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Crop raiding pattern of the African elephant (*Loxodonta africana*) in farms around Kamuku National Park, Nigeria

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ABSTRACT

Threats against some population of African elephant as a result of their crop raiding in farms are worrisome and call for all-inclusive conservation measures. This study examined the species and parts of crops affected by African elephant raids, reasons for crop raids and period of raids by African elephant (*Loxodonta africana*) in farms around Kamuku National Park (KNP), Nigeria. Data were collected through focus group discussion (FGD), structured questionnaire and on-site field assessment (OFA). Structured questionnaire was randomly distributed among two hundred and sixty four (264) farmers from eight villages around KNP. Based on FGD, farmlands with information regarding elephant raids were considered for OFA. Data collected were analyzed using descriptive statistics and Pearson's correlation test. It was revealed that ten cultivated crops are affected during elephant crop raid in farmlands around KNP. Of these crops, *Zea mays* L. (26.50%) was most raided followed by *Panicum miliare* (15.20%). Species of cultivated crops raided by these elephants ($r= 0.11$, $p>0.05$) were not significantly different on village basis. The plant part least (5.30%) consumed during crops raiding activities were the leaves. Parts of crop affected during raiding ($r=0.81$, $p<0.05$) vary significantly from one crop to another. Proximity of the farmlands to elephant migration route (30.30%) was perceived as the main cause of elephant raiding activities. Majority of elephant raids (53.79%) occurred during early morning. Effective use of related park conservation policy and environmental education programmes are recommended. Farmers are also advised to modify their planting strategies.

Keywords: Crop raiding, cultivated crops, African elephant, Kamuku National Park, Nigeria

INTRODUCTION

Increase in human population and the attendant anthropogenic activities around

protected areas embolden direct competition for biological resources. Consequently, unceasing interaction between man and wild

animals are created. When the composition and distribution of biological resources are altered as a result of anthropogenic activities, the livelihoods of the people causing such activities are negatively affected. According to Forthan-Quick and Demment (1988), increase in human population and expansion of agricultural land will force wild animals into modified habitat such as farmlands. It was suggested that understanding the processes driving habitat selection and or the suitability of habitat patches by wild herbivores provides insights into the processes driving population dynamics, community structure and functioning in ecosystems (Valeix *et al.*, 2011). Large herbivores are important components of terrestrial biomes and greatly contribute to ecosystem functioning. Damage to crops especially around protected area vicinities is a serious problem that can potentially undermine conservation effort (Bayani *et al.* 2016). Crop raiding is the most common form of human-elephant conflict (Hoare, 2011). Crop raiding was reported as partial or complete loss of crops due to consumption, trampling and dung deposition (Kagwa, 2011). In Western Uganda for example, crop raiding by wild animals has been identified as a key form of human-wildlife conflict and the most perceived disadvantage of farming close to protected areas (Archabald and Naughton-Treves, 2001). Wild animal species causing damages to crops within and around some protected areas are well documented (Sam, 2000; Barnes *et al.*, 2005; Patterson, 2005; Siex, 2005; Wang *et al.*, 2006; Agetsuma, 2007; Linkie *et al.*, 2007; Fungo, 2011; Baranga *et al.*, 2012; Ogunjobi and Adeola, 2016). Farmers in Tanzania attributed the majority of crop damage to elephant (Hoffmeir-Karimi and Schulte, 2015). Elephant was mentioned causing serious problem in Bia Conservation Area in Ghana (Sam *et al.*, 2005) even as Nyhus *et al.*

(2000) informed that elephant is of significant threat as regards crop raiding in Kambas National Park, Indonesia.

