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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 with 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 200floral species categorized under 77families 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 butij* 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 *Combritum 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

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nectar sources as a number potential plants flowering at a time [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 [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 etc. 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 [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(fifteen) 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, ninecolonies 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

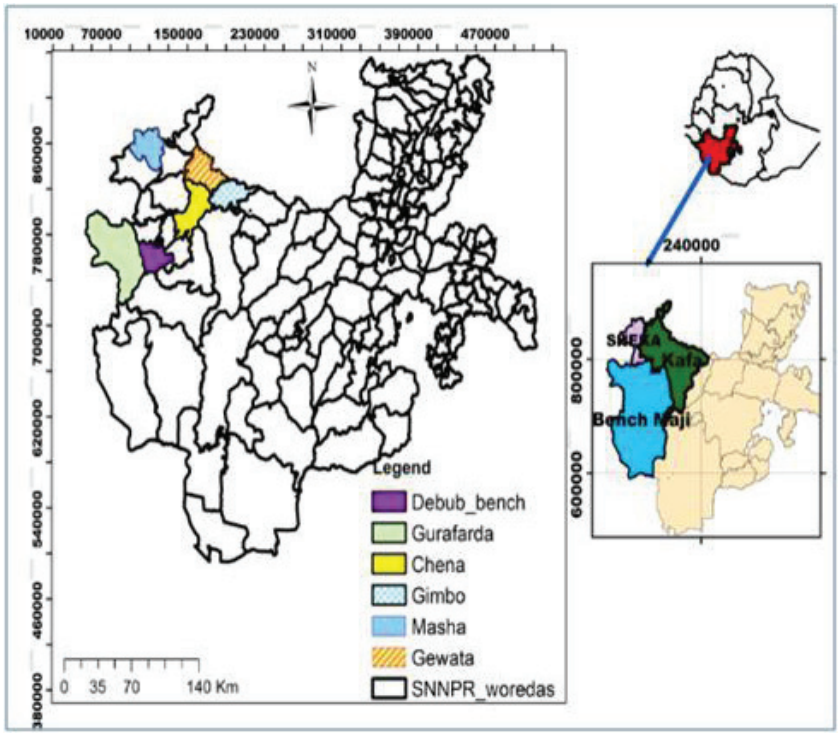

Figure 1: Map of study areas.

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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 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).

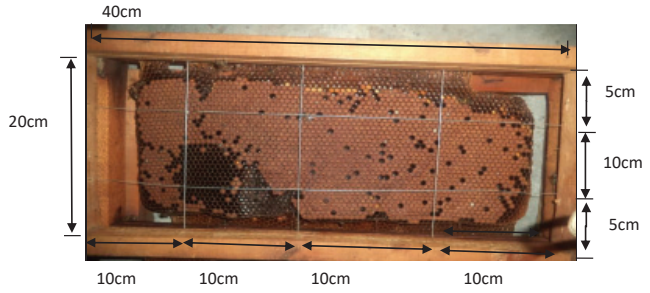

Figure 2: Deep frame area estimation.

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 by1m 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

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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***, *Phytolaccaceae*, *Pedaliaceae*, *Poaceae*, *Acanthaceae*, *Agavaceae*, *Anacardiaceae*, *Apiaceae*, *Apocynaceae*, *Aquifoliaceae*, *Araliaceae*, *Arecaceae*, *Basellaceae*, *Boraginaceae*, *Brassicaceae*, *Caricaceae*, *Celastraceae*, *Combretaceae*, *Dracaenaceae*, *Commelinaceae*, *Convolvulaceae*, *Crassulaceae*, *Capparidaceae*, *Cucurbitaceae*, *Cyperaceae*, *Ericaceae*, *Euphorbiaceae*, *Fabaceae*, *Polygonaceae*, *Guttiferae*, *Icacinaceae*, *Moraceae*, *Lamiaceae*, *Lauraceae*, *Linaceae*, *Malvaceae*, *Meliaceae*, *Melianthaceae*, *Loganiaceae*, *Moraceae*, *Moringaceae*, *Annonaceae*, *Musaceae*, *Myrsinaceae*, *Myrtaceae*, *Oleaceae*, *Oliniaceae*, *Onagraceae*, *Piperaceae*, *Plantaginaceae*, *Poaceae*, *Proteaceae*, *Punicaceae*, *Ranunculaceae*, *Resedaceae*, *Rhamnaceae*, *Rosaceae*, *Rubiaceae*, *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*, *Cordiaafricana*, *Eucalyptusspecies*, *Polysciasfulva*, *Prunusafricana*, *Combretumcollinum*, *Combritumbrownie*, *Syzygium guineense*, *Sapim ellipticum*, *Allophyllus abyssinicus*, *Euphorbia abyssinica*, *Ehretia cymosa*, *Acacia abyssinica*, *Acacia lahai*, *Acacia mellifera*, *Albizia* species, *Calpurnia aurea*, *Leucaena leucocephala*, *Maesa lanceolata*, *Ficus sur*, *Brucea antidysenterica*, *Ficus vasta*, *Piliostigma thonningii*, *Olea welwitschii*, *Dombeya torrida*, *Manilkara butugi*, *Vepris dainellii*, *Piper nigrum*, *Hagenia abyssinica*, *Olivia rochetiana*, *Erio botryajaponica*, *Grevillea robusta*, *Dracaena steudneri*, *Trichilia dregeana*, *Ekebergia capensis*, *Bersama abyssinica*, *Millettia ferruginea*, *Moringa oleifera*, *Aningeria altissima*, *Celtis africana*, *Grewia species*, *Brucea antidysenterica*, *Erythrina abyssinica*, *Spathodea nilotica and Apodytes dimidiata* were tree species. fifty four(27%) *of them beingVernonia amigdalina*, *Vernonia adoensis*, *Vernoniaauriculifera*, *Vernoniacongolensis*, *Vernonia filigera*, *Vernonia rueppellii*, *Vernonia thomsoniana*, *Phoenix reclinata*, *Carissa spinarum*, *Justicia schimperiana*, *Robus species*, *Sida rhombifolia*, *Hibiscus berberidifolius*, *Hibiscus ludwigii*, *Caesalphiniade capetala*, *Calistemon citranus*, *Pavetta abyssinica*, *Combretum collinum*, *Dracaena steudneri*, *Rhamnus prinoides*, *Dodonaea angustifolia*, *Brugmansia suaveolens*, *Lantana camara*, *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*, *Solanium dasyphyllum*, *Allophyllus macrobotrys*, *Plectranthus burorum*, *Erica genus*, *Ilex mitisL.*, *Dalbergia lacteal*, *Cajanus cajan*, *Rhusglutinosa*, *Phytolaccadodecandra*, *Cleomegynandra*, *Solaneciogigas*, *Ricinuscummunis*, *Morus alba*, *Bersemma abyssinica*, *Buddlejadavidiiand Clerodendrumspecieswere* shrubs; fifty one (25.5%) of them being *Guizotiascabra*, *Satureja paradoxa*, *Trifolium species*, *Vernonia leopoldi*, *Vernonia unionis*, *Biden prestinaria*, *Biden macroptera*, *Biden pachyloma*, *Cineraria abyssinica*, *Crassocephalummacropappum*, *Dicrocephala chrysanthemifolia*, *Nicadra physaloides*, *Lagger acrispata*, *Parthenium hysterophorus*, *Tagetes minuta*, *Pycnostachy seminii*, *Xanthium spinosum L.*, *Caylusea abyssinica*, *Hypericum species*, *Plectranthus burorum*, *Plantago lanceolata*, *Datura stramonium*, *Carduus species*, *Ipomoea species*, *Solanum nigrum*, *Galinsoga parviflora*, *Bothrioclines chimperi*, *Biden spilosa*, *Justitia ladanoides*, *Phaulopsis imbricate*, *Cyperus species*, *Hypoestes forskaolii*, *Isoglossa species*, *Zantedeschiaa ethiopica*, *Triumfettar homboidea*, *Girar diniabullosa*, *Physalis lagascae*, *Salvia leucantha*, *Anethum graveolens*, *Ageratum houstonianum*, *Anthemisti greensis*, *Commelina benghalensis*, *Urtica simensis*, *Clerodendron myricoides*, *Datura stramonium*, *Discopodium penninervium*, *Kalanchoedensi flora*, *Crotalaria species*, *Rumex abyssinicus and Sparrmanniaricinocarpawere herbs*; seventeen(8.5%) of them being *Combretum paniculatum*, *Goiania longipicata*, *Ptrolobium stellatum*, *Mikaniopsis clematoides*, *Clematis longicauda*, *Microglossa pyrifolia*, *Clematis hirsuta*, *Gymnemasyl vestre*, *Basella alba*, *Helinus mystacinus*, *Gouania longispicata*, *Apomoea species*, *Cucurbita species*, *Zehneria scabra*, *Mimosa invisa*, *Rhoicissus tridentata and Desmodium species were climber*; fourteen(7%) of them being *Guizotia abyssinica*, *Zeya mays*, *Coffee arabica*, *Ocimum basilicum*, *Helianthus annuus*, *Brassica species*, *Sorghum bicolor*, *Vicia faba*, *Linumusitatis simumL.*, *Pisum sativum*, *Sesamum indicum*, *Piper capense*, *Coriandrum sativum L. and Phaseolus specieswere crops*; Seventeen(8.5%) *of them beingLycopersiconesculentum*, *Capsicum annuum*, *Solanum tuberosum*, *Mangifera indica*, *Persea americana*, *Citrus aurantiifolia*, *Citrus simensis*, *Citrus medica*, *Citrus deliciosa*, *Annonaspecies*, *Musaspecies*, *Punica granatum L.*, *Carica papaya*, *Cucurbita pepo*, *Psidium guajava L. and Solaniummuricatum* were 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, Sisay [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 till 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 secretions [14]. Though each plant species has its own requirements for the amounts of rain falls, temperature and sun light intensities for

