | 2 | 1 | 1 | 2 |
| 25 | Kentafa    | Pterolobiumstetallata | 1 | 2 | 4 | 2 |
| 26 | Kacho      | Clematis longicauda | 1 | 1 | 0 | 1 |

Table 4: Pollen store across seasons (in²); N=8.

| Seasons | Agro ecologies (Mean+SD) | Overall |
|---------|--------------------------|---------|
| January | 141.38± 36.36            | 120.05± 27.30 |
| January | 121.3± 45.99             | 104.33± 26.96 |
| March   | 286.56± 45.34            | 256.10± 47.46 |
| April   | 249.29± 58.02            | 218.19± 62.35 |
| May     | 192.46± 27              | 165.68± 46.90 |
| June    | 143.50± 31.13            | 130.52± 31.15 |
| July    | 125.5± 37.46             | 112.85± 36.60 |
| August  | 95.88± 20.06             | 84.19± 16.36 |
| September | 193.06± 37.98         | 225.72± 48.77 |
| October | 338.04± 70.79             | 369.02± 69.37 |
| November | 221.66± 74.7          | 239.32± 60.17 |
| December | 193.74± 43.48          | 149.45± 40.00 |
| Overall | 105.68± 84.54 | 180.81± 93.38 |

NB: letters with different superscript shows significant variation of mean values of pollen stores across months.

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February and June to August are considered as dearth periods when honeybees suffer from nectar and pollen shortages due to excessive dry season occurring through January to February and the heavy rainy seasons occurring through June to August (Table 6). Unlike pollen store, brood store and adult population, the nectar store distribution has shown significant variation at p<0.05 (sig. 0.02) among agro ecologies under Kruskal Wallis test of similarity.

**Adult bee population:** Adult bees comprise of a queen, hundreds of drones and thousands of worker bees. The population sizes of worker bees is a major concern in determining the strength of colonies which could be classified as weak, medium and strong colonies. The population size of adult bees might vary from colony to colony due to genotypic (brooding efficiency of the queen) and environmental (availability of potential flowers) effects [14,17]. The Mean annual population (n*10^3) of the areas was recorded as 15369, 16128 and 16301 ranging from 8850 - 24220, 8460 - 23835 and 8340 - 23670 for high lands, midlands and low lands respectively (Table 7). Similarly, colony population of Apis mellifera species ranging from 9,800 to 24,500 was reported by Bhusal et al [28]. The Mean annual adult population (n*10^3) of the study areas was calculated as 15948 ranging from 8,550 to 22,200 (Table 7).

**The relationship among pollen stores, nectar stores, brood area and adult population**

As depicted in Figure 6, there is a significant correlation among pollen store, nectar stores, brood areas and adult population of colonies at p< 0.01. In this regard, the pollen store of colonies was found to be 85.4% correlated with brood stores, 57.7% with nectar stores and 50.5% with adult population. The correlation of brood area with nectar stores and adult population of colonies. This shows abundance level of potential bee forages has a direct implication on the pollen and nectar storing ability of colonies which inter depend their population strength through high brooding efficiencies [39]. The foraging efficiency of honeybees is highly related with population size of worker bees. In this regard, a colony with huge number of foragers produces more product than more colonies with less number of populations [28]. Studies in same literature indicated an increment of 182%, 59% and 18% of honey yield was obtained from 10, 8 and 6 frames of adult bees compared to honey yield of 2.82kg obtained from a colony with 4-frames of adult bees. According to Cramp [9], due to its high nutritional richness, pollen is what honeybees are all about; basically to feed their young. As depicted in Figure 6, there is a significant correlation among pollen store, nectar stores, brood areas and adult population of colonies. This shows abundance level of potential bee forages has a direct implication on the pollen and nectar storing ability of colonies which inter depend their population strength through high brooding efficiencies [39].

