FUDMA Journal of Sciences (FJS)
ISSN Online: 2616-1370
ISSN Print: 2645-2944
Vol. 2 No. 3, September, 2018, pp. 9 - 17

PREVALENCE OF AND SOCIO-ECONOMIC FACTORS INFLUENCING HONEY BEE STRESSORS AND THE COPING STRATEGIES IN BEE FARMS IN KWARA STATE, NIGERIA

***[1]Oladimeji Y. U. and [2]Ajao A. M.**

[1]*Department of Agricultural Economics, Ahmadu Bello University, Zaria, Nigeria*
[2]*Department of Bioscience and Biotechnology, Kwara State University, Malete, Ilorin, Nigeria*

**Corresponding author email: yusuf.dimeji@yahoo.com +2348032220000*

ABSTRACT

There has been a concern about declines in honeybees in the recent years including their pollination efficiency due to different factors, and this affect and reduce the production potential as related to every component of agricultural ecosystems. It is therefore imperative to describe prevalence of and socio-economic factors influencing honey bee stressors and the coping strategies in bee farms in Kwara State Nigeria. Descriptive statistics and multiple regression were used to analysed the data. A survey of various types of honey bee health stressors was conducted through structured questionnaire and a snowball sampling method was used to select the respondents. The honey bee pests and predators were surveyed and samples collected weekly from September 2013 to February 2014 from six apiaries and bee farms spread across ten LGAs. The result showed that the mean age of the respondents was 43 years which implies that beekeeping in the area is dominated by young managers. On human and environmentally induced bee stresses, bad apiary management practices, effect of pesticides usage and other human activity ranked most important in many apiaries in the LGAs studied. The study has also revealed that the farmers employ variety of stress management strategies: effective colony sanitation, improved human bee management and provision of adequate melliferous plant that provide bee nutrients all year round. It is recommended that training in bee farming and increase investment should be promoted among beekeepers to enable them imbibe improve techniques and acquired materials inputs that will translate into realistic quantity and quality products.

Keywords: Coping strategy, honey bee pests, socioeconomic characteristics, stressors

INTRODUCTION

Nigeria has a land area of 98.3 million hectares with northern region covering about 79% of the entire land mass and a huge potential for beekeeping given the prevailing suitable ecological conditions, diverse and unique flora and fauna diversity (Oladimeji *et al*., 2017a). The bees and the plants like all renewable natural resources are seriously underutilized and constantly under threat from lack of knowledge and appreciation of these endowments. Apart from the honey bee, there are over 4,000 species of other native pollinators engaged in crop pollination service capable of providing pollination services to a wide variety of crop species (Ajao, 2012). According to Morse and Calderone, (2000), Klein *et al*. (2007), Ajao and Oladimeji, (2017) apart from honey and other by-products derived from honey bee, many agricultural crops and natural plant populations are dependent on bee pollination, direct or indirect services provided by wild and managed bee pollinator communities thereby increasing crop yield, diversity and crop availability at all times thus sustaining food security. Estimates place the annual global value of pollination services, including those of wild and managed bees, at about USD216 billion or about ₦64 trillion per year, or 9.5% of the worldwide annual crop value (Gallai *et al*., 2009, Oladimeji *et al*., 217a). According to (Klein *et al*., 2007), an estimated 35% of crop production is as a result of insect pollination all over the world.

However, there has been a concern about declines in honeybees in the recent years including their pollination efficiency due to different factors, and this in turn will affect and reduce the production potential as related to every component of agricultural ecosystems. Although bees are ecologically and economically vital pollinators for both wild and cultivated flowers, many populations are in decline while demand for pollination-dependent crops continues to rise, generating understandable alarm and debate about the possibility of an emerging pollination crisis (Klein *et al*., 2017). Although the underlying causes of increased colony mortality remain unclear, there is growing consensus that multiple stressors are involved (Micheal *et al.,* 2016).

The term stress originated in physics to describe pressure and deformation in a system, but it has been adopted into a biological context as the response syndrome to any aversive or harmful treatment in a specific system (Naila *et al*., 2012). The concept of stress is useful in understanding the physiological and behavioral responses of honey bees to harmful situations. To date, most studies on honey bee stressors agree that there is no single acceptable reason for the extensive colony losses currently experienced, but brought about by the interactions between multiple stress factors (Figure 1).