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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
				HL	ML	LL	HL	ML	LL	
Trees	Buto	*Schefflera Abyssinica*	*Araliaceae*	March-April	March-April	-	60	60	-	N
	Wago	*Croton macrostachyus*	*Euphorbiaceae*	Apri- July	April - July	April- June	98	89	75	P ,N
	Di'o	*Cordia africana*	*Boraginaceae*	May -Sept.	May -Sept.	May - Sept.	150	141	135	N
	Bahirzaf	*Eucalyptus* species	*Myrtaceae*	Nov.-Dec.; Mar-June.	Nov.-Dec.; Mar-June.	Nov.-Dec.; Mar.-May	150	130	142	P ,N
	Keresho	*Polyscias fulva*	*Araliaceae*	Mar. –April	Mar.- April	Mar..-April	60	60	53	P ,N
	Omo	*Prunus africana*	*Rosaceae*	Oct.-Nov.	Oct.– Nov.	Oct.– Nov.	50	46	40	P ,N
	Tikurabalo	*Combretum collinum*	*Combretaceae*	-	-	Mar.- April	-	-	40	P ,N
	Wonbela	*Combritumbrownie*	*Combretaceae*	-	-	Mar.-April	-	-	45	P,N
	Yino	*Syzygiumguineense*	*Myrtaceae*	Dec.-Janu.	Dec.- Janu.	Dec.- Janu.	30	35	36	P ,N
	Shedo	*Sapium ellipticum*	*Euphorbiaceae*	Dec.-Janu.	Dec.-Janu.	Dec.-Janu.	55	47	45	P ,N
	She'o	*Allophyllusabyssinicus*	*Asteraceae*	May-Nov.	May-Nov.	May-Nov.	86	80	77	P ,N
	Gacho	*Euphorbia abyssinica*	*Euphorbiaceae*	Nov.- Dec.	Nov. -Dec.	Oct.- Nov.	52	47	40	N, Pr
	Wogammo	*Ehretiacymosa*	*Boraginaceae*	Nov.-Janu.	Nov.-Jan.	Nov.-Janu.	75	75	58	N
	Bazragrar	*Acacia abyssinica*	*Fabaceae*	Dec.- May	Dec.- May	Dec.-May	162	162	150	P
	Gerbi/girar	*Acacia lahai*	*Fabaceae*	March- May	Mar.- May	Mar.- May	85	82	80	P
	Alaro	*Acacia niloticus*	*Fabaceae*	Mar.-May	Mar.-May	Mar.-May	85	82	80	P
	Tukur girar	*Acacia mellifera*	*Fabaceae*	Mar.- May	Mar.- May	Mar.-May	85	85	82	P
	Ohiyo/sesa	*Albizia species*	*Fabaceae*	April – May	April- May	Apr- May	38	38	35	P
	Digitta	*Calpurnia aurea*	*Fabaceae*	Nov.-Janu.	Nov.-Janu.	Nov.-Janu.	50	45	45	P
	Lukina	*Leucaena leucocephala*	*Fabaceae*	Sept.–Dec.	Sept.-Dec.	Sept.–Dec.	110	110	100	P
	Kelewa	*Maesalanceolata*	*Myrsinaceae*	Aug.- Sept.	July -Sept.	July – Sept.	55	56	55	N
	Charo	*Ficus sur*	*Moraceae*	May –June	May- June	May–June	35	35	30	P,N,pr
	Nugesho	*Bruceaantidysenterica*	*Simaroubaceae*	Sept. - Nov.	Sept.-Nov.	Sept.- Oct.	75	75	60	P,N
	Mielo	*Ficusvasta*	*Moraceae*	May – June	May- June	May- June	35	35	30	P,N,pr
	Yekolawanza	*Piliostigmathonningii*	*Fabaceae*	-	-	May – June	-	-	40	P;N
	Yaho	*Olea welwitschii*	*Oleaceae*	Dec.– Janu.	Dec.- Janu.	Dec.- Janu.	30	30	28	N
	Wulkifa/Shewuko/	*Dombeya torrid*	*Sterculiaceae*	Oct.-Dec.	Oct. - Dec.	Oct.-Dec.	80	80	70	N
	Butij	*Manilkara butugi*	Sapotaceae	Nov.-Jan.	Nov.- Jan.	Nov.Janu.	45	45	35	P,N
	Adesse	*Veprisdainellii*	*Rutaceae*	Nov.-January	Nov.-Janua	Nov.-Janu.	90	90	85	P,N
	Kondo bereberie	*Piper nigrum*	*Piperaceae*	Sept.-Oct.; Jan.-Mar	Sept.-Oct.; Jan.-Mar.	Sept.-Oct.; Jan.-Feb.	85	85	73	P;N
	Koso	*Hagenia abyssinica*	*Rosaceae*	Oct.-Dec.	-	-	90	-	-	P,N
	Beye	*Olivia rochetiana*	*Oliniaceae*	Janu.-May	Janu.-May	Janu. –May	135	130	130	P,N
	Bosoka	*Eriobotrya japonica*	*Rosaceae*	Sept.-Dec.	Sept.-Dec.	Sept.-Dec.	90	90	80	P,N
	Gravillia	*Grevillea robusta*	*Proteaceae*	Oct.-Janu	Oct.-Janu.	Oct.-Janu.	115	115	98	P,N
	Chewie	*Dracaena steudneri*	*Dracaenaceae*	Oct - Dec.	Oct-Dec.	Oct-Dec.	75	75	80	P
	Luiya	*Trichiliadregeana*	*Meliaceae*	Nov.-Mar.	Nov- Mar.	Nov.- Mar.	130	120	120	P,N
	Ororo	*Ekebergiacapensis*	*Meliaceae*	March .- June	March.- June	March.- June	100	90	75	P,N
	Boko	*Bersema abyssinica*	*Melianthaceae*	Janu.-May	Janua.-May	Janua.- May	130	130	105	P,N
	Bibiro	*Millettiaferruginea*	*Fabaceae*	Mar.- May	Mar. -May	Febr – May	70	60	53	P;N
	Shiferaw	*Moringa oleifera*	*Moringaceae*	Febr.-May	Febr.- May	Febr.-April	92	110	82	N
	Kerero	*Aningeriaaltissima*	*Sapotaceae*	Nov.-Feb	Nov.-Feb	Nov.-Feb	100	90	85	N
	Shishu	*Celtis africana*	*Ulmaceae*	May-June	May-June	May-June	43	43	50	P
	Aroressa	*Grewia* species	*Thymelaeaceae*	-	Sept.-Nov.	Sept.-Nov.	-	45	40	P
	Nukesho	*Bruceaantidysenterica*	*Simaroubaceae*	Sept-Nov.	Sept-Nov.	Sept-Nov.	45	45	30	P,N
	Korch	*Erythrina abyssinica*	*Fabaceae*	Nov. –Janu	Nov. –Janu	Nov. -Janu	90	90	90	P,N
	Tsedaki	*Spathodeanilotica*	*Bignoniaceae*	April-Aug.	April-Aug.	April-Aug.	140	140	130	N
	Wondifo	*Apodytesdimidiata*	*Icacinaceae*	Dec.- Mar.	Dec.- Mar.	Dec.- Mar.	115	110	105	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
				HL	ML	LL	HL	ML	LL	
Shrubs	Dengerito	*Vernonia auriculifera*	*Asteraceae*	Janu.- Mar.	Janu.- Mar.	Jan.– Febr.	65	60	50	P;N
	Grawo	*Vernonia amigdalina*	*Asteraceae*	Janu. -Mar.	Janu. –Mar.	Jan. – Febr.	65	57	40	P;N
	Yeferes Zeng	*Vernonia adoensis*	*Asteraceae*	Sept.- Dec.	Sept.-Dec.	Sept. - Nov.	105	100	75	P,N
	Tambora	*Vernonia congolensis*	*Asteraceae*	Oct.- Dec.	Oct.- Dec.	Oct.- Dec.	95	90	73	P,N
	Hamaka	*Vernonia filigera*	*Asteraceae*	Oct.- Dec.	Oct.- Dec.	Oct.- Dec.	95	90	73	P,N
	Gujo	*Vernonia rueppellii*	*Asteraceae*	Oct.-Febr.	Oct.-Febr.	Oct.-Febr.	130	130	120	P,N
	Soyoma	*Vernonia thomsoniana*	*Asteraceae*	Oct.-Dec.	Oct.-Dec.	Oct. – Dec.	90	90	80	P,N
	Yeebboo	*Phoenix reclinata*	*Arecaceae*	Nov. – Janu.	Nov.– Janu.	Nov. – Janu.	55	55	50	N
	Agam	*Carissa spinarum*	*Apocynaceae*	Febr. - April	Febr.- Mar,	Febr.- Mar.	60	45	45	N
	Tumoga/sensel	*Justicia schimperiana*	*Acanthaceae*	Oct.- Dec.	Oct.- Dec.	Oct.- Dec.	70	70	60	P;N
	Njorie	*Robus* species	*Rosaceae*	Dec. – Febr.	Dec.- Febr.	Dec.- Janu	65	65	50	N
	Gorjejit/chifrig	*Sidarhombifolia L.*	*Malvaceae*	Sept.-Dec.	Sept.-Dec.	Sept – Nov.	100	100	90	P
	Gaajoo	*Hibiscus berberidifolius*	*Malvaceae*	Oct.-Nov.	Oct.-Nov.	Oct. - Nov.	60	60	60	P
	Sansuri	*Hibiscus ludwigii*	*Malvaceae*	Oct.- Nov.	Oct.-Nov.	Oct.-Nov.	60	60	60	P
	Kontir	*Caesalphiniadecapetala*	*Fabaceae*	Oct..- Janu.	Oct..- Janu.	Oct.- Jan.	112	110	94	P,N
	Bottel brush	*Calistemoncitranus*	*Myrtaceae*	Sept.- Janu.	Sept.- Janu.	Sept.- Dec.	135	135	120	N
	Tushimo	*Pavettaabyssinica*	*Rubiaceae*	Oct.- Dec.	Oct.- Dec.	Oct.- Dec.	90	90	90	P,N
	Digissie	*Combretum collinum*	*Combretaceae*	-	-	March –Apr	-	-	45	P,N
	Yudo	*Dracaena steudneri*	*Dracaenaceae*	Dec.-Janu. ;March-May	Dec.-Janu.; March-May	Dec.-Janu. ;March-May	105	105	100	P,N
	Geisho	*Rhamnus prinoides*	*Rhamnaceae*	Year round	Year round	Year round	365	365	365	
	Macca/kitkitta	*Dodonaea angustifolia*	*Sapindaceae*	-	-	Sept.- Dec.	-	-	115	P,N
	Mogneabeba	*Brugmansiasuaveolens*	*Solanaceae*	Year round	Year round	Year round	365	365	365	P,N
	Yewofkolo	*Lantana camara*	*Verbenaceae*	Year round	Year round	Year round	350	350	330	P
	Kincib	*Euphorbia tirucalli*	*Euphorbiaceae*	Oct.- Nov.	Oct.- Nov.	Oct.- Nov.	30	30	42	N
	Amija	*Hypericum revolutum*	*Guttiferae*	Oct.– janua	Oct.– Dec.	-	110	90	-	P,N
	Koseret	*Lippia abyssinica*	*Verbenaceae*	Febr-Mar.	Febr.- Mar.	Febr. –Mar..	45	45	40	P
	Damakesie	*Ocimum*species	*Lamiaceae*	Sept.- Dec.	Sept.- Dec.	Sept.- Dec.	105	98	90	P
	Suspania	*Sesbaniasespan*	*Fabaceae*	Janu.- Mar.	Janu.- Mar.	Janu.- Mar.	63	63	55	P
	Atat/shiko	*Maytenusgracilipes*	*Celastraceae*	Aug.-Nov.	Aug.-Nov.	Aug.-Oct.	110	110	80	P
	YayitHareg	*Ipomoea tenuirostris*	*Convolvulaceae*	Dec. – Janu.	Dec.- Janu.	Dec.- Dec.	60	60	50	P,N
	Tumo/Chocho	*Premnaschimperi*	*Verbenaceae*	March-Dec.	March-Dec.	March-Dec.	278	275	270	P,N
	Tembelel	*Jasminum abyssinicum*	*Oleaceae*	Dec.- Janu.	Dec.- Janu.	Dec.–Janu	60	60	50	N
	Dido	*Galinierasaxifraga*	*Lamiaceae*	Dec. – Febr.	Dec.- Febr.	Dec.- Janu.	55	50	50	N
	-	*Fuchsia hybrid*	*Onagraceae*	Sep- janu	Sep- janu	Sep- janu	150	150	130	N
	Key abeba	*Euphorbia latifolia*	*Euphorbiaceae*	Mar.-May	Mar.-May	Febr.- May	90	90	73	N
	Limmich	*Clausenaanisata*	*Rutaceae*	Mar.-May	Mar..-May	March.-May	90	90	85	P,N
	Embuay	*Solanum incanum*	*Solanaceae*	Mar.-Dec.	Mar.-Dec.	Mar.-Dec.	300	305	300	P
	Geber embuay	*Solaniumdasyphyllum*	*Solanaceae*	Mar.-Dec.	Mar.-Dec.	Mar.-Dec.	300	305	300	P
	Tatessa/Embus	*Allophyllusmacrobotrys*	Sapindaceae	May – Nov.	May- Nov.	May- Nov.	80	80	80	P,N
	Embusbusie	*Plectranthusburorum*	*Lamiaceae*	Febr –Mar.	Febr. –Mar.	Febr –Mar.	38	40	40	
	Chifrig	*Erica genus*	*Ericaceae*	Oct. – Nov.	Oct.- Nov.	-	40	35	-	P,N
	Ketto	*Ilex mitis L.*	*Aquifoliaceae*	Oct.-Dec.	Oct. – Dec.	Oct. – Nov.	90	90	80	N
	Yagbero	*Dalbergia lacteal*	*Fabaceae*	Sept.- Dec.	Sept.- Dec.	Sept.- Dec.	123	120	110	P,N
	YergibAter	*Cajanuscajan*	*Fabaceae*	Sept. –Dec.	Sept. –Dec.	Sept. –Dec.	107	100	100	P,N
	Embus	*Rhusglutinosa*	*Urticaceae*	May – Nov.	May- Nov.	May- Nov.	85	85	80	P,N
	Mut ansa	*Sparmannia ricinocarpa*	*Lamiaceae*	Oct- Nov.	Oct.- Nov.	Oct.- Nov.	60	50	50	P
	Endod	*Phytolacca dodecandra*	*Phytolaccaceae*	Nev.-May	Nov.-May	Nov.-May	203	200	180	N
	Awkobekel	*Cleome gynandra*	*Capparidaceae*	Oct. – Dec.	Oct – Dec.	Oct. – Dec.	120	120	110	P,N
	Yeshikokogomen	*Solanecio gigas*	*Asteraceae*	Oct- Mar	Oct.- Mar	Oct.- March	180	180	150	P
	Gulo	*Ricinus communis*	Euphorbiaceae	Oct.-Nov; Mar-Apr	Oct.-Nov.; Mar-Apr	Oct.-Nov.; Mar.-Apr	65	65	50	P
	YeferenjiInjori	*Morus alba*	*Moraceae*	Oct- Dec.	Oct- Dec.	Octo- Dec.	70	70	60	P
	Azamir	*Bersemma abyssinica*	*Melianthaceae*	Oct- Dec.	Oct- Dec.	Oct- Dec.	60	60	60	P,N
	Ataro	*Buddlejadavidii*	*Loganiaceae*	Nov.-Janua	Nov.-Janu	Nov.-Janua	75	70	60	P,N
	Misiritch	*Clerodendrum*species	*Lamiaceae*	Oct- Dec	Oct.- Dec.	Oct.- Dec.	50	52	60	P,N