**Table 5: Brood areas across seasons (in.²); N=8.**

| Months | Agro ecologies (Mean+SD) | Over all |
|--------|-------------------------|---------|
|        | High Land | Mid land | Low land |
| January | 188.62 ± 45.73 | 166.89 ± 40.75 | 125.8 ± 31.7 |
| February | 157.25 ± 30.27 | 154.68 ± 42.47 | 107.69 ± 18.09 |
| March | 333.31 ± 2.17 | 322.58 ± 27.25 | 282.5 ± 38.3 |
| April | 297.83 ± 3.13 | 278.38 ± 51.40 | 201.06 ± 30.49 |
| May | 267.56 ± 42.42 | 222.19 ± 50.66 | 162.63 ± 17.14 |
| June | 185.94 ± 33.33 | 172.81 ± 37.35 | 144.26 ± 25.98 |
| July | 165.56 ± 33.60 | 137 ± 35.89 | 124.44 ± 28.21 |
| August | 139.41 ± 73 | 119.20 ± 41.56 | 103.88 ± 29.81 |
| September | 225.94 ± 45.43 | 265.88 ± 41.86 | 334.75 ± 61.34 |
| October | 365.88 ± 74.77 | 383.75 ± 68.95 | 455.69 ± 54.27 |
| November | 291.69 ± 47.59 | 303.69 ± 36.33 | 401.50 ± 43.03 |
| December | 1817 ± 25.94 | 179.75 ± 32.53 | 229.31 ± 37.17 |
| Total | 233.29 ± 82.97 | 227.31 ± 90.59 | 227.51 ± 124.74 |

NB: letters with different superscripts shows significant variation of values mean brood population among months

**Table 6: Nectar store across seasons in squared inch (in²); N=8; p<0.05.**

| Months/seasons | Agro ecologies (Mean+SD) | Over all |
|----------------|--------------------------|---------|
|                | High Land | Mid land | Low land |
| January | 270.76±46.44 | 257.51±55.96 | 195.93±45.24 |
| February | 218.71±35.99 | 198.20±36.03 | 161.57±32.29 |
| March | 383.46±63.74 | 323.86±72.23 | 257.62±43.66 |
| April | 73.61±182.52 | 545.05±158.36 | 233.11±25.89 |
| May | 264.95±38.59 | 235.73±35.05 | 217.47±19.82 |
| June | 244.85±50.03 | 223.56±49.27 | 213±22.18 |
| July | 236.55±31.36 | 215.61±31.68 | 193.50±33.94 |
| August | 222.43±39.61 | 192.36±37.82 | 197.42±36.79 |
| September | 300±35.17 | 340.00±47.22 | 395.53±49.23 |
| October | 336.20±46.79 | 375.49±48.38 | 492.70±49.72 |
| November | 409.74±66.11 | 435.83±69.89 | 599.44±47.40 |
| December | 297.57±37.99 | 315.94±39.74 | 462.51±53.64 |

Total 326.76±152.06 304.17±20.10 298.58±145.95

Table 7: Adult bee population across seasons (n*10^3) N=8; p<0.05

| Months/seasons | Agro ecologies (Mean+SD) | Over all |
|----------------|--------------------------|---------|
|                | High Land | Mid land | Low land |
| January | 9.180±1.420 | 9.075±2.160 | 9.207±1.625 |
| February | 8.850±0.940 | 8.460±0.820 | 8.340±0.874 |
| March | 24.270±6.190 | 23.856±8.872 | 18.075±4.884 |
| April | 23.175±6.740 | 22.860±7.131 | 17.640±4.681 |
| May | 10.170±2.025 | 12.865±2.259 | 12.690±2.329 |
| June | 10.230±2.079 | 12.076±2.329 | 12.690±2.329 |
| July | 9.570±2.114 | 11.760±1.896 | 12.465±2.476 |
| August | 9.840±2.131 | 11.794±2.098 | 12.270±2.260 |
| September | 16.980±7.364 | 16.630±6.660 | 22.920±8.462 |
| October | 20.280±7.297 | 20.580±7.656 | 22.920±8.462 |
| November | 21.300±6.551 | 21.630±1.964 | 23.670±8.030 |
| December | 19.950±5.877 | 20.490±1.483 | 24.360±7.913 |
| Total | 15.369±7.57 | 16.128±530 | 16.301±7.503 |

