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Amsalu Arega
Bako Agricultural Research Centre, Oromia Agricultural Research Institute, Addis Ababa, Ethiopia

Tusa Gemechu
Bako Agricultural Research Centre, Oromia Agricultural Research Institute, Addis Ababa, Ethiopia

Megersa Debela
Bako Agricultural Research Centre, Oromia Agricultural Research Institute, Addis Ababa, Ethiopia

Corresponding Author:
Amsalu Arega
Bako Agricultural Research Centre, Oromia Agricultural Research Institute, Addis Ababa, Ethiopia

Assessment on honeybee flora species with their time of flowering in East and Horo Guduru Wollega, Oromia Regional state, Ethiopia

Amsalu Arega, Tusa gemechu and Megersa Debela

Abstract
The study were conducted to identify major and minor honey bee plants to prepare a checklist of melliferous plants with their annual flowering periods in three representative districts of highlands H/G/Wollega (J/Ganati, Horro and J/Jarte) and two districts in midland of East Wollega (S/Sire and G/seyo). For the interview, the total of 94 beekeepers were selected by the appointment of Woreda experts and from each districts honey samples were taken from five kebeles at 5km distant within three honey flow season and mellissopalynology was done. The survey result indicated that (97.9%) of respondents are male and majority of them were primary school educated (33%), age 18-30 were (33.1%), occupation (94.7%) farmers and majority of them were start beekeeping >1993 (54.3%) by catching colony (54.3%). Based on the interview with bee keepers and visual observations,92 important plant species with their habits were recorded, out of which 28 species were found as major and 64 species were found as minor honey bee flora sources in both agro ecology. It was also indicated that some of honey bee flora species identified by the respondent were similar with honey bee plant identified through pollen analysis from honey samples within each honey flow season. Based on most frequently flowering season majority of honey bee flora species of the area flower in first season (September to November) and second season (December to February) in all districts that indicate two Major nectar and pollen flow period and bee keeper can: establish apiary site, install bee hives, divide colonies, add supers, use swarm control measures and harvest honey. The next honey flow season (March to May), which is third honey flow season for highlands (J/Jarte, Horo and J/Ganati, but it is dearth period for midland(S/Sire and G/Sayo). Since the time from June to August is the dearth period for all districts: supper reduction and supplementary feeding is recommended and mellisopalynology from pollen load is timely essential to establish floral calendar.

Keywords: Floral calendar, honey bee, melliferous plants, mellissopalynology

Introduction
Ethiopia has diverse climatic conditions and topography, which favors the growth of remnant forests. Without pollen or adequate substitute colonies do not rear broods that replace the old bees (Haydak, 1973a). Surveying of honey bee plants and their flowering phenology of the areas is the basic and first step for apiary site selection and beekeeping. Plant types and their flowering duration differ from one place to another due to variation in topography, climate and other farming practices. The extensive knowledge on type, density and quality of bee flora are the important factors for successful bee keeping. Every region has its own honey flow and floral dearth periods of short and long duration.

If at all possible, a good beekeeping area is the one in which nectar and pollen plants grow abundantly and with a relatively long blooming season. Such areas are however not always available or easy to find. Beekeepers must know the time and duration of the blooming season of every major honey plant including the environmental factors affecting them and carrying capacity of the area, which includes the number of colonies that can be put for maximum production (Rajan, 1980) [14]. Production of honey and other products depend on availability of floral resources (bee forage) and is a very important field for most beekeepers in the world (Rucker *et al*., 2002) [15]. Most of the methods for obtaining information about plants utilized in an area are based on direct field observations of foraging honeybees on flowers. The analysis of bee plants, pollen loads and melissopalynological analysis of honey sample (Hepburn and Radloff, 1995) can give a true picture of the honeybee flora of the area (Admasu *et al*., 2006).

The microscopic examination of pollen grain in honey bee is termed as melissopalynology or pollen analysis. Identification of pollen in honey help in identification of the honey sources and analysis of the pollen loads reveals the pollen source of an area. Honey pollen analysis provide an index to the honey yielding plant in a particular locality (Sharma, M. and Nair, p.k.k. 1965) [16]. Analysis of pollen content of honey samples provides the reliable information of floral source along with relative preference of the bees among the diverse assemblage of plant species flowering synchronously (Garge, A.2006) [7] such analysis become more popular in the recent years, since characterization of honey, one of the most valued apicultural products and melissopalynological studies are thus helpful in bee management in development of bee keeping.

