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Research Article

Beekeeping Calendar and Identification of Honeybee Floras for Honey Production in Different Agro-Ecologies of SNNPR, Ethiopia

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Abstract

Background and Objective: Identifying honeybee plants and creating a beekeeping calendar are crucial for beekeeping development. This study aimed to identify major and minor honeybee plants and their flowering seasons and establish a beekeeping calendar for honey production in various agro-ecological districts in Southern Ethiopia. **Materials and Methods:** A quantitative survey research design with stratified random sampling was used to obtain data from 100 farmers; 20 farmers from each kebele were interviewed from the five kebele of the two study woreda. The collected data were presented in tables with descriptive analysis. **Results:** The presence of both major and minor honeybee plants, serving as sources of nectar and pollen was revealed. Besides, distinct flowering seasons, leading to two honey-harvesting periods in the region were identified. In the Wolaita Zone (Humbo District), the main honey-harvesting season occurs from October to November, with a secondary season from April to May. In the Dawro Zone (Loma District), the primary harvest spans from October to January, while the minor season extends from March to June. **Conclusion:** Different major and minor honeybee plants that provide nectar and pollen for honeybees throughout the year and constraints of beekeeping and honey production were identified in study areas.

Key words: Beekeeping calendar, flowering season, honey, harvesting season, honeybee flora

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The nature of diversified flowering plant species and agro-climatic conditions has enabled the sustenance of several honeybee colonies. Ethiopia has longstanding beekeeping practices that have been an integral part of other agricultural activities, where more than one million households keep honeybees^{1,2}. Beekeeping is one of the country's oldest farming practices, benefiting from its diverse ecological and climatic conditions. The country hosts some of Africa's most varied flora and fauna, with forests and woodlands rich in plant species that offer abundant nectar and pollen for foraging bees.

Ethiopia boasts a rich variety of natural and cultivated plant life along with diverse agro-ecological and climatic conditions that are ideal for beekeeping³. It is one of the countries in the African continent, which has diverse plant species that provide surplus nectar and pollen to foraging honeybees to produce its hive products. Ethiopia's vast climatic and soil variability supports some of the most diverse flora and fauna in Africa, offering abundant nectar and pollen sources for foraging bee colonies⁴. This diversity has contributed to the presence of over 12 million honeybee colonies in the country⁵.

Honey yield and its byproducts depend on the availability of floral resources⁶. A deep understanding of the type, density and quality of bee flora allows beekeepers to maximize resource utilization, leading to high yields of honey and other bee products, as well as improved pollination that boosts crop production³. Production of honey depends mainly on the availability of floral resources (bee forage). Honey production is also considered a natural resource conserving and environmentally friendly activity⁷. The life of honeybees depends on the availability of floral resources because they use particular species of plants for a limited period due to their flowering season. The flowering plants and their blooming periods vary by location due to differences in topography, climate and various cultural and farming practices⁸. Ethiopia, with its rich flora, favorable ecological conditions and numerous bee colonies, holds significant potential for beekeeping⁹.

Honeybee plants are those species that offer bees food sources such as nectar, pollen or both³. However, not all bee plants are equally significant for bees and honey production¹⁰. Only about 16% of the world's flowering plant species serve as food sources for honeybees¹¹. Some provide abundant nectar and pollen, while others offer only one of these¹². The study area features a rich diversity of flowering plant species, including forest trees, bushes, grasses and cultivated plants, all of which are potentially valuable for beekeeping. Identifying

key honeybee plants is beneficial for advancing beekeeping practices. When flowering plants have good nectar and pollen sources, they produce surplus hive products, especially honey and beeswax.

Generally, the study requires the identification of the major and minor honeybee plants and the establishment of a beekeeping calendar. Assessing and identification of the potential bee floras and their importance as major and/or minor honey source plants are very important. This in turn requires the proper identification of honeybee plants, establishment of a beekeeping calendar and planning of appropriate interventions to boost honey production in different agro-ecologies. This study is thus expected to contribute towards the development of beekeeping, thereby contributing to the overall improvement in food security and identifying the major and minor honeybee floras in the highland, lowland and midland of the study area of Wolaita Zone and Dawro Zone of southern regions and then establishing a beekeeping calendar and identifying bee floras and their flowering season in the study areas. The objective of the study was to identify the major and minor honeybee plants and their flowering season in both study districts and to establish a beekeeping calendar based on their flowering season.

MATERIALS AND METHODS

Study area: The study was conducted in three representative agroecologies: lowland, midland and highland from April, 2023 to December, 2023.

Study design: A quantitative research design was employed to undertake a survey using questionnaires, interviews and focus group discussions. Descriptive analysis was scrutinized to present analysis results in Tables. A stratified random sampling procedure was followed to select the representative study area (for sample zones and potential woreda as per each zone and per each woreda three potential kebeles were selected). Based on this, Humbo and Loma were selected as districts from Wolaita and Dawuro Zones, respectively based on the potentiality of the area for beekeeping and honey source floras/plants. Abala Sipa (lowland), Shochora Ogodama (midland), Ellabacho (midland), Denebe Bolla (midland) and Shayit Fullasa (highland) kebele were selected for data collection. After the selection of the study sites, 100 informants were selected based on their potentiality of honeybee floras and having beekeeping experiences. Secondary data were collected from the Bureaus of Livestock and Fishery Development Office.

Table 1: Woreda and kebele selected from Dawro and Wolaita Zones for the study, 2023

Zones	Woredas	Kebeles	Agro-ecology
Wolayta	Humbo	Abala Sipa	Lowland
		Shochora Ogodama	Midland
Dawuro	Loma	Elabacho	Midland
		Shayit Fulasa	Highland
		Denebe Bola	Lowland

In this study, selected farmers from all kebele were interviewed and direct field observations and focus group discussions were conducted. For this, twenty beekeepers from each kebele were selected using a purposive sampling method based on their experience in beekeeping and interviewed them using a structured questionnaire to collect the appropriate information on honey source plant lists in order of their importance, their names, their flowering season and durations. The group discussion was conducted with 5-10 model farmers from each selected member, with development agents and bee experts from Woreda together.

