Crop raiding and conflict: Farmers' perceptions of human-wildlife interactions in Hoima district, Uganda

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Crop raiding and conflict: farmers' perceptions of human-wildlife interactions in Hoima District, Uganda

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ABSTRACT

Conflict between humans and crop raiding wildlife is a growing problem, particularly in tropical, unmechanised farming communities where increased competition for resources intensifies the likelihood of human-wildlife interactions. However, conflict can arise as much from perceptions of risk as actual damage, and perceived and actual degrees of risk do not always match.

Hoima District in Uganda reportedly has a long-standing issue of crop raiding. Forest fragments in northern Hoima District support chimpanzees and other primates, and are surrounded by a mosaic of farms. During this study crop damage was monitored in farms next to four forest fragments each week for one year (November 2006 to November 2007), and farmers' attitudes to crop raiding were explored through interviews and focus groups. Most farms lost less than 1% of their crops, and more than half of farms did not experience crop damage by large vertebrates (primates, porcupine, bush pig and civet). Cattle were responsible for over one third of the total area of damage; more than all other large vertebrates combined.

Whilst local people do not consider crop raiding by wildlife to be as severe a risk to crops as disease and weather, conflict with wild animals does exist. Farmers' attitudes appear less influenced by the area of crop damaged than by the frequency of damage events (real or perceived) and by factors external to crop loss: i) ability to control loss and impacts of loss, ii) a fear of personal safety, iii) labour requirements of managing crops. That farmers' opinions of crop raiding animals appear to be shaped more by these external factors than by actual levels of crop loss is a likely consequence of the low level of damage present in the study sites.

This research illustrates that perceptions of conflict between humans and crop raiding animals should always be examined in tandem with actual losses, and that conflict may persist in areas where little loss occurs. Employment of amelioration techniques must therefore be selected with care, as inappropriate use of these tools risks focusing farmers' frustrations onto crop raiding activities and exacerbating conditions.

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ACRONYMS

AEO	Agricultural Extension Office/ Officer
ASA	Association of Social Anthropologists of the UK and Commonwealth
BATU	British American Tobacco Uganda
BC FS	Budongo Conservation Field Station
BFR	Budongo Forest Reserve
CFR	Central Forest Reserve
DEO	District Environmental Office/ Officer
DFO	District Forest Office/Officer
FG	Focus group
GPS	Global Positioning System
HWC	Human-wildlife conflict
IUCN	International Union of the Conservation of Nature
JGI	Jane Goodall Institute
KFR	Kingdom Forest Reserve
LC	Local Chairman
LC1	Local Village Chairman
LCII	Local Parish Chairman
LCIII	Local Sub-County Chairman
LCIV	Local County Chairman
LCV	Local District Chairman
MFC	Men's focus group
MWLE	Ministry of Water, Lands and Environment
NAADS	National Agricultural Advisory Service
NEMA	National Environment Management Authority
NFA	National Forest Authority
NGO	Non-governmental Organisation
SSI	Semi-structured interview
SPSS	Statistical Package for the Social Sciences
UBOS	Uganda Bureau of Statistics
UREC	Oxford Brookes University Research Ethics Committee
UWA	Uganda Wildlife Authority
WCS	Wildlife Conservation Society
WFG	Women's focus group

1. INTRODUCTION

This thesis explores human-wildlife conflict from the farmers' perspective by examining local perceptions of crop loss and attitudes towards raid animals. Further, by identifying which perceptions are a reflection of actual raid events and which are not, and reviewing these differences and similarities in a socio-economic context, this research aims to understand what factors influence farmers' perceptions of crop loss and shape attitudes towards raid animals.

Human-wildlife conflict (HWC) arises from interactions between humans and wild animals. These interactions are becoming more common due to increased competition for resources (Saj *et al*, 2001; Hockings, 2009). In tropical regions, the intensification of competition for resources is caused by human population growth, changing patterns of land use, commercialisation of production systems, habitat clearance and fragmentation (Blair *et al*, 1979; Happold, 1995; Hill, 1997; Chapman and Lambert, 2000; Alvarez and Naughton-Treves, 2003; Dixon *et al* 2009). This has implications for conservation as HWC undermines the stability of wildlife populations (Peine, 2001; Sitati *et al*, 2003; Choudhury, 2004; Lee and Priston 2005; Hazzah *et al*, 2009), and reduces the willingness of local people to participate in conservation efforts (Maikhuri *et al*, 2001; Naughton-Treves, 1998, 2001; Gadd, 2005). Indeed, HWC is highlighted by international conservation agencies such as the IUCN and Wildlife Conservation Society (WCS) as a fundamental challenge for conservation in the 21st Century (Hill *et al*, 2002).

A growing body of literature aims to examine and understand HWC (Madhusudan, 2003; Kagoro-Rugunda, 2004; Graham *et al*, 2005; Tweheyo *et al*, 2005; Holmern *et al*, 2007; Warren *et al*, 2007; Yihune *et al*, 2008; Hockings, 2009; Engeman *et al*, 2010), with much of this research concentrating on the frequency and severity of actual interactions between humans and wildlife. However, conflict can arise as much from perceptions of risk as actual damage (Naughton-Treves, 1997; Gillingham and Lee, 2003; Hill, 2004, 2005), and so understanding people's perception of risk is as important as recording actual losses (Naughton-Treves, 1997; Hill, 2004, Naughton-Treves and Treves, 2005; Webber, 2006). Negative perceptions of wildlife prevent local people from supporting its existence (Gillingham and Lee, 2003). Therefore research that does not review perceptions of risk may not accurately identify the main causes of conflict between local people and wildlife.

Whilst a number of HWC studies do examine local people's perceptions of risk and attitudes towards wildlife (Ezealor and Giles, 1997; Ambarli and Bilgin, 2008; Schumann *et al*, 2008; Campbell-Smith *et al*, 2010; Chauhan and Pirta, 2010), few studies review these perceptions within the context of actual raid events (Naughton-Treves, 1997; Lee and Priston, 2005). This is essential because perceived and actual degrees of risk do not always match (Naughton-Treves, 1997; Siex & Struhsaker, 1999; Gillingham and Lee, 2003; Hill, 2004, 2005; Webber, 2006; Linkie *et al*, 2007), and perceptions of conflict can arise from issues beyond the actual degree of risk. Comparison of both actual and perceived risks enables the identification of areas of conflict that are shaped by external factors, and allows for the formation of more targeted strategies to reduce HWC.

In many farming societies, a significant degree of conflict between local communities and wildlife conservation is generated by the raiding of crops by wild animals (De Boer and Baquete, 1998; Hill, 1998; Gillingham and Lee, 2003; Thirgood *et al*, 2005). Conflict is especially evident in regions where human settlements and the forest-edge are in proximity, and losses to wild animals threaten agricultural production (Knight, 2000).

The impacts of crop raiding on households in areas like Hoima District, Uganda, where farming is largely unmechanised and many farmers grow mainly subsistence crops, are both direct and indirect. Households are directly faced with a lack of food security and a loss of income (Hill, 1997; Webber, 2006; Barirega *et al*, 2010), but indirect consequences of raid events go further than simply an economic drain on households (Hill, 2004) and illustrate the 'hidden costs' of crop loss (Ogra, 2008). A lack of income can result in poor health and a delay in community level development (Webber, 2006). Loss of crop can increase workloads as damaged crops are removed and replaced (Ogra, 2008), and guarding levels are increased (Naughton-Treves, 1998; Hill, 2004). Educational opportunities can be affected by both a loss of income and the likelihood of damage to crops as school fees cannot be paid and guarding duties are undertaken during school hours (Naughton-Treves, 1998). Crop raiding incidents also increase the risk of injury by wildlife as higher levels of guarding increase the likelihood of encountering raid animals (Hill, 2004).

These impacts are likely to shape local perceptions of HWC. Certainly, farmers with prior experience of wildlife raiding activities are less tolerant of raid animals (De Boer and Baquette, 1998; Sitati *et al*, 2005; Linkie *et al*, 2007; Sarasola, 2010), and may perceive risks to be greater than they are (Woodroffe *et al*, 2005). However, as discussed above, perceptions of conflict can also arise from issues unrelated to actual losses. Conservation policies that limit or prohibit access to resources (Hill, 2002); marginal participation in decision-making processes (Gillingham and Lee, 2003, Bisi *et al*, 2007); and prohibition of traditional wildlife management practices (Naughton-Treves, 1997, 2001; Weladji and Tchamba, 2003; Hill, 2005; Naughton-Treves and Treves, 2005; Ambarli & Bilgin, 2008), can all affect perceptions of risk and attitudes towards wildlife and conservation schemes. Also, compensation schemes may be inequitably applied or considered inadequate, (Gillingham and Lee, 1999; Mishra, 1997; Naughton-Treves, 1997; Maikhuri *et al*, 2001; Hill, 2002; Weladji and Tchamba, 2003), and expectations of programmes to reduce crop loss too unrealistic (Hill, 2004).

Local attitudes towards wildlife species also influence perceptions of risk, and the behaviour and characteristics of raid species shape people's attitudes. Large, frequently observed animals are often thought to pose a greater threat to crops than actual losses suggest (Hill, 1997; Naughton-Treves, 1997; Lee and Priston, 2005; Sarasola, 2010). Species that damage large areas of crop in a single raid event, irrespective of frequency, are often perceived to be worse than species that damage greater areas of crop overall (Naughton-Treves, 1997; Naughton-Treves and Treves, 2005; Arlet, 2007), and gregarious or bold crop raiding animals are considered by local people to pose the greatest risk of injury (Sekhar, 1998; Campbell-Smith *et al*, 2010). In addition, cultural perspectives and traditional beliefs may increase or reduce tolerance of animal species, (Sekhar, 1998; Yamakoshi, 2002; Lee and Priston, 2005; Lagendijk and Gusset, 2008; LaFleur and Gould, 2009; Hockings *et al*, 2010; Riley and Priston, 2010).

Agricultural practices employed by farmers influence both actual levels of crop loss and perceptions of risk. Distance between farm and forest is the strongest indicator of actual raid levels (Naughton-Treves, 1997). In addition, crop assemblages, planting patterns, crop protection tools and the existence of neighbours' fields in between cultivated land and the forest can all affect actual losses (Hill, 1997, 2005; Naughton-Treves, 1997, 1998). Perceptions of risk are shaped by the location of farms (Sekhar, 1998; Naughton-Treves, 2001), the size of landholdings (Goldman, 1987), and the level of investment needed to cultivate crop types (Naughton-Treves, 1997, 2001). Further, the level of dependence on crop for income or subsistence (Hill, 2005) and the importance of traditional and staple crops in food security (Goldman, 1987; Hill, 1997; Naughton-Treves 1997) can affect the degree to which losses are tolerated.

In northern Hoima District, mid-western Uganda, forest cover consists mostly of riverine forest fragments surrounded by agricultural fields. The wildlife in these forests includes chimpanzees (*Pan troglodytes schweinfurthii*), olive baboons (*Papio anubis*), vervet monkeys (*Chlorocebus aethiops*), black and white colobus monkeys (*Colobus guereza*) bush pigs (*Potamochoerus larvatus*) and porcupine (*Hystrix cristata*). Forest fragments are progressively encroached upon and cleared for agriculture, and chimpanzees and other wildlife are widely reported to raid subsistence and cash crops on nearby farms (JGI/UWA, 2002a; McLennan, 2008). As a result local people assert that chimpanzees have decreased local incomes and nutritional levels (JGI/UWA, 2002a). Chimpanzees and other wildlife have consequently become the focus of aggression by local communities (JGI/UWA, 2002a; McLennan, 2008). With forest cover in Hoima District rapidly being lost to agricultural expansion, conflict between local people and wildlife, especially chimpanzees is likely to increase (JGI/UWA, 2002a; McLennan and Hill, 2012).

1.1 Aims

In summary, the aims of this thesis are to ascertain whether differences exist between levels of actual crop loss and local perceptions of crop loss in northern Hoima District; to identify the areas in which differences exist, and to explore factors that influence farmers' perceptions of loss and tolerance of risk.

1.2 Thesis structure

Chapter two

In chapter two the administrative system of governance in Hoima District is reviewed, the human demography is explored and the natural environment and classification of forests is examined. The characteristics of the four selected study sites are also discussed, including the level of forest cover, the administrative ownership of forest fragments, the wildlife species present and the degree of HWC.

Chapter three

In chapter three the methods used to map the study sites and to identify levels of crop loss are outlined. The processes of establishing communications with local farmers and the implementation of individual interviews and focus groups are discussed.

Chapter four

The types of farming practices employed by farmers in Hoima District are reviewed in chapter four. As agricultural practices influence both actual levels of crop loss and perceptions of risk, the species of crops that farmers choose to cultivate are examined, the farming systems employed on farms are explored and seasonal labour patterns are described.

Chapter five

Social, economic and cultural factors are discussed in chapter five as these factors are likely to influence farmers' willingness and ability to tolerate loss. The importance of cash and subsistence crops to livelihoods, the influence of income and labour patterns on farming practices, the social, cultural and economic reasons for crop choice, and the reasons for any changes in crop assemblage are all examined.

Chapter six

Actual levels of crop damage, and crop raiding events by wild animals and other species are examined in chapter six. These data are used to determine any differences between farmers' perceptions and actual crop raiding activity. The frequency and degree of damage to crops are identified and the frequency and severity of raids by crop raiding animals are reviewed. Factors that are likely to affect damage levels, such as seasonality, the location of farms, crop choice and employment of crop protection methods are also examined.

Chapter seven

Local people's perceptions of crop damage and attitudes to raid animals are explored in chapter seven. Farmers' perceptions are also reviewed in relation to actual levels of crop damage to determine the areas in which farmers' attitudes differ from actual events. Likely reasons for existent differences are examined, and factors that are likely to influence perceptions of crop vulnerability and tolerance of crop raiding animals are explored.

Chapter eight

Factors most relevant to the existence of HWC in the Hoima District study sample are reviewed in chapter nine. Amelioration techniques appropriate to the study sites are presented, and relevant methods of delivery of these techniques suggested. This chapter also provides indications of how this study can inform other HWC research in similar environments.

2. STUDY SITES: ENVIRONMENTAL AND SOCIAL CONTEXT

2.1 Hoima District: geographical landscape

Hoima District is located in mid-western Uganda (Figure 2.1). The area lies between latitudes 1°00'N and 2°00'N and longitudes 30°30'E and 31°45'E (NEMA, 1998) and extends for 5735km^2 (UBOS, 2007). It is bordered to the west by Lake Albert, which forms part of the Albertine Rift (itself part of the Great Rift Valley geological fault), and to the north by Masindi District.

Natural habitat consists of tropical high forests, woodland, forest savannah mosaic, grassland, broad leaved and conifer plantations, papyrus swamp and water bodies (NEMA, 1998). Tropical forests cover 10% of Hoima District (NEMA, 2008). However, much of this forest is fragmented. The two largest areas of continuous forest are Bugoma Central Forest Reserve (CFR) to the southwest of Hoima District (411.4km^2; NFA, 2005), and Budongo CFR (825.3km^2; NFA, 2005), which, although predominantly situated in Masindi District, extends into north-eastern Hoima District. Most forest fragments occur between these two bodies of forest.

Figure 2.1 Map of Uganda showing the location of Hoima District (Adapted from UBOS, 2007).

2.2 Human inhabitants

Hoima District is part of the Kingdom of Bunyoro-Kitara, and the traditional occupants are the Banyoro. The area is ethnically diverse with nearly every tribe in Uganda represented (NEMA, 1998). Nevertheless, the Banyoro are still the dominant ethnic group (Table 2.1). Population growth in Hoima District is higher than the national average; between 1991 and 2002 the annual rate of population growth in Uganda was 3.3%, whilst in Hoima District the growth rate was 4.7% (UBOS, 2007). Furthermore, the population of Hoima District is projected to double between 2002 and 2016 (UBOS, 2007). Ninety one per cent of the population in Hoima District live in rural areas (UBOS, 2007), and so the rapidly expanding population represents a growing demand for agricultural land, and an increasing strain on natural resources and environments.

Ethnic Group	Percent (%)
Banyoro	60.1
Alur	13.0
Bakiga	6.7
Lugbara	3.7
Others	16.5
Total	100.0

Table 2.1 Ethnic composition of Hoima District, 2002, n = 343.480 (UBOS, 2007)

Administratively, Hoima District consists of two Counties, Bugahya to the north and Buhaguzi to the south. The Counties are further divided into eleven Sub-Counties. Each Sub-County consists of a number of Parishes, which, in turn, contain a number of villages. Like the rest of Uganda, Hoima District has a hierarchical system of council governance consisting of elected Local Chairmen (LCs) at the district (LCV), county (LCIV), sub county (LCIII), parish (LCII) and village (LCI) levels. (NEMA, 1998; UBOS, 2007).

2.3 Classification and management of forests

Forests in Hoima District comprise of three classifications; Central Forest Reserves (CFRs), private forests, and forest owned by the Bunyoro-Kitara Kingdom administration.

2.3.1 Central Forest Reserves

CFRs are protected area forests owned by the Government and maintained by the National Forest Authority (NFA). CFRs differ from National Parks and Wildlife Reserves in

Uganda, in that regulated subsistence use and commercial activities were once permitted (Howard *et al,* 2000). However, an increasing awareness of biodiversity resulted in the classification of CFRs as either industrial sites (e.g. for the use of commercial timber harvesting) or of ecological importance (Howard *et al*, 2000; NFA, 2005). Bugahya County in northern Hoima District contains six CFRs, four of which are classified as industrial production sites (NFA, 2005). The remaining two CFRs are classified as ecological sites for the protection of biodiversity, although one of these is almost totally deforested[1].

2.3.2 Private forest

Forest that is not government owned is classified as private. This includes both individual and customary (i.e. communal) ownership[2]. Private forests are not classified as protected areas and provide rural communities with firewood for cooking, materials for building construction, shade and water for crops and plant species for medicines (MWLE, 2002). Private forest occurs in small fragments across Hoima District. Most are restricted to riverine areas, but they possess much of the remnant high forest in the District.

In 2001, the management of activities in private forests was decentralised to District Forest Offices (DFOs), (MWLE, 2002; Hartter and Ryan, 2010). However, a lack of clarity over management policies (Auren and Krassowska, 2004) caused confusion in areas such Kibale District, and resulted in forest activities being governed by a combination of national directives, traditional and customary access rights and region-specific by-laws (Hartter and Ryan, 2010). In Kibale District this has encouraged an exploitation of private forest fragments (Hartter and Ryan, 2010), which can also be seen in Hoima District and other areas of Uganda (Muwanga, Auditor General, 2010).

2.3.3 Mukihani Kingdom Forest Reserve

Mukihani Kingdom Forest Reserve (KFR) is owned and managed as part of the Bunyoro-Kitara Kingdom estate. However, the Uganda Land Act, 1998, decreed that all reserves be held in trust for the people of Uganda by central and local governments (MWLE, 2002). Consequently, Mukihani is classified as a CFR (NFA, 2005) and overall responsibility is undertaken by the NFA (Rweru[3], pers. comm. 2006).

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[1]Bujawe CFR in Buseruka Sub-county.

[2]In customary ownership forests are traditionally managed and protected by communities according to principles and rules agreed either amongst themselves or in accordance with tradition (MWLE, 2002).

[3]Simon Rweru, Bunyoro-Kitara Kingdom Forest Guard.

Mukihani KFR consists of a ring of hills surrounding tropical high forest and forest savannah mosaic. The outer slopes of the hills support woodland and scrub. Cultivation inside the Reserve is permitted by the Kingdom estate but is restricted to one year of planting, after which the land is earmarked for plantation timber (Birongo[4], pers. comm. 2006). Pine plantations also cover the peaks of previously degraded hills (Rweru[3], pers. comm. 2006).

2.4 Wildlife

The forests and forest patches of Hoima District support medium size mammals and rodents such as bush pigs, civets, porcupines, rats, squirrels, and also primates. Primates widely found are the olive baboon (*Papio Anubis*), vervet monkey (*Chlorocebus aethiops*) and the black and white colobus monkey (*Colobus guereza*). Also present are the red-tailed monkey (*Cercopithecus ascanius*), blue monkey (*Cercopithecus mitis stuhlmanni*) and the grey-cheeked mangabey (*Lophocebus albigena*). In addition, chimpanzees (*Pan troglodytes schweinfurthii*), which are classified as Endangered (IUCN, 2008), are found in areas across Hoima District (Plumptre *et al*, 2003a).

It has been estimated there are approximately 69 chimpanzees in the fragments and smaller CFRs between Bugoma CFR to the south west of Hoima District and Budongo CFR at the north-western border with Masindi District (Plumptre *et al*, 2003a; Plumptre *et al*, 2003b), although this figure is likely to be higher (McLennan, 2008). As discussed above, most CFRs in Bugahya County to the north are not managed for biodiversity and have little remaining forest, whilst most of the remnant high forest in this area occurs in private forest. These unprotected private forests therefore support chimpanzee populations either wholly or as part of their home ranges.

2.5 Human-wildlife conflict in Hoima District

Following a request by the Uganda Wildlife Authority (UWA), in 2002 the Jane Goodall Institute Uganda (JGI) partnered UWA to conduct a four-day study into human-chimpanzee conflict in Hoima District (JGI/UWA, 2002a). This was followed by a workshop attended by stakeholders including local officials, business leaders, NGO personnel and village elders (JGI/UWA, 2002b). JGI/UWA reported that farmers in Hoima District have a long standing problem of crops being raided by chimpanzees (2002a) and other wildlife. Deforestation is a “huge problem” in Hoima District

[4]Birongo, Bunyoro-Kitara rent and tax collector.

(Mwesigye[5], pers. comm. 2006), and JGI/UWA (2002a) stated that forest fragments are progressively encroached upon and cleared for agriculture. This is particularly acute in private forests (Muwanga, Auditor General, 2010) and is reportedly made worse by poor land tenure systems, little local awareness, unsustainable agricultural practices, and a lack of co-ordination between government offices (JGI/UWA, 2002b). As a result of deforestation chimpanzees have become dependent on farmers' crops (JGI/UWA, 2002a).

In addition to a loss of habitat, conflict between wildlife and local people in Hoima is informed by perceptions of personal risk. A number of attacks by chimpanzees on local people were reported to have occurred prior to the start of the study (JGI/UWA, 2002a; Cox[6], pers. comm; Kisembo, Wagaisa farmer, pers. comm)[7]. In addition, chimpanzees are particularly disliked by local people because they are believed to rape women (Mwesigye[5], pers. comm. 2006).

A number of further factors are likely to contribute to chimpanzee-farmer conflict issues. Firstly, wild forest animals classified as vermin by the Uganda Wildlife Authority (UWA) can be legally hunted with permission from the local authorities or UWA office. This classification consists of baboons, bush pigs and vervet monkeys (JGI/UWA 2002b). Chimpanzees are protected by law. However, chimpanzees, along with baboons, are considered the most rampant raid animals, and it is reported that this situation can no longer be tolerated by farmers (JGI/UWA, 2002b).

Secondly, under the National Forestry and Tree Planting Act, 2003, the NFA invited individuals to lease plots within CFRs that are classified as industrial sites, to cultivate plantation tree species such as pine and eucalyptus (Muwanga, Auditor General, 2010). This policy was designed to offset illegal logging in CFRs designated as ecologically important, and increase insufficient fuel and timber reserves (Babwatera[8], pers. comm.). However, many CFRs in northern Hoima District classified as industrial sites support chimpanzees and other wildlife, and this policy will further reduce available habitat. In addition, a number of privately leased plots within CFRs in Hoima District have been cleared and not replanted at all (Muwanga, Auditor General, 2010).

[5]William Mwesigye, Warden in Charge, UWA Hoima and Kaiso-Tonya Wildlife Reserve, Hoima District.
[6]Debbie Cox, Jane Goodall Institute (JGI), Uganda.
[7]During the study two further incidents occurred. Both cases occurred in Bulindi Parish, and in both cases a child was attacked by a chimpanzee but was released.
[8]Fred Babwatera, Director, Budongo Conservation Field Station (BCFS).

2.6 Study sample

Four villages in Bugahya County, northern Hoima District were chosen as study sites (Figure 2.2). Three are situated next to private forest fragments, whilst the fourth is adjacent to Mukihani KFR. These sites were chosen as representative of chimpanzee ranges where intense conflict was reported as well as areas where conflict was seldom reported. Villages were also selected for their proximity to a discernable forest edge, and for the range of both subsistence and cash crops farmed. In addition, all villages were within daily travelling distance from the research base in Hoima town, and could be accessed throughout the year, irrespective of weather conditions. The four villages are Kiseeta, Wagaisa, Kihomboza III and Nyakamwaga.

Closed and open woody vegetation	**Study sites**
Open trees, 40 – 65% tree cover	**Hoima town**
Closed and open trees and shrubs	**Research base**
Road	**Mukihani KFR**

Figure 2.2 Detail of northern Hoima District showing study villages (Adapted from Africover, FAO 2011).

Kiseeta, Wagaisa and Nyakamwaga lie alongside private forests. The forest adjacent to Kiseeta is a riverine fragment approximately 1km in length. The village extends alongside the forest patch and continues for 1.5km away from the forest edge. Eighty households reside in Kiseeta village. Wagaisa also lies alongside a riverine forest patch, and the forest-farm boundary extends for 1.7km. The village continues along the river for another 1km but the forest has been cleared from this section. Wagaisa village extends 500m away from the forest edge and consists of 40 households. At the beginning of the research period both forest fragments contained thick high forest. However, during the study both areas were extensively degraded and it became possible to see deeply into the forest patch at Kiseeta, and through the forest at Wagaisa. Resident primates in Kiseeta and Wagaisa are vervet monkeys, black and white colobus monkeys and also chimpanzees for periods of time. Conflict between farmers and chimpanzees, as well as other primates, has been reported in both villages.

Nyakamwaga borders a fragment of private high forest in a steep riverine valley, which is approximately 700m long and 600m wide. The village consists of 25 households and extends for 800m from the forest fragment. Primates known to be present are vervet monkeys, black and white colobus monkeys and red tailed monkeys. Farmers complain of crop raiding by baboons, vervet monkeys and black and white colobus monkeys, and some cash crop farmers also complain of chimpanzee raids.

Kihomboza III extends for 1.4km along the outer base of one of the woodland hills that delineates the Mukihani KFR boundary. The village consists of 60 households located up to 650m from the KFR edge. Tropical high forest is present over the hill inside the KFR, although some of this had been recently cleared for agriculture. Vervet monkeys, black and white colobus monkeys and baboons are present. Chimpanzees are reported infrequently, and are not known to damage large areas of crop. Consequently, few people complain about these primates.

Chimpanzees present in the forest fragments adjacent to the four villages have not previously been studied and are therefore unhabituated to researchers. However, they are likely to encounter local people on a regular basis as footpaths, wells, gin distilleries and pit-sawing operations are present in the forests. In addition, at the start of the study period a primatologist implemented a programme of chimpanzee observation inside the forest at Kiseeta and surrounding forest fragments. Those observations continued throughout the duration of this study. The two research projects were in proximity in Kiseeta only; the primatological research did not extend to Wagaisa, Kihomboza III or Nyakamwaga. Furthermore, this research into HWC issues is not associated with any primatological organisation or field station.

3. METHODS

3.1 Introduction

The field research was carried out in two parts; a pilot study was undertaken from February to June 2006, and data were collected during the main research period from mid November 2006 to early November 2007. The aims of the pilot study were to, i) investigate potential study villages adjacent to forest fragments in Northern Hoima District, ii) select favourable study sites and seek approval from local administrative, community and village personnel, iii) map a sample area next to the forest-farm boundary in each of the villages where permission was granted in preparation for data collection during the main study period.

The main study period extended for twelve months to incorporate a complete bimodal rainfall cycle. In Hoima District rainfall levels peak between March and May, and between September and December. The rain is usually heaviest during this second rainy period (UBOS, 2007). The cultivation of crops is dependent upon seasonal rains, therefore growing seasons coincide with periods of higher rainfall (Figure 3.1)

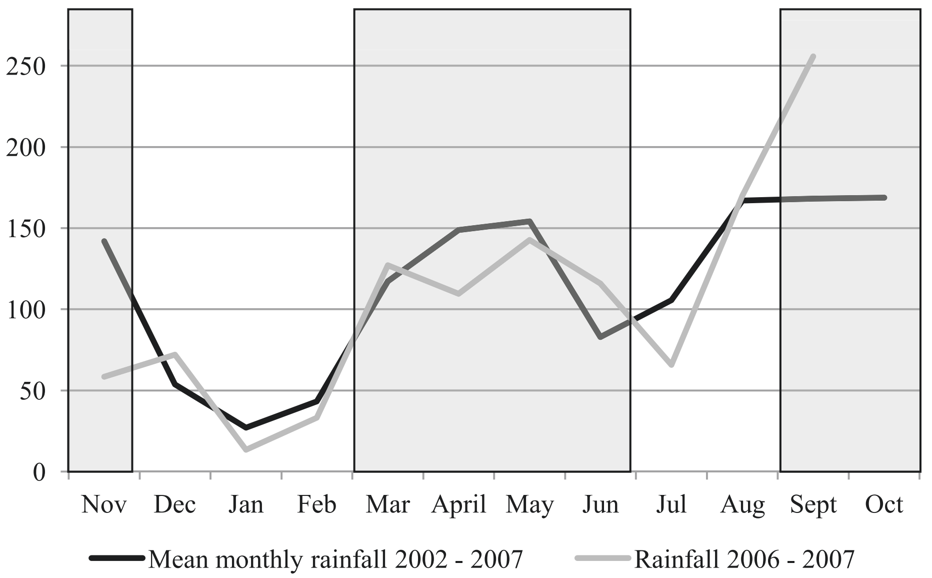

Figure 3.1 Rainfall levels (mm) during the study period (2006-2007) compared with mean monthly rainfall (mm) from 2002–2007, (provided by T. Karwemera, NARO Agricultural College, Bulindi). The shaded areas denote growing seasons.

Most crops are planted during both growing seasons, and are harvested two to three months later, at the end of that growing season (Table 3.1). The planting patterns of sweet potato, cassava and sugarcane differ from this as these crops can be planted at any time of the year. However, as with other crops, peak planting usually occurs at the onset of periods of increased rainfall (Muwanga, *et al*, 2001; Nabeta and Wetala, 2001; Otim-Nape, *et al*, 2001).

Cassava, banana and sugarcane take longer to mature than annual or biannual crops. Cassava and sugarcane plots are usually maintained for between one and two years (Nabeta and Wetala, 2001; Otim-Nape, *et al*, 2001), whilst banana is a perennial crop. On farms in Hoima District these species are usually harvested piecemeal throughout the year.

	Growing season							Growing season				
Crops	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Maize *Zea mays*	P	P	H				P	P	H	H		
Beans *Phaseolus vulgaris*	**P*	*P*	*H*				P	P	H	H		
Groundnuts *Arachis hypogaea*	P	P	H				P	P	H	H		
Rice *Oryza spp.*	P	P	H				**P*	*P*	*H*	*H*		
Millet *Eleusine coracana*	P	P	H				**P*	*P*	*H*	*H*		
Pigeon peas *Cajanus cajan*			H	H	H		P	P				
Tobacco *Nicotiana tabacum*							P	P	H	H		
Sweet potato *Ipomoea batatas*	P	P/H	P/H	H			P	P/H	P/H	H		
Cassava *Manihot esculenta*	P/H	P/H	P/H	H	H	H	P/H	P/H	P/H	P/H	H	H
Banana *Musa spp.*	P/H	P/H	H	H	H	H	P/H	P/H	H	H	H	H
Sugarcane *Saccharum officiuarum*	P/H	P/H	P/H	P/H	H	H	P/H	P/H	P/H	P/H	H	H

Table 3.1 Planting and harvesting patterns of the main crops. P=planting, H=harvesting, * minor growing season (R. Balijwa, S. Ndoleriire, J. Ruhigwa, pers. comm).

3.2 Selection of study sites

3.2.1 Area reconnaissance

Exploratory visits were made to villages adjacent to forest edges where chimpanzees were reported present. Field research of this size and type had never been undertaken in the villages in Northern Hoima District, and visits from non-national personnel were extremely unusual. In addition, no current maps of the area existed, (the most recent being Ordnance Survey maps circa 1965). For these reasons, initial visits were undertaken with the assistance of local rangers from the National Forest Authority (NFA), the District Forest Office (DFO) and the Bunyoro-Kitara Kingdom Office. In addition to being familiar with the area, these personnel were known to farmers within the villages.

The four village sites were selected for their inclusion in chimpanzee ranges and for the differing levels of chimpanzee-farmer conflict reported. Each village was adjacent to a discernible forest edge, and supported both subsistence and cash crops. All villages were within daily travelling distance from the research base, and could be accessed throughout the year, irrespective of weather conditions.

3.2.2 Local approval

Once the four villages had been selected, permission to undertake research in these areas was sought from publicly elected officers, or Local Councillors (Chairmen) (LCs). Uganda has a strong system of hierarchical governance, and it was expected by Councillors and villagers alike that permission should be obtained from the LC offices prior to approaching farmers. Thus, permissions were obtained at the District (LCV), Sub County (LCIII) and Village level (LCI).

Formal introductions to farmers took place during village meetings arranged by the LCI Village Chairman of each selected village. The purpose of the study was explained and permission to undertake the research was sought. As some farmers with land likely to be examined were absent from village meetings, the research team visited individual households to seek approval for the research programme. In addition, due to a high level of suspicion and rumour in a number of the selected villages, households outside of the likely areas of examination were also visited to familiarise farmers with the research team and the proposed study.

Permission to undertake data collection was refused by one person with fields inside the sample areas at the outset and by a second person during the last month of the study. Furthermore, seven farmers could not be contacted due to absence or sickness. With two exceptions these fields were examined from the farm boundaries. The two exceptions were excluded from the study.

3.3 Research team

Three local farmers were employed as field assistants. All belong to the locally predominant Banyoro tribe and spoke both Runyoro and English. In addition, two of the three spoke KiSwahili, a nationally recognised language in Uganda. All three had at least secondary school education and one had been employed, on an *ad hoc* basis, as an agricultural advisor (Agricultural Extension Officer: AEO) by the Hoima branch of the National Agricultural Advisory Services (NAADS). None of the field assistants resided in any of the four villages selected for the study, but they lived nearby and, being Banyoro, were considered by the mainly Banyoro village farmers to be neighbours.

Field assistants helped in the mapping of sample areas; the collection of crop damage data; and with translation during interviews, focus group discussions (FGs) and in daily encounters with farmers in the study sites. Prior to commencing data collection, field assistants were trained in the use of Global Positioning System (GPS) handsets (Garmin Ltd), and in mapping and recording techniques. This training was carried out by the researcher at the research base over the period of approximately two weeks and involved practice scenarios and small individual tests. In addition, training sessions were undertaken 'in the field'. During these sessions the team discussed and collectively agreed known signs of crop damage by particular animals. This knowledge was drawn from field assistants' experience as well as a field guide (Stuart, 2000). Each team member was then required to identify damage and to evidence their reasoning. Training at the study sites also served to ensure that all field assistants and the researcher recognised and recorded crop damage in the same way.

Once data collection had started, the monitoring of crop damage was initially undertaken by the researcher and three field assistants as one group to ensure consistency of method between field staff. After this initial period the field assistants and researcher divided into two groups to examine each sample area. Each person examined the same section of a sample area for two consecutive weeks, and rotations were staggered. In this way, one member of the research team in both groups was able to verify whether observed damage had been encountered the previous week. In addition, staggered rotations ensured that each team member regularly worked with all other team members, thereby ensuring that errors in individual observer identifications were minimised.

3.4 Mapping of farms

Three of the four sample areas were mapped during the pilot study. However, as the preliminary process of seeking permissions from village farmers took longer than anticipated, the fourth sample area, in Nyakamwaga, was mapped at the beginning of the main study period.

A sample area 1km x 0.5km in size was mapped out next to the forest/KFR edge in each of the four study sites by measuring a distance of 1km alongside the forest-farm boundary and extending 0.5km into agricultural fields. Distances were measured using the GPS handsets. The size of the sample areas was selected to incorporate a number of farms, and to enable comparison with other forest-farm boundary conflict studies (Naughton-Treves 1997, Webber, 2006). In addition, as most damage events by forest wildlife are reported to occur within 250m of the forest-farm boundary (Hill, 1997; Naughton-Treves, 1997; Webber, 2006), a sample area extending for 500m from the forest/KFR edge was likely to capture most raids by forest animals, even if they had taken place at some distance from the forest-farm boundary.

Within each sample area boundaries of farms, fields and plots were recorded using GPS technology (Garmin Map 76 handsets), and the crop assemblage of each plot was recorded (Table 3.2). Farmers assisted in the identification of farm boundaries and the ownership and management of fields. Where necessary, the outer edges of sample area were modified to ensure that whole fields were included. Homesteads, inter and intra-farm paths, primate feeding trees, and any crop protection installations such as traps, scarecrows or guard huts were also recorded. These data were then entered into mapping software (Garmin MapSource version 6.11.6, Trip and Waypoint Manager v4) in order to produce scaled maps of the sample areas (Appendix 1). The maps were used to navigate around the farms during the study period.

Level	Description	n
Study site	Villages selected for study	4
Sample area	1km x 0.5km area within each village examined each week for crop damage	4
Household	The unit of people living or working on one farm	94
Farm	Total area of land owned by one household. This may comprise one or more 'fields'	94
Field	Distinct but continuous area of ownership. Fields consist of one or more 'plots'	105
Plot	Discrete area of particular crop types or intercropping systems, usually delineated by a border (for example, bush or footpaths), or a change in crop assemblage	214

Table 3.2 The different levels of area/farming described during the study and monitored for crop damage.

The areas of each plot, field and farm were calculated using Trip and Waypoint Manager, and the total area of each crop calculated. Any changes to plot boundaries and crop assemblages that occurred during the research period were recorded at the beginning of each new season, (March, July and September). Farm sizes and the areas of each crop type were correspondingly recalibrated.

3.4.1 Crop densities

Prior to the commencement of crop damage data collection, mean planting densities for individually planted crops[9] were calculated (after Naughton-Treves, 1998) (Table 3.3). Mean planting densities allow for a rapid and accurate assessment of the area of crop damaged during a damage event. On encountering raid damage, the number of damaged stem groups[10] are counted and, using planting densities, are converted into area (m^2) damaged. This method was particularly useful for individually planted crops where direct measurement was impractical due to reduced visibility caused by crop height. In addition, the frequent inter-cropping of individually planted crops species would have skewed direct area measurements of the number of damaged stem groups.

[9]Maize, cassava, sweet potato, banana, pigeon peas, sugarcane and tomato.
[10]A stem group is a distinct group of stems or separate plants originating from the same planting point.

	Tomato	Cassava	Maize	Banana	Pigeon peas	Sugarcane	Sweet potato
Stem groups per $25m^2$ (n)	45±4.16	15±5.60	13±4.69	7±2.55	7±1.30	9±0.84	31±3.85
Tubers/canes per stem group (n)						10±0.71	5*
Tubers/canes per $25m^2$ (n)						90	155

Table 3.3 Mean planting densities for individually planted crops obtained from random quadrats in all four sample areas. The number of quadrats measured for each crop: tomato n = 5; banana n = 5; pigeon peas n = 5; sugarcane n = 5; sweet potato n = 5; cassava n = 10; maize, n = 9.*Advised by field assistant.

Mean planting densities were calculated by temporarily placing $25m^2$ (5m x 5m) quadrats in randomly selected positions in randomly selected plots across all four sample areas. A measuring tape was used to establish quadrat boundaries, and poles and string were used to construct the quadrats. The number of stem groups within each enclosure was counted. A minimum of five quadrats were placed for each crop type.

Damaged sweet potato tubers were often found detached from the parent plant, and as sweet potato plants intertwine both above ground (vines) and below ground (tubers), it was not always apparent which plants had been damaged. Similarly, sugarcane damage was often evidenced as one or two canes lying away from the main crop, within which damaged plants were not easily discernable. Thus, for sweet potato and sugarcane, in addition to calculating the mean planting density of stem groups, the mean number of tubers/canes per stem group was recorded. In this way, the area of crop damage could be ascertained from either the number of damaged stem groups or the number of individual damaged tubers/canes (Table 3.3).

The area of damage to sown crops such as beans, groundnuts, rice, millet soya bean and cow peas was measured directly. These crops could be more easily viewed, and the plants were not usually intercropped. In addition, the measuring of individual stem groups would have been impractical.

3.4.2 Complications to mapping farms

The identification and recording of farm boundaries was often not straightforward. Farms at the forest-farm boundary frequently had ‘soft’ edges, whereby the integrated regeneration of non-forest, wild vegetation and forest plant species, combined with the absence of large forest trees at the forest edge, rendered the exact delineation between farmers' land and the forest unclear. In addition, regenerating wild vegetation in fallow areas next to the forest edge was extremely dense and the research team had difficulties navigating a route through the vegetation whilst maintaining sight of the forest-farm boundary. In addition, a number of farms away from the forest-farm boundary were also delineated by inaccessible areas of regenerating uncultivated vegetation. Boundaries at these sites were estimated by gathering GPS co-ordinates as near as possible to the inaccessible areas and connecting the points on the resulting maps.

Assessment of the areas of crop cultivated in plots was also difficult to quantify in some circumstances. Areas of crop in plots were assessed by using GPS technology to determine plot sizes, and by recording the crop species cultivated within. However, plots were sometimes sub-divided into two or three distinct or overlapping areas of crop species. The areas of these sub-plots were irregular, and if small, the boundaries were difficult to assess with GPS handsets as the scale of accuracy was not precise enough. A combination of visual assessment and GPS recording of the longer boundary edges was used to determine the areas of crop in these sub-plots.

3.5 Data collection: actual crop loss

Each of the four sample areas was examined weekly for evidence of crop damage (after Naughton-Treves, 1997, and Webber, 2006). The location of damaged crops was logged using the GPS handsets, and details of the damage event were recorded. These comprised the plant species, the stage of growth, the plant parts attacked, the severity of damage and the size of the damaged area. Evidence of bite marks, trails, tracks, scats and hair strands were also recorded. Patterns of crop damage and evidence of animal presence were used to identify crop raiding animals. The likely species responsible, or other causal factor, was indicated only when positive identification could be made through two distinct pieces of evidence (after Webber, 2006) (Table 3.4).

Animal	Evidence	Evidence	Evidence
Vervet	Cobs peeled/shredded	Central stem unbroken	
Colobus	Roughly broken central stem	Bite marks/chew marks	Leaves eaten
Chimpanzee	Sizeable teeth marks	scattered remains	
Baboon	Size of damaged area	Non selective damage	
Rat	Small mouth spits present	Gentle digging	
Squirrel	Teeth marks, larger than for rat	Vigorous digging	
Bird	Footprints/peck marks	Shredding of plant fibre	
Cattle	Flat cutting of plant	Footprints	
Goat	Leaves browsed	Hair/footprints	

Table 3.4 Evidence used to identify the species responsible for damage events.

Damage that occurred in one continuous area on one type of crop was recorded as one damage event (Table 3.5). If the damaged area was intercropped each plant type was recorded. The frequency of damage events are counted differently depending on whether they are viewed from the perspective of the animal or the damaged plant. In addition, non continuous, but adjacent areas of crop damage by large vertebrates were recorded as one damage event, whereas non continuous areas of small vertebrate damage were always recorded as separate damage events.

Damage event	Animal event (n)	Crop event (n)
1 crop, continuous area	1 event	1 event
>1 crop, continuous area	1 event	>1 event
1 crop, non continuous area/adjacent areas (large vertebrate)	1 event	1 event
>1 crop, non continuous area/adjacent areas (large vertebrate)	1 event	>1 event
1 crop, non continuous area/adjacent areas (small vertebrate)	>1 event	>1 event
>1 crop, non continuous area/adjacent areas (small vertebrate)	>1 event	>1 event

Table 3.5 Quantification of damage events.

Initially, a measuring tape was used to measure all areas of damage to sown crops, but due to some negative reactions from farmers[11], it was considered more prudent to 'pace' out the area of the damage by firstly, calibrating a researcher's pace length (prior to each individual measurement), and then pacing the length and breadth of the area of damage.

[11]A number of farmers voiced suspicions (directly and within the villages) that measuring was being carried out prior to an attempt to confiscate land for a gazetting programme.

With the exception of banana and pineapple, the presence of fruit crops and cocoa plants were often observed as one or two trees or bushes rather than a cultivated plot. Therefore damage to cocoa pods and fruits, described here as 'non-plantation fruits' (guava, jackfruit, mango and papaya), was recorded as unit losses rather than area damaged. Fruit trees/cocoa bushes and the surrounding area were examined for signs of damage; partially consumed fruit, skin remains, seeds and stones, and damaged fruits were counted.

3.5.1 Complications to measuring actual crop loss

The non receipt of permissions to monitor some farms within the sample areas meant that any evidence of crop damage on these farms had to be processed from a position outside of the farm boundary. The number of damaged stem groups was counted as accurately as observation levels would allow, and areas of damage to sown crops were estimated. Fortunately, most of the fields belonging to these households were small and could easily be observed from nearby pathways. Two farms could not be fully observed from boundary positions and were excluded from the study.