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Habit	Local Name	Scientific Name	Family Name	Flowering seasons			No. of days			Utility
				HL	ML	LL	HL	ML	LL	
Herbs	Tufo	*Guizotia scabra*	*Asteraceae*	Oct- Jan	Oct.– Janu.	Oct.- Janu.	110	110	105	P,N
	Neddo	*Saturejaparadoxa*	*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 leopoldi*	*Asteraceae*	Oct. – Nov	Oct. - Nov.	-	52	50	-	P,N
	Silichie	*Vernonia unionis*	*Asteraceae*	Oct.- Dec	Oct. - Dec.	Oct. - Dec.	90	85	85	P,N
	Adey abeba	*Biden prestinaria*	*Asteraceae*	Sept. – Nov	Sept.– Nov.	Sept. – Nov.	75	75	70	P
	Meskel abeba	*Biden macroptera*	*Asteraceae*	Sept. –Dec	Sept.-Dec.	Sept.-Dec.	115	115	110	P
	Meskel abeba	*Biden pachyloma*	*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. – Dec.	140	140	130	P
	Haramo	*Dicrocephala Chrysanthemifolia*	*Asteraceae*	Sept.- Nov	Sept.- Nov.	Sept.- Nov.	85	85	70	P
	Etsefaris	*Nicadraphysaloides*	*Solanaceae*	April- Dec.	April- Dec.	April- Dec.	270	270	270	P,N
	Huphicho	*Laggera crispate*	*Asteraceae*	June - Nov.	June- Nov.	June –Oct.	157	150	143	P,N
	Partinium	*Parthenium hysterophorus*	*Asteraceae*	Year round	Year round	Year round	365	350	365	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
	Yesietmlas	*Xanthium spinosum L*	*Asteraceae*	Year round	Year round	Year round	365	365	365	P,N
	Yammo	*Caylusea abyssinica*	*Resedaceae*	Mar.Dec.	Mar.-Dec.	Mar.-Dec.	300	300	280	P,N
	Amja	*Hypericum* species	*Guttiferae*	Nov.– Dec.	Nov.– Dec.	Nov. – Dec.	40	40	35	P,N
	Motijo	*Plectranthus*species	*Lamiaceae*	Sept-Nov.	Sept.-Nov.	Sept.-Nov.	70	70	55	P,N
	Korxeb	*Plantagolanceolata*	*Plantaginaceae*	Nov.–Jan	Nov.- Janu.	Nov.- Janu	80	80	75	P
	Guccino	*Carduus* species	*Asteraceae*	Jan –Febr	Jan.- Febr.	Janu –Febr.	40	40	40	P,N
	Ye'ayit Hareg	*Ipomoea species*	*Convolvulaceae*	Octo.-Dec.	Oct.–Dec.	Oct.- Nov.	80	80	65	P,N
	Tikurawut	*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	*Bothrioclineschimperi*	*Asteraceae*	Sept.-May	Sept.-May	Sept.- May	240	240	210	P,N
	Chogogit	*Biden spilosa*	*Asteraceae*	June-Dec.	June-Dec.	June-Nov	210	210	190	P,N
	Chingerch	*Justitia ladanoides*	*Acanthaceae*	Oct.- Janu.	Oct.-Janu.	Oct.-Janu.	115	110	110	N
	Liketti	*Phaulopsis imbricate*	*Acanthaceae*	Sept.-Dec.	Sept.-Dece.	Sept– Dec.	120	120	105	N
	Engicha	*Cyperus species*	*Cyperaceae*	Mar – Apr	Mar.- April	Mar.- April	45	45	45	P, N
	-	*Hypoestesforskaolii*	*Acanthaceae*	Oct.- Janu.	Oct.-Janu	Oct.- Janu.	120	120	110	N
	Dergu	*Isoglossa*species	*Acanthaceae*	Aug.- Nov.	Aug.-Nov.	Aug.-Nov.	120	120	100	N
	Turumbaabeba	*Zantedeschia aethiopica*	*Araceae*	Sept.-Dec.	Sept.-Dece.	Sept.-Dec.	120	120	110	P,N
	Daro	*Triumfettarhomboidea*	*Tiliaceae*	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 leucantha*	*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	*Rutachalepensis*	*Rutaceae*	Oct-Dec.	Oct-Dec.	Oct-Dec.	90	90	90	P
	Shukindo	*Anthemistigreensis*	*Asteraceae*	Sept.– Janu	Sept.-Janu.	Sept. –Janu	140	140	120	P,N
	Shato	*Commelinabenghalensis*	*Commelinaceae*	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,N
	Aluma	*Discopodiumpenninervium*	*Solanaceae*	June-Dec.	June-Dec.	June-Dec.	210	200	200	P,N
	Ndahulla	*Kalanchoe densiflora*	*Crassulaceae*	Oct. –Nov.	Oct.-Nov.	Oct. –Nov.	50	50	45	P
	YayitMisir	*Crotalaria species*	*Fabaceae*	Sept.- Nov.	Sept.- Nov.	Sept.- Nov.	75	75	70	P
	Meqmeqo	*Rumex abyssinicus*	*Polygonaceae*	May-july; Oct-Nov.	May-july; Oct-Nov.	May-June; Oct-Nov.	75	75	75	P
	Moggecco	Sparmannia ricinocarpa	*Tiliaceae*	Oct.-Dec.; May-June	Oct.-Dec.; May-June	Oct.-Dec.; May-June	85	85	70	P