It was mentioned that large herbivores such as African elephant require extensive home range to satisfy their high food demand (Sukumar, 1989). Food consumed by African elephant in the wild was reported to be of low nutrient (John and Subramanian, 1991) and in order to satisfy food demand, African elephant raid farms (Sukumar, 1989). Reducing the factors contributing to crop raiding is difficult considering human expansion and population growth (Williams *et al.*, 2018). Creation of safe corridors for wild animals in developing nations is fiscally difficult (Adams *et al.*, 2016). Nyhus *et al.* (2000) opined that the inability of the natural resources managers to quickly respond to crop raiding activities of wild animal is capable of evolving into conservation problem. Implication of crop raiding activities include threat to farmers' livelihood, food security (Mackenzie and Ahabyona, 2012), limiting children's access to education and increase in resistance towards wildlife conservation (Hill, 2015). In order to prevent the aforementioned in KNP, information concerning crop raiding activities of African elephant is important to facilitate all-inclusive conservation measures in the park and other similar areas with signs of African elephant on farmlands. This study was designed to identify species and parts of crops affected, period of raids and reasons for crop raid by African elephant. The outcomes of this study will contribute towards improving conservation of elephant in KNP and provide useful information required for sustainable livelihood of the farmers around the park and similar areas with menace of crop raiding activities by African elephant.

METHODOLOGY

Study Area

Kamuku National Park (KNP) has an estimated land area of 1,120km². The park is located in Birnin Gwari in Kaduna State, Nigeria. It is situated between latitudes 10⁰ 40¹N and 11⁰ 05¹N and longitudes 06⁰ 11¹E and 06⁰ 36¹E (Abdulkadir, 2015). KNP has two ranges (Doka and Dagara). Annual rainfall in the area is an average of 1,150mm with the rainy season occurring between May and October. Environmental temperature in the park ranges between 25⁰C and 35⁰C for most part of the year (Abdulkadir, 2015). The vegetation of the area represents one of the best remaining blocks of Sudan-Guinea Savannah vegetation in the country's protected-area system (Amusa *et al.*, 2013). Dominant flora species of the Park are *Isoberlinia doka Craib & Stapf*, *Isoberlinia tomentosa Harms*, *Detarium macrocarpum Guill.* &

Perr., *Daniellia oliveri Rolfe*, *Nauclea latifolia Sm*, *Parkia biglobosa Jacq* and *Prosopis africana Taub* while common fauna include *Hippotragus equinus*, *Redunca redunca*, *Alcelaphus buselaphus* and *Loxodonta africana* (Amusa *et al.*, 2013). Villages around KNP are Kakangi, Goron Dutse, Gwaska, Mando, Kungi, Nabango, Mashigi, Kakangi Kurgi and Dogara (Abdulkadir, 2015). Majority of the people living in these villages are farmers mainly from Gwari and Kamuku tribes.

Data Collection and Analysis

Data for this study were collected through administration of structured questionnaire, Focus group discussion (FGD) and on-farm assessment from May, 2016 to March, 2017. A set of structured questionnaire was administered to 264 farmers (Table 1) in the study area who have been farming around KNP for a minimum period of ten years.

Table 1. Selected farmers for Questionnaire distribution

Villages	No of respondent
Kakangi	50
Goron Dutse	40
Gwaska	28
Mando	22
Kungi	54
Nabango	20
Maseigi	26
Kurgi	24
Total	264

Source: Field work, 2016

FGD was used to compliment information generated through questionnaire. FGD was conducted once in eight villages around the park. The discussants in each village consisted of four male farmers' who are of a minimum of sixty years and have lived in the area for at least 40 years. Based on the outcome of FGD, four sites with persistent

African elephant crop raiding activities were purposively selected for on-site assessment (Figure 1). On-farm assessment was based on indirect evidences like feeding signs, footprints and dung piles following a standardized data collection protocol (Hoare, 1999). The locations where crop raiding activities of African elephant

occurred were mapped using Global Positioning System (Model GPS Map 76C GARMIN). Data obtained were subjected to

descriptive statistics and Pearson's correlation test.

