Nature and extent of human–elephant conflict in Bia Conservation Area, Ghana

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Abstract

An investigation into the nature and extent of human–elephant conflicts in and around Bia Conservation Area was carried out during the 2004 rainy season. This exercise was done by administering questionnaires to wildlife staff and local communities as well as by actual field measurement of damaged farms. There were 49 elephant crop-damage incidents involving 44 farms belonging to 36 farmers. Elephant crop damage was a serious problem in the conservation area, with farmers around the southern portions being the most affected. The number of raids increased with the proximity of a cluster of farms to the park boundary, and the number of crop types. The area under cultivation could influence the number of raids. There was almost 50% probability that if one's farm was raided, about half of the crop would be destroyed. This was exacerbated by the fact that raiding targeted mature and good-quality crops. The high damage levels have resulted in continuous friction between farmers and conservationists since most farmers do not see any advantage in conserving elephants.

Résumé

On a mené une enquête sur la nature et l'étendue des conflits hommes–éléphants dans et autour de la Zone de Conservation de Bia pendant la saison des pluies de 2004. Cet exercice a été réalisé au moyen de questionnaires remis au personnel de la faune et aux communautés locales ainsi que par des mesures directes, sur le terrain des dégâts causés aux fermes. Il y a eu 49 incidents où des éléphants ont dévasté des récoltes, impliquant 44 fermes appartenant à 36 fermiers. Les dégâts causés par les éléphants aux récoltes sont un problème sérieux dans l'aire de conservation, les fermiers se trouvant aux environs des parties sud étant les plus affectés. Le nombre de raids augmentait avec la proximité du groupe de fermes par rapport au parc et avec le nombre de types de cultures. La zone cultivée pouvait influencer le nombre de raids. Il y avait presque 50 % de risques que, si une ferme était attaquée, près de la moitié des récoltes soit détruite. Ceci était aggravé du fait que les attaques visaient surtout des cultures arrivées à maturité et de bonne qualité. Le taux élevé de destruction a entraîné des frictions continues entre les fermiers et les protecteurs de l'environnement étant donné que la plupart des fermiers ne voient aucun avantage à la conservation des éléphants.

Introduction

Human–elephant conflict (HEC) is a problem that many parks and reserves across Africa experience. This problem is especially severe in West Africa, where isolated populations of elephants often live adjacent to areas of dense agriculture (Sukumar 1990; AfESG 1999). As human populations increase and elephant populations become more concentrated in isolated protected areas and remnant forest habitats, these conflicts are almost certain to escalate (Barnes et al. 1995), making this problem one of Africa's most challenging conservation issues (Hoare and du Toit 1999).

Crop damage by elephants around Bia Conservation Area (BCA) is a serious multifaceted management problem that authorities of the Wildlife Division of Ghana face (Sam 2000). While the problem has been investigated extensively (Barnes et al. 2003) to identify the underlying causes, there have not been many systematic data-gathering attempts on this issue in the area for park management to understand and appreciate habitat requirements and the crop-raiding behaviour of BCA elephants. To study the nature and extent of the HEC situation and to help park management tackle the problem effectively, we conducted a social survey in some of the affected communities and took measurements on affected farms.

Study area

The Bia Conservation Area comprises Bia National Park (NP) in the north and its adjoining Bia Resource Reserve (RR) in the south. The two forests form a block of 306 km^2 located in the moist evergreen and moist semi-deciduous forest zones of western Ghana. BCA lies between latitude 6°20′ to 6°40′ N and longitude 3º00′ to 3º10′ W, sandwiched between the Bia River and the border with Cote d'Ivoire (fig. 1).

