Identification of Honeybee Flora and Evaluation of Beekeeping Production Systems in Somali Region, Ethiopia

Abdi Abdilahi [a,b], Kownin Abdimahad [b*], Abdulahi Mahamed [a,b] and Mohamed Kumane [c,d]

[a] *Livestock and Forage Research Directorate, Somali Region Livestock and Agricultural Research Institute, Jigjiga, Ethiopia.*
[b] *Department of Animal and Range Science, College of Dryland Agriculture, Jigjiga University, Jigjiga, Ethiopia.*
[c] *Natural Resource Research Directorate, Somali Region Livestock and Agricultural Research Institute, Jigjiga, Ethiopia.*
[d] *Department of Natural Resource Management, College of Dryland Agriculture, Jigjiga University, Jigjiga, Ethiopia.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

The study was conducted two potential zones of Somali region to assess and characterize honeybee flora and beekeeping production practices. For this study six districts were selected using purposive sampling methods. A total of 120 beekeepers with equal proportion from the six

---

Corresponding author: Email: kawniin2015@gmail.com;

districts were selected randomly. The study comprises two parts including assessment about bee keeping production practices and field work with honeybee flora identification. The result of the study indicated that 79.2 % of total sampled households were male headed households. The primary reason of beekeeping production in the study areas was income generation and consumption as majority (75%) of the respondents implied. The traditional hives were the most commonly used hives as majority (65%) of the respondents implied and main source of their foundation colonies was by catching the swarms. The overall honey yield was 6.125+0.59 and 11.56±0.43 per hives per harvesting season in traditional and modern hives respectively. The honey harvesting is carried out at nighttime. pest and predators, absconding and scarcity of water were major constrains of beekeeping production in the study areas. The major pest and predators limiting the beekeeping production in the study areas were ants and Honey badgers. A total of 2,366 honeybee forage plants were representing a wide range of genera and families. The most dominant species were Acacia Senegal locally known as "Cadaad" with 490 individuals (20.71%). Among the study sites Salahad and Lagahida districts recorded the highest number of forage plants with 500 & 498 individuals respectively and were categorised as areas of "much more abundance" identified which belong to different genera and families containing fifteen species were identified and recorded. These findings highlight significant spatial variation in honeybee forage resources and indicate that Salahad and Lagahida districts possess the greatest potential for beekeeping development and increased honey production. The study emphasizes the need for improved honey harvesting, processing, and storage practices to improve honey quality of the beekeepers. The studied districts have high production potential for honeybee floras which is suitable beekeeping production therefore further research is required in the areas of participatory research action through community participatory approach and foraging is highly recommended.

1. INTRODUCTION

Beekeeping is an important component of agriculture and rural development programs of many countries. It helps to provide security in nutrition, economy and ecology (Jeil *et al.,* 2020; Güler, 2021). Besides, it does not compete with other resources in the farming system, it is income generation activity and supplement annual income for the beekeepers through selling bee products (honey, beeswax, and bee colonies). It also serves as a healthy food for consumers (FAO, 2015). Ethiopia is the home of diverse fauna due to its varied ecological and climatic conditions (Beyene *et al.,* 2016). This is the prime reason for the availability of large colony numbers in the country. In Ethiopia, three types of beehives (traditional, intermediate, and improved) are known, with more than 10 million colonies, from which more than 90% are traditional hives (CSA, 2021).

The total annual honey production in the country is estimated to be about 129 million kilograms of which the greater portion is harvested from traditional beehives (CSA, 2021). Identification and mapping of honey source plants are very important for the selection of suitable apiary sites and also to determine the honey bee colony carrying capacity of an area (Beyene *et al,* 2015). According to Burgett *et al.* (2004), 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. Beekeeping is more dependent on the suitability of an area than any other livestock production (Nuru, 2008). Takele (2014) conducted research titled 'Potential of Honey Production and its Utilization for Food Security in Filtu Woreda, Liben Zone, Somali Regional State, Ethiopia' and tried to assess the honey production potential and it is utilization for food security without identification of spatially honey flora species abundance areas in the region. However spatially mapping bee flora species is useful for beekeepers to exploit the resources.

Thus, while the country is a principal producer of honey, it has the potential to improve yields and harvest more if existing beekeepers are able to overcome significant issues regarding inputs, technical skills, and climate change adaptation (Gratzer *et al.,* 2021). In order to exploit the country's production potential, the government has given consideration to developing the beekeeping subsector as a strategy for the reduction of poverty and the diversification of export commodities (Shapiro *et al.,* 2015).