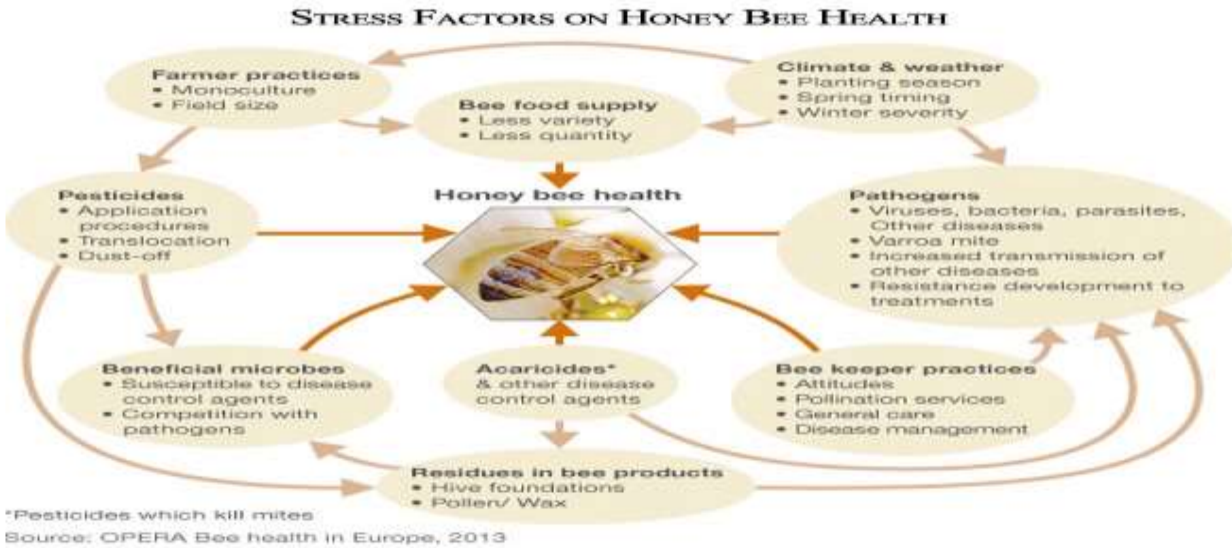

***Fig. 1**: Stress factors on honey bee health*

It is pertinent to note that honey bee are exposed to the different stresses due to a number of factors (stressors) such as climate change, genetic weakness and human-induced stressors such as pests and pesticides, poor nutrition, pollution, predators, parasites and pathogens, changes in forage quantity and quality due to land use, and other forms of environmental degradation (Naila *et al*., 2012; Figure 1).

Klein *et al*. (2017) opined that many stressors damage the bee brain, disrupting key cognitive functions needed for effective foraging, with dramatic consequences for brood development and colony survival. Under chronic stress, the immune system, metabolic pathways and cognitive processes in the organism gradually weaken until exhaustion and failure are reached (McEwen, 2000). However, the honey bee is an ideal insect model to understand the evolution of sociality. A key feature of honey bees is their high level of social organization and their well-developed system of division of labor among workers (Wilson, 1971). Honey bees exhibit age polyethism; young workers perform in-hive tasks (e.g., taking care of the brood), then become guards patrolling the entrance of the hive and later become foragers. Studying factors that induce stress might help to elucidate how to prevent and control this type of stress. Given this paradigm, the study aims to identify and describe honey bee health stressors and examine human practices (socioeconomic factors) that induced bee health stressors, determine the socio-economic factors that influence the honey bee stressors in the study area. Suggestions on coping strategies on bee health stressors were also sought from honey bee farmers.

MATERIALS AND METHODS

Study area

The study was conducted in bee farms in Kwara State, Nigeria. The State lies between latitude 8° 10' and 19° 50'N and between longitudes 3° 10'N and 6° 05'E. The area falls within the southern limits of the tropical savannah zone of northern Nigeria with mean annual rainfall ranging from 800 mm to 1500 mm, concentrated between the months of April and October with two peaks in July and September (Ajao *et al*., 2014). The mean annual temperature is between 31.5°C and 35°C. Kwara State lies in two geo-ecological zones; the derived savanna which is characterized by woodland and the Guinea savanna which is characterized by tall grasses growing intermixed with deciduous trees. The vegetation consists largely of a great expanse of arable land and rich fertile soil. The savannah is characterized by tall grasses intermixed with scattered trees such as *Citrus sinensi, Parkia biglobosa, Butyrospermum parkii, Azadiracta indica, Mangifera indica, Acacia species, Delonix regia,* and *Anacardium occidentale.* These species of trees provide forage for the honey bees (Ajao, 2012).