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

Methods

To understand the human–elephant situation around BCA, both the historical and the current crop-raiding situations were determined. This was done through questionnaires and conducting interviews with 42 randomly selected members of 11 randomly picked

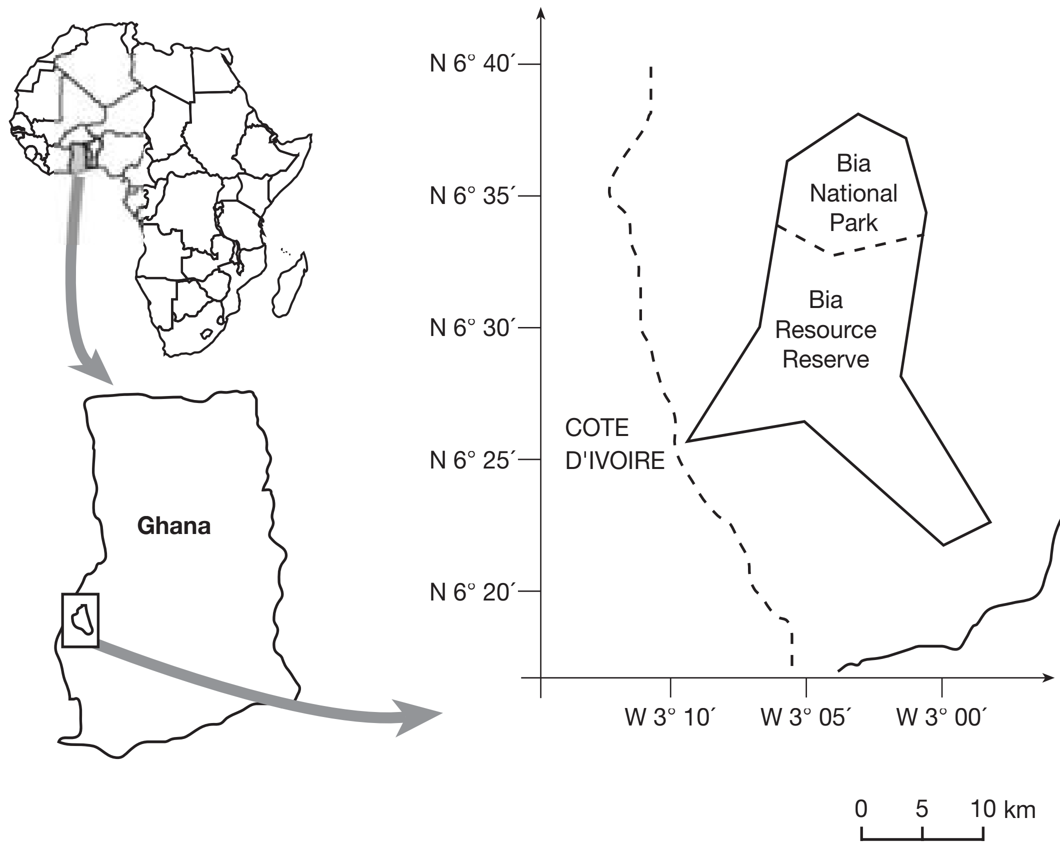

Figure 1. Bia Conservation Area, Ghana.

fringe communities out of a total of 20 major communities within 7 km of BCA. We tried to determine the types of conflicts that occurred, how long each had been going on, the frequency, spatial extent and so on, through a questionnaire specifically developed for this study. With this approach, we gathered some qualitative historical and current information on the distribution and frequency of crop raids around the study area (Sam et al. 2003).

Information on current crop-damage incidents (usually gathered within 48 hours), crops raided, growth stage at which crops were raided, crops spared, and time of year raids occurred was gathered using an elephant damage report form developed by the IUCN African Elephant Specialist Group (AfESG) (Hoare 1999). The area in square metres of a raided farm was estimated by roughly subdividing the farm into measurable shapes (squares, rectangles, triangles, etc.) and summing up the calculated areas. The total affected area of damaged crops was measured likewise.

Extent of damage was scored for raided crops and farms based on an index of damage developed by Hoare (1999). Damage score was then scaled from 0 to >9 (integers only). Scores ≤5 were interpreted as low and non-severe, scores from 6–8 were ranked medium damage, and scores ≥9 were interpreted as being high and severe.

