FINAL REPORT TO:

Rufford Small Grants for Nature Conservation
The Rufford Maurice Laing Foundation

Project: Development of techniques to reduce farmer-wildlife conflict associated with crop-raiding in Masindi District, Uganda.

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1. PROJECT BACKGROUND & AIMS

Conflict between humans and wildlife is particularly prevalent in rural areas of Africa where human communities are located adjacent to forest reserves. Interactions often have adverse effects for humans as well as wildlife, particularly when they involve competition for resources (Conover, 2002). Farmers in these areas rely on subsistence agriculture as well as cash crops for their food security and livelihoods. However, these crops are also an attractive, accessible, and predictable source of food for wildlife – as a result, numerous species may raid crops for food and inflict considerable damage with corresponding impacts on farmer livelihoods. Attempts by farmers to protect their crops may be relatively costly in terms of time and resources, and are often limited in effect. Additionally, farmer responses often result in injuries or death for wildlife and may generate negative long-term demographic impacts. The effectiveness of conservation strategies for primates and other wildlife is also frequently compromised by the impacts of crop-raiding on local communities (Happold, 1995).

In many areas of Uganda, crop damage by primates and other wildlife may reduce seasonal yields by up to 50% (Hill, 2000) and undermine farmer livelihood security. In response, farmers use traps, poison baits, dogs, guns, spears, bows and arrows, and wire snares to protect their crops. These non-species-specific and frequently lethal methods may have deleterious structural and behavioural effects on populations of primates and other wildlife, many of which may already be endangered as a result of habitat loss (Plumptre and Reynolds, 1994). The conflict generated by crop-raiding also reduces local people's tolerance of wildlife and support for conservation programmes. Many methods used to address crop-raiding are not legally sanctioned – however, it is often difficult for authorities operating with relatively few resources to monitor activities. It is also impractical and unreasonable to expect farmers to stop using the only methods that they consider to be effective without providing access to alternatives aligned with conservation goals. Crop-raiding by wildlife is likely to increase in Uganda in the immediate future as a result of government support for shifts from subsistence farming to cash crops in an attempt to reduce rural poverty (Plumptre et al., 2003). Increased habitat loss from forest clearing to facilitate sugar cane plantations will directly impact wildlife populations throughout the Masindi District (Paterson, 2005). The attractiveness of sugar cane for primates in particular, as well as its value for local communities, suggest that conflict will intensify as farmers attempt to protect their crops. This is a considerable threat to the security of primate and other wildlife populations in the region, as well as the livelihoods of local farming communities.

The current situation in Uganda is prevalent throughout many rural areas of Africa and, to date, has not been effectively addressed (Hill et al., 2002). Factors impinging upon the efficacy of techniques to reduce crop-raiding impacts include the extent of farmer co-operation and vigilance, habituation of wildlife to the range of methods used, and the economic and social costs of living with wildlife. Solutions are likely to be based on adaptive management approaches rather than complex and

potentially expensive 'all-encompassing' techniques. Accordingly, research is required to develop inexpensive, effective, and maintainable mitigation strategies that build upon familiar methods and farmer co-operation. These strategies may include early detection of crop-raiding wildlife, barriers, buffers, and/or improving the efficacy of guarding, deterrents, and repellents (Conover, 2002).

The project is investigating interactions between subsistence farmers and wildlife (particularly primates, including baboons, guenons, and chimpanzees) at forest-agriculture interfaces (FAIs) in the Masindi District of western Uganda to understand the dynamics of crop-raiding and develop techniques to minimize conflict and associated costs. The research extends studies of crop-raiding by primates developed by Dr Catherine Hill and Dr Amanda Webber of Oxford Brookes University. The scope of the project includes the impacts of crop-raiding on the livelihoods of farmers and local communities, as well as the demographic and behavioural impacts of traditional human responses to conflict on wildlife in the area. The key application of the research is mitigation of human-wildlife conflict by minimising crop-raiding via non-lethal techniques aligned with conservation goals.