The monitoring of two plots next to the forest edge was also temporarily suspended due to information that leg-hold traps (man-traps) were present. In one case the research team were advised within a week by household members as to the whereabouts of the trap, and were able to recommence the monitoring of the plot. In the second case the research team took some weeks in locating members of the household, who were able to reassure the research team that no leg-hold traps had been set.

Weekly, rather than daily monitoring of sample areas meant that evidence of some raids may have been lost by the time the research team visited. Environmental factors, such as rainfall, may have washed away tracks, trails and scats, and human behaviour, such as the removal of damage event debris, may have cleared away evidence of damaged crops. Indeed, the researcher is aware of two occasions on which damaged crops were cleared away prior to the weekly visit of the research team.

Crops were planted and harvested over extended periods (as Naughton-Treves *et al*, 1998; Arlet and Molleman, 2007). This meant that seasonal patterns of crop cultivation were difficult to identify (Arlet and Molleman, 2007) and associations between seasonal plant presence and damage events were not immediately clear.

3.6 Data collection: perceived crop loss

3.6.1 Semi-structured interviews

Semi-structured interviews (SSIs) were used to examine farmers' perceptions of crop loss, raid animals and crop cultivation. Whilst structured questionnaires allow for a more quantitative comparison of interviewee opinions by encouraging standardised responses through the provision of, or allowance for, a limited choice of answers (Bryman, 2001), the rigid structure discourages interviewees from elaborating on issues that may be especially pertinent to them. In contrast, SSIs, comprising open and closed questions, provide both an element of structure, which enables comparability between interviews, and a flexibility, which allows both participants (interviewer and interviewee) to discuss topics in more detail if required (Hill, 1998; Bryman, 2001). In this way, valuable information can be gathered that might not otherwise have been explored. This interview technique is especially beneficial when discussing sensitive topics, such as human-wildlife conflict, where relevant questions on structured questionnaires would be too direct and therefore inappropriate, and may serve to disguise, rather than reveal, local opinion.

Interviews were sought with a representative from every household that cultivated fields within the study sites (N = 94). However, a number of households (n = 39, 40%) were not interviewed due to refusal (n = 1), referral to the testimony of neighbours (n = 3), recent arrival in the area (n = 1), and unavailability due to, i) illness or absence from the village homestead (n = 11), and ii) residing elsewhere (n = 23). In order to increase comparability with other studies (Naughton-Treves, 1997; Hill, 1998; Webber, 2006) and to increase the robustness of the data collected, households outside the sample areas were also approached for interview. To ensure that participating households outside of the sample areas were equally distributed around the sample area boundaries, every fifth household was selected. If the householder was not at home or declined to be interviewed the neighbouring household was approached. This continued until most newly encountered farmers did not consider their fields to be in proximity to the forest/KFR edge, and contended that discussions about such proximity were irrelevant to their situation. At least 25% of each village (mean 40% for all villages) was interviewed (n = 81) (Table 3.6).

Village	Interviews (n)	Focus groups (n)	Date
Kiseeta	20	2	2007
Wagaisa	26	2	2007
Kihomboza III	21	2	2007
Nyakamwaga	14	2	2007
Total	81	8	

Table 3.6 The number of interviews and focus groups undertaken at each village.

In Hoima District, traditional Banyoro gender roles persist, with males assuming leadership of the household. However, many farming households do not have a resident adult male and are therefore managed by women. Even in male dominated households, women frequently undertake the sowing, tending and harvesting of crops, and often participate in household economic decisions (Women's FG members, pers. comm.). For these reasons, no gender distinction was made between household representatives during semi-structured interviews, although some women did request that the research team return when their husbands would be at home. In practice, most interviews were held with individual adult men or adult women, but also with married couples and other senior members of the household.

The programme of interviews was not initiated until the study had been established for three months (i.e. in February 2007). As a result, villagers were already familiar with the research team when they were approached for interview, and were therefore more likely to accept being questioned (Kemp, 1984). Farmers were advised as to the content and the likely duration of interviews, and those who consented were interviewed at a time and place convenient to them. Most interviews were undertaken immediately, but others took place at pre-arranged times. Farmers were either interviewed in the fields as they worked, or in their homesteads.

Interviews were conducted with the assistance of two field assistants who acted as interpreters. One field assistant interpreted English into the interviewee's language, whilst the other translated the answers back into English. This technique enabled each interpreter to concentrate completely on the dialogue of one person (be that interviewer or interviewee), and the limitations of using only one interpreter were thereby avoided. The employment of a single interpreter is likely to increase the risk of comments remaining unheard or untranslated, as the interpreter is required to simultaneously translate and listen to testimony. This can be difficult if the discussion is continuing whilst previous comments are still being translated. In contrast, the assistance of two interpreters ensured that all questions and responses were both heard and translated. In addition, the two field assistants acted as regulators for each others' interpretations, which ensured translations were accurate and efficient.

A further benefit to the employment of two interpreters was the establishment of a rapport between the interviewee and the Runyoro/KiSwahili to English interpreter. The researcher could not have as readily achieved this without being fully conversant in the interviewee's language, and the attention of a single interpreter would necessarily have been divided between interviewee and interviewer. Thus, by the provision of an interpreter who was directed almost entirely by the interviewee, a relationship between interpreter and interviewee could be quickly established. This encouraged the interviewee to feel more equal to the interviewer, and served to put the interviewee at his/her ease.

Interview answers were written down by hand. The use of a Dictaphone was considered, but after encountering initial suspicion whilst seeking permission to conduct the research, it was decided that, as an unfamiliar tool representing outsider formality (Webber, 2006) it should be discarded.
Interviewees were asked about their ethnicity, personal history and farm tenure, the type of crops they planted, where each crop was planted and why those particular species were cropped (Appendix 2). Participants were also asked about the relative importance of crops to household income and livelihood security, any recent or historical changes in crop selection and the reasons for this, perceived risks associated with farming and what, if any, preventative measures were in place to mitigate against these risk factors. Farmers were asked about any changes to the neighbouring forest and the possible reasons for, and consequences of, any change. Care was taken to be neutral and avoid initiating any direct reference to crop-raiding and chimpanzee-farmer conflict, as this might have biased the answers given.

3.6.2 Focus groups

FGs were organized at each village to examine in more detail matters raised in individual interviews. Two FGs were organised in each village; one for adult male participants (MFG) and one for adult women (WFG). This differentiation was undertaken to encourage women to express their opinions. In traditional African societies such as Bunyoro-Kitara, women are often viewed in terms of their relationships with men; as wives, mothers, sisters and daughters (Yngstrom, 2002), and may, therefore, have considered their opinions to be less important than men's in mixed gender FGs. Certainly, during interviews the research team carried out with husband and wives, some women were reticent to contribute in the presence of their husbands. Separate male and female FGs also served broadly to focus on two different aspects of life next to the forest edge; socio-economic concerns (WFGs) and attitudes toward crop raiding animals and the local environment (MFGs).

Individuals invited to attend the meetings were randomly selected from those cultivating land within the sample areas. This was done by entering each farmer's name into a pot on a folded piece of paper and extracting the required number of papers, and was repeated for each village. In addition, village leaders and one or two elders were invited where it was thought that non-invitation would cause offence. The person providing or organising the venue for each meeting also attended. The size of the FGs was intended to be large enough to encourage lively debate but not so large as to allow attendees to become observers rather than participants. Eight invitees was considered an appropriate number. In practice some invitees did not attend and other uninvited villagers did come. The resultant mean size of the FGs was six.

The group discussions were held either at a site or homestead normally used for village meetings, or at a compound near to the centre of the sample area. Farmers who owned the host homesteads or who organised the host sites were given sugar as a token of thanks, and all FG attendees were provided with soda drinks during the meetings.

Meetings were conducted by one field assistant in Runyoro. The rest of the research team did not participate in the discussions (other than occasional prompting by the researcher) and the FGs were told to ignore us. Whist the meetings progressed, the second and third field assistants quietly translated the conversation for the researcher. This system allowed the group discussions to continue in a naturalistic manner without the need to stop the conversation in order to interpret each comment, and without having the researcher as the focus of translation efforts. Further, as the discussions continued briskly both the second and third field assistants were fully utilised as interpreters by listening and translating alternately to each other. In this way dialogue was not lost even if it occurred whilst the previous speech was still being translated.

Prior to commencement, the research team discussed which roles each of the field assistants would feel most comfortable in undertaking during the meetings. One field assistant elected to conduct all eight meetings, and as such, became increasingly proficient as the meetings progressed. Subjects discussed were; the reasons for crop choice, the value of non cultivated food (fruit), the likelihood of animal damage on particular crops, spatial patterning of crop assemblages, the consequences of crop loss to the household, the effect of crop loss on domestic roles and the varying perceptions towards different raid animals (Appendix 3). Meeting notes were handwritten by the researcher and transcribed later the same day.

3.6.3 Complications to measuring perceived crop loss

When approached for interview, villagers with households as close as 101-200m from the forest edge did not view themselves as living in proximity to the forest (when asked, "Is it good having your farm near to the forest or not?") and therefore did not consider interview questions about farming near to forests relevant (Table 3.7). All households with fields in the sample areas were visited, and households outside of the sample areas continued to be approached, but at the stage where 40% (mean) of village households had been interviewed (n = 81), most farmers did not consider themselves to live near to the forest. Thus, the size of the interview sample was governed as much by farmer responses as by comparability to other research. Nevertheless, these interviews provided valuable information about agricultural and socio-economic practices and values.

Distance of farm	Interviewed (n)	Considered not close (n)	Considered not close (%)
0-100m	29	0	0
101 - 200m	18	3	16.67
201-300m	13	4	30.77
301-400m	10	5	50
401-500m	5	3	60
>500m	6	4	66.67
Total	81	19	23.46

Table 3.7 The number of interviewees with farms at increasing distance from the forest/KFR edge that did not consider themselves as farming close to the forest edge.

The number of attendees to FGs was unpredictable. In most instances eight farmers were invited to attend, however, the proportion of invitees who attended ranged from 33% to 100%. In addition, in five of the FGs, at least one attendee was uninvited. A secondary method of managing the FGs had been rehearsed by the research team in anticipation of the variability of group sizes. Should the number of attendees have been too large, the FG would have been separated into two, with one team member conducting and one team member interpreting in each group. In the event, group sizes ranged from three to nine.

3.6.4 Possible study bias

In response to initial suspicions of compulsory land seizures for chimpanzee conservation, it was considered essential to emphasise the neutrality of the study whilst conducting interviews, focus groups and general discussions with villagers. Local perceptions of research bias risked distorting farmer responses by either generating undue overemphasis on chimpanzee-farmer conflict issues, or by increasing reticence to discuss sensitive matters or illegal activity for fear of detrimental consequences (see Naughton-Treves, 1997; De Boer and Baquette, 1998; Hill, 2005; Paterson, 2005; Marchal and Hill, 2009; Campbell-Smith *et al*, 2010). In addition, whilst extreme care was taken to position this study as distinct from the chimpanzee research being undertaken at the same time in Kiseeta, the presence of two foreign researchers in an area rarely visited by non-local people was likely to draw comparisons from villagers. Thus, the research team avoided initiating discussions which directly referenced chimpanzee-farmer conflict (with the exception of within focus group meetings). Whilst this neutral position helped to reveal the significance of human-wildlife conflict within the context of agricultural and socio-economic issues generally, it may have reduced the opportunity to explore the full extent of some attitudes towards chimpanzees, as the researcher is aware that some farmers in the study voiced more extreme opinions elsewhere (McLennan, pers. comm.).

The villages were selected partly due to their accessibility from the research base in Hoima town (Section 2.6). This 'tarmac bias' (Newing, pers. comm.) means that the villagers are not isolated and are able to travel to other villages and into Hoima town. They are also able to receive radio broadcasts. Thus, farmers' opinions may be the result of an awareness of neighbouring situations as much as their own experiences.

3.7 Statistical analysis

All data were organised into Microsoft Excel spreadsheets, and analysed using Microsoft Excel and IBM SPSS Statistics v19. All tests performed were non- parametric, as data were often not normally distributed, and in the form of ranks rather than scores. Statistical tests performed were; Chi-square test, χ^2; Cramer's V test; Kendall's coefficient of concordance, *W*; Kendall's tau-b correlation coefficient, T_b; Kolmogorov-Smirnov one-sample test, *D;* Mann-Whitney U test and Kruskal-Wallis one-way analysis of variance, *KW*. Results were considered significant to $p<0.05$ or $p<0.01$, as indicated for each test. All tests were 2-tailed unless otherwise stated. Binary logistic regression analysis was used to assess the influence of environmental variables on the presence of crop raiding events at the household level, for each season. Frequency distribution calculations were obtained using the mean as the measure of central tendency. This enabled all scores to be used during calculations and allowed for a more meaningful comparison of data sets. Graphs and tables were constructed using both Microsoft Excel and SPSS.

3.8 Ethics approval and data security

All research methods abided by the ethical guidelines as stipulated by the Association of Social Anthropologists of the UK and Commonwealth (ASA, 1999) and the Oxford Brookes University Ethical Standards Code of Practice (2000). The rights, privacy and well-being of participants were respected, participation was based on informed consent and participants were clearly advised that their co-operation was voluntary and could be withdrawn at any time (ASA, 1999). Full approval for the research was awarded by Oxford Brookes University Research Ethics Committee (UREC) on 26th January 2006 (Registration No: 05179).

All personal data detailing participants and others encountered in the field was coded, and the data and code keys were kept separately. In the field, code keys were stored in a locked container. In the United Kingdom, code keys were transferred to computer files, which were secured through the use of passwords known only to the researcher.

4. FARMING PRACTICES

4.1 Introduction

Crop raiding by wildlife is influenced by a range of environmental factors such as the species of animals present, the forest habitat, rainfall levels, and wild-food availability (Lee and Priston, 2005; de Freitas *et al*, 2008; Hockings, 2007). Crop raiding is also affected by the agricultural choices made by farmers in the management of their farms. Crop selection, location of crop plots, crop protection tools and patterns of labour are all likely to influence the patterns of crop loss incurred by farming households (Hill, 1997; Naughton-Treves, 1997, 1998; Saj *et al*, 2001; Kagoro-Rugunda, 2004; Priston, 2005; Warren *et al*, 2007; Yihune *et al*, 2008). For example, maize and millet are both staple crops of the Banyoro people (Taylor, 1969; Hill, 1997). Maize is often a preferred crop for raid species (Hill, 1997, 2000; Naughton-Treves, 1997, 1998; Saj *et al*, 2001), whereas millet is less attractive (Tweheyo *et al*, 2005; Webber, 2006). Therefore, households that cultivate proportionally more maize than millet are at greater risk of losing their crops to raid animals. Planting patterns can also affect raid levels, as crops positioned closer to natural vegetation are more likely to suffer damage (Hill 1997; Kagoro-Rugunda 2004; Warren *et al*, 2007), and uncleared vegetation on farms can provide cover for animals to move further into fields in relative safety (Hill, 2000; Kagoro-Rugunda, 2004). Conversely, the employment of crop protection methods such as guard huts or guarding patrols (Sekhar, 1998) can reduce the incidence of crop raiding (Thapa, 2010).

The types of farming practices employed by farmers can also influence perceptions and tolerance of crop raiding. The location of crop plots (Dixon *et al*, 2009), the size of landholdings (Naughton-Treves, 1997), the amount of time and labour invested in cultivating particular crops (Naughton-Treves, 2001; Linkie *et al*, 2007), the cultural importance of crop types grown (Warren, 2003), and the degree of dependence on crop for income or subsistence (Hill, 2005) all affect farmers' willingness or ability to tolerate losses. For example, depending on whether households were mostly reliant on rice or garden crops, farmers in Sulawesi, Indonesia perceived either rats or pigs to be the worst raid animal on their crops (Priston, 2005). In villages around Budongo Forest Reserve (BFR), in Masindi District, Uganda, sugarcane losses to chimpanzees were tolerated much less on farms where sugarcane was cultivated as a cash crop as compared to households where sugarcane was generally grown in small stands for home consumption (Hill, 2004; Paterson, 2005).

There is a need, therefore, to examine farming practices such as crop choice, agricultural systems and labour patterns, in order to understand how this agricultural environment influences both actual losses and perceptions of crop damage.

The aims for this chapter are:

- To ascertain crop choice: the amount and type of each crop grown.
- To examine the main agricultural systems of crop management and land management.
- To examine labour patterns and time investment.

4.2 Methods

At each of the four study sites a sample area was plotted which extended for 1km alongside the forest edge and 0.5km into the cultivated landscape. The field and plot boundaries of each farm within the four sample areas were walked by the research team, and the boundary positions were recorded using a Global Positioning Systems (GPS) handset. A number of borders were inaccessible due to overgrown vegetation. Boundary positions in these situations were estimated. Similarly, at the forest-farm boundary dense undergrowth and soft edges resulted in unclear delineations between the forest edge and the adjacent farms. These edges were mapped, but with difficulty. Maps were created from these data using Trip and Waypoint software (Garmin Limited). These maps were used to calculate plot and farm sizes and to assist in navigation around the four sample areas during the study (Appendix 1).

The crop assemblage of each plot was recorded at the beginning of each agricultural season (November: interplanting season one; March: growing season one; July: interplanting season two; and September: growing season two) and any changes in crop assemblage during the year were noted. The total area of crop cultivated by each household during the study period was then calculated. A number of farmers cultivated two or more fields at distinct locations within a study site. In these situations the total area cultivated in all fields was used to assess household production. Fruit trees were also recorded using the GPS handset. Crop protection installations were noted and their positions recorded using the GPS handset. Farming practices such as the use of pesticides, fertilizers, farming tools and planting patterns were observed each season. Labour patterns and the degree of investment in different crops were ascertained from individual and group interviews.

In this chapter and the following chapters the terms ‘farms' and ‘households’ are used interchangeably. Crops are described as growing on farms, and being grown by households. As described in Chapter 3, a household is classified as a unit of people living or working on one farm. A farm is the total area of land owned by one household, which may comprise one or more fields. A field is a distinct but continuous area of ownership that consists of one or more plots, and a plot is a discrete are of particular crop types or crop mixed crop assemblage that is usually delineated by a border or a change in crop assemblage.

During some analyses farms are classified as either cash crop farms or subsistence crop farms. These classifications are based on the cultivation of crop species observed by the research team. Farms supporting the cultivation of plots of traditional cash crops are defined as cash crop farms. Farms where cash crop was present only as small groups of stands or individual stands (e.g. sugarcane) or small remnants (e.g. coffee) rather than complete plots are not classified as cash crop farms. This definition of cash and subsistence crop farms is consistent with that used in Chapter 6 and derived from outside-observer perspective (Table 4.1). The definition differs from that used in Chapters 5 and 7. Definitions in these chapters are based on farmers' own perceptions. Farmers who described themselves as regularly selling crops are classified as cash croppers.

Farm classified by	Classification basis	Chapters where applied
Research team	Observed plots of traditional cash crop	4 :Farming Practices 6: Actual Crop Loss
Farmer	Self description: cultivate crops to sell, cultivate plots of traditional cash crop	5: Socio-economic Factors 7: Perceived Crop Loss

Table 4.1 Classification of cash crop and subsistence crop farms

In order to analyse cultivation of specific crop species at the plot level, in this chapter each plot is counted individually per crop species. I.e. One plot containing two intercropped plant species is defined as two plots.

The statistical analyses used in this chapter are: Chi-square test, χ^2; Kendall's coefficient of concordance, *W*; Kendall's tau-b correlation coefficient, T_b; Kolmogorov-Smirnov one-sample test, *D;* Mann-Whitney U test and Kruskal-Wallis one-way analysis of variance, *KW*.

4.3 Results

4.3.1 Crop choice

Twenty eight cultivated crop species were recorded across the four sample areas during the study period (Table 4.2).

	Common name	Latin name	Kiseeta	Wagaisa	Kihomboza III	Nyakamwaga
Cereals	Maize	*Zea mays*	√	√	√	√
	Millet	*Eleusine coracana*	√	√	√	√
	Rice	*Oryza spp.*	√	√	√	√
	Sorghum	*Sorghum bicolour*	√		√	
Oilcrops	Groundnuts	*Arachis hypogaea*	√	√	√	√
	Sesame	*Sesame indicum*			√	
	Soya bean	*Glycine max*			√	√
Legumes	Beans	*Phaseolus vulgaris*	√	√	√	√
	Cow peas	*Vigna unguiculata*	√	√	√	√
	Pigeon Peas	*Cajanus cajan*	√	√	√	√
Roots and tubers	Cassava	*Manihot esculenta*	√	√	√	√
	Irish potato*	*Solanum tuberocum*	√		√	
	Pumpkin	*Curcurbita spp.*	√		√	
	Sweet potato	*Ipomoea batatas*	√	√	√	√
	Yam	*Dioscorea spp.*	√	√		
Plantains	Banana	*Musa spp.*	√	√	√	√
Traditional cash crops	Cocoa	*Theobroma cacao*				√
	Coffee	*Coffea robustica*	√		√	
	Sugarcane	*Saccharum officiuarum*	√	√	√	√
	Tobacco	*Nicotiana tabacum*	√	√	√	√
Vegetables	Cabbage	*Brassica oleracea*	√			
	Dodo(greens)	*Amaranthus dubius*	√	√	√	√
	Eggplant	*Solanum melongena*	√			
	Onion	*Allium cepa*	√	√		
	Tomato	*Lycopersicum esculentum*		√		√
Fruits	Guava	*Psidium spp.*		√		√
	Jackfruit	*Artocarpus heterophyllus*	√	√	√	√
	Mango	*Mangifera indica*	√	√	√	√
	Papaya	*Carica papaya*	√	√	√	√
	Passion fruit	*Passiflora spp.*			√	√
	Pineapple	*Ananas comosus*	√	√	√	√

Table 4.2 Presence and absence of cultivated crops and fruits within each sample area during the study period.

***Solanum potato, known as Irish, European or English potato in Uganda (Hakiza *et al* 2001).**

Households at all sites grew maize, cassava, beans, sweet potato, groundnuts, pigeon peas, banana, millet and rice. Cash crops tobacco and sugarcane also occurred at all sites, however, with the exception of three cultivated plots in Kiseeta and Nyakamwaga, sugarcane mostly comprised of small groups of stands or individual stands for home consumption. Nyakamwaga also contained the only commercially viable cocoa plot, although remnants did occur elsewhere in Nyakamwaga and at other sites. Similarly, coffee was only recorded in small plots of one or two bushes, none of which were viable for income generation. Rice, which was cultivated at all sites, was usually, but not always, cultivated as a cash crop. As discussed in Section 4.2, all farms containing rice plots are classified as cash crops.

The most commonly occurring fruit trees, jackfruit, mango and papaya (paw paw), were not generally cultivated in plots, but appeared randomly situated around compounds and throughout fields. One household in Nyakamwaga did cultivate a plot of mango trees and a plot of passion fruit plants, but only pineapple was cultivated in plots at all sites, albeit on a small scale; all pineapple plots were smaller than $721m^2$ in size.

There is a significant correlation in the relative (ranked) areas put under each of the main crop types across the four study sites (maize, cassava, beans, sweet potato, groundnuts, rice, pigeon peas, tobacco, banana and millet), indicating that crop assemblage in the four study villages was similar (Kendall's Tau-b, $T_b = 0.616$, $p<0.01$, n = 40). Maize, cassava and beans were the most extensively (area) cultivated crop types (Figure 4.1). Maize and cassava together comprised almost half the total area of crop cultivated (44%).

Millet, traditionally the main food crop of the Banyoro (Beattie, 1971) was grown less extensively (2.4% of the total area of crop). Yam, considered an ancient crop of the Bantu people (Ocitti p' Obwoya, 2001) was recorded in Kiseeta and Wagaisa only (Table 4.2), and constituted 0.1% of the total area of crop grown. The sugarcane plots in Kiseeta and Nyakamwaga accounted for $3074m^2$ (0.8%) and $3804m^2$ (1.1%) of the total area at each site respectively. Cash crops accounted for 11.9% of the total area of crop across the study sample, and mostly comprised of rice (49.7%) and tobacco (37.7%).

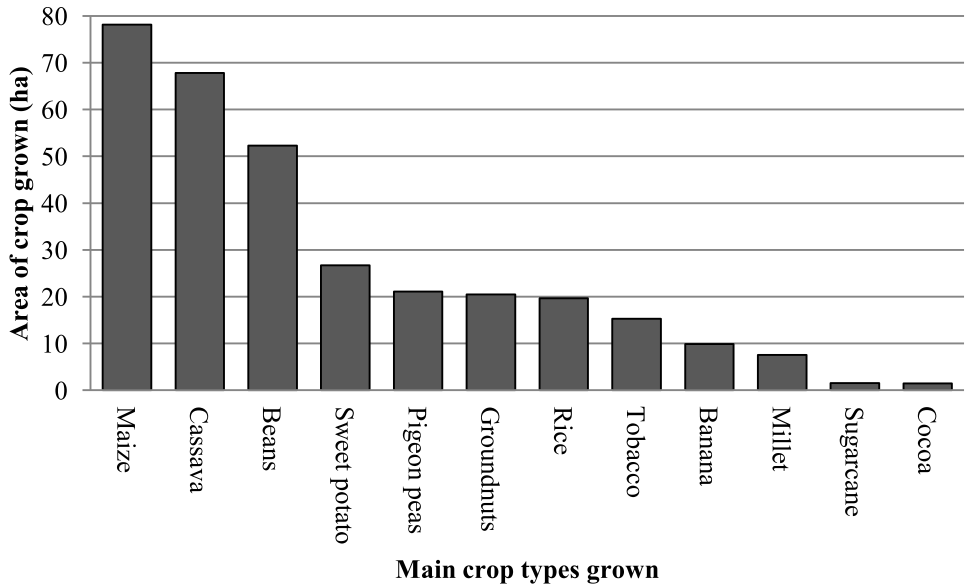

Figure 4.1 The area (ha) of each main crop cultivated at all sites during the study period.

4.3.1.1 Location of farms

Most farms (66%) are located less than 251m from the forest edge (Table 4.3), and nineteen farms (20.2%) border the forest. Six of the farms that were recorded as lying next to the forest edge also extend beyond 250m from the forest-farm boundary. Two of these comprise of two or more distinct fields separated by other farms, but four are continuous areas of land with a single boundary each.

	Kiseeta	Wagaisa	Kihomboza III	Nyakamwaga	Total
Farms (n) 0-250m	16	18	14	14	62
Farms (n) 251-500m	7	12	8	5	32
Total	23	30	22	19	94

Table 4.3 The number of farms at distances from the forest at each site (n = 94 farms). Distance is calculated from the nearest farm boundary to the forest edge.

4.3.1.2 Area cultivated

The total area of crop cultivated[12] by households ranged from 715m^2 to 94878m^2, and is

[12]This is not land area cultivated. As most plots were put under more than one crop during the study period, the total area of crop cultivated is larger than the total land area put under crop.

significantly different from a normal distribution (Kolmogorov-Smirnov, $D = 0.182$, $df = 94$, $p<0.01$). Whilst 92.6% (n = 87) of households planted less than 40,000m^2 of crop during the study period, five households; one in Kiseeta, two in Kihomboza II and two in Nyakamwaga, cultivated more than 60,000m^2 of crop (Figure 4.2). Four of these were cash crop farms, and across the study sites cash crop households planted significantly larger areas of crop than did subsistence crop households (Mann-Whitney $U = 483.00$, $p<0.01$, 1-tailed, n = 94). Whilst areas of crop planted by households differed within each study site, they did not differ significantly between village sites (Kruskal-Wallace $KW = 1.154$, $p>0.05$, $df = 3$).

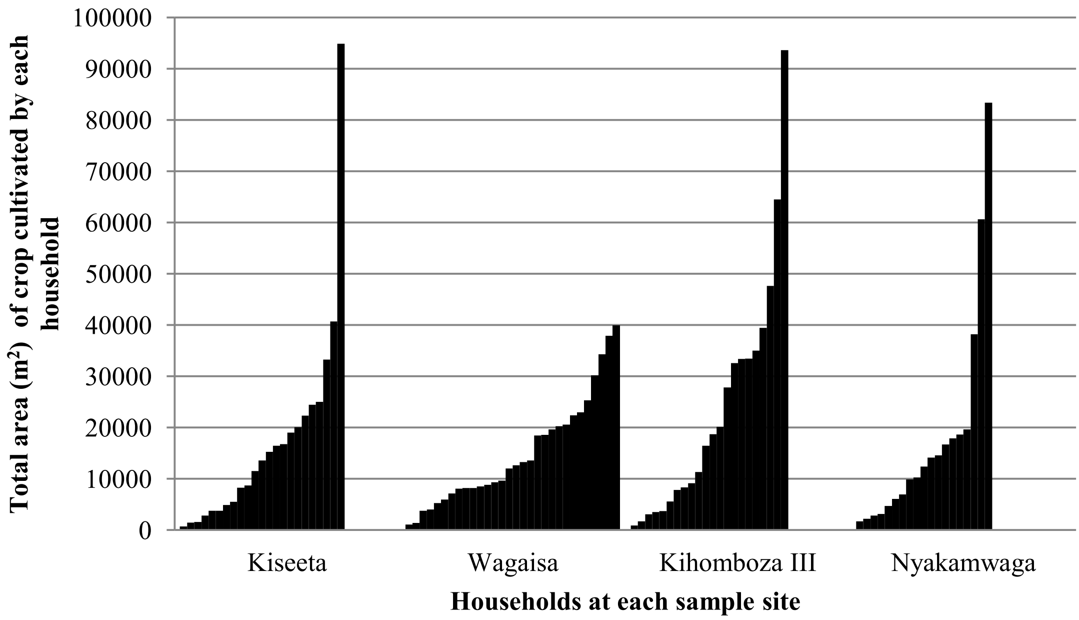

Figure 4.2 The total area of crop cultivated by each household during the study period.

4.3.1.3 Crop range

Households cultivated between two and fourteen different crop types (Figure 4.3). Most households (67 %, n = 63) planted between five and nine crop types (mean = 6.9±6.28), although the number of crops grown on farms during the year was not normally distributed across the study sample (Kolmogorov-Smirnov, $D = 0.107$, $df = 94$, $p = 0.01$).

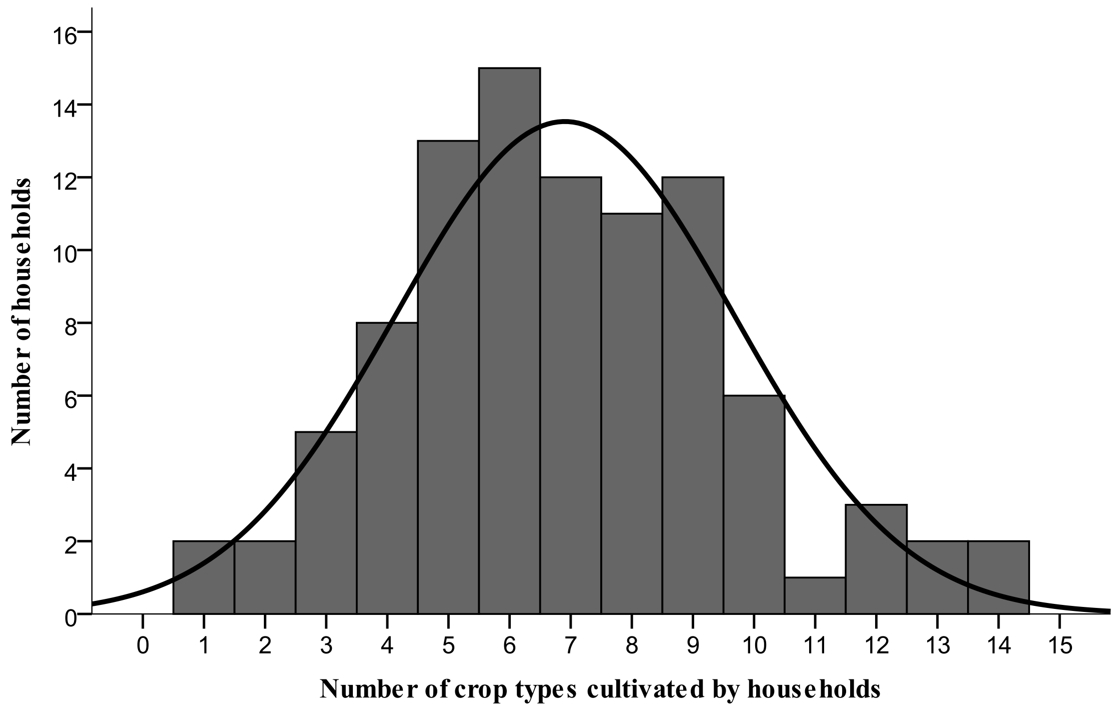

Figure 4.3 Number of crops cultivated by households (n = 94 households). The black line illustrates a normal distribution.

The most commonly grown crop, cassava, was recorded on 90.4% of farms. Maize, sweet potatoes and beans were each recorded on more than three quarters of farms (Table 4.4). There is no significant variation in the number of households growing these four crop types (Chi square, $\chi^2 = 2.103$, $df = 3$, $p>0.05$, $\chi^2 = 3.113$, $df = 3$, $p>0.05$, $\chi^2 = 0.926$, $df = 3$, $p>0.05$, $\chi^2 = 4.117$, $df = 3$, $p>0.05$ for cassava, maize, sweet potatoes and beans respectively) or groundnuts (Chi square, $\chi^2 = 6.217$, $df = 3$, $p>0.05$). Twenty two households cultivated sugarcane, although, as discussed above, only three households grew sugarcane as a cash crop. Rice was the most frequently cultivated cash crop; almost one third (33%) of households cultivated rice, as compared to 20.2% of households that cultivated tobacco.

Crop	Households (n)	Rank	Households (%)	Mean area per household (m^2)	Rank
Cassava	85	1	90.4	4116.9±4208.0	2
Maize	83	2	88.3	4829.5±4917.8	1
Sweet potato	81	3	86.2	1718.4±2042.0	10
Beans	78	4	83.0	3431.2±3724.7	5
Groundnuts	64	5	68.1	1673.1±1672.6	11
Pigeon peas	61	6	64.9	1845.0±1730.4	9
Banana	37	7	39.4	1370.4±1400.5	13
Rice	31	8	33.0	3256.3±2432.3	6
Millet	29	9	30.9	1422.4± 969.4	12
Sugarcane	22	10	23.4	353.8± 502.7	17
Tobacco	19	11	20.2	4028.4±3458.4	3
Irish potato	11	12	11.7	602.5± 754.0	15
Cow peas	8	13	8.5	329.1± 314.6	18
Pineapple	7	14	7.4	212.0± 128.3	20
Pumpkin	5	15	5.3	255.6± 221.0	19
Tomatoes	4	16.5	4.3	1042.8± 511.0	14
Yam	4	16.5	4.3	378.5± 387.0	16
Sorghum	3	18.5	3.2	2235.3±2020.6	8
Cocoa	2	21.5	2.1	3707.0±4535.4	4
Soya bean	2	21.5	2.1	3190.0±4282.3	7

Table 4.4 The number and proportion of households that cultivated the most frequently grown crops (n = 94 households).

4.3.1.4 Cash and subsistence farms

Almost two thirds of households (59.6%, n = 56) cultivated subsistence crops only, whilst 40.4% (n = 38) of households also cultivated cash crops (Table 4.5). A higher proportion of households in Nyakamwaga cultivated cash crops (57.9%, n = 11) as compared to the other sites. Nevertheless, the number of cash crop and subsistence crop households does not vary significantly across the four study sites (Chi square, $\chi^2 = 6.756$, $df = 3$, $p>0.05$).

Most cash crop households cultivated one type of cash crop (60.5% of cash crop farmers, n = 23), and 29% of cash crop households (n = 11) cultivated two varieties of cash crop. The widest range of cash crop varieties recorded on a single farm was four; this occurred on two farms, both in Nyakamwaga.

	All sites	Kiseeta	Wagaisa	Kihomboza III	Nyakamwaga
Subsistence crop households					
Frequency (n)	56	18	11	19	8
Proportion (%)	59.6	78.3	50.0	63.3	42.1
Cash crop households					
Frequency (n)	38	5	11	11	11
Proportion (%)	40.4	21.7	50.0	36.7	57.9
Total (n)	94	23	22	30	19

Table 4.5 The number and proportion of cash and subsistence households at each study site (n = 94 farms).

The area of cash crop cultivated on cash crop farms ranged from 3.3% to 82.5% of the total area of crop. Ninety two per cent (n = 35) of cash crop households grew larger areas of subsistence crop than cash crop, nevertheless there is a significant association between the area put under cash crops and the total area of crop cultivated on farms (Kendall's tau-b, T_b = 0.496, p<0.01, 1-tailed, n = 38).

It should be noted that in this chapter households are designated as cash or subsistence households depending on the crop types cultivated, (Section 4.2). However, subsistence farmers frequently sold excess crops, usually on an *ad hoc*, season by season basis. In addition, some farmers who cultivated rice did so for the purpose of household consumption.

4.3.2 Farming systems and crop management

4.3.2.1 Plot size

Plot sizes are signficantly larger on cash crop farms as compared to subsistence crop farms at all sites except for Kihomboza III (Kiseeta: Mann-Whitney-U = 61056.00, p<0.05, n = 903; Wagaisa: Mann-Whitney-U = 92026.00, p<0.01, n = 923; Nyakamwaga: Mann-Whitney-U = 32059.00, p<0.01, n = 667). In Nyakamwaga, the average plot size of cash crop households is almost twice as large as that on subsistence farms (Table 4.6). In Wagaisa, the plot size of subsistence crop plots is skewed by three farms that have larger mean plot sizes than all cash crop farms (n = 11 cash crop farms). When these outliers are removed, the average plot size for subsistence farms in Wagaisa is 702.9m^2.

Site	Cash crop farms: plot size (m^2) Mean	Min	Max	Plots (n)*	Subsistence crop farms: plot size (m^2) Mean	Min	Max	Plots (n)*
Kiseeta	812.82±755.7	20	3626	194	660.90±593.2	10	3391	903
Wagaisa	807.91±722.6	12	5391	432	834.67±1051.7	4	12663	923
Kihomboza III	868.47±1003.8	5	7791	663	810.08±701.4	36	3122	938
Nyakamwaga	1075.41±1355.3	20	7848	466	547.49±618.8	10	3682	667

Table 4.6 Mean, minimum and maximum plot sizes on cash and subsistence farms at each study site (n = 3426 plots).* Where crops did not extend across the whole plot area, the area of crop planted within the plot was used.

*** The number of plots is higher than described in Chapter 3. This is because a) in order to differentiate between cash and subsistence crop farms, the type of crop in each plot was noted. This resulted in plots being counted individually for each crop. i.e. two intercropped crop species in one plot are counted as two plots 2) the number of plots from each of the four seasons is counted individually (ie plots were usually counted four times). This is because a single plot was likely to alter in size and crop assemblage during the year.**

Plot size differs significantly between different crop types (Kruskal-Wallis $KW = 461.156$, $p<0.05$, $df = 27$). Cash crops cocoa, tobacco and rice were cultivated in larger plots than most other crop types (ranked 1st, 5th and 6th respectively) (Appendix 3). Conversely, mean plot sizes of maize, cassava and beans, the most extensively (area) cultivated crops, were ranked 13th, 14th and 16th respectively (of 28).

4.3.2.2 Intercropping

Cassava was mostly planted as a mono crop, but was also planted variously with pigeon peas, beans, maize and groundnuts, and occasionally with other crop types (Table 4.7).

Where maize and cassava were intercropped they were usually additionally planted with either beans or groundnuts, however, a minority of bean plots and groundnut plots were not intercropped with any other crop type. Most plots of sweet potato were mono-cropped, although some households, particularly in Kiseeta, intercropped it with maize, beans, cassava, millet and groundnuts. Banana plots and sugarcane plots were not generally intercropped, and tobacco, rice and tomato were not intercropped with any other crop types.

	Banana	Beans	Cassava	Groundnuts	Maize	Millet	Pigeon peas	Rice	Sugarcane	Sweet potato	Tobacco	Tomato	Mono crop
Banana			X										X
Beans			X		X		X			X			X
Cassava	X	X		X	X		X			X			X
Groundnuts			X		X		X			X			X
Maize		X	X	X			X			X			X
Millet										X			
Pigeon peas		X	X	X	X								X
Rice													X
Sugarcane													X
Sweet potato		X	X	X	X	X							X
Tobacco													X
Tomato													X
Mono crop	X	X	X	X	X		X	X	X	X	X	X	

Table 4.7 Intercropping combinations recorded during the study period. Some crops were interplanted with more than one crop.

4.3.2.3 Seasonal planting patterns

There is no significant difference in the area of maize, beans and groundnuts grown by households during the four seasons (Chi square, $\chi^2 = 27.695$, $df = 21$, $p>0.05$, $\chi^2 = 13.336$, $df = 18$, $p>0.05$, $\chi^2 = 23.255$, $df = 30$, $p>0.05$ respectively) and most crops were present throughout the year (Table 4.8). This is to be expected for crops that are not seasonally cultivated and are harvested piecemeal during the year such as cassava, banana and sugarcane, and also sweet potato, which has flexible planting and harvesting times (Muwanga *et al* 2001). However, maize, beans and groundnuts are biannual crops.

Non-significant differences in the seasonal cultivation of crops is likely due to the employment of extended planting patterns, whereby crops are planted early or late in order to take advantage of prevailing weather conditions and reduce the risk of loss of crop to raiding animals (Kiseeta and Wagaisa farmers, pers. comm). For example, rice was mostly cultivated in growing season two, but at all sites newly planted rice was observed prior to this, in interplanting season two.

	Interplanting season 1*		Growing season 1		Interplanting season 2		Growing season 2	
	Area (m^2)	Rank	Area (m^2)	Rank	Area (m^2)	Rank	Area (m^2)	Rank
Cassava	107275	2	203545	1	201076	1	**239845**	1
Maize	117829	1	**159692**	2	148616	2	129758	2
Beans	65737	3	**121274**	3	75676	3	97125	3
Sweet potato	**61468**	4	50884	5	47889	5	45131	6
Pigeon peas	42036	5	42661	6	43088	6	**60337**	5
Groundnuts	38712	6	38878	8	27394	9	**42442**	7
Banana	20265	8	**41798**	7	40969	7	38086	8
Rice	29716	7	2650	12	37397	8	**69234**	4
Tobacco	X		**76530**	4	50194	4	X	
Millet	19457	9	2912	11	454	18	**21812**	9
Sugarcane	3668	11	**7538**	9	7469	10	6991	11
Cocoa	X		7414	10	7414	11	7414	10
Sorghum	**4430**	10	2276	13	2276	13	2276	13
Irish potato	2159	12	1953	14	1805	14	**3222**	12
Soya bean	X		1771	16	**4609**	12	X	
Tomato	274	17	1937	15	1527	15	**2234**	14
Cow peas	846	15	**1368**	17	1142	16	471	18
Pineapple	905	14	722	18	**917**	17	876	15
Pumpkin	**1051**	13	537	19	227	20	537	17
Yam	339	16	138	20	438	19	**737**	16

Table 4.8 The area (m^2) cultivated each season for each main crop. Ranks indicate the relative area per season; 1 = greatest area. For each crop, numbers in bold indicate the season in which the greatest area was cultivated.

***Interplanting season one excludes Nyakamwaga as data were not collected at this site during this season. Note: annual totals calculated from these figures are not represented as these totals would be inflated; crops that remained in the same plot for more than one season were counted again at the beginning of each season, i.e. for the purposes of reviewing seasonal areas of crop cultivated, the same crops were counted more than once.**

Seasonal variations were also recorded between the village sites. Maize and beans were most extensively (area) planted during growing season one in Kiseeta and Wagaisa but during interplanting season one in Kihomboza III. Nevertheless, for most of the main crop types; maize, beans, groundnuts, sweet potato and rice; differences between village sites are not significant (Kendall's coefficient of concordance, $W = 0.644$, $p>0.05$, $df = 3$; $W = 0.467$, $p>0.05$, $df = 3$; $W = 0.100$, $p>0.05$, $df = 3$; $W = 0.733$, $p>0.05$, $df = 3$ and $W = 0.231$, $p>0.05$, $df = 3$ respectively). Only cassava shows a significant difference between the sites (Kendall's coefficient of concordance, $W = 1.000$, $p<0.01$, $df = 3$). In Kiseeta, 23.0% of damage to cassava was recorded in interplanting season one, whereas in Wagaisa damage to cassava in this season accounted for 15.4% of damage to this crop.

4.3.2.4 Location of crop plots

At the site level there is no significant correlation between crop types and the distance of plots containing those crop types from the forest edge (Kendall's tau-b, T_b = 0.002, p>0.05, n = 1820). Plots of the most extensively (area) grown crops were recorded at 0m to >400m from the forest/KFR edge (Table 4.9).