Therefore, one hundred representative farmers were selected from five kebele of two selected districts (Humbo and Loma) and 20 farmers from each kebele who are experienced in beekeeping activity for a long period and owned different hive types were selected which represent lowland, midland and highland agroecology of the area for survey purpose and interviewed as shown in Table 1.

Statistical analysis: Results were presented by descriptive statistics in the form of tables.

RESULTS AND DISCUSSION

The results of this study were based on the information obtained from the honey-producing respondents, secondary data collected, focus group discussion and personal field observations. Since the main objectives of this study were the identification of honeybee flora and the establishment of a beekeeping calendar in the Wolaita and Dawro Zones, different honeybee plants that flower in different seasons of the year are identified to establish beekeeping calendar areas. Furthermore, other researchers reported that some beekeepers are always paying attention to monitoring the herbaceous plants, shrubs and trees that are especially important for honeybees^{6,12}. The most important months of the year in which honeybees can collect a vast variety of honeybee flora are September, October and November; at that time Meskel flower and other most important weeds give flowers. During this season almost all weeds, grasses and some tree species provide the honeybee with a vast variety of flora. At this time, the experienced farmers could collect honey for 3 weeks at least¹³. The major honey flow season in

midland, Woreda is from September to November in the first stage and from April to May in the second stage and it could vary based on the availability of rainfall and honeybee flora^{12,13}. The first stage indicates major honey flow season and the second stage indicates minor flow season.

The sample respondents surveyed in the study area owned different numbers and types of beehives (Table 2). About 90% of respondents have traditional beehives and 5.5 and 4.5% of respondents have transitional and modern beehives, respectively (Table 2). Averagely 6.7, 2.4 and 5.1 traditional, transitional and modern beehives respectively owned by each representative respondent in both Humbo and Loma Districts in those surveys conducted. Nearly 75 and 79% of representative respondents in the study area have no transitional and modern beehives, respectively (Table 2). Therefore, the result showed that beekeeping and honey production systems in the study area have been traditional production systems and need improvement of production and productivity through the introduction of modern beehives and honey production techniques^{3,13}.

As shown in Table 3, the honey has been harvested two times in a year namely during major and minor honey harvesting seasons. In the major honey-harvesting season, the honey average harvested from traditional, transitional and modern beehives has been 2.8, 5.8 and 8.8 kg, respectively and in the minor honey-harvesting season has been 1.25, 2.25 and 4.25 kg from traditional, transitional and modern beehives, respectively in both study areas. Averagely, the honey harvested from traditional beehives per year was 4.1 kg, transitional beehives 6.52 kg and modern beehives 12.35 kg (Table 3)^{7,8}.

Based on the responses of respondents, October and November were the major honey harvesting seasons and April and May, were the minor honey harvesting seasons in the Wolaita area of the Humbo District (Table 4). According to Table 4 results, more than 95% of respondents responded October and November were the major honey harvesting seasons and nearly 90% responded April and May, were the minor honey harvesting months^{5,13}.

Based on the responses of respondents in the Dawro Zone (Loma District), October, November, December and January are the major honey harvesting seasons whereas March, April, May and June are the minor honey harvesting

Table 2: Number of beehives owned by beekeepers at study districts, 2023

Types of beehives	Number of respondents	Total number of beehives owned by respondents	Number of respondents responded	Number of respondents who have no beehives	Beehives average owned per person	Beehives (%) owned by respondents
Traditional (local)	100	612	91	9	6.7	90
Transitional (KTB)	100	61	25	75	2.4	5.5
Modern (Zander)	100	108	21	79	5.1	4.5

seasons (Table 5). The Dawro Zone has natural forests, trees, shrubs, herbs and cultivated crops that give flowers to honeybees throughout the years for nectar and pollen sources according to the respondents (Table 5)^{3,5,13}.

The botanical origins of honeybee plants during major and minor honey harvesting seasons in Humbo and Loma was shown in Table 6. According to Table 6, most flowering plants are identified as major and minor honeybee plants based on their flowering months and commonly used floras during major and minor honey harvesting seasons in both Humbo and Loma Districts where the survey was conducted. Those honeybee plants listed in the Table 6 are sources of pollen and nectar to produce honey, beeswax and other hive products in both districts^{2,3,9}.

Based on the Table 7 survey report, the Humbo District of selected kebele has different flowering plants that are used for honeybees or foraging bees to get their feeds. As respondents responded, different flowering plants flower in each of the months from September to February. Those plants are honey sources depending on their flowering months and there have been possibilities of honey harvesting from the beginning of the year up to the end of the year in each flowering month. As it is listed in Table 7, many plants have long flowering times and some have short flowering times depending on their flowering duration. Therefore, there have been many chances to establish a beekeeping calendar in and around the areas that have the same agro-ecologies because, in the same agro-ecologies, the same flowering plants are expected to be grown^{2,3,9,14}.

The result of Table 8 showed that, in the Humbo District, there have been different flowering plants that foraging bees use for getting their feeds for honey production and other hive products. Besides, different flowering plants flower from March to August (Table 8). Those flowering plants are honey sources depending on their flowering months and there have been possibilities of honey harvesting from each flowering month. Moreover, many plants have long flowering times and some have short flowering times depending on their flowering duration, as a result, there have been many chances to establish beekeeping calendars in and around the areas that have the same agro-ecologies. Different scholars indicated the availability of various flowering plant species used by foraging bees for honey production^{7,13,14}.

According to the results of Table 9, many plant species bear flower in first 6 months, which indicates that the study area has potential for honey production because many plants are flowering for long period and are a source of nectar and pollen for honey production. That means the district has been rich in natural trees, forests, shrubs, herbs and cultivated crops. These make the area potential enough for honey production; because the plant growing in the district gives flowers each month i.e., from September to February. Therefore, there have been many chances to establish a beekeeping calendar in and around the areas that have the same agroecologies depending on their flowering duration^{2,3,9}.

According to the result of Table 10, many plant species flowers from March to August in the Loma District of the study area in which agroecology was highland, lowland and midland. Based on the responses of respondents, direct field observation and focal group discussion with selected farmers, there have been different flowering plants that bear flowers from March to August and hence the district has possibilities of honey harvest in each month due to the presence of many plants like shrubs, trees, forest and cultivated crops that are flowering for a long period and are a source of nectar and pollen for honey production (Table 10). Therefore, there have been many chances to establish a beekeeping calendar in and around the areas that have the same agroecologies depending on flowering duration^{2,3,14}.