Ethiopia boasts the largest bee population in Africa, exceeding 10 million bee colonies, with over 90% housed in traditional hives (CSA,

2021). However, the quantity and quality of Ethiopian honey remain underdeveloped, as 95% of beekeepers adhere to traditional practices without the adoption of improved techniques or technologies. Nonetheless, beekeeping is recognized as a viable and widely accepted agricultural practice, well-suited to the diverse ecosystems found in tropical Africa (Tadele *et al.,* 2016).

Somali region, large proportion of inaccessible lands for agriculture are covered with various types of trees, shrubs, bushes, and field flowers that make this part of the regions still to be potential for beekeeping. However, it requires making efforts to address some of the major problems of beekeeping and to keep it productive in the sustainable way. In region, the majority of the households keep bees and honey serves as a source of cash incomes for many households. Thus, in order to produce and improve the quality of honey that meets the demands of national and international markets and quality criteria, information about the quality of honey produced in the area is important. Therefore, this study was aimed to identify honeybee flora and evaluate beekeeping production systems in selected zones of Somali Region, Ethiopia.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was conducted in two zones of the Somali region: Erer and Liban, both known for their strong potential in beekeeping and honeybee flora. Erer zone, previously called Nogob, is one of eleven zones in the Somali Regional State of Ethiopia. It borders Gode zone to the south, Afder zone to the southwest, the Oromia Region to the west and northwest, Fafan zone to the north, Jarar zone to the east, and Korahei zone to the southeast. The Erer River runs through this zone, which consists of eight woredas: Fiq, Hamaro, Lagahida, Salahad, Mayumuluka, Qubi, Yahoob, and Waangay. Liban zone, also in the Somali Region, borders Kenya to the south, the Oromia Region to the northwest, Afder to the northeast, and Somalia's Jubaland to the southeast. Key towns in Liban include Filtu, Bokolmayo, Deka Suftu, and Dolo.

2.2 Study Design

The study employed a cross-sectional design comprising two main components: a survey assessment and fieldwork. The survey was conducted to gather relevant information on honeybee flora identification, beekeeping production systems, constraints, and opportunities from selected beekeepers. Concurrently, the fieldwork focused on the identification and spatial mapping of major honeybee forage species across the study districts to determine their abundance and distribution.

2.3 Sampling Techniques and Sample Size

A multi-stage sampling technique was employed for this study. Initially, two zones were purposively selected from the eleven zones of the Somali Region based on their potential for beekeeping and honey production, in consultation with regional offices. In the second stage, six districts with high honeybee flora and production potential were purposively chosen. At the third stage, twelve kebeles within these districts were selected. Finally, from these kebeles, 120 beekeeping households were randomly selected to participate in the study.

2.4 Methods of Data Collection

Data were collected through semi-structured questionnaires administered to selected beekeepers, along with focus group discussions, key informant interviews, and personal observations. Two focus group discussions were conducted in each district, each involving a minimum of eight participants. Secondary data were gathered from regional, zonal, and district-level livestock and pastoral development offices, focusing on honeybee flora, production systems, and management practices. Key parameters studied included the purpose of beekeeping, production practices, honey yield, major constraints and opportunities, and the identification and mapping of dominant honeybee flora species.

2.5 Procedures and Determination of Honeybee Flora Identification and Abundance

To identify areas with abundant honeybee flora, a purposive sampling method was applied by selecting six districts based on existing information on honey production potential. Plant abundance was assessed following the methodology of Shegaw *et al.* (2021). In each study site, a systematically selected large field plot measuring 50m × 50m (2,500 m²) was established, and its coordinates recorded using a GPS device. Within each large plot, four

quadrats of 30m × 30m (900 m²) were delineated. All bee forage plant species within each quadrat were identified and recorded using their local names.

2.6 Honey Forage Plant Species Mapping Methods

All mapping methods depend on available material, as well as hardware, software, knowledge, and experience, field survey mapping methods was selected for the honey bee forage species abundance classification. This method is based on in situ observations aided with GPS location, and delineation during Field Survey (Al Sghair, 2013). Accordingly, the abundance of bee forage plants (number of plants observed per unit area (plot) was used to determine the abundance level of honey bee forage plant species in each study site. The abundance map was prepared based on the number of honey bee forage plant species recorded from each study sites and shapefile of their respective study districts using GIS software. Data was prepared in excel in a format that can be readable to the GIS software and then classified.