In order to survive, prosper and be productive, honeybee colonies, as has already been observed, must have a supply of both nectar and pollen in adequate quantities. Not all plant species are equally good for beekeeping. Some supply both nectar and pollen abundantly when in bloom, and these are often called honey plants, because they are best suited for honey production. Plants producing nectar but little or no pollen are also considered to be honey plants. Other plants, however, may yield pollen but little or no nectar. These pollen plants are also important in beekeeping, especially at the time of colony build-up, when the bees need large amounts of the protein contained in pollen for their brood-rearing.

Thus Surveying of honey bee plants and their flowering phenology and establishment of the flora calendar helps to indicate the approximate date and duration of the flowering of important bee plant species in specific area (Desalegne, 2004) [5, 13] and has paramount important for practical beekeeping (Nuru and Admasu, 2001) [9]. Because, it is an important tools to determines the availability of certain bee forage in a particular area and to predict of honey flow period and their values to bees (Mardan, 1984) [8]. Similarly, Admasu *et al*. (2006) conservation of bee plant species and management of colonies should be in relation to flowering period of bee plants of the area. Amsalu (1998) during major honey flow period great number of honey plants are seen, however, depending on the weather condition and varies year to years.

The knowledge on bee flora help in the effective management of bee colonies during different seasonal periods. Considering all the facts, study was made to prepare an inventory of existing bee flora and develop floral calendar. Therefore, assessment on honey bee plants and their flowering phonology and preparation of the flowering calendar have high important for piratical beekeeping.

Objectives

To identify major and minor honey bee plants foraged by honeybees with preparing a checklist of melliferous plants

To identify the main annual flowering periods of honey bee flora.

Materials and methods

The study and bee plants surveying was conducted in three representative districts of Horo Guduru Wollega (Jima Ganati, Horro and Jardaga-Jarte) and two district of East Wollega (Sibu Sire, Gobu seyo). From each districts three sampling kebeles and the total of 15 sampling kebeles were selected based on their potential of bee keeping, vegetation cover and altitude cover at highland and midland areas. To understand the floral species, trend of vegetation coverage, method of beekeeping in the area, individuals and group discussion was done. The total of 94 beekeepers and others were selected by the appointment and assistance of Woreda and Kebele experts. To justify the flora of the area taken from the respondent, the honey sample from each districts were collected and mellisopalynology was done at Bako Agricultural Research Centre and Holeta Bee Research centre. All the data collected were coded and organized by using SPSS (version 20) to analyze the data by using descriptive statistics.

