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Research Paper

Assessment of the impact of climate change on honey and propolis production in Nigeria

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ABSTRACT

Global warming is the rising average temperature of Earth's atmosphere and oceans. It was observed that the Earth's average surface temperature has increased by about 0.8 °C, with about two thirds of the increase occurring since 1980. Warming of the climate system is unequivocal, and scientists are more than 90% certain that most of it is caused by increasing concentrations of Greenhouse gases produced by human activities. Honey is the most important primary product of beekeeping, both from quantitative and economic points of view. The history of honey usage parallels that of man and in virtually every culture evidence can be found of its use as a food source and as a symbol employed in religious, magical and therapeutic situations. Increase in honey production can be linked to better climatic conditions. The need to ascertain the impacts of Climate Change on honey production informed this study. Findings from this study that was conducted at the University of Abuja Science and Technology Post Basic Project STEP B (World Bank Assisted) Apiary showed an elongated raining season up to October in 2010 and 2011 beekeeping seasons. The resultant effect of this was the reduction in the volume of honey harvested from the respective hives with a short fall of about 3 L of honey per hive between the harvest of 2010 and 2011 beekeeping seasons. This in turn decreased the return on investment from sales of harvested honey in the region.

Key words: Global warming, honey, beekeeping season, harvest, raining season.

INTRODUCTION

Global warming otherwise known as Climate Change is the rising average temperature of Earth's atmosphere and oceans since the late 19th century and its projected continuation. In the early 20th century, Earth's average surface temperature has increased by about 0.8°C (1.4°F), with about two thirds of the increase occurring since 1980. Warming of the climate system is unequivocal and scientists are more than 90% certain that most of it is caused by increasing concentrations of Greenhouse gases produced by human activities such as deforestation and the burning of fossil fuels (Andrew and Hughes, 2005).

Modern beekeeping adopts the principles of having box-like enclosure with removable top or frames. These framed hives proffered advantages which include efficient honey harvest and low manufacturing cost. The bees are encouraged to construct their combs from the underside of a series of top bars, thus allowing for individual inspection of combs by the beekeepers. The Langstroth hives or otherwise known as movable frame hive is one of the types of hive designed for rearing honey bees for economic benefit. This type of hive is the most widely used hive in the World (Ojeleye, 1999). Also, another notable hives for keeping bees in Africa is the Kenyan top bar hive. It has comparative advantages over Langstroth hive in small scale beekeeping in terms of low cost of procurement; as a variety of cheap local materials could be used for its construction (Oyerinde and Ande, 2006) and as well eliminates the need for expensive and not readily available hive accessories like honey extractor, queen excluder, foundation sheet and wires for strengthening frames.

Good honey production begins with the choice of a right apiary site with enormous resources in terms of pollen and nectar within 1 km radius, coupled with stable and favourable environmental conditions (Segeren, 1997; Olagunju, 2000). Consequently, a viable apiary site must have abundant trees that can serve as carbon sink and also provides adequate shade for the hive thus protecting the bee from the hot sun peculiar to the tropical countries (Segeren, 1997) coupled with availability of flowering plants, especially those that flower all year round (Segeren, 1997) as well as closeness of apiary to adequate source of water or the apiarist should provide clean water in the apiary as an alternative (Ojeleye, 1999). The other factors required for an apiary site can be associated with climatic and edaphic factors which include: rainfall, temperature relative humidity, access road, good topography, off windy plain, non water logged area and unpolluted environment (Segeren, 1997; Ojeleye, 1999; Olagunju, 2000). Bee colony activities vary with seasons and localities. In Nigeria, the record of the impact of Climate Change on bee activity remains elusive and thus this study was conducted to evaluate the influence of Climate Change on honey and propolis production in the country.