Based on the result indicated in Table 11, there has been a shortage of honeybee floras, specifically; in some months of the year even if, there have been flowering plants that flower in different months of the year i.e., from September to August in study districts. These shortages are classified as critical shortage, shortage and less shortage as responded to representative farmers of both study districts. Based on responses of nearly 90% of representative respondents (Table 11), February is the most critical shortage month; July and August are shortage months and finally, September, December, January, March and June show less shortage availability in the study areas. Therefore, there should be improved honeybee floras in two studies to fill the gap and overcome the feed shortage of foraging bees to produce honey and other hive products^{13,14}.

Table 3: Amount of honey harvested in major and minor seasons per kg per hive in the study districts, 2023

Amount of honey harvested in major season per kg per hive										Amount of honey harvested in minor season per kg per hive										Amount produced per hive per kg per year					
From traditional	Number of respondents	From trans national	Number of respondents	From modern	Number of respondents	From traditional	Number of respondents	From trans national	Number of respondents	From modern	Number of respondents	From traditional	Number of respondents	From trans national	From traditional	From national	From modern	Number of respondents	From traditional	Number of respondents	From modern	Number of respondents	From traditional	From national	From modern
0.5-2	23	0.5-5	93	0.5-8	90	0.5-1.5	31	0.5-2	88	0.5-4	88	1-3.5	88	1-7	1-14	1-7	1-14	88	1-3.5	88	0.5-4	88	1-3.5	88	1-14
2.1-4	37	5.1-8	4	8.1-12	4	Above 1.5	69	Above 2	12	Above 4	12	3.6-5.5	12	7.1-8	14.1-15	3.6-5.5	14.1-15	12	3.6-5.5	12	Above 4	12	3.6-5.5	7.1-8	14.1-15
Above 4	40	Above 8	3	Above 12	6	-	-	-	-	-	-	-	-	-	>15	>5.5	>15	-	>5.5	-	-	-	>5.5	>8	>15
Average = 2.8	-	5.8	-	8.8	-	1.25	-	2.25	-	4.25	-	4.1	-	6.52	12.35	4.1	6.52	-	4.1	-	4.25	-	4.1	6.52	12.35

Table 4: Major and minor honey harvesting season in Wolaita Area (Humbo woreda), 2023

Harvesting months	September	October	November	December	January	February	March	April	May	June	July	August
Major honey harvesting season												
Percentage of representative samples responded by respondents	25	92	94	43	44	30	21	45	42	32	32	11
Minor honey harvesting season												
Percentage of representative samples responded by respondents	31	42	46	40	21	19	34	95	96	51	36	24

Table 5: Major and minor honey harvesting season in Loma Woreda, Dawro Zone, 2023

Harvesting months	September	October	November	December	January	February	March	April	May	June	July	August
Major honey harvesting season												
Percentage of representative samples responded by respondents	35	92	94	73	84	42	32	45	30	25	30	21
Minor honey harvesting season												
Percentage of representative samples responded by respondents	41	31	16	24	32	31	64	95	99	82	46	33

Table 6: Botanical origin of major and minor honey harvesting seasons, 2023

Botanical origin of major honey harvesting										Botanical origin of minor honey harvesting																								
Flowering plant					Months of flowering occurs					Flowering plant					Months of flowering occurs					District														
Adey abeba	September	October	November	December	Humbo and Loma	Sobuwaa	January	February	March	April	Humbo and Loma	Avocado	September	October	November	December	Humbo and Loma	Shiferaw	January	February	March	April	Humbo and Loma	Barigiyaa	September	October	November	December	Humbo and Loma	Lussinia	May	-	-	Humbo and Loma
Ankaa	September	October	November	December	Humbo and Loma	Digisuwaa	January	February	March	April	Humbo and Loma	Dubaa	September	October	November	December	Humbo and Loma	Koree	January	February	March	April	Humbo and Loma	Mango	September	October	November	December	Humbo and Loma	Acacia	January	February	March	Humbo and Loma
Ohaa/akaa	September	October	November	December	Humbo and Loma	Pigeon pea	October	November	-	Humbo	Kinchib	March	April	May	June	Humbo and Loma	Wanza	January	February	March	April	Humbo and Loma	Humbo and Loma	Zembaba	September	October	November	December	Humbo and Loma	Ambiya	January	February	March	Humbo and Loma
Adenguare	September	October	November	December	Humbo and Loom	Arizimiyaa	October	November	-	Humbo	Banana	March	April	May	-	Humbo and Loma	Deebuwa	September	October	November	March	April	Humbo and Loma	Grawa	September	October	November	December	Humbo and Loma	Coffee	January	February	March	Humbo and Loma
Dambiyaa	-	-	-	-	Humbo	Mimiya	October	November	-	Humbo	Tawayiyaa	January	February	March	April	Humbo and Loma	Hareg	January	February	March	April	Humbo	Humbo	Wanza	September	October	November	December	Humbo and Loma	Mango	January	February	March	Humbo and Loma
Banana	September	October	November	December	Humbo and Loma	Koosuwa	October	November	-	Humbo and Loma	Avocado	January	February	March	April	Humbo and Loma	Bakela	September	October	November	March	April	Humbo	Ater	September	October	November	December	Humbo and Loma	Grawa	January	February	March	Humbo and Loma
Tufaa	September	October	November	December	Humbo	Galalluwaa	October	November	-	Humbo	Dokima	January	February	March	April	Humbo and Loma	Cassava	January	February	March	April	Humbo and Loma	Shumbura	September	October	November	December	Humbo and Loma	Bahirzaf	January	February	March	Humbo and Loma	
Shasha	-	-	-	-	Humbo	Shumbura	October	November	-	Humbo	Kulkual	April	May	-	-	Humbo and Loma	Papaya	September	October	November	March	April	Humbo and Loma	Kontir	September	October	November	December	Humbo and Loma	Cassava	January	February	March	Humbo and Loma
Grawa	September	October	November	December	Humbo and Loma	Shoollaa	October	November	-	Humbo and Loma	Gulluwaa	January	February	March	April	Humbo and Loma																		

