Elephant crop damage in the Red Volta Valley, north-eastern Ghana

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Abstract

We monitored the crop-raiding behaviour of elephants that seasonally migrate into the Red Volta Valley as part of a project to mitigate conflict. During 1999–2003 we organized farmers in the project area into associations, recorded the size of each raided farm, crops affected, area of farm damaged, date of damage and farm location. The percentage of registered farmers affected by elephant crop raiding ranged from 2 to 3% per year. Mean area damaged per raided farm averaged 0.98 ha in 2002. Damage varied considerably among affected farms with < 1% to 100% of the cultivated area destroyed. Most raiding incidents occurred between August and November, before and during crop harvest, which is also the period elephants migrate from Burkina Faso into the study area. Seasonal migration produced a strong geographic pattern of sequential raiding in chiefdoms bordering the Red Volta forest reserves that serve as the main elephant corridor. Chiefdoms farthest from the Ghana–Burkina Faso border were the last to experience crop raiding each year. Within affected chiefdoms, proximity to the forest boundary and the Red Volta River probably increases the risk of crop raiding. Human–elephant conflict can be reduced by planting crops that mature early to advance harvest time to occur before elephants arrive, and by locating farms away from forest reserves.

Additional key words: farm monitoring, elephant corridor

Résumé

Nous avons surveillé le comportement des éléphants qui ravagent les cultures et qui migrent de façon saisonnière dans la Vallée de la Volta rouge, dans le cadre d'un projet destiné à tempérer les conflits. De 1999 à 2003, nous avons rassemblé les fermiers de la zone du projet en associations, nous avons enregistré la taille de chaque ferme attaquée, les cultures ravagés, la surface de ferme touché, la date des dommages et l'emplacement de la ferme. Le pourcentage des fermiers enregistrés affectés par les dégâts d'éléphants allait de 2 à 3% par an. La surface moyenne touchée par attaque d'éléphant était de 0,98 ha en 2002. Les dégâts variaient considérablement selon les fermes, allant de < 1 à 100 % de la surface cultivée. La plupart des incidents se passaient entre août et novembre, avant et pendant les récoltes, ce qui correspond au moment où les éléphants migrent du Burkina Faso vers la région étudiée. La migration saisonnière a produit un pattern géographique très marqué de raids séquentiels dans les chefferies qui bordent les réserves forestières de la Volta Rouge qui servent de corridor principal pour les éléphants. Les chefferies les plus éloignées de la frontière Ghana–Burkina Faso sont chaque année les dernières à subir les raids des éléphants. A l'intérieur des chefferies, la proximité de la limite forestière et du fleuve augmente probablement les risques de dommages. On pourrait réduire les conflits hommes–éléphants en plantant des semences qui mûrissent tôt, pour avancer le moment des récoltes avant l'arrivée des éléphants, et en installant les fermes plus loin des réserves forestières.

Mots clé supplémentaires : surveillance pour les fermes, corridor d'éléphants

Introduction

Loss of habitat, illegal trade in ivory, and human intolerance to crop raiding are the major obstacles to conserving both African and Asian elephants (Sukumar 2003). Crop raiding occurs throughout elephant ranges and probably began with the advent of agriculture 10,000 years ago. It has intensified as agriculture has spread throughout the elephants' range. The scientific study of crop damage by elephants began only in the 1970s in Asia and in the 1980s in Africa. Since then, a number of deterrent methods have been developed, including disturbance shooting and electric fencing (Kangwana 1995; Thouless and Sakwa 1995). In the 1970s, electric fencing was considered the best way to stop crop-raiding elephants, but not all fences have worked (Thouless and Sakwa 1995). The high cost of constructing and maintaining electric fences is unrealistic for many elephant-conflict sites in Africa. Disturbance shooting has been widely applied since the colonial era despite suggestions that it also is only minimally successful in mitigating crop raiding (Ayigsi 1997; Osborn and Parker 2002).

