Farmers’ Perceptions of the Impact of Wildlife on Small-Scale Cacao Cultivation at the Northern Periphery of Dja Faunal Reserve, Cameroon

Małgorzata E. Arlet & Freerk Molleman

Institute of Ecology and Earth Sciences, University of Tartu, Tartu, Estonia

Abstract: Cacao is mainly grown by small-scale farmers in the understory of tropical forests. Given nutritious food which is easily accessible at low levels of the forest, offtake by wildlife is expected to be high, potentially leading to high levels of perceived human-wildlife conflict. This potential set of consequences, however, has rarely been investigated, and never in Africa. Between July and October 2004, we interviewed 28 cacao growers and visited their plantations near three villages at the northern periphery of the Dja Faunal Reserve in Cameroon. The focus of the research was to assess cacao crop-raiding by small and large mammals, and the methods used by growers to prevent crop damage. Most cacao plantations were located inside the forest; all were outside the reserve. Data from interviews suggested that the cacao was damaged by 12 types of mammal, with squirrels and three primate species (chimpanzee, agile mangabey, moustached guenon) being perceived as causing the most severe damage. Primates were perceived to be responsible for 43% of crop damage. Perceived crop loss from wildlife was not correlated with distance to the village, and was negatively correlated to active guarding of fields, including making noise. Observations in plantations with ripening pods indicated that squirrels and sitatunga antelopes were mainly responsible for crop damage at this time, although we also recorded rotting pods and high levels of dieback (dead branches and trees) due to disease.

Key words: Theobroma cacao, cacao farming, crop-raiding, protected species, small-scale farming, human-wildlife conflict

INTRODUCTION

The combination of slash-and-burn agriculture with bushmeat hunting, as practised by indigenous people in a non-market economy, often does not result in large-scale environmental damage. In contrast, market-based slash-and-burn agriculture in conjunction with transportation networks, market forces, and population growth have turned such agriculture into a major environmental concern (FAO, 1999). A United Nations conference on the environment and development identified tropical deforestation in general, and slash-and-burn agriculture in particular, as global concerns (UNCED, 1992). The resulting ‘alternatives to slash-and-burn programme’ (ASB-Partnership to the Tropical Forest Margins) identified the
humid forests of southern Cameroon as one of the initial benchmark areas in the Guinean forests of West Africa and the Congo basin. As a result of this program, cacao agroforests subsequently were found to be potentially useful for reducing global emissions of carbon dioxide. This was based on observations that agroforestry alleviates the cutting of tropical forests, which is a major factor contributing to accumulating atmospheric CO₂ (ASB 2007), and can promote biodiversity conservation (Rice & Greenberg, 2000; Bos et al., 2007; Delabie et al., 2007; Faria & Baumgarten, 2007; Faria et al., 2007; Harvey & Villalobos, 2007; Salgado-Mora et al., 2007; Schroth & Harvey, 2007).

People living and working in forests are partly responsible for deforestation and bushmeat hunting, and are the same people that could adopt more environment-friendly alternatives. These alternatives would include those which are aimed at poverty alleviation, carbon sequestration, and enhanced biodiversity conservation (Steffan-Dewenter et al., 2007). In Cameroon, cacao grown as an understory shrub in forests has, in the past, served as an economically attractive land use. This changed during the period of 1993-1996 when many farmers rejected cacao growing because of low and unpredictable prices and a changing institutional context of support (Purdy et al., 1998). Until the early 1990s, the Cameroon government provided farmers with free fungicides. With currency devaluation and the end of guaranteed prices for cacao, however, the government discontinued this assistance, insecticides became less available, and many farmers abandoned their cacao plantations. With recent increases in cacao prices, more farmers are again considering cacao growing as a profitable activity (Duguma et al., 2001).

In the human forest zone in Cameroon (Mertens & Lambin, 2000), cash crops such as groundnuts, maize and melon are grown in a transition between slash-and-burn cultivation and sedentary farming (Arlet & Molleman 2007), and cacao (Theobroma cacao) is grown as an understory shrub in forests. At the northern periphery of the Dja Faunal Reserve in Cameroon, farming of crops for personal consumption (as well as peanuts, maize and melon for local markets) is mainly delegated to women (Arlet & Molleman 2007), while men typically cultivate cacao. In this area, therefore, cacao cultivation seems a possible alternative to other male economic activities, such as bushmeat hunting, fishing, and palm-wine production (for personal consumption and for commercial sale), rather than as an alternative to slash-and-burn agriculture. The economic returns from cacao cultivation, however, could also be balanced against plans for palm oil cultivation, which involves a higher degree of forest destruction.