2.9 Data Analysis

Data collected through questionnaires were analyzed using SPSS version 25 for descriptive statistics such as means, frequencies, and percentages. ANOVA and chi-square tests were applied to assess differences and relationships among key variables like hive types, honey yield, and beekeeping practices across districts. Qualitative data from focus group discussions and key informant interviews were analyzed thematically to support and enrich the quantitative findings. Honeybee flora abundance was assessed using field plot data, and spatial classification was conducted using ArcGIS 10.8 with the Natural Breaks method to map forage plant distribution. Constraints and opportunities were summarized using index values to highlight their relative importance across the study areas.

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics of Households

The demographic profile of respondents is presented in Table 1. The majority (79.2%) of sampled households were male-headed, with only 20.8% female-headed, suggesting low female involvement in beekeeping—likely due to cultural barriers, limited empowerment, and the physical demands of tasks like harvesting from tree-hung hives. Most respondents (46.67%) were aged 26–40, followed by those aged 45–60 (40.83%), indicating that beekeeping is largely practiced by the productive age group. Regarding education, 70% of respondents were illiterate, which may hinder the adoption of modern beekeeping technologies. In terms of marital status, 70% were married, highlighting the role of household stability in beekeeping engagement. The average family size was 6.4±0.375, consistent with findings by Ma'alin *et al.* (2022) for Shabelle Zone.

3.2 Purpose of Beekeeping Production

The findings revealed that the primary purpose of beekeeping in the study areas was both income generation and home consumption, as reported by 75% of respondents. This was followed by those who practiced beekeeping solely for home consumption (15%) and those who kept bees exclusively for income generation (10%). These results contrast with the findings of Anza *et al.* (2021) in Arba Minch, where the main purpose of beekeeping was reported to be income generation alone.

3.3 Beekeeping Production Practices

3.3.1 Type and number of hives per household in the study areas

The type and number of hives per household are indicated in Table 2. The majority (65%) of respondents across the different districts reported that the available hive types are traditional, followed by 19.17% who have both traditional and modern beehives, whereas the remaining 17.5% of respondents have only modern hives. The results of the study indicate a significant difference ($p < 0.05$) among the studied districts with respect to the types of available hives. Specifically, the availability of modern hives is very limited in Gurabaksa and Guradamole districts of Liban Zone. The overall average number of traditional and modern hives per household in the study areas is 4.78 ± 0.58 and 1.25 ± 0.34, respectively. This suggests that despite some adoption of modern beekeeping technologies, traditional hives remain predominant, possibly due to factors such as cost, accessibility, and local knowledge systems.

Table 1. Characteristics of the sampled households (%)

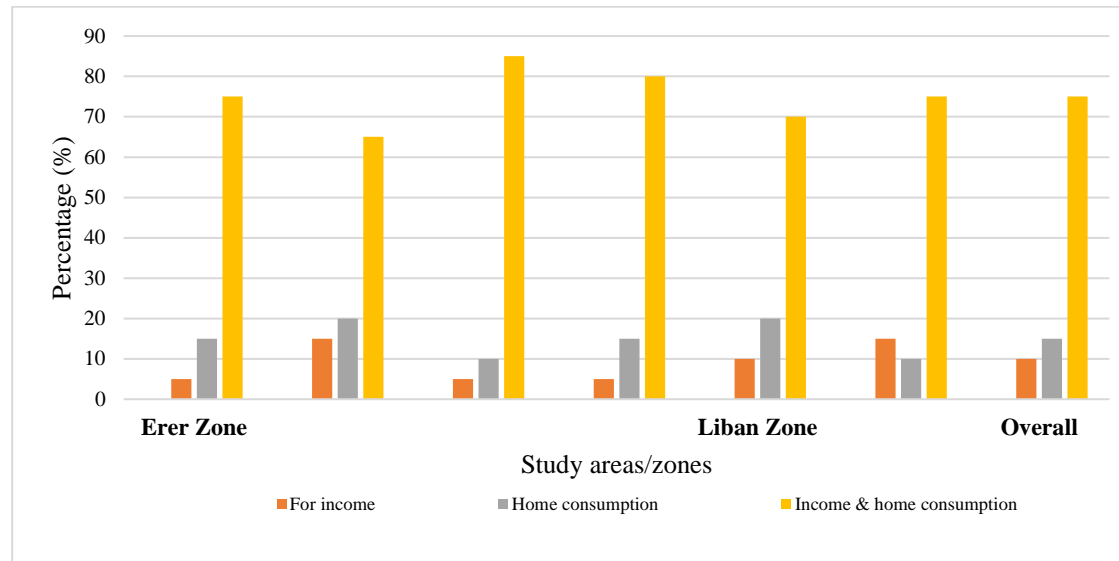| Variables	Erer Zone				Liban Zone		Overall
	Lagahida	**Salahad**	**Qubbi**	**Mayumuluko**	**Gurabakaksa**	**Guradhamle**	
Sex							
Male	80	85	75	80	75	80	79.2
Female	20	15	25	20	25	20	20.8
Age (years)							
26–40	55	35	40	55	60	35	46.67
45–60	40	50	50	30	25	50	40.83
> 61	5	15	10	15	15	15	12.5
Marital Status							
Married	70	65	75	65	70	75	70
Divorced	30	35	25	35	30	25	30
Educational Status							
Illiterate	55	60	65	75	85	80	70
Literate	45	40	35	25	15	20	30
Family Size	6.15±0.42	6.4±0.38	6.5±0.25	6.25±0.41	6.55±0.34	6.7±0.45	6.4±0.38