MATERIALS AND METHODS

Study site

The study was carried out at the University of Abuja STEP B Apiary sited in the Nigeria Federal Capital Territory (FCT, Abuja). The bee farm is located on Longitude 9.2° 9.6'N and Latitude 6.8° 7.2'E lie in the Southern Guinea Savannah Agro ecological zone with about 1500 mm of annual rainfall distributed within seven to eight months, that is March/April to October/November (Agboola, 1979).

Honey production (kg)

Weights of honey harvested from twenty randomly selected hives (that is, ten Langstroth hives and ten Kenyan top bar hives) were taking after extraction from the honey combs fortnightly. This culminated into the mean monthly honey production of each hive in the respective months of studies of 2010 and 2011 beekeeping seasons.

Income ₦

The returns from sales of the harvested honey for the two seasons were calculated based on sales price of ₦1000/kg.

Propolis feel

This was achieved by extracting and hand feeling the propolis. It was reported on a scale of hydration and elasticity to reflect level of stickiness in three broad categories, namely: Dry/Inelastic (D/e), Hydrated/Elastic (d/E) and <Hydrated/<elastic (d/e).

Rainfall index

The rainfall index was calculated by subjecting the data to filtering to eliminate seasonal variations using the low-pass Hanning order 2 non-recursive filters. This filter is made by means of equations for estimating each term of the series as follows:

$$X_{(t)} = 0{,}06X_{(t-2)} + 0{,}25X_{(t-1)} + 0{,}38X_{(t)} + 0{,}25X_{(t+1)} + 0{,}06X_{(t+2)}$$
$$Pour\ 3 \leq t \leq (n-2)$$

Where $X_{(t)}$ is the weighted total rainfall of the term, t, $X_{(t-2)}$ et $X_{(t-1)}$ are observed rainfall totals of two terms immediately preceding the term, t, and $X_{(t+1)}$ and $X_{(t+2)}$ are observed rainfall totals of two terms following the term t.

Rainfall totals weighted first two $[X_{(1)}, X_{(2)}]$ and the last two terms $[X_{(n-1)}, X_{(n)}]$ of the series are calculated through the following expressions (n being the size of the series):

$$X_{(1)} = 0{,}54X_{(1)} + 0{,}46X_{(2)}$$

$$X_{(2)} = 0{,}25X_{(1)} + 0{,}50X_{(2)} + 0{,}25X_{(3)}$$

$$X_{(n-1)} = 0{,}25X_{(n-2)} + 0{,}50X_{(n-1)} + 0{,}25X_{(n)}$$

$$X_{(n)} = 0{,}54X_{(n)} + 0{,}46X_{(n-1)}$$

To determine the wet or dry character of one year, the Standardized Precipitation Index (SPI) was calculated as defined by Ali and Lebel (2008).

$$SPI = \frac{P_R^i - \bar{P}_R}{\sigma_R} \qquad (1)$$

Where P_R^i is the regional rainfall of year i, $\bar{P}_R$ is the interannual regional rainfall average and σ_R is the standard deviation of $\bar{P}_R$. Regional refers here to an area value computed over the whole study area.

Table 1. Variations in honey production of bee hives sited in the University of Abuja Apiary.

Months	Hive type							
	Kenyan Top Bar Hive				Langstroth Hives			
	2010		2011		2010		2011	
	Mean Qty. of Honey (kg)	Income ₦	Mean Qty. of Honey (kg)	Income ₦	Mean Qty. of Honey (kg)	Income ₦	Mean Qty. of Honey (kg)	Income ₦
November	8	8000:00	5	5000:00	9	9000:00	7	7000:00
December	10	10000:00	7	7000:00	11	11000:00	8	8000:00
January	10	10000:00	8	8000:00	13	13000:00	10	10000:00
February	11	11000:00	8	8000:00	13	13000:00	11	11000:00
March	13	13000:00	10	10000:00	16	16000:00	12	12000:00
April	15	15000:00	12	12000:00	19	19000:00	16	16000:00
May	13	13000:00	10	10000:00	13	13000:00	12	12000:00
June	8	8000:00	6	6000:00	9	9000:00	7	7000:00
July	5	5000:00	5	5000:00	9	9000:00	6	6000:00
August	5	5000:00	4	4000:00	5	5000:00	4	4000:00
September	6	6000:00	5	5000:00	5	5000:00	4	4000:00
October	7	7000:00	5	5000:00	6	6000:00	5	5000:00