In 1970 the Ghana Wildlife Division (a unit of Ghana's Forestry Commission), under pressure from complaints of crop raiding in the Red Volta Valley, undertook a severe culling operation with the aim of eliminating the elephant problem from the area (B. Jamieson, consultant, 2000, pers. comm.). The cull reportedly continued until no evidence of elephants remained in the river valley. But by the mid-1990s elephants were back and the Wildlife Division used disturbance shooting to scare them away from farms. However, the Wildlife Division did not have permanent presence in the valley and instead dispatched deterrent teams from distant locations in response to complaints from farmers and local politicians. These ad hoc interventions were limited by budgetary constraints and had little impact on the conflict (Ayigsi 1997; NCRC 1999). In 1999 a community-based approach that empowered local people to implement low-cost deterrent measures was initiated and has since been increasingly effective in mitigating the problem (Adjewodah et al. 2003).

Causes of crop raiding

Several factors affect the number and location of human–elephant conflicts. In Africa seasonal movements of elephants bring them into contact with farmlands, which have encroached and fragmented on their traditional range (Hoare 1999). In India seasonal elephant movement, competition for water, reduction and degradation of natural habitat, and the higher nutritive value of cultivated crops as compared with uncultivated food are associated with increased crop raiding (Sukumar 1990). In Zimbabwe rainfall and plant moisture may influence the movement of elephants into communal land from a protected area (Osborn 2003). Insufficient habitat in protected areas and modification of the landscape by humans contribute to elephant crop raiding in the Upper Guinean forest zone of West Africa (Barnes 2002). In this same landscape Sam et al. (2003) has suggested that elephant migratory movements affect crop raiding. Sam et al. (1998) found that a growing human population and the need for new farmland has increased human–elephant conflict in the Red Volta Valley. Others (Lowry and Donahue 1994; Okoumassou et al. 1998) attributed a surge in the incidence of elephant crop raiding in the Red Volta Valley in the early to mid-1990s to the displacement of elephants in northern Togo during political instability in that country.

History of crop raiding

In the mid-1990s, crop raiding by elephants was an important problem for farmers in the Red Volta Valley (NCRC 1999). Okoumassou et al. (1998) reported farmers were intolerant to the risk of losing crops to elephants and suggested that local people's hostility was the most critical short-term threat facing elephants there. Farmers' intolerance to crop damage encouraged elephant hunters employed to protect communal farm enclaves to poach (NCRC 1999, 2000; Adjewodah et al. 2003). The Red Volta Valley Conservation Project, which was initiated in 1999 to mitigate the conflict that ensued, involved the collaboration of the Nature Conservation Research Centre (NCRC—a Ghanaian conservation NGO), the communities and traditional authorities in the project area, the Wildlife Division, and the Bolgatanga and Bawku West district assemblies among others.

In this paper, we report on patterns of crop damage during 1999–2003. Our objectives are to describe the patterns of crop raiding by an elephant herd that is only seasonally present in the region, and determine whether crop damage is related to geographic location, stage of crop maturity and type of crops.

Research area

The Red Volta Valley comprises the Red Volta East, Red Volta West, Gambaga Scarp East, Gambaga Scarp West, Morago East and Morago West Forest Reserves and adjacent woodlands and fallow lands off the reserve (latitude 10°3′2 to 11°00′2 N, longitude 0°45′2 to 0°00′2 W) in the Bolgatanga, Bawku West and Bongo Districts of the Upper East Region (fig. 1).

The area experiences two climatic seasons: dry and wet. The wet season extends from May to November, and the dry season from December to April. The mean annual rainfall is about 900 mm with an annual peak between July and September. The dry period is characterized by desiccating north-east winds known as harmattan, which bring dust and haze from the Sahara Desert, and by bushfires between December and February affecting over 90% of the area annually. The vegetation is fire pro-climax and is locally influenced by human activities such as farming, charcoal burning, small-scale mining, cattle grazing, and harvesting of firewood and building poles (Wheelan 1950).

The Red Volta, White Volta and Morago Rivers and their tributaries drain the area. Both the Red Volta (called River Nazinon in Burkina Faso) and the White Volta flow south from Burkina Faso. The Morago takes its source from northern Togo near Fosse aux Lions National Park as River Koulagouna, and flows into the White Volta River in Ghana (fig. 1). The gallery of forest reserves along these rivers and the adjoining community lands are the major areas with natural vegetation, which is predominantly Guinean savanna woodland (Taylor 1952) that constitutes a network of habitat linking the Red Volta Valley to elephant ranges in northern Togo and southern Burkina Faso. The Red Volta area has been further discussed elsewhere (Sam et al. 1998).

