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Establishing floral Calendar in West Hararghe Zone of Oromia Region, Ethiopia

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Abstract

The study was conducted in selected districts of West Hararghe Zone with the objective of characterizing and documenting the major bee forages contributing for honey production and to establish appropriate floral calendar for effective bee management in different agro-ecological condition of the area. Bee forage inventory was made using transect methods in a plot size of 20 m x 20 m, for woody plants and 2 m x 2 m for herbs. Pollen traps having 16% pollen trapping efficiency was fitted at the entrance of beehives for pollen load collection. Honey pollen analysis procedure was also followed to determine the botanical origin of honey. A total of 60 honey bee plants belonging to 29 families were identified and comprising trees, shrubs, herbs, grasses and cultivated crops in the zone. The Pollen analysis of honey showed that *Cordia africana*, *Guizotia scabra*, *Croton macrostachyus* and *Vernonia amygdalina* are the major honeybee source plants. From pollen load analysis and honey pollen analysis, many plant species were flower from October to December and also active season/honey flow season of the zone. Generally, it is recommended, to conserve the identified bee plant species to boost honey production and determination of total carrying capacity of major bee forages in the study area.

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Introduction

Ethiopia is endowed with natural and cultivated flora and diverse agro-ecological and climatic conditionthat are well-suited for beekeeping (Fichtl & Admassu, 1994; Admassu *et al.*, 2014). Oromia region is characterized by high plateau and very limited low land areas. The altitude of the region ranges from 900 masl at the rift valley to 4377masl at Mt. TulluDimtu in Bale Zone.

Out of the 58 National Forest Priority Areas of the Country, 49 are found in Oromia. The region has virgin forest of rich biodiversity like Harena, Yayu, Dindin, Anfarara, Munessa, Jibat, Chilimo and Menagesha-Suba which are highly potential for beekeeping. The Region also comprises cultivated crops such as oil and horticultural, and pulses all of which that can augment the beekeeping development further. This makes the region one of the leading regions accounting 55 % of the apiculture resources of the country with annual honey production volume of 24.8 thousand tones out of the total 54 thousand tones.

Honeybee plants are those plant species that provide bees with food sources in the form of nectar and pollen or both (Fichtl & Admassu, 1994; Admassu *et al.*, 2014). Not all bee plants are equally important to bees and honey production (Nuru *et al.*, 2017). Only about 16% of the world's flowering plant species contribute to honey bees as food sources (Crane, 1990).

In order to boost the production of honey from natural resources of the region, identification and documentation of economic bee forages and documentation of economic bee forages and establishing their flowering calendar is critical for the sub-sector development.

Though identification of bee forages and establishing floral calendar is not exhaustively done in the region for planning bee management operation, thus establishing floral calendar is a critical tool for planning various beekeeping management operations such as hive super adding and to predict the frequency and period of honey flow in a given area.

There are strong associations between the seasonal cycles of honeybee colonies and calendar of bee plants in such way that it will be applied in practical seasonal colony management. Timing of management operations corresponding to phenological pattern of bee plants of the area is critical in building up colony populations before the main nectar flow.

Even though bees naturally build up their population during periods when resources are available, the beekeeper must ensure that peak population size attained before or during the nectar flow.

The assessment of bee forages of the zone and its floral calendar are not adequately documented and their correlations with seasonal colony management plan are not established to the required level. Moreover areas with unique production potential are not identified that will contribute to the economies of local beekeepers.

Therefore, assessing the availability of bee forage and establishing flowering at the different agro-ecology of West Hararghe Zone for that enable effective seasonal colony management.

Therefore this study was conducted to identify, document and prepare flowering calendar of nectar and pollen sources bee forage that can be applied for practical bee management operation in different agro-ecological condition of West Hararghe Zone.