The damage score was the sum of the age score of crops (1 = seedling, 2 = intermediate, 3 = mature), the quality score (1 = poor, 2 = medium, 3 = good) and the damage category (1 = ≤5% of farm area damaged, 2 = 6–10 %, 3 = 11–20%, 4 = 21–50%, 5 = 51–80%, and 6 = > 80% of farm damaged). With our experience regarding the farming system in the area, we reduced the level of subjectivity in determining the quality scoring by defining the quality of various crops grown in the area as poor, medium, or good and by ensuring that the same set of enumerators was used throughout the study.

We recorded the geographical coordinates of raided farms with a GPS. By plotting relative positions on a map of the study area, we determined the distance of raided farms from the nearest forest boundary.

Results

Crop raiding in the study area is a serious problem, and it occurs throughout the year. Forty-two farmers, aged 21 to 50 years, were arbitrarily drawn from the 11 randomly selected communities (fig. 2) around BCA and interviewed. Immigrants formed the majority (72%), while natives constituted the remaining 28%.

Forty-two farmers were interviewed, the majority of whom (57%) had not seen or had any physical

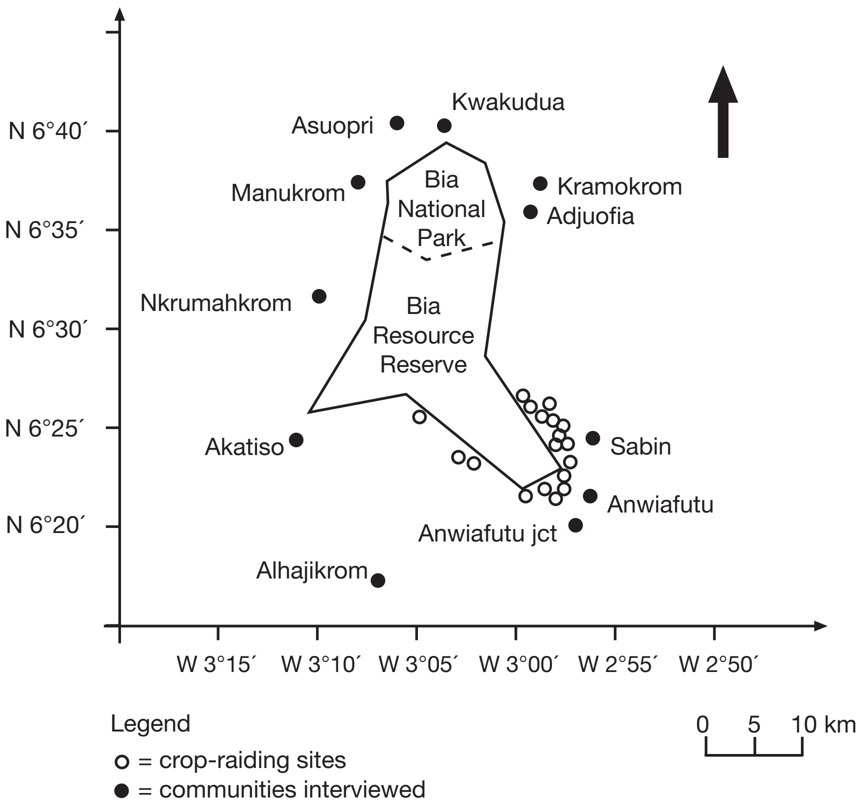

Figure 2. Distribution of the study communities and crop-raiding incidents near Bia Conservation Area.

encounter with elephants within the past six years. They also had no idea whether elephant numbers had increased or not. Most of the farmers (90%) employed different kinds of traditional deterrent methods for driving elephants away from their farms: noise making by beating on metal objects, and firing guns and carbide bombs were the most frequent. However, noise making alone was not very effective unless combined with other methods like burning car tyres or setting up fires during the night. It must be noted that in the wake of all these traditional ways of deterring elephants, most farmers would fear for their lives were they to come face to face with elephants on their farms, and hence they had always relied on the Wildlife Division guards to drive raiding elephants back to the reserves.