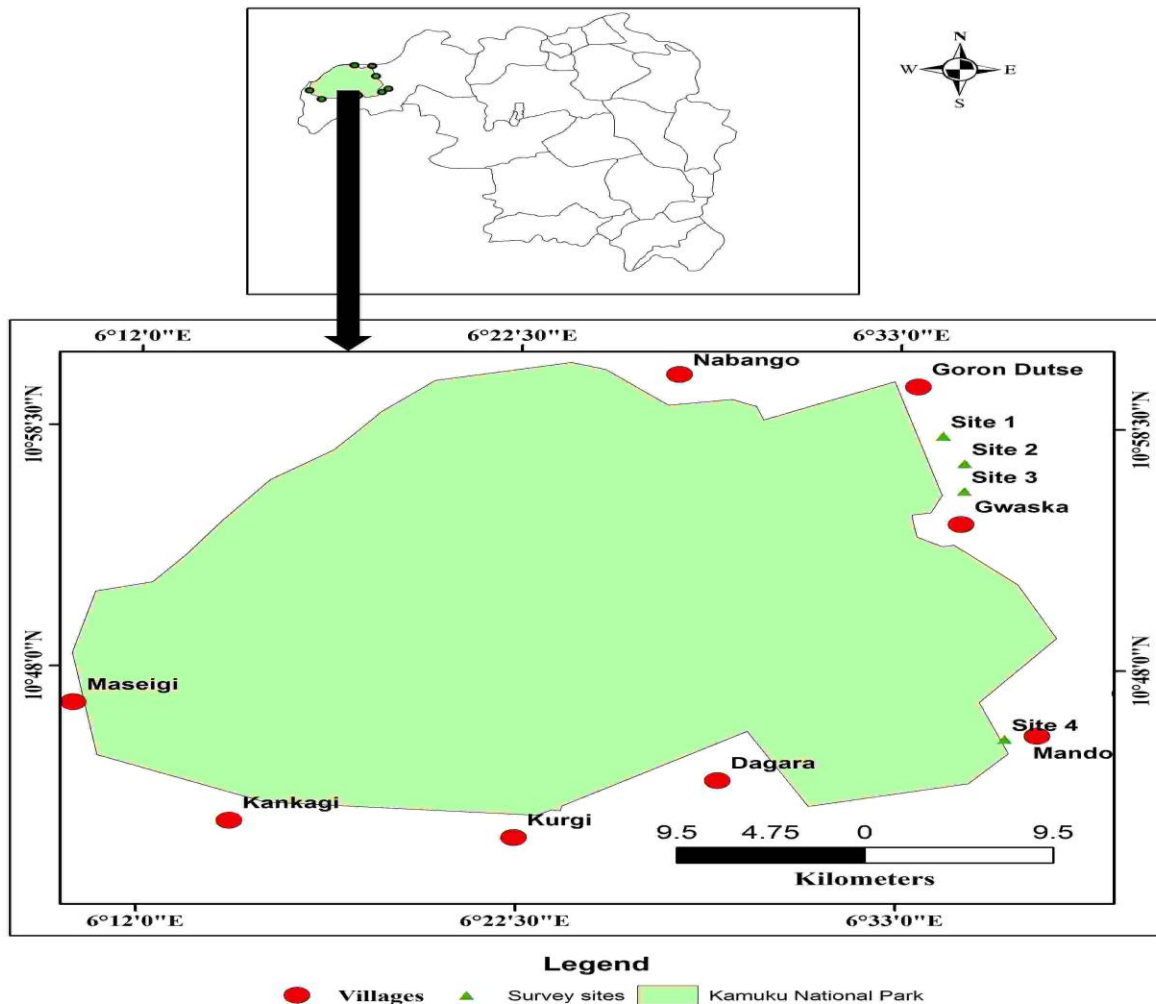


Figure 1. Map of Kamuku National Park showing the study area

RESULTS

Information gathered through FGD revealed that planting pattern of the farmers' around KNP gives more preference to the crops from poaceae family. The crops being raided by African elephant in farms around KNP followed the planting pattern of the farmers. Table 2 shows that majority of the crops raided by African elephant in the study area

were from the family of poacea and followed by crops from fabaceae family. Maize topped the list of crops raided by African elephant in the study area as indicated by respondents (Figure 2). Other crops indicated by many respondents were rice (*Oryza sativa*), millet (*Panicum miliaret*) and sugarcane (*Saccharum officinarum*) and the farmers' view was confirmed by the results obtained through

on-farm assessment (Table 3). Species of cultivated crop raided by the African elephants were not significantly ($r= 0.11$, $p>0.05$) different on village basis. Different plant parts were raided by African elephant in KNP. Assessment of plant parts raided by African elephant shows that whole plant are mostly raided (77.30%), followed by fruit (6.10%) while leaves were the least (5.30%) raided (Figure 3). Whole parts of maize, guinea corn, rice, millet and sugar cane were affected during crops raiding. However, whole plant parts or only leaves (with or without flowers) of groundnut and cowpea were respectively affected. Parts of crops affected during raids by African elephant

were significantly different ($r=0.81$, $p<0.05$) on species basis. Proximity of the farmland to the park was the major reason perceived by respondents for crop raiding (Figure 4). Other reasons mentioned by the respondents were period of elephant migration, palatability nature of the crops, timing of crop planting and succulent nature of the crops. Some of the respondents were however unable to describe the reason for crop raiding activities in the park. Majority of the incidence of crop raiding (53.79%) in the study area happened during early hours of the day followed by late in the evening (25.76%) as shown in figure 5.