Okoumassou et al. (1998) reported the movement of elephants between Ghana and Togo along the Morago–Koulagouna Rivers. Elephants were seen most frequently in the Red Volta Valley during the wet season, especially as harvest time approached. Okoumassou et al. (1998) noted that elephants seem to move northwards from the Red Volta into Burkina Faso for the dry season, and southwards again in the

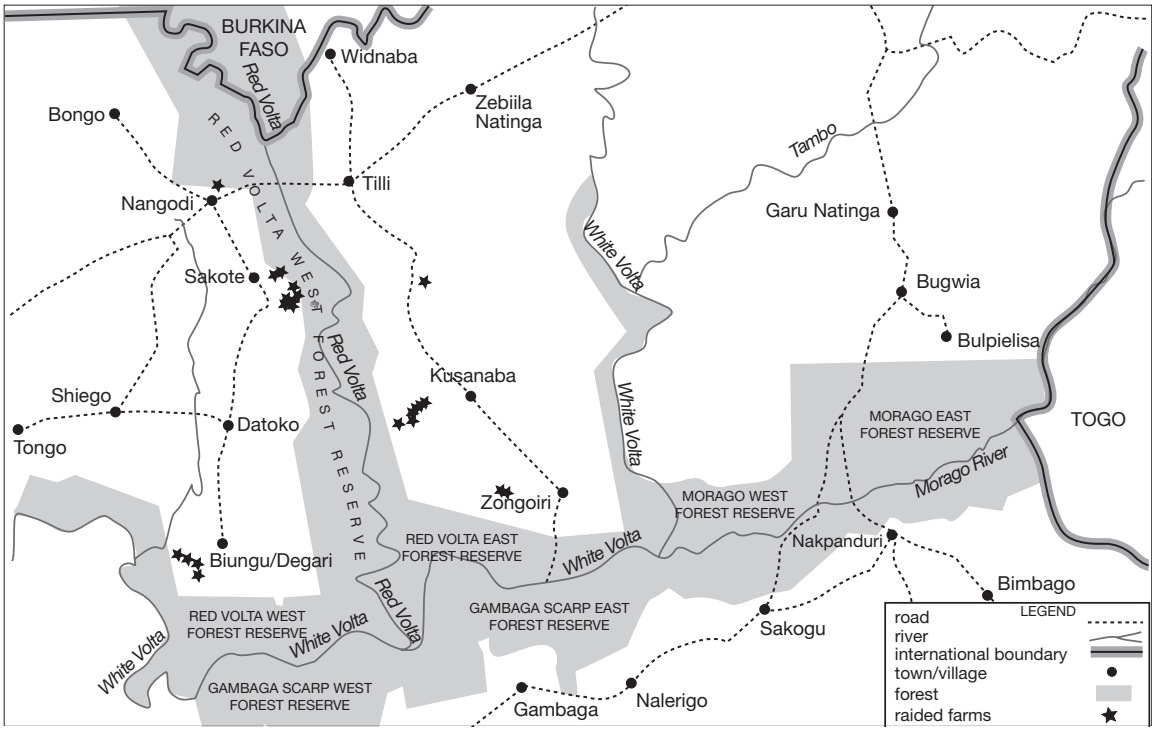

Figure 1. Map of villages and chiefdoms showing their position relative to the Ghana border and to the Red Volta River and forest reserves.

early wet season. In the early 1990s elephants were common and resident in northern Togo, but political unrest during 1990–1992 in that country encouraged encroachment of protected areas and displaced elephants into neighbouring Benin, Ghana and Burkina Faso (Lowry and Donahue 1994; Okoumassou et al. 1998). The more than 130 elephants inhabiting the Togo end of the corridor are believed to have disappeared (Okoumassou et al. 1998), and the seasonal migration of elephants across the border between Red Volta Valley and northern Togo appears to have halted (Adjewodah 2004).