Income calculated @ ₦1, 000/kg

Data analysis

The respective values were pooled and their means calculated to reflect monthly values per hive in the two seasons. The monthly means were compared using the student t test at 0.05 level of significance, while the rainfall index was expressed with the Standardized Precipitation Index plot.

RESULTS

The mean monthly honey production per hive in 2010 beekeeping season ranged between 5 and 15 kg in the Kenyan top bar hives while that of the Langstroth hives were between 5 and 19 kg respectively. The seeming difference in terms of honey yield from the two types of hives were however not significantly different ($P<0.05$) (Table 1). Of note is the fact that the least honey harvest was observed between July and August in the Kenyan top bar hive, while the smallest quantity of honey harvested in Langstroth hive occurred in the months of August and September. Observably at these periods, the general average recorded was 5 kg of honey while subsequent increase at an average rate of between 1-2 kg of honey were recorded over the following eight months; thus bringing the honey harvest to its peak (15 and 19 kg) in the month of April in both the Kenyan top bar and Langstroth hives respectively (Table 1).

On the other hand, the mean monthly honey production of hive in the 2011 beekeeping season was different from the yield obtained in the previous season. Honey yield obtained in this season for the respective months were lower (with almost 3 kg) than the yield of honey recovered in the 2010 season in the two types of hive. Honey harvested in the Kenyan top bar hives ranged between 4 and 12 kg while the Langstroth hive recorded yield of between 4 and 16 kg respectively. The variation in the quantity of honey obtained from the two types of hives were however not significantly different ($P<0.05$) (Table 1) but, the least yield of 4 kg were obtained in the month of August in the Kenyan top bar hive and as well in the months of August and September in the Langstroth hives. Also, a similar increase in yield was as experienced in the previous season with the production picking up with an average increase of between 1-2 kg from September to April in both types of hive. However, the peak honey yield of 12 and 16 kg was attained in the month of April in both Kenyan top bar and Langstroth hives respectively.

The return from investment in terms of sales of honey were significantly comparable to the honey harvested (Table 1). The income from sales of honey were between ₦ 5, 000 and ₦15, 000 for the harvest from Kenyan top bar hive as well as between ₦5, 000 and ₦19, 000 in the Langstroth hives in the 2010 beekeeping season while the returns obtained from marketing of harvested honey in the 2011 beekeeping season fell short of what was realized in the 2010 season. The money obtained from sales of the produce ranged between ₦4, 000 and ₦12, 000 in the Kenyan top bar harvest to between ₦4, 000 and ₦16, 000 in the Langstroth hives respectively. The seemingly difference in income in the two seasons were not significantly different ($P<0.05$) but, the highest income was realized in the month of April in each year for the two type of hives.

Table 2 shows the monthly trend of moisture and elasticity level of the propolis in the two years of studies.

Table 2. Differences in quality of propolis harvested from bee hives in 2010 and 2011 beekeeping seasons.

Months	Year	
	2010	2011
November	D/e	D/e
December	D/e	D/e
January	D/e	D/e
February	d/E	D/e
March	d/E	d/E
April	d/E	d/E
May	d/E	d/e
June	d/e	d/e
July	d/e	D/e
August	D/e	D/e
September	D/e	D/e
October	D/e	D/e

Dry/Inelastic (D/e) Hydrated/Elastic (d/E) <Hydrated/<elastic (d/e).