Fig. 1. Purpose of beekeeping (%) in the study areas

Table 2. Type of beehive (%) and number of hives/HH in the study area

Variables	Erer Zone				Liban Zone		Overall
	Lagahida	**Salahad**	**Qubbi**	**Mayumuluko**	**Gurabakaksa**	**Guradhamle**	
% of Households by Beehive Type							
Traditional beehive	45[a]	35[a]	65[a]	45[a]	100[a]	100[a]	65.00
Modern beehive	35[b]	25[ab]	20	25	0	0	15.83
Both	20[ab]	40[b]	25	30	0	0	19.17
p-value	**0.00**						
Average Number of Hives per HH (Mean ± SEM)							
Traditional hives	3.03 ± 0.57	3.60 ± 0.59	5.30 ± 0.92	4.55 ± 0.75	5.50 ± 0.44	6.70 ± 0.26	4.78 ± 0.58
Modern hives	2.95 ± 0.98	1.90 ± 0.32	0.85 ± 0.31	1.80 ± 0.41	0	0	1.25 ± 0.34

3.3.2 Placement of the Beehive and sources of honey bee colony

The placement of beehives and sources of honeybee colonies among interviewed respondents in the study area are presented in Table 3. The study revealed that most beekeepers (60.83%) hung their beehives on trees in dense forests, whereas 28.33% of respondents kept their beehives in backyards, and only 9.17% practiced both hanging hives on trees and keeping them in backyards. These findings indicate that beekeepers in the study areas prefer to hang their beehives in dense forests far from residential areas where there is ample bee forage. Additionally, 65% of respondents reported that their main source of foundation colonies was by catching swarms, followed by those who obtained colonies from their parents. Purchasing foundation colonies from other beekeepers was uncommon in the study areas. This clearly shows that swarming remains a key source of foundation stock in traditional beekeeping practices. This finding aligns with a study conducted in the South Wollo Zone, Amhara, Ethiopia, which also reported swarm catching as the common source of bee colonies (Bihonegn & Begna, 2021).

3.4 Honey Production Yield

Regarding honey production, the overall honey yield was 6.125 ± 0.59 kg and 11.56 ± 0.43 kg per hive per harvesting season for traditional and modern hives, respectively. There is a highly significant difference ($p < 0.05$) in honey yield between traditional and modern beehives among the studied districts (Table 4). However, no significant difference was observed in the yield obtained from traditional and modern hives across the different districts. This finding aligns with similar research indicating that modern hives generally produce higher yields due to better design and management practices (Tadesse *et al.,* 2019; Bihonegn & Begna, 2021). Nevertheless, further research using participatory approaches is recommended to comprehensively assess the beekeeping potential and facilitate adoption of improved technologies in the study areas.

3.5 Honey Harvesting Practices

Honey harvesting practice activities are summarized in Table 5. As the result of the study implies the majority (86.67%) of respondent reported that the use of smoke and fire during honey harvesting is vary common practice and the honey harvesting is carried out at night time. This affects honey quality because smoke and ashes from the fire ends up mixing with the harvested honey. The present result is in line with the findings of Lomiso (2019), Kebede and Adgaba (2011) and Shenkute *et al.* (2012) who reported the smoke and fire employed while harvesting honey may dust the honey with ash and the honey may absorb the smoke which cause contamination to the honey. Regarding the frequency of honey harvesting 75% of the respondents reported that the honey is harvested in two times a year and some of considerable respondents (19.17%) also reported that the honey might be harvested three times in a year. The result of this study is in line with that of Fikru *et al.* (2015) who reported that, in Ethiopia, there are generally two honey harvesting seasons, the major one lasting from October to November and the second one being from April to June.