Total 15.369±7.57 16.128±530 16.301±7.503

NB: S-significant variation of Adult bee population across seasons; NS - non significance of adult bee population across seasons

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of one honey types over the other [40-42]. Hence, in spite of obtaining additional income sources, consuming honey from different plant sources is also crucial to obtain important elements for human bodies. As noted from survey results, the majorities, about 212(78.5%) of the respondents harvest only once a year, 41(15.2%) of them harvest twice a year, 14(5.2%) of them harvest three times a year and 3(1.1%) of them practice harvesting up to four times a year. Similar studies by Beyene and Phillips [43] and Nuru [4] also indicated that in most parts of Ethiopia, there is once or twice; even some times three times major harvesting seasons. However, there are also other mini harvesting seasons depending on the availability of bee forages and rain fall patterns. In comparison with the existence of diverse potential floral species, the number beekeepers practicing multiple harvesting in the area are very less. This is basically due to the fact that most beekeepers practicing traditional forest beekeeping system by hanging the hives in forest trees during specific times basically about 1-2 months before the onset of major honey flow seasons and harvesting could undertaken after bringing the hives down of trees and totally removing the bees by splitting the hive logs a part. Under such types of beekeeping practices, it is inappropriate for harvesting honey during each mini harvesting season. Hence, keeping colonies in back yard system is a pre requisite to pursue proper colony managements and obtaining additional yields from multiple harvests. According to the beekeepers responses, even if beekeepers are practicing multiple harvests mainly to obtain additional incomes, some are also aimed with obtaining particular types of honey such as Vernonia species, Croton macrostachyus honey for their various therapeutic values.

In the areas, there are two peak honey flow seasons being from April to May which is considered as the major season for high land and mid land areas and from October to December which is the major season for low land areas (Figure 7). The variation of major harvesting seasons between agro ecologies is due to variations on the abundance level of potential plants types. Accordingly, the major nectar source plant for high land and mid land areas is Schefflera Abyssinica (‘Buto’-local name) whose blooming season occurs through March to April. Whereas, the major honey flow seasons for low land areas occurs through October to December related with the blooming season of Guizotiascabra (“Tufo”-local name) which is considered as minor seasons for high land and mid land areas. Actually, in some areas (in area with intense forest covers), the type of mono floral honey will be ‘Butui’honey(Manilkara Butugi) in case of Guizetia honey which is predominantly abundant in open areas. The peak harvesting season of Butugi-honey will occur during December.
In regard to the frequency of harvesting months of the respondents indicated that about 96.67% and 91.11% of them will harvest during May season for high land and mid land areas respectively. Whereas, 24.44% and 25.56% of them were also found harvesting during April in high lands and mid lands respectively. Other minor harvesting will also occur during June to July and January which is sourced from Croton macrostachyus and Vernonia species respectively. In some low land areas, considerable amount of honey will also be harvested from Combretum species (‘Abala’ and ‘wombela’) during March (Figure 7).

Honey yield

The honey yield data of each hive type for both major and minor seasons were collected from the respondent beekeepers. Accordingly, the (Mean±SD) honey yield (kg) of the areas during major season was found to be 7.28±2.95,18.48±4.61 and 26.13±6.56 for traditional, transitional and moveable frame hives respectively with significantly lower yield in lowland areas than mid land and high land areas. Whereas, it was found to be 4.05±1.97, 7.71±1.58 and 11.75±2.27 for traditional, transitional and moveable frame hives respectively during minor season (Table 8). The current result is equivalent with the report of honey yield of Apis mellifera scutellata in its potential environments [6,44-46].