Table 2. Cultivated crops raided by African elephant in communities around KNP

Common Name	Local Name	Scientific Name	Family
Maize	Masara	<i>Zea mays</i> , L.	Poaceae
Guinea corn	Dawa	<i>Sorghum bicolor</i> (L.) Moench	Poaceae
Rice	Shinkafa	<i>Oryza sativa</i> , L.	Poaceae
Millet	Gero	<i>Panicum miliare</i> , Roth ex Roem & Schult	Poaceae
Sugar cane	Rake	<i>Saccharum officinarum</i> , L.	Poaceae
Groundnut	Gyada	<i>Arachis hypogea</i> , L.	Fabaceae
Cowpea	Wake	<i>Vigna unguiculata</i> , (L.) Walp	Fabaceae
Water melon	Gunan shanu	<i>Citrullus lanatus</i> (Thunb.) Matsum. & Nakai	Cucurbitaceae
Sweet potatoes	Dankali	<i>Ipomoea batatas</i> , (L.) Lam.	Convolvulaceae
Cassava	Rogo	<i>Manihot esculenta</i> , Crantz	Euphorbiaceae

Source: Field work, 2016 - 2017

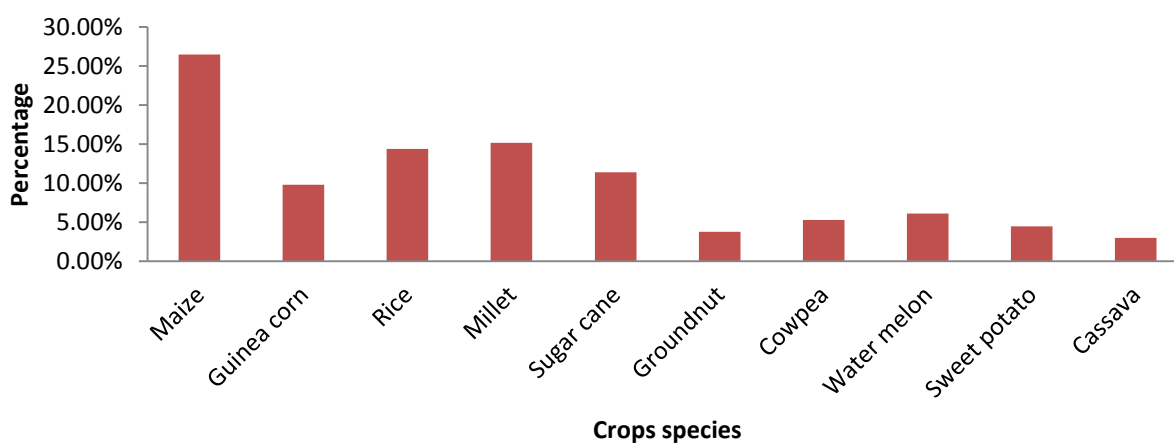


Figure 2. Perceived assessment of level of raid by African elephant on species of crops

Table 3. On-farm assessment of crops raided by African elephant in KNP

Common Name	Frequency	Percentage crop raids
Maize	50	27.03
Guinea corn	20	10.81
Rice	30	16.22
Millet	32	17.30
Sugar cane	21	11.35
Groundnut	5	2.70
Cowpea	9	4.86
Water melon	10	5.41
Sweet potatoes	6	3.24
Cassava	2	1.08
Total	185	100