Materials and Methods

Field Survey

The study was conducted at Darolabu, Oda Bultum and Gemechis districts of West Hararghe zone comprising low land, midland and highland agroecologies of the area districts. From each district three kebeles were selected and for each kebele four honey bee colonies were established and data like pollen and honey samples were collected from established bee hives. In addition, a total of 81 beekeepers were interviewed from each district with their respective kebele to collect information on status of honey bee production, bee plant availability, and their floral calendar.

Moreover Participatory Rural Appraisal (PRA) techniques through focused group discussion were conducted with experts, community groups, development agents and farmer bee keepers were carried out to generate relevant information.

Bee forage inventory

For plant inventory each district was classified into three agro-ecologies (High land, mid land and low lands) and from each agro-ecology three kebeles were selected. Based on this agroecological stratification, four transect lines were laid out from apiary sites to North, South, West and East within 2 Km radius following GPS.

Apiary sites were selected systematically within 2 km distance from one to the other in order to avoid redundancy. Along these transects plots of 20 m x 20 m were laid out within 400 m interval between the sample plots. In order to retain accuracy, five (5) subplots measuring 2 m x 2 m (4 m^2) were laid out within the larger plot to capture herbs and grasses.

All the plant species encountered in each sample plots were recorded and percentage cover of each species was estimated visually. For those plant species which could not identified in the field, sample of the specimens were collected using the standard Herbarium techniques and identified at Holeta Bee Research center following the relevant literature and published flora books. Plant inventory was also conducted in all study area and different plant specimens were collected and identified.

Honey sample collection and Laboratory analysis

Fresh honey samples of 500 gm were collected at different seasons from different agro-ecologies of the districts for laboratory analysis. All samples were kept in sealed glass jars and frozen at -20^0C until analysis. The pollen analysis was made following the methods adopted by Louvuex *et al.,* (1978) for determination of botanical composition and frequency of pollen grains in the sample.

Colony establishment for pollen collection and seasonal dynamics of honey bee population

A total of 32 honeybee colonies were established in 8 kebeles of the three districts. For each site 4 honey bee colonies were established (two for pollen trapping and two for honey harvesting). For pollen collection honey bee colonies were fitted with pollen trap having 16% pollen trapping efficiency and pollen loads were collected every seven days interval and frozen in the refrigerator until analysis weremade using the prepared reference data base and identified to the generic or species level using the pollen Atlas (Nuru, 2002).

Results and Discussion

Honey bee plant species and their flowering calendar

Floral calendar is a time-table that indicates to the beekeeper; the approximate date and duration of the flowering periods of the important nectar and pollen source plants (Diver, 2002). Accordingly the honey bee plants of the study area were composed of trees, shrubs, herbs, grasses, and cultivated crops. Moreover, the species diversity and population density varies widely from area to area. Based on surveyresult, 60 honeybee plant species belonging from 29 families were identified in the zone. Fabaceace Poaceace, Asteraceae and Myrtaceae, Solanaceae and Anacaridaceae were the dominant family comprising higher species diversity in the study area (Fig. 1).

The flowering time of common bee floraspecies in the study area based on response of beekeeper households and key informants indicated that; about 61.04% flowers from Sept- Nov, 19.48% from Dec-Jan, 12.99% from Mar-May and 6.49% from June-August. The identified flowering plants in the study area have been presented in Appendix1, 2 and3 for each district. Most of these plant species mentioned by respondents during the survey were similar to those identified through plant inventory and pollen analysis through pollen load collection.

This has indicated that all results supported each other and indigenous knowledge of the farmers is dependable. The distribution and type of honeybee plants, as well as their flowering duration, vary from one place to another place due to variation in topography, climate and farming practices. Variation in seasonal availability of honey bee forage species was observed in the zone and the same species have difference in flowering length and season with different agro ecology.

Bee flora Species Diversity in Relation to Agro-Ecology

The Shannon diversity indices for the common bee flora species in the study area was calculated (Table2). Accordingly, bee flora species diversity at Gemachis (highland) (2.16) was relatively lower than both Odabultum (midland) (2.49) and DaroLebu (lowland) (2.21).