Pollen analysis of honey samples

According to the pollen analysis of honey samples undertaken to identify the major six plants of the two major harvesting seasons being March to May (season-1) and October – December (season-2), Schefflera abyssinianates the greater pollen count both in High lands and Midland areas accounting for 50%–65% and 47%–60% which is considered as a mono floral honey [11]. Whereas Combrutum species is the major mono floral honey source in low land areas accounting for 28–62% pollen counts (Table 8). Guizotia abyssinica and manilkarabutij were become the major honey source plants across the three agro ecologies. According to the pollen analysis results indicated than honey samples collected from areas with better forest coverage had Manilkara butij honey. In contrast, the major honey source plants in areas with low forest coverage/farm lands were found to be Guizotia scabra and Biden sources though Guizotia abyssinica was the dominantsone (Table 9).

This revealed the type of honey produced in the area is highly influenced the abundance level of major honey source plants whose distribution is highly determined by agro ecological variation and levels anthropogenic impacts.

Season based colony manipulation

Based on the availability level of forages and status of bee colonies, commonly seasons could be classified into three major categories being the Dearth, the Buildup and the honey flow seasons [8,9]; each requiring distinctive colony manipulation practices [47].

The dearth seasons: Occur through January to February and May to August during which honeybees are exposed for shortages of pollen and nectar sources resulting for declining in broods and adults population. Following their starvation, it is also the time for being affected by various pests and diseases as colonies become weak for defending themselves. As a result, during such seasons, operations like provision of supplementary feeds substituting the pollen and nectar sources, reducing the hive spaces, uniting weak colonies to maintain their strength for the next active seasons are needed. However, due to the fact that the predominant numbers of beekeepers in

| Table 8: Honey yield (Kg) (Mean±SD) |
|-------------------------------------|
| **Hive types** | **Traditional** | **Transitional** | **Movable frame/box hives** |
| **Seasons** | **Agro ecologies** | **Mean±SD** | **Mean±SD** | **Mean±SD** |
| **Major** | | | | |
| High lands | 7.99±3.89 (83) | 19.66±4.81 (44) | 27.83±5.34 (40) |
| Mid lands | 7.22±2.52 (86) | 18.18±4.78 (34) | 26.82±7.33 (34) |
| Low lands | 6.66±2.08 (88) | 16.17±2.48 (18) | 20.94±4.90 (18) |
| Total | 7.28±2.95 (257) | 18.48±4.61 (96) | 26.13±6.56 (92) |
| **Minor** | | | | |
| High lands | 4.19±1.95 (21) | 7.93±1.69 (14) | 12.21±2.36 (14) |
| Mid lands | 4.83±2.73 (15) | 8.14±1.46 (7) | 11.71±1.89 (7) |
| Low lands | 3.29±0.69 (19) | 6.86±1.35 (7) | 10.86±2.48 (7) |
| Total | 4.05±1.97 (55) | 7.71±1.58 (28) | 11.75±2.27 (28) |

( ) - indicates number of respondents

Figure 7: Harvesting seasons of beekeepers.

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the areas are practicing traditional forest types of beekeeping system and lack of awareness, over 95% of beekeepers do not provide any feed supplements to their colonies. According to the report from the respondents, over 90% of absconding cases occur during these seasons.

The Buildup seasons: During which honeybees become busy in collection of much pollens for multiplying their population prior of peak nectar collection times. Perhaps, they will be more initiated to form multiple queen cells to form independent swarms. During these seasons, colony manipulations like queen rearing, increasing the hive spaces, colony transferring will be undertaken. In the study areas, the peak building up seasons will occur during October and March.

The Honey flow seasons: During which honeybees collect nectar abundantly to store it for their later uses. The peak honey flow seasons of the areas occur during April and November. Based on the production levels, the first is considered as major honey flow season and the later as minor harvesting season for high land and mid land areas; where as vice versa for lowland areas. In spite of various cares taken during pre and post harvesting times to obtain better product in terms of quality and quantity; such as avoiding over smoking, selecting calm days for harvesting(avoiding harvesting during humid days), using food graded storages, etc, determining the right time of harvesting seasons at which most parts of honey combs get ripened for harvesting is also very crucial to obtain better quality product as ripened honey has minimum water content which is considered as one of major detrimental factor for its shelf life [48,49]. Accordingly, the peak harvesting seasons of the areas will be attained during May and November-December.