Farming practices

Farming in the study area involved seasonal rain-fed subsistence agriculture. Farming activities started with land preparation beginning in the late dry season (March–April), followed by planting in May and June. Farm sizes in four chiefdoms in 2003 ranged from 0.1 ha to 7.3 ha (mean 0.7 ha, n = 104). Farm size as estimated and reported by farmers in seven chiefdoms averaged 1.3 ha (n = 814). Crops grown, in order of decreasing area cultivated, include millet, maize, groundnut, bean, guinea corn, rice and yam (table 1). In 2003 monocultures of millet comprised 33%, maize 30% and groundnut 12% (n = 104 farms) of the area of crops grown. A variety of early-maturing millet usually grown in June (in the courtyard of the farmer) takes about two months to mature. A second variety of millet, known as late millet, is sown after June on bush farms (farms closer to the forest reserves than to settlements). This variety is harvested between September and November.

Methods

To survey crop damage in farms throughout the project area we organized farmers into associations called farm-monitoring groups, within traditional authority constituencies or chiefdoms. An average of 8 (range 7–9) chiefdoms participated each year; here we report on 7 chiefdoms for which consistent records were available. Each constituency or chiefdom consisted of 4 to 12 villages, which shared a common farm enclave and a local chief. The communal farm enclaves were adjacent to the forest reserves and consisted of islands of cultivation within fallows. We did not register farmers cultivating enclaves where crop raiding was not an issue or farms inside the reserves.

We registered 996 farmers in 1999, the first year of the project. The number of participating farmers increased to 1500 in 2000 following a perceived drastic reduction in crop-raiding incidents (NCRC 2000; Adjewodah et al. 2003). In 2003, 1030 farmers were registered (table 1). Although we did not enumerate the entire farming population, we believe over 80% of farmers cultivating farmlands with raiding history participated in the project each year. In some areas, the improved confidence of farmers resulted in the return to abandoned farms, some of which were on the edge of the forest reserves.

Table 1. Area of farms (in ha) reported by registered farmers in 2003 (total for all crops exceeds total area because some crops were grown together)

Chiefdom	Farmers registered	Area cultivated[a]	Crop						
			Millet	Maize	Ground-nut	Bean	Guinea corn	Rice	Yam
Biungu	74	498	498	498	119	219	20	56	62
Kusanaba	160	114	0	70	8	0	105	0	0
Nangodi	142	–[b]	–[b]	–[b]	–[b]	–[b]	–[b]	–[b]	–[b]
Sakote	246	158	1	14	106	5	17	20	0
Tilli	94	56	1	54	1	0	14	0	0
Widnaba	127	91	74	4	22	7	8	1	0
Zongoiri	187	607	468	125	27	0	0	0	0
Total	1030	1524	1042	765	283	231	164	77	62

[a] Area cultivated by registered farmers only. The chiefdom's farm enclave was about 3600 ha in each of Biungu, Kusanaba, and Zongoiri, about 1600 ha in each of Nangodi and Sakote, 2600 ha in Tilli, and 2000 ha in Widnaba. We did not encourage farmers to register where crop raiding was not an issue or if they were inside the reserves.
[b] Data not recorded

We held a series of meetings to introduce farmers to the monitoring programme and a companion programme to reduce crop damage. Registration was voluntary. Each of the 33 groups participating in the programme in 1999 elected two representatives: a leader and an enumerator. Members of the farm groups and associations registered their farms with their respective enumerators during the planting seasons (May/June) of 1999 to 2003. We supervised these exercises and made sure the following farm variables as reported by the farmer were recorded: name of farmer, sex, general location of farm, size of farm, crops planted and date of sowing.

The farm groups cooperated to implement a set of measures against crop raiding by elephants (Adjewodah et al. 2003). Group members shared information on elephant damage and movement among themselves and with the project team, and they formed cooperatives to enable them to harvest crops in a timely manner. The project team held periodic meetings with the groups to prepare them for the crop-raiding season. The effectiveness of these measures was gauged by a monitoring exercise, which required the registered farmers to record the crop damage they reported. Affected farmers reported crop-raiding incidents to their leader or enumerator. The enumerator then visited the affected farm to assess and record the damage using a standardized format developed by the IUCN Human Elephant Working Group of the African Elephant Specialist Group (Hoare 1999). The enumerator estimated the area damaged by pacing it off; categorized crop stage as seedling, intermediate, or mature; and graded the quality of crops affected as poor, medium or good. This assessment was subjective because it relied on the judgement of the enumerator and opportunistic because it relied on farmers to report incidents. These weaknesses were, however, outweighed by affording large coverage of the elephant range, low cost and sustainability of approach.