Results and Discussion

Household information

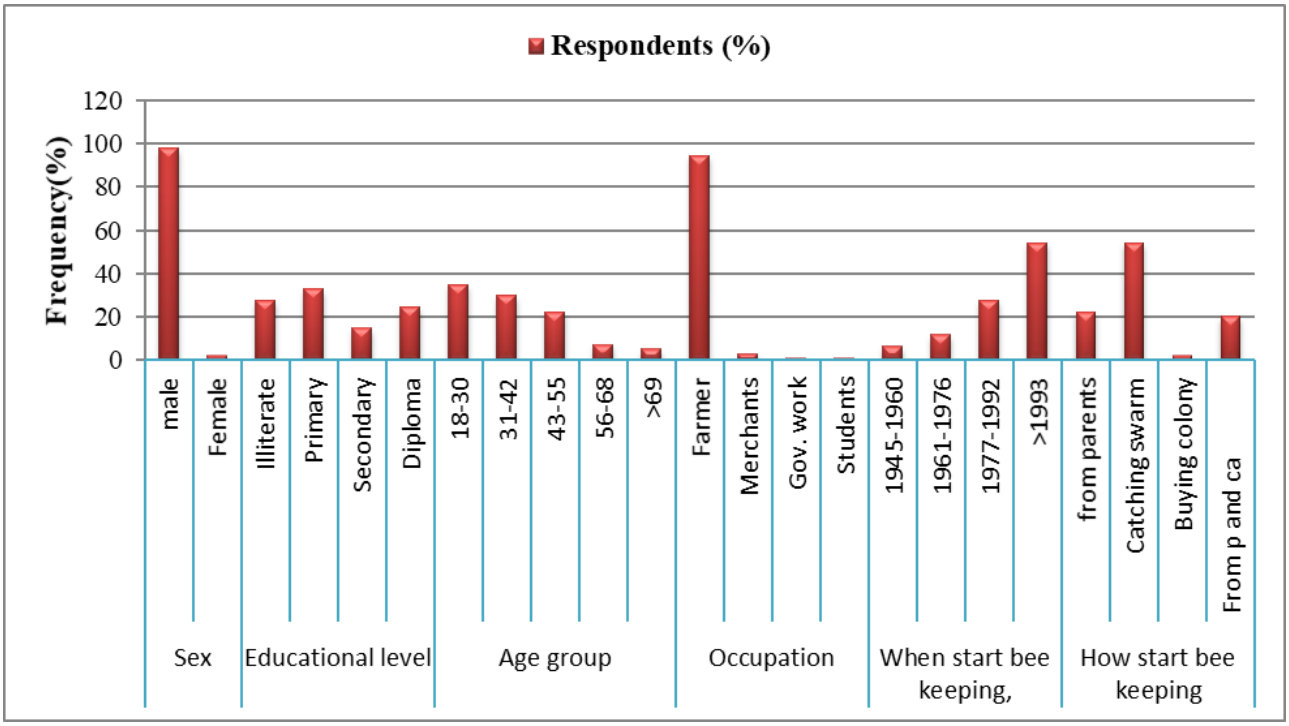

Fig 1: Socio- demographic characteristics of households

The survey result indicated that 97.9% of respondents are male and majority of them 33% primary school educated with age 18-30 were 33.1% with occupation 94.7% farmers and majority of them were start beekeeping >1993 (54.3%) by catching colony (54.3%) and they have more than 20 years of experience with indigenous knowledge in beekeeping. From the result it is clear there is potential beekeeper with early age group with better educational level which has the advantages of easily grasping for any type of trainings and apply it into practice to increase hive products and also rewarding to exert positive effort for those youngster beekeepers to integrate natural resource conservation with modern beekeeping technologies so as to get multiple results. Based on the result all of beekeepers in the area were keeping bees for the purpose of honey yield (100%) due to lack of the awareness on other bees products.

The trend of honey bee Colony numbers and honey yield

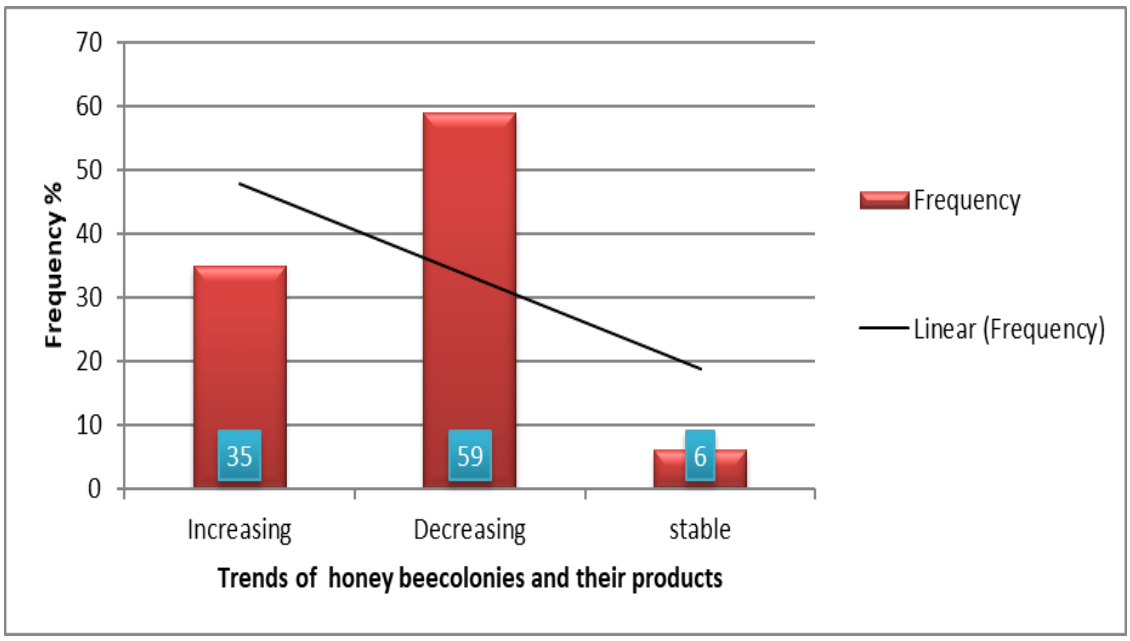

Fig 2: The trend of honey bee Colony numbers and honey yield

Based on the result, the population of honey bee colonies and honey production declined, increased and stable from time to time (48%, 46%, and 6%) correspondingly. Most of respondents mentioned that the honey bee colony numbers and honey bees by products were vary from year to year in the area. This indicate that, the major cause of decrease in colony and honey production was due to pests and predators of bee colonies and the application of agrochemicals which causing the lack of nectar and pollen source for colony build up and honey production.

