ASSET Series B (2007) 6 (1): 67-76

ASSET
An International Journal

ECOLOGICAL POTENTIALS OF BEEKEEPING IN ADAMAWA STATE, NIGERIA

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ABSTRACT

This study was undertaken to determine the ecological potentials of beekeeping in Adamawa State. Following the delineation of the state into three zones, the inventory of plant resources at both woody and herbaceous layer was made to prepare the list of plant resources utilized by bees, determine density of both tree and shrub species and estimate the cover of herbaceous plant species in the study area. These were done using the plot and total count method for trees and shrubs, while herbaceous plant cover was estimated in quadrats by the ocular estimate method. Secondary data on precipitation, temperature, relative humidity were collected from the nearest meteorological stations to the study sites. Results obtained showed that 28 species of trees, 5 species of shrubs and 12 species of herbaceous plants were listed as plants utilized by bees in the study area. Among the trees inventoried, 60%, 72% and 75% were utilized by bees in zones 1, 2 and 3 respectively, while 50%, 81.75% and 86.67% of shrubs were also utilized by bees in zones 1, 2 and 3 respectively. 68%, 65% and 20% of herbaceous plants cover were utilized by bees in zones 1, 2 and 3 respectively. Precipitation (-0.183^{ns}) and temperature (0.776^{ns}) had no significant effect on the yield of honey. The effect of relative humidity on yield of honey was significant (0.308, $P \leq 0.05$), while that of tree density was highly significant (1.297, $P \leq 0.01$).

Keywords: Beekeeping, ecological potentials.

INTRODUCTION

Honeybees are four- winged insects with a sting. There are over 12,000 species around the world but only about 600 of these species are social in habit. Among the social bees are the honeybees. They belong to the animal kingdom, phylum - Arthropoda, class – insecta, order- Hymenoptera, family – Apidae, Genus – Apis and species – mellifera. Their social individuals consists of the Queen, drones and workers, each caste having a specific role to play (Wanda, 2003). The Queen is the only female honeybee that is completely developed sexually. The drones are the male honeybees without stings whose role is to mate with the Queen. The workers are females that perform the work of building and repairing of hives depending on need. Queen could live for about 2-5 years, drone 28 – 35 days and workers 2 – 6 months depending on availability of forage and hive resources (Brian, 1983; Reinhard, 1997; Wanda, 2003).

Brian (1983), stated that honeybees (*Apis mellifera*) have remarkable memory and intelligence of being familiar with the routine of an experimenter. Lars and James (2001), observed that honeybees can learn odours faster than colours, distinguish between thousands of subtly different odours and learn to associate floral scent, size, shape, colour and tactile cues with rewards in decreasing hierarchical rank.

The honeybees can perform optimally at a temperature range of 34 – 38^{0}C or in an ambient temperature that varies from 22–50^{0}C. However, the maximum temperature for honeybee activity is 52.78^{0}C (Marieke, 1991). Rainhard (1995) confirmed that honeybees can thrive in vegetation whose annual rainfall ranges from 50mm – 350mm. The bee *Apis millifera* (dominant species in Nigeria) visit many flowers of native trees, shrubs and herbaceous plants. Among the trees visited are *Vitellaria paradoxum (sheabutter tree), Danielia oliverii (maje), Khaya senegalensis (Mahogany), Ziziphus mauritiana, Ziziphus spina-christi (Kurna).* The shrubs visited include *Anonna senegalensis, Ziziphus mauritiana, Mimosa invasa, Giuera senegalensi,* while herbaceous plants visited consist of *Tridax procumbens, Aspilia africana and Accanthospermum hispidium* (Nicola, 1992; Marieke, 1991; Reinhard, 1997; Tan, 1998).

The bees provide natural ecological services to the ecosystem by acting as agents of pollination. For instance, in Himalayas, farmers are ready to pay for any price for hiring honeybees on commercial basis to ensure pollination of their apple and other crops (John and Ayoade, 1977). Other values of honey bees include medicinal, educational, research, tourism and food.

In Adamawa State, the ecological potentials of beekeeping have not been determined hence this study, which aims at ascertaining the check-list of plants visited by honeybees, assess the status and proportion of the plants utilized and to examine the effects of ecological factors such as temperature, rainfall, relative humidity and tree density on beekeeping in the study area.