The propolis was observed to be dryer and less elastic between the months of August and January 2010, more hydrated and elastic therefore stickier between February and May 2010 and subsequently lose its elasticity and hydration drastically from June 2010 while on contrary, the quality of propolis was dry-inelastic for more months in the 2011 beekeeping season as the result obtained this year showed dryer and inelastic propolis occurred between the months of July and January 2011 and more sticky (that is, hydrated-elastic) between March and April 2011 and subsequently drop in quality as from May 2011.

The climate changing in this region of Nigeria was characterized by two major breaks of rainfall, which occurred in 1988 and 2007 (Figure 1). These two failures have resulted in a deficit of around 20% rainfall respectively and an excess of about 15%. The hydrological response to the deficit was the resultant excess rainfall of relatively close to 100% in the following year. This was observed with the drastic rise in the rainfall index of the two studied beekeeping seasons (that is, 2010 and 2011).

DISCUSSION

Maximization of production of honey by honeybees can be influenced by a host of factors such as agro-ecological zone coupled with ideal environmental conditions. The beekeeping season portrays a higher quantity of pollen as well as nectar availability in Nigeria between the months of September and May each year. Fasasi and Malaka (2005) earlier identified between November and May as the nectar flow season in Nigeria. The progressive increase in the quantity of honey harvested from the respective hives in this study conforms to the earlier findings on the availability of nectar for honey production within this period in the country (Ojeleye, 1999; Fasasi and Malaka, 2005). The peak period of honey production in this study revealed April as the month with bumper harvest in the two seasons irrespective of the type of hives engaged. This is in line with earlier report suggesting harvesting period of between March and April in the Southern Guinea Savannah Vegetation of Nigeria (Malaka and Fasasi, 2004). The honey flow season in Nigeria based on this study can be suggested as being once in a year. This finding contradicts the prediction of two honey flow periods in a year in sister African country Angola (Emery, 2006).

In addition, the progressive reduction in the volume of honey produced after April indicated the utilization of the honey due to reduction in the quantity of available nectars and pollen based on increased intensity of rainfall within this period coupled with the advent of long raining period that can be linked to Climate Change. This is in line with the record of excess rainfall as a result of Climate Change within this period as reported for West Africa basin (Dao et al., 2010). Moreover, the income obtained from sales of honey harvested from the two types of hive portrays the Langstroth hive as the best in terms of honey production in the two beekeeping seasons. This affirms the earlier report on the preference for adoption of Langstroth hives compared with the adoption of the Kenyan top bar hives in modern beekeeping practice in the World (Hussein, 2000).

Also, the steadily increased elasticity of propolis texture during the periods of increased volume of honey harvest in the two types of hive showed the possibility of synchronizing the harvesting of both the honey and propolis between February and May each year. This can be linked to increased availability of resources (that is, pollen and nectar) within this period (Fasasi and Malaka, 2005).