On farms[13], there is a significant variation in the crop types most frequently located in plots alongside the field edge nearest to the forest/KFR (nearside field edge) (Chi square, χ^2, p<0.01, n = 129 plots). Sixty six per cent of households that cultivated cassava, and 62.7% of households that cultivated maize planted stands of these crops in plots on the nearside field edges of their farms. In contrast, 22.7% of farms that grew sugarcane cultivated it in plots along nearside field edges. The crop types planted in these nearside plots did not vary significantly between farms (Chi-square, χ^2 = 1412.268, p>0.05, n = 342).

[13] Some farms consisted of two or more fields (distinct areas of cultivation separated by other farms). In this section, the relative position of crop types was examined for each field separately.

Crop	Distance of all plots containing crop Min	Rank	Max	Rank	Mean	Rank	All plots (n)	Farms growing each crop type Farms with plots in nearside field edges (n)	All farms growing crop type	Farms with plots in nearside field edges (%)
Beans	0	6	535	2	203.3±140.0	3	273	40	78	51.3
Maize	0	6	535	2	207.1±132.0	6	346	52	83	62.7
Sweet potato	0	6	535	2	221.9±128.3	10	220	38	81	46.9
Pigeon peas	0	6	508	4.5	206.3±128.0	5	125	25	61	41.0
Cassava	0	6	508	4.5	217.2±126.4	8	384	56	85	65.9
Millet	0	6	499	6	204.1±149.8	4	40	10	29	34.5
Rice	0	6	468	7	187.2±123.8	2	53	14	31	45.2
Sugarcane	0	6	465	8	226.3±128.6	11	30	5	22	22.7
Groundnuts	0	6	454	9	217.9±117.7	9	145	26	64	40.6
Tobacco	0	6	447	10	168.3±134.3	1	41	8	19	42.1
Banana	0	6	442	11	215.4±127.1	7	63	8	37	21.6

Table 4.9 Position of crop plots in study sites, and the number of farms with crop plots located alongside their field edge nearest to the forest/KFR, i.e. their nearside field edge. Ranking for maximum distance: 2 = furthest distance. Ranking for mean distance: 1 = shortest distance. Percentage (%) of farms with plots in nearside field edges indicates the proportion of the farms that grew each crop and positioned it in plots closest to the forest/KFR edge.

4.3.2.5 Labour devices

Farming in the Hoima District study sites is unmechanised. The main agricultural tool is the hand hoe, which is used for field preparation, the planting of new crops, weed extraction, and the harvesting of roots crops. Pangas (machetes) are used to clear scrub in fallow fields and in the construction of tobacco barns, which are erected to air-dry tobacco leaves. Variations on these tools differed on two farms only. In Nyakamwaga one farmer had constructed a hand-pulled wooden frame, which produced three furrows at a time for planting beans. In Kihomboza III the owner of the largest farm cleared a number of plots of cassava using a hired tractor. This was the only mechanised agricultural machinery observed.

4.3.2.6 Crop protection methods

The most frequently observed crop protection tool was the guard hut (Table 4.10). Seven guard huts were positioned across the four sites, although only one was observed to be in use (by a full-time guard, see below).

	Kiseeta	Wagaisa	Kihomboza III	Nyakamwaga	Total
Unmanned hut	3	2**	1		6
Scarecrow	2		3	1	6
Leg-hold (man) trap	1	1	1		3
Gin (Small mammal) trap	2	1			3
Cassette tape			2		2
Guarding		1	1*		2
Manned hut		1			1
Dogs			1		1
Plastic bags			1		1

Table 4.10 Crop protection methods employed in the study sites.
*Present during interplanting season one only.
** One of these huts was present during interplanting season one and growing season one only.

Two guard huts were recorded over 400m from the forest/KFR edge; in Kihomboza III and Wagaisa. They both bordered plots containing rice. The Wagaisa hut was constructed during the study period specifically to guard rice against birds (farmer, pers. comm.), but neither hut was seen to be in use during the study. An unmanned guard hut in Wagaisa collapsed during growing season one and was not replaced.

Guarding was observed on two farms. A full-time guard was hired to monitor a Wagaisa plot next to the forest that contained rice, and then maize; and a tenant farmer in Kihomboza III was regularly observed by the research team guarding a rice plot inside the KFR boundary. This second plot was given up after interplanting season one because the task of defending the crop against birds and monkeys was too time-consuming (farmer, pers. comm.). Elsewhere farmers were only observed in their fields whilst planting, weeding or harvesting crops.

Three leg-hold traps (man-traps) were present, and all were positioned next to the forest/KFR edge. In Masindi District, a local by-law has decreed leg-hold traps to be illegal[14]. However, it is unclear if this also applies to the rest of Uganda. Two of the leg-hold traps were set to deter baboons (Kihomboza III farmer, pers. comm), and vervet monkeys (Wagaisa farmer, pers. comm). The third was positioned at the forest-farm boundary adjacent to where a black and white colobus monkey carcass had been strung up at the forest edge (M. McLennan, pers. comm). One of the three gin (small mammal) traps was positioned next to the forest to trap black and white colobus monkeys (farmer, pers. comm). The remaining two were found at 135-140m from the forest edge and set to catch edible rats (cane rats: *Thryonomyidae spp*.) and squirrels (farmer, pers. comm; trapper, pers. comm.).

A number of households kept dogs, but dogs were only observed defending crops in Kihomboza III. When baboons were seen at the KFR edge a co-ordinated response resulted in dogs from a number of households being sent to chase them. In addition, one Kihomboza III household kept two dogs chained inside a plot of maize, cassava, beans, groundnuts and rice during the day. The plot was adjacent to a riverine strip and the dogs were employed to deter vervet monkeys (farmer, pers. comm.).

Other fixed deterrents included scarecrows; unwound cassette tape passed forwards and backwards across plots; and plastic bags on sticks placed throughout a plot. In addition, a system of crop protection was observed on a small number of maize plots, where the outer leaves are tied around cobs, reducing accessibility and therefore securing cobs against attack by birds and rodents (Field assistant, pers. comm.).

[14]Section 26(5) of Ordinance Supplement No2 to the Uganda Gazette No 61, volume XCV, dated 8th November 2002. States that non-selective vermin control methods including snares, poison and metal traps shall not be used (Reynolds, 2005).

4.3.3 Labour patterns

4.3.3.1 Crop cultivation

During interviews, farmers were asked about the difficulties of growing and harvesting crops. Labour requirement (preparation of land, planting, weeding) was the most frequently given reason for considering a crop problematic and accounted for 55.8% of responses regarding crop growth and 64.7% of responses relating to the harvesting of crops (Table 4.11). Beans and groundnuts reportedly require the greatest investment of labour to cultivate, and millet and groundnuts were cited most frequently as the most laborious crops to harvest. Rice was named most frequently as the most difficult crop to grow overall, mostly due to damage from wildlife (birds). Other reasons given for difficulty of cultivation are a long maturation time (n = 12), bad weather conditions (n = 2) and cost (n = 1). Other reasons given for harvesting difficulty are difficulty of storage (n = 17), unfavourable weather conditions (n = 3) and damage by wildlife (n = 1).

	Most difficult to grow				**Most difficult to harvest**			
Crop	Total (n)	Cited labour (n)	Labour (rank)	Other reason (n)	Total (n)	Cited labour (n)	Labour (rank)	Other reason (n)
Beans	18	14	1	4	16	11	3	5
Groundnut	15	10	2	5	16	12	2	4
Rice	21	9	3	12	12	8	4	4
Cassava	13	8	4.5	5	5	4	5	1
Tobacco	11	8	4.5	3	4	3	6	1
Millet	9	6	6	3	22	15	1	7
Sweet potato	5	2	7	3	3		9.5	3
Pigeon peas	2	1	8	1	1		9.5	1
Maize	7		10	7	2	2	7	
Banana	2		10	2	1		9.5	1
None	1		10	1	3		9.5	3
Total	104	58		46	85	55		30

Table 4.11 Responses relating to labour requirements when farmers were asked about the most difficult crop types to grow and to harvest (n = 81 interviews).

4.3.3.2 Guarding

Although guarding was observed on two farms only, most farmers stated they guarded their crops. Maize, beans, groundnuts and rice were particularly cited as requiring guarding. Maize reportedly has to be guarded "as soon as the cobs are showing", and guarding must be carried out, “from beginning to end otherwise you will not get any.” Rice is considered to require guarding from sowing the seed to harvesting the crop, mainly to prevent crop loss to birds. Farmers commented that due to the length of time required to defend the crop against birds, guarding rice is difficult and very tiresome.

Beans are also considered vulnerable to crop raiding, but not so difficult to guard, as the short gestation period means only a relatively small investment of time is needed for guarding (Kihomboza III farmer). Nevertheless, a number of Wagaisa farmers claimed that protecting beans is so important, either farmers must find time to guard their crops or they must plant them elsewhere (i.e. away from the forest edge). Similarly, a number of farmers recounted how they stopped cultivating groundnuts near to the forest edge due to the time and labour required to guard the crops. Cassava, sweet potato and tobacco were also said by farmers to need guarding against wild animals.

4.3.3.3 Seasonal labour patterns

When farmers’ considerations of laborious crop types are reviewed in relation to accepted seasonal planting patterns (R. Balijwa, S. Ndoleriire, J. Ruhigwa, pers. comm.)[15] both growing seasons appear to be the most labour intensive periods (Table 4.12).

	Interplanting season 1			Growing season 1				Interplanting season 2		Growing season 2		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Cassava	H	H	H	**P/H**	**P/H**	H	H.	H	H	**P/H**	**P/H**	H
Sweet potato			H	P/H	P/H	P/H			H	P/H	P/H	P/H
Banana	H	H	H	P/H	P/H	H	H	H	H	P/H	P/H	H
Sugarcane	P/H	H	H	P/H	P/H	P/H	P/H	H	H	P/H	P/H	P/H
Maize				P	P		H			P	P	H
Beans				**P**	**P**	**H**	**H**			**P***	**P***	**H***
Groundnuts				**P**	**P**		**H**			**P**	**P**	**H**
Rice				**P***	**P***		**H***			**P**	**P**	**H**
Millet				P*	P*		**H***			P	P	**H**
Pigeon peas				P	P							H
Tobacco				**P**	**P**	H	H					

Table 4.12 Planting and harvesting cycles of the main crops. P = planting, H = harvesting. Figures in bold indicate crops viewed by farmers as most laborious to grow and/or harvest. The shaded areas denote crops that farmers claim are guarded. *Minor growing season.

[15] Seasonal planting, growing and harvesting patterns,(as originally shown in Table 3.1) were provided by three field assistants in the research team , all of whom are farmers in Hoima District.

However, with the exception of tobacco, the crop varieties considered most laborious were found to be present in the study sites during all seasons (Table 4.8). Therefore, the extended planting patterns employed by farmers are likely to have expanded peak levels of labour requirements into interplanting seasons. Conversely, whilst farmers claimed that guarding took place when the most vulnerable crops were in the fields, i.e. during the growing seasons, this was not supported by the observations of the research team. Thus, guarding did not show the seasonal peaks in labour requirements that are suggested by farmers in Table 4.12.

4.3.3.4 Division of labour

Just over half the farmers interviewed (n = 41) claimed that all members of the household help to cultivate crops. However, 7% (n = 6) asserted that their children do not work on the household farm, or only work after school and during school holidays. Forty six per cent (n = 37) of farmers said they hired labour, mostly on a seasonal or *ad hoc* basis.

All four women's focus groups (WFGs) asserted that most couples work together, dividing duties to manage time effectively. However, it was agreed the task of growing the crops falls mostly to women as most men also have jobs outside of the farm (WFGs: Wagaisa and Nyakamwaga). Furthermore, members of the Kihomboza III and Nyakamwaga WFGs commented that, as women are responsible for feeding the family, they need to ensure that food crops are being cultivated properly, and are therefore always responsible for the cultivation of household food crops.

Most WFG members agreed that husbands take ownership of cash crops, despite these crops being cultivated by both husband and wives. Nyakamwaga WFG suggested this is because men are more able to sell the cash crops and therefore provide an income. However, Kihomboza III WFG members commented that, where couples initially agreed to cultivate cash crops together, this can lower a wife's morale, and is a reason why women often focus on food production.

It was widely agreed that women do most of the harvesting. In Kiseeta women suggested this is a cultural habit, although they did comment that "men should never pick millet because they have a weakness for that work".

Farmers in Nyakamwaga stated that all members of the household guard crops. However, most interviewees and focus group (FG) members at other sites claimed that guarding is mostly undertaken by women and especially by children. As one Kiseeta FG member commented, "when raiding is on, the first to be sent are the kids." Members of FGs did emphasise that children do not guard if they are supposed to be in school; guarding by children is confined to evenings and weekends. Nevertheless some farmers and FG members claimed that children may be taken out of school to guard if parents have other duties, are sick, or on "special occasions", but this is considered a rare event. In Nyakamwaga, both FGs commented that children are kept off school to guard during peak crop raiding periods. Whilst the WFG asserted this had not happened for a number of years, the men's focus group (MFG) claimed that families nearest the forest do this every season when raids are most frequent. However, this is not supported by research team observations. Children were not seen guarding fields during times of peak crop raiding activity.

4.4 Discussion

Farms in the Hoima District study sample are unmechanised and, with one exception, farmed by hand. Most farms are planted with subsistence crops only. Those households that do cultivate cash crops mostly grow only one type of crop to sell, and almost all cash crop households cultivate larger areas of subsistence crop varieties than cash crops. Nevertheless, subsistence farmers are not precluded from achieving an income from their produce, and often sell excess food crops. This is comparable to communities around nearby Budongo Forest Reserve (BFR) where a number of subsistence farmers also cultivated cash crops (Hill, 1997; Tweheyo *et al*, 2005; Webber, 2006).

Hoima District study households rely mostly on starchy, carbohydrate rich crops; cassava, maize and sweet potato. These crops provide high levels of energy and are efficient at satiating appetites. In addition, they produce high yields, and, with the exception of sweet potato, can be stored for a period of time without deterioration, all of which makes them good for food security. Furthermore, cassava, the most frequently cultivated crop, is able to thrive in marginal and stressed environments where other crops might suffer (Otim-Nape *et al*, 2001), thereby making it a reliable food crop.

The traditional staple crops of the Banyoro people; millet and yam, were recorded on relatively few farms (ranked 9 and 16.5 respectively). Indeed, a greater number of households cultivated cash crops (rice, ranked 7th; tobacco, ranked 8th). This differs from a similar study, also in the old Bunyoro-Kitara Kingdom, which found yam to be the 4th most frequently cultivated crop (number of households), and tobacco and rice to be the 13th and 27th respectively (Webber, 2006). The relatively large number of Hoima District study sample households supporting rice and tobacco is likely due to the promotion of rice cultivation by NAADS in Hoima District[16], and an increase in tobacco production in Hoima District since 2005[17] (Odomel, 2006).

Studies in similar villages (around BFR) found that the frequency of plots of crop varieties correlates with both actual damage events (Webber, 2006) and perceptions of crop vulnerability (Hill, 1997). Consequently, the most frequently cultivated crops in the Hoima District study sites; cassava, maize, sweet potato, beans and groundnuts might be expected to be most vulnerable to damage events, and to be perceived as vulnerable by farmers. In addition, as most farms are located less than 251m from the forest/KFR edge, and 20% border the forest, it is likely that a large proportion of households are at risk of experiencing damage events, as farms positioned closest to the forest-farm boundary receive greater numbers of raids than those further away (Hill, 1997; Naughton-Treves, 1997; Tweheyo *et al*, 2005; Webber, 2006).

Most crop types were present throughout the year, and farmers claimed that extended planting patterns helps to reduce the risk of damage to crops by unfavourable weather conditions and wildlife. Planting crops before or after normal seasonal peak times for crop varieties may be effective in reducing crop loss to animals, as damage events are influenced by seasonal crop availability (Naughton-Treves *et al*, 1998). Nevertheless, extended planting patterns are likely to spread farmers' agricultural requirements across the agricultural seasons, and result in longer periods of labour investment. Extended crop presence would also require more hours spent guarding, although guarding was not generally observed in the study sites.

The labour requirements of crop cultivation are the main concern for farmers in the study sites. It was the degree of labour required, rather than the risk of loss to wildlife that was cited by farmers as the main reason for considering a crop to be difficult to cultivate. This

[16]From 2006 to 2009 revenue raised by rice cultivation in Hoima District rose from sh18bn in 2006 to sh79bn in 2009 (Kwesiga, 2011).
[17]In 2005 BATU purchased 1.6m kg tobacco from Hoima District farmers. This figure doubled to 3.2m kg in 2006 (Odomel, 2006).

focus on labour investment rather than crop loss may explain why farmers continued to plant vulnerable crops in vulnerable places, even though guarding levels were low. Almost two thirds of farms that planted maize did so in plots lying at the nearside edges of their farms (i.e. nearest edge to the forest) despite maize being attractive to wild animals at tropical forest-farm boundaries (Hill, 1997; Naughton-Treves, 1997; Tweheyo *et al*, 2005; Webber, 2006; de Freitas *et al*, 2008).

Farmers were often aware of the benefits of preventative crop protection strategies such as planting vulnerable crops away from the forest, and discussed the employment of such schemes, but rarely applied them. For example, a number of Wagaisa farmers commented that, due to the vulnerability of groundnut plots next to the forest edge, and the prohibitive temporal investment that guarding requires, they had ceased to cultivate groundnuts adjacent to the forest edge. However, groundnut plots continued to be planted next to the forest edge in Wagaisa throughout the study period, and all of these plots remained unguarded. Similarly, one Kihomboza III farmer asserted he did not plant rice, beans or groundnuts next to the KFR edge due to the risk of crop raiding. However, for two seasons these crops were recorded in his plots next to the forest-farm boundary. Thus, the risk of damage by wildlife did not influence the positioning of crops on household farms.

It appears that the employment of protection strategies is not as immediate a consideration to farmers as the degree of labour required to cultivate crops. This would suggest that farmers do not perceive raid levels to be high. However, labour requirements can influence perceptions of vulnerability of crop types to raid animals; crops that are perceived to be most laborious to cultivate are considered more vulnerable to raids by wildlife (Naughton-Treves, 1997). Thus, although farmers in the study sites appear particularly concerned with constraints on cultivation of beans, millet and groundnuts due to labour requirements, this may also cause them to consider these crops as especially vulnerable to raids by animals.

Guarding was only observed on two plots (only one plot for more than one season). Despite farmers asserting their crops required guarding, farmers appeared unwilling or unable to devote time to guarding their plots. Guarding requires a large investment of time and labour (Hill, 2004), and a number of farmers commented that men often have other jobs that take them away from the farm, whilst children attend school during the day and therefore cannot guard. Thus, in these households women are left to tend the crops, look after young children, cook for the family, run errands and guard. It is likely that farmers find adequate levels of guarding hard to achieve. This is unsurprising. Strum (2010) found that baboons required only a short break in farmers' guarding duties to forage for energy rich human food crops that were sufficient to meet their nutritional needs, and it was beneficial to the animals to wait for this opportunity. Thus, despite acknowledging that crops require guarding, farmers may be unwilling to guard at all if the likelihood is that crops will be raided anyway. Guarding does not represent efficient use of a farmer's time, and any investment in unsuccessful guarding signifies an extra loss of time and the opportunity to do other tasks, in addition to the loss of the crop itself. As one Wagaisa farmer commented whilst discussing the labour requirements of guarding, "If it (crop) goes, it is wasted energy and investment. It demoralises."

Furthermore, given the small size of the forest fragments and likelihood of correspondingly small populations of raid animals, it is possible that, even when farms experience damage events, the actual level of crop loss to animals is often so low that the costs of guarding outweigh the benefits. Guarding may therefore represent a 'double cost': the cost of guarding crops which could be raided anyway, and the cost of losing crops, which are unlikely to suffer a large proportional loss even if raided. Certainly, farmers in the study sites do view guarding as a cost rather than as a benefit to their crops, and this is a further example of farmers' focus on the labour requirements of crop cultivation rather than the risks of crop loss.

4.5 Summary

- Crop cultivation is non-mechanised and the main tools used are the hand-hoe and the panga (machete).

- The most extensively and frequently grown crops were cassava, maize, beans and sweet potato. Banyoro staple crops of millet and yam were cultivated less frequently.

- Less than half the number of households in the study sites cultivated cash crops. These were mainly rice and tobacco. Most households that cultivated cash crops grew only one variety, and most cash crop households continued to cultivate predominantly subsistence crops.

- Seasonal crops such as maize, beans and rice are planted over an extended period, resulting in a graduation of crop maturity and a prolonged presence of the crop species in the fields during all four seasons.

- Agricultural tasks are reportedly shared between all household members. Women were said to be responsible for kitchen crops, men for cash crops (although women are reportedly still the main cultivators), and guarding was said to be mostly undertaken by children, albeit outside of school hours.

- Few farmers employ crop protection strategies. Static deterrents were recorded on a number of farms, but guarding was only consistently observed on one plot throughout the study period.

- Labour requirements of crop cultivation are the main concern for farmers in the study sites, rather than the risk of loss to wildlife. This would suggest that farmers do not view crop damage levels as high, and investment in guarding and other crop protection strategies represents a cost to the farmer of lost opportunities to do other activities, rather than a benefit, i.e. preventing the loss of crops. If farms do experience damage events, guarding may then represent a 'double cost' to farmers: the cost of time spent guarding crops, and the cost of losing crops.

5. SOCIO-ECONOMIC AND CULTURAL FACTORS

5.1 Introduction

Human behaviour is directed by attitudes, norms and perceptions of control (Manfredo and Dayer, 2004). In agricultural communities, societal characteristics such as cultural traditions and attitudes; economic characteristics such as impacts on household budgets (financial and time); and perceptions of financial control all influence practical decisions made by farmers. These include the choice of crop cultivated, the type of farming systems adopted and the patterns of labour used. Furthermore, the types of farming practices employed are likely to affect both actual levels of crop loss and farmers' perceptions of loss (see Chapters 6 and 7). For this reason, the socio-economic and cultural basis for farmers' decision making on agricultural matters should be reviewed.

Crop choice can be informed by cultural factors such as taste, ethnicity and gender (Hill, 1997; Naughton-Treves, 1997), and by economic factors such as the cost of seeds and the potential financial returns. Factors can also combine to inform crop choice; in two rural areas in Kenya, Goldman (1987) found that a decrease in the cultivation of sorghum and millet in favour of maize was due to taste, a ban on sorghum and millet beer, and an expansion of primary education, which reduced the availability of children to guard.

Changes to farming systems can be influenced by economic factors, for example, an increased investment in cash crops and the availability of trade opportunities: in western Ethiopia, Dixon *et al* (2009) found that development of the coffee market increased household cultivation of coffee crops. These crops were planted in fields historically given over to subsistence crops, which were displaced to wetland areas (where they were more vulnerable to crop raiding by wildlife). Farming systems can also be affected by societal changes. In Tanzania in 1935, cattle grazing was banned in all Forest Reserves. As a result the Wambugu people of Western Tanzania switched from pastoral to agrarian farming (Conte, 1999).

Social and economic factors also influence labour patterns. In the Dja Reserve in Cameroon, families historically and successfully farmed inside the forest by siting fields close together and taking turns to guard. Availability of alternative sources of income and increasing contact with markets reduced willingness to guard and cooperation between families ceased, so that only fields around the villages were maintained (Arlet and

Molleman, 2007). This also illustrates how levels of actual crop loss can be affected by changes in farming practices prompted by socio-economic and cultural factors. A further example is illustrated by Goldman (1987). He found that, in two rural areas in Kenya, economic considerations, together with official recommendations and individual perceptions resulted in insecticides being applied at less than the recommended dose. This reduced the effectiveness of the chemicals.

Adoption or prevention of farming practices based on economic or sociological considerations may also influence farmers' perceptions of loss and shape attitudes to crop raiding animals (Naughton-Treves, 2001). Thus, favouring cultivation of cash crops over subsistence crops is likely to reduce tolerance of loss (Hill, 2004; Lee and Priston, 2005). Similarly, an inability to plant unpalatable buffer crops due to small landholding sizes (Naughton-Treves, 1997, 2001), or to access adequate pasture land for cattle (Kideghesho *et al*, 2007) may also affect perceptions of loss. Other factors that influence farming practices and are likely to shape farmers' attitudes towards crop loss include an absence of funds for the hiring of labour or the purchase of seeds; lack of land to cultivate favoured crops; a physical inability to grow crops requiring lots of manual investment, or the cultivation of traditional and culturally important crops irrespective of their attractiveness to raid species.

In conclusion, social, economic and cultural factors need to be reviewed in order to understand how they are likely to shape agricultural choices and farmers' behaviour, which may in turn affect perceptions of crop loss and tolerance of pest species, and influence actual damage events.

The aims for this chapter are:

- To establish the cultural backgrounds of farmers, and the longevity of residence.
- To determine the cultural and financial importance of crop species.
- To identify social, cultural and economic reasons for crop choice.
- To ascertain trade opportunities available to farmers.
- To review the influences on farming practices of socio-economic circumstances.
- To examine the socio-economic effects of changes in crop assemblages.

5.2 Methods

Semi structured interviews (SSIs) (n = 81)[18] and focus groups (FGs) (n = 8) were undertaken in the four villages, as described in Chapter 3 (Methods), section 3.6. Interviews were sought initially with a member of each household that cultivated farms within the boundaries of the sample areas, and then from randomly selected households in each study site. Interviews were conducted each week after the recording of crop damage had been completed at all sites, and continued for six months (February to July 2007) during the study period. Two FG discussions were conducted at each study site; one with only adult male participants (MFG) and the other with only adult females (WFG). These were held after all interviews had been completed (August to October 2007). Data were analysed using the Chi-square test, χ^2.

Definitions of cash and subsistence farms are based on farmers' own perceptions; farmers who described themselves as regularly selling crops are classified as cash croppers. This differs from Chapter 4 (see Table 4.1).

[18]Kiseeta; n = 20, Wagaisa; n = 26, Kihomboza III; n = 21 and Nyakamwaga; n = 14.

5.3 Results

5.3.1 Household characteristics

5.3.1.1 Ethnicity

Over 90% of interviewed farmers were ethnically Banyoro from the Bunyoro-Kitara Kingdom (Table 5.1), and only one or two farmers at each site (three at Kihomboza III) came from other ethnic groups. In addition, only two interviewees within the whole study sample were not Ugandan: a Rwandan farmer resides in Kihomboza III and a Congolese farmer has settled in Nyakamwaga.

	Kiseeta	Wagaisa	Kihomboza III	Nyakamwaga	All sites
Interviewees (n)	20	26	21	14	81
Gender	M: 8 F: 12	M: 12 F: 9	M: 5 F: 21	M: 8 F: 6	M: 33 F: 48
Ethnicity					
Banyoro	18 (90.0%)	25 (96.2%)	18 (85.7%)	12 (85.7%)	73 (93.5%)
Other, (Bagungo, Batoro, Congolese, Lendu, Lugbara, Rwandan)	2 (10.0%)	1 (3.8%)	3 (14.3%)	2 (14.3%)	8 (10.2%)
Years lived in village (mean)	33±26.76	21±15.48	39±23.78	26±17.27	29.6±21.95
Reason for residence					
Inherited/born here	11 (55.0%)	10 (38.5%)	15 (71.4%)	2 (14.3%)	38 (48.9%)
When married	5 (25.0%)	12 (46.2%)	3 (14.3%)	6 (42.9%)	26 (33.2%)
With parents	1 (5.0%)		1 (4.8%)		2 (2.6%)
For land	1 (5.0%)	4 (15.4%)	2 (9.5%)	5 (35.7%)	12 (15.2%)
For work				1 (7.1%)	1 (1.2%)
No answer	2 (10.0%)				2 (2.6%)
Ownership					
Own land	18 (90.0%)	26 (100.0%)	20 (95.2%)	14 (100.0%)	78 (99.8%)
Rent	2 (10.0%)				2 (2.6%)
No answer			1 (4.8%)		1 (1.3%)
Farm type					
Cash crop	5 (25.0%)	10 (38.5%)	13 (61.9%)	9 (64.3%)	37 (47.2%)
Subsistence crop	15 (75.0%)	16 (61.5%)	8 (38.1%)	5 (35.7%)	44 (56.5%)

Table 5.1 The frequency of interviewee characteristics in the study sample (n = 81 interviewees).

5.3.1.2 Time lived in area

The population showed little immigration; 88% of interviewees (n = 71) had lived in the area for over five years, and over 60% of farmers had been resident for twenty years or more. In Kihomboza III this figure rose to 81%. Most recent settlers were not Banyoro. In Kiseeta and Nyakamwaga the only interviewees that had been resident for fewer than five years were also the only non-Banyoro interviewed. In Wagaisa the only non-Banyoro villager interviewed had been in the area for fewer than five years (although four Banyoro households had settled more recently), However, not all non-Banyoro residents were recent settlers; all of the non-Banyoro households in Kihomboza III, and one in Nyakamwaga had been established for over 20 years.

5.3.1.3 Reason for residence

The most common reason for residence was historical family ownership; 48.9% of interviewees said they inherited their land from their elders (Table 5.1). In addition, almost one third (33.2%) of interviewees said they settled in the area after marriage. All of these interviewees were female and although three of them (11.5%) stated that their land was new to them and did not previously belong to their husband's family, a number were likely to have inhabited their husband's ancestral land. There were few economic migrants. Only one farmer came to the area specifically to find work, and 15.2% (n = 12) came to find land.

5.3.1.4 Farm ownership

Farm ownership was high, with only two interviewed farmers renting, rather than owning their land (Table 5.1) (In addition, the researcher was aware of two rental households in Kiseeta and Nyakamwaga that were not interviewed). Five interviewees, (6.2%) said they had lived in the area longer than they had owned their current homesteads. Four of these had settled after marriage and one had come to acquire land. The average length of time these households were present in the area before they became land owners locally was six years.

5.3.1.5 Cash or subsistence farms

Most interviewees in Kiseeta and Wagaisa described themselves as subsistence farmers. In contrast, approximately two thirds of interviewees in Kihomboza III and Nyakamwaga commented that they cultivated crops specifically to sell (Table 5.1). However, as is often the case in developing countries (Barbier, 1987), the distinction between subsistence and cash crop farms was unclear, and crop varieties reportedly sold by farmers included both traditional cash crop species (e.g. tobacco) and staple food crops. Relatively few farmers claimed to set aside land annually for cash crops. Instead, the farming systems of interviewees who described themselves as cash croppers ranged from 1) Frequently growing cash crops, although not necessarily every year; 2) Cultivating a surplus of food crops each season in order to sell the excess; 3) Frequently although unintentionally producing surplus crop, which was then sold; to 4) Not usually producing surplus crops, but selling any that did occur. For the purposes of the research, farmers who claimed to be cash croppers and who grew traditional cash crops or who regularly and intentionally cultivated surplus food crops to sell, were defined as cash crop farmers. Interviewees who claimed to be cash croppers but only sold excess crops on an *ad hoc* basis were defined as subsistence farmers.

5.3.2 Social and economic importance of crops

5.3.2.1 *Reasons for crop importance*

Interviewed farmers were asked what crop type they considered most important and why. The most frequently given reasons for naming crop varieties as important were the provision of food security and income generation, (Table 5.2).

Reason	Responses (n)	Percentage (%)
Food security	27	33.3
Income	25	30.9
Variety*	13	16.0
Taste	6	7.4
No answer	6	7.4
Nutrition	2	2.5
Little labour	1	1.2
Little expenditure	1	1.2
Total	81	

Table 5.2 Reasons for crop importance given by interviewees (n = 81 interviewees).
***A variety of crops were viewed as most important for a variety of reasons., and no one crop or reason was considered more important than any other.**

Secure food provision was said to include reliability of production, high yields, hardiness against weather and diseases, accessibility over a period of time both as a fresh crop and from storage, and the ability to stave off hunger. As a farmer in Kiseeta commented, "It's no good being able to sell crops if you are starving."

There is no significant variation in the reasons given for crop importance between interviewees from different study sites (Chi square, $\chi^2 = 24.052$, $df = 21$, $p>0.05$). Nevertheless, more interviewees in Kiseeta and Nyakamwaga named food security as the reason for cultivating their most important crops than named income generation (food security: 45% and 42.9% of interviewees in Kiseeta and Nyakamwaga respectively). Conversely, over twice as many interviewees in Kihomboza III asserted that income generation is the predominant consideration than cited food security (42.9% and 19% respectively). In Wagaisa farmers cited income generation and food security with equal frequency (n = 30.8% each).

Farmers did not suggest tradition as the major reason for cultivating any of their most important crops. However, one farmer did comment that millet is an important crop to cultivate because according to Banyoro tradition, kalo (millet porridge) should always be served to visitors. Nutrition was only considered to be the main factor in crop selection by two farmers in Wagaisa, who named beans and vegetables (cabbage, greens, bugora, dodo and carrots) as their most important crops. The degree of labour required to cultivate crops was not a major influence in the consideration of crop importance.

5.3.2.2 *Crop importance: cash and subsistence crop households*

When the two main reasons for crop importance are reviewed separately from other reasons, there is a significant difference between the opinions of cash crop and subsistence crop farmers (Chi square, $\chi^2 = 6.240$, $df = 1$, $p = 0.012$). Almost half of all interviewed cash crop farmers cited income generation as the main reason for considering crop types as most important to cultivate (48.6%) (Table 5.3). In contrast, the most frequently given reason by subsistence crop interviewees was food security. There is no significant difference between cash and subsistence crop farmers for any of the other reasons given for considering crops as important (Chi square, $\chi^2 = 8.274$, $df = 5$, $p>0.05$).

	Cash crop farmers			Subsistence crop farmers			
	Responses (n)	Rank	Percentage (%)	Responses (n)	Rank	Percentage (%)	Total (n)
Food security	9	2	24.3	**18**	**1**	**40.9**	**27**
Income	**17**	**1**	**48.6**	8	3	18.2	25
Variety*	4	3	10.8	9	2	20.5	13
No answer	3	4	8.1	3	5	6.8	6
Taste	2	6	2.7	4	4	9.1	6
Nutrition	1	6	2.7	1	6.5	2.3	2
Little expenditure	1	6	2.7				1
Little labour				1	6.5	2.3	1
Total	37			44			81

Table 5.3 Reasons given for crop importance by cash and subsistence crop interviewees (n = 81). Reasons were given in response to naming particular crop types as the important to cultivate. Most frequent answers = ranked 1. Figures in bold indicate crops most frequently named as most important.
***A variety of crops were viewed as most important for a variety of reasons, and no one crop or reason was considered more important than any other.**

5.3.2.3 *Importance of crop species*

Cassava was named most frequently as the most important crop to cultivate (Table 5.4). Over one third (35.8%) of interviewees cited this crop, which was more than twice the number who gave the second most frequent answer; ‘all crops’ (n = 14). Farmers described cassava as a staple food crop. It was viewed as reliable, robust in the face of extreme weather conditions, versatile to cook and, because it could be harvested from the field piecemeal, continuously available. One farmer stated, “Cassava should always be grown.” Another said, “Although the land is small we always ensure that cassava is the first crop planted.” Seventy per cent (n = 19) of interviewed farmers who named food security as the predominant reason for crop choice (Table 5.2) cited cassava as their most important crop. One farmer stated, “Cassava protects the family against hunger. If you have cassava stands you are rich.”

At the site level there is no significant difference in the crop types considered most important to grow(Chi square, χ^2 = 14.914, *df* = 33, *p*>0.05). Interviewees at three of the four study sites suggested cassava more frequently than any other answer (in Kiseeta it was ranked equal 2nd after ‘all crops’). There is also no significant difference in the number of interviewed farmers at each of the study sites that cited cassava as their most important crop (Chi square, χ^2 one sample test, *p*>0.05).

	Most important (n)	Rank	Most important to eat (n)	Rank (to eat)	Most important to sell (n)	Rank (to sell)
Cassava	**29**	**1**	**29**	**1**	7	5
All crops	14	2	1	9	3	9
Banana	5	4	7	4	4	6.5
Millet	5	4	20	2	3	9
Rice	5	4	1	9	**16**	**1**
Beans	4	6.5	2	6.5	13	2
Groundnuts	4	6.5	2	6.5	3	9
Tobacco	3	8.5			9	4
Maize	2	11.5	1	9	2	11.5
Onions	2	11.5			2	11.5
Sweet potato	2	11.5	12	3		
Tomato	1	14			1	14
Cocoa					1	14
Sugarcane					1	14
Other	2	11.5				
No answer	3	8.5	6	5	4	6.5
Don't sell					12	3
Total	81		81		81	

Table 5.4 Crops named by interviewees as most important: overall, for home consumption and to sell (n = 81 interviewees). Most frequent answer = ranked 1. Figures in bold indicate crops most frequently named as most important.

When asked about crops specifically for home consumption, cassava and millet were cited as most important by more farmers than all other crops (Table 5.4). Thirty six per cent (n = 29) of interviewees named cassava, and 24.7% of interviewees cited millet (n = 20). Sweet potato was ranked third. Millet was said to, “Feed many people and last for a long time. Nothing spoils it” (Kihomboza III farmer, pers. comm.). During his interview, another farmer commented, “Cassava and millet are staple foods. If these are not grown then they must be bought because the family needs them to be satisfied.”

Farmers were asked if they sold their crops, and if so, which varieties were most important to them as cash crops[19]. Farmers most frequently named rice (19.8% interviewees) (Table 5.4). Beans were ranked second; 16% of interviewed farmers considered this crop to be their most important for income generation. Tobacco was cited as the most important crop by 11% (n = 9) of interviewees.

[19] A number of interviewees categorised as subsistence crop farmers named crop varieties that they sold.

Rice was described by farmers as a crop in high demand, sold for a good price and capable of producing large yields. One Wagaisa farmer additionally stated how the waste product from rice fattened her chickens, which could, in turn, be sold; "Therefore money invested in rice goes further." Reasons given by farmers for naming beans as their most important crop for income generation were similar; a high demand for the crop and good productivity. Farmers also commented that beans are a biannual crop with a short gestation period, which allowed for a relatively quick financial return. The main reason given for cultivating tobacco was the high level of income achievable on selling it.

Crops cited as the most important for income generation differed between study sites, although the data are too small to be tested statistically. Thirty per cent of interviewees in Kiseeta (n = 6) named beans most frequently, and one third of farmers in Kihomboza III (n = 7) suggested tobacco. Thirty five per cent of farmers in Wagaisa (n = 9) and 21.4% of Nyakamwaga farmers named rice as their most important crop.

5.3.2.4 *Importance of crop species: Cash and subsistence crop households*

There is no significant difference in the crops named as most important by cash crop and subsistence crop interviewees. Both groups named cassava most frequently as the most important crop to cultivate (Table 5.5). A larger number of cash crop interviewees named rice and tobacco as their most important crops than cited most other crop types (n = 5 and n = 3 respectively). However, twice as many cash crop interviewees named cassava as suggested rice or tobacco (cassava, n = 10).

Beans were cited by few cash crop interviewees as being their most important crop (n = 1), which suggests that the high ranking of beans as an important crop to sell (Table 5.4) originates from subsistence crop farmers. Beans are ranked (equal) third in terms of the number of subsistence crop interviewees citing it as their most important crop, however, this is less than a sixth of the number of subsistence crop interviewees who cited cassava (15.8%).

	Cash crop farmers			Subsistence crop farmers			
	Responses (n)	Rank	Percentage (%)	Responses (n)	Rank	Percentage (%)	Total (n)
Cassava	**10**	**1**	**27.0**	**19**	**1**	**43.2**	**29**
All of them	5	2.5	13.5	9	2	20.5	14
Millet	2	6.5	5.4	3	3.5	6.8	5
Banana	3	4.5	8.1	2	6	4.5	5
Rice	5	2.5	13.5				5
Beans	1	11	2.7	3	3.5	6.8	4
Groundnuts	2	6.5	5.4	2	6	4.5	4
Tobacco	3	4.5	8.1				3
Maize	1	11	2.7	1	9.5	2.3	2
Onions	1	11	2.7	1	9.5	2.3	2
Sweet potato	1	11	2.7	1	9.5	2.3	2
Tomato	1	11	2.7				1
Other	1	11	2.7	1	9.5	2.3	2
No answer	1	11	2.7	2	6	4.5	3
Total	37			44			81

Table 5.5 Crops named by cash crop and subsistence crop interviewees as most important (n = 81 interviewees). Most frequent answers = ranked 1. Figures in bold indicate crops most frequently named as most important.

5.3.3 Level of available market

There is no significant variation in the routes by which cash crop and subsistence crop farmers sell their cash crop and surplus food crops (Chi square, $\chi^2 = 7.136$, $df = 4$, $p>0.05$). Most farmers in both groups claimed to either sell their produce in the local market or to traders who visit the house (cash croppers, 53.1%; subsistence croppers, 71.7%) (Table 5.6). Subsistence crop farmers are more likely to sell locally; 56.5% of subsistence farmers said they sold excess crops in the local or town markets (cash croppers: 38.8%). By comparison, more cash crop interviewees described selling crops to traders and national and international company representatives than did subsistence croppers (Cash croppers, n = 24: 50% of responses; Subsistence croppers, n = 16: 34.8% of responses).

	Cash crop farmers			Subsistence crop farmers			
	Responses (n)	Rank	%	Responses (n)	Rank	%	Total responses (n)
Local market**	12	2	24.5	**18**	**1**	**39.1**	**30**
Traders visit house	**14**	**1**	**28.6**	15	2	32.6	29
Town market**	7	4	14.3	8	3	17.4	15
No answer	6	5	12.2	4	4	8.7	10
Traders in town	8	3	16.3	1	5	2.2	9
International market*	2	6	4.1	0			2
Total	49			46			95
Do not sell	0			12			12

Table 5.6 Routes by which farmers (n = 81) stated that their crops were sold. Most frequent answers = ranked 1. Figures in bold indicate route most frequently cited.
Note: some interviewed farmers gave more than one answer.
***Purchased by the Hoima branch of British American Tobacco Uganda (BATU).**
****Includes selling in local and town shops and also directly to local people who visited the homestead.**

5.3.4 Social and economic influences on farming practices

5.3.4.1 *Crop choice*

Economic influence on crop choice is particularly relevant for cash crop species. Interviewed farmers stated that rice, tobacco and beans are selected for cultivation because they fetch a high price (Section 5.3.2.3). However, crop choice can be negatively, as well as positively affected by market economics. Returns from tobacco dropped in 2004 (Mubiru, 2005; Nsambu, 2008), and although prices have since risen (Odomel, 2006), one Wagaisa farmer commented that the reduction in the value of tobacco, “caused poverty, not only to me but to the entire community.” A number of farmers consequently switched to rice cultivation, which has been promoted as a cash crop in Hoima District since 2003 (Kwesiga, 2011). Farmers also cited groundnuts as troublesome crops due to frequent fluctuations in price.

Crop selection was also influenced by farmers’ ability to invest labour and time in their crops. A number of farmers claimed they stopped cultivating certain crop types (mainly cash crops) because they could no longer physically manage the agricultural processes. A Wagaisa farmer claimed she was forced to cease tobacco cultivation because the degree of labour and time required in cultivating it prevented the maintenance of her food crops, which caused household food insecurity. Another Wagaisa farmer described how she was unable to continue with the cultivation of rice as the time and effort required to guard the crop was prohibitive. A Kiseeta farmer complained that beans, when provided as part of the household food budget, increased labour requirements as the crop consumed a lot of firewood during cooking, which had to be regularly collected from the forest. Frequent visits to the forest are also likely to have a further consequence; an increased likelihood of encountering chimpanzees and other forest wildlife. Other socio-economic influences on crop choice included the area of farming land available. A Wagaisa farmer stated that her choice of crop was dictated by the size of her land holding, which was too small to support a viable amount of cash crops.

5.3.4.2 *Farming systems*

Farmers in the study sample described ways in which financial constraints influenced their farming systems. Many interviewees and FG members commented that insecticides or fertilizers were financially unattainable, and alternative methods of cultivation were employed, such as "crop management," (Wagaisa farmer, pers. comm), which incorporated a system of early planting and crop rotation. One farmer commented that, in lieu of using fertilizer to improve the soil in existing plots, he, "cut into the forest for new soil." The financial value of one farming product relative to another also influenced farming systems. For example, a Kiseeta cattle owner described how his cattle used to graze next to the forest, but he relocated them near to the homestead so they could be more easily monitored. He planted his crops at the forest edge instead. During the study period, raids from the forest were recorded on these crops.

Societal factors also influenced farming systems. A number of farmers claimed that the real or perceived risk of crop loss to thieves had caused them to stop cultivating particular crop species; mainly cassava and banana. One Kihomboza III farmer also described how frequent thefts cause him to stop cultivating pineapple and passion fruit. He remarked, "Now we grow what everyone else grows." Farmers at all sites asserted that their most valuable crops were planted nearer to the homestead in an attempt to deter thieves. This most frequently referred to cassava crops. In Wagaisa, farmers claimed that pollution of the local river with effluent from the local factory (a gin distillery), had ended their main source of water for agricultural needs and had forced them to modify their cultivation systems. One farmer commented, "This farm was known to be good for tomatoes, now the molasses are changing the farming system because the tomatoes now have to be irrigated by rainwater and not river water." Given that rainwater was less reliable than river water (this was not a seasonal water body), and was likely to contain fewer nutrients (Ntow *et al,* 2008), the success of these crops was also more unpredictable.