Unlike research to date that has focused on farmer perceptions and documenting crop-losses, this study is examining the behaviour of farmers and wildlife on and near farms to (i) understand the behaviour of wildlife while crop-raiding, (ii) predict how farmer activity influences crop-raiding patterns, (iii) evaluate the efficacy of current crop protection techniques, and (iv) use this information to develop a series of locally appropriate and effective mitigation strategies. Because the research is being conducted in partnership with stakeholders, it is expected that the mitigation techniques developed will (a) be more effective, and used and adapted on an ongoing basis, (b) increase tolerance of wildlife and support for local conservation, and (c) improve relations between farmers, community groups, environmental organizations, and government authorities. Given the increasing prevalence of human-wildlife crop-raiding conflict throughout rural Africa, it is likely that the strategies developed will be transferable to other areas and contexts with equivalent benefits.

2. METHODS

The project is being conducted over three stages, including two extended periods of fieldwork. The first year of research has been completed in accordance with the following timetable:

- Year 1 – October 2005 to September 2006: Pilot study and collecting baseline data. Fieldwork in Uganda from February 2006 to October 2006.
- Year 2 – October 2006 to September 2007: Analysis of baseline data and conducting focus groups and feedback sessions with farmers and other stakeholders. Developing, implementing, and monitoring deterrent techniques, and collection of mitigation data. Fieldwork in Uganda from February 2007 to October 2007.
- Year 3 – October 2007 to September 2008: Conducting workshops and disseminating outcomes with farmers and other stakeholders in Uganda for approximately one month in early 2008. Data analysis and research write-up in the United Kingdom.

The first fieldwork stage of the project has involved interviews with farmers to acquire background information as well as systematic observations of farm-based and forest-edge activities to assess (i) the behaviour of humans on farms, (ii) patterns of crop-raiding across farms, (iii) the effectiveness of farmer-initiated mitigation techniques, (iv) the behaviour of primates and other wildlife during crop-raiding events, and (v) the responses of primates and other wildlife to current crop-protection methods.

The research is being conducted in villages around the southern edge of the Budongo Forest Reserve in the Masindi District of western Uganda. Focusing on the same study area and villages as earlier investigations of primate crop-raiding at forest-agriculture interfaces by Dr Catherine Hill and Dr Amanda Webber of Oxford Brookes University is providing research continuity and facilitating comparisons of results across methods. Villages included in the study are listed in Table 2.1.

Table 2.1 Study villages and locations.

Village	Description	Latitude north	Longitude east	Elevation (m)	Farms in study	FAIs in study
Fundudolo	Fundudolo area in Kanyege village	1.41.083	31.28.627	1053	2	2
Kanyege	Kanyege village and farms	1.41.232	31.29.646	1074	-	-
Kyempunu	Kyempunu village and farms	1.39.567	31.32.095	1079	2	4
Marram	Marram village and farms	1.40.757	31.31.150	1085	2	3
Nyakafunjo	Nyakafunjo village and farms	1.41.741	31.32.451	1087	3	4
Nyabyeya2	Nyabyeya2 village and farms	1.41.265	31.33.215	1102	2	2
Nyabyeya	Nyabyeya village and trading centre	1.40.569	31.32.980	1136	-	-
Panyana	Panyana area in Marram village	1.41.335	31.31.430	1081	2	3

The chairperson of each village was approached after research approvals were granted by the Uganda Wildlife Authority (UWA) and the Uganda National Council for Science and Technology (UNCST). Each chairperson was provided with an outline of the proposed project and data collection methods, and then requested to permit the research to be conducted in the village as well as allow the principal investigator to approach individual farmers for recruitment to the project. Permissions were granted in all cases and farms within each village were visited to introduce the principal researcher to farmers and their families. Farms were identified for potential inclusion in the study after evaluation of their location, dimensions, crop-raiding history, planned range and distribution of crops, and range of view. Information about the background, objectives, and methods of the project was presented to farm-owners for consideration, and then individual farmers were invited to participate in the research. All of the farmers that were approached were interested in the project, supported its objectives and methods, and consented to inclusion in the study. All meetings and discussions with village chairpersons and farmers have been conducted with the assistance of local guides and translators.