**Conclusion and recommendation**

As a conclusion, in related ample precipitations and favorable environments, the area is enriched with diverse floral species important for honeybees in providing either pollen, nectar, propolis or a combination of these resources for bees. The diverse floral species creates an opportunity for bees to access forages throughout most seasons which also considered as golden opportunity to obtain a valuable and additional honey yield of various botanical origins from multiple harvestings. Hence, from the current study, the following points could be forwarded as recommendation;

- Advancing the current widely practiced traditional forest types of beekeeping system into improved/backyard system accompanied with appropriate seasonal colony management practices are imperative to maximize honey yield from multiple harvestings.
- The sustainability of beekeeping is highly reliable on the abundance of potential floras in the near surroundings of beekeeping areas. In this regard, despite the normal perpetuation of plants under natural conditions, the efforts taken to conservation and rehabilitation of such plants are almost nonexistent. Hence, conservation measures especially in focus of increasing the abundance of potential bee plants should be a due focus issue.
- The nectar secretion efficiency of major bee plants across agro ecologies need follow up studies to determine the carrying capacities of each locality.
- The current study focuses only one bee species (i.e., honeybees); and detailed investigation on seasonal colony status, honey harvesting seasons and identification of potential floras for other important bee species like stingless bees need follow up studies.
- In some localities, the traditional practice/Kobo system’; owner ship of forest/trees for hanging hives which passes over successive generations might considered as opportunity for achieving improved ways mitigation options for natural resource conservation.

Furthermore, detailed analysis on physico-chemical composition and nutritional values of each mono floral honey sources including mini harvesting seasons is very essential to initiate conservational measure for floral species.

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**Table 9:** Pollen counts of major plants in honey samples (in %).

| Major Seasons | Plant name | Pollen counts |
|---------------|------------|---------------|
| Season-1 (Mar.- May) | - Schefflera abyssinica | 50-65 |
| | - Guizotia Scabra | 10-30 |
| | - Croton microstachys | 2-13 |
| | - Eucalyptus species | 1-7 |
| | - Vernonia amygdalina | 0-21 |
| | - Bersema abyssinica | 2-8 |
| | - Guizotia scabra | 20-60 |
| | - Bidens species | 0-80 |
| | - Manilkara butij | 0-8 |
| | - Eucalyptus species | 0-5 |
| | - Syzygium guenesis | 0-7 |
| | - Coffee arabica | 0-7 |
| | - Rumex abyssinica | 0-7 |
| Season-2 (Oct. - Dec.) | - Schefflera abyssinica | 47-60 |
| | - Guizotia Scabra | 20-30 |
| | - Croton microstachys | 7-12 |
| | - Eucalyptus species | 0-3 |
| | - Vernonia amygdalina | 0-13 |
| | - Bersema abyssinica | 2-8 |
| | - Guizotia scabra | 35-82 |
| | - Manilkara butij | 0-70 |
| | - Bidens species | 20-64 |
| | - Eucalyptus species | 0-8 |
| | - Coffee arabica | 0-7 |
| | - Rumex abyssinica | 0-6.2 |

**High Land/Mid Land/Low Land**

| Plant name | Pollen counts |
|------------|---------------|
| High Land | Mid Land | Low Land |
| - Schefflera abyssinica | 28-62 |
| - Guizotia scabra | 20-35 |
| - Croton microstachys | 5-23 |
| - Eucalyptus species | 0-9 |
| - Vernonia amygdalina | 0-11 |
| - Bersema abyssinica | 0-5.2 |
| - Guizotia scabra | 38-85 |
| - Manilkara butij | 15-80 |
| - Bidens species | 20-67 |
| - Eucalyptus species | 0-12 |
| - Syzygium guenesis | 0-9 |
| - Rumex abyssinica | 1.2-10 |

