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Identification and Characterization of Honeybee Flora in Western Amhara Region, Ethiopia

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Abstract
The study was conducted in nine sample districts of western Amhara region to identify major and minor honeybee plant species in each season of the year and to develop floral calendar. Based on the interview with beekeeper farmers and visual observations, 290 important plant species which clustered in 105 families were recorded. Out of these *Guizotia species*, *Bidens species*, *Trifolium species*, *Eucalyptus species*, *Cordia africana*, *Acacia species*, *Croton macrostachyus*, *Vernonia species*, *Brassica carinata*, and *Andropogon abysssinicus* were among the most abundant species accounting for 23.1% of the species frequency in the study areas. Moreover, four main flowering seasons followed by two distinct honey flow seasons were identified. Majority of honeybee plants (41.7%) were predominantly flower after the big rainy season while 5.2% flower during the small rainy season. About forty honeybee plants (13.8%) flower in extended period, and there were 15 honeybee plants (5.2%) which provide pollen and nectar throughout the year. Based on available flora, utility status and flowering duration a bee floral calendar was developed for the region. However, very important herbaceous honey plants such as *Bidens species*, *Guizotia scabra*, *Trifolium species*, and trees like *Cordia africana*, *Albizia gummifera*, *Ekebergia capensis*, and *Erica arborea* are in the state of declining due to herbicides application, intensive cultivation, overgrazing and deforestation. Thus, in order to conserve these floras, attention must be made to maintain and multiply these endangered bee floras. It is also recommended that conservation of honey plant species and management of colonies should be in relation to flowering period of honey plants.

1. Introduction

Bees and plants have been perfecting their relationship over the last 50 million years or so, literally millions of years before man appeared on the scene. A wonderful and complex interdependency has evolved whereby flowering plants depend upon bees to bring about pollination and thereby the production of viable seeds (Svensson, 1991). The bees in turn depend upon plants for their nutrition and protection. Some plants are also important for hive placement and hive construction while others used in local procedures for scenting new hives to attract swarms (FAO, 1986).

The potential for honey, beeswax and other hive products and success in beekeeping development is dependent first and foremost on the type and quantity of bees and bee flora available (Paterson, 2000). There are over 7000 species of flowering plants existing in Ethiopia and these mainly comprise natural trees, forage plants, horticultural and cultivated crops (EARO, 2000). However, not all of these are useful to honeybees, and even those that provide bee forage vary in their value to beekeeping. There are also variations in the utility of a species depending upon the climate, soil and other factors in the place of its occurrence.

Beekeeping is the most widely spread practice in the farming communities of the Amhara region and it is an integral part of the smallholder farming system. In the region, the apicultural resources are immense, particularly in the western parts of the region, the natural vegetation coverage is relatively high (Kerealem et al., 2009). The potential of land for beekeeping depends on the nature of the vegetation it supports. Thus, vegetation characteristics of a region are considered to be an important indicator of its potential for beekeeping. As honeybees do not visit all plants for their nutrition, identification of the honeybee plants and assessing their abundance, their value to bees, time of blooming and flowering period have a paramount importance for practical beekeeping and in assessing the potential of an area for beekeeping (Nuru et al., 2001; Amssalu, 2004) as well as in planning appropriate seasonal management and effectively uses of the resources.

Admasu et al. (2005) noted that nectar and pollen source plants identification and establishment of flowering calendar are important steps in beekeeping development. It serves the more useful purpose of showing the sequence of flowering of various plants in a given area thereby helping to identify the main flowering and dearth periods so that eventually suitable plants could be grown to bridge flowering gaps. The floral calendar of an area however usually varies from year to year since flowering depends on the weather conditions (Nuru et al.,

2001; Gichora, 2003), however it helps to predict range of time at which flowering may take place. So far in the region detail studies on the types of bee plants, their flowering calendar as well as potentiality for beekeeping are not conducted.

In assessing the beekeeping potential it is of prime importance to know about the composition of the vegetation in the locality, bee forage value of individual species and the usual flowering periods of important bee forage plants. Therefore in line of these facts this project proposal is initiated to identify major and minor honeybee flora species in each season of the year and establish floral calendar of the region.