The sample of farmers and farms recruited to the study is heterogeneous in terms of farm characteristics, crops, and current protection methods as well as farmer ethnicity, age, family-size, property ownership, and relative wealth, and is representative of the diversity of the human population and farms in the area (see Johnson, 1993). The common feature of all farms is that at least one boundary is directly adjacent to forest and comprises a forest-agriculture interface (FAI). A total of 13 farms incorporating 18 forest-agriculture interfaces have been included in the study (see Table 2.2).

The majority of farms (84.6%) are owned by adult males; only two (15.4%) of the farms are owned by adult females. Farm-owner age groups range from 16-25 years to 55+ years and seven ethnic groups are represented in the sample – Acholi (1), Alur (2), Kakwa (2), Logo (2), Loukuyu (1), Lugbara (4), and Mukonjo (1). Nine (69.2%) of the farm-owners have completed primary-level school education and one (7.7%) has completed secondary-level school education; three (23.1%) of the farm-owners have not received any school-level education. Length of time living in their village ranges from 1 year to 44 years (average = 30.2 years) and length of farm tenure ranges from 1 year to 42 years (average = 15.4 years). The number of people working on farms included in the study ranges from 1 to 8 (average = 3 to 4) and the number of people supported by each farm ranges from 1 to 15 (average = 7 to 8). All farm-owners primarily grow crops for subsistence consumption, although nine (69.2%) also grow some crops for cash sale when yields permit. Working on their farm is the sole source of livelihood and income for ten (76.9%) of the farm-owners, while three (23.1%) also occasionally work outside of their farm, primarily doing contract work on other farms for additional money and/or food. Eleven (84.6%) of the farm-owners own only the single farm while two (15.4%) own an additional farm or field.

Table 2.2 Locations and lengths of forest-agriculture interfaces included in the study.

Forest-Agriculture	Village	Farm	Location	Length (m)
FAI01	Nyakafunjo	Farm01	Southern farm-forest edge adjacent to Farm01.	175
FAI02	Nyakafunjo	Farm01	Forest edge of Farm01.	37
FAI03	Nyakafunjo	Farm02	Forest edge of Farm02.	89
FAI04	Nyakafunjo	Farm03	Forest edge of Farm03.	125
FAI05	Marram	Farm04	Southern forest edge of Farm04.	56
FAI06	Marram	Farm04	Northern forest edge of Farm04.	90
FAI07	Marram	Farm05	Forest and buffer edge of Farm05.	93
FAI08	Panyana	Farm06	Forest and buffer edge of Farm06.	231
FAI09	Fundudolo	Farm07	Forest edge of Farm07.	196
FAI10	Fundudolo	Farm08	Forest edge of Farm08.	116
FAI11	Kyempunu	Farm09	Forest / bush edge of Farm09.	175
FAI12	Kyempunu	Farm09	Eastern farm-forest edge adjacent to Farm09.	108
FAI13	Kyempunu	Farm10	Southern forest / bush edge of Farm10.	92
FAI14	Kyempunu	Farm10	Eastern forest / bush edge of Farm10.	61
FAI15	Nyabyeya2	Farm11	Forest and buffer edge of Farm11.	149
FAI16	Nyabyeya2	Farm12	Forest and buffer edge of Farm12.	57
FAI17	Panyana	Farm13	Northern forest and buffer edge of Farm13.	214
FAI18	Panyana	Farm13	Western forest and buffer edge of Farm13.	183

Each farm has been mapped using a Garmin GPSMAP® 60CS global positioning system (GPS) unit. Information compiled for each farm includes geographic location co-ordinates, key features, perimeter characteristics, edge lengths, area, and elevation above mean sea level. A Stanley 30m open reel measuring tape has been used to calibrate the GPS unit as well as for measurements up to approximately 60m. All GPS data have been averaged over fifty measurements to maximise accuracy of fix, and records have been collated with Garmin MapSource® version 6.11.5 software. Observation sites on each farm have been selected to permit continuous viewing of farmer and wildlife activity and an unobstructed view of the forest-agriculture interface. For the purposes of this study, a crop-raiding event (CRE) is defined as where one or more individuals of a wildlife species enters a farm, interacts with one or more crops, and leaves the farm.