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References

1. Abadi B, Abebe A, Delenasaw Y (2016) Community Perception on Beekeeping Practices, Management, and Constraints in Tarmaber and Basona Wereda Districts, Central Ethiopia. Hindawi Publishing Corporation Advances in Agriculture 2016: 4106043. Link: https://bit.ly/3lWkHyd

2. Yilibeh T (2008) Review on: Beekeeping practices, Opportunities, Marketing and challenges in Ethiopia. Journal of Dairy and Veterinary Science 5.

3. Haftey S, Gashaw E, Ayalew N, Tsehaye N (2018) Assessment of honey production system, constraints and opportunities in Ethiopia: Review. International Journal Pharmacy & Pharmacology 6: 42-47. Link: https://bit.ly/3ITTMG

4. Nur A (2008) Atlas of pollen grains of major honeybee flora of Ethiopia. Holeta Bee Research Centre. Commercial Printing Enterprise. Addis Ababa, Ethiopia 152.

5. Demissew W (2016) Bee keeping in Ethiopia: Country situation paper. The 5th ApiExpo Africa, September 2016. Kigali, Rwanda.

6. Awraris G, Yemisrach G, Dejen A, Nuru A, Gebeyehu G, et al. (2012) Honey production systems (Apis mellifera L.) in Kaffa, Sheka and Bench-Maji zones of Ethiopia. Journal of Agricultural Extension and Rural Development 4: 528-541. Link: https://bit.ly/3fVj3kK

7. Janet L, Andrian W (2014) A discussion of the importance of forest beekeeping and commercial honey and beeswax trade for the sustainable management of natural forests in SW Ethiopia. Bees for Development and University of Huddersfield, UK. Link: https://bit.ly/3fW9Kol

8. UNBS (Uganda National Bureau of Standard) (2006) Code of Practice for apiary management, handling and processing of bee-products. First Ed. Kampala, Uganda. Link: https://bit.ly/2ZbfMAF

9. Cramp D (2008) Pollen Collecting. A practical manual of Beekeeping. ed 36. Link: https://bit.ly/3APDNP

10. Sisay N (2008) Flora Biodiversity Assessment in Bonga, Boginda and Mankir Forest, Kafa, Ethiopia. Submitted to PPP-project, Addis Ababa, Ethiopia. Link: https://bit.ly/3j6fJWt

11. Louiseaux J, MaurizioA, Vorwogh G (1978) Methods of melissopanology. Bee World 59: 139-157. Link: https://bit.ly/3wrgoFX

12. Delaplance KS, Van der steen J, Guzman E (2013) Standard methods for estimating strength parameters of Apis mellifera colonies. In V Dietemann; J D Ellis; P Neumann (Eds) The ColossoBeebook, Volume I: standard methods for Apis mellifera research. Journal of Apicultural Research 52: 1-12. Link: https://bit.ly/3AYG5b8

13. Tesfaye B, Kitessa H, Ensermu K (2013) Floristic Composition and Structural Changes Areas in Ethiopia: Status and Future Prospects. journal of Biology, Agriculture and Healthcare 6. Link: https://bit.ly/3DTESmT

14. Tesfaye B, Kiteesa H, Ensermu K (2013) Floristic Composition and Structural Changes Areas in Ethiopia: Status and Future Prospects. Journal of Biology, Agriculture and Healthcare 6. Link: https://bit.ly/3DTESmT

15. Kazafy E, Abdou T (2015) A study on nectar and pollen sources for honeybee, Apis mellifera L in Al-Asha Saudi Arabia. Journal of Entomology and Zoology Studies 3: 272-277. Link: https://bit.ly/3BZjHyL