In this study species richness (S) was computed as, the observed number of bee flora species for each agro ecology (Table 2). As a result, the number of species observed in DaroLebu district was higher in terms of number. The Shannon diversity indices for the common bee flora species in the study area were calculated and there was no significance difference between different sites.

Major colony dynamics in the study area

For practical beekeeping application it is very important to identify honey plant flowering seasons in their area in relation to honeybee colony daynamics in order to provide bees with additional feed during the drought period. In study area the major colony dynamics such as pick time of brood rearing, colony swarming, migration, honey flow and dearth period season were identified.

Accordingly January to March was the peak time of dearth period in the west Hararghe Zone and also the colony swarming, broad rearing and honey flow season listed by respondents were September, October to November and October to December., From these seasons September to October is the major ones and October to December is the minor honey flow periods of the study area (Fig.1). The variation of the honey colony dynamic due to climatic condition, variation in forage abundance and flowering period of the plants.

Extraction of pollen from honey

Mono floral honey is where the bees have been foraging predominantly on one type of plant, and is named according to that plant. As the result of pollen analysis of honey, two types of mono floral honey types were identified in the area and their relative pollen count for species contributing for mono floral honey.

The dominance of pollen from the *Guizotia spp* and *Hibiscus spp* can be attributed to widespread distribution in the area and high pollen and nectar potential of the plants.

Table.1 Flowering calendar of major bee plants in west Hararghe zone

Botanical name	Family	Food Source	Jan	Feb	March	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Delonixregia	Fabaceae													
Helichrysumschimperi	Asteraceae													
Malussaylvestris	Roseaceae													
Bersamaabyssinica	Melianthaceae	N and P												
Carica papaya	Caricaceae													
Cissuspetiolata	Vitaceae													
Citrussinensis	Rutaceae													
Ehretiacymosa	Boraginaceae													
Erythrinabrucei	Fabaceae													
Eucalyptuscamaldlensis	Myrtaceae	Nand P												
Hygeniaabyssinica	Rosaceae	Nand P												
Ocimumhamiifolium	Lamiaceae													
Pterolobiumstellatum	Fabaceae	Pand N												
TrifoliumSpp	Fabaceae													
AcaciaalbidaDel.	Fabaceae	Nand P												
Acacia etbaica	Fabaceae													
AcaciaSp.	Mimosaceae													
AgrocharisSp	Apiaceae													
Allophylusrubifolius	Sapindaceae													
Annonasenegalensis	Annonaceae													
Boswelliapapyrifera	Burseraceae	PanN												
Caesalpiniadecapetala	Caesalpiniodeae													
Capsicum annuum	Solanaceae	N and P												
Carissaedulis	Apocynaceae	PanN												
CarthamustinctoriusL	Asteraceae	Pand N												
CicerarietinumL.	Fabaceae	Nand P												
CoffeaArabica	Rubiaceae	Nand P												
Commelinabenghalensis	Commelinaceae	P												
CordiaAfricana	Boraginaceae	Pand N												
Crotonmacrostachyus	Ephorbiaceae	Nand P												
Cucurbitapepo	Cucurbitapepo													
Cynodondactyl	Poaceae	P												
Daturastramonium	Solanaceae	Nand P												
Dovyaliscaffra	Flacourtiaceae	*PandN*												
Embeliaschimperi	Myrsinaceae													
Entadaabyssinica														
Guizotiaabyssiniea	Asteraceae	Nand P												
Guizotiascabra	Asteraceae	PanN												
Juniperusprocera	Cupressaceae													
Justicaschimperiana	Acanthaceae													
Lagenariaabyssinica	Cucurbitaceae	Pand N												
Lycopersiconesculentum	Solanaceae	Nand P												
Mangiferaindica	Anacardiaceae	PanN												
Perseaamericana	Lauraceae	PanN												
Phytolaccadodecandira	Phytolacaceae	Nand P												
Podocarpusfalcatus	Podocarpaceae													
Psdiumguajava	Myrtaceae	N												
Rhusspp	Anacardiaceae													
Rosaabyssinica	Rosaceae	P												

