# An update on crop-raiding by elephants at Bia Conservation Area, Ghana from 2004 to 2006

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## Abstract

The study updates the post 2004 elephant crop-raiding situation around Bia Conservation Area (BCA). This was done through an analysis of data on elephant damage from crop-raiding report forms completed for all raids occurring between 2004 and 2006 at BCA. There were 103 elephant crop damage incidents involving 95 farms belonging to 72 farmers. The southern portions of BCA were found to experience the most raids. The number of raids increased with the proximity of farms to the park boundary, types and the diversity of crops grown and size of farms. Elephants crop-raiding was targeted largely at mature crops. In light of these risks, farmers should be encouraged and supported to protect their crops especially during the peak raiding season. Farmers should also grow their food crops away from the boundary of the park or be supported to practise mono-cropping of low-risk crop species near the park to act as a buffer.

## Résumé

L'étude met à jour la situation d'invasion des cultures par les éléphants après 2004 dans la Région de Conservation de Bia (RCB). Cela a été fait par une analyse des données sur les dégâts des éléphants sur les cultures. Ces données provenaient des formulaires de rapport remplis sur l'invasion des cultures pour toutes les attaques qui se sont produites entre 2004 et 2006 à RCB. Il y avait 103 incidents de dégât des cultures par les éléphants qui affectaient 95 fermes appartenant à 72 fermiers. On a trouvé que les portions sud de RCB subissaient le plus d'attaques. Le nombre d'attaques augmentait avec la proximité des fermes de la frontière du parc, les types et la diversité des cultures et les dimensions des fermes. L'attaque des cultures par les éléphants visait en grande partie les cultures mûres. À la lumière de ces risques, les fermiers devraient être encouragés et assistés à protéger leurs cultures surtout pendant la saison de grande attaque. Les fermiers devraient aussi planter leurs cultures vivrières loin de la frontière du parc ou ils devraient être appuyés pour pratiquer la monoculture des espèces de culture à peu de risques près du parc pour servir de zone tampon.

## Introduction

Crop damage by elephants around Bia Conservation Area (BCA) is a serious problem facing the Wildlife Division (WD) of Ghana (Sam et al. 2005; Sam 2000). Surprisingly, until recently (Sam et. al. 2005) the interaction between humans and elephants at BCA had received little attention. Surely, more effort is needed to properly investigate this challenging conservation issue (Hoare and Du Toit 1999).

This study is an update of the investigation conducted by Sam et al. (2005) during the 2004 rainy season which examined the nature and extent of human/elephant conflicts in and around the BCA. Since the study, data collection on elephant crop depredation activities has continued with the help of the wildlife guards at BCA. An analysis of the accumulated data is deemed necessary to assess the current elephant crop-raiding situation at BCA and inform park authorities on appropriate crop-raiding management strategies.

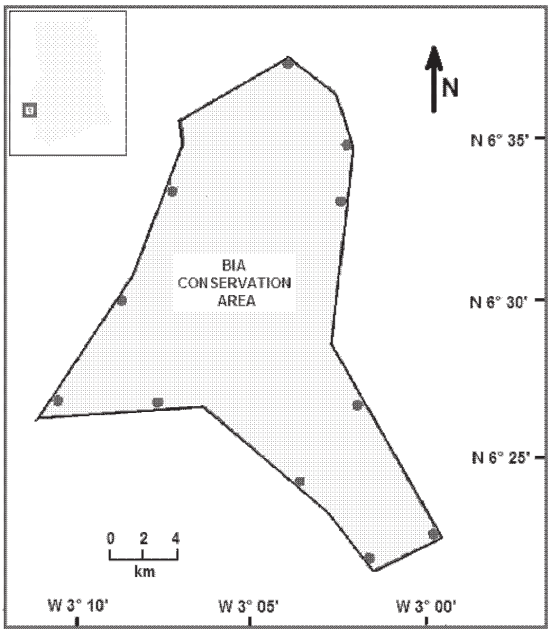


Figure 1. Bia Conservation Area (BCA) showing location of wildlife camps. The inset map shows the location of BCA in Ghana.

## Materials and Methods

### *Study Area*

The Bia Conservation Area (BCA) forms a 306 km$^2$ block in the moist evergreen and moist semi-deciduous forest zones of western Ghana. BCA lies between latitude 6º20' to 6º40'N and longitude 3º00' to 3º10'W, sandwiched between the Bia River and the border of Cote d'Ivoire (fig. 1).

The area has an annual rainfall of between 1500 mm and 1750 mm (Hall and Swaine 1976) with two peaks in June and October. Average monthly temperature in the area falls between 24ºC and 28ºC with extremes being 18ºC and 34ºC. The farming system is rain-fed, with farming activities undertaken throughout the year.