Systematic data collection for the first phase of research has occurred from February 2006 to September 2006 inclusive, coinciding with the primary maize-growing season of the year. All data have been collected after consultation with local communities as well as with the ongoing consent and support of village councils and all farmers participating in the study. Arrangements for data collection are mutually agreed with farmers and all are aware of when they are being observed and that data collection is taking place. Farmers have been encouraged to continue their usual farm practices and activities, including vigilance behaviour and their responses to crop-raiding. Three local Ugandan field assistants have been recruited and trained to assist with all aspects of data collection. Based on information provided by Hill (1993), lists of locally-occurring crops and animal species have been compiled and then coded for data collection purposes. Details of farmers and farms have been coded to preserve anonymity, and confidentiality of data and related information occurs at all times. Protocols, data sheets, and ethograms describing human and animal behaviours were developed over the course of initial observation and training sessions. Both quantitative data and qualitative data have been obtained.

Quantitative data are collected through systematic observations of farm activities, crop-raiding activities, and associated human and animal behaviour. Methods used are instantaneous point scan sampling, all-occurrences continuous sampling, and *ad libitum* sampling (Altmann, 1974; Rose, 2000). Observers work in teams of two at each observation site – one records scan sampling data and the other records continuous sampling data. Timex chronograph digital stopwatches are used to determine time. Bushnell 10x42 wide-angle waterproof binoculars and Brunton Eterna® 405 8x24 waterproof binoculars are used for observations. Scanning occurs from left to right across the study arena and each scan is conducted at a constant and relatively slow rate, requiring an average of between fifty and sixty seconds to complete. Estimates of the type and extent of damage to crops are based on observed counts and are likely to be conservative. Distance estimates for each observer are calibrated with measured values to ensure consistency and reliability (Lehner, 1996; White and Edwards, 2000). Other data collected include weather conditions, crop information, and farmer reports of crop-raiding.

Quantitative data collection is supplemented by semi-structured interviews with farm-owners and their families to acquire background information about farm characteristics as well as qualitative data in relation to perceptions and attitudes (Babbie and Benaquisto, 2002; Bernard, 2002). Initial interviews provided information about (i) land tenure, (ii) farm layout, (iii) crops grown, (iv) methods used to protect crops, and (v) an overview of practices throughout the agricultural year. Subsequent interviews focused on farmer perceptions of the season in terms of crop yields, farm activities, and crop-raiding activity. Informal, short discussions with farmers also occur during visits to farms and villages, providing opportunities to monitor activities and acquire feedback.

Data collection has occurred across all days of the week and daylight hours in order to sample as representatively as possible (Lehner, 1996; Sutherland, 2000; White and Edwards, 2000). However, sampling was conducted relatively less frequently on Sundays to allow farmers and their families' time without observers on their farms. Sampling that did occur on Sundays did not indicate any differences in the range of activities observed compared with other days of the week. Five observation sessions included sampling between sunset and midnight. A total of 346 observation sessions were conducted for a total sampling time of 1,802 hours 30 minutes. Two semi-structured interviews were conducted with each farm-owner, one prior to and one following the primary maize-growing season. Interviews averaged 35-minutes to 40-minutes in duration.