3.6 Constraints and Opportunities of Beekeeping

The major constraints limiting the beekeeping production practices in the studied disitricts were presented in Table 6. The major constraints of beekeeping in the study areas were pest and predators , absconding and scarcity of water with index vakues of 0.245,0.225 and 0.227 respectively. The present study isis line with that of Yirga *et al.* (2012), who reported that bee pests, predators and absconding are major constra ints affecting beekeeping sub-sector in northern Ethiopia. The other constraints reported by respondents were included lack of beekeeping equibment including the modern hives and and shortage of bee forage and this is also consistent with Fikru *et al.* (2015), who reported that during the field survey, the interviewed beekeepers in Jigjiga zone responded that some bee equipment, such as modern bee hives, wax printers, and honey extractors, are very expensive, and thus farmers cannot afford to buy and use these equipment. Despite all the constraints and challenges currently facing the beekeeping subsector, there are still enormous opportunities and potentials to boost honey production in the studied Districts. Based on the information captured from key informants and focus group discussions as well as field observations, the major opportunities for beekeeping development are: increasing hive products' demand, availability of honeybee floral resources, and availability of honeybee resources.

Table 3. Placement of beehive and sources of bee colony (%) by sample households

Variables	Erer Zone				Liban Zone		Overall
	Lagahida	Salahad	Qubbi	Mayumuluko	Gurabakaksa	Guradhamle	
Placement of Beehive							
Hanging on trees	50	60	60	70	55	70	60.83
Backyard	35	20	35	20	40	20	28.33
Both	15	10	5	10	5	10	19.17
p-value	0.367						
Source of Honeybee Colony							
Catching swarms	55[a]	60[a]	65[a]	70[a]	75[a]	65[a]	65.00
Gift from parent	40[a]	20[b]	35[b]	30[b]	25[b]	30[b]	30.00
Buying	5[b]	20[b]	0	0	0	5	5.00
p-value	**0.000**						

Table 4. Honey yield (kg) in the study area (Mean±SD) by sampled households

Type of Beehive	Erer Zone				Liban Zone		Overall
	Lagahida	Salahad	Qubbi	Mayumuluko	Gurabakaksa	Guradhamle	
Traditional Hive	6.63±0.59	6.05±0.80	6.25±0.71	5.95±0.58	6.00±0.60	6.25±0.28	6.12±0.59
Modern Hive	11.55±0.44	11.50±0.46	11.05±0.45	11.70±0.43	–	–	11.56±0.43

Table 5. Methods, frequency and time of honey harvesting (%) in the study area

Variables	Erer Zone				Liban Zone		Overall
	Lagahida	Salahad	Qubbi	Mayumuluko	Gurabakaksa	Guradhamle	
Harvesting Method							
Smoking only	5	10	20	25	10	10	13.33
Smoking & fire	95	90	80	75	90	90	86.67
Harvest Frequency							
Once a year	5	5	10	5	0	10	5.83
Twice a year	75	80	75	80	70	70	75.00
Three times a year	20	15	15	15	30	20	19.17
p-value (Frequency)							**0.000**
Harvesting Time							
Day time	15	25	15	20	30	15	20.00
Night time	75	70	75	70	60	80	71.66
Both	10	5	10	10	10	5	8.33

Table 6. Major constraints of beekeeping in the study area

Pests and predators	Erer zone						Liban zone						Overall
	R1	R2	R3	R4	R5	İndex	R1	R2	R3	R4	R5	Idex	Index
Absconding of bees	28	20	21	8	2	0.25	10	10	13	5	0	0.20	0.225
Pests & predator	23	20	22	12	0	0.27	13	9	7	7	4	0.22	0.245
Water scarcity	19	12	20	22	0	0.26	8	11	9	8	0	0.194	0.227
Beekeeping equipment	7	19	12	10	14	0.11	5	4	6	11	10	0.198	0.154
Shortage of bee forage	3	8	3	15	17	0.05	4	7	5	9	11	0.188	0.119

*Constraints were ranked based on the number (frequency) of respondents prioritize the problems