Based on visual and track identification in eight different settings or occasions, it can be said that at least 24 males and 12 females were involved in the raids. In terms of age, some 43 adults and 33 subadults and infants had been seen on different occasions. Some of these could be the same elephants showing up in different places at different times. Severe crop damage starts in June and increases steadily before peaking in September and October. It declines in November and by December has become minimal.

During the 2004 major farming season, 44 farms belonging to 36 farmers from 18 villages experienced 49 raids around the conservation area (table 1). Farmers whose farms border the south and south-eastern boundary line of Bia RR experienced the highest number of raids (fig. 2).

There was no significant (NS) relationship between the number of raids and the size of individual farms raided ($r^2 = 0.057$, NS) or the nearest distances of individual farms to the reserve boundary line ($r^2 = 0.102$, NS). Hence the data were further analysed at two levels by regression. First, we examined crop-raiding incidents for a particular area, that is, at the village level. For this level of analysis, the data for all raids within a common village were combined and related to the total cultivated (farmed) area of the village (table 1). The number of raids that a raided farm suffered was evaluated in relation to the area of land under cultivation in that area. Secondly, the data were analysed by relating the total number of raids in a particular village to the mean distance of raided farms in the village from the nearest reserve boundary.

The number of raids registered in an area was inversely influenced ($r^2 = 0.857$, $p < 0.05$) by the mean of their distances to the nearest reserve boundary line (fig. 3).

For farms that were raided, the risk of a farm suffering damage increased with the total area cultivated

Table 1. Crop-raiding incidences in relation to proportion of farm area destroyed around affected villages

Villages	Mean distance to reserve (m)	Farmers affected	Farms raided	Total area of farms in a village (m^2)	Total area destroyed (m^2)	Raids registered
Akosua Aden Krom	2.5	2	3	4,880	1,890	3
Alhaji Nkwanta	3	1	1	1,620	1,460	1
Anwiefutu Nkwanta	1	5	7	16,500	11,050	8
Asiri	3	1	1	3,575	920	1
Bio Krom	2.5	3	3	11,720	3,600	3
Boampong Krom	4	1	1	3,360	480	1
Camp 4	3	1	1	1,240	980	2
Camp 10	3	1	1	1,560	960	1
Eye Nyame Krom	2	2	2	3,460	1,650	2
Iron Boy	2	3	3	5,200	3,220	3
Kofiko Krom	3.5	1	1	2,570	1,220	1
Kofi Kyere (Camp10)	4	1	1	2,750	640	1
Kojo Donkor Camp	1.5	4	5	13,600	4,200	5
Kwaku Boakye (Camp10)	3.5	1	1	1,430	520	1
Kwasi Donkor Camp	2	1	1	2,200	1,760	2
Kwasi Donkor Krom	1.5	2	3	6,430	2,860	4
Nyamebekyere	2	3	3	5,800	2,800	4
Yamediagoro	0.8	3	6	13,300	6,250	6
Total		36	44	101,195	46,460	49

in a village farm enclave ($r^2 = 0.755$, $p < 0.05$) (fig. 4).

The risk of crop raiding also increased with the number of food crops on any individual raided farm ($r^2 = 0.756$, $p < 0.05$) (fig. 5), that is, the more the different types of crops the higher the number of raiding incidents.

Thus a farmer who monocropped was at low risk of elephant crop raiding. By planting two or more crops the farmer increased the risk.