METHODOLOGY

Study Area

Adamawa State is located in the North -Eastern part of Nigeria. It lies between latitude 7^0 and 11 ^{1}N and longitude 11^0 and 14 ^{1}E. The study area covers the three ecological/vegetation types of Adamawa State. The three vegetation types consists of the southern guinea savanna, the northern guinea savanna and the Sudan savanna (Akosim *et al.*, 1999) as shown in Fig 1.

Maximum temperature ranges from 18^{0}C – 40^{0}C between April –December. Mean annual rainfall in the southern guinea zone ranges from 1100 mm – 1600 mm and lasts for 6 – 7 months, while in northern guinea zone ranges from 900 mm – 1100 mm and lasts for 4 – 5 months. In the sudan savanna zone, it ranges from 700 mm – 900 mm and lasts for 3 – 4 months (Akosim *et al.*, 1999; Adebayo and Tukur, 1999). The abundant woody plants in the study area include *Prosopis africana, Vitex doniana, Parkia biglobosa, Khaya senegalensis, Balanites aegyptica, Danielia oliverri, Ziziphus spina-christi, Adansonia digitata*

and *Tamarindus indica.* The common shrubs include *Guiera senegalensis, Annona senegalensis and Combretun species.* Among the existing grass species are *Panicum species, Hyparrhenia species, Cenchrus species, Pennisetum species, Tridax procumbens, Andropogon species* and *Aristida species.* The fauna resources of the area include mammals such as *Syncerus caffer (Buffalo), Loxondota africana (Elephant) Papio anubis (Baboon)* and *Phacochoerus aethiopicus* (Warthog). Reptiles consists of *Python sebae (Python),Crocodilus niloticus* (Crocodile). Bird species include *Numida meleagris (Guinea fowl), Struthio camelus (Ostrich), Tyto alba (Owl)* and *Coracias abyssinica* (Absyssian roller). Most of these animals (90%) can be sighted over the zones. The major land use in the study area is agriculture, fisheries and forestry (Akosim *et al.*,1999).

Study Design and Data Collection

The study design and data collection involved the division of the entire state (Adamawa) into three zones based on the three vegetation types in the state. Five plots of one hectare each were randomly located in each of the zones. Total count method as outlined by Sutherland (1999) was adopted in counting all the species of trees and shrubs present in each of the one -hectare plot and the result is expressed as number of a given species of trees and shrubs per hectare.

To estimate the cover of herbaceous plants utilized by honeybees in the study area, a visual estimate method as outlined by Sutherland (1999) was used. This involves the laying of $1m^2$ Quadrat at points randomly selected along pre-determined transects and visual estimate made of the cover of herbaceous species utilized by the bees. The result was expressed in percentage classes as follows: <1% cover, 1 – 5% cover, 6 – 25% cover, 26 – 50% cover, 51 – 75% cover and 76 – 100% cover.

Secondary data on rainfall, temperature and relative humidity for a period of three years (2002 – 2004) were collected from the nearest meteorological stations to the study sites.

Statistical Analysis of Data

Data collected were analyzed using the analysis of variance (ANOVA) and multiple linear regression model based on Wahu'a (1999) and Swarmy (2002) principles, respectively. This is illustrated below.

Regression Equation

$Y = X_1 + X_2 + X_3 + X_4 + e$

where:

Y	=	Yield of Honey (kg)	(Dependent Variable)
X_1	=	Rain fall (mm)	(Independent variable)
X_2	=	Relative Humidity (%)	,, ,,
X_3	=	Temperature (^0C)	,, ,,
X_4	=	Tree and shrub density (No./ha)	,, ,,
e	=	Error term	

RESULTS AND DISCUSSION

The check-list of plant resources utilized by bees in the study area (Table 1) indicates that 28 species of trees, 5 species of shrubs and 12 species of herbaceous plants were utilized by bees in the study area during various period of the seasons. The total number of tree species (28) is 100% of the 28 species reported (Nicola, 1992) for savanna zones of Nigeria. The number of shrub species (5) and herbaceous species (12) listed are 80% and 100% respectively of the shrubs and herbaceous species reported by Nicola (1992), Akobundu and Agyakwa (1998) and Nell (1998) for savanna zones of Nigeria. The above results indicate high availability of plant resources needed by the bees for food in the study area.