Table 7: Honeybee plants, their flowering months (September-February) and their type in Humbo District, 2023

Local name (Wolaytic/ Amharic) of plants	Scientific names of plants	Type of plants	Flowering months of plants				District
Adey abeba	<i>Bidens</i> spp.	Weeds	September	October	November	December	Humbo
Abezash sar	<i>Grass</i> spp.	Grass	September	October	November	December	Humbo
Arizimiyaa	-	Grass	September	October	November	-	Humbo
Avocado	<i>Persea americana</i>	Tree	September	October	November	December	Humbo
Agamee/ladiyaa	-	Shrub	January	February	-	-	Humbo
Abeba zaf	-	Shrub	November	December	-	-	Humbo
Akirsaa	-	Tree	December	-	-	-	Humbo
Ambiyaa	-	Tree	January	February	-	-	Humbo
Ankaa/Bisana	<i>Croton macrostachyus</i>	Tree	September	October	November	January	Humbo
Badana	<i>Balanites aegyptiaca</i>	Tree	September	October	November	January	Humbo
Barigiyaa	-	Tree	September	October	November	February	Humbo
Buluwaa	<i>Solanum incanum</i>	Shrub	September	October	February	-	Humbo
Bortuwaa	<i>Erythrina abyssinica</i>	Tree	January	February	-	-	Humbo
Burtukaniyaa	<i>Citrus</i> spp.	Tree	October	January	February	-	Humbo
Buuuuzwaa	<i>Solanum</i> spp.	Shrub	October	November	December	January	Humbo
Baccaa	-	Shrub	-	December	January	-	Humbo
Dalishaa	<i>Bidens</i> spp.	Weed	September	October	November	-	Humbo
Donuwa/Dinich	<i>Solanum tuberosum</i>	Crop	September	October	-	-	Humbo
Donguwaa	-	Tree	September	October	February	-	Humbo
Dandreta	-	Shrub	October	November	-	-	Humbo
Dambiyaa	-	Tree	November	February	-	-	Humbo
Deebuua	-	Herbs	November	January	February	-	Humbo
Digisuwaa	-	Tree	November	January	February	-	Humbo
Ettaa/Sholla	<i>Ficus platyphylla</i>	Tree	September	November	January	-	Humbo
Erigib ater	-	Crop	September	October	November	-	Humbo
Gabaa	-	Shrub	September	October	-	-	Humbo
Galaluwaa	<i>Maytenus</i> spp.	Tree	September	October	November	February	Humbo
Gegeruwaa	<i>Maytenus senegalensis</i>	Tree	September	October	-	-	Humbo
Garaa/Grawa	<i>Vernonia</i> spp.	Tree	September	October	November	January	Humbo
Gravillea	<i>Grevillea robusta</i>	Tree	October	November	December	February	Humbo
Guganta	<i>Acacia seyal</i> /Del.	Tree	February	-	-	-	Humbo
Gassaa	<i>Maytenus</i> spp.	Tree	February	-	-	-	Humbo
Geliceca	<i>Euclea</i> spp.	Tree	February	-	-	-	Humbo
Hamaka	-	Tree	November	December	-	-	Humbo
Hagilaa	-	Tree	February	-	-	-	Humbo
Jacaranda	<i>Solanum</i> spp.	Shrub	October	November	December	-	Humbo
Koosuwa	<i>Hagenia abyssinica</i>	Shrub	September	October	November	-	Humbo

Table 7: Continue

Local name (Wolaytic/ Amharic) of plants	Scientific names of plants	Type of plants	Flowering months of plants					District
Koshiyiyaa	-	Shrub	September	October	November	-	-	Humbo
Koree	<i>Aningeria altissima</i>	Tree	January	February	-	-	-	Humbo
Karicucha	<i>Bidens</i> spp.	Weed	September	October	-	-	-	Humbo
Leehiyaa/Duba	<i>Cucurbita pepo</i>	Herbs	September	October	November	-	-	Humbo
Lokomaa/Adengware	<i>Phaseolus vulgaris</i> L.	Crop	September	October	-	-	-	Humbo
Hawulakaa/Cassava	-	Crop	December	January	February	-	-	Humbo
Maaxxuuwaa/Kincib	-	Shrub	September	October	November	December	January	Humbo
Manguwaa	<i>Mangifera indica</i>	Tree	September	October	November	December	January	Humbo
Maliduwaaz/Mashila	<i>Sorghum bicolor</i>	Crop	September	October	November	December	January	Humbo
Moqotaa/Wanza	<i>Cordia Africana</i>	Tree	September	October	November	December	January	Humbo
Muuziyaa	<i>Musa paradisiaca</i>	Crop	September	October	November	December	January	Humbo
Mimiya	<i>Schefflera</i> spp.	Tree	September	October	November	January	-	Humbo
Mulishakiyaa	<i>Acacia</i> spp.	Tree	September	October	November	-	-	Humbo
Mucakuwaa	-	Shrub	October	November	-	-	-	Humbo
Ochaa/Dokima	<i>Syzygium guineense</i>	Tree	October	November	December	January	February	Humbo
Ohaa	<i>Solanum</i> spp.	Shrub	September	October	November	December	-	Humbo
Ongafriyaa	<i>Rhus natalensis</i>	Tree	October	November	-	-	-	Humbo
Oduuwaal/Acacia	<i>Acacia sibiica</i>	Tree	September	October	November	December	January	Humbo
Papayiyaa	<i>Carica papaya</i>	Crop	September	October	November	December	January	Humbo
Qaaccaa	<i>Euphorbia</i> spp.	Shrub	September	October	November	December	January	Humbo
Qobuuwaa/gulluwaa	<i>Ricinus communis</i> L.	Tree	November	December	January	-	-	Humbo
Qoruwaa/mech	<i>Guizotia</i> spp.	Weed	September	October	November	December	-	Humbo
Santaa/Gomen	-	Herbs	September	October	November	-	-	Humbo
Shaaashaa	<i>Solanum</i> spp.	Shrub	September	October	-	-	-	Humbo
Shiferaw	<i>Schefflera</i> spp.	Tree	December	January	February	-	-	Humbo
Suffiyaa	<i>Helianthus annuus</i>	Herbs	February	-	-	-	-	Humbo
Sobuuwaa/Abalo	<i>Combretum molle</i> R	Tree	November	December	January	February	-	Humbo
Tawayiyaa	<i>Grewia bicolor</i> Juss	Tree	October	December	January	February	-	Humbo
Tukiyyaa/buna	<i>Coffea arabica</i>	Tree	September	October	November	December	January	Humbo
Tsigereda abeba	<i>Bidens</i> spp.	Shrub	September	-	-	-	-	Humbo
Xunduiyaa/Kontir	<i>Ziziphus abyssinica</i>	Shrub	September	October	February	-	-	Humbo
Wollaa/Warka	<i>Ficus platyphylla</i> Del.	Tree	November	January	February	-	-	Humbo
Zaafiyyaa/Bahr zaf	<i>Eucalyptus</i> spp.	Tree	September	October	November	December	January	Humbo
Zambaa/zembaba	-	Shrub	September	October	November	December	January	Humbo