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Habit	Local Name	Scientific Name	Family Name	Flowering seasons			No. of days			Utility
				HL	ML	LL	HL	ML	LL	
Climbers	Beggo	*Combretum paniculatum*	*Combretaceae*	Oct – Mar	Oct. – Mar.	Oct. – Mar.	170	170	165	N
	Achbeno	*Goiania longipicata*	*Rhamnaceae*	Oct.- Janu	Oct.- Janu.	Sept.- Janu.	87	87	80	N
	Kentaffa	*Ptrolobiumstellatum*	*Fabaceae*	Oct- Jan	Oct.- Janu.	Oct.- Janu.	100	100	85	P,N
	Haddi	*Mikaniopsisclematoides*	*Asteraceae*	Oct.- Mar	Oct.- Mar.	Oct.- Mar.	160	160	130	P,N
	Yazohareg/ Kacho	*Clematis longicauda*	*Ranunculaceae*	Oct.– Mar	Oct. – Mar.	Oct. – Mar.	160	155	135	P,N
	Hareg	*Microglossapyrifolia*	*Asteraceae*	Sept.-May	Sept.-May	Sept.-April	255	250	220	P,N
	Nechye'azohareg	*Clematis hirsuta*	*Ranunculaceae*	Dec.- Mar	Dec. – Mar.	Nov.- Febr.	125	120	105	N
	Qombo	*Gymnemasylvestre*	*Asteraceae*	Oct.-June	Oct.-June	Oct.-June	260	260	250	P,N
	Nopho	*Basella alba*	*Basellaceae*	Sept.- Nov.	Sept.- Nov.	Sept.- Oct.	75	72	60	P,N
	Xaro	*Helinusmystacinus*	*Rhaminaceae*	Sept. – Dec.	Sept.- Dec.	Sept. – Dec.	115	115	110	N
	Hareg	*Gouanialongispicata*	*Rhaminaceae*	Sept. – Janu	Sept. – Jan.	Sept.– Janu.	135	135	135	N
	Morning glory(Eng)	*Apomoea*species	*Convolvulaceae*	Nov.-Febr	Nov.-Febr	Nov.-Febr.	115	115	110	P,N
	YemdrEmbuay	*Cucurbita* species	*Cucurbitaceae*	Aug –Nov.	Aug.–Nov.	Sept.- Oct.	88	85	70	P
	HaregResa	*Zehneria scabra*	*Cucurbitaceae*	Sept.-Nov.	Sept.-Nov.	Sept.-Nov.	80	70	60	P,N
	-	*Mimosa invisa*	*Fabaceae*	May-Dec.	May-Dec.	May-Nov.	215	210	180	P,N
	Wodel asfes	*Rhoicissus tridentata*	Vitaceae	Mar- Apr	Mar.- April	Mar.- Apr	60	60	50	N
	Desmodium	*Desmodium*species	*Fabaceae*	Sept. – Nov.	Sept.- Nov.	Sept. – Nov.	60	60	50	N
Crops	Nugo	*Guizotia abyssinica*	*Asteraceae*	Octo. - Dec.	Oct. - Dec.	Oct. - Dec.	60	60	55	P,N
	Baaroo	*Zeya mays*	*Poaceae*	May - July	May - July	May – June	60	60	45	P
	Buno	*Coffee arabica*	*Rubiaceae*	Janu. – Febr.	Janu.-Febr.	Janu.-Febr.	35	35	30	P,N
	Besobila	*Ocimumbasilicum*	*Labiatae*	April – June	April - June	April – June	60	60	60	P
	Yefernjisuf	*Helianthus annuus*	*Asteraceae*	Oct. – Dec.	Oct.– Dec.	Oct.– Dec.	70	67	55	P,N
	Shaachiafo	*Brassica* species	*Brassicaceae*	Sept.- Nov.	Sept.- Nov.	Sept.- Nov.	70	70	65	P,N
	Yango	*Sorghum bicolor*	*Poaceae*	May-July; Oct.-Nov.	May-July; Oct.-Nov.	May-June; Oct.-Nov.	145	145	120	P
	Bakelo	*Vicia faba*	*Fabaceae*	June – July	June – July	-	40	40	-	P
	Mutto	*Linumusitatissimum L*	*Linaceae*	Sept.-Nov.	Sept.-Nov.	Sept.-Nov.	70	65	50	P,N
	Atero	*Pisum sativum*	*Fabaceae*	June – July	June– July	-	40	40	-	P
	Selit	*Sesamum indicum*	Pedaliaceae	-	-	Nov– Dec.	-	-	45	P,N
	Timiz/Turifo	*Piper capense*	*Piperaceae*	March-June	March-June	March-June	75	75	62	P
	Debo/dimbilal	*Coriandrum sativum L*	*Apiaceae*	May –Dec.	May –Dec.	May –Dec.	230	230	215	N
	Goobbo	*Phaseolus* species	*Fabaceae*	April-May	April-May	April-May	30	30	25	P
Fruits &vegetables	Timatim	*Lycopersiconesculentum*	*Solanaceae*	July – Augt	July – Aug.	July – Aug.	45	45	40	
	Berberie/baro	*Capsicum annuum*	*Solanaceae*	Aug– Oct	Aug.– Oct.	Aug.- Sept.	55	55	50	P
	Dinnich/Doko	*Solanum tuberosum*	*Solanaceae*	May-Aug	May-Aug	May-Aug	56	56	50	P
	Mango	*Mangifera indica*	*Anacardiaceae*	Oct.-Janu; May-June	Oct.-Janu.; May-June	Oct.-Jan.; May-June	145	145	140	P,N
	Avocado	*PerseaAmericana*	*Lauraceae*	Oct.-Dec.; May –June	Oct.-Dec.; May –June	Oct.-Dec.; May -June	135	135	125	P,N
	Lomi	*Citrus aurantiifolia*	*Rutaceae*	Dec.- Jan.; May –June	Dec.-Janu.; May – June	Dec.-Janu& May-June	80	80	75	P
	Bertukan	*Citrus sinensis*	*Rutaceae*	Dec.-Janu.; May-June	Dec.-Janu.; May-June	Dec.-Janu; May-June	80	80	75	N,P
	Tiringo	*Citrus medica*	*Rutaceae*	Dec.-Janu.; May-June	Dec.-Janu.; May-June	Dec.-Janu; May-June	80	80	75	N,P
	Menderine	*Citrus deliciosa*	*Rutaceae*	Dec.-Janu.; May-June	Dec.-Janu.; May-June	Dec.-Janu; May-June	80	80	75	N,P
	Gishta	*Annona* species	*Annonaceae*	Oct.-Janu.; May-June	Oct.-Nov.; May-June	Oct.-Jan.; May – June	75	75	70	P
	Muz	*Musa* species	*Musaceae*	May- July	May - July	May -July	75	75	75	N
	Roman	*Punica granatum*	*Punicaceae*	Oct.-Dec., May-June	Oct.-Dec., May-June	Oct.-Dec., May-June	90	90	75	P,N
	Papaya	*Carica papaya*	*Caricaceae*	Dec.–Janu.; May- June	Dec.-Janu.; May June	Dec.-Jan.; May - June	115	115	115	P
	Dubba/Buqo	*Cucurbita pepo*	*Cucurbitaceae*	May – Dec.	May – Dec.	May – Nov.	240	240	210	P
	Apple	*Malus sylvestris*	*Rosaceae*	Oct.-Nov	Oct.-Nov	-	45	45	-	P
	Zeytun	*Psidium guajava*	*Myrtaceae*	May-July; Oct.-Jan.	May-July; Oct.-Jan.	May-July; Oct.- Jan	210	210	210	P
	Kocke	*Solaniummuricatum*	*Solanaceae*	Mar-June	Mar.-June	Mar.-June	120	120	105	P