The results of the status of plants and the proportion utilized by bees in the three zones are presented in Tables 2, 3 and 4. The results show that the utilized tree species in the three zones had the highest mean density (number per hectare), which ranged from 1.400 to 45.800. The tree species visited by bees were 60% in zone 1, 72% in zone 2 and 75% in zone 3. This trend was also observed in the shrub species in all the zones, in which density (number per hectare) ranged from 8.200, to 12.00, while the percentage utilization were 50, 81.25 and 86.67% for zones 1, 2 and 3 respectively. Furthermore, when the percentage cover of the herbaceous plants are considered the species utilized by the bees were found to constitute 68, 60 and 20% for zones 1, 2 and 3, respectively. Therefore, apart from the low status of herbaceous layer in zone 3, the results of the woody plant species density, herbaceous cover and utilization are sufficiently indicative of high ecological potentials of the zones for beekeeping.

The results of the effect of some ecological factors which include precipitation (-0.183^{ns}), temperature (0.776^{ns}), relative humidity (0.308, $P \leq 0.05$) and tree and shrub density (1.297, $P \leq 0.01$) on the yield of honey in the study area are presented in Table 5. Although each ecological factor contributed to the yield of honey, the tree and shrub density (1.297, $P \leq 0.01$) is shown from the result to have contributed more than any of the other factors. Mustsaers (1992), observed that too low temperature (8^0C) and too high temperature (50^oC and above) as well as relative humidity below 50% can affect laying of eggs, cause destruction of the larva and make the bees inactive. However, the ambient temperature in the study area ranged from 30 to 45^0C throughout the year, and the relative humidity rarely falls below 50%. This perhaps explains why plant factor is the major determinant of the yield of honey in the study area. The trees and shrubs do not only provide food for the bees, they also provide shelter or homes for the bees. Most colonies of bees build their hives in or on trees trunks. Hence tree and shrub density is an important ecological requirement of the bees in the study area.

CONCLUSION

From the results obtained, it can be concluded that the study area (Adamawa State) contain abundant plant resources required by bees for both food and cover. Furthermore, tree density which is a key factor in determining the bee population is also adequate in the three zones. It is therefore, not out of place to conclude from these findings that the ecological potentials

of beekeeping in the state is reasonable high. Therefore, beekeeping should be encouraged in the State by the Government.