2 Materials and Methods

2.1 Description of the study area

This study was conducted during a four years period from 2009 to 2011 in Amhara National Regional State (ANRS). The region is located between 8^0 45'N to 14^0 N latitude and 35^0 46'E to 40^0 25'E longitude. It covers an approximate area of 157,076.28 square kilometer (occupies 15 percent of the total area of the country) with an elevation ranging from 500 to above 4000 m.a.s.l. The population of the region is estimated at 20.1 million out of which 87.5 percent resides in the rural areas (BoFED, 2009). Administration division includes 10 zones, 151 districts and 2986 kebeles.

2.2 Site selection and sample size

Reconnaissance tours were used in different districts to be able to visualize the context of honey source plants in the area and select relevant sites. From potential beekeeping districts of the western Amhara region 9 representative districts were selected randomly. Table 1 shows the zones and districts where the study conducted. From each district two to four sampling sites, a total of 30 sampling sites were selected based on vegetation cover and altitude differences for plant identification and sample collection. From each sampling sites representative sample plots (quadrates) were measured for the main land use in the study area. The botanical inventory was done for farmland, grass land (enclosure), bush land and forest land areas.

Table 6. Sample districts of the study areas

Zone	District	Sampling Sites				Total	Percent
		Kolla	W/Dega	Dega	Wurch		
East Gojam	Gozamin		2	2		4	13.3
	Enebsie Sar Midir	1	1	1	1	4	13.3
Awi	Dangela	1	2			3	10.0
West Gojam	Bahir Dar Zuria	1	3			4	13.3
	Burie	1	2	1		4	13.3
South Gonder	Estie		1	2		3	10.0
	Ebinat		3			3	10.0
North Gonder	Debark			1	2	3	10.0
	Takusa		2			2	6.8
Total		4	16	7	3	30	100.0

2.3 Experimental design

Plant species were counted within the sample plots using stratified random sampling procedures for the estimation of plant density and frequency in the specific locations. The size of the quadrates varies depending on vegetation types: 1 m x 1 m for the grassland, 4 m x 4 m for the bush land, 5 m x 10 m for the farmland and 10 m x 10 m for forest land (Admasu *et al*., 2005; Gichora, 2003) with three replications. The occurrence frequency of the plant species were recorded from the sample plots. The diagnostic features, morphologically examined for each honey plant, were based on their flowers, leaves, steams, fruits, seeds, and the type of habitat where the plant grew.

2.4 Data collection and analyses

The methods used for data collection and identification were field observation, questionnaire and oral interview. Honey plants were identified to species level on the spot where possible, and plants that were difficult to be identified in field were later identified using reference texts (Bekele-Tesemma, 2007; Fichtl and Admasu, 1994). During field studies honey plant species visited by foraging honeybees were collected, botanically identified and the necessary data about the honey plant species was registered. Using transact walk, field observations were made and data were recorded on the nature and habit of plants, plants flowering during that time, and feed sources collected by bees. Moreover, honeybee flora photos were taken for documentation. In order to strengthen the field observation key informants were interviewed about bee plants based on the questionnaire (checklist). Major, secondary and minor plants were identified using ranking index and frequency of occurrences.

Finally, the collected data was analyzed using the Descriptive Statistics (such as mean, frequency and percentile). Data are presented in table and figure forms. Based on field information collected and available data base, details of each bee plant species was illustrated and published as working document.

3 Result and Discussion

3.1 Honeybee flora composition

Due to its favourable climatic conditions and edaphic factors, a wide range of species of cultivated and uncultivated honey plants that comprises herbaceous, shrubs and trees grow in the western Amhara region of Ethiopia. 290 plant species representing 105 plant families were identified as honeybee plants in the study areas. *Asteraceae, Leguminoseae, Fabacae,* and *Lamiaceae* were the dominant honeybee plant families representing 14.8%, 6.6%, 5.9% and 5.9% respectively. Moreover, honeybee plant species such as *Guizotia species, Bidens species, Trifolium species, Eucalyptus species, Cordia africana, Acacia species, Croton macrostachyus, Vernonia species, Brassica carinata , and Andropogon abysssinicus* were principal honeybee plants in most of study areas. However, the density and cover value of the plant species per sites were greater (44.5%) for herbaceous plant species (Table 2). This is consistent with Amssalu (2005) who indicated that honey plants of the central highlands of Ethiopia are predominantly herbaceous in nature. The trees and shrubs density was relatively lower due to deforestation and farmland expansion.