Salanumtuberosum	Solanaceae													
Salvianilotica	Lamiaceae													
Scheffleraabyssinica	Araliaceae	PanN												
Sorghumbicolor	Poaceae	P												
Trifoliumspp	Fabaceae	Pand N												
Vernoniaamygdalina	Asteraceae	Nand P												
Viciafaba	Papilionaceae	Nand P												
Zea mays	Poaceae	P												

Table.2 Shannon Diversity Index for Bee Flora Species in West Hararghe Zone

	Districts		
Bee flora species diversity index	**Gemachis (highland)**	**Odabultum (midland)**	**Darolabu (lowland)**
Observed number of species(S)	38	32	**40**
Shannon diversity (H')	2.16	2.49	**2.21**
Shannon evenness (E)	**0.593**	**0.718**	**0.599**

Table.3 Identified bee plants species from trapped pollen in West Hararghe zone along different agroecology

Plant species	**Agroecology**	**Foraging length**											
		S	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**
BidensSpp	Highland		X	X									
Rumex2				X									
Eucalyptuscomldens,			X	X	X				X				
Plantago			X	X	X	X							**X**
Giuzotia Scarba,			X	X	X								
Phyllanthus Reticaltor				X	X	X							
Hypostes Spps					X								
Rumex					X	X							
Hypostes Spps,			X	X									
Giuzotia Scarba			X		X								
Echinops Spp,			X	X									
Phyllanthus			X	X									
Coffe Arbica (Domins),		X											
Vernonia spp.			X	X			X						
GrassSpp,				X	X								
GuizotiaSpp					X								
Phonix					X								
RumexSpp.					X								
Achyanthesaspera							X						**X**
Terminalia							X						
Justiciaspp.								X					
Eucalyptus					X								
AndroPogon			X										
Coffee			X										
Plantago Lalaca,					X								
Guizotiascalor,				X									
Trifoliumspp,				X									

AwxiiXiqaa				X									
AcationSpp,				X									
Maize													**X**
Saturejapara													**X**
Androposonabyssinca		X											
Zeamaize	Midland											X	**X**
GuizatiaSpp.				X	X								**X**
Bidens		X			X								
Eucalyptus					X							X	
Phyllanthus				X								X	
GuizotiaScarbus		X		X									
AndroPogonabbyssinica,		X											
ReticaltorSpp		X											
UnkownPollen		X											
PhyllanthusReticaltor		X											
Grass2				X									
Plango				X									
Eucalyptuscomldens		X											
Achyranthesaspera					X	X							**X**
Banana													**X**
Grassspp.													**X**
Isoglossalaxa												X	
Achyranthes					X							X	
Achyranthesaspera					X	X						X	**X**
Juisticacufodonti					X								
Rumex						X							
Parkinsuniaacweatu							X						
Guizotiaabyssinica													**X**
VarnoniaSpp,						X							
EchinopsSpp,						X							
BidensSpp				X		X							**X**
Coffespp.					X								
Scarba					X								
Vernonia							X						
Trifoliumspp	Lowland				X	X	X						
Vernonia,					X								
Guizotiaspp					X								
Coffespp					X								
Isoglossalaxa					X								
Vernonia spp.					X	X							
Schinusmolle						X							
Brasica					X								
Guizotiascarab				X	X								
Eucalptus						X					X		
Terminalia							X	X					
GrassSpp												X	**X**
AndroPogonabbyssinica		X										X	**X**
EucalyptusSpp				X									
InisicaSpp				X									
Trifolium				X									
Plantago					X					X			

Lanceolata					X					X			
Eschinops					X								
Guizotia		X								X			
BidenSpp		X										X	**X**
Maize												X	
Eucalptus												X	
Aloaspp												X	
Eucalyptuscomldens				X									
VisiaFiba				X									
AndroPogn				X									
Rumex				X									
Sunflower				X									
Echinopsspp					**X**				**X**				