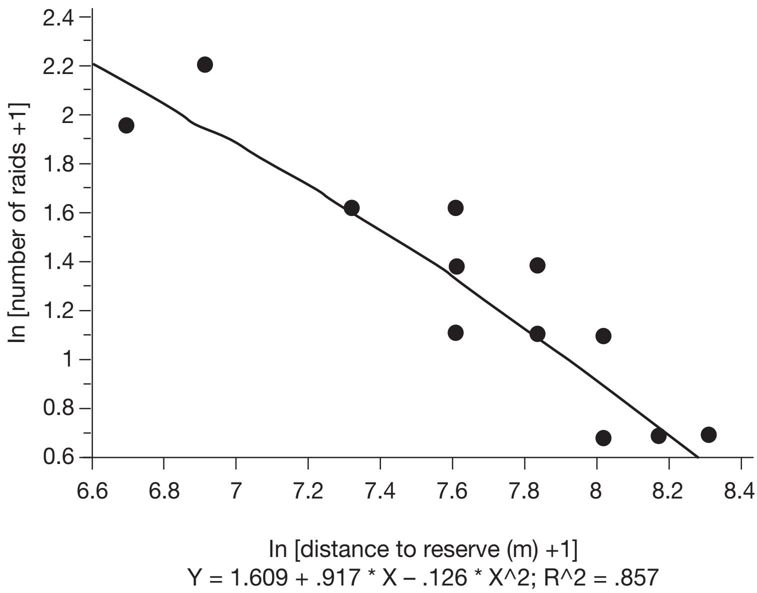

Figure 3. Relationship between number of raids registered in an area and the mean distance of farms in a village from the nearest reserve boundary line.

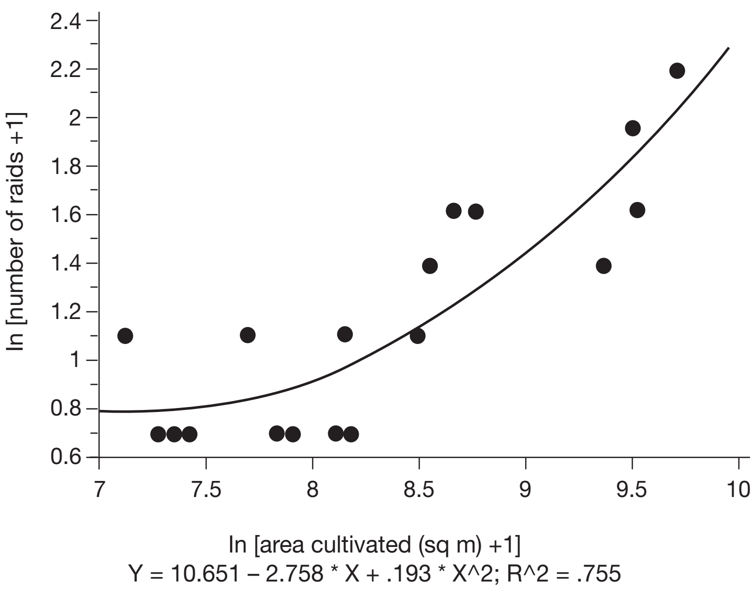

Figure 4. Relationship between number of raids registered in an area and the area of land under cultivation (farm).

There was no significant relationship between raids and acreage of individual crops grown: cassava, $r^2 = 0.160$, NS; plantain, $r^2 = 0.604$, NS; cocoa, $r^2 = 0.011$, NS; maize, $r^2 = 0.507$, NS; yam, $r^2 = 0.044$, NS; cocoyam, $r^2 = 0.541$, NS; banana, $r^2 = 0.063$, NS and vegetables, $r^2 = 0.063$, NS. Nevertheless, for five of the eight crops cultivated in the area, there seems to be an unusual phenomenon (table 2)—a U-shaped relationship between number of crop-raiding incidents and sizes of crops cultivated, suggesting that when crops are grown in modest amounts they are raided least or not at all.

Farming in the study area involved seasonal, rain-fed subsistence agriculture. Cassava was the most raided crop (30% of crops raided), followed by plantain (26%) (table 3). Raiding was largely targeted at crops that were mostly mature (71% of total frequency of crops raided). Crop raiding was largely targeted at crops that were of good quality (69% of total frequency of crops raided) (table 3). Table 4 also indicates that most crops other than cocoyam suffered an appreciable level of damage.

Damage on half the raided farms amounted to about 46% with about 5% suffering more than 80% damage (fig. 6).