Data Collection and Sampling Techniques

A survey of various types of honey bee health stressors was conducted through structured questionnaire and interview schedule to elicit necessary information. A snowball sampling method was used to select the respondents (Goodman 1961). This sampling method was used because bee farms in the study area were not well enumerated. The method involved initial selection of certain numbers of sampling units (respondents) from a source. Later, additional sampling units were obtained based on referral process (Adeogun, 2014, Salganik and Heckathorn, 2014). This means that initially selected respondents provided addresses of additional respondents for their interviewers. For this study, our initial respondents were obtained from the information provided by Beekeeping Training and Research Centre, BTRC, (www.ajaocbtr.com) while subsequent respondents was drawn based on referral by the initial respondents. Consequently, a total of 57 beekeepers were interviewed which consist of 6 institutions based and 51 private bee farms from 10 LGAs)\ of Kwara State, Nigeria.

The questionnaire sought the demographic status of the beekeepers, type of bee health stressors experienced, type of hive used and management strategies for coping with the challenges. In addition, the honey bee pests and predators were surveyed and samples collected weekly from September 2013 to February 2014 from six apiaries spread across LGAs at the study area. For the study, the apiaries were divided into three categories (2 each of institutional, organizational and private bee farms) respectively. Sweep net was used for catching insects; hand picking was used for arthropods, amphibian and reptiles while traps were used for rodents and other vertebrate animal collection. The samples collected were transferred to specimen bottles, and were preserved in 70% alcohol. They were taken for proper identification at the animal museum of the Kwara State University.

Analytical Techniques

Descriptive statistics such as frequency counts, percentage, mean, standard deviation and pictures were used to assess the socio-economic characteristics of beekeepers and honey bee stressors data collected. Multiple regression analysis was used to determine the socio-economic factors that influenced the honey bee stressors.

The multiple regression model was specified as:

$$Y_i = \beta_o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + e \quad (1)$$

Y = Output per hive (Litre); X_1 = Age (years); X_2 = No of hives per ha; X_3 = Beekeeping experience (years); X_4 = Training received in beekeeping; X_5 = Amount of investment committed to bee farming (Naira) and X_6 = Occupation (Dummy, beekeeping as main=1 and 0, otherwise); β_1-β_6 = Coefficient of the independent variables and e = Error term.

RESULTS

Table 1 showed the age range of the respondents to be between 20 and 60 years with 30(52.6%) of the beekeepers or managers falling between 41-60 years and 2 (33.4%) from institutional, 12 (57.1%) organizational and 16 (53.3%) private/individual apiaries. The average age of the beekeepers or managers was 39 years, 37 years and 53 years for institutional, organizational and individual beekeepers respectively. In addition, the mean age of pooled respondent was 43 years. This means that beekeeping in the area is dominated by young managers in both institutional and organizational apiaries while older beekeepers dominated individual ones. The result of the gender analysis revealed that male dominated beekeeping in institutional (66.67%), organizational (81%) and individual (83.33). Therefore, the majority of pooled respondents (80.7%) were males reflecting their dominance in the beekeeping enterprise.

The result of beekeeping experience revealed that both institutional (83.3%) and organizational (85.7%) apiaries were relatively new with beekeeping experience ranged from 1-10 years while most of the respondents in individual beekeeping (66.7%) had at least 11 years of beekeeping experience. The mean beekeeping experience was 4, 5and 14 years for institutional, organizational and individual respectively with pooled mean of 8 years. The result also revealed that the majority of farm managers from institutional (66.7%) and organizational (90.5%) apiarists had tertiary level of education while most individual apiarists (66.7%) had secondary education. Similarly, all institutional and organizational beekeepers sampled received training in beekeeping while only 30.4% of individual were trained in some aspect of beekeeping enterprise.

Table 1: Socio-Demographic Characteristics of Beekeepers in Kwara State, Nigeria

Parameters	Apiary							
	Institutional		Organizational		Private		Average	
	F	%	F	%	F	%	Total	%
Age (years)								
20-40	4	66.6	9	42.9	12	40.0	25	43.9
41-60	2	33.4	12	57.1	16	53.3	30	52.6
>60	0	0	0	0	2	6.7	2	3.5
Mean (years)	39		37		53		43	
Stdev	2.097		1.853		4.650		2.023	
Gender								
Male	4 66.7	66.67	17	81.0	25	83.3	46	80.7
Female	2 33.3	33.33	4	19.0	5	16.7	11	19.3
Experience (years)								
1-10	5	83.3	18	85.7	10	33.3	33	57.9
11-20	1	16.7	2	9.5	15	50.0	18	31.6
>20	0	0	1	4.8	5	16.7	6	10.5
Mean (years)	4		5		14		8	
Stdev	1.008		1.227		3.945		1.982	
Level of Education	(years)							
Informal	0	0	0	0	2	6.6	2	3.5
Primary	0	0	0	0	2	6.6	2	3.5
Secondary	2	3.33	2	9.5	20	66.6	24	42.1
Tertiary	4	66.7	19	90.5	6	20.2	29	50.9
Total	6	100	21	100	30	100	57	100