Duration of honey bee colony staying in bee hives

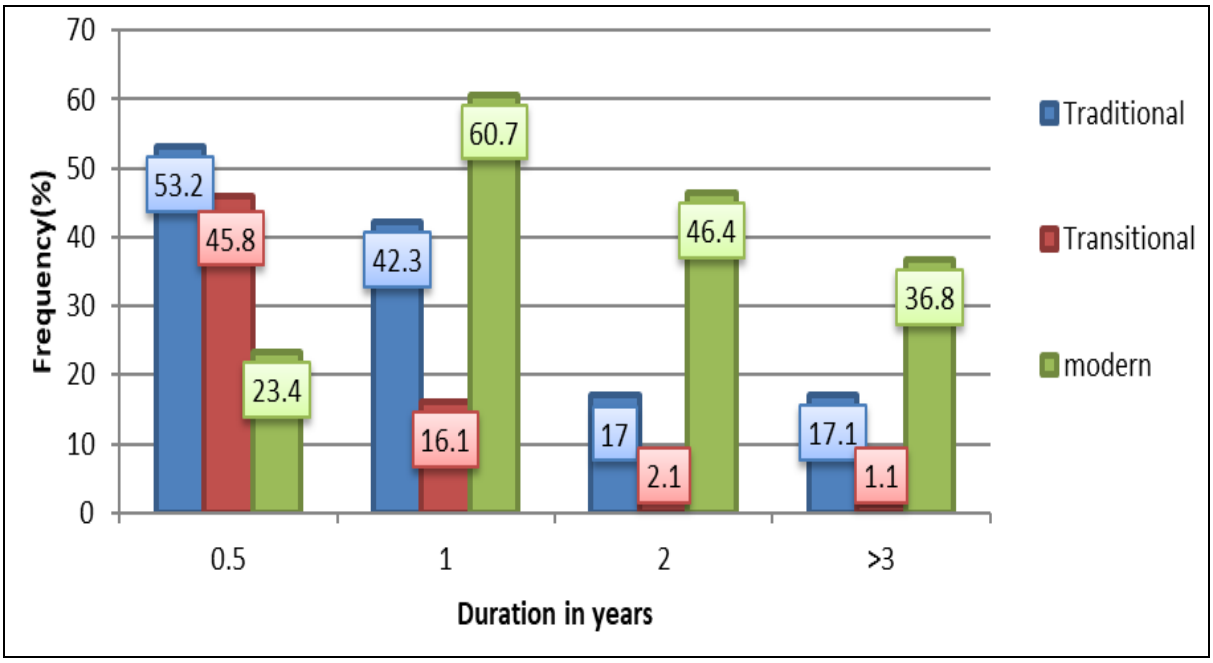

Fig 3: Duration of honey bee colony staying in bee hives

Concerning the duration of honey bee colonies in different bee hives, the respondent stated that the honey bee colonies stay in traditional bee hives as per cropping cycle of honey for six or less months. In Transitional bee hives honey bee colonies stay for one or more years while in modern bee hives honey bee colonies stay for more than two years and bee keeper can harvest honey and other bee products without cost of honey bee colonies for many years.