Table 8: Honeybee plants, their flowering months (March-August) and type in Humbo District, 2023

Local name (Wolaytic/Amharic) of plants	Scientific names of plants	Type of plants	Flowering months of plants
Avocado	<i>Persea americana</i>	Tree	March
Agamee/Ladiyaa		Shrub	March
Abeba zaf		Shrub	July
Ambiyaa		Tree	March
Ankaa/Bisana	<i>Croton macrostachyus</i>	Tree	April
Badana	<i>Balanites aegyptiaca</i>	Tree	May
Boiyi/aa/Hareg		Crop	April
Barigi/aa		Tree	April
Buluwaa	<i>Salanum incanum</i>	Shrub	March
Bortuwaa	<i>Erythrina abyssinica</i>	Tree	March
Burtukaniyaa	<i>Citrus</i> spp.	Tree	March
Buuzu/aa	<i>Salanum</i> spp.	Shrub	March
Baccaa		Shrub	March
Badala/Bokolo	<i>Zea mays</i>	Crop	July
Dalishaa	<i>Bidens</i> spp.	Weed	July
Donuwaa/Dinich	<i>Solanum tuberosum</i>	Crop	May
Donguwaa		Tree	March
Dandreta		Shrub	April
Dambiyaa		Tree	March
Deebu/aa		Herbs	March
Digisu/aa		Tree	March
Ettaa/Sholla	<i>Ficus platyphylla</i>	Tree	March
Galalu/aa	<i>Maytenus</i> spp.	Tree	March
Gegeru/aa	<i>Maytenus senegalensis</i>	Tree	August
Garaa/Grawa	<i>Vernonia</i> spp.	Tree	March
Guganta	<i>Acacia seyal</i> Del.	Tree	March
Gassaa	<i>Maytenus</i> spp.	Tree	March
Gelice/aa	<i>Euclea</i> spp.	Tree	April
Hagilaa		Tree	March
Itriwani/aa	<i>Ehretia cymosa thonn</i>	Tree	April
Jacaranda	<i>Salanum</i> spp.	Tree	May
Kasili/aa		Tree	March
Koshimi/aa		Shrub	March

Table 8: Continue

Local name (Wolaytic/Amharic) of plants	Scientific names of plants	Type of plants	Flowering months of plants	
Koree	<i>Anigaria altissima</i>	Tree	August	
Karicucha	<i>Bidens</i> spp.	Weed	June	July
Leehiyaa/Duba	<i>Cucurbita pepo</i>	Herbs	July	August
Lokomaa/Adengware	<i>L. phaseolus vulgaris</i>	Crop	May	June
Hawulakaa/Cassava		Crop	March	May
Maaxxuwaa/Kincib		Shrub	March	April
Manguwaa/Mango	<i>Mangifera indica</i>	Tree	March	April
Moqotaa/Wanza	<i>Cordia africana</i>	Tree	March	April
Muuziyaa	<i>Musa paradisa</i>	Crop	March	April
Mimiya		Tree	May	
Mulishakiyaa	<i>Acacia</i> spp.	Tree	May	July
Ochaa/Dokima	<i>Syzygium guineense</i>	Tree	March	April
Ohaa	<i>Salanum</i> spp.	Shrub	April	
Ongafiriya	<i>Rhus natalensis</i>	Tree	March	
Odoruwaa/Acacia	<i>Acaccia sibiriana</i>	Tree	March	April
Papayiyaa	<i>Carica papaya</i>	Crop	March	April
Qaaccaa	<i>Euphorbia</i> spp.	Shrub	March	April
Qoruwaa/Mech	<i>Guizotia scabra</i>	Weed	June	July
Santaa/Gomen		Herbs	March	April
Shiferaw	<i>Scheffera</i> spp.	Tree	March	April
Suffiyaa	<i>Helianthus annus</i>	Herbs	May	July
Sobuwaa/Abalo	<i>Combretum molle</i> R	Tree	March	April
Tawayiyaa	<i>Grewia bicolor</i> juss	Tree	March	April
Tukiya/Buna	<i>Coffea arabica</i>	Tree	March	April
Xunduiyaa/Kontir	<i>Zizighus abyssinica</i>	Shrub	March	April
Wollaa/Warka	<i>Ficus platyphyla</i> Del.	Tree	March	
Zaafiya/Bahrzaf	<i>Eucalyptus</i> spp.	Tree	March	April
Zambaa/Zembaba		Shrub	March	April

Table 9: Honeybee plants names, types and flowering months of the plants, Dawro Zone, 2023