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

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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, *Scheffleraabyssinica*,*Polyscias fulva and Croton microstachys* will bloom during the onset of minor rainy seasons (through 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.

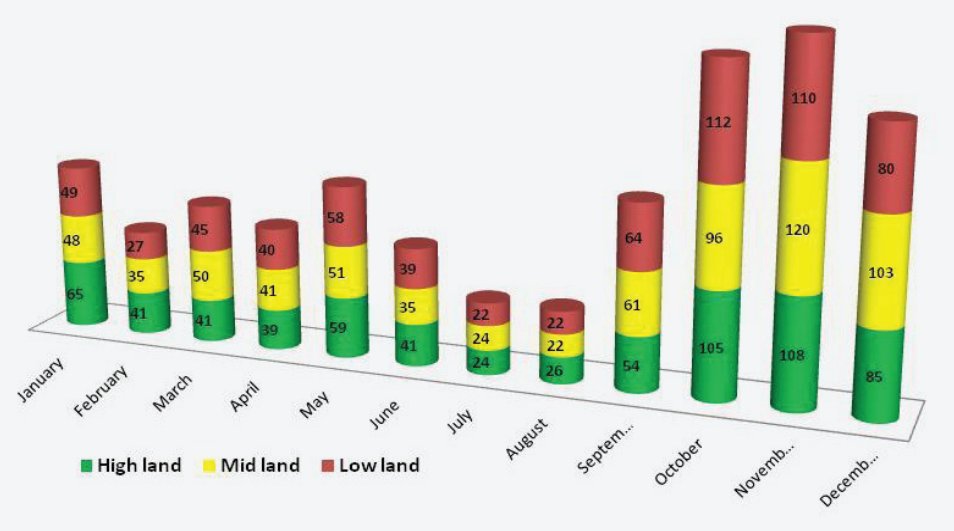

Figure 3: Number of flowering bee plant species.