5.3.4.3 *Labour patterns*

Hired labourers were observed working on a number of farms in the study sample. However, many farmers complained that they were financially unable to hire workers, and agricultural tasks had to be undertaken by household members only. A number of these farmers complained that insufficient access to labour resulted in their land being under-utilized.

Labour patterns were also affected by societal factors. For example, farmers who lived alone often complained that maintenance of their fields completely ceased if they were unable to continue farming for a period, e.g. through illness. In Wagaisa, one farmer observed that labour patterns in local farms were changing since the local factory, (a gin distillery), had started to employ many of the local men. He commented that hired labour was now harder to obtain.

Cultural factors that influence labour patterns include responsibility for the household nutritional budget lying with women. This results in food crops being largely cultivated by women (Chapter 4). Another influence on labour patterns is the cultural conviction that children should attend school despite being the main household members responsible for guarding. Nevertheless, some members of the Wagaisa WFG commented that continued school attendance actually increases the likelihood of children contributing to household labour patterns, because without children available to guard crops, the risk of damage to crop raiding animals is increased, which in turn reduces the money available for school fees.

Whilst comments by farmers illustrate the effects of socio-economic factors on each aspect of farming systems, these factors can be multiple in their effect. One Kihomboza III farmer succinctly described how his lack of money affected labour patterns, crop choice and income, “Lack of money restricts the variety of crop and the workforce, which restricts choice and therefore income. I need to grow sweet potato and cassava for the family, but this means that groundnuts cannot be grown, which means we can’t get money from them.”

5.3.5 Changes to crop assemblage

Over two thirds of farmers interviewed (66.7%, n = 54) said they had either stopped growing particular crop types or had introduced new species to their fields in recent years. Disease was the most frequent reason given for discontinuing the cultivation of crop types (n = 44 responses), particularly with respect to banana and coffee (Table 5.7). A number of farmers stated that the loss of these cash crops affected income levels, which, in turn affected food security; labour was unaffordable and some crops were no longer cultivated due to absence of funds for seeds. In addition, farmers asserted that school fees were more difficult to obtain. One farmer, commenting on the loss of banana crops observed, “Conditions are generally not good.”

The second most frequently cited reason for the discontinuation of crop cultivation was a loss of market, mainly for tobacco (n = 10 responses). However, fewer farmers commented about the impacts of ceasing tobacco cultivation on household food and income security than discussed the impacts of stopping banana and coffee cultivation. This is likely to be because, i) the loss of the tobacco market was local and temporary. Overproduction of tobacco in 2004 resulted in many farmers from Hoima and Masindi Districts being unable to sell their crops back to British American Tobacco Uganda (BATU)[20]. Consequently, farmers at the study sites asserted that BATU “had a bad way of dealing with farmers” (Kihomboza III farmer, pers. comm.). However, BATU quotas in the area have since increased (Odomel, 2006), and a number of farmers have recommenced tobacco cultivation. ii) Some farmers changed from cultivating tobacco to growing rice[21], and asserted that this conversion prevented conditions in the household from changing.

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[20]The BATU production system consists of farmers purchasing seed from BATU and then recouping this financial outlay by selling mature crops back to BATU at the end of the season. In 2004 BATU refused to re-purchase tobacco from 3000 tobacco farmers who had bought seeds, citing overproduction and a lack of external markets. BATU was sued for breach of contract in 2005, and ordered to pay costs to 3000 farmers in 2008 (Mubiru, 2005; Nsambu, 2008).

[21]Rice was introduced into Hoima District as a commercial crop in 2003, and revenues increased fourfold from 2006 to 2009 (sh18bn to sh79bn), (Kwesiga, 2011).

	Reasons	Crop	Responses (n)
		Stopped growing	
Agricultural	Disease	Banana	28
		Coffee	13
		Cassava	1
		Cocoa	1
		Groundnuts	1
	Small yields	Groundnuts	2
		Onions	1
	Bad soil quality	Groundnuts	1
	Land too small	Tobacco	1
	Crop loss: raiding	Groundnuts	1
		Sugarcane	1
	Crop loss: thieves	Cassava	1
Economic	Loss of market	Tobacco	10
		Cotton	1
		Soya bean	1
	Market price reduction	Irish potato	2
		Groundnuts	1
Social and labour	Physically unable	Tobacco	4
		Cassava	1
		Coffee	1
		Maize	1
		Millet	1
	Neglected other crops	Tobacco	1
		Total	**76**
		Started growing	
Agricultural	Lower risk of crop raiding	Sweet potato	1
Economic	Good market price	Rice	11
		Beans	1
		Maize	1
		Tomato	1
	Available market	Tobacco	4
		Rice	2
		Dodo	1
		Eggplant	1
	Regular yields/income	Rice	2
		Total	**25**
		No change	23
		No answer	4

Table 5.7 Reasons given by farmers for changes in crop assemblage (n = 81 interviewees). Note: a number of farmers gave more than one response (n = 127).

Two farmers cited crop raiding by animals as the reason they stopped cultivation of particular crops (groundnuts and sugarcane). Conversely, a Kihomboza III farmer resumed sweet potato cultivation next to the Mukihani Kingdom Forest Reserve (KFR) edge during the survey period. This farmer asserted that baboons, which had previously caused him to stop cultivation of this crop, now visited his farm less frequently (pers. comm.).

All newly cultivated crops were chosen due to economic factors, although the most frequently cited 'new' crop; rice, was said to be doubly valuable because it could be eaten as well as sold (unlike tobacco). Farmers also said that income from rice is more readily available as the crop takes less time to grow than tobacco. Furthermore, income could still be obtained as a lump sum (as is the case for tobacco). Farmers commented that provision of a lump sum payment enabled them to purchase products or invest in a way that is not possible with more frequent but smaller sources of income.

5.4 Discussion

5.4.1 Household characteristics

The communities in the four villages were stable, with high levels of long-term residence and land ownership. In addition, over 90% farmers interviewed were from the local tribe, the Banyoro. Security of tenure is likely to increase tolerance of raid animals (Romanach *et al*, 2007). However, long-standing cultivation of established fields and cultural homogeneity with neighbours may have entrenched farming practices, irrespective of crop loss levels. Well established farmers may be less able, or willing, to respond to changing levels of crop loss.

5.4.2 Crop choice

Food security was cited as the predominant reason for considering crops as most important to cultivate, although income generation was suggested almost as frequently. The opinions of cash and subsistence crop households differed, with subsistence farmers stating that food security was the most important factor in crop choice, and cash crop farmers citing income generation as the main reason for naming a crop as most important. Nevertheless, in both cash and subsistence crop households, cassava was reportedly the most important crop to cultivate. This crop was not ranked by cash crop households as particularly important for income generation, which suggests that food security was an important factor in both subsistence and cash crop households, and the loss of cassava in particular, would be less well tolerated than the loss of any other crop, even in cash crop households.

In contrast, beans appeared to be particularly important to subsistence crop households as a way to obtain income from excess crops. Damage to this crop may therefore represent a significant loss to subsistence households as it would impact upon the relatively little income that is derived from crop cultivation.

5.4.3 Level of available market

Despite the assertion that cassava, a crop produced overwhelmingly for food security, was the most important crop to cultivate, the influence of commercial food production and micro-economics was observed at all sites. Only 15% of interviewees (n = 12) asserted they did not sell any crops, and even some subsistence farmers suggested that income generation was the main reason for considering a crop as most important to cultivate. Furthermore, both cash crop and subsistence farmers showed an awareness of market forces, with some farmers noting that crops which stored well could be retained and sold later for a better price when general availability was low, and other farmers demonstrating knowledge of which crops would be in greater demand at the local level or with traders from elsewhere. Increased awareness of available markets even at the local level can change farming practices and influence crop loss. In western Ethiopia, Dixon *et al* (2009) found that the development of local markets and a move beyond subsistence agriculture caused farmers to increase production in wetland areas inhabited by wild animals, thereby increasing the number of raid incidents.

5.4.4 Farming practices

Many farmers commented that they could not undertake their preferred farming practices, either due to financial constraints, for example, a lack of funds with which to purchase insecticides or hire labourers; or due to intolerable risks to crops, for example, from thieves, local industry or through illness. Further, many farmers were unable to find alternative methods of coping with these issues that did not affect their crop production. The capacity to absorb risk depends largely on wealth and political influence (Naughton-Treves and Treves, 2005). Because the poorest households cannot access tools with which to mitigate losses, for example hiring guards, these households face compounding vulnerability to crop loss (Naughton-Treves and Treves, 2005). Many farmers interviewed in Hoima District simply stopped cultivating the affected crops, or suffered the loss. This may have affected farmers' perceptions of crop loss. Certainly, institutional constraints on coping strategies were found to amplify local perceptions of risk (Naughton-Treves, 1997).

Most changes in crop assemblage did not occur through choice, but were prompted by the presence of disease, low soil quality, crop raiding and size of landholdings. More changes in crop assemblage were caused by the presence of disease than by any other factor. Farmers commented that the loss of both eating and brewing banana crops to disease affected both food security and income, and advice given by local government advisors (Agricultural Extension Officers; AEOs) to completely grub out and replace all infected plants was reluctantly received by farmers (Ester, AEO, pers. comm.). Given the financial and nutritional impacts of losing crops like banana and coffee, and the limited coping strategies available, it may be the case that households affected by these losses were particularly sensitive to the loss of further crops, especially crops that were used to replace banana and coffee in the crop assemblage.

As aspects of crop choice, farming systems and labour patterns are clearly influenced by social, economic and cultural conditions, a review of these socio-economic and cultural factors was necessary to help illustrate the reasons for a range of farming practices, which will be especially helpful when reviewing these farming practices in the context of influences on actual and perceived loss of crop.

5.5 Summary

- Communities were stable, with high levels of long-term residence and land ownership. In addition, over 90% farmers interviewed were from the local tribe, the Banyoro.

- Food security was cited as the predominant reason for considering crops as most important to cultivate, although income generation was suggested almost as frequently.

- Only 15% of interviewees (n = 12) asserted they did not sell any crops.

- In both cash and subsistence crop households cassava was reportedly the most important crop to cultivate.

- Many farmers commented that they could not undertake their preferred farming practices, either due to financial constraints or due to intolerable risks to crops, for example, from thieves, local industry or through illness.

- Most changes in crop assemblage did not occur through choice, but were prompted by the presence of disease, low soil quality, crop raiding and size of landholdings.

- Changes in crop assemblage were caused more frequently by the presence of disease than by any other factor.

6. ACTUAL CROP LOSS

6.1 Introduction

Farmers can lose a significant amount of crops to raids by wildlife, (Kagoro-Rugunda, 2004; Naughton-Treves and Treves, 2005; Priston 2009; Barirega *et al*, 2010). Cultivated crops are attractive to wild animals because they typically contain a greater and more concentrated nutritional value and lower toxicity than do wild plants (Osborn and Hill, 2005; Strum, 2010).

For crop raiding animals in the tropics maize is frequently a preferred crop (Naughton-Treves, 1997, 1998; Hill, 2000; Warren, 2003; Danquah *et al*, 2006; Webber, 2006), and is attractive to a wide range of species such as baboons, bush pigs, porcupines, guinea fowl, vervet monkeys, civets and chimpanzees (Hill, 1997). Cassava and banana are also often favoured by crop raiding animals, especially primates, ungulates and elephants (Naughton-Treves 1997, 1998; Hill, 2000; Kagoro-Rugunda, 2004), whereas sorghum is often mainly foraged by birds (Hill, 1997).

Although insects, birds, rodents and ungulates are considered to be some of the most common crop raiding groups (Hill, 1997; Naughton-Treves, 1997; Osborn & Hill, 2005; Arlet and Molleman, 2007), in many tropical areas primates are strongly identified as the most frequent crop raiding animals (Hill, 1997, 2000; Naughton-Treves *et al*, 1998; Yihune *et al,* 2008). Certainly, where levels of crop damage by primates and other animals have been examined, primates do feature prominently. Baboons foraged crops more frequently than other species on farms around BFR in Uganda (Hill, 2000); tantalus monkeys and baboons were responsible for most crop damage events in fields near Gashaka Gumti National Park, Nigeria, (Warren *et al*, 2007), and on farms around Kibale National Park, Uganda, Naughton-Treves, (1998), found that the most frequently observed forager on crops was the red-tailed monkey. Further, in fragmented forests, and rural and semi-urban areas, vervet monkeys are successful generalists that forage on farmers' gardens regularly (Hill 1997; Saj *et al*, 2001).

As well as crop raiding frequently, baboons, bush pigs and elephants in particular, can damage large areas of crop. Around BFR, Uganda, baboons damaged a greater area of crop than did any other animal (Webber, 2006). Next to Kibale National Park, Uganda, baboons damaged both the greatest area of crop, and the highest proportion of the area of crop grown. Further, elephants were responsible for the second largest proportional loss and the greatest area of damage in a single foray (Naughton-Treves, 1997, 1998). Elephants are also known to cause large areas of loss in India (Madhusudan, 2003), and in Assam farmers lost a third of their annual production of paddy rice (*Oryza sativa*) crop to elephants (Choudhury, 1998, cited in Choudhury, 2004). Bush pigs can destroy whole fields of crop, and in Mburo, Uganda, they were responsible for 90% of the total recorded damage in household fields, (Kagoro-Rugunda, 2004).

Although wild animals can and do have a significant impact upon farmers' crops, in some areas crops are also vulnerable to damage by domestic livestock. Cattle and goats in particular, can be responsible for more crop raiding events than wildlife species (Naughton-Treves, 1998, Webber, 2006) and can damage larger areas of crop than wildlife (Webber, 2006; Warren *et al*, 2007).

The severity of crop loss depends not only on the species of animal or the type of crop favoured but also on the stage of the life cycle at which crops are targeted, and the particular parts of the plant that are damaged (Hill, 1997). Baboons forage on maize through much of the life cycle of the plant, and the consumption of stems, fruits, flower tassels and seedlings removes the plants from further agricultural production (Naughton-Treves *et al*, 1998; Hill, 2000). In contrast, baboon raids on cassava are largely limited to attacking tubers (Hill, 2000). Although this would reduce the plant's productivity, it is unlikely to prevent further production of tubers. A further example was observed around Lake Mburo National Park, Uganda; bush buck (*Tragelaplus scriptus*) and duiker (*Cephalophus natalensis*) both foraged on bean crops, but whereas duikers ate the pods and stem stalks, bush bucks browsed the leaves only (Kagoro-Rugunda, 2004). Young crops can be especially vulnerable. For example, Blair, *et al* (1979) reported that Asian elephants attacked young palms by uprooting the whole plant, whereas the animals took only a few shoots from older palms, resulting in much less serious damage. Nevertheless, damage to mature crops can mean a significant loss to the household, as the damaged crops represent a wasted investment of time as well as money and effort. It can also result in an unavoidable loss of nutrition or income as there may not be enough time, labour or financial capacity to plant another crop (Hill, 1997, 2000). Madhusudan, (2003) found that most elephant damage to paddy crops near to the Bhadra Tiger Reserve in South India occurred in the month before harvest. Here, local people rely heavily on paddy crop and most only grew one crop annually.

Not all farmers are equally at risk to crop loss, and the distribution of losses for farmers is not uniform (Naughton-Treves, 1998; Hill, 2000, 2004). Some fields can suffer little damage, others can be damaged heavily (Naughton-Treves, 1997). Variations in crop raiding behaviour are likely to reflect local differences in farming practices such as crop assemblages and planting patterns (Sukumar, 1990; Hill, 1997; Naughton-Treves *et al*, 1998; Saj *et al*, 2001; Yihune *et al*, 2008), variations in protection strategies such as trapping (Naughton-Treves, 1998), and guarding (Saj *et al*, 2001; Sitati *et al*, 2005; Hill and Wallace, 2012), and the presence of cultivated fields in between a farmer's own fields and the forest (Hill, 1997; Naughton-Treves, 1997). One of the strongest predictors of risk is proximity of crop fields to the forest edge (Hill, 1997; Naughton-Treves, 1997; Saj *et al*, 2001; Webber, 2006).

The loss of crops can have a considerable impact on households. Lower levels of harvested crop can reduce food security (Hill, 1997; Barirega *et al*, 2010) and diminish physical wellbeing (Webber, 2006; Ogra, 2008). The health of women especially, can be affected by crop loss. If food resources are reduced, women tend to ensure that other members of the family are fed first (Ogra, 2008). The loss of crop can also affect households beyond a reduced availability of food. Crop loss can cause an extended financial impact whereby the ability to buy food and other domestic items is reduced, and the availability of school fees is limited, which results in fewer education opportunities (Webber, 2006). In addition, children are further denied educational opportunities as they are kept out of school to guard the family fields (Naughton-Treves, 1997; Hill 2004, Thirgood *et al*, 2005).

Crop loss also increases farmers' workloads. Damaged plants have to be removed and replanted (if possible) and damaged fences have to be repaired (Ogra, 2008). In addition, new methods adopted by people to protect their crops may result in additional expenditure and labour costs (Sekhar, 1998), such as increased guarding levels (Naughton-Treves, 1998; Hill, 2004) or the hiring of guards. Further, uncertainties of agricultural production may force family members to seek employment away from their fields (Campbell, 2000; Ogra, 2008), leaving the remainder of the household to maintain the family farm. A greater incidence of guarding also increases the risk of disease. Farmers who guard at night expose themselves to contracting malaria (Hill 2004; Thirgood *et al,* 2005), and contact with wild animals can also result in diseases such as rabies (Thirgood *et al,* 2005) and herpes B-virus, (Engeman, 2010).

As with other regions where crop raiding occurs, the loss of crops to animals in Hoima District is likely to increase conflict between farmers and wildlife. For this reason, the amount of crop lost to animals, the identity of crop raiding species, and the factors that affect the frequency and severity of crop loss need to be established. Further, conflict can arise as much from perceptions of risk as actual damage (Naughton-Treves *et al*, 1997; Hill, 2004, 2005). Actual patterns of crop damage need to be determined in order to review them in relation to farmers' perceptions; identification of any differences between actual and perceived losses will allow for a more focused exploration of the reasons behind perceived ideas of crop loss.

The aims for this chapter are:

- To examine the frequency of damage events experienced by households, the area of crops damaged and the percentage of crops lost.
- To determine which crops are most vulnerable to damage events, and which plant parts are damaged.
- To identify animal species that damage crops most frequently and extensively (area).
- To assess the influence of environmental variables on levels of crop damage, namely; seasonality, crop types grown, the distance of farms from the forest edge, and the use of crop protection methods.

6.2 Methods

The four 1km x 0.5km sample areas were thoroughly inspected once a week for evidence of crop damage by crop raiding animals. The sample areas in Kiseeta, Wagaisa and Kihomboza III were monitored weekly from November 2006 to November 2007. Weekly inspections in Nyakamwaga commenced in February 2007.

Recording the locations of damaged crops (using GPS handsets) allowed for an examination of spatial patterning of damage events in relation to the forest/KFR edge. Noting the plots, fields and farms[22] in which damage occurred, enabled levels of crop loss sustained by individual households to be assessed, and the vulnerability of individual households to particular crop raiding species to be determined.

The area of crop damaged during a damage event was calculated using either mean planting densities or direct measurement (after Naughton-Treves *et al*, 1998), as described in Chapter 3 (Methods). Damage to non-plantation fruits (guava, jackfruit, mango and papaya) and cocoa pods was recorded as unit losses.

To assess the behaviour of crop raiding animals more clearly, species were divided into three groups for analysis; large vertebrates, small vertebrates and domestic animals, as well as reviewing damage activity at the species level. In this study large vertebrates are wild animals weighing over 1.8kg (Kingdon, 2004), and include primates, porcupines, bush pigs and civets. Small vertebrates are rats, squirrels and wild birds.

As in Chapter 4, cash crop farms are classified as those observed by the research team as cultivating complete plots of traditional cash crop species. All other farms are defined as subsistence crop farms.

Binary logistic regression analysis was used to assess the influence of environmental variables (distance of farm, crops grown, use of crop protection tools) on the presence of crop raiding events at the household level, for each season. Stepwise regression was used as this allows the statistical model to automatically calculate which variables are most

[22]As explained in Chapter 3: each household farm comprised a set of fields, and each field comprised a series of plots. The term ‘farm’ denotes the total area of land owned or managed by one household. Farms may comprise one or more ‘fields’. Fields are continuous areas of land managed or owned by one household. If a household farm comprises one field, then the terms ‘farm’ and ‘field’ refer to the same area of land. If a household farm comprises more than one field, the fields may be situated at a distance from each other, but are still collectively referred to as one ‘farm’. Fields may comprise one or more ‘plots’. Plots are discrete areas of particular crop types or intercropping systems, usually delineated by a border (for example, bush or footpaths), or a change in crop assemblage.

likely to predict the presence of crop raiding damage. More specifically, a backward stepwise model was employed. This ensured that all the environmental factors were assessed initially and the weakest predictor of the presence of crop damage was removed by the statistical model. This process was repeated until only the most influential factors remained. A Bonferroni correction can be applied to calculations in which repeated significance tests are carried out in order to reduce the likelihood of Type I errors. However, in this case a Bonferroni correction was not used as this would have increased the likelihood of Type II errors. Other statistical tests used in this chapter are: Chi-square test, χ^2; Cramer's V test and Kendall's tau-b correlation coefficient, T_b.

6.3 Results

6.3.1 Crop raiding

During the study 1919 damage events were recorded and 21,944.22m^2 of crop was damaged across the four study sites. Large vertebrates accounted for 7805.91m^2 (35.6%) of the total area of damage. Small vertebrates and domestic animals accounted for 16.6% and 47.8% respectively. Each household experienced an average of 3.79 damage events by large vertebrates. However, farms in Kiseeta were visited more frequently and damaged more extensively (area) than at other sites (Table 6.1).

Per farm	Mean number of raids (n)	Mean area damaged (m^2)	Mean percentage damaged (%)
All sites	3.79±5.95 (1990)	83.04±226.94(21,944.22)	0.37±1.04 (1.3)
Kiseeta	5.83±8.25 (586)	193.27±387.90 (7587.16)	0.97±1.72 (1.9)
Wagaisa	4.40±5.06 (656)	34.13± 70.70 (3999.80)	0.18±0.53 (0.9)
Kihomboza III	1.77±4.60 (439)	72.96±201.19 (5811.46)	0.14±0.29 (1.1)
Nyakamwaga	2.68±4.64 (309)	38.51± 72.18 (4545.80)	0.30±0.91 (1.3)

Table 6.1 Damage by large vertebrates per farm during the study period: mean number of raids (n), area damaged (m^2) and percentage (%). The total for each/all site(s) is shown in parenthesis.

Almost all farms (n = 89) sustained damage by crop raiding animals. Nevertheless, 42.6% of farms (n = 40) were not visited by large vertebrates, and 53.2% farms did not experience crop damage by large vertebrates[23]. Farms most commonly experienced 1 - 10 damage events by large vertebrates (n = 43 farms) (Figure 6.1a). This is also the case for small vertebrates (n = 42 farms) and domestic animals (n = 62 farms). Whilst a small number of farms were visited over ten times by large vertebrates (n = 11), almost half the farms in the study experienced more than ten damage events by small vertebrates (n = 46)

[23] The number of farms where crop was not damaged by large vertebrates differs from the number of farms that did not experience raid events by large vertebrates overall (Figure 6.1a). This is because raid events by large vertebrates include damage to both crops and non-plantation fruit.

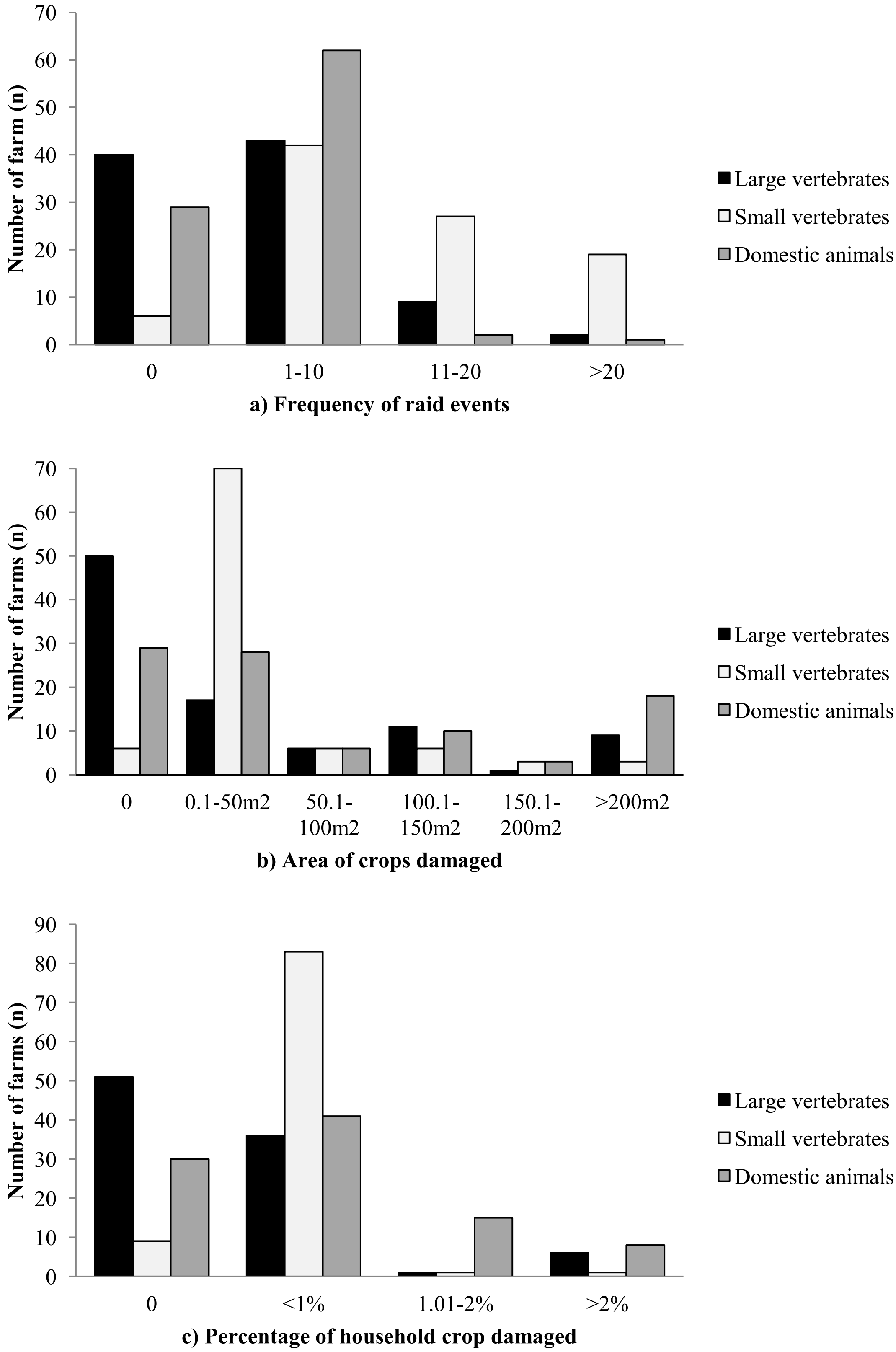

Figure 6.1 The number of farms that experienced; a) damage events* (n), b) area of crops damaged (m^2), c) percentage of crop damaged (%) (n = 94 farms).

***Includes damage events on non-plantation fruit (guava, jackfruit, mango and papaya).**

Farms most frequently experienced between 0.1m^2 and 50m^2 of crop damage by both small vertebrates (n = 70 farms) and domestic animals (n = 28 farms) during the study period (Figure 6.1b). Eighteen farms experienced over 200m^2 of damage by domestic animals, whilst half that number experienced this level of damage by large vertebrates.

Most farms that experienced damage lost less than 1% of their total crops (n = 47), although a small proportion of households (n = 7) suffered over 5% crop damage, and one household lost 8% of their crop. Large vertebrates damaged over 2% of crop on six farms, whilst eight farms lost over 2% to domestic animals (Figure 6.1c). There is a significant correlation between the number of damage events and the area of damage experienced by farms for each of the three animal groups, (large vertebrates: Kendall's tau-b, T_b = 0.714, p<0.01, n = 94; small vertebrates: Kendall's T_b = 0.554, p<0.01, n = 94; domestic animals: Kendall's T_b = 0.833, p<0.01, n = 94. All tests are 1-tailed).

6.3.2 Crop species damaged

Eighteen crop and fruit species were damaged during the study period (Table 6.2). Maize sustained the largest area of damage; 50% of the total area of damage was to maize. It was also the second most frequently raided crop (22.2% of all damage events). Cassava experienced the second greatest area of damage and received 11.9% of damage events. Maize and cassava were the most frequently cultivated crops on farms in the four villages. Sweet potato was also cultivated by a large number of households (ranked 3rd), and experienced more damage events than any other crop type: 42.5% of the total number of raids. It also sustained the 4th greatest area of damage.

Groundnuts were the third most frequently raided crop (n = 273), but only received 0.6% of the total area of damage. In contrast, 5.2% of the total area of damage was to rice, despite this crop experiencing only twenty one damage events. Rice was also cultivated on fewer farms than groundnuts. For the most frequently damaged crop types, there is a significant correlation between the number of damage events experienced by households and the area of crop damaged (Kendall's tau-b, T_b, p<0.01, 1-tailed, n = 94: sweet potato = 0.797, maize = 0.799, groundnuts = 0.851, cassava = 0.789, beans = 0.908, sugarcane = 0.982, rice = 0.981).

Crop	Damage events (n)	Area damaged (m^2)	Frequency crop grown (rank)
Sweet potato	**784**	1167.68	3
Maize	401	**11018.50**	2
Groundnuts	273	129.43	5
Cassava	221	4494.42	**1**
Beans	76	3198.48	4
Sugarcane	37	192.03	10
Rice	21	1149.13	8
Banana	15	197.30	7
Millet	6	111.40	9
Pigeon peas	6	274.90	6
Tomato	2	4.45	16.5
Cow peas	1	2.50	13
Soya bean	1	4.00	20.5
Total crop	1844	21944.22	
Fruit		Units damaged	Frequency fruit grown (rank)
Jackfruit	**109**	326	**1**
Mango	26	**732**	2
Cocoa	6	21	5
Papaya	3	3	3
Guava	2	20	6.5
Total fruit	146	1102	
Total*	1990		

Table 6.2 Damage to each crop type: the number of damage events, the area damaged, and the frequency (ranked) with which households cultivated the crops (1 = highest number of households). The highest number of damage events, largest area damaged and highest rank is shown in bold.

***The total number of damage events on crop types is larger than the total number of damage events by crop raiding species (Sections 6.3.1 and 6.3.3), as some animals damaged more than one crop type during one damage event.**

The most frequently damaged non-plantation fruit was jackfruit, which experienced 74.7% of the total damage events on fruit. Mango was the second most frequently damaged fruit crop. Both jackfruit and mango were found on more farms than were all other fruit crops.

Some frequently grown crops were not damaged during the study period; tobacco (ranked 11th most frequently grown crop), Irish potato (ranked 12th), pineapple (ranked 14th), pumpkin (ranked 15th), yam (ranked 16.5) and sorghum (ranked 18th).

6.3.3 Crop raiding animal species

Ten species of wild animal and six species of domestic animal damaged crops during the study period (Table 6.3) Wild animals accounted for 52.2% of the total area of crop damage and 85.4% of the total number of damage events.

Animal	Damage events (n)	Area damaged (m^2)	Crop types damaged (n)
Large vertebrates			
Chimpanzee	141	292.59	4
Chimpanzee on fruit	*105*	*951**	*5*
Vervet	105	2744.12	9
Vervet on fruit	*24*	*120**	*3*
Colobus	62	3342.42	4
Baboon	26	1217.28	3
Porcupine	18	76.43	3
Civet	3	33.07	1
Bush pig	1	100.00	1
Small vertebrates			
Rat	**844**	478.53	7
Bird	237	2716.35	7
Bird on fruit	*3*	*3**	*2*
Squirrel	201	451.43	5
Domestic stock			
Cattle	185	**8108.49**	**10**
Goat	33	964.94	8
Domestic pig	32	336.92	6
Chicken	29	1071.98	3
Sheep	1	8.00	1
Guinea fowl	1	1.67	1
	1919	21944.22	

Table 6.3 The number of damage events, the area of crop damaged and the total number of crop types damaged by each crop raiding species. Figures in bold indicate the greatest number in each category.
***Number of fruit units.**

Domestic animals damaged a larger area of crop (47.8%) than either large vertebrates (35.6%) or small vertebrates (16.6%). This was largely due to cattle, which were responsible for the largest area of crop damage of any animal; over one third (37%) of the total area of damage during the study. Nevertheless, three of the five most damaging species in terms of crop area lost were large vertebrates: black and white colobus monkeys (ranked 2nd, area damaged), vervet monkeys (ranked 3rd, area damaged) and baboons, (ranked 5th, area damaged).

Small vertebrates visited crops most frequently; 66.8% of damage events were undertaken by this group. Rats damaged crops most often, but were responsible for a relatively small area of loss (2.2%). In contrast, wild birds damaged crops both frequently (ranked 2nd) and extensively (total area: ranked 4th). Every large vertebrate species was responsible for fewer damage events than were cattle or each small vertebrate species. Interestingly, almost three quarters of chimpanzee damage events (n = 105) were recorded on fruit.

The number of damage events by each primate species, except for baboon, varies significantly between the study sites (vervet monkey: Chi square, χ^2 = 34.771, *df* = 3, $p<0.01$; black and white colobus monkey: χ^2 = 93.613, *df* = 3, $p<0.01$; chimpanzee: χ^2 = 193.043, *df* = 3, $p<0.01$). Damage events by baboons occurred only in Kihomboza III (Table 6.4). Seventy seven per cent of damage events by black and white colobus monkeys were recorded in Kiseeta (n = 48), and almost three quarters of chimpanzee raids were found in Wagaisa (73%). However, the largest area of crop damaged by chimpanzees was in Kiseeta (70.6%).

	Kiseeta	Wagaisa	Kihomboza III	Nyakamwaga	All sites
Frequency (n)					
Chimpanzee	34	**103**	1	3	141
Vervet	34	19	6	**46**	105
Colobus	**48**	10	2	2	62
Baboon	0	0	**26**	0	26
Total	116	132	35	51	334
Area (m^2)					
Chimpanzee	**206.49**	52.55	30.77	2.78	292.59
Vervet	**1120.51**	693.95	254.57	675.09	2744.12
Colobus	**2922.88**	277.29	88.40	53.85	3342.42
Baboon	0	0	**1217.28**	0	1217.28
Total	4249.88	1023.79	1591.02	731.72	7596.41

Table 6.4 The number of damage events and area of crop damaged by each primate species at each of the four study sites. Figures in bold indicate the site with the highest figure for each animal.

Whilst black and white colobus monkeys damaged the largest total area of crop of all primates, at the site level vervet monkeys most frequently damaged the second largest area of crop of any animal, and are ranked, on average, as the most extensively damaging crop raiding species after cattle (Appendix 5).

Most damage events by wild animals were on mature crops (73.4%). In contrast, domestic animals most frequently damaged immature crops (64.3% of raids) (Figure 6.2). The difference between the age of crops damaged by wild and domestic animals was significant (Chi square, $\chi^2 = 773.820$, $df = 2$, $p<0.01$).

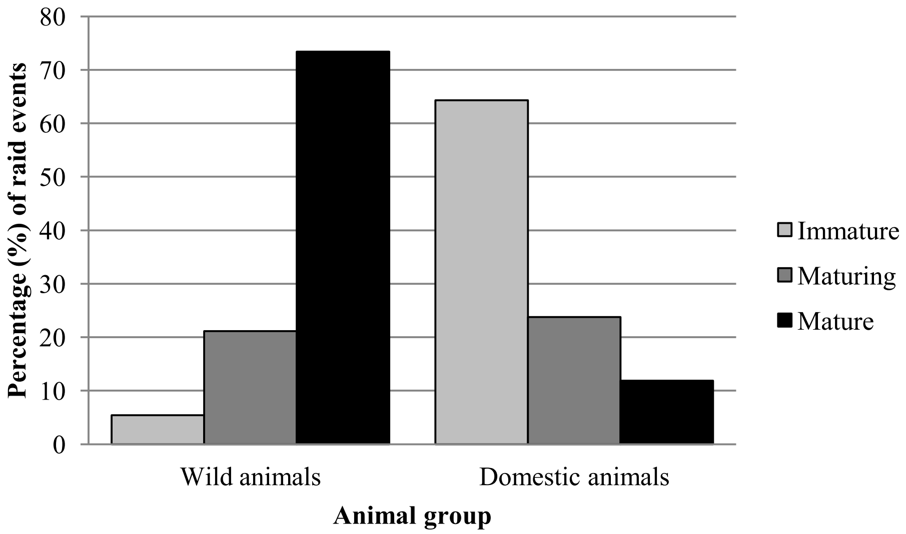

Figure 6.2 The percentage (%) of damage events on crops of varying maturity by wild and domestic animals (n = 1990 damage events).

Every wild animal species damaged mature or maturing crops more frequently than immature crops. Chimpanzees and baboons in particular foraged on mature crops; 93.2% of damage events by chimpanzees (n = 151) (crops and fruit trees), and 69% of raids by baboons (n = 20) were on mature plants. Vervet monkeys and black and white colobus monkeys foraged on both mature and maturing crops. Fifty one per cent (n = 56) of vervet monkey raids were on mature crops, and 33.3% (n = 37) were on maturing crops. Black and white colobus monkeys damaged mature and maturing crops on 36.4% (n = 24) and 39.4% (n = 26) occasions respectively. In contrast, 65.4% of damage events by cattle (n = 142) were on young plants, as were 79.3% of damage events by chickens (n = 23) and 77.8% of damage events by goats (n = 28).

The type of crop damaged during damage events differs significantly between wild and domestic animal groups (Chi square, $\chi^2 = 537.279$, $df = 17$, $p<0.01$). Eighty four per cent of damage events on maize (n = 334) were undertaken by wild animals. Conversely, domestic animals were responsible for 60.2% of damage events on cassava (n = 133) (Table 6.5).

	Sweet potato	Maize	Ground nuts	Cassava	Beans	Cash crop[a]	Other[b]	Fruit[c]	Total
Wild									
Bird	2	**196**	1	2	**29**	3	1	3	237
Chimpanzee	0	3	0	1	0	0	**39**	**119**	162
Vervet	7	56	3	5	2	6	8	24	111
Colobus	0	36	0	17	11	0	2	0	66
Baboon	8	8	0	13	0	0	0	0	29
Porcupine	3	0	1	15	0	0	0	0	19
Rodents	**720**	31	**256**	35	0	2	2	0	**1046**
Other	0	4	0	0	0	0	0	0	4
Total wild	*740*	*334*	*261*	*88*	*42*	*11*	*52*	*146*	*1674*
Domestic									
Cattle	27	50	4	**109**	8	**10**	9	0	217
Other	17	17	8	24	26	0	7	0	99
Total domestic	*44*	*67*	*12*	*133*	*34*	*10*	*16*	*0*	*316*
Total	784	401	273	221	76	21	68	146	1990

Table 6.5 Frequency of damage events by specific animals on crop types.
Figures in bold indicate the most frequently damaging animal species on each crop.
[a]Rice, [b]banana, cow peas, millet, pigeon peas, soya bean, sugarcane, tomatoes, [c]cocoa, guava, jackfruit, mango, papaya.

Almost half the damage events on maize (48.9%) were by wild birds (n = 196). Vervet monkeys foraged second most frequently (14%, n = 56) and were responsible for 18.8% of the area of damage on maize; greater than for any other wild animal. However, cattle damaged the largest area of maize of any animal (29.7% total area damage). Cattle were also accountable for over two thirds of the area of damage to cassava (69.7%)

Black and white colobus monkeys were responsible for almost half the area of damage to beans (47%), despite all large vertebrates foraging on this crop less frequently (n = 13) than both domestic animals (n = 34) and small vertebrates (n = 29). Rats and squirrels foraged particularly frequently on sweet potato and groundnuts. Eighty one per cent (n = 634) of damage events on sweet potato were by rats, and both rats and squirrels were responsible for 93.8% (n = 256) of damage events on groundnuts. Both sweet potato and groundnuts experienced a greater area of loss to rodents (25% and 37.8% area of damage respectively) than to large vertebrates (16.3% and 0.1% respectively).

Vervet monkeys and cattle damaged the widest range of crop types; ten crop varieties each. Vervet monkeys additionally consumed two types of fruit. Other crop raiding animals that foraged widely were: goats (n = 8 crop types), rats (n = 7), wild birds (n = 6) and black and white colobus monkeys (n = 6). Chimpanzees foraged on five crop species and four fruit varieties.

The plant part damaged varies significantly between wild and domestic animals (Chi square, $\chi^2 = 1236.36$, $df = 11$, $p<0.01$) and also between large and small vertebrates ($\chi^2 = 923.993$, $df = 11$, $p<0.01$). Seventy six per cent (n = 171) of damage events in which stems were broken or consumed were by domestic animals. Large vertebrates undertook 23.9% (n = 54) of damage events on stems. Similarly, on occasions where the whole plant was damaged (stem, cob/nut, leaves etc), domestic animals accounted for 70% (n = 21) of the damage events and large vertebrates accounted for 20% (n = 6). Most damage events on leaves (64.7%, n = 101) were by domestic animals. The two plant parts most frequently damaged by large vertebrates relative to other animal types, were fruits (97.3% of damage events on fruit, n = 144 damage events) and pods (cocoa, pigeon pea and bean); (88.2%, n = 15 of damage events on pods). Damage events on tubers, nuts, cobs and seeds were most frequently undertaken by small vertebrates. (93.3%, n = 757; 97.3%, n = 253; 68.1%, n = 213; and 94.4%, n = 17 respectively).

At the species level, each animal damaged a range of parts on different crops (Table 6.6). Nevertheless, some animals damaged a particular plant species or part more frequently than other crop species or parts. Forty five per cent of vervet monkey damage events (n = 50), and 53% of black and white colobus monkey damage events (n = 35) were on maize cobs. Similarly, 87.7% of wild bird damage events (n = 196) were on maize cobs.

	Sweet potato	Maize	Ground nuts	Cassava	Beans	Cash crop[a]	Other[b]	Fruit[c]
Wild								
Bird	T	C	S	T	L	L,S	FR	FR
Chimpanzee	0	C*	0	ST	0	0	FR,L,ST	FR
Vervet	ST,T	C,ST	N*	L,T	L,P	ST*	FR,P,ST	FR
Colobus	0	C,ST	0	L,ST	L,P,ST	0	P	0
Baboon	T*	C	0	T*	0	0	0	0
Porcupine	T	0	N	R,ST,T	0	0	0	0
Rodents	T	C,R,S,ST*	N,R,S	R,T*	0	S	P,S	0
Other	0	C	0	0	0	0	0	0
Domestic								
Cattle	L,ST*	C,L,ST*	L,ST*	L,ST*	L,ST*	L,ST	L,ST	0
Other	L,ST,T*	L,S	L,N,R	L,R,ST,T*	L*	0	L,ST*	0

Table 6.6 Plant parts damaged by crop raiding animals. C = Cob, FR = fruit, L = leaves, N = nut, P = pod, R = root, S = seed, ST = stem, T = Tuber.
***The whole plant was damaged during some damage events.**

Ninety four per cent of damage events by goats were on leaves (n = 34), and just under one third (31.8%) of black and white colobus monkey raids were on leaves only (n = 21). Forty five per cent of baboon raids were on cassava tubers (n = 13), and 74% of chimpanzee raids were on fruit (n = 120). Squirrels fed on groundnut nuts and sweet potato tubers with almost equal frequency (88.1% of all squirrel damage events), but rats foraged most frequently on sweet potato tubers; 75% of damage events by rats were on this plant part (n = 634).

6.3.4 Factors affecting crop damage

Current literature concerning human-wildlife conflicts in tropical areas suggests the risk of damage to crops is not uniformly distributed across a village or study site, but is influenced by environmental variables, such as the distance of farms from the forest boundary, the type of crops cultivated, seasonality and the use of crop protection methods (see Introduction, this chapter). In view of this, crop raiding events on farms at the four study sites in Hoima District were examined in relation to a number of variables to determine, firstly, whether changes within the variables are associated with differing levels of crop damage, and secondly whether these variables can be used to predict levels of crop damage on farms. The environmental variables examined were:

- Seasonality
- Crops grown
- Distance from forest boundary
- Crop protection methods

6.3.4.1 Seasonality

The number of damage events during the four seasons varies significantly (Chi square $\chi^2 = 399.205$ $df = 3$, $p<0.01$)[24]. The total area of crop damaged per farm also shows a significant seasonal variation ($\chi^2 = 32.566$, $df = 12$, $p<0.01$), although the area of crop damaged during a damage event does not (Chi square $\chi^2 = 5.963$ $df = 9$, $p>0.05$). Growing season one experienced the greatest number of damage events (n = 730), and the largest area of damage (38.6% the total area) of any season (Table 6.7).