Formal training								
Yes	6	100	21	100	7	30.4	34	59.7
No	0	0	0	0	23	69.6	23	40.3

Table 2 indicates responses of beekeepers on human and environmental induced bee health stressors. On human and environmentally induced bee stresses, bad apiary management practices, effect of climate change, effect of pesticides usage and effect of some human activity such farm clearing and bush burning ranked most important in many apiaries in the LGAs. The result revealed that about 15.7% identified bad management practice has honey bee most stressful to bees in Irepodun, 15.8% chose effect of climate change in Baruteen, 15.8% for effect of pesticide usage in Ekiti and 15.8% effect of some other human activities in Edu LGAs apiaries.

Table 2: Analysis of Responses on Human and Environmental Induced Bee Health Stressors

Location (LGA)	**Bad Management Practice**		**Effect of Climate Change**		**Effect of Pesticides Use**		**Effect of other Human Activity**	
	F	%	F	%	F	%	F	%
Asa	6	10.5	2	3.5	2	3.5	5	8.7
Baruteen	7	12.3	9	15.8	3	5.3	6	10.5
Edu	7	12.3	8	14.1	5	8.7	9	15.8
Ekiti	3	5.3	2	3.5	9	15.8	4	7.0
Ifelodun	3	5.3	6	10.5	7	12.3	1	1.8
Ilorin South	3	5.3	5	8.7	7	12.3	7	12.3
Irepodun	9	15.7	6	10.5	7	12.3	8	14.0
Moro	5	8.7	7	12.4	6	10.5	8	14.0
Oyun	7	12.3	5	8.7	4	7.0	3	5.4
Patigi	7	12.3	7	12.3	7	12.3	6	10.5
Total	**57**	**100**	**57**	**100**	**57**	**100**	**57**	**100**

Source: Field survey 2014

Table 3 revealed the various types of hives and nature of hive management practices at the study area. Of the 6778 colonies understudied 1668 Kenya Top Bar hives (KTB) were of Institutional apiaries, 1667 of Organizational apiaries while 2056 were of private or individual apiaries. Most Lahgstroth (LANG) hives encountered were from Institutional (60) and Organizational apiaries. Tanzania Top Bar (TTB) were found mostly in individual apiary and uniformly spread across the LGAs but predominant in Baruteen, Edu and Moro LGAs.

Table 4 depicts the prevalence of insects' bee health stressors at the study area while figure 2 through to 7 shows different plates of insects and vertebrates attacking honey beehive structures. The result revealed that ants (18.8%), spiders (17.7%) and wasp (15.6%) were the most prevalent insect pests and predators in the study area.

Table 3: Type of Hives used by Different Strata of the Beekeepers

Apiary Type/ Location	**Institutional Apiaries**			**Organizational Apiaries**			**Private /Individual Apiaries**			
	Hive type			**Hive type**				**Hive type**		**Total**
LGA	**KTB**	**TTB**	**LANG**	**KTB**	**TTB**	**LANG**	**KTB**	**TTB**	**LAN**	**Colonies**
Asa	110	105	0	120	15	0	13	33	0	396
Baruteen	112	0	0	203	30	0	112	110	0	567
Edu	203	0	0	145	48	0	230	120	0	746
Ekiti	145	34	0	150	0	0	124	23	0	476
Ifelodun	150	0	4	203	105	0	203	76	0	741
Ilorin South	120	35	0	145	0	4	400	75	3	782
Irepodun	520	130	3	203	0	0	340	90	3	1289
Moro	120	12	50	145	34	12	257	120	0	750
Oyun	68	0	3	150	0	0	223	13	3	460
Patigi	120	40	0	203	0	0	154	54	0	571
Total	1668	356	60	1667	232	16	2056	714	9	6778
MEAN	166.8	35.6	6	166.7	23.2	1.6	205.6	71.4	1	
STD	128.8	46.3	15.5	32.3	33.7	3.8	112.8	39.6	1.5	
MAX	520	130	50	203	105	12	400	120	3	

MIN	68	0	0	120	0	0	13	13	0

Source: Field survey 2014

Table 4: Prevalence of Insects Bee Health Stressors at the Study Area

Location/LGA		**Insect pests and predators attack N=337200** (%)						
		Termite	**Spider**	**Hive beetle**	**Wax moth**	**Wasp**	**Ants**	**Others**
Total	**337200**	**51980**	**59590**	**46750**	**34510**	**52500**	**63550**	**28320**
Percentage	**(100)**	**(15.4)**	**(17.7)**	**(13.9)**	**(10.2)**	**(15.6)**	**(18.8)**	**(8.4)**