Apiary place of Bee keeper

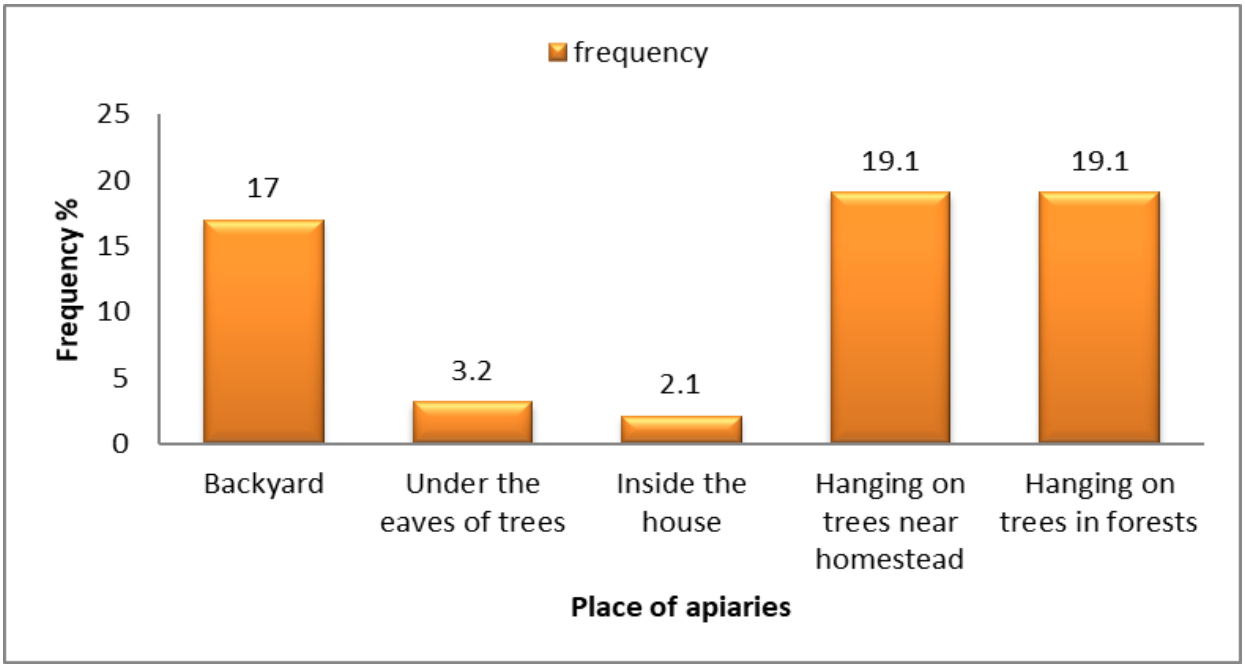

Fig 4: Apiary place of Bee keeper

Majority of the bee keepers keep bees hanging bee hives on trees near home stead and in forest followed by backyard bee keeping method. These indicate the lack of awareness on method of modern beekeeping and apiary site selection parameters in the area.

The trends of bee keepers

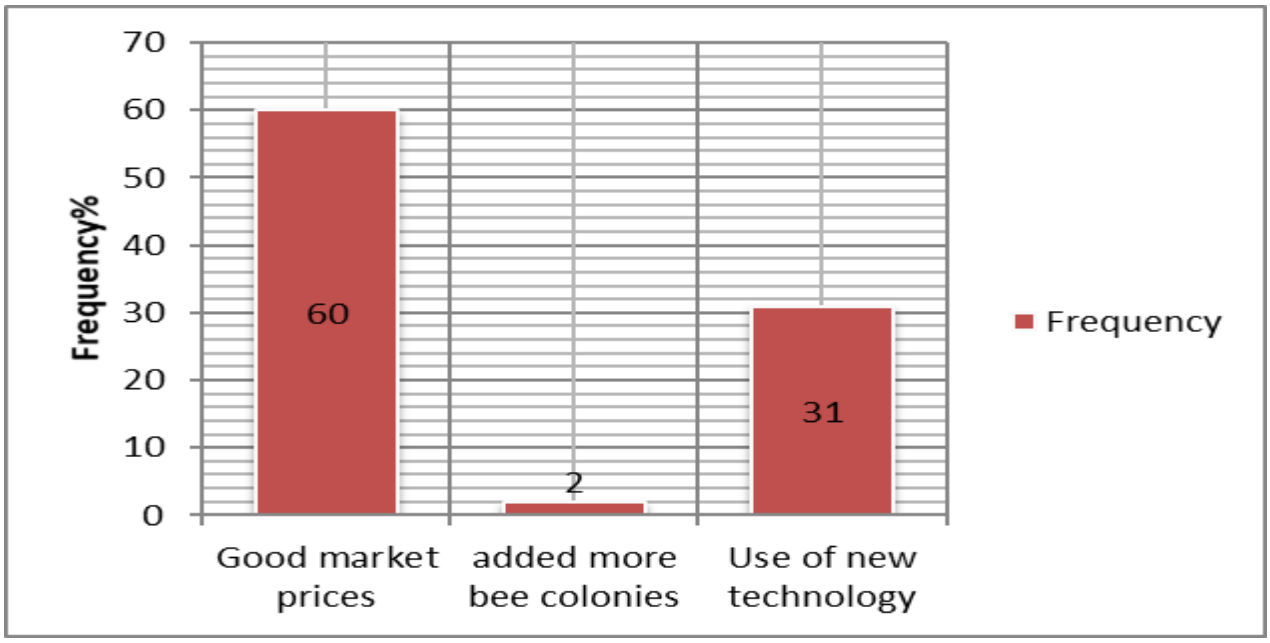

Fig 5: The trends of bee keepers

The numbers of bee keepers increase from time to time due to the availability of good marketing price (60%) on honey bee colonies and bee products. Even the availability of new bee keeping technologies (31%) and across natural resource conservation with green policy, the beekeeping activities were increasing.

Bee Flora Species

Based on the interview with bee keepers and visual observations,92 important plant species were recorded, out of which 28 species were found as major and 64 species were found as minor honey bee flora sources in both agroecology of the study area. From trees *Syzygivm guineese*, *Cordia*

Africana, *Vernonian* sp, *Eucalyptus* sp, Schefflera abyssinica and from shrubs *vernonia* sp…and from herbs *Guizotia sp*, *Trifollium* sp, *Brasssica*

From the study area based on potentiality of flora selected by the assistance of Woreda and Kebele development agents, samples of honey from five districts, three honey sample within one kebele from each districts in three honey flow seasons, totally forty five honey samples were taken. To identify major and minor honey bee flora species, pollen analysis was done through pollen analysis procedure. It was also indicated that some of honey bee flora identified by the respondent were similar with honey bee plant identified by through pollen analysis from honey samples with each honey flow season and time of flowering.