	Interplanting season 1	Growing season 1	Interplanting season 2	Growing season 2	Total
All animals					
Total raids (n)	663	**730**	237	289	1919
Total area damage (m^2)	6251.71	**8470.22**	3677.64	3544.65	21944.22
Large vertebrates					
Total raids (n)	103	**143**	51	59	356
Total area damage (m^2)	2097.15	**3322.77**	1542.32	843.67	7805.91
Damage per farm, large vertebrates					
Mean raids (n)	1.1±2.44	**1.52±2.81**	0.54±1.17	0.63±1.41	3.79±5.95
Mean area damage (m^2)	24.87± 84.45	**32.79± 170.28**	16.8± 76.91	8.58± 29.58	83.04± 226.94
Mean % damage	**0.32±1.20**	0.25±1.13	0.17±0.50	0.14±0.65	0.37±0.94

Table 6.7 Damage per farm during the 12 month study period: mean number of raids (n), area damaged (m^2) and percentage (%). Figures in bold indicate the greatest number for each category.
Interplanting season 1: December–February, growing season 1: March-June, interplanting season 2: July-August, growing season 2: September – November.

[24]The number of damage events in interplanting season one is likely to be higher than is presented here. This is because recording of crop damage events in Nyakamwaga did not commence until week 15.

Growing season two had the smallest overall area of crop damage ($3544.65m^2$) and experienced fewer damage events than interplanting season one. Nevertheless, there is a significant variation between the frequency of damage events during growing and interplanting seasons (Chi square, $\chi^2 = 7.379$, $df = 1$, $p<0.01$).

The number of damage events by large vertebrates, small vertebrates and domestic animals varied significantly across the four seasons (Chi square, $\chi^2 = 61.303$, $df = 3$, $p<0.01$, $\chi^2 = 227.445$, $df = 3$, $p<0.01$, and $\chi^2 = 68.167$, $df = 3$, $p<0.01$ respectively). Each animal group damaged crops most frequently during growing season one; 40.2% of the damage events by large vertebrates, 37.4% of damage events by small vertebrates, and 38.4% of raids by domestic animals occurred during this season (Figure 6.3). Fewest damage events were undertaken by each animal group during interplanting season two (14.33% of large vertebrate damage events, 12.17% of small vertebrate raids and 10.68% of domestic animal damage events).

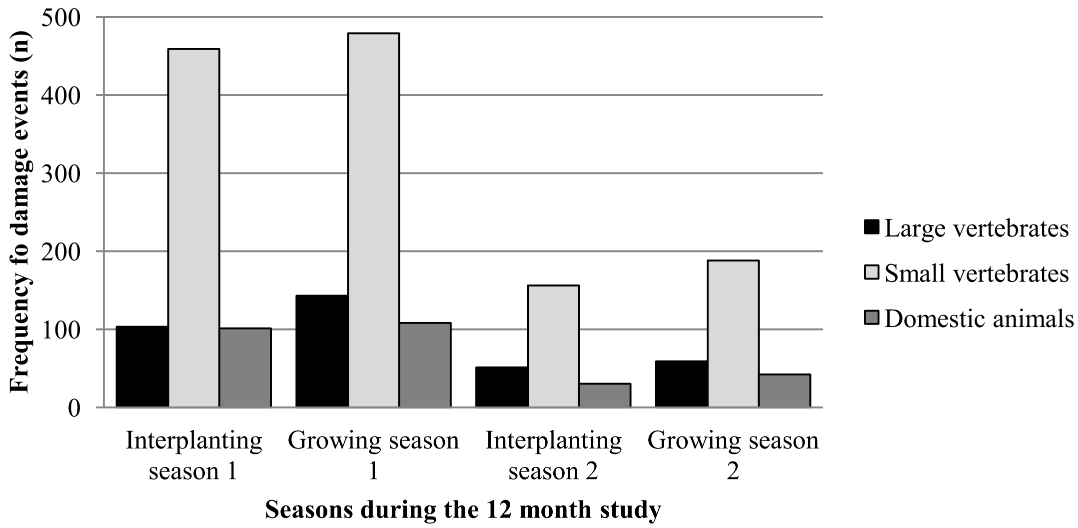

Figure 6.3 The number of damage events by large vertebrates, small vertebrates and domestic animals during each season.

6.3.4.1.1 Seasonality and animal species

All animal species except baboons show a significant variation in the number of damage events across the four seasons (Chi square, χ^2) (Table 6.8). Nevertheless, 46.2% of baboon damage events were recorded in growing season one (Figure 6.4).

	Chi square(χ^2)	Interplanting season 1	Growing season 1	Interplanting season 2	Growing season 2	Total (n)
Rat	225.659**	**348(+137)**	281(+70.0)	72 (-139)	143(-68.0)	844
Bird	48.249**	60 (+0.8)	**87(+27.8)**	74(+14.8)	16(-43.3)	237
Squirrel	114.682**	51 (+0.8)	**111(+60.8)**	10 (-40.3)	29(-21.3)	201
Cattle	40.276**	**77(+30.8)**	56 (+9.8)	25(-21.3)	27(-19.3)	185
Chimpanzee	14.943**	44 (+8.8)	**46(+10.8)**	17(-18.3)	34 (-1.3)	141
Vervet	33.933**	25 (-1.3)	**51(+24.8)**	14(-12.3)	15(-11.3)	105
Colobus	24.065**	21 (+5.5)	**28(+12.5)**	10 (-5.5)	3(-12.5)	62
Goat	11.242*	8 (-0.3)	**16 (+7.8)**	3 (-5.3)	6 (-2.3)	33
Baboon	7.538	3 (-3.5)	**12 (+5.5)**	7 (+0.5)	4 (-2.5)	26

Table 6.8. The number of damage events by the main animal species, and the significance in seasonal variation (Chi square, χ^2). Asterisks indicate significant results: *p<0.05, **p<0.01. Chi square residuals are shown in parentheses. For all calculations: df = 3. Figures in bold indicate the season in which most damage events were recorded for each animal.

Most animal species damaged crops more frequently during growing season one than during any other season (Table 6.8). In contrast, growing season two experienced fewer damage events by all animal species than expected (according to Chi square residuals). Similarly, during the second interplanting season, birds and baboons damaged more frequently than expected; 31.2% of damage events by wild birds (n = 74) and 26.9% of damage events by baboons (n = 7) occurred during this season.

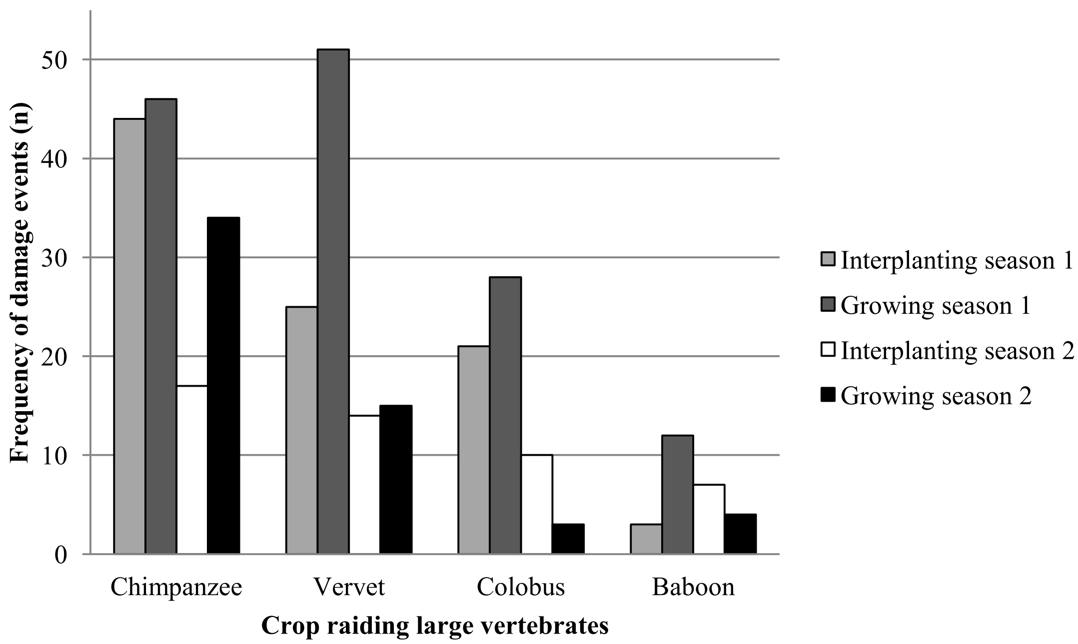

Figure 6.4 The number of damage events by large vertebrate species during each season.

6.3.4.1.2 Seasonality and crop species

The number of damage events varies significantly across the four seasons for each of the most frequently damaged crop types: sweet potato (Chi square, χ^2 = 208.296, *df* = 3, *p*<0.01); maize (χ^2 = 94.990, *df* = 3, *p*<0.01); groundnuts (χ^2 = 214.810, *df* = 3, *p*<0.01); cassava (χ^2 = 60.538, *df* = 3, *p*<0.01) and beans (χ^2 = 77.158, *df* = 3, *p*<0.01). Maize was most frequently damaged in growing season one (42.1% of damage events). Nevertheless, half of all damage events on maize (n = 201) took place in the interplanting seasons (interplanting season one: 24.9%; interplanting season two: 25.2%) (Figure 6.5). Similarly, cassava and sweet potato were damaged more frequently in interplanting season one than in other seasons, (45.7% and 42.1% of damage events on cassava and sweet potato respectively). Like maize, groundnuts and beans were most frequently damaged in growing season one (groundnuts: 59.7%; beans: 67.1%).

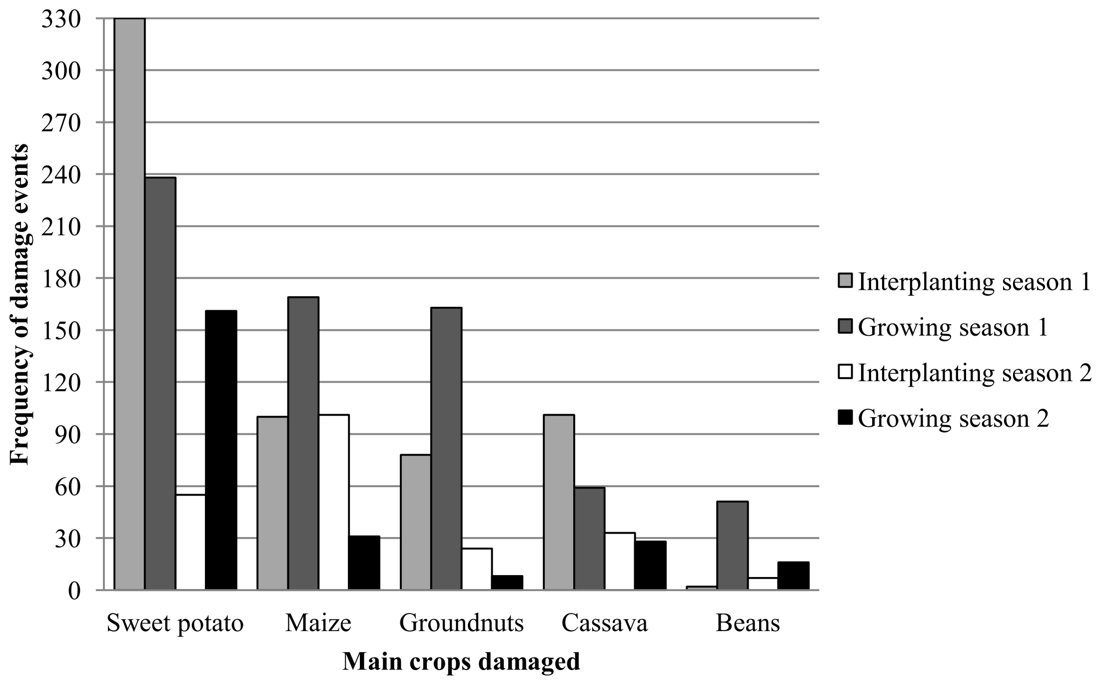

Figure 6.5 The number of damage events on the most frequently damaged crops during each season.

Most damage events on rice and sugarcane occurred during growing season two (81% and 48.7% of damage events respectively), and fruit was most frequently damaged during growing season one (44.5% of damage events on fruit). Damage events on rice, sugarcane and fruit show significant seasonal variation (Chi square, $\chi^2 = 35.190$, $df = 3$, $p<0.01$, $\chi^2 = 11.973$, $df = 3$, $p<0.01$, and $\chi^2 = 53.397$, $df = 3$, $p<0.01$ respectively).

6.3.4.2 Crops grown

The frequency of damage events on farms is significantly correlated with area (m^2) of subsistence crop planted in all four seasons (Table 6.9). Similarly, the area of cash crops planted is significantly correlated with raid frequency in every season except growing season one. This corresponds with the main cultivation period of tobacco, which accounted for 85.6% of the area planted with cash crops during growing season one (Chapter 4), but was not damaged by crop raiding animals (Section 6.3.2).

	Interplanting season 1***	Growing season 1	Interplanting season 2	Growing season 2
Cash crop	**0.164***	0.124	**0.346****	**0.182***
Subsistence crop	**0.448****	**0.505****	**0.462****	**0.428****

Table 6.9 Correlation between the area (m^2) of cash and subsistence crops planted on farms and the frequency of damage events (Kendall's tau-b, T_b, n = 94 farms). Figures in bold indicate significant results; *$p<0.05$, **$p<0.01$.

***** Interplanting season 1 excludes Nyakamwaga farms. As the recording of damage events were not commenced until part way through the season at this site, a comparison of crops grown versus crops damaged cannot be meaningfully made.**

Crop presence is significantly associated with the presence/absence of damage by each animal group, particularly small vertebrates (Table 6.10). The presence of beans, groundnuts, cassava, maize and sweet potato on farms was associated with damage by small vertebrates for all seasons except for sweet potato during interplanting season two. Nevertheless, 54.2% of farmers that cultivated sweet potato during this season experienced damage by small vertebrates (n = 32).

	Cassava	Beans	Maize	Sweet potato	Groundnuts
*Interplanting season 1****					
All animals	**0.313****	**0.273***	**0.420****	**0.403****	**0.269****
Large vertebrates	**(0.282)***	**(0.246)***	0.225	0.043	0.171
Small vertebrates	**0.247***	**0.429****	**0.506****	**0.462****	**0.435****
Domestic	0.13	0.017	**0.35****	**0.314****	**0.331****
Growing season 1					
All animals	**0.381****	**0.297****	**0.376****	**0.243***	**0.243***
Large vertebrates	0.159	**(0.210)***	0.177	0.150	0.038
Small vertebrates	**0.428****	**0.295****	**0.391****	**0.448****	**0.406****
Domestic	**0.270****	0.187	0.185	**0.214***	0.111
Interplanting season 2					
All animals	**0.366****	**0.384****	**0.516****	0.064	**0.289****
Large vertebrates	0.119	0.069	0.115	0.153	0.015
Small vertebrates	**0.321****	**0.369****	**0.480****	0.138	**0.360****
Domestic	**(0.252)***	0.181	0.176	0.095	0.015
Growing season 2					
All animals	**0.316****	**0.398****	**0.255***	**0.428****	0.710
Large vertebrates	0.020	**(0.249)***	0.073	0.069	0.042
Small vertebrates	**0.264***	**0.348****	**0.292****	**0.490****	**0.217***
Domestic	**(0.272)****	**(0.333)****	0.156	0.144	0.024

Table 6.10 Measures of association between the presence/absence of damage events by crop raiding animals and the presence/absence of each main crop on farms, per season (Cramer's V, n = 94 farms). Figures in bold indicate significant results; *p<0.05, **p<0.01. Figures in parentheses indicate significant associations between crop presence and raid absence.

***** Interplanting season 1 excludes Nyakamwaga farms. As the recording of damage events were not commenced until part way through the season at this site, an association between crop presence and damage presence cannot be meaningfully made.**

The presence/absence of damage events by large vertebrates is less frequently significantly associated with the presence of the main crops, and is not significant for maize, sweet potato or groundnuts at any season during the year. Where associations are indicated, (beans and cassava), they are negative; most farms that cultivated these crops did not experience large vertebrate damage.

6.3.4.3 Distance from the forest

The number of damage events by large vertebrates varies significantly at different distances from the forest/KFR edge (Chi square, χ^2 = 727.652 , df = 4, p<0.01). Over three quarters of damage events (76.4%) were recorded less than 101m from the forest-farm boundary (Figure 6.6). Primates in particular, foraged close to the forest.

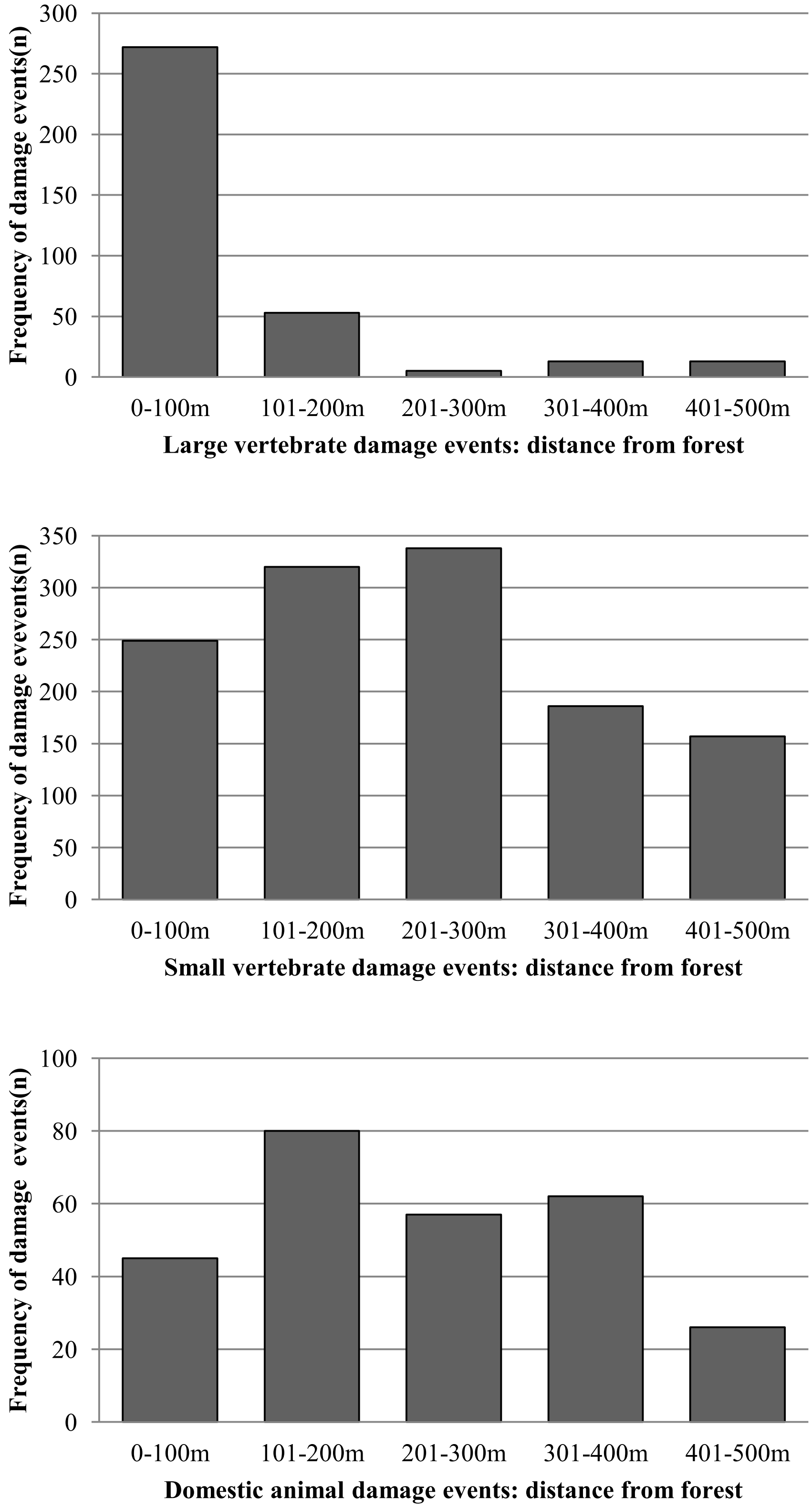

Figure 6.6. The number of damage events by large vertebrates, small vertebrates and domestic animals at varying distances from the forest/KFR edge.

All damage events by baboons and black and white colobus monkeys occurred less than 201m from the forest/KFR edge. Vervet monkey and chimpanzee damage was found up to 500m from the forest-farm boundary, however, most was recorded within 100m of the forest edge (74.3% and 69.5% of damage events by vervet monkeys and chimpanzees respectively).

In contrast, damage events by small vertebrates and domestic animals most frequently occurred over 100m from the forest edge. Fifty one per cent of small vertebrate raids were recorded at 101-300m from the forest, and 70.8% of domestic animal damage events were found at 101-400m. The distribution of damage events at varying distances from the forest/KFR edge is significant for both small vertebrates and domestic animals (Chi square, χ^2 = 304.181, *df* = 5, $p<0.01$, and χ^2 = 67.363, *df* = 5, $p<0.01$ respectively), nevertheless all small vertebrates (rats, squirrels and wild birds) and most domestic animals (cattle, domestic pigs, chickens and goats) foraged on crops at all distances from the forest/KFR edge (0-500m).

6.3.4.4 Crop protection methods

An association between the presence of crop protection methods on farms and the presence/absence of damage events was only significant for large vertebrates (Cramer's V = 0.240, n = 95 farms[25], $p<0.05$), and this association was negative; 82.4% of the farms that implemented crop protection methods did experience damage events by large vertebrates. Damage events by small vertebrates and domestic animals were not associated with the presence or absence of crop protection methods (Cramer's V = 0.027, n = 95 farms, $p>0.05$ and Cramer's V = 0.096, n = 95 farms, $p>0.05$ respectively).

Where households did employ crop protection methods, the number of strategies used is not correlated with the frequency of damage events experienced (Kendall's tau-b, T_b, = 0.208, $p>0.05$, 1-tailed, n = 17). One of the two households that implemented the greatest number of protection tools (n = 4) was ranked as 57.5 (of 95) in terms of frequency of damage events (Table 6.11), whilst the household that employed the greatest variety of protection methods (n = 3) was ranked as 17.5 (of 95 households).

[25]The study site comprised 94 households. However, during interplanting season 1 only, one plot was rented from an existing farmer in the study site, cultivated with rice and guarded by the tenant. This plot is only included in discussions regarding crop protection methods (here and in Chapter 4).

Farm	Crop protection method	Number of tools	Frequency of damage events per farm (ranked)
1	Guard hut (unmanned), scarecrow (n = 3)	4	57.5
2	Guard hut (unmanned), Leg hold trap, scarecrow (n = 2)	4	17.5
3	Guard hut (unmanned), gin trap	2	1
4	Leg hold trap	1	2
5	Guard hut (unmanned)	1	7
6	Guard hut (manned)	1	8
7	Leg hold trap	1	22
8	Scarecrow	1	24
9	Gin trap	1	32
10	Guard dogs	1	34.5
11	Guard hut (unmanned)	1	34.5
12	Cassette tape	1	39
13	Guard hut (unmanned)	1	49.5
14	Plastic bags	1	64
15	Gin trap	1	69
16	Cassette tape	1	88
17	Guarding	1	92.5

Table 6.11 The number of crop protection tools used by households (n = 95 households), and the frequency of damage events, ranked (1 = most damage events, 95 = least damage events).

6.3.5 Predicting crop damage

Binary logistic regression was used to assess the relationship between the environmental variables discussed above and the presence of damage events on farms. Damage by all crop raiding animals was examined, as was damage by large vertebrates, small vertebrates and domestic animals. Due to the assumptions of logistic regression, seasonal data cannot be directly compared within the same analysis (Field, 2009). For this reason the regression procedure was performed on each season separately. Data from Nyakamwaga were not included in the analysis of interplanting season one, as the incomplete data set may have skewed the outcome. Environmental variables assessed were those discussed in Section 6.3.4; the distance of farms from the forest/KFR edge, the presence of each of the main crops (maize, cassava, beans, groundnuts, sweet potato) and the presence of crop protection tools. All types of crop protection method were assessed as one variable. This is because each individual method occurred with relatively low frequency.

a) Interplanting season 1

Variables and test groups	B	SE	Wald	*df*	*p*	*Exp(B)*
All raids						
Cassava	1.707	0.869	3.858	1	≤ 0.05	5.510
Large vertebrates						
Distance	-0.004	0.003	2.524	1	>0.05	0.996
Protection tool	**2.529**	**0.942**	**7.206**	**1**	**<0.01**	**12.538**
Cassava	**1.954**	**0.932**	**4.399**	**1**	**<0.05**	**7.058**
Groundnuts	**1.244**	**0.622**	**3.999**	**1**	**<0.05**	**3.468**
Small vertebrates						
Sweet potato	**1.962**	**0.852**	**5.307**	**1**	**<0.05**	**7.115**
Beans	**1.965**	**0.876**	**5.030**	**1**	**<0.05**	**7.136**
Groundnuts	**2.750**	**1.194**	**5.302**	**1**	**<0.05**	**15.646**
Domestic animals						
Protection tool	**-1.710**	**0.857**	**3.981**	**1**	**<0.05**	**0.181**
Maize	**1.523**	**0.617**	**6.086**	**1**	**<0.05**	**4.584**

b) Growing season 1

Variables and test groups	B	SE	Wald	*df*	*p*	*Exp(B)*
All raids						
Cassava	**1.565**	**0.739**	**4.488**	**1**	**<0.05**	**4.784**
Maize	**1.629**	**0.741**	**4.835**	**1**	**<0.05**	**5.098**
Large vertebrates						
Distance	**-0.007**	**0.002**	**9.230**	**1**	**<0.01**	**0.993**
Small vertebrates						
Sweet potato	**2.471**	**0.836**	**8.741**	**1**	**<0.01**	**11.838**
Beans	**2.159**	**0.981**	**4.842**	**1**	**<0.05**	**8.660**
Cassava	**2.017**	**0.862**	**5.471**	**1**	**<0.05**	**7.513**
Domestic animals						
Cassava	**1.438**	**0.577**	**6.219**	**1**	**<0.05**	**4.214**

Table 6.12 Logistic regression analysis examining the influence of environmental variables on the presence of damage events on farms (a: n = 95 farms; b: n = 94 farms). Figures in bold indicate variables with a significant effect on the presence of crop raiding.

c) Interplanting season 2

Variables and test groups	B	SE	Wald	*df*	*p*	*Exp(B)*
All raids						
Maize	**2.003**	**0.659**	**9.244**	**1**	**<0.01**	**7.410**
Beans	**1.241**	**0.601**	**4.261**	**1**	**<0.05**	**3.460**
Large vertebrates						
Distance	**-0.010**	**0.004**	**6.221**	**1**	**<0.05**	**0.990**
Small vertebrates						
Maize	**2.055**	**0.700**	**8.626**	**1**	**<0.01**	**7.809**
Beans	**1.051**	**0.513**	**4.193**	**1**	**<0.05**	**2.860**
Domestic animals						
	No significant results					

d) Growing season 2

Variables and test groups	B	SE	Wald	*df*	*p*	*Exp(B)*
All raids						
Sweet potato	**1.943**	**0.547**	**12.615**	**1**	**<0.01**	**6.979**
Beans	**1.776**	**0.545**	**10.626**	**1**	**<0.01**	**5.907**
Large vertebrates						
Distance	**-0.008**	**0.003**	**5.723**	**1**	**<0.05**	**0.992**
Protection tool	**1.708**	**0.703**	**5.905**	**1**	**<0.05**	**5.518**
Small vertebrates						
Sweet potato	**2.156**	**0.514**	**17.590**	**1**	**<0.01**	**8.639**
Beans	**1.473**	**0.526**	**7.834**	**1**	**<0.01**	**4.363**
Domestic animals						
Beans	**1.650**	**0.674**	**5.991**	**1**	**<0.05**	**5.208**

Table 6.12 cont. Logistic regression analysis examining the influence of environmental variables on the presence of damage events on farms (n = 94 farms). Figures in bold indicate variables with a significant effect on the presence of crop raiding.

The greatest influence on the presence of damage by large vertebrates is the distance of farms from the forest/KFR edge (Table 6.12). This factor was significant in all seasons except interplanting season one, but the effect was strongest in interplanting season two: for every metre increase in distance from the forest edge, the likelihood of large vertebrate damage presence was reduced by 0.01 (B) (Table 6.12c). Large vertebrates are the only group for which distance is a significant factor in influencing the presence of damage. Damage events by small vertebrates and domestic animals are not significantly affected by distance.

Protection tools do not significantly reduce the presence of damage events, with the exception of domestic animals in interplanting season one (Table 6.12a). Indeed, the models suggest that the likelihood of damage presence by large vertebrates in interplanting season one and growing season two was increased by the presence of crop protection tools (Interplanting season 1: *Exp(B)* = 12.538; growing season 2: *Exp(B)* = 5.518), indicating that the presence of crop protection measures might be a response to crop raiding events.

The likelihood of damage by small vertebrates was increased by the presence of beans in every season, and by sweet potato in three of the four seasons. In interplanting season one the risk of damage was increased sevenfold in the presence of beans (*Exp (B)* = 7.136), and sevenfold in the presence of sweet potato (*Exp (B)* = 7.115). In growing season one the presence of beans increased the likelihood of damage by over eight times (*Exp (B)* = 8.660), and the presence of sweet potato increased the likelihood of damage almost twelvefold (*Exp(B)* = 11.838). The risk of small vertebrates raids was also increased in interplanting season one by the presence of groundnuts. During this season this crop indicated a greater likelihood of damage than either beans or sweet potato (*Exp(B)* = 15.646).

The presence of maize did not significantly affect the likelihood of damage by large vertebrates, and only increased the risk of damage by small vertebrates in interplanting season two (*Exp(B)* = 7.809), and by domestic animals in interplanting season one (*Exp(B)* = 4.584). Cassava presence influenced the risk of damage events most strongly in growing season one (small vertebrates: *Exp(B)* = 7.513, domestic animals: *Exp(B)* = 4.214).

6.4 Discussion

Losses to crop raiding species on unmechanised, small-scale farms in the tropics have been measured in other studies (Hill, 1997; Naughton-Treves, 1997; Naughton-Treves *et al*, 1998; Kagoro-Rugunda, 2004; Webber, 2006; Arlet and Molleman, 2007; Warren, 2007). However, losses can prove difficult to quantify accurately because, as in Hoima District, farmers employ complex farming systems consisting of intercropped plant varieties, varied planting densities, plots of ill-defined area, and extended planting and harvesting periods, which make it difficult to assess both the amount of crop cultivated and the amount of crop damaged (Naughton-Treves and Treves, 2005; Arlet and Molleman, 2007). Nevertheless, studies that have quantified crop damage and loss to crop raiding species indicate a level of loss to households ranging from less than <1% to 100% (Naughton-Treves, 1997; Hill, 2000; Kagoro-Rugunda, 2004; Webber, 2006; Warren, 2007).

6.4.1 Crop damage

In Hoima District, as in other cultivated areas near to African forests (Naughton-Treves, 1997; Hill 2000, Saj *et al*, 2001; Webber, 2006) maize and cassava were most vulnerable to damage by crop raiding species. Maize, in particular, accounted for 50% of the total area of crop damage and was the second most frequently raided crop. Cassava experienced the second largest area of damage.

6.4.2 Crop raiding animals

A similar area of damage was caused by wild and domestic animals during the study period, however, by far the most extensively (area) damaging animals were cattle. They were responsible for over one third of the total area of all crop damage recorded, and damaged a greater area of crop than all large vertebrates combined. They were also responsible for almost two thirds of the damage events on cassava. This is similar to domestic livestock (cattle and goat) crop raiding patterns found in other farming communities close to forested areas (Naughton-Treves, 1997; Webber, 2006; Warren, 2006), in which domestic livestock damaged crops frequently and extensively (area) relative to other crop raiding animals.

Despite cattle damaging the largest area of crop overall, it should be noted that three of the five animals that damaged the largest areas of crop were primates: vervet monkeys, black and white colobus monkeys and baboons. Furthermore, vervet monkeys most consistently damaged the greatest area of crops of any animal after cattle across the four sites. Nevertheless, each primate species was responsible for less than half the area of crop damage of cattle. It should also be noted that damage events by wild birds were both frequent and extensive. Birds were the second most frequent animal to visit crops, after cattle, and they damaged the fourth largest area of crop. Furthermore, birds were responsible for almost half of all damage events on maize; 3.5 times more than the second most frequent visitor to maize: vervet monkeys. Similar crop-raiding studies in sub-Saharan environments tend to concentrate on the activities of larger animals, and so it is unclear if this is unusually extensive.

6.4.3 Age and plant part

Almost three quarters of damage events by large vertebrates were on mature crops. Damage to mature crops is a particular problem, as farmers have little or no time remaining towards the end of a season within which to replace spoilt crop (Hill, 2000). In addition, mature crops present a significant investment of time and labour, which is wasted if the crops are damaged.

Over two thirds of damage events by domestic animals were on immature crops. Whilst damage early in a season does give farmers the opportunity to replant spoilt crops, it also increases labour and investment costs. Farmers are forced to buy more seed/saplings, or contend with a reduced yield. In addition, domestic animals tended to damage crops more severely than did large or small vertebrates. Nearly three quarters of crop raiding events in which the whole plant or stem was damaged were undertaken by domestic animals. Damage of this type removes the plant from further cultivation and thus represents a total loss of yield from that plant (Hill, 2000).

6.4.4 Site variations

Primate activity varied from site to site. Black and white colobus monkeys damaged a greater area of crop of any crop raiding species in Kiseeta, but damaged relatively small areas of crop at the other sites. Similarly, only households in Kihomboza III were at risk of crop damage by baboons. Furthermore, whilst chimpanzees most frequently damaged crops in Kiseeta, they most frequently damaged fruit in Wagaisa. This was probably due to differences in crop availability at the two sites; only Kiseeta supported large sugarcane plots. However, no chimpanzee damage was found on sugarcane in Nyakamwaga, despite the existence of the largest sugarcane plot in the study sample, situated less than 100m from the forest edge. It is likely that levels of risk are lower for the sugarcane plot in Nyakamwaga due to the extremely degraded quality of the forest in Nyakamwaga and the absence of a frequently visiting group of chimpanzees, as occurred in Kiseeta (Bulindi) (McLennan, 2008) and Wagaisa (K. Venans, pers. comm; pers. obs.). In addition, crop raiding events by chimpanzees in Kiseeta corresponded to a seasonal reduction in the availability of forest fruits (McLennan, 2010).

These variations illustrate that crop vulnerability next to extremely small forest patches should be assessed on a site by site basis. Animal assemblages in similar but distinct forest patches may vary as some populations are subject to local extinction or can no longer be supported by the remaining forest, whilst others are more successful at inhabiting a highly disturbed environment (Caughley and Gunn, 1996). Furthermore, decreased availability of forest foods, or increased availability of more palatable agricultural foodstuffs is likely to prompt disparate groups of the same species to develop different tastes and/or adopt their feeding behaviours at different sites.

6.4.5 Loss to households

Almost all households experienced damage events (94.7%), although over half the farms in the study sites did not experience damage to crops by large vertebrates. Just over half of households lost less than 1% crop (56.4%), and over three quarters of households lost 2% of their crop or less. This proportion of crop damage is small compared with studies around nearby Budongo Forest Reserve (Hill, 2000) and Kibale National Park (Naughton-Treves, 1998), where household losses were recorded as 19% and 25% (maize and cassava), and 6.8% and 5.5% (maize and cassava) around BFR and Kibale National Park respectively. Nevertheless, the degree to which households in the Hoima District study sites were vulnerable to crop damage varied. A small number (7.4%) lost more than 5% of their crops, and one household in Kiseeta lost 8% the total area of cultivated crop.

The pressures on farmers generated by crop raiding do not only relate to the area of crop damaged; most farmers in the study sites also experienced numerous damage events by smaller animals such as rats, squirrels and birds (rats were responsible for 44% of all damage events). Whilst these animals may have damaged smaller areas of crop per damage event than was found with large vertebrates and some domestic animals, damage by these animals was frequent and persistent. In addition, small vertebrates foraged on ‘energy rich’ plant parts such as tubers, nuts, cobs and seeds. These are also the most important parts of the plant for the household, as they represent the highest value in terms of nutrition and market produce. Farmers in the study sites therefore have to cope with the impact of both extensive (area) damage events, and intensive (frequent) damage events.

6.4.6 Factors that influence crop damage

6.4.6.1 Distance

Distance was the clearest indicator of the presence of damage events for large vertebrates. The greater the distance between the forest edge and a farm, the smaller the risk of damage by these animals. Indeed, over three quarters of damage events by large vertebrates (76.4%) occurred less than 101m from the forest/KFR edge. This is similar to other studies (Hill, 1997; Naughton-Treves, 1997; Saj *et al*, 2001; Webber, 2006; Warren *et al*, 2007). Nevertheless, during interviews at the Hoima District study sites, most farmers asserted that having land next to the forest was preferable due to soil fertility and moisture content. This differs from farmers' attitudes in Naughton-Treves' (1997) study next to Kibale National Park, and to some of the farmers in Hill's (1997) and Webber's (2006) studies near to BFR in Uganda, whereby having land situated near to the forest was viewed as a disadvantage. The opinions of the Hoima District farmers are likely influenced by farming near to forest patches that are extremely small. Fragmented forests can support only relatively small populations of crop raiding animals, and thus the relatively small costs of farming next to them are outweighed by the benefits.

6.4.6.2 Crops grown

The presence of maize, cassava or groundnuts was shown to increase the likelihood of crop raiding during one or more seasons. However, the strongest association with damage events, especially by small vertebrates, was the presence of beans and sweet potato. In terms of area damaged, maize, cassava and beans were the most palatable crops to all animals, Nevertheless, households cultivated greater areas of these crops as compared with other types (see also Hill, 1997 and Saj *et al*, 2001). The type of crops farmers choose to cultivate are most likely due a range of factors including the labour requirements of planting, harvesting and cooking, ease of storage and taste preference (Hill, 1997). However, the nutritional, financial and/or cultural, importance of some crops is likely to compel farmers to cultivate them, irrespective of the risk of damage events. For example, cassava is viewed by farmers in the Hoima District study sites as essential for food security and hunger prevention (Chapter 5). Nevertheless, this crop experienced the second largest area of loss in the study.

In addition, the ability of farmers to select other crops that fill the same nutritional and economic niche but are less attractive to crop raiding animals has been curtailed by the appearance of diseases. In particular, banana and coffee wilt has reduced yields and forced many farmers to cease cultivation of these important cash generating crops. Some farmers are opting to plant rice as an alternative cash crop. However, rice experienced the fifth largest area of damage during the study.

Nevertheless, some farmers did cultivate crops that were not attractive to animals. Tobacco, sorghum and Irish potato were not damaged by crop raiding species at all. The same is true for sesame, yam and pineapple, although these crops were only cultivated in small plots. Further, whilst pigeon peas, soya bean, tomato and cow peas were damaged at one or more sites, they were also relatively unaffected by animals. Pigeon peas were amongst the most extensively (area) planted crops, and were undamaged in three of the four study sites, and soya bean damage occurred only in Kihomboza III ($4m^2$), not in Nyakamwaga, where 97% of the soya bean crop was cultivated.

6.4.6.3 Season

The most frequent losses and greatest area of damage occurred in growing season one, although rats, porcupines and domestic pigs and cattle all foraged most extensively (area) in inter-growing seasons. In addition, whilst most species damaged greater areas of crop at certain times of the year, most animals continued to forage on crops throughout the year, (as Naughton-Treves *et al*, 1998; Webber, 2006). As a consequence, the risk posed to crops from crop raiding animals was present during the entire year (as Hill, 2000). In addition, due to extended planting patterns, the main edible crops (with the exception of rice) were present during all four seasons (Chapter 4).

Extended temporal patterns of planting and harvesting as seen in the Hoima District study sites provide prolonged crop availability for crop raiding species, but may actually reduce the overall loss to households of some crop types. Firstly, early planting enables crops to be harvested before the frequency of damage events peaks (Farmer, pers. comm). Secondly, crops in staggered stages of maturity are likely to represent different levels of attractiveness for crop raiding animals. Crop stands that mature at the same time provide peaks of food availability for animals at the favoured growth stage, and whole plots can be consumed (Naughton-Treves *et al*, 1998; Thapa, 2010). However, if fields containing crop stands at varying stages of the life cycle are damaged, less palatable stands may be left undisturbed in favour of more tasty ones. Indeed, with limited access to tools or options to protect crops, Hoima District farmers use extended planting patterns as a method to deal with both crop raiding animals and unseasonal weather conditions (Farmer, pers. comm.). Furthermore, differential peaks of crop maturity can help to avoid bottlenecks of labour requirements, which can occur as the need for guarding increases at peak times during the year (Hill, 2004). In addition, extended planting and harvesting patterns also serve to provide a human presence in fields over longer periods of time, which is known to be an effective method to deter crop raiding animals (Kagoro-Rugunda, 2004; Thapa, 2010; Hill and Wallace, 2012).

6.4.6.4 Crop protection methods

Most households did not employ crop protection methods (82.1%). Where crop protection tools were used, they were not significantly associated with a reduction in the presence of crop damage events. In other studies the presence of guards was shown to reduce crop raiding incidents, (Kagoro-Rugunda 2004; Thapa, 2010; Hill and Wallace, 2012). However, in Hoima District the influence of guarding was difficult to assess because most fields were not guarded. Farmers were largely present only when undertaking agricultural tasks, which resulted in sporadic farmer presence in the fields (as Wallace, 2010). This intermittence is likely to have been exacerbated by the social system of guarding. Farmers contended that women and children undertook a large proportion of guarding duties (Chapter 4), but women were also expected to nurse the children and cook the meals during the day, which took them away from the fields. Meanwhile, children were often in school, and only able to guard outside school hours.

The two plots that were guarded full-time, however, were affected very differently; one was amongst the most frequently damaged plots in the study sample, and the other incurred no damage at all, despite both being situated next to the KFR edge (although the undamaged plot was only present in interplanting season one). Sight distance is likely to be a factor here (Naughton-Treves, 1998). The damaged plot was large and could not be observed in its entirety from any one vantage point. Conversely, the whole of the undamaged plot could easily be seen from any point within the boundary.

The one plot that supported the presence of dogs is worthy of note. The dogs were present throughout the day, and during their employment only one crop raiding event by forest animals occurred. This is despite the plot being positioned alongside a riverine strip of forest that supported vervet monkeys.

6.4.7 Other risks of crop raiding

It is important to recognise that, in addition to the loss and damage of crops, animal raiding activity carries another risk; the risk of farmer-wildlife encounters. In Wagaisa, aside from rats, chimpanzees were the most frequent crop raiding animal. They mostly foraged on fruit trees along the forest edge, but they also travelled further into fields. As a consequence of this, farmers with fields next to the forest and close by were very likely to encounter chimpanzees. In Kiseeta, chimpanzees crossed a number of fields several times to reach sugarcane. This increased the chances of farmers encountering chimpanzees within the human agricultural landscape, and therefore established a risk of injury by wildlife in addition to the risk of crop loss, (as occurred on one occasion in this area during the study)[26].

6.5 Summary

- Maize and cassava were the most extensively damaged crops. Crops that were not damaged included tobacco, sorghum and Irish potato.

- Cattle were responsible for the greatest area of damage to crops. They spoilt a greater area of crops than all large vertebrates combined. They were also the fourth most frequent crop raiding animals.

- Three of the five animals that damaged the largest areas of crop were primates; vervet monkeys, black and white colobus monkeys and baboons. Vervet monkeys most consistently damaged the greatest area of crops of any animal after cattle across the four sites. Nevertheless, each primate species damaged less than half the area of cattle.

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[26]In October 2007 a child of the owner a farm 13 over 400m from the forest edge, which was situated next to a farm containing a sugarcane plot, was injured by a chimpanzee. The child was set down into crops to allow the mother to work, but it surprised a chimpanzee. The chimpanzee let go of the child after being hit with a stick by the mother.

- Birds were the second most frequent crop raiding animal after cattle, and were responsible for the fourth largest area of crop damage. They accounted for almost half the damage events on maize; 3.5 times more than vervet monkeys.

- Most damage events by large vertebrates were on mature crops. In contrast, most damage events by domestic animals were on immature crops. Nearly three quarters of crop raiding events in which the whole plant or the central stem was damaged were carried out by domestic animals.

- Almost all households experienced damage events, although over half of all farms did not sustain crop damage by large vertebrates. Over three quarters of households lost less than 2.1% of their crops, although some experienced greater than 5% loss.