Field survey 2014
Figures in parenthesis are percentages

Fig. 2: Black ants preying on bee combs

Fig. 3: A mouse invading bee hive as home

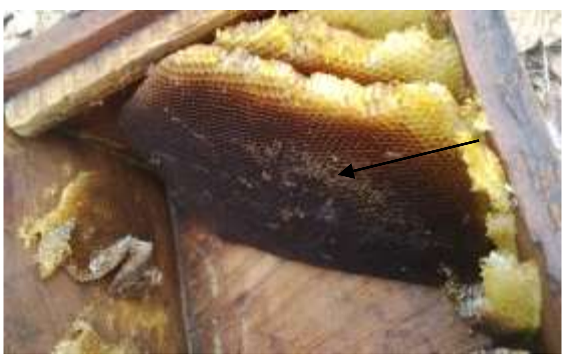

Fig. 4. Red ant attacking and feeding on bees

Fig. 5. Litters of squirrel living in bee hive

Fig. 6. Red ant attacking and feeding on bees

Figure 7. Litters of squirrel living in bee hive

Table 5 shows the percentage occurrence and means density of vertebrate and birds induced bee health stressors. The study revealed that of the total of 6778 colonies examined 869 (12.8%) of squirrels, 577 (8.5%) gecko, 513 (7.6%) bears, 1284 (18.9%) mice, 1146 (16.9%) toads, 842 (12.4%) lizards and 641 (9.5%) birds were encountered. Of 476 bee colonies examined at Ekiti LGA, squirrels constituted 22.7%, gecko 7.9%, bears 12.6%, mice 31.5%, frogs 16.4%, lizards 19.5% and birds14.1% of the vertebrate and birds predators at the study areas.

Table 5: Percentage Occurrence and Mean Density of Vertebrate and Birds Induced Bee Health Stressors

Location LGAs	**No of Colonies**	**Vertebrates Pests and Predators Attack (%) Squirrels**	**Gecko**	**Bears**	**Mice**	**Toads**	**Lizards**	**Birds**
Asa	396	63(15.9)	41(10.4)	34(8.6)	127(32.1)	143(36.1)	86(21.7)	83(20.9)
Baruteen	567	92(16.2)	34(5.9)	21(3.7)	104(18.3)	99(17.5)	63(11.1)	52(9.2)
Edu	746	82(10.9)	59(7.9)	55(7.4)	143(19.2)	56(7.5)	65(8.7)	73(9.8)
Ekiti	476	108(22.7)	38(7.9)	60(12.6)	150(31.5)	78(16.4)	93(19.5)	67(14.1)
Ifelodun	741	80(10.8)	67(9.0)	44(5.9)	94(12.7)	167(22.5)	105(14.2)	56(7.6)
Ilorin/S	782	86(10.9)	90(11.5)	79(10.1)	113(14.5)	136(17.4)	73(9.3)	64(8.2)
Irepodun	1289	127(9.9)	57(4.4)	74(5.7)	226(17.5)	173(13.4)	112(8.7)	82(6.4)
Moro	750	73(9.7)	41(5.5)	45(6.0)	119(15.7)	158(21.1)	75(10.0)	61(8.1)
Oyun	460	66(14.3)	98(21.3)	39(8.5)	86(18.7)	103(22.4)	84(18.3)	39(8.5)
Patigi	571	92(16.1)	52(9.1)	62(10.9)	122(21.4)	33(5.8)	86(15.1)	64(11.2)
	6778	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)
Total	**6778**	**869(12.8)**	**577(8.5)**	**513(7.6)**	**1284(18.9)**	**1146(16.9)**	**842(12.4)**	**641(9.5)**

Field survey 2014; Ilorin/S denote Ilorin South
Figures in parenthesis are in percentage

The response on coping strategies adapted on bee health stressors were described in Table 6 & 7.