3. PRELIMINARY RESULTS & DISCUSSION

A total of 249 crop-raiding events (CREs) involving 14 animal species were observed over the primary maize-growing season. Primates were involved in 218 (87.6%) CREs, other wildlife species were involved in only 9 (3.6%) CREs, and farm animals were involved in 22 (8.8%) CREs. The total duration of all observed crop-raiding events was 2,693 minutes (44 hours 53 minutes), amounting to 2.5% of total observation time. Although raiding was observed throughout the season and peak raiding months varied, the majority of raiding occurred during July, August, and September. Primates were clearly the most extensive crop-raiders in terms of the number of individuals raiding as well as frequency of raids. Vervet monkeys and baboons were most likely to be crop-raiding when observed near farms. Table 3.1 summarises observed crop-raiding event frequency by month for each species. Almost 60% of crop-raiding events involving primates occurred between noon and sunset rather than between sunrise and noon. Observed crop-raiding events were distributed relatively evenly across days of the week, with the exception of Wednesdays and Sundays. The lower incidence on Sundays may be partly attributed to less sampling as well as to increased human presence on and around farms. Farmer detection of primates during observed crop-raiding events varied for each species. Baboons typically raided in larger numbers than other primates during observed CREs; baboons and chimpanzees tended to travel further onto farms than did other primates. More than half of CREs involved only adults and many involved one adult individual. Whereas all adult and sub-adult primates on farms during CREs ate at least one crop item, infants did not always do so.

Table 3.1 Observed crop-raiding events by species and month – Season 1, 2006.

Species	Observed crop-raiding events: Season 1 - 2006								
	Feb	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Season**
Baboon			6	2	1	18	30	19	76
Blue monkey			1	4	1	10	7	3	26
B&W colobus							5	1	6
Chimpanzee		1	4	4	1		1	1	12
Red-tailed monkey		4	2	8	7	19	13	5	58
Vervet monkey		4		1	3	4	8	20	40
Domestic chicken		5							5
Duiker						1			1
Domestic pig	1					1	2		4
Guinea fowl								1	1
Domestic goat	1		1	1			6	4	13
Hornbill	1								1
Mongoose	1								1
Squirrel						5			5
Total	4	14	14	20	13	58	72	54	249

Chimpanzees and black & white colobus monkeys exhibited a narrower range of behaviours than other primates during observed CREs. Baboons engaged in social behaviours on farms more frequently than other primates. Vocalisations by each species were less frequent during crop-raiding. More than 80% of primates left farms voluntarily during CREs that were not detected by farmers; otherwise, individuals typically fled to forest habitat when chased. The majority of crop-raiding events occurred as single raids during an observation session; however, almost 25% were multiple raids. Crop-raiding by one species at adjacent forest-agriculture interfaces occurred on only 7 occasions; two species were observed crop-raiding at the same forest-agriculture interface on 8 occasions.

Farmer perceptions of wildlife species in terms of the level of damage caused via crop-raiding were gauged from responses during initial semi-structured interviews. Perceptions were consistent across farmers; 84.6% considered baboons to be the 'worst' crop-raider. Resting, travelling, working, and guarding were the main categories of farmer behaviour. Resting and travelling were relatively consistent over the season, whereas working and guarding fluctuated each month. Broadly, CRE frequency was lower when guarding was high, suggesting that crop-raiding is influenced by guarding. Farmers adopted a wide range of responses during observed CREs, primarily chasing, yelling, waving arms, or throwing objects; most responses were by adult males or adult females. Farmers occasionally acted on a pre-emptive basis to the presence of wildlife near farms by using a catapult, yelling, and/or throwing rocks or sticks at them.

Fifteen primary crops were grown on study farms during the season (see Table 3.2). Although crop distributions varied across farms, maize was clearly the most extensive crop in terms of area occupied. Maize was also the most frequently raided crop during observed CREs (see Table 3.3).

Weather data were collected in conjunction with scan sampling; the range and frequency of ambient weather conditions was consistent across observation sessions as well as during observed crop-raiding events, indicating that crop-raiding activity was not associated with particular levels of cloud cover, wind, or rain.

Table 3.2 Crop densities and distributions – all farms.