### *Methods*

Data on elephant crop depredation activities (2004 to 2006) were gathered using the standard elephant damage report form developed by the IUCN African Elephant Specialist Group (AfESG). A form was filled out each time a farm was raided by wildlife guards stationed around BCA.

Information collected on each raided farm included; date and time of the raid, types and part(s) of raided crops, stage of maturity of raided crops, frequency of raids, description of animal(s) if seen and dung and foot-print measurements. The area (in acres) of raided farms was estimated by roughly subdividing a farm into measurable shapes (squares, rectangles, triangles etc.) and summing up the calculated areas. Also, the geographical coordinates of raided farms were recorded with a global positioning system (GPS). By plotting relative positions on a map of BCA, distance of raided farms from the nearest park boundary was determined.

### *Data Analysis*

All analyses were conducted using the Statview software (SAS 1999). Regression analyses were used to investigate the relationships that exist between elephant crop-raiding incidents and factors that may influence their occurrence. Tables were used to summarize number of raids, affected crops and farms per village.

A Kruskal-Wallis one-way analysis of variance test was used to detect yearly differences in the distribution of raids.

## Results

During the period under study, 95 farms, belonging to 72 farmers (from 30 villages) experienced a total of 103 raids around BCA (table 1). Farmers whose farms border the south and south-eastern boundary of BCA had the highest number of raids.

Based on visual and track identification in 22 different occasions, at least 57 males and 43 females were found engaged in raids involving about 100 adults and 63 sub-adults and infants.

A Kruskal-Wallis one-way analysis of variance showed a distinct yearly difference in the distribution of raids ($H = 7.914$, $DF = 2$, $P < 0.05$). However, severe crop damage starts from April with a peak in June and persists until December where it attains minimal levels. At the farm level, raiding incidence was not related to any of the variables collected from raided farms hence; data were pooled and treated at the cultivated enclave (village) level. The number of raids per village was inversely influenced ($r^2 = 0.954$, $P < 0.05$) by the mean farm distance to the nearest park boundary (fig. 2).

Table 1. Crop raiding incidents and crop types destroyed in villages (n = 30) surrounding BCA from 2004 to 2006

| Villages | Mean farm distance to park (km) | Farms affected | Number of raids | Crop types | Mean cultivated area (acres) |
|---|---|---|---|---|---|
| Asiri | 5 | 1 | 1 | 1 | 0.5 |
| Yamediagoro | 0.01 | 19 | 19 | 6 | 28 |
| Kojo Donkor Camp | 3 | 4 | 4 | 4 | 2 |
| Eye Nyame krom | 3 | 2 | 2 | 2 | 1 |
| Bio krom | 3.5 | 5 | 5 | 3 | 5 |
| Akosua Aden krom | 4 | 2 | 2 | 2 | 1.1 |
| Kwasi Donkor krom | 2.1 | 2 | 8 | 5 | 7 |
| Nyamebekyere | 2.5 | 5 | 3 | 2 | 1.3 |
| Boampong krom | 4 | 2 | 2 | 2 | 0.9 |
| Aaboboya junction | 4.5 | 2 | 2 | 2 | 2 |
| Alhaji Nkwanta | 6 | 1 | 1 | 3 | 1 |
| Anwiefutu Nkwanta | 0.01 | 16 | 16 | 5 | 15 |
| Camp 4 | 5.2 | 1 | 1 | 1 | 0.6 |
| Camp 5 | 3 | 3 | 3 | 3 | 1.7 |
| Camp 8 | 5 | 1 | 1 | 3 | 0.6 |
| Kofi Kyere (Camp 10) | 3 | 5 | 5 | 4 | 3 |
| Iron Boy | 5.5 | 1 | 1 | 3 | 0.4 |
| Kofiko krom | 5 | 1 | 1 | 1 | 0.5 |
| Mofra mfa adwen | 2 | 4 | 8 | 5 | 4.3 |
| Nana anan village | 5 | 1 | 1 | 1 | 0.5 |
| New brekum | 2.5 | 5 | 5 | 4 | 3.4 |
| Awona komfo | 4 | 1 | 1 | 3 | 1 |
| Abulai krom | 4.4 | 1 | 1 | 3 | 0.4 |
| Bonsu nkwanta | 4.6 | 1 | 1 | 3 | 0.7 |
| Eye awurade naye | 3.1 | 4 | 4 | 4 | 2.4 |
| Kwakra krom | 5 | 1 | 1 | 1 | 1 |
| Gyaw camp bonsu | 5.5 | 1 | 1 | 3 | 0.3 |
| Sowodademu | 4.5 | 1 | 1 | 2 | 0.6 |
| Y B krom | 4.4 | 1 | 1 | 1 | 0.8 |
| Yehowa krom | 5.1 | 1 | 1 | 2 | 1 |