Table 6: Responses on Coping Strategies (insect pests) on Bee Health Stressors by Beekeepers

Insect Pests and Predators		
Pests and predators	Scientific names	Methods of Control
Termite	*Macrotermes Bellicosus*	use of leaves of eucalyptus & aje (local naming) as deterrents when it appears, wrapping the hive stands with polythene bag, hunting and killing ant queens
Spider	Argiope aurantia	use of leaves of eucalyptus & aje (local naming) as deterrents when it appears, wrapping the hive stands with polythene bag, hunting and killing ant queens
Hive beetle	(*Aethina tumida)*	Clean apiary, narrowing the hive entrance, hand picking and kill, cover opening of hive, Clean apiary, narrowing the hive entrance, hand picking and kill
Wax moth	(*Gallera mellonela*)	Clean apiary, remove old comb, and strengthen the colony, fumigation with cotton cloth and sorghum bran, rubbing with recommended plant materials like, Vernonia amygdalina, spraying garlic juice. Clean apiary, remove old comb, and strengthen the colony, fumigation with cotton cloth and sorghum bran, rubbing

		with recommended plant materials like, Vernonia amygdalina, spraying garlic juice
Wasp	*Polistes fuscatus*	use of leaves of eucalyptus & aje (local naming) as deterrents when it appears, wrapping the hive stands with polythene bag, hunting and killing ant queens
Ants	*Solenopsis invicta*	Applying ash under the hive stands, clean the underneath of the hives & keep their apiary neat. use of leaves of eucalyptus & aje (local naming) as deterrents when it appears, wrapping the hive stands with polytine bag, hunting and killing ant queens, for ants destroying the ant nest and killing the queen of ant, putting ash around hive stand, tying "Teff" straw on the hive stands and using of another small ant
Scorpion	*Hadrurus arizonensis*	Hand pick and kill, Clean apiary, fumigate with Olea Africana and cigarette and sorghum bran and make the colony strong.

Table 7: Responses on Coping Strategies (vertebrate) on Bee Health Stressors by Beekeepers

Vertebrate Pests and Predators		
Pests & predators	Scientific names	Methods of Control
Squirrel	*Marmota marmot*	Clean apiary, use spin around and kill
Gecko	*Hemidactylus frenatus*	Clean apiary, use spin around and kill
Bear	*Ursid ursus*	barriers putting like thorny woods around the tree; fixing smooth iron sheet on trunks of a tree where hives are hanged, hanging hives on ficus trees which has very smooth bark which is not suitable for honey badgers to climb, fastening corrugated iron on the bark of the trees containing honey bee colonies
Mice	*Mus musculus*	Clean apiary, use spin around and kill
Toads	*Bufo bufo*	
Lizard	*Agama agama*	Clean apiary, use spin around and kill
Birds	(*Merops orientalis)*	Putting cloth, festa and spin around the hive and, killing using stones etc.

Results showed that in study area, the postulated explanatory variables in equation 1 explained about 61% in the variations of socio-economic factors that influenced the honey bee stressors and F-value was statistically significant at 1% probability level. The coefficients of number of hives (0.295) stocked in bee farming and beekeeping experience (0.503) were positive and significant at 1% while the coefficients of training received (-0.202) and amount invested in beekeeping (-0.094) were negative and statistically significant at 5% and 1% respectively.

Table 8**:** Socio-economic factors that influenced the honey bee stressors

Variables	Coefficient (β)	SE	t-ratio	Sig. level
Constant	-0.045	0.024	-1.85	*
Age	0.008	0.010	0.79	ns
No. of hives	0.295	0.113	2.62	***
Beekeeping experience	0.503	0.152	3.30	***
Training received in beekeeping	-0.202	0.101	-2.01	**
Amount invested in beekeeping	-0.094	0.053	-1.76	*
Occupation	0.0192	0.019	1.04	ns
R^{-2}	0.609			
F-test	16.06			***

Source: Field survey, 2014; SE denote Standard Error; *, ** and *** indicates significance at 10%, 5% & 1% probability level respectively; ns denote not significant

DISCUSSION

The result of the socioeconomic status showed that beekeepers in institutional and organizational apiarists are young, well-educated and received beekeeping training compared to individual beekeepers. All things been equal, labour productivity is a function of age. It is believed that old people tends to adhere strictly to traditional methods of production while young people tends to be more willing to adopt new production methods in order to increase bee output (Oladimeji *et al*., 2014, 2016). The majority of pooled respondent were males reflecting their dominance in the beekeeping enterprise in line with findings of Oladimeji *et al*. (2017b). It is also possible that men are more involved in individual beekeeping because honey hunting which has been practiced by humans over centuries was predominantly a male activity because it involved tree climbing which is not culturally suitable for most women in

Africa (Kalanzi *et al*., 2015). The level of formal education attained by bee farm managers in institutional and organizational apiaries were high whereas individual beekeepers had low education. This shows that individual beekeeping enterprise in the study area is mainly undertaken by the less educated. Oladimeji *et al*. (2017b) opined that higher education and training expose bee farmers to extension service, technology driven information and training, improved management practices with attendance improvement in bee production, productivity and higher honey output per hive.