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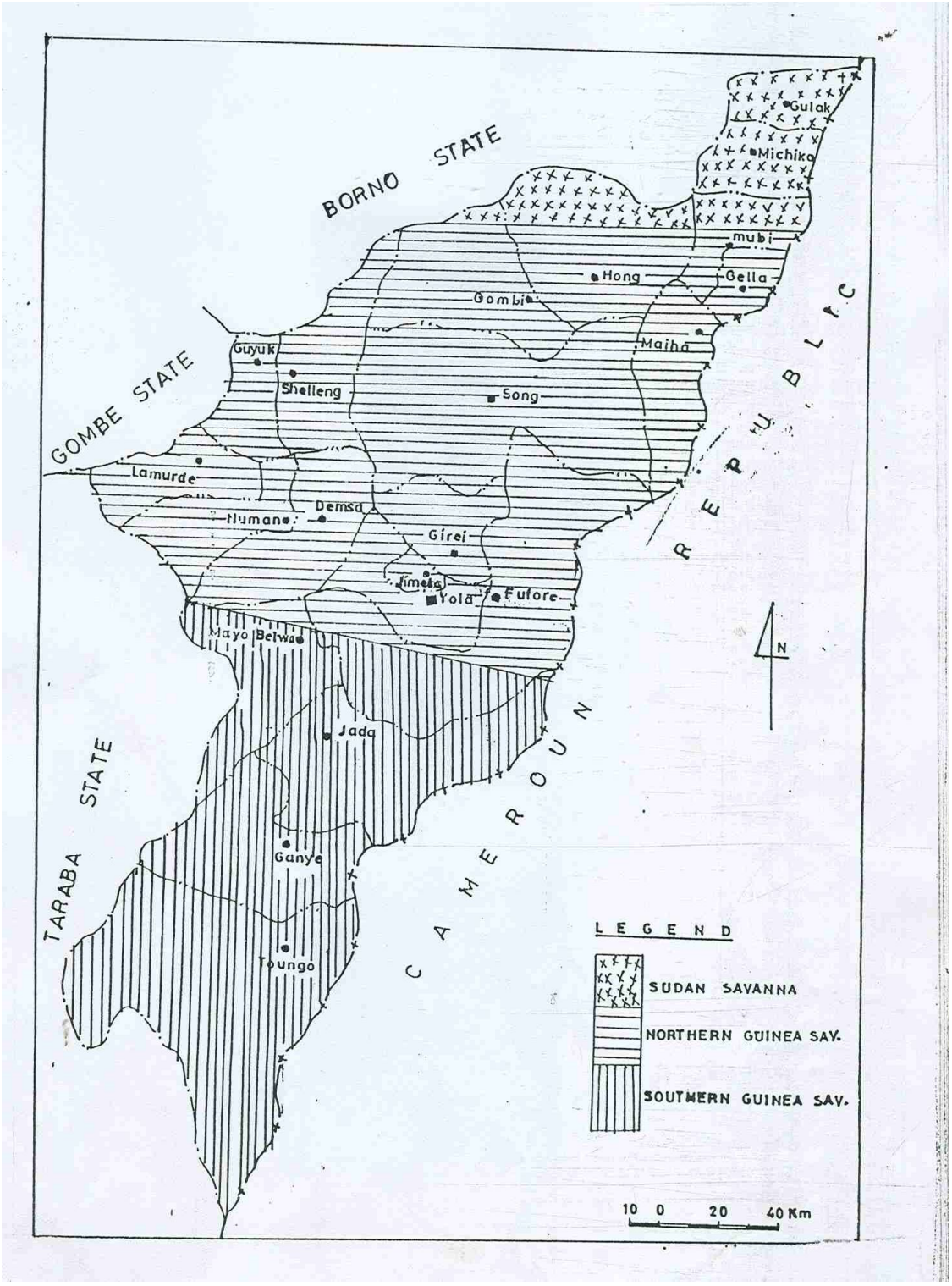
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Yola
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Mayo Belwa
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LEGEND
SUDAN SAVANNA
NORTHERN GUINEA SAV.
SOUTHERN GUINEA SAV.
10 0 20 40 Km

Table 1: Plants visited by Bees in the Study Area

A Tree Species	Dry Season Jan –March	Rainy season Apri – June	Rainy season July – Sept.	Dry season Oct. – Dec.
1. *Adansonia digitata*		xxx	x	
2. *Danielia oliverri*	xx	x		
3. *Parkia biglobosa*	xx	x		
4. *Acacia torlis*		x	xx	xxx
5. *Ziziphus mauritiana*			xx	x
6. *Ziziphus spina-christi*		x	x	xxx
7. *Acacia albida*	x			
8. *Terminalia catapa*			x	
9. *Vitellaria paradoxa*	x	xx		
10. *Khaya senegalensis*	xx	x		
11. *Coffea arabica*			x	
12. *Anogeissus leiocarpus*		x		
13. *Sterculia setigera*	x	x		
14. *Balanites aegyptiaca*	xx			
15. *Acacia sieberiana*			x	
16. *Vitex doniana*	x	x		
17. *Elaies guinensis*		x		
18. *Azadirachta indica*	x			
19. *Sclerocarya birrea*		x		
20. *Ficus ingens*	xx			
21. *Ficus platyphylla*	x			
22. *Albezia mara*		x		
23. *Mangifera indica*	xx			
24. *Psidium guajava*	xx	x		
25. *Hybericum revolutum*			x	
26. *Prosopis africana*	xx			
27. *Piliostigma thonningii*	x			
28. *Tamarindus indica*	xx	x		
B **Shrub Species**				
1. *Mimosa invasa*			x	xxx
2. *Guiera senegalensis*			xx	xxx
3. *Moringa oliefera*	xxx	x	xx	xxx
4. *Annona senegalensis*		x		
5. *Securidaca virosa*			x	xx
C Herbaceous Plants				
1. *Waltheria indica*		xx	xxx	xx
2. *Hyptis Suaveolens*		x	xxx	x
3. *Croton hirtus*		x		xxx
4. *Synedrella nodiflora*		x		xx
5. *Monechma ciliatum*		x		xx
6. *Sida acuta*			xxx	xx
7. *Sena obtusifolia*		x	xx	xxx
8. *Hibiscus asper*		x		xx
9. *Chrysanthellum indicum*		x		xx
10. *Acanthospermum hispidium*		x		xx
11. *Tridax procumbens*			x	xx
12. *Aspilia africana*			x	