Based on the reports of respondents and field observations the most valuable herbaceous honey plants such as *Bidens* species(Adey Ababa), *Guizotia scabra (Mech), Trifolium* species *Amaget*), and indigenous Honeybee trees like *Albizia gummifera (Sesa), Cordia Africana (Wanza), Ekebergia capensis (Lol), Erica arborea (Asta), Hagenia abyssinica (Kosso), Prunus Africana (Tikur inchet), Schefflera abyssinica (Getem)* are in the state of declining due to herbicides application, intensive cultivation, overgrazing and clearing of vegetation.

It was noted that some of the identified honey plants serve as vegetable, fruit, medicine, animal feed, construction, fuel wood, soil and water conservation, ornamental, shade, and the like.

Table 2. Plant species recorded in the study area

S/N	Plant nature	Score	Percent	Remark
1	Herbaceous	129	44.5	
2	Herb/shrub	10	3.4	
3	Climber	10	3.4	
4	Shrub	34	11.8	
5	Shrub/tree	42	14.5	27 plants are categorized under small tree
6	Tree	61	21.0	
7	Grass	4	1.4	
	Total	290	100.0	

Comparatively plantation of eucalyptus species is increasing from time to time and it expands into the farm land. However, in most areas this plant is cut down before it produce flowers. Moreover, important bee plants like *Bidens* species *(*like *Adey Abeba), Guizotia scabra (Mech), Trifolium* species, and *Andropogon abysssinicus (Gajja)* are diminishing from time to time due to decline of grazing land, overgrazing, and herbicides application. The coverage of *Guizotia abyssinica* (Noug) is decreasing due to its low yield productivity.

The species diversity in sample sites were generally higher at the midland (Weyna Dega) altitudes and decreasing towards higher altitudes (Fig.1) and this is in agreement with the findings of Admasu *et al*., 2005. This may be associated with geology and climate. However, in higher altitudes there are honey plants, like *Erica arborea* (*Asta*), *Hagenia abyssinica* (*Kosso*) and *Lobelia gibberoa* (*Gibbera*) which can provide potential nectar and pollen.

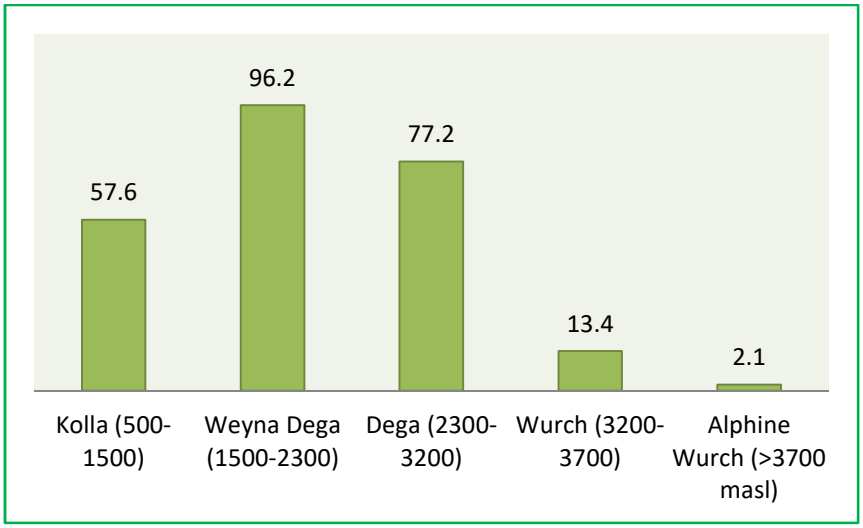

Figure 1. Percent availability of honey flora along agro climatic zones (When percents add up it gives more than 100 percent, because one plant can be found in different agro climatic zones)

3.2 Flowering time

The flowering time of honeybee plants vary from species to species depending on the climatic conditions of their habitat. Based on the results of this study, four flowering seasons followed by two distinct honey flow seasons were identified. In most potential areas of the region having bimodal rainfall patterns, honey is harvested after the big and small rainy seasons. The phenology of honey plants corresponding to the availability of rainfall and agro climatic zone. Majority of herbaceous plants and shrubs (41.7%) mainly flower after the big rainy season (September – November) while majority of tree species bloom during the small rainy season (March – May) (Figure 2).