For farms that were raided, the risk of a farm suffering damage increased with the mean cultivated area ($r^2 = 0.944$, $P < 0.05$, fig. 3) and diversity of food crops on farms ($r^2 = 0.859$, $P < 0.05$, fig. 4). Thus, the larger a farm and the higher the diversity of crops that were grown on that farm, the higher was the incidence of raids. The study also showed that farms with cocoa, plantain, maize, cassava and yam were more likely to be raided than farms with cocoyam, pineapple, vegetable, banana and sugarcane (table 2).

Farming around the vicinity of BCA is seasonal, rain-fed and subsistence agriculture. Plantain was the most raided crop (23% of total frequency of all crops raided). Cocoa and cassava each comprised 22% of crops raided, followed by maize (14%) and yam (11%). Cocoyam, pineapple, vegetable, banana and sugarcane formed an insignificant proportion of crops raided. Raiding was largely targeted at crops that were mature (87% of crops raided; table 3).

Table 2: Regression coefficients ($r^2$) of the relationships between monthly number of raids per village and a suite of different raided crops cultivated around the BCA

| Variable | $R^2$ | P |
|---|---|---|
| Cocoa farms | 0.907 | < 0.01 |
| Plantain farms | 0.904 | < 0.01 |
| Maize farms | 0.899 | < 0.01 |
| Cassava farms | 0.739 | < 0.01 |
| Yam farms | 0.722 | < 0.01 |
| Cocoyam farms | 0.140 | > 0.05 NS |
| Pineapple farms | 0.049 | > 0.05 NS |
| Vegetable farms | 0.039 | > 0.05 NS |
| Banana farms | 0.001 | > 0.05 NS |
| Sugarcane farms | 0.001 | > 0.05 NS |

## Discussion

The problem of crop-raiding by elephants at BCA is increasing (Sam et al. 2005) and should be a concern to the management of the conservation area, government and all interested groups. The current study confirms an increasing trend in crop-raiding and types of raided crops around BCA since the study of Sam et al. (2005). In their study, crop-raiding activity involved 8 crop types in 18 villages, whilst approximately two years later, the scale of raids had increased to include an additional two crop types and 12 extra villages. Similar to Sam et al. (2005), family groups, comprising of adult females, males and sub-adults were involved in the crop-raiding activity. However, elephants may be strategising in their raiding behaviour to avoid anti-crop-raiding patrols at night because current trends suggest that sometimes, elephant raids occurred in broad daylight, in the late afternoons, when farmers and wildlife guards were at rest at home. The largest crop-raiding group comprised of 25 elephants compared to the 8 elephants recorded in the study of Sam et al. (2005).

While damage at BCA was restricted to the wettest part of the year (Sam et al. 2005), the current study recorded damage during December as well. Similar findings were reported in the Kakum Conservation Area (KCA), where severe damage occurred in June, coinciding with the major rainy season (Danquah et al. 2006, Barnes et al. 2003, Dudley et al. 1992) and also peaked in October in the Red Volta area in northern Ghana (Sam 2000).

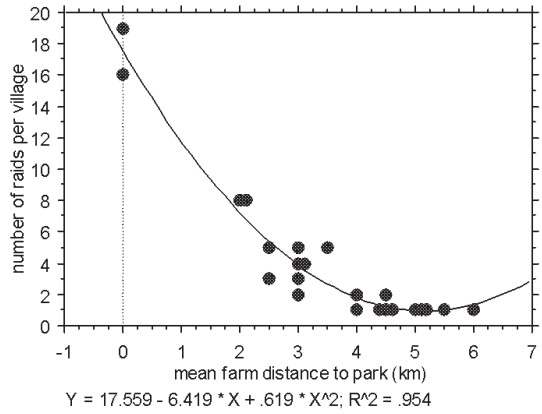


Figure 2. Relationship between number of raids per village and the mean distance of raided farms to the nearest park boundary.

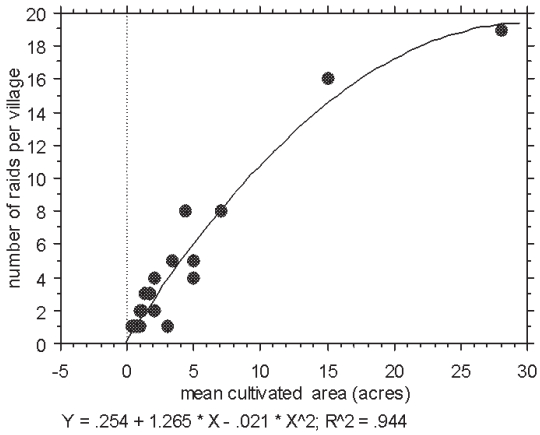


Figure 3. Relationship between number of raids per village and the mean area of land under cultivation (farm).