Table 7. Dominance of honeybee floras in the study areas

| Honeybee flora species		Districts						Rank		
Botanical name	Local Name	Gora Bakaksa	Guradamole	Mayimulok	Qubi	Salahad	Lagahida	Total	%	Rank
Acacia senigal	Cadaad	72	106	77	60	68	107	490	20.71	1
AciaReficiens	Qansax	0	0	0	0	145	0	145	6.13	7
Acacia Milifora	Bilcin	65	82	56	50	15	94	362	15.3	2
Acacia Horidida	Sarman	26	0	40	38	86	84	274	11.58	4
BosiaMinimifolia	Maygaag	0	0	27	0	66	0	93	3.93	8
Terminalia poly carpa	Hareri	71	38	32	48	50	0	239	10.10	5
Capparidaceae family	Gabre	0	0	0	0	34	22	56	2.37	10
Acacia Tortelis	Qudhac	77	30	56	53	34	66	316	13.35	3
GrewiaTembensis	Midhayo	0	0	0	0	0	55	55	2.32	11
GrewiaPensilata	Hohob	0	0	0	0	0	21	21	0.89	13
EphorbiaRobock	Qamami	0	0	39	31	0	20	90	3.8	9
Kirkiaburger	Dofar-Qod	16	0	0	0	0	29	45	1.9	12
Acacia Bussia	Galol	28	48	36	32	2	0	146	6.17	6
Canthiumsetiflorum	GacmaDheere	10	0	0	8	0	0	18	0.76	14
	Timir Gel Jir	0	0	0	16	0	0	16	0.67	15
Total species /district		**365**	**304**	**363**	**336**	**500**	**498**	**2366**	**99.98**	
Ranks		3	6	4	5	1	2			
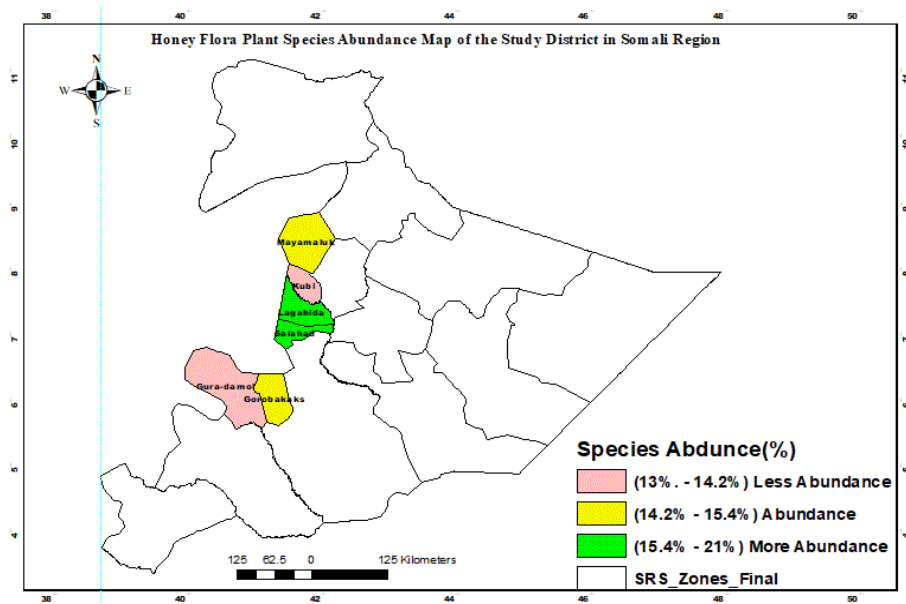
Fig. 2. Honey bee forage plants abundance map

Table 8. Honey bee forage plants abundance labels

No	Abundance label	No of plants	Districts	Rank
1	Abundance	304 -336	Gura-damole and Qubi	3
2	More abundance	336-365	Gura-baqaqsa and maymuluqo	2
3	Much more abundance	365-500	Lagahida and salahad	1

3.7 Honeybee Flora Species Dominance and Identification

The honeybee floral plants data from each plot were summarized and registered under their respective study districts as indicated in Table 7. A total of 2,366 honey bee forage plants which are belong to different genera and families were identified and recorded. These plant species was identified by the local community as a major bee forage plants in the study area. This indicates the availability of diverse bee forage plant species in the area and can be created abundance sources of nectar for the honey bees in different seasons of the year (Shegaw *et al.,* 2021). Also stated Ethiopia has an estimate of 7000 floral species. However, only few of which are identified as major bee plants in their contribution for honeybees. In our study these bee forage plants were identified during field observation with experienced beekeepers familiar with the plants that produce nectar pollen, generally the availability abundance bee forage plants are very important for honey production in the study area. As the result of the study indicates the major honey bee flora species and their percentage in the study sites (districts). From the above table '*Cadad'* and '*Bilcin*' were most abundant

honeybee flora species in the study area, whereas '*gacmadheer*' and '*Timir gel jire*' are least available honey bee flora species. In the district wise Salahad is the 1st rank interms dominance of honeybee floras followed by Lagahida district.