We collected data forms for analysis from the group leaders at the end of the crop-raiding season in November. Because records for 1999 were incomplete, 1999 data were not used in some analyses. We used an index of damage developed by Hoare (1999). The damage score is the sum of the age score of crop (1 = seedling, 2 = intermediate, 3 = mature), the quality score (1 = poor, 2 = medium, and 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%). We interpreted damage scores as low (1–5), medium (6–8), or high (9–12).

We recorded the geographical coordinates of some villages and raided farms with a hand-held geographical positioning system. We used a GIS to calculate the distance of settlements and raided farms from the nearest forest reserve boundary and from the Red Volta River. In 2003 only, we randomly selected and measured 20% of the registered farms in the two chiefdoms most affected (Kusanaba and Sakote) and the two least affected (Tilli and Widnaba). For each of the 104 farms, we recorded GPS coordinates, measured the cultivated area (by pacing) and recorded the crops raised.

Results

Elephant damage

Each year less than 4% of registered farmers were affected and the mean damaged area per raided farm was less than 1.5 ha (table 2). Damage varied considerably among farms and ranged from less than 1% to 100%, with about 56% of raided farms experiencing damage to less than 21% of the farm and about 27% of raided farms experiencing damage to over 50% of the farm (fig. 2).

During 1999–2002 elephants raided 111 registered farms affecting 2.3% of the farms registered during this period (table 2). The percentage of farmers affected ranged from 2 to 3% per year with little change among years until 2003, when elephants were absent in the Red Volta during harvest. The mean damage score of affected farms was low (table 2).

Between 2000 and 2002 millet was the most affected crop followed by guinea corn, groundnut and rice (table 3). The affected crops were usually raided during mature stages when they were ready for harvest. Most raiding affected crops of medium to good quality with considerable variation among crops (table 3).

Temporal and geographic pattern of crop raiding

Crop raiding by elephants usually occurred from June to November. October was the peak crop-raiding month in each year (fig. 3) with about 72% of the raiding cases during 2000 to 2002 being recorded. The peak period

Table 2. Number of farmers registered and affected by elephant crop raiding, and mean annual damage score for 1999–2003

Year	Number of registered farmers	Number affected	Percentage of farmers affected	Average number of hectares damaged per raided farm	Mean damage score per raided farm (on scale of 1–12)
1999	996	30	3	not available	not available
2000	1500	32	2	1.29	1.39
2001	1500	24	2	0.53	1.31
2002	859	25	3	0.98	1.25
2003	1030	0	0	–	–