Crop-raiding often causes substantial losses to farmers living near wildlife habitats and protected areas (e.g., Nyhus et al., 2000; Morf et al., 2008; Priston & Underdown, 2009; McKinney & Zamora, 2008; Warren et al., 2007; Kagoro-Rugunda, 2004; Madhusudan, 2003; Tweweyo et al., 2005; Hockings et al., 2009; Hockings & Humle, 2009). Because crop-raiding can affect the profitability of cacao cultivation and also causes resentment of wildlife and lack of compliance with conservation activities, this study examined farmers’ perception of crop-raiding on cacao plantations by mammals, and looked at the methods used to prevent damage to crops, in areas in the northern periphery of Dja Faunal Reserve, Cameroon.

METHODS

Study site

Dja Faunal Reserve (DFR) covers an area of 5000 km² and is located on the Dja River in the central-southern and eastern provinces of Cameroon. Our field site was located at the northern periphery of the Reserve (2° 49’ - 3° 23’ N, 12° 25’ -13° 35’ E), where logging and hunting degrade the still vast forests harboring a high biodiversity (Dupain et al., 2004, Molleman et al., 2005, Mertens and Lambin, 2000).

Data Collection

We investigated cacao damage in three village communities (Mimpala, 12 km from DFR; Doumo-Pierre, 18 km from DFR; and Malen V, 24 km from DFR) through the use of questionnaires and visits to plantations between August - October 2004. These villages work with Projet Grands Singes (PGS) to carry out research on gorillas and chimpanzees at a nearby site, to protect these apes, and to develop alternative sources of income. The plantations were inside unprotected, continuous forest (with scattered clearings around villages) and had a canopy of large indigenous trees. All of the owners of the 39 plantations in this area, 26 men and two women, were interviewed: 16 in Malen V, 7 in Doumo, and 5 in Mimpala. The size of the plantations was variable and not measured, but was estimated to range from 100 to 2000 trees. The two women in our sample had lost their husbands and had younger male relatives working their cacao plantations; these workers also were present during the interviews. Most of the respondents spoke French; those who did not were interviewed with the assistance of one local guide in each village who translated questions into the local Bantu language (Baaju) and the interviewees’ answers into French. The majority of the interviews were conducted by one or both of the authors, and occasionally by a volunteer from PGS, Sandrine Istas.

Information was collected on family size, additional income, labor on cacao plantations (family or hired workers), distance to the village, damage caused to cacao pods and trees, the animal species responsible for damage at each plantation, methods of crop protection, and the
size of the harvest of the previous season (2003). In order to promote greater objectivity in answers to the questions posed, the responders were not made aware of the specific purpose of this study, and knew that we were not going to assist them with pest control.

For each animal perceived to be responsible for cacao crop damage, the damage was categorised by the interviewed person as one of four graded classes: 'very bad (4)', 'bad (3)', 'medium (2)', or 'little (1)'. The cumulative damage (summing the scores of all animals perceived to be active in crop damage) was used as an estimate of total perceived damage to a field.

After the interviews (during the period of August-October 2004), we visited the plantations that were in use in 2004, usually accompanied by the man who worked each plantation, and we recorded visible damage and observed or inquired about methods used to repel animals and prevent raiding. We attempted to quantify damage by randomly selecting 20 trees from each plantation (using blind pointing) and counting pods, noting if there was damage, and assessing which species might have caused the damage. We tried to determine the crop-raiding animal species by studying the specific marks that were left on the pods or the trees, with input from our guides or the owner of the field. The timing of this work was such that the interviews and plantation data were collected approximately two months before peak harvest time in 2004. As such, the farmer’s assessments of the degree of damage/loss to their crops were based on their perceptions regarding the previous year's harvest (2003). Information on the 2004 cacao harvest was later provided by Manfred Epanda Aimé of PGS.