16. Ahmed AG, Nur A, Awraris G, Yilma T (2014) New approach for determination of an optimum honeybee colony’s carrying capacity based on productivity and nectar secretion potential of bee forage species. Saudi Journal of Biological Sciences 23: 92-100. Link: https://bit.ly/3p9g4g1F

17. Nur A, Ahmed A, Yilma T, Awraris G, Awad M, et al. (2017) Nectar secretion dynamics and honey production potentials of some major honey plants in Saudi Arabia. Saudi Journal of Biological Sciences 24: 180-191. Link: https://bit.ly/3DEVEz7Q

18. Riechmann D (2007) Introduction of sustainable coffee production and marketing complying with international quality standards using the natural resources of Ethiopia. Literature Survey on biological data and research carried out in Bonga area, Kafa, Ethiopia.

19. Manrique AJ, Thimmann RE (2002) Coffee arabica pollination with Africanized honeybees in Venezuela. Journal of Network of Scientists from Latin America, the Caribbean, Spain and Portugal. Non-profit academic project, developed under the open access initiative 27. Link: https://bit.ly/3n1eHn0

20. Segeren P (2004) The value of beekeeping for pollination. Beekeeping in tropics (5'ed.). Digigraph, Wageningen, the Netherlands.

21. Guesh D, Asaminew T (2016) Importance of Integrating Beekeeping with Closure Areas in Ethiopia: Status and Future Prospects. journal of Biology, Agriculture and Healthcare 6. Link: https://bit.ly/3DTiz0i

22. Bradbear N (2009) Non-wood Forest Products: Bees and their role in forest livelihoods. A guide to the services provided by bees and the sustainable harvesting, processing and marketing of their products. Rome, Italy. Link: https://bit.ly/2Z7NdNn

23. Bogdanov S (2004) Quality and standards of Pollen and Beeswax. AIPACTA, 38: 334-341. Link: https://bit.ly/3nOan04

24. Alaux C, Ducloz F, Crauser D, Le Conte Y (2010) Diet effects on honeybee immune competence. Biol Lett 6: 562–565. Link: https://bit.ly/3C9EyQd

25. Mutsaers M, Blitterswijk H, Leven L, Kerkvliet J, Waerd J (2005) Bee products. Properties, Processing and Marketing. In M. Mutsaers (Ed.), Agrodok Series 42. Wageningen, the Netherlands.

26. Avni D, Hendriksma HP, Dag A, Uni Z, Shafir S (2014) Nutritional aspects of honey bee-collected pollen and constraints on colony development in the eastern Mediterranean. J Insect Physiol 69. 65-73. Link: https://bit.ly/3WFXpDs

27. Keller I, Fluri F, Indore A (2015) Pollen nutrition and colony development in honey bees-Part II. Swiss Federal Research Station for Animal Production and Dairy Products (ALP). Bee Research Centre, Liebefeld, CH-3003 Bern. Link: https://bit.ly/3A4qjT

28. Awad M, Ayman A, Abdelzeiz S (2016) Performance of two honeybee species during harsh weather and Acacia gerrardii nectar-rich flow. Scientia Agricola 74: 474-480. Link: https://bit.ly/3gwWMHH

29. Tadele A, Gemechis L, Zewdu A (2014) Performance Evaluation of Honeybee (Apis mellifera scutellata) in Guji Zone. International Journal of Innovation and Applied Studies 9: 1987-1993. Link: https://bit.ly/3phltrl

30. Bhushal S.J, Lekhnath K, Resham BT, Cheng JS (2011) Effect of Colony Strength on the Performance of Honeybees (Apis mellifera) in Nepal. In Hymenoptera Apidae. Journal of Socio Biology 58: 435-447. Link: https://bit.ly/3BYG7Nu

31. Gregory P (2011) The life of the Bee. The Basic Beekeeping Manual. 3rd edition, March 2011. Ed. Gay Marris. UK, National Bee Unit (the Food and Environmental Research Unit).