Table 1: Bee flora species

Districts	Scientific name	Common Name	Frequency of plants (%)	Flowering Calendar
G/Sayyo	*Syzygivm guineese*	Baddesssa	26.7	Dec-May
	Croton macrostachys	Bakkanisa	93.3	June-Dec
	Cordia africana	Waddeessa	83.7	June-Nov
	Vernonia amygdlena	eebicha	86.7	Dec-Febr
	Eucalyptus spp	bargamo	80	Dec-May
	Albizia schimperian	Mukarba	26.7	Mar-May
	Millettia ferruginea	Sotalloo	86.7	Mar-May
	Acacia spp	lafto	40	Mar-May
	Combretum Paniculatum	Hidda bagi	60	Dec-May
	Rhus glutinosa	Xaaxessaa	40	Dec-Augest
	Pterolobium stellatum	Harangama	33.3	Sept-May
	Trifolium burchellianum	Siddisa	40	Sept-Nov
	Bidens spp	Kelloo	100	Sept-Nov
	Guizota scapra	Tufo	73.3	Sept-Nov
	Brassica carinata	Goomanzara	33.4	June-Nov
	Linum usitatissimum	Talba	26.7	June-Nov
	Ocimum santum	Mosobila	33.3	Sep-Nov
	Capsium spp.	Hotpepper	40	Sep-Nov
	Mangifira indica	Mango	40	June-Nov
	Zea mays	Maize	92.3	June-Nov
	Pisum sativam	Pea	26.7	Sep-Nov
	Vicia faba	Bean	40	Sep-Nov
	Minor Honey bee Flora			
	Papaya carica	Papaya	13.3	Sep-Nov
	Carisa edulis	Agamsa	6.7	Dec-Febr
	Stereospermum kunthianum	Botoro	13.4	Dec-May
	Hypostes spp.	dereku	6.7	Mar-May
	Helianthus annus	sufi	26.7	Sept-Nov
	Clamates spp	Hidda fitii	13.4	Dec-May
	Rubus apetalus	Gora	6.7	Dec-Febr
	Coffe arabica	Coffee	26.7	Mar-Aug
Jardaga Jarte	*Syzygivm guineese*	Baddesssa	95.7	May-June
	Croton macrostachys	Bakkanisa	33.4	May-June
	Cordia africana	Waddeess	26.1	Nov-dec
	Vernonia SPP	eebicha	95.7	Dec-march
	Schefflera abyssinica	Getema	17.3	May-June
	Accasia spp	lafto	21.7	March-May
	Ekbergia capensis	Sombo	17.3	March-May
	Justitia schimperana	Dhumugaa	43.5	Sep-Feb
	Acanthus seni	Kosoruu	30.4	Sept-Nov
	Vernonian auriculifera	Rejii	26.1	Dec-march
	Plantago lanceolatum	Qorxobbii	20.4	Aug-Nov
	Trifolium burchellianum	Siddisa	39.1	Sept-Nov
	Biden spp	Hadaa	26.1	Sept-Nov
	Guizota abysinica	Nougii	100	Sept-Nov
	Brassica carinata	Gomanzar	52.2	Sept-Nov
	Torrida	Dannisa	32	Sep-Dec
	Minor Honey bee Flora			
	Eucalyptus spp	bargamo	4.3	Dec-march
	Guizota scapra	Tufo	4.3	Sept-Nov
	Linum usitatissimum	Talba	4.3	Sept-Nov
	Pisum sativam	Atara	8.7	Sept-Nov
	Hayenia abyssinica	Heexoo	12.1	Oct-Feb
	Clamatus spp	Hidda fitii	17.4	Nov-dec
Horroo	*Syzygivm guineese*	Baddesssa	84.2	Nov-March
	Croton macrostachys	Bakkanisa	26.3	May-Augest