Data analysis

To compare family size with number of cacao fields per household, we used simple regression analysis. When the scores for all mentioned crop-raiding animals were summed across plantations, the resulting cumulative damage variable was nearly normally distributed and ranged from 7 to 56, with a median and mean of 24. Based on this, we made the decision to treat these damage scores as a continuous variable and to then utilize regression analysis in examining relationships between perceived damage and the other measured factors. The subjective damage-category scores were treated as ordinal variables in multinomial logistic regression when analyses were performed on the basis of separate animal species. To estimate the connection between cumulative damage and methods of crop protection, we performed a multiple regression with data from the 28 interviews, with fence, trap, guarding, scarecrow, making noise, and making smoke, as factors. To test whether cumulative damage in a plantation increased with increasing distance to the village, the distance between plantation and village was included in a regression analysis, first on its natural scale, and then in a separate analysis after being log-transformed; this was due to the expectation that the farther from the village, the less any extra distance would matter. All analyses were performed in Statgraphics 5.0.

RESULTS

Quantification of the agricultural system

Most cacao growers were subsistence farmers and reported no other source of income; five growers reported working as field-assistants in PGS, and two also engaged in catching and drying fish.

Surveyed families had on average six members, including an average of 3.5 children. Most had one cacao plantation (67.7%), with a maximum of three (6.45%). Larger families cultivated more cacao fields (regression: F=7.5, N=28, R²=23.7%, P=0.012). In five households, wives and children helped on the cacao plantation. Fourteen farmers worked in cooperation with others during weeding, and helped with guarding neighbouring plantations from crop-raiding animals during the harvest season. One family utilized paid workers on the plantation during the harvest. Out of the 39 cacao plantations visited, 75% were situated inside the forest at distances of >800 m from villages. Most cacao plantations dated from German colonial times (1884-1916), when each man (the great-grandfathers of present growers) had been assigned cacao plants.

Perceived cacao damage

Farmers mentioned 12 species of mammals that they believed damaged cacao pods in the plantations (this is based on N=43 plantations worked in 2003, the harvest year on which the interviews were based; several plantations were abandoned between the last harvest and 2004, the year of the study). These species are enumerated in Table 1. The most common crop-raiding animal was said to be squirrel Sciuridae sp., with 83% of growers affected. Second most cited, and reported to be responsible for 43% of damage, were three primate species: chimpanzee Pan troglodytes, agile mangabey Cercocebus agilis, and moustached guenon Cercopithecus cephus. Farmers complained most frequently about chimpanzees (74% of fields affected), followed by agile mangabeys (68%), moustached guenons (64%), gorillas Gorilla gorilla gorilla (29%), and grey-cheeked mangabeys Lophocebus albigena (3.2%). While squirrels occurred in virtually all plantations, the degree of damage by these animals was not perceived to be as serious as the damage done by other animals.

Prevention of cacao loss

Cacao growers varied in their strategies to prevent crop losses to wildlife. Some growers stated that they camped in their plantations during the period when ripe pods were present. The most frequently reported method to prevent
crop loss was making noise (shouting, beating the trees or metal drums) while guarding (91.7%). Growers actively guarded plantations during the harvest season (45.8%), staying throughout the day and night. They also set traps (37.5%), and 8.3% shouted at animals when these were noticed. Additional reported defensive methods included use of scarecrows (54.2%), or making smoke on the plantations (41.7%). Protective fences around plantations were used only by two growers. Some farmers believed that the fungicides used to prevent cacao damage from black pod \((\text{Phytophtora } \text{species})\), or the insecticides applied to control bugs of the family \text{Miridae} (common name: capsids), were effective in repelling certain mammals.

Most growers (89%) hunted any animals encountered in the forest; most used traps, although two used guns, and one, spears. Although bow and arrows were used by one grower to shoot crop-raiding squirrels, these weapons are no longer used to shoot larger animals. To do so would require poisoned arrows and the tracking of shot animals for several hours (until the poisoned animal collapses). This method has been replaced with the more effective hunting methods that are now available, such as traps with metal wires, and guns (as reported by one grower).

### Effectiveness of crop loss prevention

The perceived cumulative damage was not any greater in the plantations further from the villages (regression: \(F=0.5, R^2=1.9\%, P=0.49\); Table 2). Similar results were obtained when distance +1 was log-transformed, and for all animal types when analyzed separately using multinomial logistic regression.

Reported methods of guarding with making noise \((F=46.31, R^2=76.0\%, P<0.001\%\)), and guarding alone \((F=9.23, p=0.006)\), were those significantly associated with farmers’ perception of lesser degrees of cacao crop damage.