It is evident that elephants raided and caused more damage to larger and nearby farms than smaller ones. The reasons for this may be due to ineffective deterrent methods and the difficulty in guarding and warding off elephants in larger farms compared to smaller farms. Hence, elephants may find it more convenient to enter nearby large farms undetected than smaller farms. There is also the possibility of finding a wider array of food plants in larger farms where they could easily meet their energy needs compared to small farms with little diversity in food plants. Nevertheless, proximity of farms to the boundary line was the strongest predictor of raiding risk. Sam et al. (2005) in BCA, Barnes et al. (2003; 2005) in KCA, Ghana and Naughton-Treves (1998) in Kibale, Uganda had similar findings.

Table 3. Stages of growth of raided crops and frequency of raids by elephants in BCA from 2004 to 2006

| Crop | Frequency of raiding | Frequency of raiding mature stage | Frequency of raiding intermediate stage | Frequency of raiding seedling stage |
|---|---|---|---|---|
| Cocoa | 47 (22%) | 45 | 2 | 0 |
| Plantain | 49 (23%) | 44 | 5 | 0 |
| Maize | 31 (14%) | 31 | 0 | 0 |
| Cassava | 48 (22%) | 42 | 6 | 0 |
| Yam | 23 (11%) | 12 | 11 | 0 |
| Cocoyam | 7 (3%) | 2 | 5 | 0 |
| Pineapple | 3 (1%) | 3 | 0 | 0 |
| Vegetable | 1 (1%) | 1 | 0 | 0 |
| Banana | 5 (2%) | 5 | 0 | 0 |
| Sugarcane | 1 (1%) | 1 | 0 | 0 |

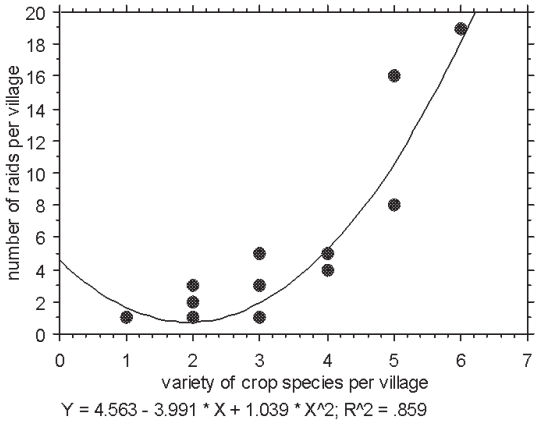


Figure 4. Relationship between variety of crop species and number of raids per village.

In spite of the fact that farms with high crop diversity had a higher tendency to be raided by elephants than less diversified ones, certain crop types appeared to attract elephants or were much more favoured by elephants than others (Barnes et al. 2005). Hence, farms containing such crops were more likely to be raided by elephants than farms with other crop types. For instance, farms with cocoa, plantain or maize had exceptionally high raiding risk levels followed by farms composed of cassava or yam or a combination of these crops. However, cocoyam, pineapple, vegetable, banana or sugarcane farms were least likely to be raided by elephants.

Given that people must eat, and that the current policy of the Government of Ghana is to conserve the country's last remaining elephants, farmers should be encouraged to protect their crops through the detection and repulsion of elephants (Osborn and Parker 2002; Barnes et al. 2003). Improving methods of detecting the approach of elephants considerably reduces the chance of damage (Osborn and Parker 2002). However, most farmers only detect the elephants when the elephants are already in the farm. For this reason farmers mostly concentrate their ability on repelling elephants back into the reserve. Unfortunately, elephants quickly habituate to single repulsive methods; hence effective repulsion requires a combination of methods in order to successfully drive elephants away. Farmers interviewed confirmed that they mostly resort to noise making in addition to other scaring tactics to successfully drive elephants away from their fields.

The fact that farmers take these risks, in addition to the other problems of farming near the reserve (limited road access, distance from the village) demonstrates the need for a pragmatic solution to crop-raiding by wild animals on communities fringing nature reserves. Some solutions suggested are that farmers should be discouraged from cultivating food crops within the immediate environs of the reserve (Danquah et al. 2006; Sam et al. 2005; Barnes et al. 2005; Boafo et al. 2004; Barnes et al. 2003). They should grow their food crops away from the boundary of the reserves. If farmers are incapable of resettling and farming elsewhere, they should be encouraged to grow mono-crops that have low crop-raiding risk.

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