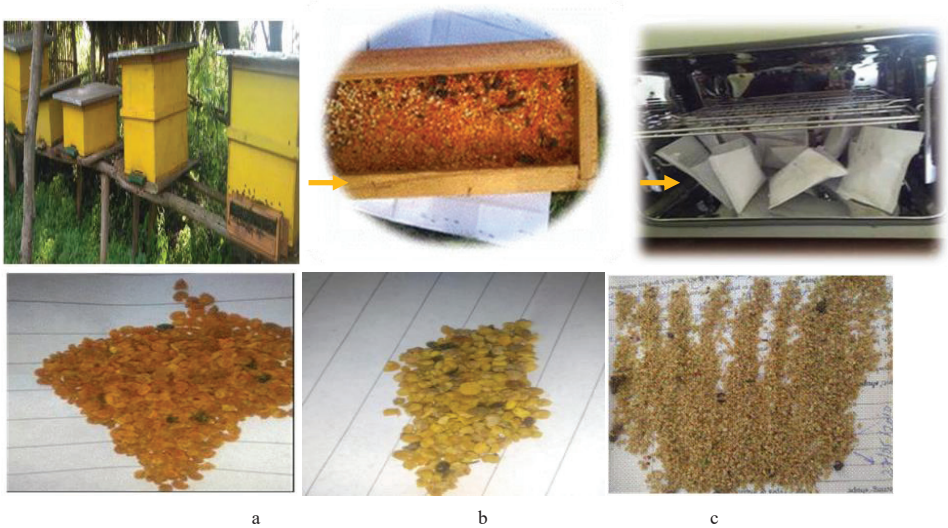

Figure 4: Pollen Collection.
Pollen grain of some major bee plants (a. *Guizetia*; b.*Croton macrostachyus; C: Vernonia species*).

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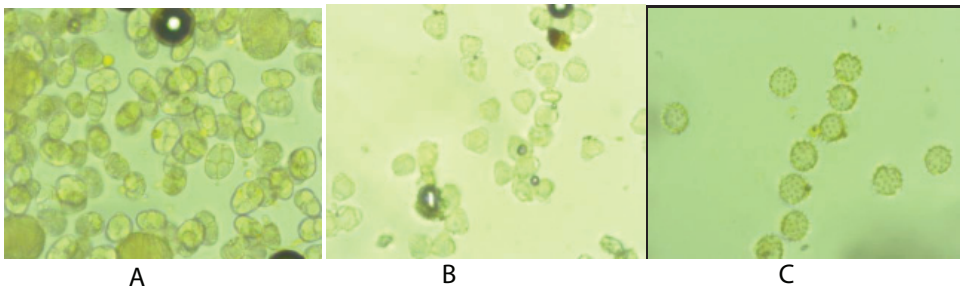

Figure 5: Pollen analysis.
a) *Erica genus.* b) *Eucalyptus* species. c) *Guizetia scabra.*

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*	*Euphorbiacae*	260	96.11
4.	Adey abeba	*Biden* species	*Asteraceae*	255	94.44
5.	Grawo	*Vernonia amygdalina*	*Asteraceae*	251	92.78
6.	Dengerito	*Vernonia auriculifera*	*Asteraceae*	228	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.	Bahirzaf	*Eucalyptus* species	*Myrtaceae*	207	76.67
11.	Buna	*Coffee arabica*	*Rubiaceae*	203	75
12.	Mogneabeba	*Brugmansiasuaveolens*	*Solanaceae*	195	72.22
13.	Acibano	*Goiania longispicata*	*Rhamnaceae*	150	55.56
14.	Tikurabalo	*Combretum collinum*	*Combretaceae*	135	50
15.	Wonbela	*Combritum 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 saxifraga*	*Lamiaceae*	90	33.33
23.	Shachiafo	*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 (in^2) considering the number of comb cells filled with pollen or beebread. The average pollen stores of the areas were found to be 186.68in^2, 179in^2 and 177in^2 ranging from 95.88in^2 to 338 in^2, 77in^2 to 351in^2 and 79in^2 to 417in^2 in high land, midland and low land areas respectively. The Overall annual pollen store of the study areas was found to be 180.81in^2 ranging from 84in^2 to 369.02in^2 (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 colonies has significant variation at p<0.05 among seasons. Accordingly, the higher pollen store occurs through September - November and March - April; and the lowest pollen store occurs through June - August and January-February (Table 4).

Brood area: Brood in honeybees' context includes the developmental phases of pre-adult lives including egg, larvae and pupae [29,30]. A colony comprises of three casts being the queen, the workers and the drones. Both the queen and worker bees are female in sex emerging from fertile eggs while the drones which are male in sex emerging from the unfertile eggs. Even if there is certain hours deviation based on species and environment, on average, honeybees require 16 days, 21 days and 24 days for an egg to its emergence for queen, worker bees and drones respectively. The variation of emergency dates among casts is principally governed by the type and level of feeds the larvae provided in response to the need of colony [31,32]. Even though egg laying and brood rearing is a continuous task, the queen will be initiated to lay more eggs and brooding during seasons when pollen and nectar sources are excessively abundant. A queen may lay over 2000 eggs in a day during peak blooming seasons. However, it drops to minimum number during harsh seasons; even sometimes to the level hardly to maintain the number of worker bees being lost due to natural deaths [33]. The mean annual brood area of colonies in the studied areas were found to be 233.29in², 227.31in² and 222.75in² ranging from 139in² to 365.88in²;119.20in² to 383.75in² and 103.88 in² to 455.69in² in high land, mid land and lowland agroecologies respectively. The overall annual brood areas of colonies were recorded to be 227.78in² ranging from 120.69in² to 401.77in² (Table 5). The brood area of the current result of *A.m. scutellata* race was found to be nearly equivalent with the annual brood areas of *A.m.jementica* race 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).

Table 3: Abundance of Major bee plants.

SN	Local name	Scientific name	Density			Over all
			High lands	Mid lands	Low lands	
1	Buto	*Schefflera abyssinica*	6	5	0	4
2	Tufo	*Guizetia scabra*	28,333	47,083	69,321	48,246
3	Wago	*Croton macrostachyus*	3	4	3	3
4	Adey abeba	*Biden* 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	Bahirzaf	*Eucalyptus* species	8	5	3	5
11	Buno/Buna	*Coffee arabica*	18	109	88	72
12	Mogneabeba	*Brugmansiasuaveolens*	40	18	18	25
13	Acibano	*Gouanialongispicata*	6	5	1	4
14	Tikurabalo	*Combretum collinum*	0	0	4	1
15	Wonbela	*Combritum brownie*	0	0	2	1
16	Butij	*Manilkara butugi*	2	1	1	1
17	Wulkifa	*Dombeya torrid*	2	1	1	1
18	Omo/ tikurincet	*Prunus africana*	2	2	1	2
19	Shedo	*Sapium ellipticum*	3	3	2	3
20	YeferenjiNug	*Helianthus annuus*	1	1	2	1
21	Nugo	*Guizotia abyssinica*	0	0	83,333	27,778
22	Dido	*Gallinierasaxifrage*	7	5	2	5
23	Shachiafo	*Brassica* species	11,223	18,740	15,254	15,072
24	Wondifo	*Apodytesdimidiate*	2	1	1	2
25	Kentafa	*Pterolobiumstellatum*	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
	High Land	Mid land	Low land	
January	141.38± 36.36^{fg}	116.13±27.07^{def}	102.05± 27.30^{ef}	120±34.11^{ef}
February	121.38± 45.99^{f}	109.74±29.59^{ef}	82±20.23^{f}	104.33±36.96^{fg}
March	286.56±45.34^{bc}	264.73±36.05^{b}	217±31.67^{c}	256.10±47.46^{b}
April	249.29±58.02^{cd}	243.34±54.89^{b}	161.13±24.97^{d}	218.19±62.35^{c}
May	192±46.27^{ef}	171.08±47.39^{cd}	134.19±26.24^{de}	165.68±46.90^{d}
June	143.50±31.13^{fg}	130.13±32.60^{def}	118±25.69^{ef}	130.52±31.15^{ef}
July	125.56±37.46^{f}	108.63±41.55^{ef}	104.38±28.23^{ef}	112.85±36.60^{efg}
August	95.88±20.06^{f}	77±17.51^{f}	79±16.32^{f}	84±19.63^{g}
September	193.06±37.98^{ef}	231.81±52.44^{b}	252.28±36.49^{bc}	225.72±48.77^{bc}
October	338.04±70.79^{a}	351±106.11^{a}	417.81±69.60^{a}	369.02±89.37^{a}
November	221±66.74^{de}	210.85±44.97^{bc}	286.13±36.15^{b}	239.32±60.17^{bc}
December	132.74±33.48^{ef}	134±27.31^{de}	167.50±60.23^{d}	145±45.00^{de}
Total	186.68±84.54	179±91.42	177±103.42	180.81±93.38

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

Nectar stores: Nectar is an aqueous solution secreted from floras 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 types. 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 nectars 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 326.76in², 304.17in2 and 298.58in² ranging from 218.71in² - 736in², 192.36in² - 545.05in² and 161.57in² - 599.4in² for high land, mid land and low land areas respectively. The Overall average annual nectar store of the study areas was found to be 309.84in² ranging from 193 in² – 504.72in² (Table 6). The current result was found to be somehow greater than the result of *A.m. scutellata* obtained in Guji Zone which was 262.28in² [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

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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 showed significant variation at p<0.05(sig.0.002) among agro ecologies under Kruskal Wallis test of similarity.