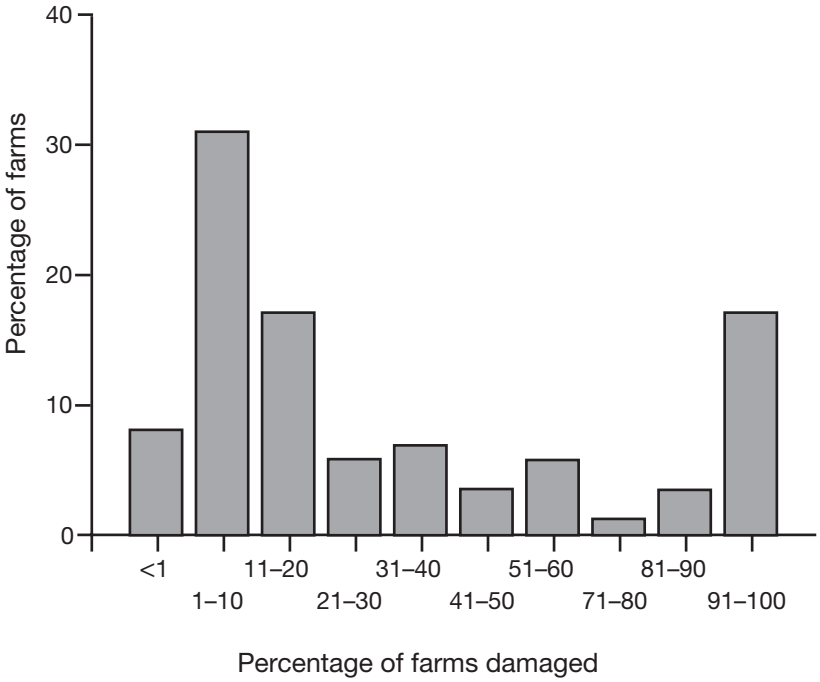

Figure 2. Frequency distribution of percentage of farm damage for 87 farms raided during 2000–2002.

coincided with the time when farm crops were mature, ripe or ready for harvest. However, in 2002 raiding started as early as June (28%) and ended in November (4%).

Crop raiding was localized, with elephants returning to the same communities over the years. The Sakote chiefdom recorded 45 of the 90 raids between 2000 and 2002; next were 18 raiding incidents in Kusanaba, 9 in Nangodi and 9 in Biungu (table 4). The annual incidents per chiefdom were low near Ghana's border with Burkina Faso, where the elephants are assumed to spend most of the year, peaked further south along the Red Volta at Sakote and Kusanaba, and decreased in chiefdoms further south (fig. 1).

In 2000 the first crop-raiding incident was at Kusanaba on 2 September, followed by raids in Sakote later in the same month. It was not until 2 October that Biungu, the chiefdom farthest from the Ghana–Burkina Faso border, experienced its first raid that year. In 2001 the first raided chiefdoms were Nangodi and Sakote. Zongoiri, the chiefdom farthest from the border, experienced its first raid on 15 November, about two months after the first reported cases at Sakote and Nangodi. A similar pattern occurred in 2002. This pattern is consistent with an annual movement from Burkina Faso into the Red Volta Valley (fig. 1).

All crops the elephants raided were on bushfarms about 2–8 km from the nearest village. Compared with the main village in each chief-dom, farms damaged by elephants were relatively close to the Red Volta West and Red Volta East Reserves (fig. 1). Because only farmers historically affected by elephants were likely to register, we could not further quantify proximity to forest reserves as a risk factor. Overall, there was no correlation between the percentage of registered farms in a chiefdom that was raided by elephants and the distance from the main village in the chiefdom to the Red Volta River ($r = –0.28$, $p > 0.50$, $n = 7$). For the two most heavily raided chiefdoms (Sakote

Table 3. Composition of damaged area for 105 farms raided by elephants during 2000–2002

Crop	Percentage of crop area damaged	Percentage of crop in			Percentage of crop of		
		mature stage	intermediate stage	seedling stage	good quality	medium quality	poor quality
Millet	31	71	29	0	38	44	18
Guinea corn	27	42	58	0	56	40	4
Groundnut	17	100	0	0	94	0	6
Rice	16	16	79	5	32	37	31
Maize	8	68	32	0	43	43	14
Bean	1	100	0	0	100	0	0

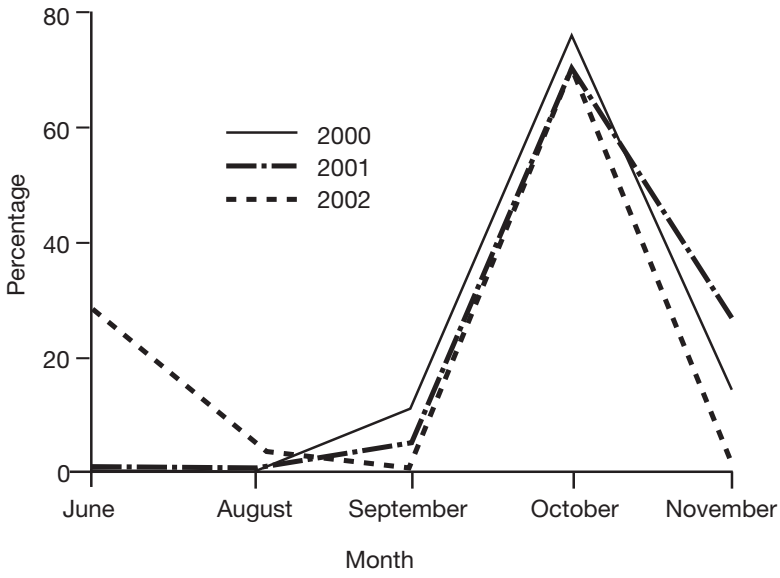

Figure 3. Percentage of annual crop-raiding incidents occurring in each month by year during 2000–2002.