- Distance from the forest was the clearest indicator of the likelihood of damage events by large vertebrates. The presence of beans or sweet potato was the strongest indicator of the likelihood of damage by small vertebrates.

- The frequency and extent (area) of damage events were not distinct between growing and interplanting seasons, and most animals continued to forage on crops throughout the year. Extended temporal patterns of planting and harvesting provide prolonged availability for crop species.

- Most households did not employ crop protection methods. Where crop protection tools were used, they were not associated with a reduction in the presence of damage events.

7. PERCEIVED CROP LOSS

7.1 Introduction

Human – wildlife conflicts arise from the interaction between animal behaviour and human activities. With this in mind, many amelioration programmes advocate modifying these behaviours and activities as a way to reduce conflict. For example wildlife may be discouraged from damaging crops through the use of barriers (Danquah, 2006; Jones and Elliot, 2006; King *et al*, 2009), unpalatable crops (Parker and Osborn, 2006; Ambarli and Bilgin, 2008), chemical repellents (Avery, 1989; Belant, 1997; Strum, 2010) or by guarding (Sitati and Walpole, 2006). Local people may be encouraged to protect livestock by improving husbandry techniques (Mishra, 1997; Jones and Elliot, 2006), or reduce risks to crops and livestock by altering land use methods and stewardship practices (Yoder, 2002; Sitati *et al,* 2003; Marker and Dickman, 2004). Whilst these approaches may successfully reduce interactions between animals and human activities, they are unlikely to change local people's attitudes to raid species. This is because conflict between humans and wildlife can arise as much from perceptions of risk as actual damage (Naughton-Treves, 1997; Hill, 2004, 2005). Perceptions of risk are often influenced by socio-economic and cultural factors external to the human-wildlife interaction *per se*, such as financial losses, access to benefits and resources, government policy, attitudes towards the animals that raid (or are perceived to raid), farming practices and land ownership.

Financial losses can be extensive (Naughton Treves and Treves, 2005) and systems of recompense may not be in place, despite people's expectations (Naughton-Treves, 2001; Hill, 2004). Where compensation schemes do occur, they may award a fraction of the value of lost crop or livestock (Mishra, 1997; Maikhuri, 2001). In addition to economic costs, limited access to benefits and resources can affect households and influence perceptions of wildlife. Benefits aimed at mitigating the impacts of living at the human-wildlife interface are often inequitably distributed (Gillingham and Lee, 1999), and loss of access to resources (land, fuel, timber, foods and animal fodder) can reduce household livelihood security in rural communities (Hill, 2002). Thus, the heavy costs of lost productivity and livelihoods can be an overriding cause of conflict (Western and Waithaka, 2005).

The prevention of traditional or historic wildlife management practices results in communities feeling unable to defend themselves and their resources (Naughton-Treves, 1997, 2001; Hill, 2005; Naughton-Treves and Treves, 2005; Ambarli and Bilgin, 2008). At the same time these policies are seen to encourage wildlife numbers and to increase human-wildlife conflict events (Ambarli and Bilgin, 2008; Dixon, 2009). Further, limited participation in decision making processes about wildlife and land management can cause feelings of marginalisation and a lack of influence over coexistence with wildlife (Gillingham and Lee, 2003; Bisi *et al*, 2007), and unrealistic expectations that are not addressed can lead to misunderstanding and disagreement (Hill, 2004; Osborn and Hill, 2005). These factors encourage the conviction that the rights of wildlife are respected, whereas those of the human are not (Maikhuri, 2000; Naughton-Treves, 2001; Hill, 2005; Dixon 2009), and promote the perception that wildlife is the property, and the responsibility, of the government (Ezealor and Giles, 1997; Naughton-Treves, 1997; Osborn and Hill, 2005).

Perceptions of wildlife are also influenced by cultural attitudes (Lee and Priston, 2005). Animals may be traditionally protected due to taboos on harming them (Lee and Priston, 2005; LaFleur and Gould, 2009), or they may be appreciated as part of a cultural heritage (Lagenijk, 2008). Equally some species may be culturally reviled, as is the chimpanzee by the Mende people of Sierra Leone, who consider them to be 'evil' (Yamkoshi, 2002). In religion, some animals may be revered and heralded as totemic animals and thus protected (Sekhar, 1998; Yamakoshi, 2002; Hockings *et al*, 2010; Riley and Priston, 2010), whereas others may be hunted for religious practices (Lee and Priston, 2005).

Physical and behavioural characteristics of raid species also influence perceptions of conflict. Large, conspicuous animals that are diurnal and therefore more frequently observed tend to be perceived as a greater risk by people, irrespective of the amount of crop or livestock they take (Hill, 1997; Naughton-Treves, 1997; Lee and Priston, 2005; Sarasola, 2010). In addition, large, bold and gregarious animals are more likely to be feared due to perceived risks of personal injury or intimidation (Sekhar 1998; Campbell-Smith *et al*, 2010). Furthermore, animals that raid rarely but inflict very large amounts of damage when they do visit are perceived to be worse than more frequently raiding animals, which may damage greater areas overall (Naughton-Treves, 1997; Naughton-Treves and Treves, 2005; Arlet and Molleman, 2007). Perceptions of primates are influenced by their similarities to humans, (Hill and Webber, 2010). Due to these similarities primate conduct is judged against human social rules and expectations, with primates being perceived positively if they adhere to the rules and negatively if they do not (Hill and Webber, 2010).

Previous knowledge or experience of an animal can also influence attitudes to raid species. People tend to perceive more conflict, irrespective of actual loss, or be less supportive of conservation efforts if they have had previous experience of the raid animal (Chauhan and Pirta, 2010; Sarasola, 2010) or have suffered extreme damage events by the raid species (Naughton-Treves, 1997), although this is not always the case (Hill, 1998).

Agricultural practices such as land use, crop choice, labour patterns, the size and location of farms, and security of tenure all influence perceptions of resource loss and attitudes towards raid species. For example, in Kenya, Gadd (2005) found that pastoralists were more tolerant of elephants than were agriculturists. A change from subsistence farming to commercial agriculture and animal husbandry in the Indian trans-Himalaya reduced tolerance of wolf depredation (Mishra, 1997). In Masindi, Uganda, as declining local forest industries forced previous employees to become wholly dependent on their subsistence farms, their tolerance of crop loss decreased (Hill, 2005). Also in Masindi, farmers who cultivated sugarcane as a cash crop for the local sugarcane company regarded chimpanzees as a major threat to both sugarcane and people, whereas subsistence farmers were more tolerant of sugarcane losses to chimpanzees (Paterson, 2005).

On subsistence farms, the loss of culturally important staple crops is less likely to be tolerated, and farmers may perceive the loss to be worse than for other crops (Warren, 2003). This is because the loss of staple food crops greatly reduces food security (Barirega *et al*, 2010). In addition, the amount of labour invested in the cultivation of various crop species influences farmers' perceptions of crop vulnerability (Naughton-Treves, 1997, 2001). In short, animals targeting crops that are perceived to be important or vulnerable are likely to be perceived more negatively (Goldman, 1987). Further, a reduction in the cultivation of crops that are attractive to raid animals, in favour of less palatable (to raid animals) but less profitable crops (Engeman *et al*, 2010), or crops that are less culturally important or tasty (to humans) is likely to influence farmers' perceptions of the animals responsible.

Farmers cultivating land nearest to forest edges are likely to consider themselves in conflict with wildlife, as proximity to the forest is a powerful predictor of crop damage (Naughton-Treves, 1997, 2001). In addition, farmers with access to larger farms are more likely to tolerate the risk of loss than smallholder subsistence farmers (Naughton-Treves, 1997). Perception of risk is also influenced by security of land tenure. Temporary land use arrangements (Webber, 2006) or uncertainty over possible appropriation of land (Reardon *et al*, 1999; Laudati, 2010), will decrease tolerance of damage and provide disincentives to support wildlife. Conversely, farmers with more secure land holdings show greater tolerance of crop loss (Infield and Namara, 2001; Romanach *et al*, 2007).

In addition to the influences of socio-economic and cultural factors on farmers' perceptions of conflict as described above, indirect consequences of crop loss are also likely to shape attitudes. Losing crops can result in a reduced diet and lower nutritional levels (Ogra, 2008; Barirega *et al*, 2010), a lack of school fees and a reduction in education opportunities (Webber, 2006), disruption of schooling due to guarding duties (Hill, 2004; Thirgood *et al,* 2005), increased risks of contracting disease (Hill, 2004: Thirgood *et al,* 2005; Engeman, 2010), an increased risk of injury from raiding animals (Hill 2004), and an increased workload due to replanting, repairing fences and guarding (Sekhar, 1998; Hill, 2004; Ogra, 2008).

In summary, as perceptions of crop damage and attitudes to raid species on farms are often based on factors other than actual levels of crop loss, there is a need to identify farmers' perceptions of crop loss and tolerance of raid animals in Hoima District and examine them in relation to, firstly, actual crop loss, and secondly, to factors that may influence perceptions irrespective of actual damage events; i.e. farming practices, socio-economic circumstances and cultural attitudes towards raid species.

The aims for this chapter are:

- To identify factors viewed by farmers as the main risks to crops.
- To determine which crop types are considered by farmers as most vulnerable to damage.
- To ascertain which animal species are viewed by farmers as most problematic.
- To examine farmers' perceptions of crop raiding in relation to a number of factors; the distance of farms from the forest edge, seasonality, historical changes, and the use of crop protection methods.
- To compare farmers' perceptions of conflict with actual damage events and identify where farmers' attitudes are shaped by actual damage events, and where farmers' opinions are influenced by factors external to actual crop loss.

7.2 Method

Semi structured interviews (SSIs) (n = 81) and focus group (FG) discussions (n = 8), were conducted as discussed in Chapter three (Methods). FGs were asked about crop raiding levels from the forest, animals considered most frightening, and attitudes towards chimpanzees. In addition, women's focus groups (WFGs) were asked about the importance of crops to the household food budget and household labour patterns. Men's focus groups (MFGs) were asked about the vulnerability of crop species, historic and present levels of crop loss, and thoughts about deforestation. Questions asked during FG meetings were open and were designed to encourage discussion. Depending on the direction of the discussion, supplementary questions varied slightly for each focus group. As in Chapter 5, farmers that described themselves as cash croppers are classified as such during analysis (Also see Table 4.1).

Perceived risks were quantified by compiling a risk index (Rj) for each problem (after Smith *et al*, 2000; Quinn *et al*, 2003; and Webber, 2006). This comprised of a severity index (S) and an incidence index (I). The severity index measured the severity of each problem named by each interviewee on a scale from 1 (most severe) to 2 (least severe). It was calculated as: $Sj = 1 + (r - 1)/ (n - 1)$, where r is the rank given to a specific problem based on the order of an interviewee's responses, and n is the number of problems cited by that interviewee (Quinn *et al*, 2003, Webber, 2006). A mean severity index was calculated for each problem for each cohort of interviewees (e.g. village, distance from forest edge). The incidence index illustrates the proportion of interviewees who cited each problem, and ranges from 0 (not mentioned) to 1 (mentioned by all) (Webber, 2006). A risk index was calculated for each problem by dividing the incidence index by the mean severity index: $Rj = Ij/Sj$. Higher scores indicate a greater perceived risk. In order to compare perceived risks and actual damage by crop raiding animals, risk indices were also compiled from actual damage data. A severity index was calculated for each farm, based on the area of damage by each animal species and the number of animals that raided the farm (Webber, 2006). The incidence index comprised the proportion of farms affected by each crop raiding species. Other statistical analyses in this chapter were carried out using the Chi-square test, χ^2 and Kendall's tau-b correlation coefficient, T_b.

7.3 Results

7.3.1 Perceived risks to crops

Interviewees were asked to rank problems they encountered whilst cultivating crops. A risk index was compiled (Table 7.1).

	Risk index all sites	Kiseeta risk index	Wagaisa risk index	Kihomboza III risk index	Nyakamwaga risk index
Disease	**0.6377**	**0.7026**	0.5727	0.6062	**0.7207**
Crop raiding	0.6374	0.6539	**0.6380**	**0.7393**	0.4633
Weather	0.6138	0.6334	0.6243	0.5772	0.6742
Livestock	0.4776	0.4971	0.4152	0.5617	0.4391
Insects	0.4685	0.5309	0.4796	0.4834	0.4258
Weeds	0.1043	0.1500	0.0659	0.1292	0.0700
Soil fertility	0.0966	0.0500	0.1833	0.1000	X
Labour	0.0864	0.1000	0.1200	0.0500	0.0700
Thieves	0.0254	0.0842	0.0200	X	X

Table 7.1 Risk index (*Rj*) of perceived problems on crops at each village site (interviewees n = 81). Higher scores indicate a greater perceived risk, and the risk factors viewed as most problematic are shown in bold. X identifies where risk factors were not named.

Disease has the highest risk index of all problems on crops across the four sites (Rj = 0.6377). However, the score for crop raiding by wildlife is very similar (Rj = 0.6374). Whilst crop raiding has a higher risk index in Wagaisa and Kihomboza III, disease is scored as the greatest risk to crops in Kiseeta and Nyakamwaga. Nevertheless, crop raiding was ranked as the greatest problem (i.e. ranked first) more frequently than any other risk factor by interviewees in Kiseeta (30% interviewees; disease = 25%). In contrast, 7.1% of interviewees in Nyakamwaga ranked crop raiding as their greatest problem (50% ranked disease first).

Risk indices were plotted onto a risk map to demonstrate the relationship between perceived severity (S) and the proportion of interviewees that cited each problem (incidence, I) (Figure 7.1).

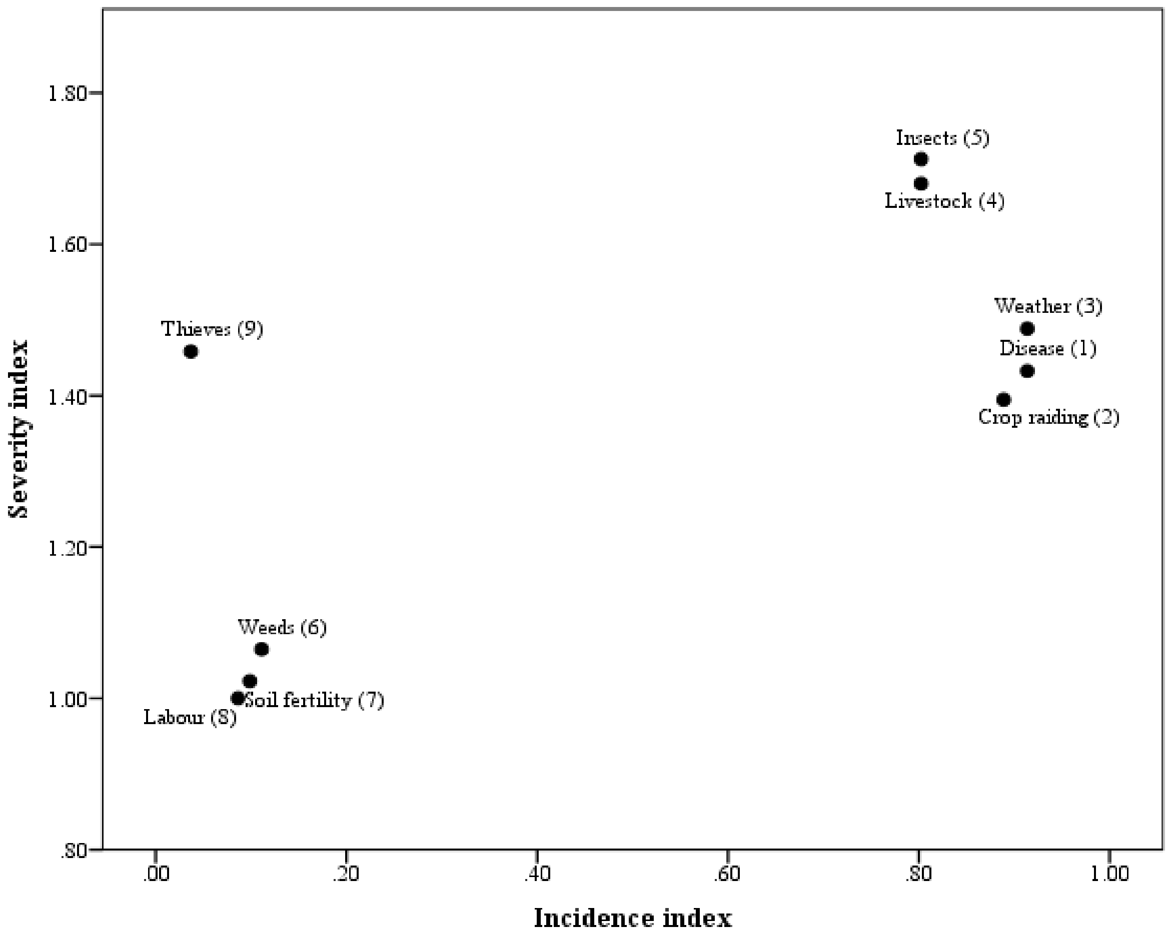

Figure 7.1 Risk map showing perceived severity of risk factors (*S*) and incidence of response (*I*) by interviewees (n = 81). The severity index (*Sj*) ranges from 1 (most severe) to 2 (least severe). The incidence index (*Ij*) ranges from 0 (not mentioned) to 1 (mentioned by all). Risk index ranks (*Rj*) are shown in parentheses.

Disease, weather and crop raiding have the highest incidence indices of all problems (disease: I = 0.9136; weather: I = 0.91358; crop raiding: I = 0.8889). Disease and weather were cited by interviewees more frequently than crop raiding, however, crop raiding is scored as the most severe of the three problems (crop raiding: S = 1.3946; disease: S = 1.4327; weather: S = 1.4884).

Labour, soil fertility and weeds are considered severe by the interviewees that named these problems (labour: S = 1; soil: S = 1.0229; weeds: S = 1.0648), but they have lower incidence indices than all other risk factors except thieves (thieves: I = 0.037; labour: I = 0.0864; soil: I = 0.0988; weeds: I = 0.1111), indicating that few farmers consider these issues problematic. Livestock and insects have high incidence indices (livestock: I =

0.80247; insects: $I = 0.8025$ but are not considered to be a severe problem (livestock: $S = 1.6803$; insects: $S = 1.7127$).

A larger proportion of subsistence crop households ranked crop raiding as the greatest threat to crops (45%, n = 20) than did cash crop farmers (27%, n = 10). Furthermore, more cash crop farmers ranked weather as the predominant risk factor (n = 12) than ranked crop raiding first (n = 10). Nevertheless, there is a significant correlation between the ranking of these problems by cash croppers and subsistence crop farmers (Kendall's tau-b, $T_b = 0.982$, $p<0.01$, 1- tailed, n = 14).

Disease and weather were frequently identified by farmers as difficult to mitigate. Weather is believed to be "hard to predict", "uncontrollable" and best left to nature and to God. Disease is seen as a constant threat and expensive to control due to the often prohibitive cost of pesticides. In contrast, crop raiding is viewed by a number of farmers as "controllable by guarding", and one Wagaisa resident said the local government Wildlife Warden (from UWA) would come and "solve the problem" of baboons if they were reported to LC1. However, other farmers asserted that methods to reduce crop raiding were ineffective. An interviewee in Wagaisa complained that guarding was futile, "nothing can be done. You guard, but vermin (vervet monkeys and black and white colobus monkeys) are not easy to guard against." In addition, another Wagaisa farmer said of wildlife officials, "they don't come often, despite me asking."

Some farmers stated that cattle could be a "big problem." However, interviewees at all sites consider that crop damage and the impacts of loss could be controlled, either by negotiating with the owner or accessing systems of recompense via the LC1. Not all farmers believe these systems are effective, but most consider them to be. As one farmer in Kiseeta stated, "the owners try to sort out any problem by controlling the animals, not like with wild animals."

7.3.2 Perceptions of vulnerable crops

The frequency with which interviewees cited crop species as risky to cultivate was collated (Table 7.2). Maize and groundnuts were identified most often as vulnerable crops, and the most commonly given reason was crop raiding by wildlife. Most interviewees who named particular crop species as vulnerable gave crop raiding as the reason (67%

responses). Nevertheless, a large proportion of responses regarding beans identify weather as the greatest risk factor (29%). Bananas are mostly viewed as vulnerable to disease (86% responses), and tomatoes are thought to be most threatened by disease and weather (100% responses).

	Perceived vulnerability, all reasons (n)	Perceived vulnerability, crop raiding (n)	Perceived vulnerability, crop raiding, ranked	Actual damage (m^2) ranked	Actual damage events (n) ranked
Maize	**21**	**16**	**1.5**	**1**	2
Groundnuts	20	**16**	**1.5**	9	3
Beans	17	10	4.5	3	5
Cassava	16	10	4.5	2	4
Rice	12	12	3	5	7
Banana	7			7	8
Millet	2	1	7.5	10	9.5
Sweet potato	3	3	6	4	**1**
Tomato	2			11	12
Cocoa	1	1	7.5		11
Pigeon peas				6	9.5
Sugarcane				8	6

Table 7.2 The frequency with which crop types were named as vulnerable at all sites. Some interviewees gave more than one response (interviewees: n = 81). The most frequent responses/highest ranks are shown in bold.

Farmers' perceptions of maize corresponded to levels of actual damage (Table 7.2). A larger area of damage was recorded on maize than on any other crop type, and it was also the most frequently damaged crop after sweet potato. Conversely, farmers' perceptions of groundnut vulnerability did not directly correspond with the actual area damaged (ranked 9th). However, groundnuts were the most frequently damaged crop type after sweet potato and maize. The high frequency of damage events on sweet potato was not reflected in interviewee perceptions as few farmers named this crop as vulnerable (n = 3). Nevertheless, all those that did name sweet potato gave crop raiding as the reason. No correlation was found between the ranked perceptions of crop vulnerability and area of each crop type damaged (Kendall's tau-b, T_b = 0.250, p>0.05, 1-tailed, n = 7), or the ranked perceptions of crop vulnerability and the frequency of damage events on each crop (Kendall's tau-b, T_b = 0.250, p>0.05, 1-tailed, n = 7). There are also no significant differences in the crop species viewed as most vulnerable by cash and subsistence households (Kendall's tau-b, T_b, p>0.05).

Maize, beans and cassava are each thought to be vulnerable to a wider range of animal species than are other crops (n = 10) (Table 7.3). Maize in particular, was said to be, "taken by everything" (Nyakamwaga MFG). A range of crop raiding species were also named as foraging on sweet potato (n= 6), groundnuts (n = 5), millet (n = 5) and rice (n = 5).

Crop	Species thought to cause damage	Number of animal species named as causing damage
Beans	Baboon, cattle, chicken, colobus, insects, porcupine, rat, red tail, squirrel, vervet	10
Cassava	Baboon, bush pig, cattle, chimpanzee, colobus, domestic pig, insects, porcupine, rat, vervet	10
Maize	Baboon, bush pig, chimpanzee, colobus, insects, rat, red tail, squirrel, vervet, wild bird	10
Sweet potato	Baboon, domestic pig, porcupine, rat, squirrel, vervet	6
Groundnuts	Colobus, porcupine, rat, squirrel, vervet	5
Millet	Chicken (in storage), insects, porcupine (in storage), vervet, wild bird	5
Rice	Baboon, insects, rat, vervet, wild bird	5
Banana	Chimpanzee, vervet	2
Cocoa	Chimpanzee, red tail	2
Tomato	Chimpanzee, vervet	2
Onions	Vervet	1
Sugarcane	Chimpanzee	1
Yam	Bush pig	1

Table 7.3 The number of crop raiding species cited by interviewees and focus group members as damaging each crop type.

7.3.3 Perceptions of crop raiding species

Interviewees were asked to rank wildlife species they viewed as problematic on crops. Severity and incidence indices were calculated and were compared with risk indices of actual damage by crop raiding species (area damaged) on household farms (Table 7.4).

Animal	Perceived risk index (*Rj*)	Actual risk index (*Rj*)	Variance	Perceived severity index (*Sj*)	Actual severity index (*Sj*)	Variance	Perceived incidence index (*Ij*)	Actual incidence index (*Ij*)	Variance
Vervet	**0.56**	0.24*	P	1.29	1.26*	A	0.73	0.30*	P
Squirrel	0.50	0.34.	P	1.50	1.85.	P	**0.75**	0.64.	P
Rat	0.49	**0.51.**	A	1.48	1.66.	P	0.73	**0.85.**	A
Baboon	0.30	0.04.	P	1.49	1.18.	A	0.44	0.04.	P
Chimpanzee	0.29	0.08*	P	1.68	1.60*	A	0.49	0.13*	P
Porcupine	0.23	0.05.	P	1.64	1.85.	P	0.37	0.09.	P
Colobus	0.22	0.14.	P	1.68	1.25.	A	0.37	0.17.	P
Bush pig	0.09	0.01.	P	1.61	**1.17.**	A	0.15	0.01.	P
Bird	0.08	0.49.	A	**1.04**	1.36.	P	0.09	0.67.	A
Red tail	0.05	X.	P	1.35	X.	P	0.07	X.	P
Termite	0.03	0.01.	P	1.11	1.50.	P	0.04	0.01.	P

Table 7.4 Perceived and actual risk indices for crop raiding animals (actual indices = m^2 damage. N = 81 interviewees, n = 94 farms). Higher scores for risk index (*Rj*) indicate a greater risk. Severity index (*Sj*) scores range from 1 (most severe) to 2 (least severe). Incidence index (*Ij*) scores range from 0 (not named/ damaged) to 1 (named by all interviewees/ damaged all farms). The animal ranked as most problematic in each category is shown in bold. Variance denotes which is greater; perceived risk (P) or actual risk (A) (after Webber, 2006). X identifies species that this study did not find to damage crops. Animals not cited by interviewees were not listed, irrespective of actual risk index.

***Actual risk indices were based on area of crop damaged. Therefore damage events on fruit were not included**

Perceived risk indices are greater than actual risk indices for all animals except rats and birds, indicating that for all other species, farmers' perceptions of risk are higher than actual crop damage would suggest. Vervet monkeys have the highest perceived risk index of any named species (Rj = 0.56). In addition, the variance between actual and perceived risk indices is the largest for any animal except birds (although for birds A is greater than P), illustrating that for vervet monkeys in particular, farmers' perceptions of risk are higher than actual levels of risk.

For all primates, perceived incidence indices are higher than actual incidence indices. Conversely, with the exception of red-tailed monkeys, perceived severity indices are lower than actual severity indices. This suggests that farmers believe primates visit a wider proportion of farms than was found, but damage crops less extensively (area) than was the case. Vervet monkeys are particularly viewed as more ubiquitous than they actually were. Whilst they have the (equal) highest perceived incidence index of any animal after squirrels (Ij = 0.73), the variance between perceived and actual incidence indices is greater than for any other named species. It should be noted that actual risk indices are based on damage to crops only. Inclusion of damage to fruit might have decreased the variance between actual and perceived incidence index for vervet monkeys (fruit: n = 7 farms) and chimpanzees (fruit: n = 30 farms).

In contrast to primates, birds have a lower perceived incidence index (Ij = 0.09) than actual incidence index (Ij = 0.67). They also have the largest variance between incidence indices of any animal, indicating that birds are not recognised by farmers as damaging as widely (proportion of farms) as they do. Furthermore, birds have the highest actual risk index (Rj = 0.49) after rats (Rj = 0.51) and cattle (Rj = 0.50, not shown on table), but are perceived as less risky than all animals except red tailed monkeys and termites.

The direction of variance between actual and perceived risk indices (P or A) corresponds exactly with the direction of variance between incidence indices. This suggests that farmers' perceptions of risk are shaped more strongly by the frequency of damage events rather than their severity, i.e. farmers' anticipation of risk reflects the frequency with which animals visit, or are thought to visit farms, more strongly than it reflects the area of crops damaged, or thought to be damaged during damage events.

The compilation of a risk map enabled differences between perceived and actual risks to be illustrated figuratively (Figure 7.2).

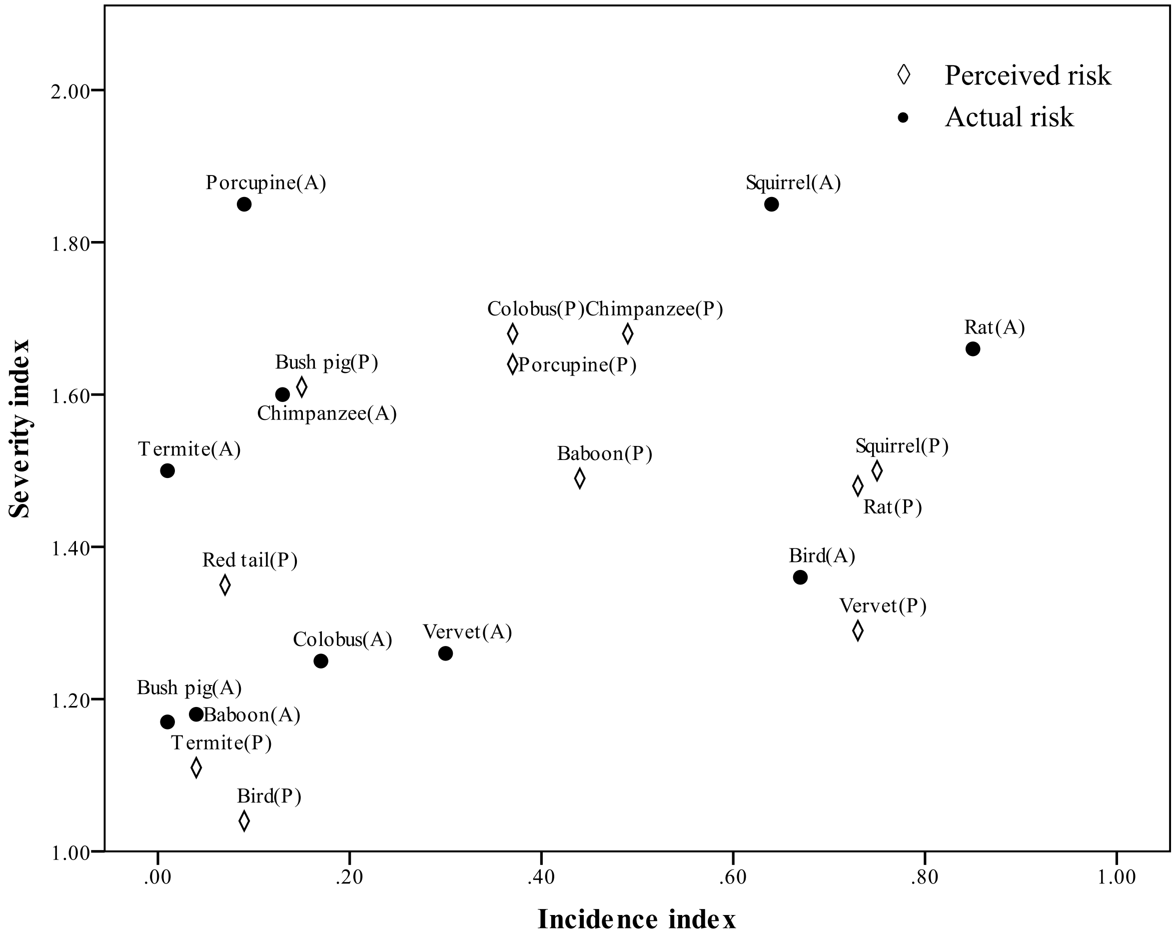

Figure 7.2 Risk map showing actual and perceived severity risk indices (*Sj*) and incidence risk indices (*Ij*) (actual indices = area of damage. N = 81 interviewees, n = 94 farms). The severity index ranges from 1 (most severe) to 2 (least severe). The incidence index (ranges from 0 (not mentioned/damaged) to 1 (mentioned by all/damaged all farms). Letters shown in parentheses denote perceived risk (P) or actual risk (A).

Black and white colobus monkeys and chimpanzees are positioned lowest on the severity index, indicating that they are not viewed as problematic, relative to other crop raiding animals. Birds and termites have the highest severity index scores, which signifies that farmers who cited these animals consider them troublesome. However, low incidence index scores indicate that birds and termites were mentioned by few interviewees.

There is a significant correlation between farmers' perceptions of crop raiding animals at all village sites (for animals that were named at all sites) (Kendall's tau-b, T_b = 0.833, p<0.01, 1-tailed, n = 28). Nevertheless, there were variations in perceptions between the villages (Table 7.5). At all sites except for Kiseeta, vervet monkeys, squirrels and rats have the three highest risk indices of all animals. Kiseeta farmers are more concerned with porcupines (ranked 2nd) and black and white colobus monkeys (ranked 3rd) than at other sites. However, actual damage by porcupines in Kiseeta accounted for a relatively small area of crop (ranked 11th). Black and white colobus monkeys damaged the largest total area of crop.

	Kiseeta		Wagaisa		Kihomboza III		Nyakamwaga	
	Risk index	Rank of *Rj*	Risk index	Rank of *Rj*	Risk index	Rank of *Rj*	Risk index	Rank of *Rj*
Vervet	**0.4716**	**1**	**0.6114**	**1**	**0.6342**	**1**	0.4995	3
Squirrel	0.3439	4	0.5155	3	0.5668	2	**0.6050**	**1**
Rat	0.3007	6	0.5751	2	0.5233	3	0.5741	2
Red tail	X		X		X		0.3168	4
Chimpanzee	0.3157	5	0.4187	4	0.1629	7	0.2366	5
Baboon	0.1778	7	0.4091	5	0.4978	4	X	
Colobus	0.3480	3	0.2780	6	0.0476	8	0.1980	6
Porcupine	0.3639	2	0.1403	8	0.3382	5	0.0357	9
Bird	X		0.1870	7	0.0476	9	0.0612	7
Termite	0.0500	8	0.0385	9	X		0.0536	8
Bush pig	X		0.0256	10	0.3005	6	0.0357	10

Table 7.5 Perceived risk indices (*Rj*) for crop raiding animals at each village site. Risk indices are ranked for each site. The animal ranked as having the highest risk index at each village site is shown in bold. X identifies where crop raiding species were not named

Chimpanzees have a lower risk index in Kihomboza III (Rj = 0.1629) than at any other site. Correspondingly, fewer chimpanzee damage events were recorded here (n = 1) than elsewhere. Conversely, baboons have a higher risk index in Kihomboza III (Rj = 0.4978) than in other villages. This also mirrors actual crop damage, as baboons foraged on crops in Kihomboza III only. Only farmers in Nyakamwaga view red-tailed monkeys as a risk to crops. Nevertheless, no damage events by this primate were recorded in any village site. There are no significant differences between cash and subsistence crop households in the perception of animal species as problematic on crops.

Crop types perceived by farmers as vulnerable to particular animal species were recorded (Table 7.6). A wider range of crops were named as vulnerable to damage by vervet monkeys than by any other crop raiding species (crop: n = 8; fruit: n = 1). This corresponds to actual damage; vervet monkeys foraged on the largest range of crops of all wild animal species (crop: n = 10; fruit: n = 2). Conversely, only two crop types were named as vulnerable to cattle, despite these animals damaging as many crop species as vervet monkeys (n = 10).

Species thought to cause damage	**Crops**	**Crops named as vulnerable (n)**	**Actual crops damaged (n)**
Vervet	Banana, beans, cassava, groundnuts, maize, millet, rice, sweet potato (jackfruit)	**8(1)**	**10(2)**
Rat	Beans, cassava, groundnuts, maize, millet, rice, sweet potato	7	7
Baboon	Beans, cassava, groundnuts, maize, rice, sweet potato	6	3
Chimpanzee	Banana, cassava, cocoa, maize, sweet potato, sugarcane (jackfruit, mango, papaya)	6(3)	5(4)
Insects	Beans, cassava, maize, millet, rice	5	1
Porcupine	Beans, cassava, groundnuts, millet (in storage), sweet potato	5	3
Colobus	Beans, cassava, groundnuts, maize	4	6
Squirrel	Beans, groundnuts, maize, sweet potato	4	5
Bush pig	Cassava, maize, yam	3	1
Redtail	Beans, cocoa, maize	3	0
Wild bird	Maize, millet, rice	3	6
Cattle	Beans, cassava	2	**10**
Chicken	Beans, millet (in storage)	2	3
Domestic pig	Cassava, sweet potato	2	4
Goat		0	8

Table 7.6 The number of crops cited by interviewees as vulnerable to each crop raiding species, and the actual number of crop species damaged. Figures in bold indicate the largest number of crop species. Parentheses indicate fruit species (mango, jackfruit, papaya, guava).

Black and white colobus monkeys are thought to damage fewer crop types (n = 4) than all other primates species except red-tailed monkeys, but actually damaged a wider range of crop species than baboons and chimpanzees. In contrast, farmers believe baboons to forage on twice as many crops species (n = 6) as was actually recorded (n = 3).

7.3.3.1 Vervet monkeys

Vervet monkeys are considered to be the most troublesome crop raiding species by interviewees (Table 7.4). Farmers stated that vervet monkeys were frequent raiders, continuously present and unselective, and a number of farmers stated that, “vervets destroy anything.” In Kiseeta vervet monkeys are also perceived to damage large areas of crop. One farmer commented, “you can’t risk planting maize and think you will harvest.” Vervet monkeys were said to forage on “vast areas” of groundnuts, and “whole fields” of beans. Interviewees also described vervet monkeys as difficult to control, because they were “stubborn” and “persistent”. Vervet monkeys were also described as “cunning”, “tricky” and “naughty” because, according to interviewees, when chased they knew how to hide nearby and wait until the farmer had gone, after which the monkeys returned immediately. Further, the members of the Kiseeta MFG stated that vervet monkeys were aware that they were stealing, and therefore acted guiltily, unlike black and white colobus monkeys (see below). Many farmers feel unable to manage vervet monkey raids on their crops. One farmer in Wagaisa commented, “it is a problem we can’t dominate”, and another in Kihomboza III said, “It is easier to chase baboons than vervet.”

7.3.3.2 Squirrels and rats

Squirrels and rats have the highest risk indices after vervet monkeys (Table 7.4), although in Nyakamwaga they are viewed as more troublesome than any other crop raiding animals (Table 7.5). A farmer in Wagaisa stated that rodents were a “big problem” and could “damage an entire field”, and an interviewee in Kihomboza III called them, “notorious and full time.” Seven crop species were named as vulnerable to rats, and four were viewed as vulnerable to squirrels (Table 7.6). Nevertheless, both rats and squirrels are thought to feed most extensively (area) on groundnuts. They are also viewed as difficult to control, but were not described in as negative terms as primates were by most interviewees. One farmer in Nyakamwaga described the impact of rodents as “minor”. A farmer in Wagaisa remarked that, “(the) rat can destroy, but it is not as bad as vervet, baboon and chimp”, and a number of Kiseeta farmers stated that, although squirrels were not easy to guard against, they were easy to trap.

7.3.3.3 Baboons

Baboons were more frequently described as a threat to crops by farmers in Kihomboza III than in the other villages. Baboons are viewed as extremely destructive and were said to, "destroy everything in their way" (Kihomboza III WFG). They are also believed to be non-selective in their foraging and to raid more frequently than other animals (Kihomboza III MFG). A number of interviewees stated that baboons raid so extensively (area and frequency) they reduce the amount of food produced for human consumption each year.

Baboons are considered a threat to livestock as well as to crops. One Kihomboza III farmer commented that baboons took goats and on one occasion took a pig. She further contended, "The area used to have many goats, now they have all been taken." In Wagaisa baboons are also perceived as a threat to livestock. One farmer commented on how baboons took poultry, and another farmer stated that a breeding sheep he lent to a farmer in the next village was killed by a baboon.

Farmers also view baboons as a risk to personal safety. In Wagaisa an absence of baboons did not diminish perceptions of them as dangerous, and the Wagaisa WFG considered baboons the least liked wild animal alongside vervet monkeys because they view them as a threat to people's safety. In Nyakamwaga, baboons were described as aggressive and likely to confront anybody that tried to chase them. Farmers in Kihomboza III claimed to be intimidated by the large numbers of baboons that visit the farms, and by the animals' resistance to being chased away. One farmer stated that nobody would attempt to chase baboons, and the WFG commented that, if anybody tried, the baboon would turn around and chase the pursuer. There is also reportedly a history of personal injury relating to baboon activity in Kihomboza III. According to one farmer, in 2005/2006 a baboon was caught in a trap. The other members of the baboon group inhabited the surrounding area and chased a farmer from her fields. She broke her leg running away. Further, the Kihomboza III WFG asserted that, on another occasion, baboons assaulted a farmer who attempted to chase them away from the area.

Although farmers in Kihomboza III believe that chasing baboons is too dangerous, they do consider that baboon raiding activities could be reduced by using dogs to harry the baboons if they are observed close to farmers' fields. Further, farmers stated that, when baboons are chased away, they remain scarce for a number of days. Nevertheless, one member of the Kihomboza III MFG said of baboons, “baboons cannot live in harmony with humans. We will kill them one by one if we get the chance. It is the most dangerous animal here.”

7.3.3.4 Red-tailed monkeys

Nyakamwaga was the only village site where farmers discussed the presence of red-tailed monkeys, and where these primates were observed by the research team. Red-tailed monkeys have the highest risk index in Nyakamwaga after squirrels, rats and vervet monkeys (Table 7.5), nevertheless, only one interviewee ranked them as the most troublesome crop raiding species on their farm. The behaviour and raid activities of red-tailed monkeys are distinct from that of vervet monkeys to most farmers. However, some farmers reviewed the two species together, which may have affected perceptions of both primates. One farmer remarked, “I can’t tell the difference between vervet and red-tail damage and I don’t care to know. All I care about is the damage on my crops.”

7.3.3.5 Black and white colobus monkeys

Black and white colobus monkeys are believed to be less troublesome than squirrels, rats and chimpanzees on crops at every site except for Kiseeta (Table 7.5). However, even in Kiseeta most farmers consider that black and white colobus monkeys cause little damage and remain scarce for days or weeks if chased away. Farmers in Wagaisa and Nyakamwaga stated that black and white colobus monkeys raided cassava leaves, but most people did not consider this to be a problem. One Wagaisa farmer commented, “(they) don’t eat much, only leaves.” Nyakamwaga farmers suggested this practice had only started recently. In Kihomboza III some farmers have never seen black and white colobus monkeys feed on crops, and view these primates as rare, shy, fearful of people and negligible crop raiders. Other farmers said they consumed only fruit. One member of the MFG remarked, “colobus only eat the fruits, and we don’t care about them.” Another Kihomboza III farmer asserted that black and white colobus monkeys had separated into different groups, some of which raided beans whilst the others did not. But all Kihomboza III farmers believe they are easily chased away.

In contrast, some farmers in Kiseeta and Wagaisa regard black and white colobus monkeys as problematic. A Wagaisa farmer asserted that black and white colobus monkeys could “devastate” a field of cassava; another suggested that they were the most destructive animal on cassava due to their tendency to break the stems of young plants (approximately 4-5 months old), which prevented the plant from producing tubers. In Kiseeta, two farmers who both cultivate fields next to the forest stated that black and white colobus monkeys cause a lot of damage and crops required guarding against them. Further, the body of a dead black and white colobus monkey was observed strung up at the farm-forest boundary in Kiseeta, facing towards the forest (M. McLennan, pers. comm.). Nevertheless, black and white colobus monkeys are not perceived as knowing and devious, unlike vervet monkeys or chimpanzees. The Kiseeta MFG commented, "a colobus doesn't know it is stealing. It doesn't feel guilty."

7.3.3.6 Porcupines

Porcupines are mostly considered to be a problem in Kiseeta, where they have the highest risk index after vervet monkeys (Table 7.5). Porcupines were said to "cause havoc" on cassava in Kiseeta. One farmer recited a Banyoro saying: "you plant, they eat, you eat the remains." However, porcupine presence appears to be localised as some farmers viewed them as common (mostly those with fields less than 300m from the forest edge), whilst other farmers (mostly with fields over 300m from the forest edge) claimed they did not encounter them. Porcupines raid at night, which makes them difficult to catch. This may have affected farmers' perceptions of them as destructive. However, all farmers agreed that porcupine damage events could be managed by contacting members of the Lugbara tribe, originally from the West Nile district (Beattie, 1971), who would hunt porcupines for food. As the Kiseeta WFG said "we can put people in to control them." All farmers agreed this measure had reduced the number of porcupines in the area.

7.3.3.7 Wild bird

Most farmers do not believe wild birds to be a problematic crop raiding species. The risk index for birds is not ranked above 7th at any site (Table 7.5), and they are thought to damage few crop types (Table 7.6). Nevertheless, the few farmers who did identify birds as risky viewed them as a severe threat to rice. Rice plots were said to require guarding throughout the whole period of cultivation, and one Wagaisa farmer stated that wild birds could consume 50% of the annual crop.

7.3.3.8 Bush pig

Bush pigs are not considered a problem by farmers at any site except Kihomboza III. One farmer in Kihomboza III ranked bush pigs as the most problematic species on crops, and complained that bush pigs were difficult to guard against because they came at night. A second farmer stated that bush pigs could damage a large area of crop overnight. In Wagaisa one farmer claimed that bush pigs raided yams, but most other farmers in Wagaisa, Kiseeta and Nyakamwaga commented that hunting had extirpated bush pigs in the local area.