The result of the present study also revealed the existence of arthropods and vertebrate pests and predators in addition to other factors such as bad management practices occasioned by inexperience handling of the various hive types Kenya Top Bar (KTB), Tanzania Top Bar (TTB) and Langstroth (LANG) hive, hardship effect of climate change, incessant use of hazardous pesticides in farms around apiaries and effect of some human activities as a major stress factors causing pollinators decline and its consequences. The bee farmers responses and sample collections showed that termites *(Macrotermes bellicosus)*, spiders (*Argiope aurantia*), hive beetles (*Aethina tumida*), wax moth *(Galleria mellonella)*; squirrels (*Marmota marmota*), geckos (*Hemidactylus frenatus*), bear (*Ursid ursus*), lizards (*Agama agama*) and birds (*Merops orientalis)* were the most destructive pests and predators at the various apiaries in the study area. These results were similar to those of (Solomon, 2009, Lawal and Banjo, 2010 and Haylegebriel, 2014) who reported similar pest infestation in bee farms in their studies.

Varied species of ants, wasps and hornets were collected and identified in the course of the present study and these included the fire ants (*Solenopsis spp.*), the black ant (*Monomorium indicum*) and weaver ant (*Oecophylla smaragdina*), and the *Formica spp* and wasps and hornets that have been reported as major predators and attacks apiaries often causing colonies to forced swarming and absconded. Geckos (*Gecko gecko*), toads (*Bufo melanostictus, Kaloula pulchra)* and frogs (*Rana limnocharis* and *Rana tigrina*) and other lizards and birds (*Merops apiaster*, *Merops orientalis*), swifts (*Cypselus spp.*, *Apus spp*.), drongos (*Dicurus spp*.), shrikes (*Lanius spp*.), woodpeckers (*Picus spp*.) and honey guides (*Indicator indicator*) prey upon honey bees in both the individual, institutional and organizational/commercial apiaries across the LGAs at Kwara State, North-Central ecozones of Nigeria.

It is an established fact that honey bee population declines due to many of the factors identified by this and other previous works. This is in line with Klein *et al*. (2017) which affirmed that bee populations are in decline due to factors that include pathogens and parasites, human-induced stressors such as pesticides, and other forms of environmental degradation. This has a profound negative effect on personal/individualized, institutional/training and research and organizational or commercial bee farms and beekeepers, effective crop pollination and the food processing industry and the general consumers of hive and other agricultural products.

The result of socio-economic factors that influence the honey bee stressors in multiple regression analysis shows that the coefficient of number of hives variable included in the factors affecting honey bee stressors carried positive signs which imply that the more the number of hives, the tendency the farm is prone to stressors especially where the management is poor. However, the variable beekeeping experience was positive and this supports the hypothesized that inexperience beekeepers are likely to be exposing to be stressors compared to experience beekeepers. On the other hand, training and/or education attained by beekeepers, and amount invested have negative coefficients which indicated that an increase in these variables would decrease bee stressors.

Conclusion and Recommendations

To address the interconnected factors contributing to honey bee population decline a multifaceted approach both at local, state, and national and regional levels is required and suggested. These include effective colony sanitation, improved human bee management to increase colony strength, provision of adequate melliferous plant that provide bee nutrients all year round, improved human /bee activity including honey theft and bush burning, avoid undue exposure of bees to pesticides and adopting specific control measures for respective pests and predators.

Other strategies that farmers, beekeepers, and the general public can employ to reduce the prevalence and intensity of stressors on honey bees and a reduction in the incidence of hive mortality are: Planting or allowing growth of native vegetation, including cropland margins, that provides a diverse range of food sources for honey bees, adopting more diversified planting scheme, reduce to the minimum the application of pesticides, particularly systemic insecticides, and or apply to crops long before flowering occurs and integrate beekeeping into a favorable part of agricultural practices.

It is recommended that training in bee farming and increase investment should be promoted among beekeepers to enable them imbibe improve techniques and acquired materials inputs that will translate into reasonable quantity and quality honey bee products.

REFERENCES

Adeogun, O., Alimi, T. & Adeyemo, R. (2014). Comparative Analysis of Profitability and Technical Efficiency of Fish Farming using Different Rearing Techniques in Nigeria. *Asian Journalof Agricultural Extension, Economics & Sociology, 3*(5): 405-418.

Ajao, A. M. (2012). Comparative Studies on Ecology and Morphometrics of Reared and Feral Honeybees in Geological ones of Kwara State, Nigeria. Phd Thesis. Federal University of Agriculture, Abeokuta.

Ajao , A. M., Oladimeji, Y. U., Babatunde, S. K. and Obembe, A. (2014). Differential Morphometric Patterns of Apis Mellifera and Adaptation to Climatic Variations in Kwara State, Nigeria. *Global Journal of Bioscience and Biotechnology*, 3(1): 34-40.