x = Occasionally Visited
xx = Frequently Visited
xxx = More Frequently Visited

Table 2:Tree species Density and Utilization by Bees in the Study Area

S/No	Tree Species	Local Name (Hausa)	Mean Density Per Hectare Per Zone			Utilization
			Zone I	Zone II	Zone III	
1	*Anogeisus leiocarpus*	Marke	11.000[a]	45.800[a]	1.400[bc]	UT
2	*Prosopis africana*	Kiriya	4.20[b]	4.400[b]	1.000[bc]	UT
3	*Terminalia macroptera*	Kwandari	3.800[cb]	-	0.200[c]	NUT
4	*Ziziphus mauritiana*	Magariya	3.600[cbd]	0.400[b]	3.000[ba]	UT
5	Detarium microcarpum	Taura	3.200[cebd]	4.600[b]		NUT
6	*Balanites aegyptiaca*	Aduwa	1.800[cebd]	0.400[b]	2.000[bc]	UT
7	*Acacia sieberiana*	Farar kaya	1.600cebd	1.800[b]	1600[bc]	UT
8	*Conbretum glutinosum*	Taramriya	1.600[cebd]	7.400[b]	-	NUT
9	*Terminalia laxiflora*	Zindi	1.400[cebd]	3.800[b]	-	UT
10	*Sterculia setigera*	Kukuki	1.400[cebd]	1.400[b]	0.400[c]	UT
11	*Tamarindus indica*	Tsamiya	0.800[cebd]	-	1.800[bc]	UT
12	*Acacia nilotica*	Bagarnwa	0.800[cebd]	0.600[b]	-	UT
13	*Stereopermum kunthianum*	Sasami	0.400[cd]	0.400[b]	0.200[c]	UT
14	*Lannea acida*	Faru	0.400[ed]	-	-	NUT
15	*Danielia oliverii*	Maje	0.200[e]	2.200[b]	0.600[c]	UT
16	*Piliostigma thonningii*	Kalgo	-	6.400[b]	0.200[c]	NUT
17	*Vitellaria paradoxum*	Kadaruya	-	5.200[b]	1.200[bc]	UT
18	*Parkia biglobosa*	Dorowa	-	2.000[b]	0.400[c]	UT
19	*Azadirachta indica*	Neem	-	1.000[b]	-	UT
20	*Ficus sycomorus*	Baure	-	0.400[b]	0.200[c]	NUT
21	*Vitex doniana*	Dinya	-	0.200[b]	-	UT
22	*Acacia tortis*	Chilluki (Fulani)	-	-	4.800[a]	
23	*Acacia seyal*	Dushe keraji	-	-	2.200[bc]	NUT
24	*Acacia albida*	Gawo	-	-	0.400[c]	NUT
25	*Sclerocarya birrea*	Danya	-	-	1.000[bc]	UT
26	*Ficus ingens*	Kawuri	-	-	0.400[c]	UT
27	*Adansonia digitata*	Kuka	-	-	2.400[bc]	UT
28	*Ficus platyphylla*	Gamji	-	-	0.200[c]	UT
29	*Ziziphus spina-christi*	Kurna	-	-	0.200[c]	UT
30	*Diopyus mespilifomis*	Kanya	-	-	0.800[bc]	NUT
31	*Khaya sengalensis*	Madaci	-	-	0.400[c]	UT
	Percentage Utilization		60	72	75	

Mean values with the same superscripts are not significantly different [P≤0.05].
UT = Utilized
NUT = Not utilized