Honey plants such as *Salvia leucantha, Tecoma stans* (Trumpet tree), *Ocimum urticifolium* (*Damakessie*) and *Eucalyptus camaldule* flower year round while, *Agave species, Datura arborea, Jacaranda mimosifoli, Acacia decurrens, Leucaena leucocephala , Callistemon citrinus* (Bottle brush) bloom most times of the year and the flower continue for extended period. Moreover, *Erica arborea* (*Asta*), *Grevillea robusta, Casimiroa edulis* (*Kazmir*) and *Eriobotrya japonica* (*Woshmella*) flower after rains. *Acacia polyacantha (Gmarda), Eucalyptus* species, *Schefflera abyssinica* (*Getem*), *Syzygium guineense* (*Dokma*), *Vernonia amygdalina* (*Grawa*) offer nectar and pollen during dearth period.

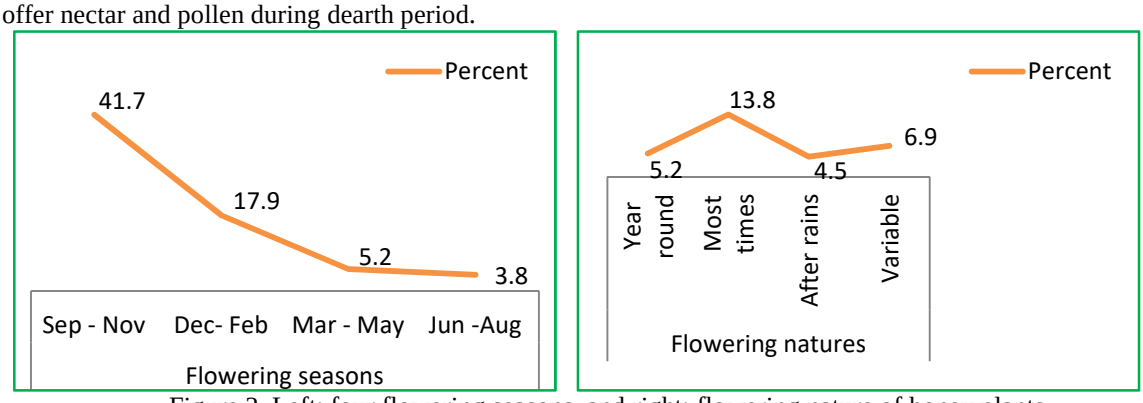

Figure 2. Left: four flowering seasons, and right: flowering nature of honey plants

3.3 Food sources

Various plants were blossoming in different seasons and honeybees visited these plants mainly for nectar and pollen. In this study, the bee plants were categorized and graded on the basis of the frequency of visits of bees to the flowers for collection of nectar and pollen. Of the total honeybee plants identified in the study areas, about 87.6% are sources of both nectar and pollen sources (Figure 3). During honey flow season's nectar is mostly used for honey production while pollen is used for brood rearing.

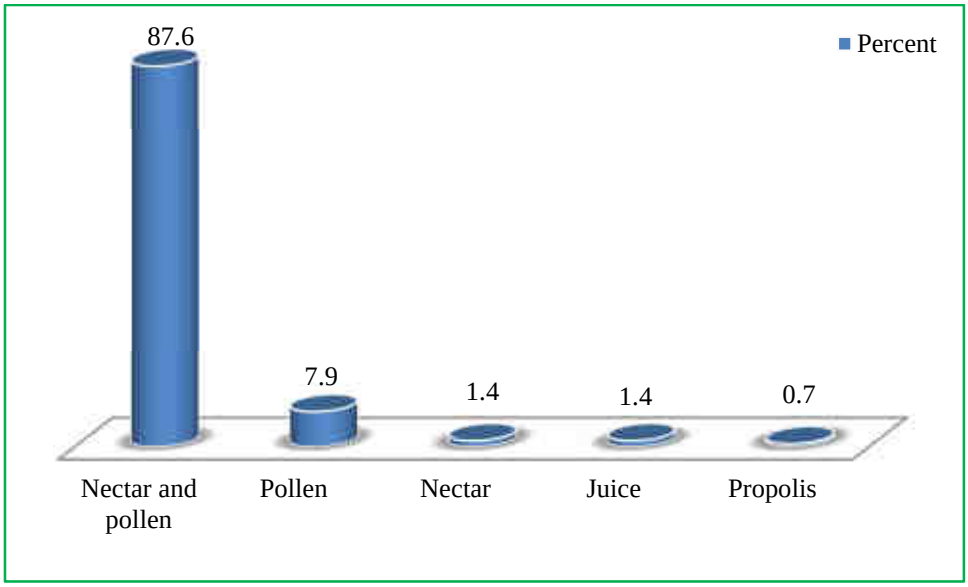

Figure 3. Food sources of honey plant species of the study areas

3.4 Major honeybee plants

Major honeybee plants are the most important plants which are used for brood rearing and abundant honey production. Of the total 290 species of honey plants identified at western Amhara, major honey source plants such as *Bidens species, Guizotia species, Trifolium species, Cordia africana, Acacia species, Eucalyptus species, Croton macrostachyus, Vernonia species, Brassica carinata, Andropogon abysssinicus, Schefflera abyssinicica, Erica arborea* and others were account 23.1% due to their immense flowering nature.