Discussion

Elephant crop raiding in BCA is a serious problem that occurs throughout the year. It dates back into the 1970s when immigrant farmers

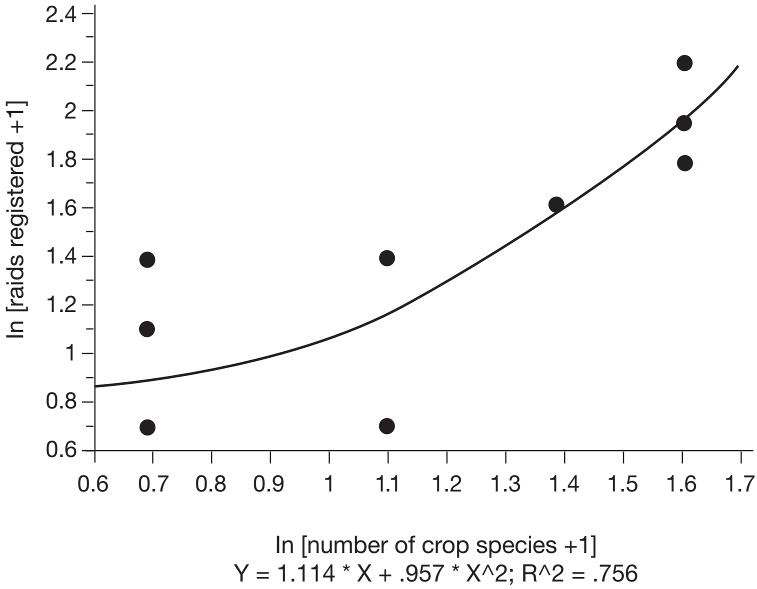

Figure 5. Relationship between number of crop species grown and number of raids registered in that area.

started cultivating between reserves (pers. comm. Phillip Mensah, Camp 9 leader, February 2004). Although there are no data to show the trend in crop-raiding frequency over the last two or three decades, there is much anecdotal evidence supporting an increasing trend with a growing influx of migrant farmers. Consequently, the problem has developed into a big issue, and the Wildlife Division is constantly under pressure from local communities to curb it. Wildlife guards are blamed by irate farmers for their inability to control the elephants.

Based on data gathered through the questionnaire, it appears that elephant behaviour has changed; according to farmers, in the past it was primarily males that raided and then

Table 2. Frequency (*f*) and percentage of crop raiding in relation to the area of each species grown on each farm

	Cultivated area									
	0 m²		1–999 m²		1000–1999 m²		2000–2999 m²		> 3000 m²	
	f	%	*f*	%	*f*	%	*f*	%	*f*	%
Cassava	10	20	0	0	6	12	9	18	24	49
Plantain	26	53	0	0	4	8	0	0	19	39
Cocoa	45	92	0	0	0	0	1	2	3	6
Maize	11	22	0	0	3	6	4	8	28	57
Yam	45	92	4	8	0	0	0	0	0	0
Cocoyam	30	61	0	0	5	10	14	29	0	0
Banana	48	98	0	0	1	2	0	0	0	0
Vegetables	48	98	1	2	0	0	0	0	0	0

Table 3. Stage of growth of crops damaged on 44 farms raided by elephants, 2004

Crop	How many times crops were raided	Percentage of raided crop damaged	Crops in mature stage (no.)	Crops in intermediate stage (no.)	Crops of good quality (no.)	Crops of medium quality (no.)	Crops of poor quality (no.)
Cassava	25	30	15	10	11	7	7
Plantain	21	26	18	3	16	2	3
Cocoa	15	18	11	4	11	2	2
Maize	13	16	12	1	12	1	0
Yam	6	7	2	4	5	1	0
Cocoyam	1	1	0	1	0	1	0
Banana	1	1	0	1	1	0	0
Vegetables	1	1	1	0	1	0	0
Total	83		59	24	57	14	12

No crops in the seedling stage were reported raided

Table 4. Damage score for crops raided by elephants

Crop	Age score	Quality score	Damage category	Damage score	Interpretation
Cassava	3	2	5	10	high and severe
Plantain	3	3	4	10	high and severe
Cocoa	3	3	2	8	medium
Maize	3	3	5	11	high and severe
Yam	2	3	4	9	high and severe
Cocoyam	2	2	1	5	low and not severe
Banana	2	3	4	9	high and severe
Vegetables	3	3	1	7	medium