Source: Field work, 2017

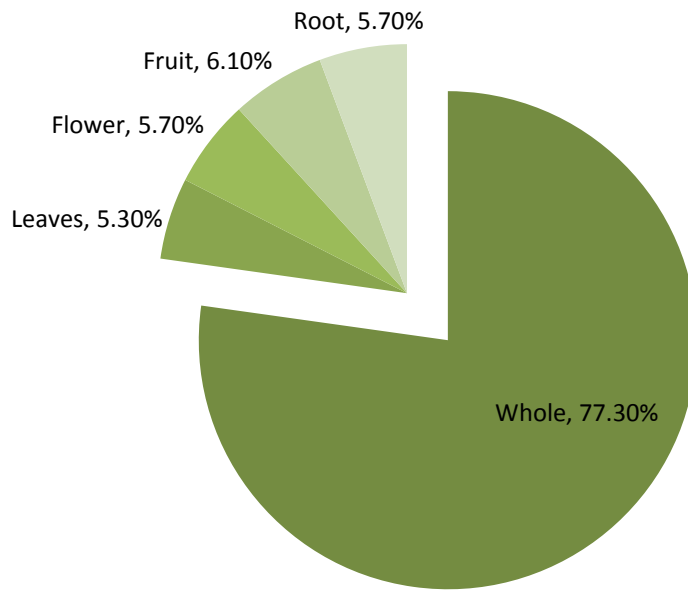


Figure 3. Percentage parts of cultivated crop raided by elephant in KNP during on-farm assessment

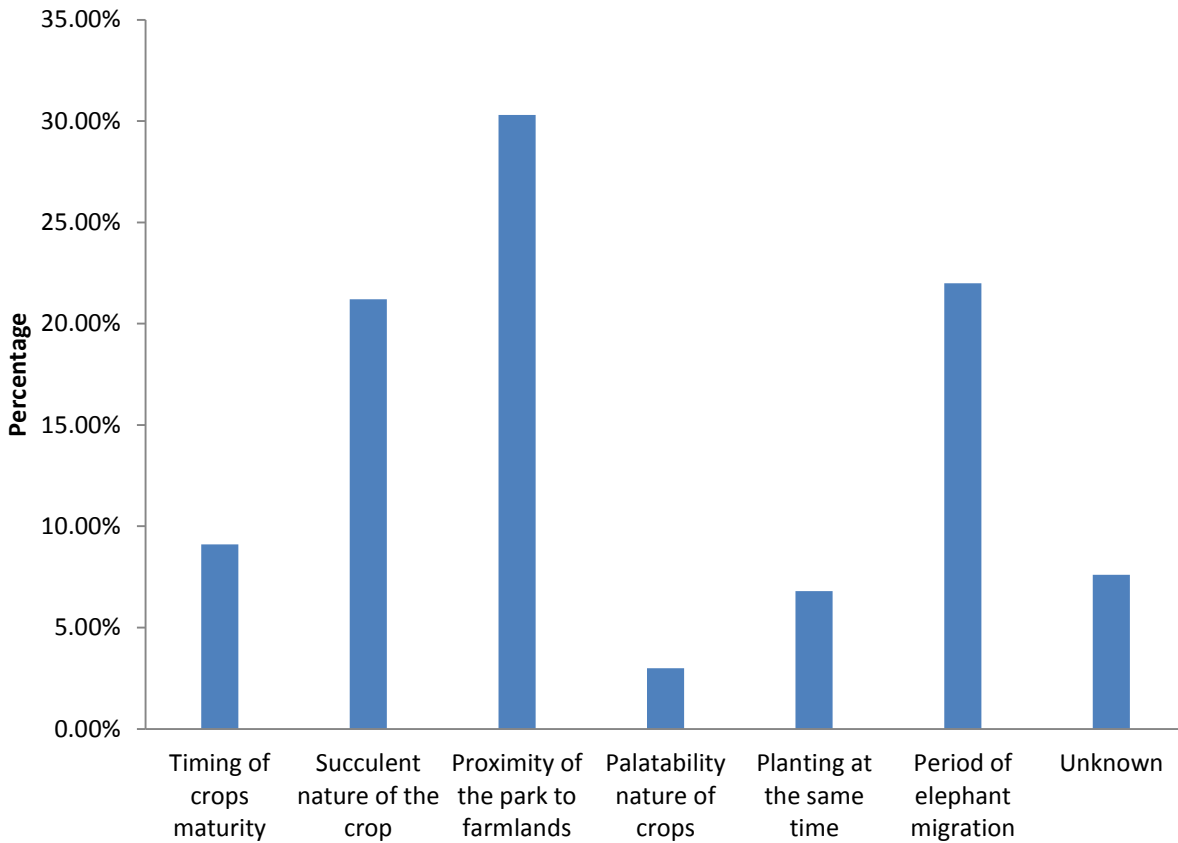


Figure 4. Percentage distribution of respondents based on reasons for crop raiding around KNP by African elephants