and Kusanaba), we calculated distances of a random sample of registered farms from forest reserves. For Sakote, the mean distance of farms raided during 2000–2002 (0.58 km) was less than the mean distance of registered farms from forest reserves (1.27 km). However, these distances did not differ at Kusanaba with 2.23 km for random farms and 2.33 km for raided farms.

Discussion

In most years about 2–3% of registered farms were raided by elephants. Because our programme attracted only farmers at risk of elephant crop raiding, the overall incidence of crop raiding in the chiefdoms is probably lower than this (although some raids may not have been reported). Furthermore, most raided farms suffered ≤ 20% crop loss. Apparently, crop damage in the Red Volta region of Ghana has remained low since 1999 (see below), and is no longer important in the regional economy as a whole. However, farms are small, the cultivated field is the farmer's investment for the whole year, and the impact on individual farmers can be considerable. Even a small area raided is catastrophic to the farmer and the farm family. Farmers identify with the plight of their neighbours, and crop raiding affecting one family may generate animosity towards elephants in many. Thus continual efforts should be made to maintain the current low level of raiding incidents and harmony between farmers and elephants. Diversifying economic activities in communities along the corridor could make a significant difference in how farmers perceive elephants.

Unlike most human–elephant conflict zones in Africa, crop raiding in the Red Volta is predictable because of the seasonal migration. Raiding incidents are concentrated in a few months close to the time crops are harvested. Thus, simple measures such as planting crops that can be harvested early helped reduce crop raiding to the low levels reported here (2–3% of registered farmers) from higher levels in the early 1990s (Adjewodah et al. 2003). Although there were no reliable baseline data for assessing crop damage before the project intervention, NCRC (2000)

Table 4. Frequency and extent of crop raiding in relation to distance of chiefdoms from the nearest forest reserve boundary and the Red Volta River

Main village in chiefdom	Distance from main village to forest reserve (km)	Distance to Red Volta (km)	Number of incidents				Mean area damaged per affected farm (ha)			
			2000	2001	2002	Total	2000	2001	2002	Total
Biungu	4.36	7.99	8	0	1	9	0.09	0.00	0.00	0.09
Kusanaba	7.10[a]	8.26	2	12	4	18	1.04	0.09	0.01	1.14
Nangodi	1.28	5.24	0	2	7	9	0.00	0.15	0.75	0.90
Sakote	1.58[b]	4.81	28	5	12	45	0.16	0.02	0.11	0.29
Tilli	2.62[c]	5.33	0	1	2	3	0.00	0.05	0.02	0.07
Widnaba	2.16[d]	6.78	0	0	0	0	0.00	0.00	0.00	0.00
Zongoiri	4.24	14.45	0	6	0	6	0.00	0.21	0.00	0.21
Total			38	26	26	90	1.29	0.52	0.89	2.70

[a] Compared with the main village in each chiefdom, most registered farms were located closer to the river and to forest reserves. For a random sample of 32 registered farms in this chiefdom in 2003, distances to forest reserve ranged from 0.63 to 3.83 km (mean 2.23).
[b] For a random sample of 34 registered farms in this chiefdom in 2003, distances to forest reserve ranged from 0.49 to 1.88 km (mean 1.27).
[c] For a random sample of 18 registered farms in this chiefdom in 2003, distances to forest reserve ranged from 1.23 to 5.48 km (mean 2.65).
[d] For a random sample of 20 registered farms in this chiefdom in 2003, distances to forest reserve ranged from 0.47 to 2.16 km (mean 1.01).

estimated from farmer interviews that about 400 ha of farm were destroyed by elephants over a two-year period (1995–1996) compared with a documented total of 18 ha during 2000–2002. However, we caution that crop-damage data collected through interviews are most likely an exaggeration and may not provide a reliable basis for comparison with our quantitative data. But as many as 133 farms were damaged in 1996 (Sam et al. 1997), compared with an average of 22.2 farms affected from 1999 to 2003 (table 2).