Table.4 Pollen extracted from honey

Districts	Year	Plant species	No pollen count	Total pollen count	%
OdaBultum	2012	*Eleusine fioceifolia*	5	40	**12.5%**
		Guizotia spp	35		**87.5%**
	2011	*Eleusine fioceifolia*	10	65	**5.4%**
		Guizotia spp	5		**7.7%**
		Hibiscus spp	50		**76.9%**
Gemechis	2011	*Apodytesdimidiate*	2	47	**4.3%**
		Guizotia spp	45		**95.7%**
	2012	*Guizotia spp*	40	45	**88.9%**
		Grass spp	5		**11.1%**
	2011	*Guizotia spp*	44	45	**97.8%**
		Grass spp	1		**2.2%**
DaroLabu	2012	*Guizotia spp*	40	60	**66.7%**
		Trifolium spp	20		**33.3%**
	2011	*Cleusine foiceifolia*	3	41	**7.3%**
		Guizotia spp	**38**		**92.7%**

Figure.1 Major Families of honey bee plants in West Hararghe zone

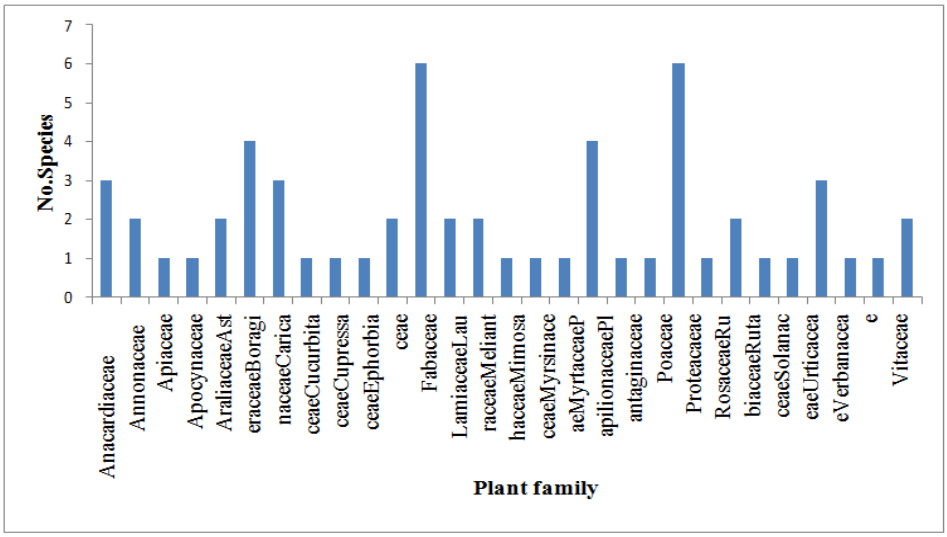
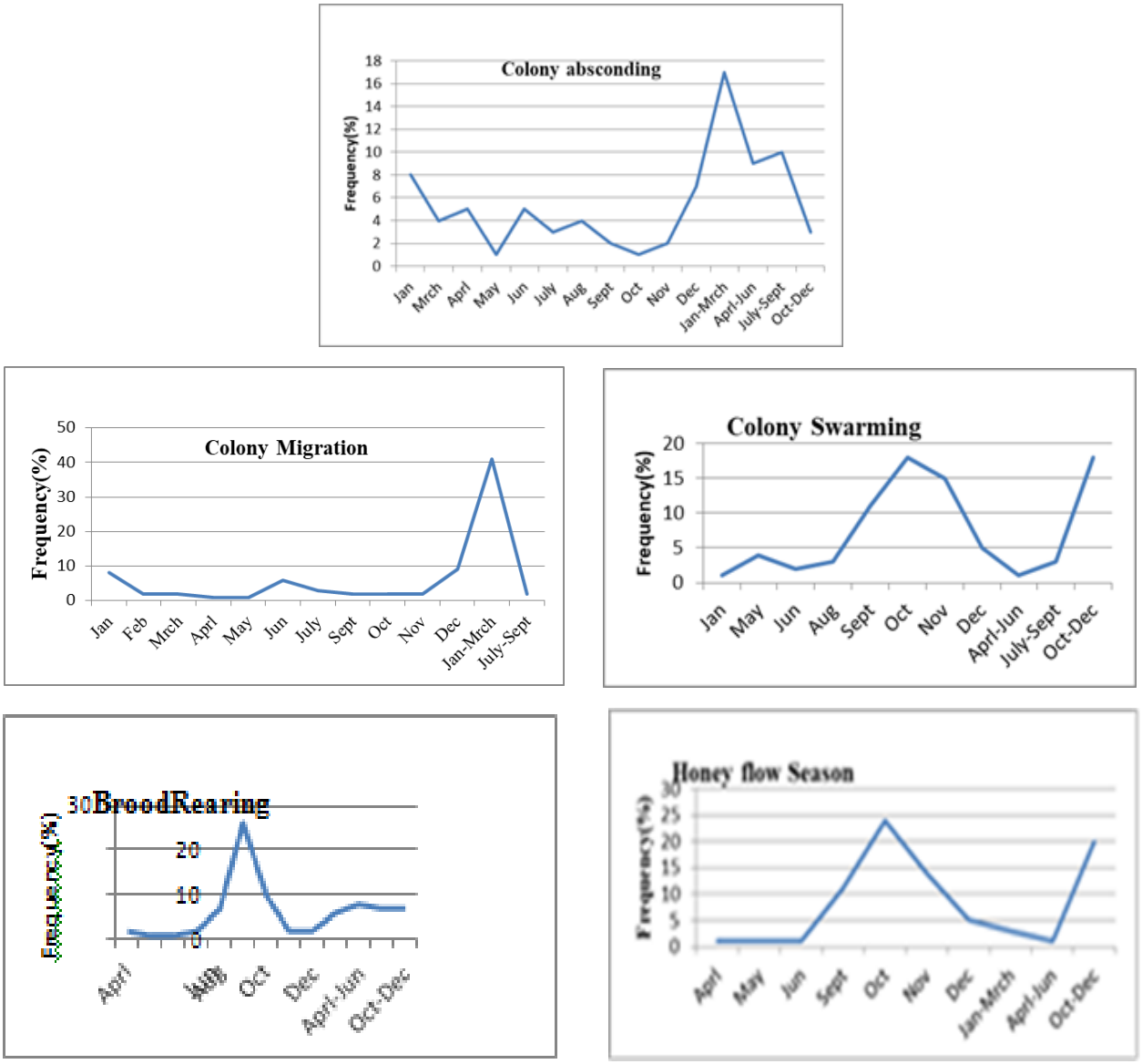


Figure.2 Major colony Dynamics of the area



Conclusion and Recommendation

Knowledge of honeybee plants, and proper understanding of relationship between seasonal management of honey bees and floral calendar of the plant species is very important to improve the productivity of bee keeping. In West Hararghe Zone experienced bee keepers also familiar with honeybee plants that give good honey, and duration of flowering Two honey flowering season was identified Majority of bee forages in the zone flowered from September to November and March to May and very few plant species flowers from August to December.

Colony migration, absconding and shortage of bee forage were also seen from January to March in all selected districts of the Zone. The herbaceous honeybee forage species were the dominant honey source plants during September to November. However, in March to May majority of honey source plants are trees and shrubs species, Among the identified plant species.

Guizotiasppa, Eucalyptus spp, and *Vernonia spp are* dominate honey source plants in all selected districts s both in social survey and from pollen analysis.

Based on the result of the study, bee keepers; should be awared in line with the flowering calendar, of the area to manage the honey bee colonies to boost honey production.

Further study should be conducted on determination of total carrying capacity for potential of flowering plants identified in the study area.

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