32. Sihar RC, Kaur G (2018) Patterns of short- and long-term responses of honeybee (Apis mellifera L.) colony to changes in its internal environment. Journal of Ecology and the Natural environment 10: 108-128. Link: https://bit.ly/3DTEsmt
33. Mid Atlantic Apiculture Research and Extension Consortium (MAAREC) (2005) Seasonal cycles of activities in honey bee colony. Honeybees Biology. Link: https://bit.ly/3jBI1WD

34. Clara I, Miguel A (2012) A review on: Plant biodiversity enhances bees and other insect pollinators in agro ecosystems. Journal of Agronomy for Sustainable Development 33: 257-274. Link: https://bit.ly/3BVmWSA

35. Mohammed AE, Mogbel EN, Tallat DA (2013) Identification of botanical origin and potential importance of vegetation types for honey production in the Sudan. Journal of Natural Resources and Environmental Studies 1. Link: https://bit.ly/3AUwTUB

36. WAC (World Agroforestry Center) (2015) Beekeeping for honey production training to benefit Lamu farmers and boost biodiversity conservation efforts. The Link: A newsletter of ICRAF’s Eastern and Southern Africa Region 9. Link: https://bit.ly/3AYy7Yq

37. Boleslaw Jand ZbigniewK (2005) Nectar Secretion and Honey Potential of Honey-plants growing under Poland’s Conditions–Part Xv. Journal of Apicultural Science 49: 59-63. Link: https://bit.ly/30yHVSx

38. Abdulaziz S, Hassan M, Ayman A (2013) Performance Evaluation of indigenous and exotic honeybee(Apis mellifera L.) races in Assir region, Southwestern Saudi Arabia. Saudi Journal of Biological Science 21: 256-264. Link: https://bit.ly/3BVw3Q

39. Kangave A, Butele CA, Onzoma A, Kato A (2012) Floral Calendar and Bee Keeping. The National Beekeeping Training and Extension manual 34. Link: https://bit.ly/3votdch

40. Valeria PA (2010) Determination of Quality chemical parameters of Honey from Chubut (Argentinean Patagonia). Chilean Journal of Agricultural Research 70: 640-645. Link: https://bit.ly/3FZCSL7

41. Laleh ML, Esmaiili M (2012) Honey & Honey Adulteration Detection: A Review. Department of Food Science and Technology, University of Urmia, Iran.

42. Efflen L (2013) Current Issues and Trends of Honey Quality in the Global Honey Market. Intertake Food Services, Bremen Germany.

43. Beyene T, Phillips D (2007) Ensuring Small Scale Producers in Ethiopia to Achieve Sustainable and Fair Access to Honey Markets. 64.

44. Chala K, Taye T, Kebede D (2013) Assessment of Honey Production and Marketing System in Gomma District, Southwestern Ethiopia. Greener Journal of Business and Management Studies 3: 099-107. Link: https://bit.ly/3RWEA9

45. Yoshimasa ITO (2014) Local honey production activities and their significance for local people: a case of mountain forest area of southwestern Ethiopia. African Study monography 48: 77-97. Link: https://bit.ly/3BHYHm0

46. Teklu G, Dinku N (2016) Honeybee Production System, Challenges and Opportunities in Selected Districts of Gedeo Zone, Southern Nation, Nationalities and Peoples Regional State, Ethiopia. International Journal of Research-Granthaalayah 4. 49-63. Link: https://bit.ly/30znBAX

47. AHBC (Australian Honeybee Industry Council) (2008) Participants learning Guide: on managing honeybee swarms. Beekeeping certificate III. Australian Government, Department of Agriculture, Fisheries and Forestry.

48. Fredris D, Peteris K, Ize C, Mara K (2006) The criteria for Honey quality and itschandes during Storage and Thermal treatment. LLU, Raksti 16: 73-78. Link: https://bit.ly/3jdfIak

49. Gallmann P, Thomas H (2012) Beekeeping and honey production in southwestern Ethiopia 1–24. Link: https://bit.ly/3AP3CKN