On the other hand, it is possible the decline in crop raiding is a reflection of declining numbers of elephants migrating from Burkina Faso. The lack of incidents in 2003 is likely because elephants apparently that year did not enter Ghana when crops were at the preferred stage of growth (Adjewodah 2004). However, migratory elephants were recorded within 7 km of the Ghana border in 2003 (Sawadogo 2003) and NCRC staff have recorded their return in 2004.

Location of chiefdoms or farm enclaves with respect to the Ghana–Burkina Faso border (on a north–south axis) and to the forest reserves (on an east–west axis) are among factors that determine timing and frequency of elephant crop raiding within chiefdoms. Each year, the annual events of crop damage start with elephant raids in chiefdoms close to the border including Sakote, Tilli and Kusanaba. This pattern probably reflects the cross-border migration and movement of elephants from south-central Burkina Faso to the Red Volta Valley. However, Widnaba, the chiefdom nearest to the border, experienced no crop raiding from 2000 to 2002, indicating that distance from the border is not the only factor. Sam et al. (2002) found that an increasing number of cattle reduces the probability of finding elephants outside the Red Volta forest reserves. Elephants may also avoid areas with increased human presence and disturbance (Barnes et al. 1991; Mpanduji et al. 2002), high poaching or prevalence of physical barriers. However, we have no evidence that Widnaba differs from other communities with respect to these factors.

Within chiefdoms, farms closest to forest reserves and the major rivers are at increased risk of crop damage by elephants. Our observation is consistent with results from elsewhere in Africa. Bell (1984) mentions animals using rivers as channels for crop damage. Naughton-Treves (1997) mentions heavier crop damage in fields at the edge of forests. Parker and Osborn (2001) note increased crop damage at the edge of protected areas and increased crop raiding along river systems in the dry season. Although we lacked the data (that is, locations of a large sample of farms) needed to quantify how risk varies with distance from

forest, the very fact that only farmers near forest reserves registered for the programme indicates the importance of such proximity. This almost certainly reflects elephant preference for these rivers and forests as a migratory corridor (Sam et al. 1997) and underscores the importance of maintaining natural vegetation in these areas against farm encroachment and unnaturally frequent bush fires. We recommend moving some farms away from the reserve boundary to further reduce elephant raiding in the Red Volta Valley. However, crop raiding will continue to remain an issue as long as elephants remain in the valley because they prefer cultivated grasses, such as finger millet, to wild grass, as they seek more nutritious foods in line with the optimum forage theory (Sukumar 1990, 1994). Again in line with the optimum forage theory, our results indicate elephant preference for mature and good-quality crops, which are likely to be more nutritious than immature crops. Bell (1984) and Parker and Osborn (2001) also found that elephants select mature crops over seedlings or immature crops. Thus it will remain important to organize farmers at risk into groups that can share knowledge and quickly haze elephants or harvest crops in response to approaching elephants.

Conclusion

The results from our survey also underscore the urgent need for measures to conserve the Red Volta Valley. This area holds a small and vulnerable population of elephants that seasonally migrate between Ghana and Burkina Faso (and to Togo in the recent past). The key to successful management of the valley and the elephants within it lies in a collaborative effort by stakeholders both in-country and across the borders. A collaborative community reserve approach that will make local communities decision-makers not onlookers, that will make them benefactors from elephants not victims of their activities, holds a promising future for elephants.

We support efforts by IUCN/AfESG to facilitate international collaboration among Ghana, Burkina Faso and Togo to create the Nazinga–Kabore Tambi–Red Volta–Doung elephant corridor to formally link the Red Volta Valley with elephant ranges in south-central Burkina Faso and northern Togo. In this regard, we have developed a concept paper for the Ghana component of this corridor, which will be validated with a broad group of stakeholders and then developed into an implementation plan. The Earthwatch Institute, a charitable international institution supporting field research, is also working with us on a long-term ecological research project in the Red Volta starting from 2005, which will advance Ghana's effort to develop the elephant corridor.

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