	Cordia Africana	Waddeessa	47.3	May-Augest
	Vernonia Amygdlena	eebicha	78.9	Dec-March
	Eucalyptus spp	bargamo	57.9	Dec-Augest
	Schefflera abyssinica	Getema	42.1	Mar-May
	Justitia schimperana	Dhumugaa	36.9	Dec-May
	Plantago lanceolatum	Qorxobbii	36.8	Sept-Nov
	Trifolium burchellianum	Siddisa	26.3	Sept-Nov
	Bidens spp.	Kelloo	42.1	Sept-Nov
	Guizota abysinica	Noug	42.1	Sept-Nov
	Helianthus annus	sufi	26.3	Sept-Nov
	Zea mays	Maize	10.5	Sept-Nov
	Minor Honey bee Flora			
	Baha	baha	10.6	Feb-June
	Sorghum bicolor	Sorghum	5.3	Dec-Febr
	Cucuerbita pepo	Dabaaqula	5.3	Sept-Nov
	Brassica carinata	Gomanzar	5.3	Sept-Nov
	Phytolacca dedecandra	Andode	5.3	Dec-May
	Dovalis abyssinica	Koshim	5.3	Dec-May
	Acanthus seni	Kosoruu	10.6	Marh-May
	Hidda fitii	Hidda fitii	5.3	Dec-May
	Vernonian auriculifera	Rejii	5.3	Dec-May
Jima Ganati	*Croton macrostachys*	Bakkanisa	31.6	Mar-Augest
	Cordia africana	Waddeessa	26.3	Sept-Nov
	Vernonia amygdalina	eebicha	68.8	Dec-May
	Euculaptus spp	bargamo	47.4	Sept-may
	Albizia grandibracteata	Mukarba	21.1	Mar-Augest
	Albizia gummifera	Sootalloo	21.1	Sep-Dec
	Acesia spp	lafto	31.6	Mar-Augest
	Vernonian auriculifera	Rejii	31.6	Mar-May
	Plantago lanceolatum	Qorxobbii	36.8	Sept-Nov
	Trifolium burchellianum	Siddisa	57.9	Sept-Nov
	Rosa abyssinica	Qaqawwii	21.1	Dec-May
	Bidens spp.	Kelloo	36.8	Sept-Nov
	Tufo	Tufo	57.7	Sept-Nov
	Minor Hone bee Flora			
	Syzygivm guineese	Baddesssa	5.3	Mar-May
		Birbira	5.3	Dec-May
		mixo	5.3	Sept-Augest
		cako	5.3	Mar-May
	Helianthus annus	sufi	15.8	Sept-Nov
	Ocimum santum	Mosobila	5.3	Dec-Febr
	Nechasmud	Nechasmud	5.3	Dec-Febr
	Sisal	sisal	5.3	Dec-Febr
	Justitia schimperana	Dhumugaa	10.2	Through year
Sibu Sire	*Syzygivm guineese*	Baaddeessaa	94.4	Dec-May
	Croton macrostachys	Bakkanniisa	78.9	Mar-Augest
	Cordia africana	Wadeessa	44.5	Sept-Feb
	Vernonia amygdlina	Eebicha	88.8	Dec-May
		Wandaboo	38.9	Sept-Nov
	Prunus africana	Hoomii	11.1	Sept-Nov
	Euculptus spp	Baargamoo	16.7	Dec-May
		Birbirraa	27.8	Mar-May
	Schefflera abyssinica	Gatamaa	38.9	Mar-May
		Dhandhansa	33.4	Dec-May
	Albezy shyflera	Mukarbaa	38.9	Mar-May
	Accasia spp	Laaftoo	77.8	Mar-May
	Hidda fitii	Hidda fitii	27.8	Sep-Feb
	Hidda bagi	Hidda bagi	72.5	Dec-Aug
		Abbagabo	27.6	Mar-Augest
		Cemi	27.8	Dec-Febr
	Pterolobium stellatum	Harangamaa	27.8	Dec-May
	Plantago lanceolatum	Qorxobbii	50.1	Sep-May
		Qunni	27.8	Jun-Aug
	Trifolium burchellianum	Siddisa	83.3	Sept-Nov
	Bidens spp.	Bidens spp.	27.8	Sept-May
		Dhoqini	27.8	Jun-Aug
	Guizota scapra	Tufo	66.7	Sep-Feb

	Biden spp	Habaaboo masqalaa	38.9	Sep-Feb
	Guizota abysinica	Nuugii	100	Sep-Nov
	Brassica carinata	Goommanzara	44.5	Aug-Nov
	Capsium spp.	Mixmixa	22.2	Aug-Nov
	Solanumtubersum	Dinnicha	22.2	Sep-Feb
	Zea mays	Boqqolloo	66.6	Jun-Nov
	Sorghum bicolor	Bisinga	55.6	Sep-Feb
	Pisum sativam	Atara	16.7	Sep-Nov
	Vicia faba	Baaqalaa	27.8	Aug-Nov
	Coffe arabica	Buna	27.8	Mar-May
	Vernonian auriculifera	Reejjii	11.1	Dec-Febr
	Minor Hone bee Flora			
	Sesbania	Sasbaaniyaa	5.6	Jun-Aug
	Ekbergia capensis	Somboo	5.6	Sep-Nov
	Justitia schimperana	Dhumuugaa	5.6	Sep-Nov
	Cucuerbita pepo	Dabaaqula	5.6	Dec-Febr
	Citrus	Burtukana	5.6	Sep-Nov
	Helianthus annus	sufi	5.6	Sept-Nov
	Ocimum santum	misobilaa	16.7	Sep-Nov
	Nechasmud	Abasuuda adii	5.6	Sep-Nov
	musa paradisca	muuzii	11.1	Through year
	Phytolacca dedecandra	Andode	5.6	Mar-May
	Carisa edulis	Agamsa	5.6	Dec-May
	Borassus aethiopum	Meexxii	5.6	Mar-May