### Site visits

We described 760 trees and counted 7103 pods (2043 ripe or ripening, and 5060 unripe). Sixteen percent of pods were recorded as damaged when counted. One fourth of all trees and 5.4% of all pods were assessed as having been damaged by mammals. When the damage could be assigned to a particular animal, most was by squirrel (3.0% of pods) and sitatunga \((\text{Tragelaphus spekei})\) (1.6% of pods). We saw very little damage to pods that clearly could be assigned to primates (0.03% of pods were designated as damaged by agile mangabeys, and 0.01% by chimpanzees), and damage by these animals was found only during our site visits in October when more pods were ripening. Other animals that had damaged pods were duiker \((\text{Cephalops sp.})\) (0.02% of observed pods), palm rat \((\text{Cricetomys gambianus})\) (0.06%), rat \((\text{Cricetomys sp.})\) (0.6%), and porcupine \((\text{Atherurus africanus})\) (0.06%). We saw some cases of insects damaging pods (0.2% of pods; mirids and some scaly bugs). Damage varied from removed pods to bite marks, but all damage probably led to complete loss of the pod through rot.

Severe black pod damage from the year 2003 was often still noticeable (dried pods in trees or on the ground) during the 2004 surveys, and rotting pods were the most common damage (7.7% of all pods). In addition, an unknown disease had caused gradual dying of the young shoots,
starting at the tips and progressing to the larger branches (dieback). Some trees were so severely affected by this disease that they had died, due to leaf shedding from the dying branches. In total, 20% of all trees examined in 2004 had been affected by dieback. While in some plantations all trees were severely affected, other plantations appeared free of the disease. Even within plantations, the dieback appeared to have a patchy distribution and growers often compared it with fire damage. Trees with serious dieback were generally not bearing pods.

**DISCUSSION**

Our interviews with cacao growers at the northern periphery of DFR complemented a simultaneous study on crop-raiding in subsistence farming in the same area (Arlet & Molleman 2007). All farmers that we interviewed are dependent on agriculture, hunting and gathering for their subsistence, and about 70% reported dependence on cacao crops as their only source of cash income during this study. There are few published studies on cacao crop-raiding (Bhat, Nair et al. 1981; Nchanji & Wright, 2002). Riley (2007) looked specifically into the relationship between humans and macaques in a community in Sulawesi, Indonesia, and noted that crop-raiding on cacao was not (yet) a significant problem. Another study (Priston, 2005), also in Sulawesi, found that monkeys damaged cacao more severely than did pigs, and also noted rodent damage to cacao pods.

The results presented here should be considered preliminary and interpreted with caution. This is largely due to the fact that our study relies heavily on interview data that are inherently subjective, rather than direct observations of animals raiding cacao. We have also taken some degree of liberty in our utilization of regression for the analyses; i.e., the treatment of the cumulative damage scores as a continuous variable when they are artificially created by summing the interview-based ordinal (albeit graded) per-species damage scores for the plantations. Although these caveats need to be kept in mind when interpreting the results, we believe that the main conclusions from the study are robust.

With almost all cacao plantations being inside the forest and only two plantations being adjacent to the villages, it is not surprising that distance to the village was not associated with perceived damage by mammals in our analyses. This result is different from what we found in our examination of crop-raiding by wildlife in subsistence farming, where the crops grown close to the villages were less damaged by wildlife (Arlet & Molleman, 2007). The animals that were raiding cacao are all forest dwellers, including squirrels, primates, antelopes and porcupines; this is in contrast to what was found for the food crops that are grown near the villages, which are mainly affected by resident rodents (Arlet & Molleman 2007). In Mimpala village, which is closest to the Dja reserve, farmers thought that they lost more of their 2003 cacao crop to primates than did the growers in the other two villages. This result could be due to higher wildlife densities nearer the reserve.

Primates accounted for 43% of total perceived damage to cacao crops in the three villages. Cacao growers complained mainly about crop-raiding by chimpanzees and agile mangabeys, and regarded them as important pests at the plantations. Agile mangabeys were also perceived as an important pest for food crops in the studied villages (Arlet & Molleman 2007). Cercopithecine monkeys, such as these agile mangabeys, are omnivorous and adaptable primates that may be perceived as the worst pests among primates because they have an ability to exploit both forest crops and the edge between forests and human farming (Else, 1991; Thomas, 1991).