7.3.3.9 Domestic livestock

Cattle, chickens, domestic pigs and goats were not listed alongside wild animals when farmers were asked to rank problematic species on crops. Instead, domestic livestock was ranked as a risk factor, and is considered less of a threat than disease, crop raiding and weather (Section 7.3.1). Nevertheless farmers did complain that cattle and domestic pigs damage their crops, especially those farmers with plots adjacent to cattle routes. A Wagaisa farmer said he had to guard against cattle "from morning to night." However, each type of domestic livestock is thought to damage fewer crop varieties than all wildlife species (Table 7.6).

7.3.3.10 Chimpanzees

Chimpanzees have the lowest perceived severity index on the risk map (along with black and white colobus monkeys) (Figure 7.2), indicating they are not viewed as a threat to crops. Although a wide range of crops was named as vulnerable to damage by chimpanzees (Table 7.6), most farmers believe these primates either do not damage crops, or forage on few crop species, and many farmers are unconcerned about chimpanzee damage on crops. Farmers most frequently spoke about chimpanzees foraging on small stands of sugarcane and fruit trees, which are generally considered less valuable than plots of cultivated crops. As one farmer in Kihomboza III commented, "They don't come for crops, they come for the fruit trees. I don't mind that." In Kiseeta, despite evidence of regular chimpanzee damage on cocoa gardens adjacent to nearby forest patches outside of the sample area, (McLennan and Hill, 2010), most interviewees stated that chimpanzees raid little cocoa. The Kiseeta MFG asserted that vervet monkeys raided more cocoa than did chimpanzees. Farmers who did state that chimpanzees damaged food crops mostly believe that damage events are occasional and limited to mature maize. However, the

Kihomboza III WFG and a number of Wagaisa famers thought that the amount of maize damaged by chimpanzees is increasing.

Not all farmers perceive chimpanzees to raid so little. In Kiseeta the owner of a commercial sugarcane plot next to the forest complained, "I make no money from my sugarcane because they raid it every day." He also claimed he had abandoned the plot as a cash crop due to the damage caused by chimpanzees. In addition, a number of farmers in Wagaisa stated that chimpanzees destroy crops as they passed through fields in search of fruit trees. Although most of these farmers believe any crop damage to be accidental, some thought the intention of chimpanzees was to "just spoil" crops. Chimpanzees were also said to have taken chickens from two household compounds, one in Kiseeta and one in Wagaisa. Both compounds were 0-200m from the forest edge and both had no other fields in-between the household plots and the forest.

In Nyakamwaga, perceptions of chimpanzees as crop raiders are more marked than at any other site. Whilst most farmers believe that chimpanzees visit only occasionally, others described how chimpanzees "disturb" and "destroy everything." Farmers also thought that chimpanzees are consuming an increasing variety of crop types. Members of the WFG claimed that chimpanzees are learning to eat maize and other food crops, and one farmer stated that, in addition to sugarcane and banana, chimpanzees also uproot cassava, (although he did comment they mostly raid mango and jackfruit trees). A second farmer asserted that chimpanzees consume the leaves of cassava plants. Further, a tobacco farmer next to the forest described how he observed chimpanzees removing tobacco leaves and, "laying them down as a kind of matting"[27].

Nyakamwaga was the only one of the four sites where attempts were reportedly made to have the local group of chimpanzees removed. Prior to the commencement of the study UWA had been approached to relocate the visiting group elsewhere. Despite this, the main protagonist did acknowledge that for most of the time chimpanzees "only" took fruit. However, a member of the Nyakamwaga MFG stated that farmers would kill chimpanzees if they were not prevented from doing so by law.

[27]It is possible this was a day nest, but as the damaged crop had been removed by the time the research team visited this could not be confirmed, and the incident could not be included in the crop loss data.

7.3.3.10.1 Chimpanzees: personal safety

Despite most farmers' belief that chimpanzees are responsible for very little crop loss, these primates are the most feared by farmers at all sites. This is likely due to the perception that chimpanzees pose a risk to personal safety. Chimpanzees were described as, 'vicious', 'ferocious' 'notorious' 'aggressive', 'fearless', 'determined' and 'strong.' Farmers in Kihomboza III consider chimpanzees to be more aggressive than baboons and commented that a chimpanzee would kill a pursuing human or a dog. Further, one Kihomboza III farmer stated that, unlike baboons, chimpanzees would not allow a farmer to simply pass by. Additionally, the Kiseeta MFG agreed that, if a chimpanzee wants something "nothing will get in its way." In Wagaisa, chimpanzees were said to beat dogs with sticks until they died, slap women, carry away children[28] and pull the fingernails from people they considered to be aggressors[29]. Farmers in Kiseeta and Kihomboza III also stated that chimpanzees carried away children.

Interestingly, despite a perceived increase in crop raiding incidents and some strong negative reactions to chimpanzees as crop raiding animals, farmers in Nyakamwaga appear to be more tolerant of chimpanzees' behaviour towards people than at other sites. Farmers asserted that chimpanzees could be chased away and are deterred from returning for "a long time" (this was probably because there is so little forest left, that chimpanzees are not resident and simply pass through Nyakamwaga to another site). Further, farmers suggested that chimpanzees were fierce only if disturbed, and would ignore and pass by a farmer if the farmer found a safe place to stand.

7.3.3.10.2 Chimpanzees: influences on labour patterns

Farmers are particularly aware that chimpanzee presence curtails the undertaking of household and agricultural tasks. Farmers in Kiseeta (mainly women), told how they are afraid to work in their fields when chimpanzees are around, and are afraid to go into the forest to collect water. A member of the Kiseeta WFG stated, "the further you go into the forest, they really chase you." Further, one farmer in Wagaisa commented that she could

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[28]During the study period chimpanzees seized a child on two occasions (January and October 2007) in or nearby to Kiseeta. Both children were subsequently released. News of the first incident was broadcast on local radio.

[29]Reportedly three boys from the village neighbouring Wagaisa (Dwoli), attempted to take a young chimpanzee from its mother in 2005/6. The adult female pulled out the fingernails of one of the boys on one hand. The members of the Wagaisa men's focus group and some members of the Wagaisa women's focus group asserted that they knew the boys personally and had seen the damaged hand.

no longer cultivate groundnuts in her field at the forest-farm boundary as her son refused to guard them for fear of encountering chimpanzees. She planted millet instead. This farmer additionally stated that, due to changes enforced by chimpanzee behaviour, such as the prevention of guarding, and working in fields only in groups rather than alone, she was afraid that crops grown throughout the whole season were at risk. In Kihomboza III the WFG agreed that the presence of chimpanzees prevents cultivation. One farmer commented, “Where a chimp is, you cannot go and cultivate. You can’t work there and if it stays for a week you lose a week’s work.” Another farmer in Kiseeta described how chimpanzee presence in the area increases her daily workload as, in addition to working in her garden, she escorts her child to school in order to protect him.

7.3.3.10.3 Chimpanzees: influences on other raid species

Farmers believe that chimpanzee activity influences the risk of crop loss to other raid species. Chimpanzee presence is understood to deter baboons from crop raiding, whilst the threat of raids by vervet monkeys and wild birds is thought to increase if chimpanzees are present; as farmers are chased by, or flee in fear from, chimpanzees, vervet monkeys and wild birds take advantage of unattended fields.

7.3.3.10.4 Chimpanzees and human-like behaviour

Farmers believe that chimpanzees both understand human behaviour, and exhibit human-like behaviour, and this influences both farmer attitudes towards chimpanzees and farmer behaviour in the fields. The Kiseeta MFG claimed that, because chimpanzees “know how humans behave”, men are no longer able to chase them away as had been the case in the past. Further, a farmer in Kihomboza III stated that chimpanzees dislike farmers carrying anything, such as a hand hoe. During an encounter a chimpanzee would either attempt to snatch the hoe, or pick up a stick to mirror its ‘opponent’. For this reason farmers agreed that they instantly dropped their hoes when they sighted a chimpanzee, thereby preventing further work. Chimpanzees are also thought to understand they are stealing property that does not belong to them. This is because chimpanzees creep quietly into gardens, whereas they are very noisy in the forest.

Such is the perception of chimpanzees as human-like animals, that chimpanzees are thought to rape women. All women who discussed this topic believe this does occur.

Members of the Wagaisa WFG agreed "it is clear that it could easily happen."[30] One member further commented, "Whenever a chimp meets a man (with a woman) he gives a hand sign (to the man) to signify 'go away." In Kihomboza III this encounter was retold with a different emphasis; "if a female chimpanzee finds a female human in a garden she would put her hand up to signify 'please go' the male is coming. This is because they can rape human women." This illustrates a perception that female chimpanzees both empathise with female humans and attach value judgements to male chimpanzee behaviour, i.e. they think like human beings. A reason for the human-like behaviour of chimpanzees was suggested by a village elder in Nyakamwaga, who recounted an old story that chimpanzees were originally humans who entered into the forest to live and did not return.

7.3.4 Distance from the forest edge

Interviewees' perceptions of problems were grouped according to the distance of interviewees' fields (nearest edge) from the forest-farm boundary, and risk indices calculated (Table 7.7).

	0-100m	101-200m	201-300m	301-400m	401-500m	>500m
Disease	0.538	**0.761**	**0.669**	**0.724**	0.582	**0.652**
Crop raiding	**0.811**	0.582	0.558	0.609	**0.606**	0.467
Weather	0.625	0.661	0.589	0.595	0.599	0.587
Livestock	0.506	0.386	0.503	0.582	0.367	0.617
Insects	0.423	0.434	0.584	0.505	0.418	0.591
Labour	0.043	0.063	0.111	X	0.214	0.143
Soil fertility	0.087	0.058	0.111	0.250	0.065	X
Weeds	0.087	0.058	0.089	0.067	0.214	0.143
Thieves	0.054	0.056	X	X	X	X

Table 7.7 Risk index (*Rj*) of perceived problems on crops at 100m distance increments from the forest/KFR edge (interviewees n = 81). Higher scores indicate a greater perceived risk, and the risk factors viewed as most problematic are shown in bold. X identifies where risk factors were not named.

[30]This comment was specifically in response to a report by a Wagaisa interviewee that a woman living in the next village was raped by a chimpanzee and gave birth to a child that was human from the waist down and chimpanzee from the waist up. A similar story is told in Northern Sumatra, Indonesia, about orangutans (Campbell-Smith *et al*, 2010).

Nearest to the forest edge (0-100m) crop raiding has the highest perceived risk index of all problems. Beyond 100m disease and weather are most frequently scored as the greatest risk to crops. There is a significant association between distance and perceptions of crop raiding as the predominant risk factor (Chi square, $\chi^2 = 4.243$, $df = 1$, $p = <0.05$, n = 47).

Farmers' perceptions of crop raiding animals at increasing distance from the forest/KFR edge were explored. Perceived risk indices were calculated for household fields at each 100m increment from the forest-farm boundary (Table 7.8) and plotted alongside actual risk indices for each animal (Figure 7.3).

Distance	0-100m	1-200m	2-300m	3-400m	4-500m	>500m
Vervet	**0.734**	0.417	0.614	**0.570**	**0.597**	0.202
Squirrel	0.112	0.489	**0.675**	0.467	0.576	**0.416**
Rat	0.500	**0.492**	0.613	0.508	0.458	0.392
Baboon	0.529	0.259	0.361	0.125	0.176	0.180
Chimpanzee	0.367	0.417	0.424	0.225	0.122	0.095
Porcupine	0.333	0.188	0.280	0.132	0.180	0.171
Colobus	0.278	0.258	0.150	0.267	0.166	0.078
Bird	0.044	X	0.207	0.154	0.143	X

Table 7.8 Perceived risk index (*Rj*) of the main animals thought by interviewees to damage crops at 100m distances from the forest/KFR edge (interviewees n = 81, distance of interviewee farms calculated from nearest edge). Higher scores indicate a greater perceived risk, and the animals viewed as most problematic at each 100m distance increment are shown in bold. X identifies where risk factors were not named.

Vervet monkeys have the highest risk indices at most distances, indicating that farmers up to 500m from the forest edge view this animal as a risk to crops (Table 7.8). This is despite a decline in the actual risk index at increasing distance from the forest edge (Figure 7.3). Baboons have the second highest risk index at 0-100m (*Rj* = 0.529) but are not considered particularly risky by farmers beyond this distance. This corresponds with actual damage events, as damage by baboons was not recorded beyond 200m. At 1-200m from the forest edge rats and squirrels have the highest risk indices of all animals (*Rj* = 0.492 and (*Rj* = 0.489 respectively), showing that farmers at this distance consider rodents a greater risk to their crops than large vertebrates. Wild birds have a lower perceived risk index than actual risk index at every distance increment.

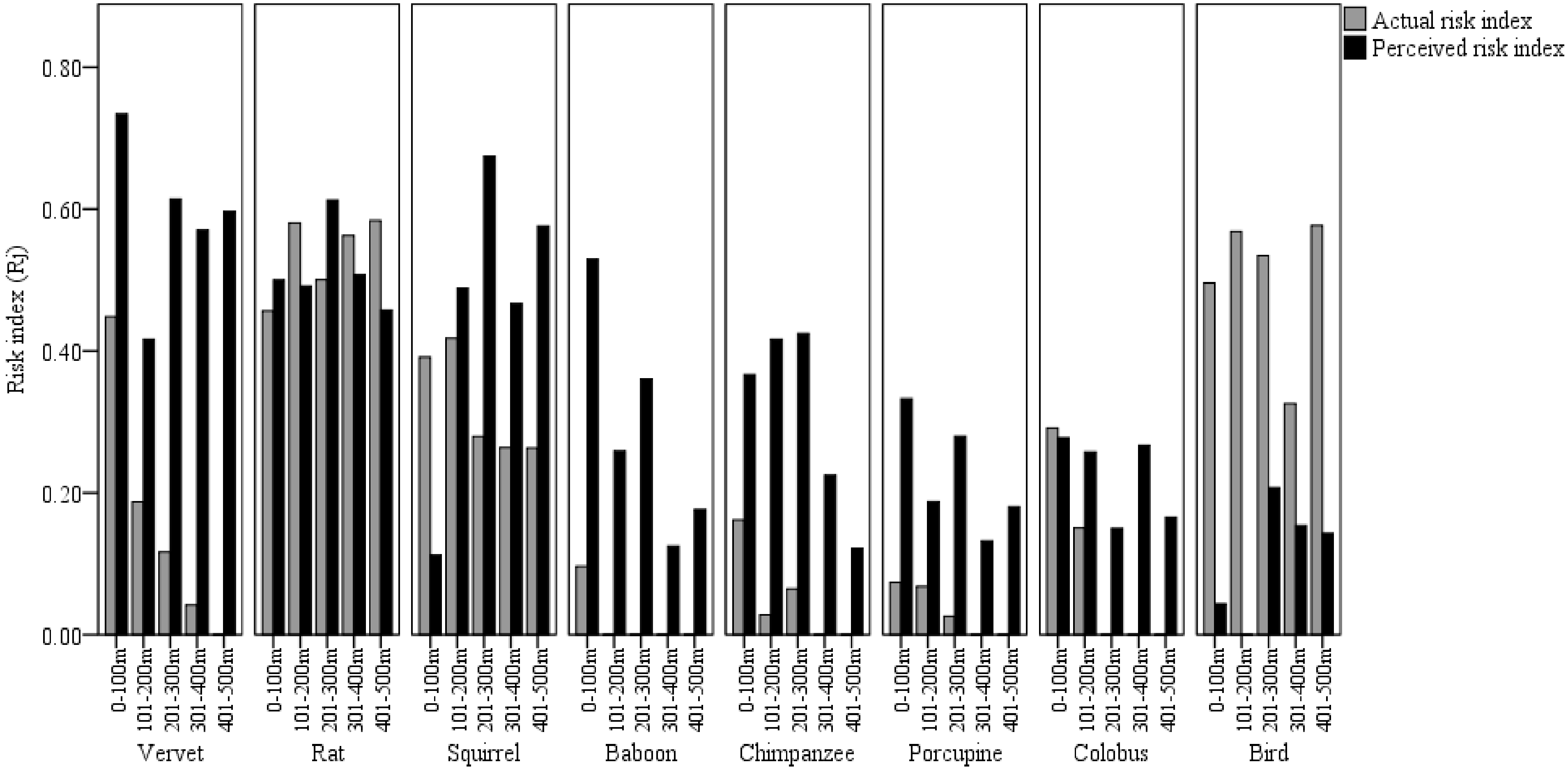


Figure 7.3 Perceived and actual risk indices of the main animals thought by interviewees to damage crops at 100m distances from the forest edge. Higher scores for risk index (*Rj*) indicate a greater risk (actual indices = area of damage. N = 81 interviewees, n = 94 farms).

7.3.5 Seasonal variations

During interviews and focus group discussions, beans and maize were cited most frequently as susceptible to seasonal loss or damage. Most farmers who identified seasonality of risk referred to crop raiding by wildlife as the main problem, although beans were also said to be vulnerable to excessive seasonal rains.

Beans and maize are considered most at risk of wildlife raids during germination and as young plants. Young bean pods were said to be particularly vulnerable to vervet monkeys and baboons; and maize seeds to rats, squirrels and vervet monkeys (Table 7.9).

Crop	Perceptions: plant part damaged	Perceptions: animal responsible	Actual crop damage: animal responsible (most frequent)
Banana	Male bud	Vervet monkey	No recorded damage
	Young fruit	Vervet monkey	No recorded damage
	Mature fruit		Vervet monkey, chimpanzee
Beans	Germinating pods	Vervet monkey, baboon	No recorded damage
	Maturing pods	Vervet monkey	Vervet monkey
	Mature pods	Vervet monkey, chimpanzee	Black and white colobus monkey
Cassava	Whole plant		Cattle
	Mature tuber	Vervet monkey	Rat, baboon, squirrel
	Stem	Black and white colobus monkey	Cattle
	Young leaves	Vervet monkey, black and white colobus monkey	Black and white colobus monkey, cattle, vervet monkey
Groundnuts	Germinating nuts	Vervet monkey	Squirrel
	Maturing nuts	Vervet monkey	Rat, squirrel
	Mature nuts	Vervet monkey	Rat, squirrel
Maize	Seed	Vervet monkey, rat, squirrel	Squirrel
	Maturing cob	Vervet monkey	Vervet monkey, black and white colobus monkey, wild bird
	Mature cob	Vervet monkey, baboon, chimpanzee	Wild bird
Rice	Seed, all stages	Wild bird	Wild bird
Sweet potato	Young tubers	Vervet monkey	Rat

Table 7.9 Crop parts considered vulnerable by interviewees, and the animals viewed as responsible. Animals that undertook actual damage events (most frequent on each plant part) are also shown.

Some farmers view maize and beans as vulnerable to vervet monkeys at any time during the growth cycle. One farmer in Nyakamwaga stated that vervet monkeys and red-tailed monkeys are, "A threat to maize from beginning to end." Mature maize was said to be damaged by baboon and chimpanzees as well as vervet monkeys, and one farmer commented that chimpanzees damage mature beans.

In addition to young bean pods and maize seeds, vervet monkeys were said to favour young plants of other species: young sweet potato tubers, young banana fruits and cassava leaves. Members of the Kiseeta MFG also commented that vervet monkeys destroy the male bud in young bananas, thereby preventing reproduction. Further, both vervet and black and white colobus monkeys were said to raid cassava plants which are 5-6 months old and have not yet produced tubers. Black and white colobus monkeys were particularly identified as problematic on cassava at this stage, due to their tendency to break the central stems, which halts the production of tubers. Nevertheless, this was not observed by the research team. Whilst black and white colobus monkeys did damage the leaves of young cassava plants more frequently than any other animal, they were not recorded as breaking the central stems. With the exception of one incident by chimpanzees, all damage events on cassava stems (n = 67) were carried out by cattle.

7.3.6 Crop raiding species: perceived changes

Most interviewees consider that, whilst primate numbers have decreased in recent years, raid activity on crops by chimpanzees, black and white colobus monkeys and vervet monkeys has actually increased. For chimpanzees and black and white colobus monkeys in particular, this is believed to be because the animals are travelling further into farmers' fields to look for food than they used to.

Chimpanzee damage events are thought to have increased in Wagaisa, Kihomboza III and Nyakamwaga. Kiseeta farmers believe that foraging is extending further into cultivated land, but the frequency of damage events has reduced. Farmers in Wagaisa stated that the loss of forest fruit trees has recently prompted chimpanzees to start feeding on jackfruit and mango trees outside of the forest, increasingly foraging for these fruits in family compounds and crop gardens. The Kihomboza III WFG commented that chimpanzee raids on maize have increased in recent times, although, one village elder in Kihomboza III did assert that chimpanzee damage events are less frequent than in the past. Members of the

Nyakamwaga WFG asserted that, whereas in the past chimpanzees had mostly foraged on sugarcane and cocoa, they have recently started to learn to eat maize and other food crops. In Kiseeta, the MFG remarked that chimpanzees are learning new foraging and defensive behaviours; the stealing of chickens and resisting men's attempts to chase them away. One farmer commented, "now these chimps are developing ways of dealing with things."

Farmers in Wagaisa and some farmers in Kiseeta believe that group sizes of chimpanzees are increasing. Members of the Kiseeta MFG considered this the reason for increased chimpanzee crop raiding activity. Wagaisa farmers commented that chimpanzees are permanently present in the forest, whereas they were thought to visit the area only occasionally in the past. One Wagaisa farmer stated, "first there were one or two, now there are hundreds." In Kihomboza III farmers reported that chimpanzees had started to sleep in farmers' compounds, which they had not done previously.

Black and white colobus monkey activity in Kiseeta is thought to be decreasing in frequency, but extending in range from the forest edge. In Wagaisa and Nyakamwaga black and white colobus monkeys are believed to raid crops increasingly, and forage on crops and plant parts that had previously not been damaged, such as the leaves of cassava, and the pods and leaves of beans. Farmers in Wagaisa consider this to be in response to a reduction in vervet monkey activity.

Vervet monkey numbers are thought to be reducing in Wagaisa and Nyakamwaga. However, they are also considered to be an increasing problem. The MFG in Wagaisa asserted that vervet monkeys are less affected by deforestation than other primates and are able to inhabit small trees outside of the forest, which has resulted in vervet monkeys being, "the big problem now." Conversely, the Wagaisa WFG, whilst also believing that vervet monkeys are frequent crop raiding animals, stated that vervet monkeys foraged on crops less frequently than in the past due to guarding and chasing efforts by farmers. As most farmers agreed that guarding is mainly undertaken by women and children, (Chapter 4, section 4.3.3.4.), and the research team more frequently observed women in the fields than men, the observations of the WFG may be the more accurate. Nevertheless, both groups believed vervet monkeys are troublesome crop raiding animals. In Nyakamwaga, red-tailed monkeys were also said to increasingly raid farmers' crop gardens.

Baboons are no longer considered to be a problem at any site except for Kihomboza III. In Kihomboza III, farmers with land further from the KFR (over 300m away) contend that baboons no longer raid their crops as they had done in the past. However, farmers with fields next to the KFR believe the threat to crops posed by baboons has increased. One Kihomboza III farmer commented, "Baboons have been a problem since our grandmothers were here and they are still here." The frequency of damage events is believed to have escalated due to the loss of fruit trees in the KFR, and the type of crops damaged is said to have changed. Members of the WFG stated that, "baboons used to eat beer banana, which could be spared. Now they are becoming notorious because they will cause food insecurity."

Porcupine and bush pig activity is also perceived to have changed in recent years, mainly because both animal types are believed to have disappeared or been greatly reduced due to hunting. In Kiseeta and Kihomboza III farmers assert that porcupines are still present, but farmers in Wagaisa and Nyakamwaga believe they have been rendered locally extinct in recent years. Most farmers in Kiseeta, Wagaisa and Nyakamwaga consider that bush pigs are no longer present in the local area due to their being hunted for human consumption, or having been chased away. One farmer in Nyakamwaga commented that bush pigs and baboons had stopped visiting fields when the village expanded and new houses were built[31], which blocked traditional foraging routes. In Kihomboza III, whilst a small number of farmers believe that bush pigs are still numerous, most farmers in Kihomboza III also agree that bush pig numbers have reduced due to hunting drives.

7.3.7 Crop protection and mitigation strategies

Interviewees were asked about strategies they employed to cope with problems on crops[32] (Table 7.10). Crop raiding by wildlife and livestock damage are the only problems where a larger proportion of responses were active (i.e. specified strategies to mitigate the risk) rather than passive (i.e. did not specify mitigation strategies, or indicated that no strategies were used).

[31]Possibly around 2000 (taken from Hill, unpublished data).

[32]Some interviewees suggested solutions to problems that they had not initially cited. i.e. that were not cited in section 7.3.1. All suggested solutions were recorded in this section, and thus all corresponding risk factors were also recorded.

Crop protection activity	Crop raiding	Livestock	Disease	Weather	Insects	Weeds	Soil	Thieves	Labour	No problem
Chase	2	2								
Guard	**37**	2								
Hunt/Trap	8									
Inform owners		**8**								
Recompense		7						1		
Report to LC1	1									
Plant more crop	1									
Diversify			2				1			
Remove crop			1							
Pest/herbicide			8		4	1				
Plant early/late				**10**	1					
Weed	1					1				
Irrigate				1						
Total active responses	50	19	11	11	5	2	1	1	0	0
Nothing	3	2	**11**	**10**	2		1			1
No answer	8	1	10	5	**6**	**5**	**3**	**2**	**4**	
Total passive responses	11	3	21	15	8	5	4	2	4	1

Table 7.10 Frequency of interviewee responses describing crop protection strategies employed to mitigate problems. Figures in bold denote most frequent response to problem. Some interviewees cited more than one protection strategy.

With regard to strategies to reduce crop raiding, guarding was cited by interviewees more frequently than any other response (60.7% responses), indicating that most interviewees who are concerned about crop raiding assert that they guard their crops. Interviewees who identified livestock as a risk to crops suggested consulting with livestock owners and accessing systems of recompense more frequently than other strategies (68.2% all responses relating to livestock). Most responses concerning disease and weather were passive, nevertheless, the most frequently cited positive response to disease was the use of pesticides and herbicides (25% of all responses relating to disease), and the most frequently cited active response to weather was to plant early or late according to the prevailing conditions (38.5% all responses relating to weather).

7.4 Discussion

Unlike other studies in Africa (Gillingham and Lee, 2003; Webber, 2006), where crop raiding is clearly perceived to be the worst risk factor, farmers in the Hoima District study sample do not view damage by crop raiding wildlife as a much greater risk to crops than other problems. This is likely to be because levels of crop loss in the Hoima District study sites are generally low. Nevertheless, conflict between farmers and crop raiding animals does exist. Where crop species were named as vulnerable, crop raiding was most frequently given as the reason. This indicates that, although disease and weather are most frequently thought by farmers to be the biggest problems they encounter, the risk of crop loss is most immediately linked with crop raiding activity.

Examination of farmers' attitudes to crop raiding and comparison with actual damage events at the study sites reveals that conflict arises from three main areas: i) crop loss (actual and perceived); ii) factors that indirectly affect crop loss (actual and perceived); iii) factors external to crop loss. Whilst a combination of factors within these three areas contributes to farmers' perceptions of conflict, attitudes appear to most strongly correspond with: a) the frequency of damage events (actual or perceived); b) the ability to control animals and impacts of damage events; and c) feared threats to personal safety from animals. These and other key factors are reviewed.

7.4.1 Crop loss

7.4.1.1 Frequency of damage events

Farmers' perceptions of risk reflect the frequency of damage events more strongly than they reflect the area damaged, or thought to be damaged by crop raiding animals. Crops damaged frequently are often viewed as vulnerable, particularly maize and groundnuts. Animals viewed as frequent and persistent foragers are considered troublesome, particularly vervet monkeys (as Hill, 1997; Naughton-Treves, 1997; Saj *et al*, 2001; Gillingham and Lee, 2003; Warren, 2003) and rodents (as Gillingham and Lee, 2003; Priston, 2005; Arlet and Molleman, 2007). Equally, animals viewed as infrequent visitors are tolerated more, irrespective of the actual frequency of damage events; birds undertook the largest number of damage events after rats but are not considered frequent crop raiders by most farmers, and are not viewed as a threat to crops. These findings differ from a number of studies in similar environments, which found that large, infrequent damage events shaped attitudes most strongly (Naughton-Treves, 1997; Webber, 2006) (although see Gillingham and Lee, 2003; Arlet and Molleman, 2007), and illustrates that frequent, persistent damage events can also influence farmers' perceptions of conflict. These types of damage events should therefore be considered when addressing human-wildlife conflict issues. However, the influence of small frequent damage events relative to large, infrequent episodes on local perceptions of conflict has probably arisen due to the relatively small area of crop damage in the Hoima District study sites. If farmers had experienced the complete loss of a plot, or a majority loss of a particular crop type during the season, as seen in other sub-Saharan sites (Naughton-Treves, 1997; Kagoro-Rugunda, 2004; Warren *et al*, 2007), the area of crop damaged might have more strongly informed perceptions of risk. This illustrates that human-wildlife conflict situations must be viewed on a case by case basis.

7.4.1.2 Area of crop loss

Actual and perceived areas of damage correspond with farmers' perceptions of crop vulnerability and tolerance towards some animals, especially large vertebrates and domestic livestock. Crops damaged over relatively large areas are considered vulnerable; maize, cassava, beans and rice. However, exceptions to this suggest other factors influence farmers' perceptions of risk: sweet potato is not considered vulnerable, whilst groundnuts are viewed as a risky crop despite a relatively small area of observed damage (see Section 7.4.3.2).

Vervet monkeys damaged large areas of crops across the four study sites more consistently than any animal except for cattle (mean ranking of area), and are correspondingly viewed as the worst crop raiding animal by farmers. Perceptions of baboons also reflect the area of crop damaged. Nevertheless, whilst perceptions of the area of crop damaged may correspond with tolerance towards crop raiding animals, these perceptions can be inaccurate. Despite damaging over twice as large an area of crop as any other animal, cattle are not viewed as extensive (area) raid animals, and are not generally considered a risk to crops. Similar attitudes towards livestock have been found in other studies (Naughton-Treves, 1997; Hill, 2004; Webber, 2006).

Perceptions of human-chimpanzee conflict are not associated with the area of crops damaged, or thought to be damaged. Chimpanzees are disliked, and are the most feared animal in the villages (Section 7.4.3.1) but they are not thought to damage large areas of crop. This concurs with the findings of McLennan and Hill (2012), but differs from similar studies (JGI/UWA, 2002a; Humle, 2003; Reynolds *et al*, 2003; Tweheyo *et al*, 2005), which suggest that a lack of tolerance towards chimpanzees is influenced by farmers' perceptions of crop damage by this primate.

7.4.1.3 Crop range

The number of crop types thought to be damaged by animals corresponds with farmers' attitudes towards crop raiding species, (as Priston, 2005; Webber, 2006; Marchal and Hill, 2009), although this does not necessarily reflect the variety of crop types that were actually damaged. Vervet monkeys, rats, baboons, chimpanzees and porcupines are all named as foraging on a wide variety of crops. Except for vervet monkeys and rats, most wild animals viewed as troublesome actually damaged fewer crop types than was thought. Equally, animals not viewed as particularly risky; domestic animals, wild birds and black and white colobus monkeys are thought to damage fewer crop varieties than was the case.

7.4.1.4 Crop characteristics

Perceptions of crop vulnerability can correspond to tolerance of particular crop raiding species (Warren, 2003). Thus farmers' perceptions of groundnuts as a vulnerable crop, despite little observed damage, appear to be linked with the belief that groundnuts are mostly damaged by rodents; animals which are viewed as a particular risk to crops. Nevertheless, as discussed in the previous section, beliefs about animal crop choice are not always accurate, and rodents actually foraged most frequently on sweet potato. Furthermore, beliefs about crop vulnerability or importance do not always mirror perceptions of crop raiding animals; cattle were responsible for almost two thirds of the total area of damage on cassava, which is considered the most important crop for households to cultivate. Despite comments by some farmers that cattle do damage cassava, these animals are not generally viewed as a threat to cassava or other crops.

The maturity of damaged crops can influence farmers' attitudes towards crops raiding animals. Most damage events by wild animals were on mature crops, whereas most damage events by domestic animals were on immature crops. Whilst the loss of immature crops represents a financial cost due to the repurchasing of seed (Tweheyo *et al*, 2005), and a labour cost due to replanting requirements (Hill, 1997), the loss of mature crops is particularly severe as farmers have little or no opportunity in the season to replace damaged crop (Hill, 2000). The loss of mature crop not only represents a wasted investment of time and labour, but results in households having no choice but to absorb any nutritional and/or financial loss. Vervet monkeys, viewed as the worst crop raiding animal, are thought by farmers to damage both immature and mature crops.

Plant parts damaged, or thought to be damaged, contribute to perceptions of risk for some crop raiding species. Vervet monkeys, rodents and baboons damaged energy rich plant parts such as maize cobs, sweet potato tubers, cassava tubers, and groundnut nuts. Black and white colobus monkeys, which are considered less problematic than most other large vertebrates, also foraged on maize cobs (more frequently than other plant parts), but are thought by farmers to 'only' damage cassava leaves. Similarly, chimpanzees are believed to forage mostly on fruit, which is viewed as less important than food or cash crops. Correspondingly, whilst chimpanzees are disliked by most farmers, they are not considered to be troublesome crop raiding animals.

7.4.2 Factors that indirectly affect crop loss

7.4.2.1 Control

Farmers' ability to control and manage animal behaviour affects tolerance levels for animal presence. This is similar to other studies (Gillingham and Lee, 2003; Hill, 2005; Webber, 2006).). Vervet monkeys, chimpanzees and baboons are viewed as particularly difficult to control, although baboons can apparently be chased by dogs. Similarly, porcupine, a nocturnal animal described as difficult to catch, is considered a greater risk to crops than damage levels would suggest (as Priston, 2005; Hill, 1997; Webber, 2006). Although chimpanzees are not viewed as extreme crop raiding animals, farmers are frightened of them and claim that chimpanzee presence modifies the behaviour of farmers and consequently other raid species, thereby indirectly impacting upon crop yields (as Campbell-Smith *et al*, 2010, but see McLennan and Hill, 2012). Farmers' inability to manage chimpanzee behaviour reduces tolerance of this animal.

Conversely, where crop raiding behaviour is viewed as more manageable or more preventable, animal species are considered less problematic, irrespective of loss. Thus, levels of tolerance for domestic animals are much higher than for wild animals. The ability to prevent livestock damage (e.g. by tying animals up) or ameliorate losses through financial or replanting schemes corresponds with the perception of livestock as a relatively small risk to crops, despite cattle damaging a larger area of crop than all large vertebrates together. This is consistent with other studies (Naughton-Treves, 1997; Hill, 2004; Warren *et al*, 2007). Similarly, farmers in Kiseeta consider that black and white colobus monkeys can be easily chased away, and do not recognise that this primate damages large areas of crop.

Around nearby BFR in Masindi District, wild birds were believed to forage at predicable times (Hill, 2005). This enabled the provision of crop protection during those times, and wild birds were not considered a troublesome crop raiding species. Although these opinions were not voiced in the Hoima District study sample, this could indicate why farmers at the four village sites do not view wild birds as a problem on crops, despite the high frequency of damage events and the relatively large area of damage recorded.

7.4.3 Factors external to crop loss

7.4.3.1 Fear for personal safety

Farmers' fear of personal injury reduces tolerance for animal presence, irrespective of actual or perceived levels of crop loss (as Campbell-Smith *et al*, 2010). Thus, tolerance for baboons and chimpanzees is low; baboons were described as aggressive and dangerous, (as Hill, 1997; Webber, 2006), and chimpanzees were named as the most feared animals at all village sites (as McLennan and Hill, 2012). Furthermore, a fear of chimpanzees is claimed by farmers to impact upon the welfare of the household, e.g. by reducing access to forest water supplies, or increasing workloads by necessitating children to be escorted to school to ensure their safety (as Hill and McLennan, 2012). Thus, any programme to reduce chimpanzee-farmer conflict needs to go beyond an examination of actual or perceived crop damage and address the wider concerns of farmers.

None of the most extreme activities ascribed to baboons and chimpanzees occurred during the study (e.g. chimpanzees raping women, or baboons confronting farmers). Nevertheless, most farmers show a willingness to believe that such behaviour is likely. The propensity to believe in such proactive and aggressive acts is most likely due to the size of the animal, the size of the visiting groups (particularly baboons) and their resistance to farmers' attempts at scaring them away (as Hill, 2000; Naughton-Treves and Treves, 2005; Webber, 2006; Campbell-Smith *et al*, 2010). Unfortunately, during the study two incidences of chimpanzee attacks on children did occur in Kiseeta (also see

McLennan and Hill, 2012). These attacks are likely to compound farmers' willingness to believe local stories about chimpanzees, both real and imagined, and amelioration schemes must address this or risk curbing farmers' willingness to participate in any conflict reduction programmes. Interestingly, a number of farmers who commented on the above incidents and a previous event near Wagaisa (Dwoli) suggested that chimpanzees were reacting aggressively to provocation, rather than initiating aggressive acts. Farmers postulated that the Kiseeta schoolchild who was snatched had been throwing stones at the chimpanzees, apparently a common occurrence (McLennan, 2010), and the boy whose nails were removed by a chimpanzee in Dwoli was reportedly attempting to seize its infant. Not all farmers view chimpanzees so sympathetically. Nevertheless, educational programmes could capitalise on this nascent thinking in order to increase local understanding of chimpanzee behaviour and develop local coping strategies.

7.4.3.2 Investment of labour

The level of investment needed to cultivate and guard crops influences farmers' perceptions of risk (as Naughton-Treves, 1997, 2001). In the Hoima District study sites the crops viewed as most vulnerable to crop raiding animals are also those that are said to demand the greatest investment of time and effort to cultivate, and also to guard; maize, groundnuts, beans and rice. Groundnuts, in particular, are viewed as laborious due to guarding requirements. In contrast, sweet potato is said to require little labour for cultivation and no investment in guarding. Correspondingly, groundnuts are considered vulnerable to crop raiding animals whilst sweet potato is not, irrespective of actual damage levels.

Most animals that damage, or are thought to damage labour intensive crops are viewed as troublesome, although this is not always the case; whilst birds are believed to forage mainly on rice, a crop viewed as tiresome to cultivate and to guard, they are not considered a particularly risky animal. Farmers' perceptions appear more strongly influenced by other factors.

Despite farmers' claims that guarding represents a large investment in the cultivation of crops, very little guarding was observed (as Hill and Wallace, 2012). As crop losses in the study sites are relatively low, the costs of investing time in guarding outweigh the benefits of preventing crop damage. Indeed, only two thirds of farmers said they guarded their crops. Thus, crop raiding events represent a 'double cost' to farmers; the cost of time spent guarding crops (Hill, 1997; Naughton-Treves, 1998), and the cost of losing crops. As a consequence, tolerance for animals that damage 'labour intensive' crops is lower than would be expected, given the degree of crop damage they cause. Indeed, when reviewed within the context of labour costs, it is likely that perceptions of conflict in this study appear *because* damage is low, i.e. labour intensive crops are already considered troublesome due to labour requirements (rather than crop raiding), and so damage to these crops serves to compound farmers' perceptions of conflict (also see Tweheyo *et al*, 2005). Therefore, conflict arises from the presence of low levels of crop damage *in proportion* to the investment of labour required, rather than from levels of crop damage alone.

7.4.3.3 Primate behaviour and morality

Tolerance of primates reflects the human values of morality that farmers ascribe to these animals (Hill and Webber, 2010). Whilst black and white colobus monkeys are not believed to be conscious that crop raiding is 'wrong', vervet monkeys and chimpanzees are thought to be aware of the immorality of their behaviour. This is likely to reduce tolerance of vervet monkey and chimpanzees crop raiding activities irrespective of the amount of crop lost to these animals (Webber, 2006).

In addition, the perception that chimpanzees understand and anticipate human behaviour and use this to execute more effective hunting and defensive strategies contributes to farmers' fear of chimpanzees and increases perceptions of conflict. This is similar to farmers' perceptions in other areas of Uganda, where baboons were described as calculating, intelligent and vindictive (Hill, 1997; Naughton-Treves, 1997; Hill and Webber, 2010).

7.4.3.4 Social and economic risks to households

Perceptions of crop vulnerability appear to be influenced by the reliability of crop yields, both as a source of income and as a kitchen garden crop, irrespective of actual levels of loss. For example, groundnuts, which are viewed as unreliable, are named as the crops most at risk of damage events by crop raiding animals, (alongside maize) despite relatively little observed damage during the study period. In contrast, cassava is not viewed as a vulnerable crop despite a large area of observed damage. This is most likely because cassava is considered to be a reliable, continuously available crop.

Perceptions of socio-economic and cultural impacts on the household also influence farmers' tolerance of wild animals. Although not observed during the study, farmers complained that baboons and chimpanzees take livestock. Losses of livestock represent a large financial and nutritional deficit to the household. Furthermore, as meat is a culturally valuable commodity and often only eaten on special occasions, the loss of livestock animals also represents a cultural impact as well as an economic one. Behaviour of this type by baboons and chimpanzees, be it real or perceived, is likely to shape farmers' perceptions of these primates as problematic animals.

7.4.3.5 Ability to mitigate socio-economic impacts of loss

The availability of compensatory procedures to mitigate the impact of crop damage by livestock is likely to have increased farmers' tolerance of livestock species (as Naughton-Treves, 1997; Hill, 2004; Warren *et al*, 2007). Systems of recompense are not only financial; one cattle owner in Kiseeta spent a morning replanting a neighbour's damaged sweet potato field under the direction of the village LC1 (pers. obs.). However, systems are not in place to reduce the impact of crop loss to wildlife. As chimpanzees are protected by law, farmers are prevented from dealing with chimpanzees by their own means. Similarly, farmers in Kihomboza III were advised that issues with 'problem' baboons should be referred to the local government wildlife officer (UWA), who would arrange for the animals to be shot (Kihomboza III farmer, pers. comm.). Farmers therefore consider that a reduction in the negative impact of wildlife on crops and people is the responsibility of the government (also see Naughton-Treves, 1997; Hill, 2004; Webber, 2006). Furthermore, Kihomboza III farmers complained that nobody came to remove the baboons, and expressed frustration that, not only did the local government not implement a system of recompense, but they were not managing the animals properly by removing them from the local area. This is similar to attitudes found around Kibale National Park (Naughton-Treves, 1997) and BFR (Hill, 2004), where the local government is seen to be a 'bad neighbour' for not taking responsibility for its own animals properly, as a neighbouring cattle farmer would do. This very likely helped to shape perceptions of chimpanzees and baboons as troublesome animals in Hoima District.

7.4.3.6 History and previous experience

Animals described as having been extremely destructive to crops in the past are often still viewed as more problematic than current levels of damage would otherwise suggest (as De

Boer and Baquette, 1998; Sitati *et al*, 2005; Woodroffe *et al*, 2005; Linkie *et al*, 2007; Sarasola *et al*, 2010). Baboons, porcupines and bush pigs are all described as historically numerous and very problematic. Despite baboons damaging crops in Kihomboza III only, a number of farmers in Kiseeta and Wagaisa ranked this primate as the most troublesome crop raiding animal. Porcupines and bush pigs are still viewed by some farmers as troublesome crop raiding animals even though little actual damage was recorded. In addition, farmers in Nyakamwaga are notably less tolerant of chimpanzee crop raiding than at other sites, despite only one crop raiding event having been recorded at the site. Historically, during the introduction of cocoa into Hoima District in the 1960s (Kayobyo *et al*, 2001) cocoa planting reportedly extended throughout the whole of Nyakamwaga and beyond, but was mostly abandoned due to extensive foraging by chimpanzees (Ndoleriire, pers. comm.). In contrast to the historical reputation of baboons, porcupines, bush pigs and chimpanzees, farmers believe that black and white colobus monkey foraging activity on crops is a recent development, which may explain why farmers are currently more prepared to tolerate it.

7.5 Summary

- Disease is perceived as the greatest risk to crops. This may be a measure of the relatively low level of actual crop loss to crop raiding animals in the Hoima village sites. Nevertheless, crop vulnerability is most immediately linked with crop raiding activity.

- Maize and groundnuts are viewed as the crops most at risk to crop raiding animals. Sweet potato is not considered risky to cultivate, despite being the most frequently raided crop and experiencing a relatively large area of damage.

- Vervet monkeys, squirrels and rats are viewed as the most problematic animals on crops. Domestic livestock, wild birds and black and white colobus are not viewed as problematic, despite the area of crop damaged by these animals.

- Farmers' perceptions of risk reflect the frequency of damage events (actual and perceived) more strongly than they reflect the area damaged, or thought to be damaged by crop raiding animals. This shows that frequent, persistent damage events can influence farmers' perceptions of conflict and should be considered when addressing human-wildlife conflict issues.

- Perceptions of crop raiding animals are most strongly shaped by the degree of difficulty in controlling and mitigating species' access to crops.