Local name (Wolaytic/ Amharic) of plants	Scientific names of plants	Type of plants	Flowering months of plants					District
Abezash sar	Grass spp.	Grass	September	October	November	December	-	Loma
Odoruwaal/Acacia	<i>Acacia sibirica</i>	Tree	September	October	November	December	February	Loma
Aday abeba	<i>Bidens</i> spp.	Herbs	September	October	November	December	-	Loma
Adengware/Iokomaa	<i>Phaseolus vulgaris</i> L	Crop	September	October	November	-	-	Loma
Akaa/ohaa	<i>Solanum</i> spp.	Shrub	September	October	November	December	-	Loma
Ater	-	Crop	September	October	November	-	-	Loma
Arizimiyaa	-	Grass	September	October	November	-	-	Loma
Avocado/avoduwa	<i>Persea americana</i>	Tree	September	October	November	December	February	Loma
Agamee/ladiyaa	-	Shrub	October	November	January	February	-	Loma
Abalo/sobuwa	<i>Combretum molle</i> R	Tree	November	December	January	February	-	Loma
Abeba zaf	-	Shrub	November	December	January	-	-	Loma
Ambiyaa	-	Tree	January	February	-	-	-	Loma
Bahr zaf/zaafiya	<i>Eucalyptus</i> spp.	Tree	September	October	November	December	February	Loma
Bakela	<i>Vicia faba</i>	Crop	September	October	November	-	-	Loma
Banana/muuziyaa	<i>Musa paradisiaca</i>	Crop	September	October	November	December	February	Loma
Bisana/anaka	<i>Groton macrostachyus</i>	Tree	September	October	November	December	-	Loma
Buluwa	<i>Solanum incanum</i>	Shrub	September	October	November	-	-	Loma
Bortuwa	<i>Erythrina abyssinica</i>	Tree	October	January	February	-	-	Loma
Burtukaniyaa	<i>Citrus</i> spp.	Tree	October	January	-	-	-	Loma
Coffee/buna/tukiya	<i>Coffea arabica</i>	Tree	September	October	November	December	February	Loma
Cassava/hawulakaa	-	Crop	December	January	February	-	-	Loma
Dalishaa	<i>Bidens</i> spp.	Weed	September	October	November	-	-	Loma
Dinich/donuwa/potato	<i>Solanum tuberosum</i>	Crop	September	October	November	-	-	Loma
Donguwa	-	Tree	September	October	November	February	-	Loma
Duba/leehiyaa	<i>Cucurbita pepo</i>	Herbs	September	October	November	December	-	Loma
Dokima/ochaa	<i>Syzgium guineense</i>	Tree	October	November	December	January	February	Loma
Dambiyaa	-	Tree	November	February	-	-	-	Loma
Deebuua	-	Herbs	November	January	February	-	-	Loma
Digisuwa	-	Tree	November	December	January	February	-	Loma
Galaluwa	<i>Maytenus</i> spp.	Tree	September	October	November	December	February	Loma
Grawa/garaa	<i>Vernonia</i> spp.	Tree	September	October	November	December	February	Loma
Gomen/santaa	-	Herbs	October	November	-	-	-	Loma
Gravillea	<i>Grevillea robusta</i>	Tree	September	October	January	-	-	Loma
Guganta	<i>Acacia seya</i> /Del.	Tree	September	October	January	February	-	Loma
Gassaa	<i>Maytenus</i> spp.	Tree	September	-	-	-	-	Loma
Geliceeca	<i>Euclea</i> spp.	Tree	October	-	-	-	-	Loma
Hareg	-	Crop	September	-	-	-	-	Loma
Itrirariiyaa	<i>Ehretia cymosa</i> Thonn	Tree	October	-	-	-	-	Loma
Jacaranda	<i>Solanum</i> spp.	Tree	November	December	-	-	-	Loma
Kincib/maaxuwa	-	Shrub	September	October	November	December	February	Loma
Kontir/gamo	<i>Ziziphus abyssinica</i>	Shrub	September	October	November	December	February	Loma
gaadiyaa/xunduqiya	-	Shrub	September	October	November	December	-	Loma
Koshimiyaa	<i>Aningeria altissima</i>	Tree	September	February	-	-	-	Loma
Koree	<i>Bidens</i> spp.	Weed	September	October	-	-	-	Loma
Karicucha	<i>Euphorbia</i> spp.	Shrub	October	November	-	-	-	Loma
Kulkuwal	-	-	-	-	-	-	-	Loma

Table 9: Continue

Local name (Wolaytic/ Amharic) of plants	Scientific names of plants	Type of plants	Flowering months of plants				District
Lussinia	-	Herbs	November	-	-	-	Loma
Badalaa/bokolo/Maize	<i>Zea mays</i>	Crop	September	October	January	February	Loma
Mango/manguwaa	<i>Mangifera indica</i>	Tree	September	October	November	December	Loma
Mashila/malduwaa	<i>Sorghum bicolor</i>	Crop	October	November	-	-	Loma
/sorghum							
Mimiya	<i>Schefflera</i> spp.	Tree	September	October	November	-	Loma
Onqafiriya	<i>Rhus natalensis</i>	Tree	October	November	-	-	Loma
Papaya	<i>Carica papaya</i>	Crop	September	October	November	December	Loma
Qaaca	<i>Euphorbia</i> spp.	Shrub	September	October	November	December	Loma
Qoruwaa/mech	<i>Guizotia</i> spp.	Weed	September	October	November	-	Loma
Shaashaa	-	Shrub	September	October	-	-	Loma
Shiferaw	<i>Schefflera</i> spp.	Tree	December	January	February	-	Loma
Shollaa/ettaa	<i>Ficus platyphylla</i> Del.	Tree	November	December	January	-	Loma
Shumbura	<i>Cicer arietinum</i>	Crop	November	December	-	-	Loma
Tsigereda abeba	<i>Bidens</i> spp.	Shrub	September	-	-	-	Loma
Tufoo	<i>Guizotia scabra</i>	Shrub	September	October	November	-	Loma
Tawayiyya	<i>Grewia bicolor</i> Juss	Tree	October	November	December	-	Loma
Wanza/moqotaa	<i>Cordia africana</i>	Tree	September	October	November	December	Loma
Warka/wollaa	<i>Ficus platyphylla</i> Del.	Tree	November	February	-	-	Loma
Zambaba/zambaa	-	Shrub	September	October	November	December	Loma

Table 10: Honeybee plants; their flowering months (March-August) and their type in Dawro Zone (Loma District), 2023