Ajao, A. M. and Oladimeji, Y. U. (2017). Farmers' Knowledge, Attitude and Perception of Bee Pollination of Watermelon and Soybean in North-Central, Nigeria. *Journal of Advances in Biology & Biotechnology*, 12(1): 1-9.

Charlieveurel, C. (2017). Honey bee stressors. Retrieved from https://www.usda.gov/nass/PUBS. Retrieved 19/02/2018.

Gallai, N., Salles, J-M., Settele, J. and Vaissière, B. E. (2009). Economic Valuation of the Vulnerability of World Agriculture Confronted with Pollinator Decline. *Ecological Economics*, 68: 810-821.

Goodman, L. A. (1961). Snowball Sampling. *Annals of Mathematical Statistics,* 32: 148–170.

Haylegebriel, T. (2014). Honey Bee Diseases, Pest and their Economic Importance in Ethiopia. *International Journal of Innovation & Scientific Research,* 10(2): 527-535.

Kalanzi, K., Nansereko, S., Buyinza, J., Kiwuso, P., Turinayo, Y., Mwanja, C., Niyibizi, G., Ongerep, S., Sekatuba,J. and Denis Mujuni, D. (2015). Socio-economic Analysis of Beekeeping Enterprise in Communities Adjacent to Kalinzu Forest, Western Uganda. *International Journal of Research on Land-use Sustainability,* (2): 81-90.

Klein, A. M., Vaissiere, B. E., Cane, J. H., Steffan- De- wenter, I., Cunningham, S. A., Kremen C. and Tscha- rntke, T. (2007). Importance of Pollinators in Changing Landscapes for World Crops. *Proceedings of Royal society of London,* 274: 303-313.

Klein, S., Cabirol, A., Devaud, J., Barron, A. B. and Lihoreau, M. (2017). Why Bees are so Vulnerable to Environmental Stressors, Trends in Ecology and Evolution?. Tree 2201,11Pp.

Lawal, O. A and Banjo, A. D. (2010). Appraising the Knowledge and Perception of Pests Problems in Beekeeping Business at Different Ecological Zones in South Western Nigeria. *World Journal of Zoology,* 5(2): 137-142.

Michael. S., Hongmei, L., Ming H. H., Micheline, K. S., Olav, R. and David R. T. (2016). Migratory Management and Environmental Conditions affecting Lifespan and Oxidative Stress in Honey Bees. Scientific Reports.

Morse, R. A. and Calderone, N. W. (2000). The Value of Honeybees as Pollinator of U.S Crops. *Bee Culture,* 20: 1-15.

Naïla E., Jean-Marc, D. and Andrew B. B. (2012). General Stress Responses in the Honey Bee. *Insects,* (3): 1271-1298.

Oladimeji, Y. U., Abdulsalam, Z., Damisa, M. A. and Omokore, D. F. (2014). Estimating the Determinants of Poverty among Artisanal Fishing Households in Edu and Moro Local Government Areas of Kwara State, Nigeria. *Agriculture & Biology Journal of North America,* 4(4): 422.429.

Oladimeji, Y. U., Ajao, A. M., Abdulrahman, S., Suleiman, R. and Bolaji, A. M. (2016). Estimation of Efficiency Differentials in Honey Bee Enterprises: Implications for Higher Productivity in Kebbi and Kwara States of Nigeria. *Gashua Journal of Irrigation and Desertification Studies,* 2(2): 38-49.

Oladimeji1, Y. U., Ajao, A. M. and Abdulsalam, Z. (2017a). Arable Crop Farming and Adoption of Bee Pollination Services among Farming Households in Kwara State, Nigeria. *Asian Journal of Agricultural Extension, Economics & Sociology,* 15(2): 1-10.

Oladimeji, Y.U., Ajao, A. M.,Abdullahi, A. N. , Abdulsalam, Z. and Damisa, M. A. (2017b). Adoption of Improved Technologies and Management Practices among Bee Farmers in North Central and North Western Nigeria towards Sustainable Development Goals. *Ethiopia Journal of Applied Science and Technology,* 8 (1): 1-13

Salganik, M. J. and Heckathorn, D. D. (2014). Sampling and Estimation in Hidden Populations Using Respondent-Driven Sampling. *Sociological Methodology,* 34 (1): 193–239.

Solomon, B. (2009). Indigenous Knowledge and its Relevance for Sustainable Beekeeping Development: A Case Study in the Highlands of Southeast Ethiopia. *Livestock Research for Rural Development,* 22(11): 11-18.