Bee floral Calendar

The floristic situation of the studied area was very suitable for beekeeping and the abundance of many nectar and pollen plants let beekeepers to establish many colonies in these both high and midland areas. Based on the result and availability of different plants identified through survey, visual observation and mellissoplynology from honey samples along with their flowering time, a bee floral calendar has been developed in this area. (Figure 2). Using the identified plants with their flowering period, beekeepers can calculate when they could transfer colony, suppering hive, colony multiplication and honey harvesting in their area. Preparation of apicultural calendar for this region and determining of rangeland capacity for beekeeping can be proposed. This calendar is as per the season of flowering and distributed in Major, Medium and Minor bee flora.

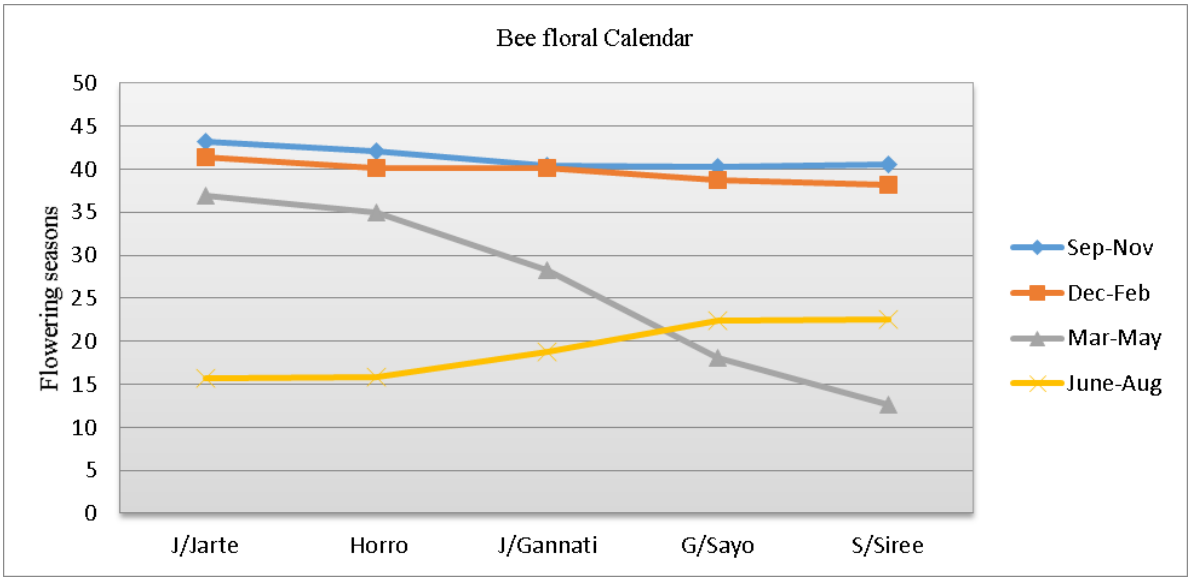

Fig 6: Bee floral Calendar

Based on most frequently flowering season majority of honey bee flora species of the area flower in first (September to November) and second season (December to February) in all districts that indicate two main honey flow season, The next honey flow season (March to may), which is third honey flow season for highlands (J/Jarte, Horo and J/Ganati.

Conclusion and Recommendation

Identification of nectar and pollen producer plants with apicultural calendar is very important for apiculture. Based on the results of this study, three flowering season was identified and the floristic situation is very suitable for beekeeping. Based on most frequently flowering seasons, majority of honey bee flora species of the area flowers in first (September to November) and second season (late December to February) in all districts that indicate two major nectar and pollen flow period and bee keeper can establish apiary site, install bee hives, divide colonies, add supers, use swarm control measures and harvest honey. The other identified honey flow season was (March to May), which is third honey flow season

for highlands, but it is dearth period for midland. Since the time from June to August is the dearth period for all districts: supper reduction and supplementary feeding is recommended. Generally most honeybee plants with its time of flowering was identified however further study on mellissopalynology from pollen load is recommended to establish floral calendar.

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