3.5 Secondary honeybee plants

Secondary honeybee plants are ordinary plants which are used as pollen and nectar sources. These include *Acacia decurrens, Dombeya torrid, Apodytes dimidiate, Aloe berhana, Echinops species, Rhus glutinosa, Ritchiea albersii, Melia azedarach, Plantago lanceolata, Jacaranda mimosifoli*, and the like comprise 39.0 %. This category of honey plants is also important for brood rearing and honey production.

3.6 Minor honeybee plants

Some of honeybee plants identified and reported as minor honey plants (37.9%) include *Boswellia papyrifera, Caesalpina decapetal, Milletia ferruginea, Argemone mexicana, Zea mays, Kalanchoe species, Euclea racemosa,* and *Ficus* species. Some of this group plant species were found less frequently in sample plots while the others were less potential for honeybees to forage nectar and pollen.

However, honey plant species that identified as dominant by respondents were not recorded in sample sites, and some honey plant species that were not reported by respondents were observed in sample sites because sampling was done in open and protected areas of lower and higher altitudes. Moreover, predominant and secondary important honey plants availability were low while minor honey plants were highly available (Figure 4).

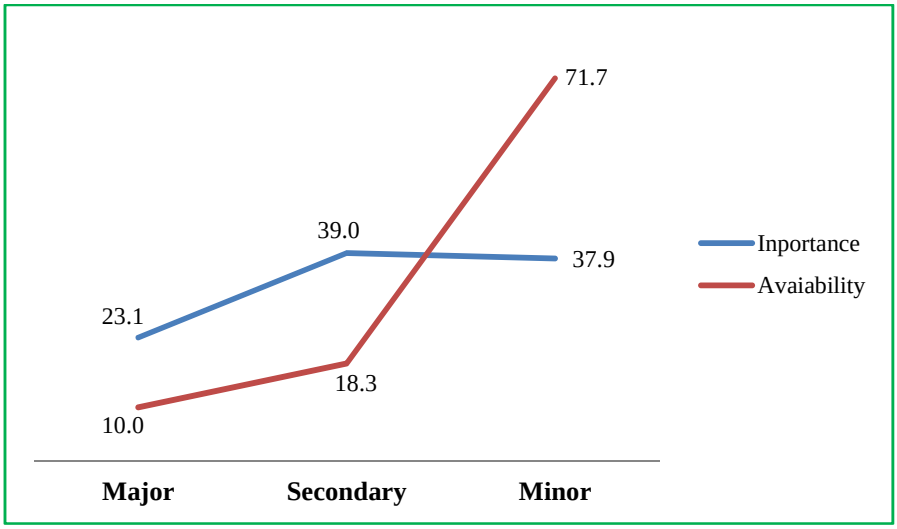

Figure 4. Importance and availability of honey plant species (%)

3.7 Bee floral calendar

Based on the availability of different plants along with their flowering time, a bee floral calendar was developed for western Amhara region (Table 3).

Table 3. The flowering calendar of the major bee plant species

Plant species	Flowering months											
	S	O	N	D	J	F	M	A	M	J	J	A
Acacia abyssinica					■	■	■	■	■			
Acacia lahel								■	■	■		
Acacia mearnsii		■	■	■								
Acacia polyacantha								■	■	■		
Acanthus eminens			■	■	■	■						
Acanthus sennii				■	■	■						
Albizia gummifera					■	■	■	■				
Allophylus abyssinicus	■	■	■						■	■	■	■
Andropogon abysssinicus	■	■	■	■								
Aningeria altissima			■	■	■	■						
Bidens species	■	■										
Brassica carinata	■	■	■									
Cordia africana		■	■	■								
Croton macrostachyus									■	■	■	
Dombeya torrida		■	■	■								
Ekebergia capensis			■	■	■	■	■	■	■			
Erica arborea		■	■	■				■	■	■		
Eucalyptus camaldule	■	■	■	■	■	■	■	■	■	■	■	■
Eucalyptus globulus									■	■		
Guizotia abyssinica	■	■	■									
Guizotia scabra	■	■	■	■	■	■						■
Hagenia abyssinica		■	■	■	■	■						
Hypoestes forskaolii	■	■	■									
Lathyrus sativus			■	■	■							
Lobelia gibberoa		■	■	■	■							
Ocimum basilicum	■	■	■	■								
Phacelia tanacetifolia		■	■									
Schefflera abyssinicica							■	■	■	■		
Syzygium guineense					■	■	■	■	■			
Schinus molle		■	■	■								
Trifolium species	■	■	■								■	■
Vernonia auriculifera			■	■	■	■	■	■	■			
Vernonia amygdalina				■	■	■						
Vicia dassycarpa		■	■	■								
Plant species	S	O	N	D	J	F	M	A	M	J	J	A