Local name (Wolaytic/ Amharic) of plants	Scientific names of plants	Type of plants	Flowering months of plants				District
Abalo/sobuwa	<i>Combretum molle</i> R	Tree	March	April	May	-	Loma
Abezash sar	<i>Grass</i> spp.	Grass	March	April	May	June	Loma
Adengware/lokomaa	<i>Phaseolus vulgaris</i> L.	Crop	May	June	July	-	Loma
Ambiyaa	-	Tree	March	April	May	-	Loma
Agamee/ladiyaa	-	Shrub	March	-	-	-	Loma
Avocado/avocaduwa	<i>Persea americana</i>	Tree	March	April	May	June	Loma
Acacia/odoruwa	<i>Acacia sibirica</i>	Tree	March	April	July	August	Loma
Akaa/ohaa	<i>Solanum</i> spp.	Shrub	April	-	-	-	Loma
Abeba zaf	-	Shrub	July	-	-	-	Loma
Aday abeba	<i>Bidens</i> spp.	Shrub	August	-	-	-	Loma
Ater/ataraa	-	Crop	August	-	-	-	Loma
Bahr zaf/zaafiyyaa	<i>Eucalyptus</i> spp.	Tree	March	April	May	June	Loma
Banana/muuziyaa	<i>Musa paradisiaca</i>	crop	March	April	May	June	Loma
Bisana/ankaa	<i>Croton macrostachyus</i>	Tree	March	April	May	June	Loma
Bortuwa/korch	<i>Erythrina abyssinica</i>	Tree	March	April	-	-	Loma
Buluwaa	<i>Solanum incanum</i>	Shrub	March	April	May	-	Loma
Burtukaniyaa	<i>Citrus</i> spp.	Shrub	March	April	May	-	Loma
Buuzuwa	<i>Solanum</i> spp.	Shrub	March	-	-	-	Loma
Bakela	<i>Vicia faba</i>	Crop	August	-	-	-	Loma
Coffee/tukiyaa/buna	<i>Coffea arabica</i>	Tree	March	April	May	June	Loma
Cassava/hawulakaa	-	Crop	March	April	May	June	Loma
Dalishaa	<i>Bidens</i> spp.	Weed	June	July	August	-	Loma

Table 10: Continue

Local name (Wolaytic/ Amharic) of plants	Scientific names of plants	Type of plants	Flowering months of plants					District
Dinich/donuwaa/potato	<i>Solanum tuberosum</i>	Crop	May	June	July	August	-	Loma
Donguwaa	-	Tree	March	April	-	-	-	Loma
Duba/leehiyaa	<i>Cucurbita pepo</i>	Herbs	April	July	-	-	-	Loma
Dokimaa/ochaa	<i>Syzgium guineense</i>	Tree	March	April	May	June	-	Loma
Dambiyaa	-	Tree	March	April	-	-	-	Loma
Deebuua	-	Herbs	March	April	-	-	-	Loma
Digisuwaa	-	Tree	March	April	-	-	-	Loma
Dandreta	-	Shrub	April	-	-	-	-	Loma
Enset	-	Crop	March	April	May	June	July	Loma
Galaluwaa	<i>Maytenus</i> spp.	Tree	March	April	May	June	August	Loma
Grawa/garaa	<i>Vernonia</i> spp.	Tree	March	April	May	-	August	Loma
Gomen/santaa	-	Herbs	July	August	-	-	-	Loma
Gravillea	<i>Grevillea robusta</i>	Tree	March	April	-	-	-	Loma
Guganta	<i>Acacia seya</i> /Del.	Tree	March	April	July	August	-	Loma
Gassaa	<i>Maytenus</i> spp.	Tree	March	-	-	-	-	Loma
Geliceeca	<i>Euclea</i> spp.	Tree	April	-	-	-	-	Loma
Gegeruwaa	<i>Maytenus senegalensis</i>	Tree	August	-	-	-	-	Loma
Getemee	<i>Schefflera abyssinica</i>	Tree	March	-	-	-	-	Loma
Hareg/boyiyaa	-	Crop	April	June	July	August	-	Loma
Itrwanjiyaa	<i>Ehretia cymosa</i> Thonn	Tree	April	-	-	-	-	Loma
Jacaranda	<i>Solanum</i> spp.	Tree	May	June	-	-	-	Loma
Kincib/maaxuwaa	-	Shrub	March	April	May	June	August	Loma
Kontir/gamo gadiyaa	<i>Ziziphus abyssinica</i>	Shrub	March	April	May	June	August	Loma
/xunduqiyyaa	-	Shrub	March	April	May	June	-	Loma
Koshimiyaa	<i>Aningeria altissima</i>	Tree	March	-	-	-	-	Loma
Koree	<i>Bidens</i> spp.	Weed	June	July	August	-	-	Loma
Karicucha	<i>Euphorbia</i> spp.	Shrub	April	May	-	-	-	Loma
Kulkuwal	-	Herbs	May	-	-	-	-	Loma
Lussinila	<i>Zea mays</i>	Crop	June	July	August	-	-	Loma
Maize/badala/bokolo	<i>Mangifera indica</i>	Tree	April	May	August	-	-	Loma
Mango/manguwaa	<i>Schefflera</i> spp.	Tree	May	-	-	-	-	Loma
Mimiya	<i>Rhus natalensis</i>	Tree	March	-	-	-	-	Loma
Ongafiriyyaa	<i>Carica papaya</i>	Crop	March	April	May	June	August	Loma
Papaya/papayiyaa	<i>Euphorbia</i> spp.	Shrub	March	April	May	June	August	Loma
Qaacia	<i>Guizotia</i> spp.	Weed	June	July	August	-	-	Loma
Qoruwaa/mech	<i>Schefflera</i> spp.	Tree	March	April	-	-	-	Loma
Shiferaw	<i>Ficus platyphylla</i> Del.	Tree	March	April	-	-	-	Loma
Sholla/ettaa	<i>Helianthus annuus</i>	Herbs	May	June	July	August	-	Loma
Suffiyaa	<i>Guizotia scabra</i>	Shrub	April	July	August	-	-	Loma
Tufoo	<i>Grewia bicolor</i> Juss	Tree	March	April	-	-	-	Loma
Tawayiya	<i>Cordia africana</i>	Tree	March	April	May	June	August	Loma
Wanza/moqotaa	<i>Ficus platyphylla</i> Del.	Tree	March	-	-	-	-	Loma
Warka/wollaa	-	Shrub	March	April	May	June	August	Loma
Zambaba	-	Shrub	March	April	May	June	August	Loma