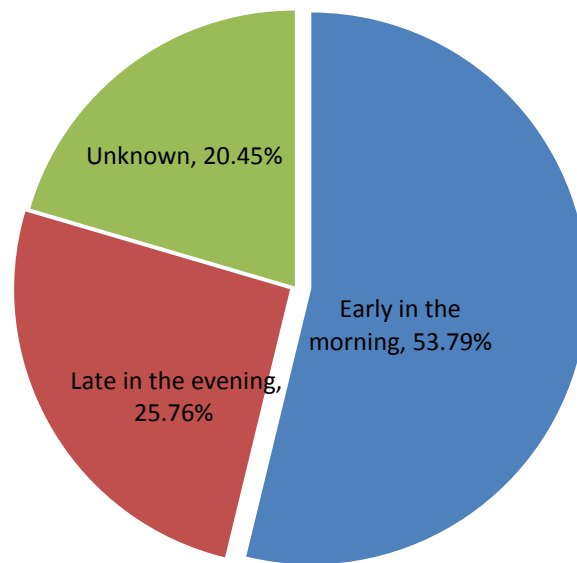


Figure 5. Period of crop raiding activities in KNP by African elephant as indicated by respondents

DISCUSSION

The knowledge on the crop raiding pattern of African elephant in communities around protected area is critical in sustainable food production capable of livelihood enhancement and conservation of endangered species. Findings of the study indicated that crop cultivation is primarily based on ecological position of KNP and the sociocultural needs of the consumers. Either for subsistence or commercial food production, rainfall pattern around KNP, market values of crops, input requirement and crop yield are paramount in crops selected for planting and the planting pattern of these farmers. The farmers solely depend on rainfall before embarking on planting. Planting pattern of most cultivated crops followed the order maize > millet > rice > sugarcane > guinea corn > water melon > cowpea > sweet potatoes > groundnut > cassava (Table 2). Some of these crops especially members of poacea family (maize, millet and rice) are important stable crops among the people living in the Guinea Savanna, Nigeria. These crops also serve as

fodder for livestock or raw material to many agro-based industries. High productivity of the crops, low input requirement and crops ability to adapt to wide range of agro-ecological zones as claimed by the farmers agree with past reports (Kehinde, 1997; Babatunde *et al.*, 2008; Jirgi *et al.*, 2010; Ogunlade *et al.*, 2010; Enyisi *et al.*, 2014). Order of planting is related to quantity of rainfall in the area. This substantiates the submission of Sokoto *et al.* (2016) that species of crops mostly cultivated in the savanna thrive well in an area with less rainfall. Observation on the planting pattern of the farmers around KNP agreed with the submission of Weinmann (2018). Maize, rice and sugarcane were listed among the major cash crops around Rajaji National Park in India (Joshi and Singh, 2008). Despite various effort put together by farmers' in improving their livelihood through faming, raiding of crops by elephant around KNP persist (Table 2; Figure 3). Crop raiding by Asian elephants was reported as a common phenomenon in adjoining areas of the Rajaji National Park

in India (Joshi and Singh, 2008). Threat posed by the activity of African elephant in KNP is of socioeconomic concern to the farmers as ten different crops species mostly cultivated were involved in elephant crop raiding activities across farms. Amusa *et al.* (2015) reported eleven cultivated plant utilized by elephant in along elephant migratory route in and around KNP. Exclusion of calabash tree (*Crescentia cujete*) in the present study justified the planting pattern of the farmers. The ten cultivated crops raided in this study are in consonance with the assertion of Santinipillai and Widodo (1993) where it was stated that elephants are unspecialized feeders. The difference in the species of crops been raided by elephant was also observed by Hoare (2011) when it was reported that crop raiding activities of elephant is a complex problem that may vary enormously from one area to the next. Sam (2000) and Fernando *et al.* (2005) highlighted similar crops raided around Bia conservation area in Ghana and in Kahalle northwest Sri-Lanka, respectively. Elephant crop raiding in the study also aligns with the reports given by Webber *et al.* (2011) and Sitienei *et al.* (2014). The abundance and conspicuous nature of crops from poacea family (maize, millet and rice) in the sampled farms as indicated through planting pattern of the farmers around KNP can attract elephant into farmland and pointing towards food preference among available crops. Raiding of the members of poacea family has also been reported by Sampath *et al.* (2011) in southeastern Sri Lanka. Plant parts either as a whole or in their parts are essential part of animal on earth. Different plant parts were consumed by animals for either nutritional purpose or medicinal value (Karuna and Vijaya, 2014). From the study, plant parts were not raided in equal proportion. Whole plant parts of the cultivated crops were