A total of 2,366 honey bee forage plants which are belong to different genera and families were identified and recorded. All spatial analyses were performed using (Arc Map 10.8 version) and then the honey bee forage plant species was classified in to the three categories using 'Natural breaks algorithms 'classification method in arc map, namely 'Abundance, more abundance and much more abundance as shown in Fig. 1.

As shown in the above map. we used these terminologies because abundance refers to the number of any species present in a given area. As Matthews & Whittaker, (2015) stated species-abundance distributions are a convenient and common method for describing ecological communities and no agreement has been reached as to which models are best, this lack of agreement is in part owing to the inherent differences in the abundance measure used. Accordingly, the abundance labels that can reflect our study objectives were used. Then

study sites that has number of honeys be plants between (304-336) are categorized abundance and study sites that has number of honeys be plants between (336-365) more abundance, whereas those has number of honeys be plants between (365-500) much more abundance. This result shows areas around lagahida and salahad districts have more honey bee forage plants thann other districts.

4. CONCLUSION

The studied areas possess rich natural resources and strong tradition of beekeeping though female participation remains low, likely due to cultural barriers and limited empowerment. Traditional hives are most common and many beekeepers hang them in forested areas rich in forage, relying on swarm capture for colony establishment. Average honey yield were about 6kg from traditional and 11.5kg from modern hives per harvest implying the study areas has high production potential of beekeeping. Honey harvesting is typically done at night using smoke and fire, occurring twice a year. Key challenges identified include pests and predators, absconding, water scarcity, and lack of modern beekeeping tools. Despite these challenges, there are promising opportunities such as high demand for hive products, abundant floral resources, and the presence of local honeybee populations. Furthe more the study confirmed a rich diversity of honey bee forage palnt spevies in the study areas with 15 makor species identified, notably from acacia genus. The spatial variation in honey flora across the the distrcits indicated that Salahad and Lgahiga hold the highest potential for expanding apicultural activities due to thier greater abundance of key foarge plants. This finding provides crucial input for several areas including beeleeping site selection, seasonal honey prouction planing , biodiversity conseravtion , and policy formulation for regional apiculture development. to build those fidnings it is recomended that further participatory research should be conducted to identify floral resources, flowering periods and paterns nectar yeild , and harmful plants, and to implement integrated pest and predator management.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Al Sghair, F. G. (2013). *Remote sensing and GIS for wetland vegetation study* (Doctoral dissertation, University of Glasgow). University of Glasgow Enlighten: Theses. http://theses.gla.ac.uk/4581/.

Anza, A., Yemane, N., &Bezabeh, A. (2020). Postharvest Handling Practices and Marketing of Honey at Arba Minch Zuria District of Gamo Zone, Southern Ethiopia. *OMO International Journal of Sciences*, *3*(2), 84-96. https://doi.org/10.59122/135a351

Beyene T, Abi D, Chalchissa G, & Mekonen WM (2016). Evaluation of transitional and modern hives for honey production in the Mid Rift Valley of Ethiopia. *Bulletin of Animal Health and Production in Africa* 64(1): 157–165. https://www.ajol.info/index.php/bahpa/article/view/150474.

Bihonegn, A., & Begna, D. (2021). Beekeeping production system, challenges, and opportunities in selected districts of South Wollo Zone, Amhara, Ethiopia. *Advances in Agriculture*, *2021*(1), 2278396. https://doi.org/10.1155/2021/2278396

Burgett, M., Rucker, R. R., & Thurman, W. N. (2004). Economics and honey bee pollination markets. *American Bee Journal*, 144(4): 269-271.

CSA (Central Statistical Agency). (2021). Agricultural Sample Survey. Report on Livestock and Livestock Characteristics. Volume II. Statistical Bulletin 589. Addis Ababa, Ethiopia, pp. 22-29.

FAO (Food and Agriculture Organization of the United States) (2015). Agricultural Growth Program Agribusiness and Market Development Project Submitted by ACDI/VOCA to Contracting Officer's Representative TewodrosYeshiwork, USAID Ethiopia.