Table 11: Shortage periods of honeybee floras responded by representative respondents in the study districts, 2023

Shortage levels	Flowering months of plants											
	September	October	November	December	January	February	March	April	May	June	July	August
Critical shortage of honeybee floras period/months												
Number of representative respondents	16	5	12	14	44	87	25	14	12	25	33	21
Shortage of honeybee floras period/months												
Number of representative respondents	15	9	15	9	21	33	31	16	11	32	79	61
Less shortage of honeybee floras period/months												
Number of representative respondents	61	21	6	79	84	5	83	25	13	72	15	22

Table 12: Seasonal management of colonies in the study districts, 2023

Colony management during active season	Number of representative respondents	Colony management during dry season	Number of representative respondents
Catching and controlling swarms and managing swarming bees by transferring new hives	81	Cleaning apiary areas and beehives continuously/timely	75
Cleaning apiary areas and beehives continuously/timely	89	Giving/providing additional feeds like sugar, flour, shuro, honey, water, berbere, eride, sugarcane and other feed types	73
External and internal inspections timely	82	External and internal inspections timely	78
Adding supers and changing frames	62	Reducing supers and changing frames	64
Harvesting ripened honey timely	79	Planting different honeybee floras to overcome feed shortage	62
		Putting teff straw and dried natural grass to control high temperature	79

Based on the result of Table 12, there has been seasonal colony management based on the activity of active season and dry season as responded, discussed and directly observed in both Humbo and Loma Districts. Besides, catching, controlling and managing swarms, cleaning and harvesting ripened honey and inspecting and adding suppers are active season colony management systems as well as providing different types of additional feeds and water, continuous inspection of apiaries and reducing suppers and planting different bee floras are dry season colony management systems (Table 12). According to the respondents, some respondents are not perfect for controlling and managing swarms, adding and reducing supers, cleaning apiaries and hives timely, providing additional feeds and water during dearth periods and planting different bee flora for feed shortage periods^{8,13}.

The result of Table 13 showed that different colony dynamics activities occurred in different months of the year. As representative respondents responded, brood rearing, natural swarming, colony migration, colony absconding, honey flow, dearth period and drone availability are activities of colony dynamics that occurred in both study areas of Humbo and Loma. Accordingly, September and October are brood-rearing and natural swarming months whereas October, November, April and May are honey flow periods as

responded by representative respondents in both study areas (Table 13). Besides, the result showed that January and February are dearth periods for honeybees whereas October, November, April and May also are drone available months in the study areas. However, colony absconding occurs in almost all months of the year because it is accidental activity as responded in both study areas and colony migration is a dearth period activities occurred during the dearth period like January and February in all areas of beekeeping activities performing¹³.

Table 14 shows that there are honeybee-poisonous plants in the study area, hence, aydamiya (Tena-adam) is a honeybee-poisonous plant identified in both study districts. As a result, it is indicated that the flowering months of aydamiyaa are September, October, November, December, January and February in both study areas^{3,9,13}.

Therefore, this study implied the appropriate flowering times for honeybee flora in Wolaita Zone (Humbo woreda) were October to November and April to May for the first and second honey-harvesting seasons, respectively. In the same taken, it is from October to January and March to June for the major and minor honey harvesting seasons in the Dawro Zone (Loma woreda), respectively. The aforementioned months were identified as the minor and major honey harvesting seasons in both study districts.

Table 13: Colony dynamics in the Wolaita and Dawro Zone study districts, 2023

Colony dynamics	Occurring months											
	September	October	November	December	January	February	March	April	May	June	July	August
Brood rearing												
Number of representative respondents	35	94	93	9	0	0	3	13	8	7	10	17
Natural swarming												
Number of representative respondents	31	92	91	16	5	13	5	5	4	0	0	5
Colony migration												
Number of representative respondents	2	11	9	2	83	90	32	13	10	6	23	16
Colony absconding												
Number of representative respondents	20	55	38	79	80	36	57	44	59	14	43	77
Honey flow												
Number of representative respondents	21	93	97	6	6	4	10	79	83	6	10	0
Dearth period												
Number of representative respondents	4	3	6	8	89	94	43	8	2	13	24	31
Drone availability												
Number of representative respondents	30	93	95	18	14	12	4	73	87	0	3	1

Table 14: Honeybee poisonous plants in the study district, 2023

Poisonous plant	Blooming months											
	September	October	November	December	January	February	March	April	May	June	July	August
Aydamiyaa												
Number of representative respondents	37	54	77	59	32	12	14	14	15	1	0	0

Moreover, the limitation of this study was that, for instance, it identified the honeybee flora that was essential for its existence and those plants poisonous for it only based on respondents; however, it did not include the laboratory analysis due to which elements that exist in the aydamiya plant made poisonous and other flora non-poisonous to the honeybee. Besides, the study was limited to two sample zones of the South Ethiopia Region, much more honeybee flora would have been identified if the study had been at the country level.

CONCLUSION

In the chosen districts, apiculture farming shows significant potential due to favorable conditions such as diverse flora, appropriate agro-ecological settings for apiaries and the presence of natural forests. These factors create an encouraging environment for participants in the sector. Nevertheless, challenges like the lack of improved honeybee flora, insufficient apiculture equipment, the presence of honeybee pests and limited technology adoption need to be addressed. To advance the sector, it is crucial to focus on establishing small-scale farming cooperatives, enhancing capacity, scaling up improved techniques and assessing disease and pest prevalence. Additionally, identifying and researching local flora at the national level and investigating the potential toxicity of plants like aydamiya, could help

in producing and marketing organic honey both nationally and internationally.

SIGNIFICANCE STATEMENT

It is very important to assess and identify potential bee floras and their importance as major and minor honeybee feed resource plants. Proper identification of honeybee plants for the establishment of a beekeeping calendar and for planning appropriate interventions to improve honey production and productivity in highland, midland and lowland study areas. This study is expected to contribute towards the development of the beekeeping and apiculture sector, contributing to an overall improvement in honey production and productivity improve the food security system, which is used for identifying major and minor honeybee floras in three agro-ecology of the study areas and then establishing beekeeping calendar and identifying bee floras and their flowering season in the study areas.

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