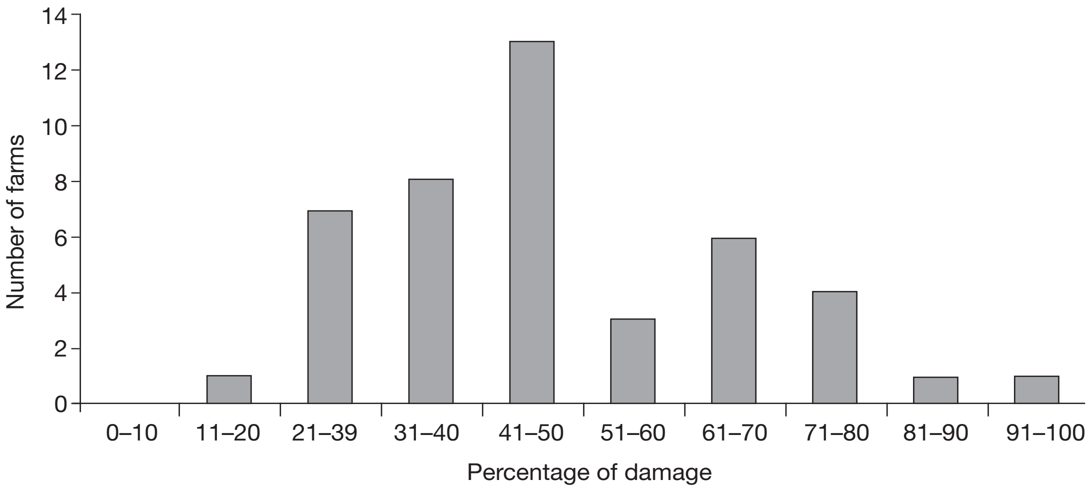

Figure 6. Frequency distribution by percentage of area damaged on raided farms.

only at night. In recent times, however, family groups consisting of adult females, males and especially subadults are often the culprits. Elephants have also been seen in the fields in broad daylight. This is also true at the Kakum CA, and to help the Wildlife Division plan a more effective crop-raiding deterrent method, a concerted investigation should be made into this change in elephant behaviour at the two sites.

While damage may be restricted to the wettest part of the year, this study recorded most damage in September and October coinciding with the minor rainy season. In the Kakum CA, severe damage occurs in June, coinciding with the major rainy season (Dudley et al. 1992). Both Barnes et al. (2003) and Danquah (2003) discuss crop raiding in relation to rainfall at Kakum CA . Damage in the Red Volta area is severest in October, when the single rainy season would be ending and most crops would be being harvested (Sam 2000).

Elephants were originally found in both Bia NP and Bia RR (Martin 1982; Short 1982). Since timber companies started logging in Bia RR in the early 80s (Parren et al. 2002) elephants have left Bia NP and moved downwards into the south-eastern portions of Bia RR. Thus it has been suggested that the absence of elephants in Bia NP was temporarily a reaction to the different and more palatable secondary vegetation conditions created by logging within Bia RR (Short 1981; Martin 1982). Both Barnes (1996) and de Leede (1994) observed a similar pattern where more elephants were observed in the south-west of BCA.

Occurrences of crop raids have been reported mainly in the wet season, along the eastern borderline of Bia RR where elephants concentrated (Opoku 1988; de Leede 1994). Moreover, Martin (1982) has indicated that the Bia population usually confined movements to the same, often traditional, routes.

However, present distribution is gradually changing; records of elephant activities probably dating back to the previous rainy season around the northern boundary lines of Bia RR indicate that elephant movements and crop raiding, in addition to concentrating in the south and south-eastern Bia RR boundary line, occasionally spread northwards. Similarly, reports from wildlife staff and local communities indicate that elephant crop raiding actually spreads periodically to the northern sections including areas adjacent to Bia NP. It is believed that this pattern occurs during the late rainy crop-growing season when water sources increase throughout both reserves, and food crops like maize mature around the park boundaries. These two factors may be the most important determinants of elephant distribution in the wet season. However, a section of the park staff still contends that the relative increase and spread in raiding activities is a result of elephants crossing over from neighbouring Cote d'Ivoire during the wet season.