Adult bee population: Adult bees comprises 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 - 24270,8460 - 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*103) 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 was found to be, 62.9% and 54.5% respectively (Figure 6). Similarly, higher correlation, 47.1% was recorded between 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 intern determining 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 strengthening or building up their population and excessive nectar collection. Honeybees mainly nurse bees consume pollen in large amounts which is essential to feed glandular secretions for young broods [26]. In the other study done on comparison of *Apis mellifera* L. races (i.e. on *A.m. jementica and A.m. carnica*) indicated that there was significant correlation of brood areas with pollen stores for both races at p<0.05. However, only *A.m. carnica* was found to have significant correlation of brood areas with nectar stores [38]. This might be due to the high brooding rates of *A.m. jementica* accompanied with the high nectar consumption rates of the race compared to *A.m. carnica* [17].

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

Months	Agro ecologies (Mean+SD)			Over all
	High Land	Mid land	Low land	
January	188.63± 45.73^{ef}	168.88±40.75^{fgh}	125.81±31^{gh}	161.10±49.95^{f}
February	157.25±30.27^{fg}	154.68±42.47^{fgh}	107.69±18.09^{h}	139.88±38.77^{ef}
March	333.31±32.17^{ab}	323.52±37.25^{b}	282±52.38^{d}	312.94±46.41^{b}
April	297.81±31^{bc}	278.38±51.40^{bc}	201.06±30.49^{ef}	259.08±56.83^{c}
May	267.56±46 .42^{cd}	222.19±50.66^{de}	162.63±17.14^{fg}	217.46±59.04^{d}
June	185.94±31.33^{efg}	172.81±37.35^{efg}	144.25±26.98^{gh}	167.67±36.06^{e}
July	165.56±33.60.4^{fg}	137±35.89^{gh}	124.44±28.21^{gh}	142.33±36.44^{ef}
August	139±41.73^{g}	119.20±41.56^{h}	103.88±29.81^{h}	120.69±40.03^{f}
September	225.94±35.43^{de}	265.88±41.86^{cd}	334.75±61.34^{c}	275.52±65^{c}
October	365.88±74.77^{a}	383.75±68.9^{a}	455.69±54.27^{a}	401.77±76.02^{a}
November	291.69±47.59^{bc}	303.69±36.33^{bc}	401.50±43.03^{b}	332.29±64.85^{b}
December	181±27.25^{efg}	197.75±32.53^{ef}	229.31±37.17^{e}	203±37.77^{d}
Total	233.29±82.97	227.31±90.59	222.75±121.24	227.78±99.57

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

Table 6: Nectar store across seasons in squared inch (in^2); N=8; p<0.05.

Months/ seasons	Agro ecologies (Mean+SD)			Over all
	High Land	Mid land	Low land	
January	270.76±46.44^{cde}	257.51±55.96^{de}	195.95±34.24^{f}	241.41±56.10^{e}
February	218.71±35.99^{e}	198.20±36.03^{e}	161.57±32.25^{f}	193.00±41.60^{e}
March	383.46±63.74^{b}	323.86±72.23^{cd}	257.62±43.66^{e}	321.65±79.17^{d}
April	736±182.52^{a}	545.05±158.36^{a}	233.11±25.89^{e}	504.72±250.45^{a}
May	264.95±38.59^{cde}	235.73±35.05^{e}	217.47±18.92^{ef}	239.38±37.04^{e}
June	244.86±50.03^{de}	232.56±49.27^{e}	213±22.18^{ef}	230.14±43.66^{e}
July	236.55±31.36^{de}	215.61±31.68^{e}	193.50±33.94^{f}	215.21±36.30^{e}
August	222.43±29.61^{de}	192.36±37.82^{e}	197.42±36.79^{f}	204.07±5.36.67^{e}
September	300±35.17^{cd}	340.00±47.22^{d}	395.53±49.23^{cd}	345.12±58.73^{cd}
October	336.20±46.79^{bc}	357.49±48.38^{d}	492±70.02^{b}	395.21± 88.69^{b}
November	409.74±66.11^{b}	435.83±69.89^{b}	599.4±97.40^{a}	481.66±114.79^{ab}
December	297.57±37.79^{cde}	315.94±39.74^{cd}	426.51±53.64^{c}	346.67±72.04^{cd}
Total	326.76±152.06	304.17±120.10	298.58+145	309.84±139.94

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	9.810±1.420^{c}	9.675±1.460$^{b;}$	9.270±1.625^{c}	9.585± 1.490^{c}
February	8.850±0.940^{c}	8.460±0.820^{b}	8.340±0.874^{c}	8.550±0.886^{c}
March	24.270±6.190^{a}	23.835±6.872^{a}	18.075±4.884^{ab}	22.060±6.562^{ab}
April	23.175±6.740^{a}	22.860±7.131^{a}	17.640±4.681^{ab}	21.225±6.655^{ab}
May	10.170±2.025^{c}	12.285±2.265^{b}	12.810±2.101^{bc}	11.755±2.384^{bc}
June	10.230±2.079^{c}	12.075±2.325^{b}	12.690±2.327^{bc}	11.665±2.439^{bc}
July	9.570±2.114^{c}	11.760±1.896^{b}	12.465±2.476^{bc}	11.265±2.466^{bc}
August	9.840±2.131^{c}	11.794±2.098^{b}	12.270±2.260^{bc}	11.300±2.369^{bc}
September	16.980±7.364^{b}	18.630±6.660^{a}	22.920±8.462^{a}	19.204±7.597^{a}
October	20.280±7.297^{ab}	20.580±7.656^{a}	22.920±8.462^{a}	21.260±7.744^{a}
November	21.300±6.551^{ab}	21.630±1964^{a}	23.670±8.030^{a}	22.200±7.423^{a}
December	19.950±5.877^{ab}	20.490±1483^{a}	23.460±7.913^{a}	21.300±6.684^{a}
Total	15.369±7.575	16.128±530	16.301±7.503	15.948±7.483

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

Honey harvesting frequencies of beekeepers

The nutritional composition and physical qualities of honey has a distinctive variations based on the type of plant it is originated. This could attribute for the variation in demands