In contrast to the farmers’ perceptions based on the results from interviews, the most actually observed damage during the visits to the plantations was by squirrel and antelope. This may, however, be a function of the timing of our data collection. Most pods were not yet ripe during our field visits and it is likely that antelopes and squirrels are responsible only for a small proportion of damage to ripe pods. Moreover, antelopes can only damage pods near to the ground. Body size and sizes of groups typical of animal species are also known to affect perception of damage (Hill, 1997; Hill, 2000; Linkie et al., 2007; Siex & Struhsaker, 1999). It is also possible that the results of our interviews could be affected by resentment of conservation intervention. Chimpanzees and gorillas, two of the primates

<table>
<thead>
<tr>
<th>Community</th>
<th>Distance to DFR (km)</th>
<th>Number of Cacao Fields</th>
<th>% of Damage Attributed to Primates</th>
<th>Harvest (kg)</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td>Total 2003</td>
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<tr>
<td>Malen V</td>
<td>24</td>
<td>24</td>
<td>35.1</td>
<td>455</td>
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<tr>
<td>Doumo-Pierre</td>
<td>18</td>
<td>9</td>
<td>35.7</td>
<td>550</td>
</tr>
<tr>
<td>Mimpala</td>
<td>12</td>
<td>6</td>
<td>50.0</td>
<td>81</td>
</tr>
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</table>
which farmers reported to be significant crop-raiders, are protected species and people of these three villages signed an agreement with PGS not to kill apes. This was a major reason why we asked farmers only about possession of guns that could serve as crop-raiding deterrents, rather than asking about the specifics of their use. If these apes are damaging cacao crops, then with decreasing gorilla and chimpanzee populations in the DFR (Wang et al., 2007), and sufficient natural food sources remaining for the smaller populations, the crop-raiding by these primates may decrease.

The only method of crop-damage prevention and protection perceived to be effective by the farmers was active guarding - by making noise, and/or staying at the plantations for long periods of time. A study around Kibale National Park (NP) in Uganda (Naughton-Treves 2001) also showed that guarding was most commonly used by farmers to defend crops against animals, although at that site guarding did not appear to reduce damage from wildlife. This difference may be explained by the degree of cooperation between the cacao growers near Dja in guarding plantations, something which was lacking in the area around Kibale NP (Naughton-Treves 2001). The salience of guarding in our data also may be a function of factors specific to the other potential methods. With only two growers having guns, this factor could not be included in the analysis. Traps or fences are not an effective protection against animals that move in the canopy, or against large animals like chimpanzees; these methods would be expected to be targeted only toward porcupines that feed on pods that are close the ground.

Our observations indicate that plant diseases could have been the most pressing problem for cacao cultivation in this area in 2004. Pod rot was common, and dieback affected 20% of cacao trees (up to 100% of the trees in some plantations), often killing whole trees. This factor should receive attention by specialists, given that more than 80 species of fungus can cause dieback in cacao (Purdy et al., 1998). Dieback certainly was a major concern for the growers, although we did not systematically study their perception of its contribution to crop loss.

More detailed information clearly is needed to quantify crop loss and effectiveness of methods to prevent crop-raiding. Additional research should include data on plantation sizes, types, ages, and productivities; identification of squirrel species; and utilization of exclusion experiments such as those conducted by Priston (2009). Such data could then be compared with growers’ perceptions of the impact of wildlife on harvests. This is not to discount information on peoples’ perceptions, as this is important for designing effective strategies for mitigating problems (Mekoya et al., 2008). Moreover, it seems evident from our data that in this area of Cameroon, cacao cultivation with very little capital input is significantly impacted by crop-raiding by wild animals, insect pests, and diseases which can destroy considerable proportions of harvests. Because growers perceive cacao crop-raiding as a serious problem, raiding by protected animals may decrease local credibility in conservation efforts and the success of protected areas. Based on the results of our study, we feel that if the disease problems can be mitigated, and if cacao prices remain high enough, growers may be motivated to invest more time in guarding plantations from crop-raiding wildlife, a cooperative strategy which appears to be effective in this area. If cacao production can become more profitable, this may both reduce the pressure to grow other crops that cause more deforestation (e.g., oil palm) and decrease the time available for hunting further away from villagers’ homes.

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**AUTHORS’ CONTACT INFORMATION**

*Corresponding author*: Małgorzata E. Arlet, Institute of Ecology and Earth Sciences, University of Tartu, Vanemuise 46, EE-51014 Tartu, Estonia. Email: maarlet@yahoo.com.

Freerk Molleman, Institute of Ecology and Earth Sciences, University of Tartu, Vanemuise 46, EE-51014 Tartu, Estonia. Email: freerkmolleman@hotmail.com.