The strange U-shape relationship between raids and abundance of certain raided crops is difficult to explain—the incidence of raids ranged from low to high when a farm had little or none of specific crops in an area. In moderate amounts (1–2999 m^2), crop raiding fell to almost zero. Then the frequency of raids rose again with larger amounts (> 3000 m^2) of these crops. A similar relationship was reported at Kakum CA for cocoyam (Barnes et al. 2003). However, within the limits of data gathered for raided areas, the most consistent lesson here and advice to farmers is that elephants may avoid a modest-size farm. At this stage we cannot explain why this should be so. The pattern of raiding suggests that elephants usually raid farms clustered close to the park, and for those farms raided, the area under cultivation and the number of different crop types were major predictors of raiding. The mean distance from the boundary line was the strongest predictor of risk, and the same was true for Kakum CA (Barnes et al. 2003) in Ghana and of Kibale NP in Uganda (Naughton-Treves 1998). Given that people must eat, and that the current policy of the government of Ghana is to conserve the country's last remaining elephants, we need to search for a form of agricultural practice that reduces the risks of attracting elephants. Cultivation of food crops should be discouraged within the immediate environs of the reserves. Hence, the most effective action a farmer can take is to move away from the park boundary. If a farmer is incapable of resettling and farming elsewhere, then that farmer has to reduce the types of crops grown or cultivate crops in modest amounts. Barnes et al. (2003) made this recommendation for Kakum CA as well.

Sam et al. (1997) recorded two types of food crop damage. First is damage elephants cause by walking across farmland without feeding extensively, referred to as 'collateral damage', as in military parlance. The second type is when elephants intentionally stop to feed on crops. In this case, the percentage of crop damage is high and can be of real economic consequence to the farmer. While Sam et al. (1997) recorded damage of less than 10% in most fields in the Red Volta area in northern Ghana and only about 20% of the second type, the situation at Bia CA was the far different; only 2% of farms suffered collateral damage, and over 85% suffered between 21 and 70% of damage. Although Martin in 1982 said that damage caused by elephants to farms might be completely negligible for communities around Bia CA, Sam (2000) recorded the severest farm damage around BCA as being 40%. The current range of 14 to 93% suggests that crop raiding is becoming more severe. Single bulls and bull groups as well as family groups are involved.

Farmers should be encouraged to protect their crops. Protection comes in two stages: detection and repulsion (Osborn and Parker 2002; Barnes et al. 2003). Improving methods of detecting the approach of elephants can considerably reduce the chance of damage (Osborn and Parker 2002). But at present, most farmers detect elephants only when they are already on the farm. For this reason farmers mostly concentrate their ability on repelling elephants, trying to send them back into the park. Unfortunately, elephants quickly habituate to any one method of repulsion; hence to successfully drive elephants away a number of methods in combination are necessary. Farmers interviewed confirmed that they must always combine noise making with other scaring tactics to be successful in driving elephants away from their fields. Consequently, farmers spend much time, resources and money to mitigate these conflicts. Under such conditions, villagers often resort to many forms of violence. The fact that farmers take such risks, in addition to the other problems of farming near the park (limited road access, distance from the village), demonstrates the intense demand for land in the area. It also means that subsistence farming is not a suitable form of land use around BCA, a situation also observed around Kakum CA (Barnes et al. 2003).

This paper's weakness is that we looked only at farms that were raided. As we did not look at those not raided we cannot calculate the percentage of farms that were affected by this problem to show its gravity. Also we cannot calculate what proportion of the farms growing cassava, plantain, and so on were raided. Knowledge of the features of the farms that were not raided, that is the successful farms, and why they were successful, would have helped us realize what raided farm owners need to do to move their farms into the 'undamaged' category.

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