Fikru, S. (2015). Review of honeybee and honey production in Ethiopia. *Journal of Animal. Science Adv*ances, 5(10): 1413-1421. DOI: 10.5455/jasa.20151019083635

Gratzer, K., & Brodschneider, R. (2021). How and why beekeepers participate in the INSIGNIA citizen science honeybee environmental monitoring project.

Environmental Science and Pollution Research, *28*(28), 37995-38006.

Güler D (2021). The Determination of the Efficiency of Beekeeping by Provinces in Turkey via Data Envelopment Analysis. *UludağArıcılıkDergisi,* 21(2):146-156. Doi: https://doi.org/10.31467/uluaricilik.940167.

Jeil EB, Segbefia AY, Abass K, Adjaloo M (2020). Livelihood security along beekeeping value chain: lessons from Ghana's beekeeping experience. *GeoJournal*, 85(2): 565-577. Doi: https://doi.org/10.1007/s10708-01909982-4.

Kebede, A., & Adgaba, N. (2011). Honeybee Production Practices and Honey Quality in Silti Wereda Ethiopia. *Honeybee production practices and honey quality in Silti Wereda, Ethiopia.* MSc Thesis, Haramaya University, Ethiopia.

Lomiso, D. F. (2019). Assessment on Postharvest Handling Practices of Honey in Chena District, Southwestern Ethiopia. *Food Science and Quality Management*, 89. https://iiste.org/Journals/index.php/FSQM/article/view/49051

Ma'alin, A., Abdimahad, K., Hassen, A., Mahamed, A. and Hassen, M. (2022) Management Practices and Production Constraints of Indigenous Somali Cattle Breed in Shabelle Zone, Somali Regional State, Ethiopia. *Open Journal of Animal Sciences*, 12, 103-117. doi: 10.4236/ojas.2022.121008.

Matthews, T. J., & Whittaker, R. J. (2015). On the species abundance distribution in applied ecology and biodiversity management. Journal of Applied Ecology, 52(2), 443-454.

Nuru, A. (2008). *Atlas of pollen grains of major honeybee flora of Ethiopia*. Holeta Bee Research Centre, Commercial Printing Enterprise.

Shapiro, B.I., Gebru, G., Desta, S., Negassa, A., Negussie, K., Aboset, G. and Mechal, H. (2015). Ethiopia livestock master plan: Roadmaps for growth and transformation.

Nairobi, Kenya: ILRI. https://hdl.handle.net/10568/68037

Shegaw, T., & Giorgis, D.H. (2021). Identification, characterization and evaluation of honeybee floras in Kafa, Sheka and Benchi Maji zones of Southern Nations Nationalities and Peoples Region (SNNPR), Ethiopia. *International Journal of Agricultural Science & Food Technology*, *7*, 310-326. DOI: 10.17352/2455-815X.000125

Shenkute, A. G., Getachew, Y., Assefa, D., Adgaba, N., Ganga, G., and Abebe, W. (2012). Honey production systems (Apis mellifera L.) in Kaffa, Sheka and Bench-Maji zones of Ethiopia. *Journal of Agricultural Extension and Rural Development,* 4(19): 528-541, DOI: 10.5897/JAERD12.088

Tadele, A., Eshetu, B., Getachewu, S., Bedeke, W., & Zeleke, B. (2016). Assessment of honeybee production system, honeybee flora and poisonous plants, post-harvest handling and marketing of honey in South Omo Zone of SNNPR of Ethiopia. *Assessment*, *6*(13).

Tadesse, B., Alemu, T., & Mekonnen, T. (2019). Comparative honey yield performance of traditional and modern beehives in the Oromia Region, Ethiopia. *International Journal of Agriculture and Forestry*, 9(4), 120–128. https://doi.org/10.xxxx/ijaf2019.09.04.120

Takele, A. (2014). Potential of honey production and its utilization for food security in Filtu Woreda, Liben Zone. *American-Eurasian Journal of Agricultural & Environmental Sciences*, *14*(9), 863–865. https://doi.org/10.5829/idosi.aejaes.2014.14.09.85202.

Yirga G., Bethelhem K., Dawit K., Alem M. (2012) Assessment of beekeeping practices in AsgedeTiembla district, Northern Ethiopia: Absconding, bee forage and bee pests. *African Journal of Agricultural Research* 7:1-5. DOI: 10.5897/AJAR10.1071

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.mbimph.com/review-history/5049