4 Conclusion and Recommendation

Based on the results of botanical study, the species diversity in sample sites was generally higher at the mid altitudes and decreasing towards higher altitudes. This may be associated with geology and climatic condition. The phenology of honey plants corresponds to the availability of rainfall and agro climatic zone. Four main flowering seasons have been identified followed by two distinct honey flow seasons in annual cycle. Majority (41.7%) of herbaceous plants and shrubs were mainly flower after the big rainy season (September – November) while majority of tree species bloom during the small rainy season (March – May).

The results of this study revealed that important herbaceous honeybee plants and indigenous trees are in the state of declining due to herbicides application, intensive cultivation, overgrazing and deforestation. Therefore, in order to use the beekeeping subsector in a sustainable way, it is suggested to integrate beekeeping with cultivation of fast growing, multipurpose plants, those bloom in most parts of the year and supplying rich nectar and pollen.

Therefore, seasonal management of the colonies should be adjusted with flowering periods of major identified floras in the study areas.

5 References

Admasu Addi, Debissa Lamessa and Amsalu Bezabih, (2005). Botanical inventory and phenology of bee plants in rift valley regions of East Showa Zone. Proceedings of the 13th Annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 25 -27, 2005. ESAP, Addis Ababa. Pp.31-40.

Amssalu Bezabeh, (2005). Nature and phenology of honeybee plants in the central highlands of Ethiopia. Proceedings of the 12th Annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 12-14, 2004. ESAP, Addis Ababa. Pp 193 – 205.

Bekele-Tesemma, A. 2007. Useful trees of Ethiopia: identification, propagation and management in 17 agroecological zones. Nairobi: RELMA in ICRAF Project, 552p.

BoFED (2009). (Bureau of Finance and Economic Development). 2007 / 2008 Budget Year Annual Statistical Bulletin, January 2009, Bahir Dar, Ethiopia.

EARO (2000). (Ethiopian Agricultural Research Organization). Apiculture research strategy, Ethiopian Agricultural Research Organization, Animal Science Research Directorate, 45p.

Fichtl, R. and Admasu Addi (1994). Honeybee Flora of Ethiopia. Margraf Verlag, Germany. 510p.

FAO (1986). (Food and Agriculture Organization of the United Nations). Tropical and sub tropical apiculture. FAO Agricultural Services Bulletin 68, FAO, Rome, Italy. 285p.

Gichora, M. (2003). Towards Realization of Kenya's Full Beekeeping Potential: A Case Study of Baringo District. *Ecology and Development Series No. 6, 2003*. Cuvillier Verlag Gottingen, Germany. 157p.

Kerealem Ejigu, Tilahun Gebey and T. R. Preston (2009). Constraints and prospects for apiculture research and development in Amhara region, Ethiopia. *Livestock Research for Rural Development, Volume 21, No 10, October 2009.* http://www.lrrd.org/ public-lrrd/proofs/lrrd2110/ejig21172.htm

Nuru Adgaba, Admasu Addi and Dereje Woltedji (2001). Pollen spectrum of honeys and honeybee flora calendar of West Shoa. pp.68-77. Proceedings of the third National Annual Conference of Ethiopian Beekeepers Association (EBA). September 3-4, Addis Ababa, Ethiopia.

Paterson, P.D. (2000). The basis for success in beekeeping within development projects. *Apiservices – Virtual Beekeeping Gallery website.* http://www.apiculture.com/_ menus _us/ index.htm. (December 5, 2006)

Svensson, B. (1991). Bees and trees. Swedish University of Agricultural Sciences, International Rural Development Center. Working paper 183. Uppsala, Sweden.