Rank	Crop	Total crop area (m^2)	Proportion of total crop area (%)	Estimated number of stems / plants
1	Maize	91,370	61.2	263,654
2	Beans	17,370	11.6	84,211
3	Sorghum	9,685	6.5	56,249
4	Matooke	7,715	5.2	2,365
5	Cassava	6,090	4.1	7,373
6	Tobacco	5,475	3.7	4,655
7	Millet	3,435	2.3	85,771
8	Sesame	2,450	1.6	290,654
9	Sugar cane	1,550	1.0	4,712
10	Groundnut	1,200	0.8	21,933
11	Rice	1,125	0.8	23,771
12	Yam	650	0.4	1,389
13	Vanilla	450	0.3	198
14	Sweet potato	380	0.3	1,039
15	Soya bean	280	0.2	215
	All	149,225	100.0	848,189

Table 3.3 Crops raided during observed crop-raiding events.

Crop raided[1]	Baboon	Blue monkey	B&W colobus	Chimpanzee	Red-tailed monkey	Vervet monkey	Other wildlife[2]	Farm animals[3]	All
Maize	48	23			39	12	7	16	145
Beans	22	3	6		8	31		5	75
Matooke	1				11			3	15
Mango	3	1		9			1		14
Greens	6		5						11
Papaya				3			1		4
Cassava	1							2	3
Millet	3								3
Yam								3	3
Total	84	27	11	12	58	43	9	29	273

[1] Two or more crops were raided during a single observed crop-raiding event on 24 occasions.
[2] Other wildlife = duiker, guinea fowl, hornbill, mongoose, and squirrel.
[3] Farm animals = domestic chicken, domestic goat, and domestic pig.

4. FURTHER RESEARCH & PROJECT ACTIVITIES

The first fieldwork stage of the project has been completed, providing:

(i) key insights into the behaviour of wildlife and farmers associated with crop-raiding, and
(ii) the required baseline information for developing, monitoring, and evaluating crop-raiding deterrent techniques as well as human-wildlife conflict mitigation strategies.

Collation and analysis of preliminary results is continuing, and increased detail may be expected as further analysis occurs.

The second fieldwork stage of the project (February 2007 to October 2007) will focus on developing and testing a range of techniques and strategies to deter crop-raiding on the basis of data acquired during the first phase of research. This will involve implementing, monitoring and evaluating these methods in partnership with farmers and other stakeholders. Farmers will be encouraged to modify their crop-protection strategies and practices (or adopt new ones) during this stage of data collection to assess the efficacy of deterrent methods in minimising or eliminating crop-raiding. Focus groups and workshops will be conducted with farmers (i) to provide feedback of preliminary results and considerations, and (ii) as a forum for discussion of their views and perceptions of crop-raiding activities and problems, as well as possible solutions. The third stage of the project (during early 2008) will involve dissemination of results, training, and workshops with stakeholders to implement ongoing strategies aimed at reducing or eliminating crop-raiding conflict across the study area.

Development of cost-effective and time-effective techniques to minimize or eliminate crop-raiding and associated costs will directly benefit farmers by improving their livelihoods and food security. These techniques will also promote wildlife conservation by providing alternatives to current crop-protection methods and increasing tolerance of wildlife as well as support for conservation initiatives. Conservation efforts will be further enhanced by minimising the adverse impacts of conflict on wildlife behaviour and demographics. With permission, all deterrence tools and techniques trialled on farms (such as warning systems, barriers, netting, and repellent devices) will be left in-situ for ongoing use by farmers and extension to other areas and contexts with equivalent benefits.

5. ACKNOWLEDGEMENTS

The following organisations and individuals have provided valuable support and assistance to the project:

Uganda Wildlife Authority.
Uganda National Council for Science and Technology.
National Forestry Authority.
Chairpersons of Participating Villages.
All Participating Farmers and Their Families.
Rufford Small Grants for Nature Conservation – The Rufford Maurice Laing Foundation.
The Leverhulme Trust.
North England Zoological Society
The Primate Society of Great Britain.
Field Assistants – Mawa, Andama, and Amandu.
Andrea Coombs.
Dr Catherine Hill and Professor Simon Bearder.
The Budongo Forest Project.

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