observed mostly raided while the leaves were the least raided (Figure 3). This finding disagreed with the submission of Nwambola *et al.* (2014) where it was stated that more of the plant leaves were observed in feeding preference of African elephant in Rubondo Island National Park, Tanzania. Physiological and morphological characteristics of the cultivated crops compared with woody plant species studied by Nwambola *et al.* (2014) might be responsible. Parts of the cultivated plants raided by the elephants as revealed in this study is consisted with the earlier reports (Chafota and Owen-Smith, 2012; Mohapatra *et al.*, 2013; Pradhan *et al.*, 2015; Koirala *et al.*, 2016). Different plant parts consumed in the study are connected to resources need of the elephants (Santiapillai and Widodo, 1993), palatability of cultivated crops (Sukumar, 1989), sexual foraging pattern of elephant (Chomba and Banda, 2016) and nutrient deficiencies in wild forage (Osborn, 2004; Chiyo *et al.*, 2005) reported. Elephant around KNP visited some farms in Goron Dutse, Gwaska and Mando villages were they raided crops. GIS mapping of the study sites revealed the location of the farms surveyed with respect to KNP boundary. As observed in figure 1, farms with Mando village seem too close to KNP boundary. g Shifting cultivation farmers' method of farming in the area can be blamed for gradual encroachment into the park boundary. Many factors were perceived by the farmers as the reasons for elephant crop raids in the area (Figure 4). Reasons for crop raid may be unconnected to the closeness of the farms particularly the farms to migration route of the elephant (Amusa *et al.*, 2013), locations of the farm close to park boundaries (Chiyo *et al.*, 2005; Naughton-Treves and Treves, 2005; Monney *et al.*, 2010), crop ripen period and period of crops ready for harvest (Sitienei *et al.*, 2014; King

et al., 2017). Despite several conscientious effort of the farmers' living in Mando village to sight these elephant during crop raiding activities on farmland, none of these farmers was able to do so as these elephant failed to visit on any agreed night. Observation on elephant crop raiding activities through farmers' perception and on-farm assessment solely depends on indirect indices. It was observed that these elephant often left the park at night and carried out crop raiding early in the morning (Figure 5). The period of crop raid in this study affirmed the fact that free ranging elephant exhibit nocturnal behaviour (Fernando, 1997). This finding collaborate the submission of Jackson et al. (2008) where they stated that elephant raids took place at night.

The study concludes that crop raiding pattern of the African elephant in the study area depend on crops availability and abundance on farmlands. Although different parts of the crop raided were consumed, whole part of the crops constitutes the highest proportion eaten. Location of farmlands along elephant migration route, farming closer to the park boundary and timing of crop maturity/ripen were among the perceived reasons for elephant crop raiding activities. It was established that elephant moved from their hide-out inside KNP in the night and carried out crop raiding early in the morning. In order to reduce the menace of crop raiding in KNP, livelihood of the farmers need to be enhanced in such a way that it will not jeopardize conservation of African elephant around the park. To this end, these farmers are advised to diversify in terms of crops being cultivated. Diversification into cultivation of crops such chilies, onion, peanut and ginger that are not palatable to African elephant but of good economic benefits are hereby suggested. Agronomy

knowledge of the aforementioned crops to determine their productivity in the area is however mandatory. In the same vain, the management of KNP is also advised to use relevant conservation policy and programmes. Since this study only provided result for northern Guinea Savanna ecological zone, it is essential to expand the work to other ecological zones in Nigeria where elephant crop raiding is a threat on farmlands.

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