Table 3: Shrub species Density and Utilization by Bees in the Study Area

S/No	Tree Species	Local Name (Hausa)	Mean Density Per Hectare Per Zone			Utilization
			Zone I	Zone II	Zone III	
1	*Combreutm glutinosum*	Tarminya	42.600[a]	14.400[b]	5.400[cb]	NUT
2	*Ziziphus mauritiana*	Magariya	-	-	12.800[b]	UT
3	*Acacia tortis*	Chilluki (Fulani)	-	-	12.400[b]	UT
4	*Guiera senegalensis*	Sabara	10.400[b]	-	6.00[b]	UT
5	*Piliostigma thonningii*	Kalgo	0.400[c]	8.200[bc]	2.600[b]	UT
6	*Mimosa invasa*	-	6.800[b]	-	-	UT
7	*Anonna senegalensis*	Gwandan daji	0.800[c]	5.200[cb]	3.400[cb]	UT
8	*Securidaca vakrosa*	-	3.000[cb]	0.400[d]	-	UT
9	*Moringa species*	Zugalle	2.800[cb]	-	-	UT
10	*Synedrella modiflora*	-	1.800[cb]	1.00[d]	-	UT
11	*Nwewbouldia laevis*	Aduruku	1.600[cb]	0.400[d]	-	NUT
12	*Acacia nilotica*	Bagaruwa	1.200[cb]	1.600[d]	4.00[cb]	UT
13	*Terminalia microptera*	Kwandari	1.800[cb]	-	0.600[cb]	NUT
14	*Tamarindus indica*	Tsamiya	0.800[c]	-	-	UT
15	*Terminalia laxiflora*	Zindi	0.800[c]	-	-	NUT
16	*Stereospermum kunthianum*	Sasami	0.600[c]	-	-	NUT
17	*Balanites aegyptiaca*	Aduwa	0.400[c]	-	2.00[cb]	UT
18	*Detarium microcarpum*	Taura	-	1.200[d]	-	UT
19	*Ficus sycomorus*	Baure	0.400[c]	0.400[d]	-	NUT
20	*Anogeissus leiocarpus*	Marke	0.400[c]	11.800[ba]	1.600[cb]	UT
21	*Prosopis africana*	Kiriya	-	0.800[d]	1.600[cb]	UT
22	*Sterculia setigera*	Kukuki	-	0.600[d]	-	UT
23	*Acacia siebenana*	Farar kaya	-	0.400[d]	0.600[cb]	UT
24	*Vitellaria panadoxae*	Kadanya	-	0.400[d]	0.600[cb]	UT
25	*Azadirachta indica*	Neem	-	0.200[d]	-	UT
26	*Sclerocarya birrea*	Danya	-	-	0.400[cb]	UT
27	*Ziziphus spina-christi*	Kurna	-	-	0.200[c]	UT
	Percentage Utilization		50	81.25	86.67	

Mean values with the same superscripts are not significantly different $P \leq 0.05$

UT = Utilized

NUT = Not utilized

Table 4: Mean Values of Herbaceous plants utilized by bees in the Study Area

Mean Values	Zone (s)
68.000[a]	1
65.000 [a]	2
20.000 [b]	3

Means with the same superscripts are not significantly different ($P \geq 0.05$).

Table 5: Linear Regression of Ecological Factors on the Yield of Honey In the Study Area

Variables	Parameter Estimate (Coefficients)	Standard Error
Intercepts	251.473[ns]	± 71.230
Rainfall	- 0.183[ns]	± 0.200
Relative Humidity	0.308*	± 0.236
Temperature	0.776 [ns]	± 1.976
Tree and shrub Density	1.297 **	± 0.483

**	-	Significant at 1%
*	-	Significant at 5%
NS	-	Not Significant
CV	=	15.810
R^2	=	0.411

Regression Equation,

$$Y = \underset{(71.230)ns}{251.472} + \underset{(0.200)ns}{0.183X_1} + \underset{(0.236)*}{0.308X_2} + \underset{(1.976)ns}{0.776\,X_3} + \underset{(0.483)**}{1.297X_4}$$

where:

Y	=	Yield of Honey (kg)	(Dependent Variable)
X_1	=	Rain fall (mm)	(Independent variable)
X_2	=	Relative Humidity (%)	,, ,,
X_3	=	Temperature (^{0}C)	,, ,,
X_4	=	Tree and shrub density (No/ha)	,, ,,