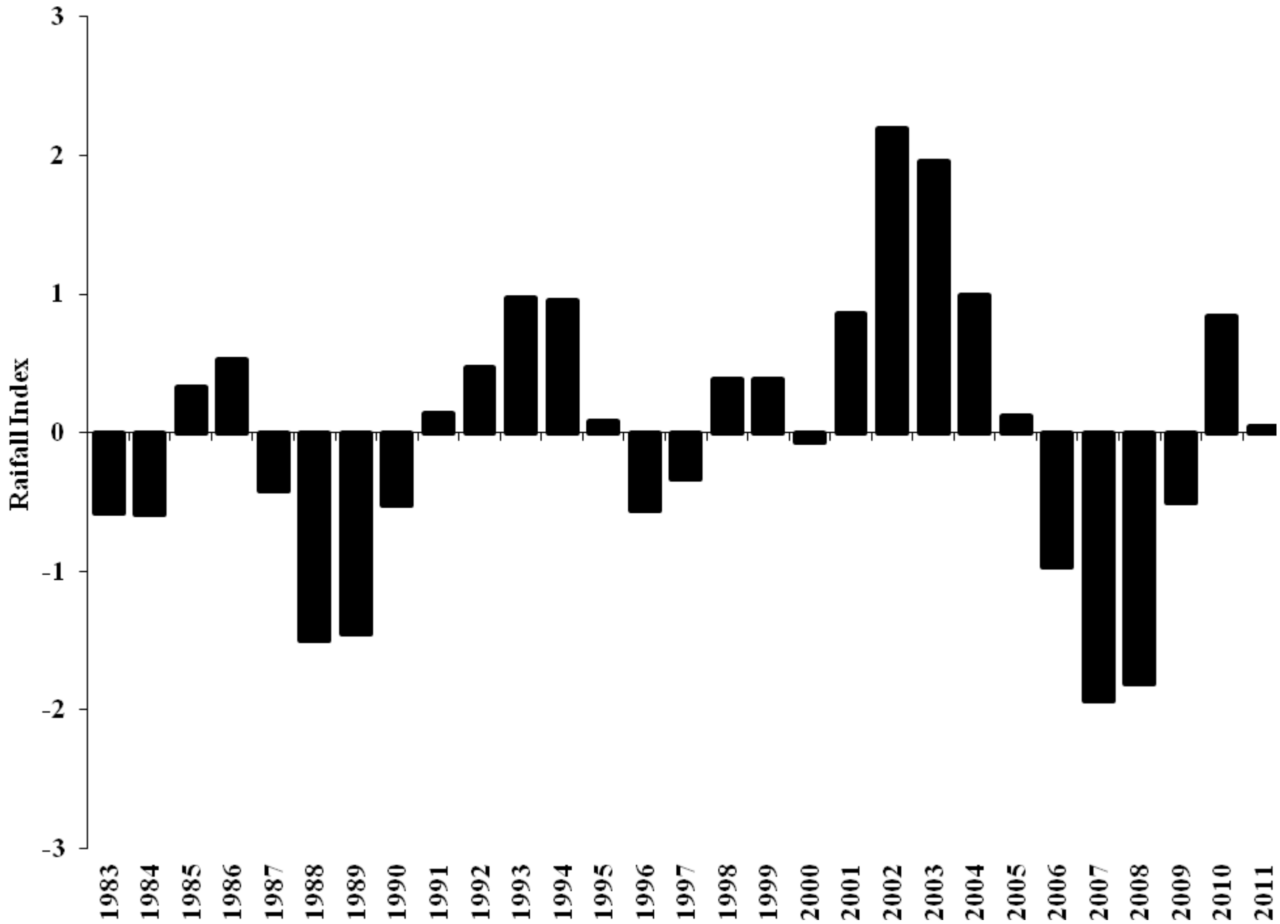

Figure 1. Standardized Precipitation Index of Abuja Nigeria from 1983 to 2011.

Thus the adoption of harvesting honey and propolis within this period will in turn lead to maximizing the potential of the respective colonies in terms of return from sales of honey and propolis and also curtail the utilization of honey by the bees due to the advent of scarcity period (that is, from June to October) as well as propolis losing its elasticity and hydration (Kaal, 1990). Propolis in this study was most elastic and gummy between February and May in 2010 as well as March and April in 2011. The ripening of propolis in 2010 is in line with Fasasi and Malaka (2005) prediction that propolis harvesting can be done in the zone between February and May. In addition, the harvested propolis was dryer and inelastic for six months in 2010 and eight months in 2011. This portrayed reduction in the quality and quantity of propolis harvested in 2011 compared to 2010. These findings can be as a result of excessive rainfall, which lead to prolonged raining season (that is, scarcity period for the honey bee activity) that occurred within the period of study and confirms the earlier suggestion on the impact of Climate Change induced rainfall on yield of agricultural products (Dao, 2010).

Conclusion

The established adverse effects of Climate Change based on the resultant reduction in returns accrued from sales of honey and propolis in Abuja calls for the need to find ways of ameliorating its effects on agric/agro-related products in the developing countries such as Nigeria so as to curtail further loss of hive products in the country.

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