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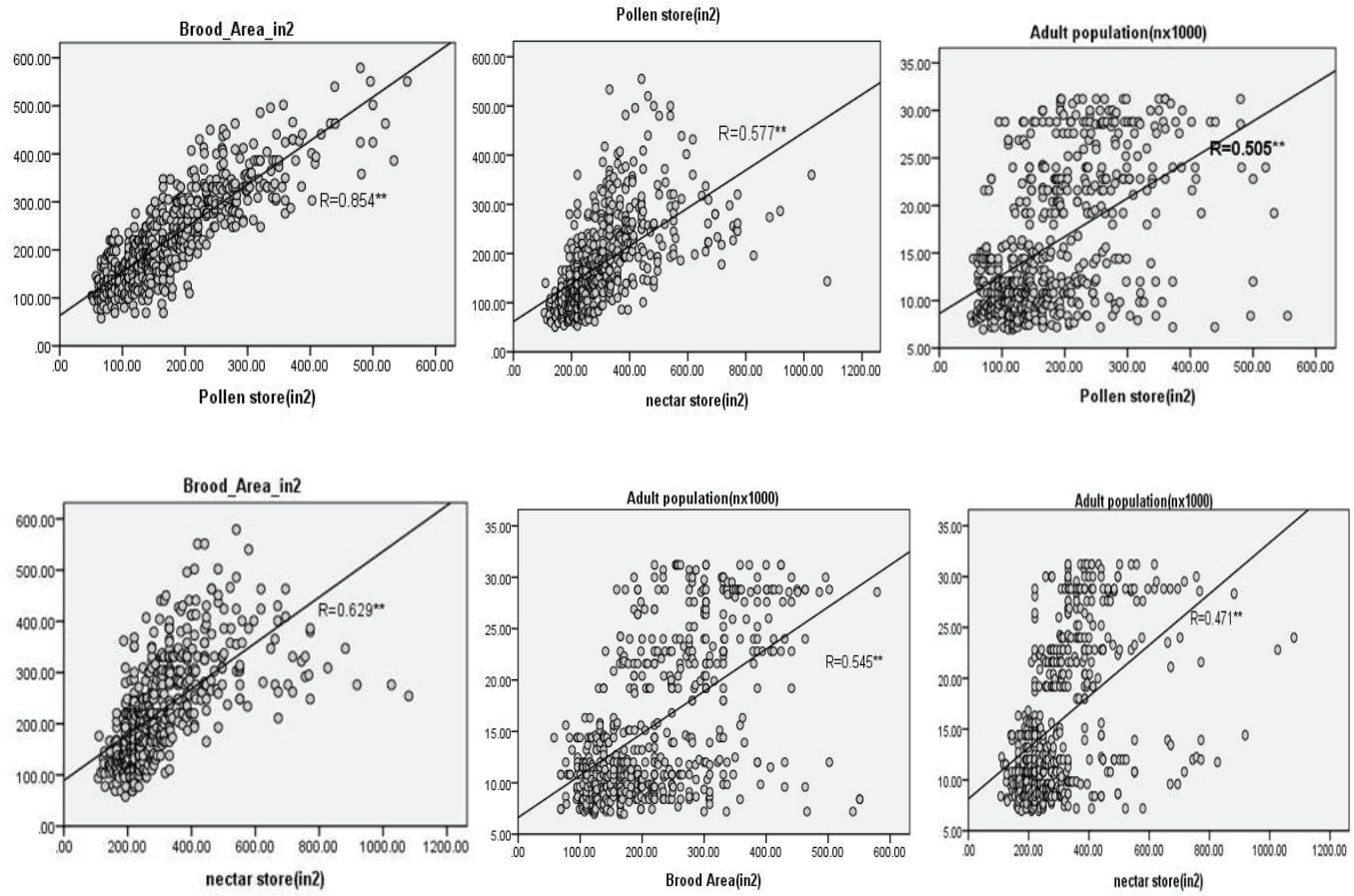

Figure 6: Relationship among pollen store, nectar stores, brood areas and adult population.
** = significantly correlated at p<0.01.

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 tradition 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 *'Butij'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.

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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* speciesrespectively. In some low land areas, considerable amount of honey will also be harvested from *Combretum* species (*'Abalo'* and *'wombela'*) during March (Figure 7).

Hone yield

The honey yield data of each hive typefor 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 seasonsbeing March to May (season-1) and October – December (season-2), *Schefflera abyssinicatakes* the greater pollen countboth in High lands and Midland areas accounting for 50%-65% and 47%-60 % which is considered as a mono floral honey [11]. Whereas *Combritum species* is the major mono floral honey source in low land areas accounting for 28-62%pollen counts (Table 8). *Guizotia abyssinica* and *manilkarabutijwere* 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 butijhoney*. 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 dominantone (Table 9). This revealed the type of honey produced in the area is highly influenced theabundance 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).

Seasons	Agro ecologies	Hive types		
		Traditional	Transitional	Movable frame/ box hives
Major	High lands	7.99± 3.89^{a}*(83)*	19.66±4.81^{a}*(44)*	27.83±5.34^{a}*(40)*
	Mid lands	7.22±2.52^{a}*(86)*	18.18± 4.78^{a}*(34)*	26.88±7.33^{a}*(34)*
	Low lands	6.66±2.08^{b}*(88)*	16.17±2.48^{b}*(18)*	20.94±4.90^{b}*(18)*
	Total	7.28±2.95 *(257)*	18.48±4.61 *(96)*	26.13±6.56 *(92)*
Minor	High lands	4.19±1.95^{ab}*(21)*	7.93±1.69 *(14)*	12.21±2.36 *(14)*
	Mid lands	4.83±2.73^{a}*(15)*	8.14±1.46 *(7)*	11.71±1.89 *(7)*
	Low lands	3.29±0.69^{b}*(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

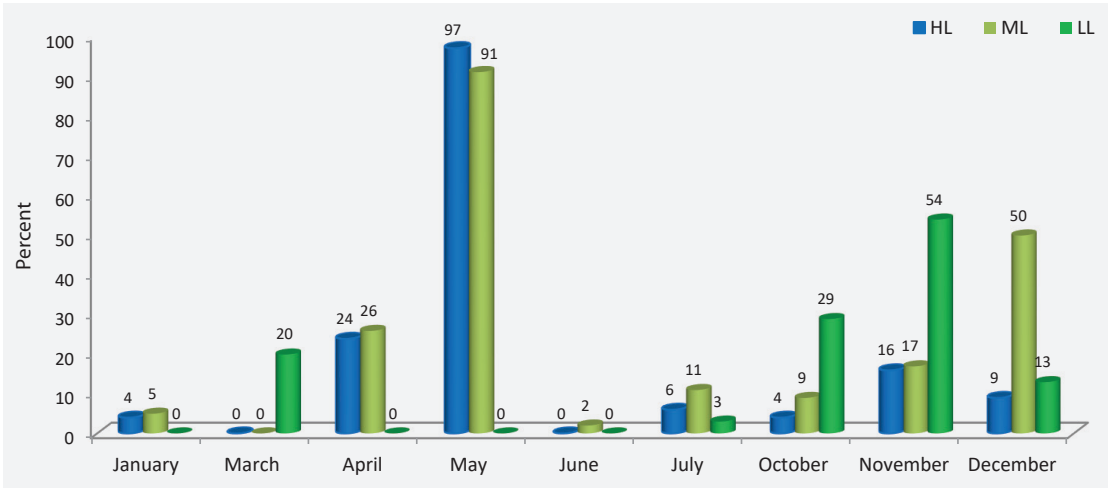

Figure 7: Harvesting seasons of beekeepers.

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Table 9: Pollen counts ofmajor plants in honey samples (in %).

Major Seasons			High LandMid Land Low Land			
			Plant namePollen counts	Plant namePollen counts	Plant namePollen counts	
Season-1 (Mar.- May)	- *Schefflera abyssinica* - *Guizotia Scabra* - *Croton microstachys* - *Eucalyptus species* - *Vernonia amygdalina* - *Bersema abyssinica*	50-65 10-30 2-13 1-7 0-21 2-8	- *Schefflera abyssinica* - *Guizotia Scabra* - *Croton microstachys* - *Eucalyptus species* - *Vernonia amygdalina* - *Bersema abyssinica*	47-60 20-30 7-12 0-3 0-13 2-8	- *Combritum species* - *Guizotia scabra* - *Eucalyptus species* - *Croton microstachys* - *Vernonia amygdalina* - *Rumex abyssinica*	28-62 20-35 5-23 0-5 0-11 0-5.2
Season-2 (Oct. - Dec.)	- *Guizotia scabra* - *Biden species* - *Manilkara butij* - *Eucalyptus species* - *Syzygium guenesis* - *Coffee arabica*	20-60 0-80 0-8 0-5 0-7	- *Guizotia scabra* - *Manilkara butij* - *Biden species* - *Eucalyptus species* - *Coffee arabica* - *Rumex abyssinica*	35-82 0-70 20-64 0-8 0-7 0-6.2	- *Guizotia scabra* - *Manilkara butij* - *Biden species* - *Eucalyptus species* - *Syzygium guenesis* - *Rumex abyssinica*	38-85 15-80 20-67 0-12 0-9 1.2-10

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, conservational 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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