- Farmers' fear of personal injury reduces tolerance of animals' crop raiding behaviour, irrespective of actual or perceived levels of crop loss. Nevertheless, farmers' fear of chimpanzees is not associated with perceived levels of crop loss. Although chimpanzees are the most feared animal in the villages they are not thought to damage large areas of crop.

- The investment of labour required to cultivate and guard crops influences farmers' tolerance towards crop raiding animals. As crop losses in the study sites are relatively low, the costs of investing time in guarding outweigh the benefits of preventing crop damage, and so conflict arises from the presence of low level of crop damage *in proportion* to the investment of labour required, rather than from levels of crop damage alone.

- Primates are perceived to possess human values of morality, and farmers' tolerance of these animals reflects the degree to which primates are thought to adhere to or deviate from these values.

- The financial and agricultural reliability of crops, and the socio-economic and cultural impacts of damage events on households, affects farmers' perceptions of risk. The ability to mitigate the impact of damage events also influences perceptions of conflict.

8. DISCUSSION AND CONCLUSIONS

8.1 Introduction

It is increasingly understood that examining human-wildlife conflict from the human perspective is essential in identifying causes of conflict (Naughton-Treves, 1997; Siex & Struhsaker, 1999; Gillingham and Lee, 2003; Hill, 2004, 2005; Webber, 2006; Linkie *et al*, 2007; Dickman, 2010). This is because perceptions of conflict do not always arise from actual damage events but can originate from socio-economic, cultural or political issues external to any actual losses to wildlife and other animals (Naughton-Treves, 1997; Gillingham and Lee, 2003; Hill, 2004, 2005; Webber, 2006; Dixon *et al*, 2009; Dickman, 2010). Nevertheless, whilst a number of studies do explore local people's perceptions of conflict, examination of attitudes without comparison with actual damage events limits researchers' abilities to determine whether conflicts originate from actual situations or other sources. Comparison of both farmers' perceptions and actual levels of loss in the Hoima District study sites allowed for a more accurate identification of the origination of conflicts (see also Gillingham and Lee, 2003; Hill, 2004; Webber, 2006; Dickman, 2010). In doing so, this study revealed a number of issues particularly relevant to local people within the village study sites that can help to inform other studies of human-wildlife conflict in similar environments.

8.2 Issues relevant to human-wildlife conflict in the study sample

(1) Human-wildlife conflict in the Hoima District study sites is not strongly shaped by levels of actual or perceived crop loss, or impacts of loss. Whilst farmers are concerned about crop raiding, and attitudes are influenced by the financial and socio-economic impacts of loss, and by farmers' ability to access mitigation tools (as Hill, 2005; Dixon *et al*, 2009), the amount of actual or perceived crop loss is not a major cause of conflict. This is illustrated in several ways: i) the frequency of visits by animals appears to cause greater concern to farmers than the amount of crop lost to crop raiding species; ii) farmers do not plant strategically (i.e. palatable crops are not necessarily planted away from the forest-side of their farms); iii) few crop protection measures are employed, and farmers appear to view the costs of guarding as outweighing the benefits; iv) most farmers believe that farming next to the forest edge is preferable to farming further away, as they benefit from increased access to shade, water and better soil. This differs from farmers' attitudes in other study areas where levels of crop raiding are more significant. At these sites all

farmers would prefer to live further away from the forest edge (Naughton-Treves, 1997; Webber, 2006).

(2) As crop damage levels are low, and tolerance of animals is not strongly linked to crop loss, or the impacts of crop loss, amelioration techniques suggested in other studies of human-wildlife conflict are not appropriate for the Hoima District study sites. For example; guarding, buffer crops, trenches, alarms, lights, scents, netting, and dogs, (Hill, 1997; Naughton-Treves, 2001; Sillero-Zubiri and Switzer, 2001; Webber, 2006; Hill and Wallace, 2012), compensation schemes, jobs and revenue sharing, consumptive use of resources, tourism and community participation in crop protection schemes, (Maikhuri *et al*, 2000; Naughton-Treves, 2001; Bauer, 2003; Nyus *et al*, 2005; Webber, 2006). Whilst these mitigation tools may be a valuable part of the human-wildlife conflict reduction toolkit in areas where actual crop loss is a significant issue, in the Hoima District study sites such schemes will make little difference as there is little scope for reductions in the levels of crop loss. Worse, they would serve to focus farmers' attentions on crop raiding as a major source of conflict, and reinforce farmers' perceptions that the only way to reduce conflict is to modify wildlife crop raiding behaviour (also see Priston, 2005).

(3). Conflict between farmers and wildlife in the Hoima District villages is most strongly shaped by factors not directly connected to actual or perceived crop loss, or impacts of loss. Amelioration tools employed in the Hoima District study villages and similar sites should therefore pay particular attention to these external factors: i) a perceived lack of ability to control wildlife behaviour (as Naughton-Treves, 1997; Ezealor and Giles, 1997; Hill, 1998; Campbell-Smith *et al*, 2010); ii) fears for personal safety (as Webber, 2006; Campbell-Smith *et al*, 2010); iii) reduced tolerance relating to the degree of labour required for the cultivation and protection of crops (as Naughton-Treves, 1997; Hill, 2000); iv) expectations of primates to exhibit human values of morality (as Naughton-Treves, 1997; Hill, 2000; Hill and Webber, 2010);

(4). Differences between perceptions and actual conditions are not limited to issues of human-wildlife conflict; they also occur in the underlying agricultural environment within which human-wildlife conflict takes place. In the Hoima District study sites farmers claimed they invested time and effort in guarding crops. However, this was not observed. Thus, when examining human-wildlife conflict, assumptions of parity between stated and actual conditions within the agricultural background cannot be made as this will reduce the effectiveness of any amelioration tools employed to reduce conflict.

(5) Forest fragments of northern Hoima District are undergoing rapid deforestation for commercial timber, and farmers' perceptions of a lack of control regarding wildlife may be rooted in a greater sense of powerlessness with regard to controlling or modifying these changes in the local environment. Farmers state that timber extraction is affecting the micro-climate, reducing rainfall and degrading soil quality. They also complain of a reduction in the availability of firewood, poles for construction and medicines. In addition, farmers believe that the loss of forest wildlife habitat and feeding trees is forcing forest animals to forage more frequently on domestic crops (although, as farmers agree that overall numbers of forest wildlife have reduced, this has not increased overall frequency of visits or area of crop lost). However, farmers feel powerless to prevent this deforestation. Many timber extractions are undertaken by groups from outside the area, who reap the benefits but do not absorb the costs. They also "come with letters of introduction from the authorities" meaning that farmers "cannot say anything because we don't have the authority." In addition, programmes of timber extraction are also undertaken by local farmers with land next to the forest. Other farmers feel unable to object to these extractions as their neighbour will benefit from the revenue, something that most farmers would themselves take advantage of if they had access to the trees.

8.3 Appropriate amelioration techniques

Techniques to reduce perceptions of conflict in areas such as the Hoima District study sample, where levels of crop loss are low, should primarily address the relevant factors external to crop loss. Furthermore, amelioration methods that emphasise the actual and perceived levels and impacts of crop loss should be applied extremely carefully. Thus, whilst efforts to increase local understanding of wildlife behaviour is recommended, addressing issues such as access to mitigation tools, the improvement of cultivation skills, the limiting of unregulated timber extraction and the implementation of legal protection for private forests should also be a priority.

1) Establish practical steps to access the correct mitigation tools more efficiently.

Lack of access to, or lack of efficiency of, mitigation tools contribute to perceptions of conflict towards wildlife (Naughton-Treves, 1997; Maikuri *et al*, 2000). Standardised systems should be established within villages so that farmers can, firstly, identify the most appropriate tool with which to address their particular issue, and secondly, access it in a more efficient manner. These systems are already in place in so far as most villagers contact their LC1 village leader in the first instance, and recompense for crop damage by livestock is expected. However, systems should be more standardised and more transparent, and include, for example, a knowledge of local government responsibilities, procedures and contacts. Farmers should also be advised that the most appropriate mitigation tools may sometimes involve modifications to their own activities.

2) Provide best-practice information for crop cultivation and protection

The National Agricultural Advisory Service (NAADS) branch in Hoima District dispatches Agricultural Extension Officers (AEOs) to villages throughout the District to provide practical information to improve the cultivation of famers' crops. Most of the assistance they provide is in response to environmental and agricultural conditions such as weather conditions, soil quality, insect attacks and disease (Ndoleriire, AEO, pers. comm.). AEOs should be additionally trained in advising farmers about agricultural housekeeping in the light of farming alongside wildlife and other animals, such as where best to plant crops that farmers view as vulnerable to crop raiding animals, and how to invest labour most efficiently to protect crops from crop raiding animals (see Wallace, 2010).

3) Raise awareness of the benefits to farmers of preserving forests.

The loss of forests leads to degraded environments and reduced household welfare (Naughton-Treves and Weber, 2001; Bush *et al*, 2004; Mbow *et al*, 2008). Many farmers in Hoima District know the benefits of protecting their local forests, and in the recent past, environmental education programmes advocating forest conservation were reportedly implemented. However, according to one Wagaisa farmer, this has since stopped, and "now people don't care." Wider and more regulated access to information about the economic, environmental and household benefits of forest conservation should be re-established, in tandem with community forest conservation initiatives that emphasise these benefits.

4) Raise awareness of the benefits to farmers of wildlife.

Raising awareness of the benefits of wildlife to local people may help to increase tolerance levels. In the study sites, a number of farmers recounted information heard on local radio broadcasts that baboons, vervet monkeys and chimpanzees should not be killed as they are responsible for dispersing the seeds of forest trees. However, the types of potential benefits suggested must be examined carefully. Ecotourism is inappropriate in the Hoima District study sample as habituation of wildlife in this human-dominated landscape could lead to increased negative interactions between wild animals and local people (McLennan and Hill, 2010). Furthermore, a loss of fear of humans could actually increase the frequency of damage events (McLennan and Hill, 2010). In addition, benefit schemes based on access to wild meat are not applicable in the study sites as; i), local people do not traditionally consume wild meat, with the exception of bush pig, and ii) local populations of bush pigs are unlikely to support organised extraction. Most farmers considered that bush pigs had already been hunted to extinction in the area. Furthermore, it should not be assumed that increased local awareness of the benefits of wildlife will heighten tolerance for wildlife presence. This is not always the case (Walpole and Goodwin, 2001).

5) Increase local understanding of animals through knowledge.

Increasing farmers' understanding of wild animals may increase tolerance levels (Siex and Struhsaker, 1999; Bauer, 2003; Marker and Dickman, 2004; Ormsby and Kaplin, 2005; Lee and Priston, 2005; Lagendijk and Gusset, 2008; Campbell-Smith *et al*, 2010). In addition to the ecology, behaviour, ecological niche and endemic nature of wildlife species, emphasis should be placed on addressing the negative perceptions of farmers that contribute to human-wildlife conflict, such as notions of a lack of control of crop raiding animals, the attribution of human values to primates, fear of chimpanzees and baboons, and attitudes based on historic activities of wildlife. As discussed in Chapter 7 (section 7.4.3.1), a number of farmers consider that chimpanzee aggression is reactive rather than proactive, which may indicate a receptiveness to learn more about these animals. In addition, farmers in the Hoima district study sites did show an interest in the intrinsic value of forest wildlife. One farmer commented that chimpanzees are good to look at because they look like humans, and another remarked that the loss of forest wildlife would be a disadvantage to children as they will have to rely on stories about such animals without being able to see them (also see McLennan and Hill, 2012).

6) Legal provision

Despite acknowledgement of the benefits of forest on crops and on the local environment, as described above, a number of farmers who 'own'[33] areas of forest opted for short term gain at the expense of long term benefits (also see Robertson and Lawes, 2005). This is to be expected. As Hill (2002) argued regarding the conservation of primates; where development opportunities arise that promise to give a better return than the conservation alternative, given the likely pressures on farmers they cannot not be expected to reject these opportunities. Consequently, political policy is needed to underpin a programme of education. Unfortunately, this involves navigating around a combination of national guidelines, local by-laws, traditional customary law (Hartter and Ryan, 2010), a lack of facilities to implement and monitor laws, and the possibility of local level corruption. Nevertheless, as it is unrealistic to expect farmers' perceptions of conflict to be reduced by education alone, this legal framework is necessary in order to address some of the causes of perceived conflicts.

8.4 Application of amelioration techniques

8.4.1 Programmes in schools

Environmental educational programmes should be a permanent part of the school curriculum. Given the degree of knowledge regarding Uganda's wildlife as encountered by the researcher when conversing with people educated to at least secondary school level, it is clear that teaching children about the local environment and wildlife is not currently a priority.

8.4.2 Village meetings

Village meetings chaired by the LC1 Village Leader provide the main opportunity for villagers to meet and discuss local issues. These can also serve as a suitable place for educational information about wildlife and farming systems to be disseminated and discussed. LC1s should be regularly briefed and provided with information regarding human-wildlife conflict issues. In addition, feedback systems to local government and environment organisations should be established and encouraged in order to raise awareness about the main issues of concern for both villagers and environment personnel.

[33]Farmers often perceive ownership rights of public forests, which cannot be owned, due to customary law and by simply residing next to the forest (Harrter and Ryan, 2010).

8.4.3 Programmes on local radio broadcasts

Educational information broadcast on local radio stations has already been affective in Hoima District. This system should be used to full advantage to reach as many people as possible. However, care must be taken to avoid exacerbating perceptions of powerlessness and entrenching opinion; one farmer recounted information heard on a local radio broadcast that advised farmers not to kill chimpanzees. When asked why she thought this was the case, she replied, “Who knows? Because they are liked so much by Europeans.”

8.4.4 Village workshops

Similar to the outreach service provided by AEOs (section 8.3.1), a system of village-based educational programmes and workshops could be implemented by the office of the District Environmental Officer (DEO). However, a lack of finances is likely to limit this scheme; during the study, the office of the DEO expressed frustration that enforcement of current environmental protection laws was difficult due to a lack of manpower and facilities (pers. comm.). Nevertheless, a collaborative project between the offices of the DEO, DFO, NFA and/or UWA might be more able to supply a co-ordinated programme of outreach workshops, provided that the collaborative members remained active, participatory and mindful of the collaboration objectives.

8.4.5 Government activities

Visits and inspections by local and national government bodies charged with upholding legal protection for forests should take place more frequently and without notice. Greater facilities should be diverted into the DEO to enable more frequent monitoring of forest fragments, and the more efficient removal of illegal pit-sawing camps and gin distilleries.

8.5 Further research

A more detailed study of the socio-economic conditions of farmers in relation to their attitudes towards wildlife and crop cultivation is recommended to more closely identify which factors external to crop loss most strongly influence perceptions of conflict. In addition, a review of farmers’ attitudes towards wildlife in the four villages after the implementation of recommended amelioration techniques would help to identify which amelioration techniques were most successfully applied, and which, if any, served to reduce perceptions of human-wildlife conflict.

8.6 Conclusion

Whilst farmers' attitudes towards animals at the Hoima District study sites are most strongly shaped by factors external to crop loss, or impacts of loss, there is no single factor that influences farmers' perceptions (as Dickman, 2010). Nevertheless, the causes of conflict differ from those seen at other research sites, especially sites where greater areas of crop are damaged. This illustrates that human-wildlife conflict situations must be reviewed on a case by case basis (Hill, 2000), and any strategies implemented must be site specific. Whilst there is no 'one size fits all' method of reducing farmers' perceptions of conflict in developing countries, the Hoima District study sample highlights some particular issues that could inform similar conflict situations elsewhere.

- In situations where there is very little actual crop loss, it cannot be assumed that the causes of human-wildlife conflict can wholly be addressed by tools based on reducing the impacts of crop loss, even indirectly. Inappropriate application of these tools runs the risk of focusing farmers' frustrations onto crop raiding activities and actually exacerbating conditions.

- It should not be presumed that differences between actual and perceived conditions are limited to issues of human-wildlife conflict. An assumption that farmers' assertions of the underlying agricultural conditions mirror actual activities will reduce the accuracy of amelioration suggestions.

- Whilst community outreach schemes and educational tools are important in influencing perceptions of forests and wildlife, farmers cannot be expected to always opt for the most conservation–friendly option voluntarily. The implementation and/or application of laws to prevent environmental degradation can assist, thus producing an 'educational carrot and legal stick' system.

Given the rate of deforestation in northern Hoima District, it is likely that these recommendations come too late to be really effective at this site. Nevertheless, this work may help to inform strategies in similar sites elsewhere.

REFERENCES

Alvarez N. and Naughton-Treves L. (2003). Linking national agrarian policy to deforestation in the Peruvian Amazon: A case study of Tambopata, 1986-1997. *Ambio* 32: 269-274.

Africover, Food and Agriculture Organisation of the United Nations. Retrieved 2011 from http://www.africover.org/index.htm

Ambarli, H., Bilgin, C. C. (2008). Human-brown bear conflicts in Artvin, northeastern Turkey: Encounters, damage, and attitudes. *URSUS* 19(2): 146–153.

Arlet, M. E. and Molleman, F. (2007). Rodents damage crops more than wildlife in subsistence agriculture on the northern periphery of Dja Reserve, Cameroon. *International Journal of Pest Management.* 53(3): 237–243.

ASA (1999). *Ethical guidelines for good research practice*. Association of Social Anthropologists of the UK and the Commonwealth (online) Retrieved 28th July 2011 from: http://www.theasa.org/ethics/guidelines.shtml.

Auren, R. and Krassowska, K. (2004). *Small and medium forest enterprise in Uganda*. Uganda Forest Sector Co-ordination Secretariat, Ministry of Water, Lands and Environment, Kampala, in collaboration with International Institute for Environment and Development

Avery, M. L. (1989). Experimental evaluation of partial repellent treatment for reducing bird damage to crops. *Journal of Applied Ecology* 26: 433-439

Barbier, E. B. (1987). *Cash crops, food crops and agricultural sustainability.* International Institute for Environment and Development, Gatekeeper series No2.

Barirega, A., Buyinza, M., Kansiime, F. and Basuta-Isabirye, G. (2010). The Effects of Crop Raiding on Household Food Security in the Albertine Rift: A Case Study of Queen Elizabeth National Park, Western Uganda. *Human Dimensions of Wildlife* 15: 45-54.

Bauer, H. (2003). Local perceptions of Waza National Park, northern Cameroon. *Environmental Conservation* 30(2): 175-181

Beattie, J. (1971). *The Nyoro State*. Oxford University Press, London.

Belant, J. L., Ickes, S. K., Tyson, L. A. and Seamans, T. W. (1997). Comparison of four particulate substances as wildlife feeding repellents. *Crop Protection* 16(5): 439-447.

Bisi, J., Kurki, S., Svensberg, M., and Liukkonen, T. (2007). Human dimensions of wolf (*Canis lupus*) conflicts in Finland. *European Journal of Wildlife Research* 53(4): 304–314.

Blair, J. A. S., Boon, G. G. and Noor, N. M. (1979). Conservation or cultivation: the confrontation between the Asian elephant and land development in Peninsular Malaysia. *Land Development Digest* 21(1): 25-58.

Bryman, A. (2001). *Social research methods*. Oxford University Press.

Bush, G., Nampindo, S., Aguti, C. and Plumptre, A. (2004). *The value of Uganda's forests: a livelihood and ecosystems approach.* WCS/ EU Forest Resources and Conservation Programme/ NFA.

Campbell, B. (2000). Animals behaving badly; indigenous perceptions of wildlife protection in Nepal. In Knight, J. (Ed) *Natural Enemies; people-wildlife conflicts in anthropological perspective.* London and New York: Routledge, pp.124-144.

Campbell-Smith, G., Simanjorang, H. V. P., Leader-Williams, N., and Linkie, M. (2010). Local attitudes and perceptions toward crop-raiding by orangutans (*Pongo abelii*) and other nonhuman primates in northern Sumatra, Indonesia. *American Journal of Primatology* 72(10): 866-76.

Caughley, G. and Gunn, A. (1996). *Conservation biology in theory and practice.* Cambridge, Massachusetts: Blackwell Science Inc.

Chapman C. and Lambert, J. (2000). Habitat alternation and the conservation of African primates: Case study of Kibale National Park, Uganda. *American Journal of Primatology* 50: 169-185.

Chauhan, A. and Pirta, R. S. (2010). Public Opinion Regarding Human-Monkey Conflict in Shimla, Himachal Pradesh. *Journal of Human Ecology* 30(2): 105-109.

Choudhury, A. (2004). Human-elephant conflicts in Northeast India. *Human Dimensions of Wildlife* 9(4): 261-270.

Conte, C. A. (1999). The forest becomes a desert: forest use and environmental change in Tanzania's West Usambara Mountains. *Land Degradation and Management* 10: 291-309.

Danquah, E., Oppong, S. K. and Sam, M. K. (2006). Aspects of elephant crop raiding behaviour in the Kakum Conservation Area, Ghana. *Flora and Faune* 21(2): 15–19.

De Boer, W. F. and Baquete, D. (1998). Natural resource use, crop damage, and attitudes of rural people in the vicinity of the Maputo Elephant Reserve, Mozambique. *Environmental Conservation* 25(3): 208 – 218.

de Freitas, C. H., Setz, E. Z. F., Araújo, A. R. B. and Gobbi, N. (2008). Agricultural crops in the diet of bearded capuchin monkeys, *Cebus libidinosus Spix* (Primates: Cebidae), in forest fragments in southeast Brazil. *Revista Brasileira de Zoologia* 25(1): 32-39.

Dickman, A. J. (2010). Complexities of conflict: the importance of considering social factors for effectively resolving human-wildlife conflict. *Animal Conservation* 13: 458-466.

Dixon, A. B., Hailu, A., Semu, T., and Taffa, L. (2009). Local responses to marginalisation: human-wildlife conflict in Ethiopia's wetlands. *Geography* 94: 38-47.

Engeman, R. M., Laborde, J. E., Constantin, B. U., Shwiff, S. A., Hall, P., Duffiney, A. and Luciano F. (2010). The economic impacts to commercial farms from invasive monkeys in Puerto Rico. *Crop Protection* 29: 401–405.

Ezealor, A. U., and Giles JR, R. H. (1997). Vertebrate pests of a Sahelian wetland agro-ecosystem: perceptions and attitudes of the indigenes and potential management strategies. *International Journal of Pest Management* 43(2): 97-104.

Field, A. (2009). Discovering statistics using SPSS, third edition. SAGE Publications Ltd, London.

Gadd, M. E. (2005). Conservation outside of parks: attitudes of local people in Laikipia, Kenya. *Environmental Conservation* 32(1): 50-63.

Gillingham, S., and Lee, P. C. (1999). The impact of wildlife-related benefits on the conservation attitudes of local people around the Selous Game Reserve, Tanzania. *Environmental Conservation* 26(3): 218-228.

Gillingham, S., and Lee, P. C. (2003). People and protected areas: a study of local perceptions of wildlife crop-damage conflict in an area bordering the Selous Game Reserve, Tanzania. *Oryx* 37(3): 316-325.

Goldman, A. C. (1987) Agricultural pests and the farming system: a study of pest hazards and pest management by small-scale farmers in Kenya. In Tait, J. and Napompeth, B. (Eds) *Management of Pests and Pesticides, Farmers' Perceptions and Practices.* Boulder and London: Westview Press, pp.117-131.

Graham, K., Beckerman, A. P. and Thirgood, S. (2005). Human-predator-prey conflicts: ecological correlates, prey losses and patterns of management. *Biological Conservation* 122 (2): 159-171.

Hakiza, J. J., Kanzikwera, R. C. and Kakuhenzire, R. M. (2001). Solanum potatoes (*Solanum tuberocum spp.* in Mukiibi, J.K. (Ed) *Agriculture in Uganda, Vol II, Crops*. NARO, Kampala: Fountain Publishers Ltd, pp.252-278.

Happold, D.C. D. (1995). The interactions between humans and mammals in Africa in relation to conservation: a review. *Biodiversity and Conservation* 4:395-414.

Hartter, J. and Ryan, S. J. (2010). Top-down or bottom up? Decentralization, natural resource management and usufruct rights in the forests and wetlands of western Uganda. *Land Use Policy* 27: 815-826.

Hazzah, L., Mulder, M. B., and Frank, L. (2009). Lions and Warriors: Social factors underlying declining African lion populations and the effect of incentive-based management in Kenya. *Biological Conservation* 142 (11): 2428-2437.

Hill, C. M. (1997). Crop-raiding by wild vertebrates: the farmer's perspective in an agricultural community in western Uganda. *International Journal of Pest Management* 43(1): 77-84.

Hill, C. M. (1998). Conflicting attitudes towards elephants around the Budongo Forest Reserve, Uganda. *Environmental Conservation* 25(3): 244-250.

Hill, C. M. (2000). Conflict of interest between people and baboons: crop raiding in Uganda. *International Journal of Primatology* 21(2): 299-315

Hill, C. M. (2002). Primate conservation and local communities - ethical issues and debates. *American Anthropologist* 104(4): 1184-1194.

Hill, C. M. (2004). Farmers' perspectives of conflict at the wildlife-agriculture boundary: some lessons learned from African subsistence farmers. *Human Dimensions of Wildlife* 9(4): 279-286.

Hill, C. M. (2005). People, crops and primates: a conflict of interests. In Paterson, J. D. and Wallis, J. (Eds) *Commensalism and conflict, the human-primate interface*. Norman, Oklahoma: American Society of Primatologists, pp. 40-59.

Hill C.M., Osborne F.V., Plumptre A.J., (2002). *Human-Wildlife Conflict: Identifying the Problem and Possible Solutions.* Albertine Rift Technical Reports Series Vol. 1. Wildlife Conservation Society.

Hill, C. M. and Webber, A. D. (2010). Perceptions of nonhuman primates in human-wildlife conflict scenarios. *American Journal of Primatology* 72(10): 919-924.

Hill, C. M. and Wallace, G. (2012). Crop protection and conflict mitigation: reducing the costs of living alongside non-human primates. *Biodiversity Conservation* 21(10): 2569-2587.

Hockings, K. J. (2007). *Human-chimpanzee coexistence at Bossou, the Republic of Guinea: A chimpanzee perspective.* PhD thesis. Department of Psychology, University of Stirling, Stirling.

Hockings, K. J. (2009). Living at the interface Human-chimpanzee competition, coexistence and conflict in *Africa Interaction Studies* 10(2): 183-205.

Hockings, K. J., Yamakoshi, G., Kabasawa, A. and Matusuzawa T. (2010). Attacks on local persons by chimpanzees in Bossou, Republic of Guinea: long term perspectives *American Journal of Primatology* 72: 887–896.

Holmern, T., Nyahongo, J., and Roskaft, E. (2007). Livestock loss caused by predators outside the Serengeti National Park, Tanzania *Biological Conservation* 135(4): 518-526.

Howard P.C., Davenport T. R. B., Kigenyi F. W., Viskanic P., Baltzer M. C., Dickinson C. J., Lwanga J., Matthews R. A. and Mupada E. (2000). Protected Area Planning in the Tropics: Uganda's national system of Forest Nature Reserves. *Conservation Biology* 14: (3) 858-875.

Humle, T. (2003). Chimpanzees and crop raiding in West Africa. In Kormos, R., Boesch, C., Bakarr, M. I. and Butynski, T. (Eds) *West African chimpanzees. Status survey and conservation action plan*. IUCN/SSC Primate Specialist Group, Gland, Switzerland and Cambridge, pp 147-150.

Infield, M. and Namara, A. (2001). Community attitudes and behaviour towards conservation: an assessment of a community conservation programme around Lake Mburo National Park, Uganda. *Oryx* 35 (1): 48-60.

IUCN (2008). *Red List of Threatened Species.* International Union for Conservation of Nature (online). Retrieved 6th August 2010 from http://www.iucnredlist.org/

JGI/UWA (2002a). *Investigation into the human-chimpanzee conflict in Hoima District*. Jane Goodall Institute/Uganda Wildlife Authority.

JGI Uganda/UWA (2002b). *Hoima workshop report*. Jane Goodall Institute/ Uganda Wildlife Authority.

Jones, B.T. B. and Elliot, W. J. (2006). Human wildlife conflict in Namibia: experiences from a portfolio of practical solutions. *Nature and Faune* 21(2): 20-24.

Kagoro-Rugunda, G. (2004). Crop raiding around Lake Mburo National Park, Uganda. *African Journal of Ecology* 42: 32-41

Kayobyo, G., Hakiza, G. J. and Kucel, P. (2001). Cocoa *Theobroma cacao.* In Mukiibi, J.K. (Eds) *Agriculture in Uganda, Vol II, Crops.* National Agricultural Research Organisation, Fountain, Kampala, Uganda, pp 462–486.

Kemp, J. H. (1984). Producing data. In Ellen, R. F. (Ed) *Ethnographic Research, a guide to general conduct*. Academic Press, London, pp. 221-236.

Kideghesho, J.R., Roskaft, E. and Kaltenborn, B.P. (2007). Factors influencing conservation attitudes of local people in Western Serengeti, Tanzania *Biodiversity and Conservation* 16(7): 2213–2230.

King, L. E., Lawrence, A., Douglas-Hamilton, I. and Vollrath, F (2009) Beehive fence deters crop raiding elephants *African Journal of Ecology* 47(2): 131-137.

Kingdon, J. (2004) The Kingdon pocket guide to African mammals. A&C Black, London.

Knight, J. (2000). Introduction. In Knight, J. (Ed) *Natural Enemies; people-wildlife conflicts in anthropological perspective*. Routledge, London and New York, pp.1-35.

Kwesiga, P (2011). *Hoima farmers reap big from rice growing*. New Vision (online). Retrieved 31st July 2011 from http://enteruganda.com/ brochures/westug01.html.

LaFleur, M. and Gould, L. (2009). Feeding outside the forest: the importance of crop raiding and an invasive weed in the diet of gallery forest ring-tailed lemurs (*Lemur catta*) following a cyclone at the Beza Mahafaly Special Reserve, Madagascar. *Folia Primatol*. 80: 233-246.

Lagendijk, D. D. G. and Gusset, M. (2008). Human-carnivore coexistence on communal land bordering the Greater Kruger Area, South Africa. Environmental Management 42(6): 971-976.

Laudati, A. A. (2010). The encroaching forest: struggles over land and resources on the boundary of Bwindi Impenetrable National Park, Uganda. *Society and Natural Resources* 23(8): 776-789.

Lee, P. C. and Priston, E.C. (2005). Human attitudes to primates: perceptions of pests, conflict and consequences for primate conservation in *Commensalism and conflict: the human-primate interface.*

Linkie, M., Dinata, Y., Nofrianto, A. and Leader-Williams, N. (2007). Patterns and perceptions of wildlife crop raiding in and around Kerinci Seblat National Park, Sumatra. *Animal Conservation* 10: 127–135.

Madhusudan, M. D. (2003). Living amidst large wildlife: livestock and crop depredation by large mammals in the interior villages of Bhadra Tiger Reserve, South India. *Environmental Management* 31 (4): 466-475.

Maikhuri, R. K., Nautiyal, S., Rao, K. S., Chandrasekhar, K., Gavali, R. and Saxena, K. G. (2000). Analysis and resolution of protected area-people conflicts in Nanda Devi Biosphere Reserve, India. *Environmental Conservation* 27(1): 43-53.

Maikhuri, R. K., Nautiyal, S., Rao, K. S. and Saxena, K. G. (2001). Conservation policy - people conflicts: a case study from Nanda Devi Biosphere Reserve (a World Heritage Site), India. *Forest Policy and Economics* 2: 355 – 365.

Manfredo, M. J. and Dayer, A. A. (2004). Concepts for exploring the social aspects of human-wildlife conflict in a global context *Human Dimensions of Wildlife* 9 (4): 317-328.

Marchal, V. and Hill, C. M. (2009). Primate crop raiding: a study of local perceptions in four villages in northern Sumatra, Indonesia. *Primate Conservation* 24: 107-116.

Marker, L. and Dickman, A. (2004). Human aspects of cheetah conservation: lessons learned from the Namibian farmlands. *Human Dimensions of Wildlife* 9: 297-305.

Mbow, C. Mertz, O., Diouf, A., Rasmussen, K, and Reenberg, A. (2008). The history of environmental change and adaptation in eastern Saloum, Senegal; driving forces and perceptions. *Global and Planetary Change* 64: 210-221.

McLennan, M. (2008). Beleaguered chimpanzees in the agricultural district of Hoima, western Uganda. *Primate Conservation* 23: 45–54.

McLennan, M. (2010). *Chimpanzee ecology and interactions with people in an unprotected human-dominated landscape at Bulindi, western Uganda*. PhD thesis. Department of Anthropology and Geography, Oxford Brookes University, Oxford.

McLennan, M. and Hill, C. M. (2010). Chimpanzee responses to researchers in a disturbed forest-farm mosaic at Bulindi, western Uganda. *American Journal of Primatology* 72: 907-918.

McLennan, M. and Hill, C. M. (2012). Troublesome neighbours: changing attitudes towards chimpanzees (*Pan troglodytes*) in a human-dominated landscape in Uganda. *Journal for Nature Conservation* 20: 219-227.

Mishra (1997) Livestock predation by large carnivores in the Indian trans-Himalaya: conflict perceptions and conservation prospects. *Environmental Conservation* 24(4): 338–343.

Mubiru, A. (2005). *BATU angers farmers.* New Vision (online). Retrieved 31st July 2011 from http://www.newvision.co.ug/D/8/220/417934.

Muwanga, J. F. S., Auditor General (2010). *Environmental audit report on forestry activities in Uganda*. Office of the Auditor General, Uganda. Kampala.

Muwanga, R.O. M., Ocitti p' Obwoya, C.N., Odongo, B. and Turyamureeba, G.M. (2001). Sweet potato *Pomoea batatas* In Mukiibi, J.K. (Eds) *Agriculture in Uganda, Vol II, Crops*., National Agricultural Research Organisation, Fountain, Kampala, Uganda, pp 233-251.

MWLE (2002). *The National Forest Plan*. Ministry of Water, Lands and Environment, PO Box 27314, Kampala, Uganda.

Nabeta, N. and Wetala, M. P. E. (2001). Sugar cane *Saccharum officiuarum* In Mukiibi, J.K. (Eds). *Agriculture in Uganda, Vol II, Crops*. National Agricultural Research Organisation, Fountain, Kampala, Uganda, pp 487–499.

Naughton-Treves, L. (1997). Farming the Forest Edge: Vulnerable Places and People around Kibale National Park, Uganda. *The Geographical Review* 87(1): 27–46.

Naughton-Treves, L. (1998) Predicting Patterns of Crop Damage by Wildlife around Kibale National Park, Uganda. *Conservation Biology* 12(1): 156 – 168.

Naughton-Treves, L. (2001). Farmers, wildlife and the forest fringe. In Weber, W., White, L. J. T., Vedder, A. and Naughton-Treves, L. (Eds) *African rainforest ecology and conservation.* Yale University Press, New Haven and London, pp 369-384.

Naughton-Treves, L., Treves, A., Chapman, C. and Wrangham R. (1998). Temporal patterns of crop-raiding by primates: linking food availability in croplands and adjacent forest *Journal of Applied Ecology* 35(4): 596-606.

Naughton-Treves, L. and Weber, W. (2001). Human dimensions of the African rain forest. In Weber, W., White, L. J. T., Vedder, A. and Naughton-Treves, L. (Eds) *African rainforest ecology and conservation.* Yale University Press, New Haven and London, pp 30-43.

Naughton-Treves, L. and Treves A. (2005). Socio-ecological factors shaping local support for wildlife: crop-raiding by elephants and other wildlife in Africa. In Woodroffe, R., Thirgood, S. and Rabinowitz, A. (Eds) *People and wildlife; conflict or coexistence?* Cambridge: Cambridge University Press, pp. 252-277.

NEMA (1998). *District Environment Profile, Hoima*. National Environment Management Authority (online). Retrieved 2005 from: http://www.nemaug.org/index.php.

NEMA (2008). *State of the Environment Report for Uganda, 2008*. National Environment Management Authority, Kampala, Uganda.

NFA (2005). *Uganda's forests, functions and classification*. National Forest Authority, Kampala, Uganda

Nsambu, H (2008). *BAT orderd to pay farmers sh3b*. New Vision (online). Retrieved 31st July 2011 from http://www.newvision.co.ug/D/8/13/636265/hoima%20tobacco.

Ntow, W.J., Drechsel, P., Botwe, B.O., Kelderman, P. and Gijzen, H.J. (2008). The impact of agricultural runoff on the quality of two streams in vegetable farm areas in Ghana *Journal of Environmental Quality* 37 (2)**:** 696-703.

Nyus, P. J., Osofsky, S. A., Ferraro, P., Madden, F. and Fischer, H. (2005). Bearing the costs of human-wildlife conflict: the challenges of compensation schemes. In Woodroffe, R., Thirgood, S. and Rabinowitz, A. (Eds) *People and wildlife; conflict or coexistence?* Cambridge: Cambridge University Press, pp. 107-121.

Ocitti p' Obwoya, C. N. (2001). Yams (*Dioscorea ssp*) in Mukiibi, J.K. (Ed) *Agriculture in Uganda, Vol II, Crops*. National Agricultural Research Organisation, Fountain, Kampala, Uganda, pp.229-232.

Odomel, J. (2006). *BATU Hoima crop production doubles*. New Vision (online). Retrieved 31st July 2011 from http://www.newvision.co.ug/D/8/220/523065/hoima%20tobacco.

Ogra, M. V. (2008). Human-wildlife conflict and gender in protected area borderlands: A case study of costs, perceptions, and vulnerabilities from Uttarakhand (Uttaranchal), India. *Geoforum* 39(3): 1408–1422.

Osborn, F. V. and Hill, C. M. (2005). Techniques to reduce crop loss: human and technical dimensions in Africa. In Woodroffe, R., Thirgood, S. and Rabinowitz, A. (Eds) *People and wildlife; conflict or coexistence?* Cambridge: Cambridge University Press, pp. 72-85.

Otim-Nape, G.W., Semakula, G.N., Bua, A., Baguma, Y. K. and Ogwal, S. (2001). Cassava *Manihot esculenta* In Mukiibi, J.K. (Eds) *Agriculture in Uganda, Vol II, Crops.* National Agricultural Research Organisation, Fountain, Kampala, Uganda, pp 194–228.

Ormsby, A. and Kaplin, B. A. (2005). A framework for understanding community resident perceptions of Masoala National Park, Madagascar. *Foundation for Environmental Conservation* 32(2): 156-164.

Parker, G. E. and Osborn, F. V. (2006). Investigating the potential for chilli Capsicum spp. to reduce human-wildlife conflict in Zimbabwe. *Oryx* 40(3): 343-346.

Paterson, J. D. (2005). Primate and Human Interaction in Masindi District, Uganda. In Paterson, J. D. and Wallis, J. (Eds) *Commensalism and conflict: the human-primate interface.* Norman, Oklahoma: American Society of Primatologists, pp. 77-89.

Peine, J. D. (2001). Nuisance bears in communities: strategies to reduce conflict. *Human Dimensions of Wildlife* 6: 223-237.

Plumptre A.J., Cox D., Mugume S. (2003a). *The Status of Chimpanzees in Uganda*. Albertine Rift Technical Reports Series, Number 2. Wildlife Conservation Society, New York.

Plumptre, A. J., Arnold, M., Nkuutu, D. (2003b). *Conservation Action Plan for Uganda's Chimpanzees 2003-2008*. Uganda Wildlife Authority.

Priston, N. E. C. (2005). *Crop-Raiding by Macaca Ochreata Brunnescens in Sulawesi: Reality, Perceptions and Outcomes for Conservation.* PhD thesis. Department of Biological Anthropology, University of Cambridge

Priston, N. E. C. (2009). Exclosure plots as a mechanism for quantifying damage to crops by primates. *International Journal of Pest Management* 55(3): 243-249

Quinn, C. H, Huby, M., Kiwasila, H. and Lovett, J. C. (2003) Local perceptions of risk to livelihood in semi-arid Tanzania *Journal of Environmental Management* 68: 111-119.

Reardon, T., Barrett, C. Kelly, V. and Savadogo, K. (1999). Policy reforms and sustainable agricultural intensification in Africa. *Development Policy Review* 17: 375-395.

Reynolds, V., Wallis, J. and Kyamanywa, R. (2003). Fragments, sugar and chimpanzees in Masindi District, western Uganda. In Marsh, L.K. (Ed), *Primates in fragments: ecology and conservation.* Kluwer Academic/Plenum Publishers, New York, pp 309-320.

Reynolds, V. (2005). *The chimpanzees of the Budongo Forest*. Oxford University Press.

Riley, E. P. and Priston, N. E. C. (2010). Macaques in Farms and Folklore: exploring the human-nonhuman primate interface in Sulawesi, Indonesia. *American Journal of Primatology* 72: 848–854.

Robertson, J. and Lawes, M. J. (2005). User perceptions of conservation and participatory management of iGxalingenwa forest, South Africa. *Environmental Conservation* 32(1): 64-75.

Romanach, S. S., Lindsey, P.A. and Woodroffe, R. (2007). Determinants of attitudes towards predators in central Kenya and suggestions for increasing tolerance in livestock dominated landscapes *Oryx* 41(2): 185–195.

Saj, T. L., Sicotte, P. and Paterson, J. D. (2001). The conflict between vervet monkeys and farmers at the forest edge in Entebbe, Uganda. *East African Journal of Ecology* 39: 195–199.

Sarasola, J. H., Santillán, M. A. and Galmes, M. A. (2010). Crowned eagles rarely prey on livestock in central Argentina: persecution is not justified. *Endangered Species Research* 11: 207–213.

Schumann, M., Watson, L.H. and Schumann, B.D. (2008). Attitudes of Namibian commercial farmers toward large carnivores: The influence of conservancy membership. *South African Journal of Wildlife Research* 38(2): 123-132.

Sekhar, N. U. (1998). Crop and livestock depredation caused by wild animals in protected areas: the case of Sariska Tiger Reserve, Rajasthan, India. *Environmental Conservation* 25(2): 160-171.

Siex, K. S., and Struhsaker, T. T. (1999). Colobus monkeys and coconuts: a study of perceived human-wildlife conflicts *Journal of Applied Ecology* 36: 1009-1020.

Sillero-Zubiri, C. and Switzer, D. (2001). Crop raiding primates: searching for alternative, humane ways to resolve conflict with farmers in Africa. People and Wildlife Initiative. Wildlife Conservation Research Unit, Oxford University (online). Retrieved on 23rd September 2011 from www.peopleandwildlife.org.uk/crmanuals/CropRaidingPrimatesP&WManual.

Sitati, N., Walpole, M., Smith, J. and Leader-Williams, N. (2003). Predicting spatial aspects of human-elephant conflict. Journal of Applied Ecology 40: 667-677.

Sitati, N. W., Walpole, M. J. and Leader-Williams, N. (2005). Factors affecting susceptibility of farms to crop raiding by African elephants: using a predictive model to mitigate conflict. *Journal of Applied Ecology* 42: 1175–1182.

Sitati, N. W. and Walpole, M. J. (2006). Assessing farm-based measures for mitigating human-elephant conflict in Transmara District, Kenya. *Oryx* 40(3): 279-286.

Smith, K., Barrett, C. B. and Box, P. W. (2000) Participatory risk mapping for targeting research and assistance: with an example from east African pastoralists *World Development* 28: 1945-1959.

Strum, S. C. (2010). The Development of Primate Raiding: Implications for Management and Conservation. *International Journal of Primatology* 31: 133-156.

Stuart, C. and Stuart, T. (2000). *A field guide to the tracks and signs of Southern and East African wildlife.* Struik Publishers, Cape Town.

Sukumar, R. (1990). Ecology of the Asian elephant in southern India. II. Feeding habits and crop raiding patterns. *Journal of Tropical Ecology* 6: 33 – 53.

Taylor, B. K. (1969). The Western Lacustrine Bantu. In *Ethnographic Survey of Africa* Forde, D. (Ed) pp17-41. London, International African Institute.

Thapa, S. (2010). Effectiveness of crop protection methods against wildlife damage: A case study of two villages at Bardia National Park, Nepal. *Crop Protection* 29:1297–1304.

Thirgood, S., Woodroffe, R. and Rabinowitz A. (2005). The impact of human-wildlife conflict on human lives and livelihoods. In Woodroffe, R., Thirgood, S. and Rabinowitz, A. (Eds) *People and wildlife; conflict or coexistence?* Cambridge: Cambridge University Press, pp. 13-26.

Tweheyo, M., Hill, C. M. and Obua, J. (2005). Patterns of Crop Raiding by Primates around the Budongo Forest Reserve, Uganda *Wildlife Biology* 11(3): 237–246.

UBOS, (2007). Hoima District 2002 *Population and Housing Census Analytical Report*. Uganda Bureau of Statistics, Kampala, Uganda

UREC (2000). *Ethical standards for research involving human participants, Code of Practice.* Oxford Brookes University Research Ethics Committee, pp1-6.

Wallace, G. (2010). *Monkeys in maize: primate crop-raiding behaviour and developing on-farm techniques to mitigate human-wildlife conflict.* PhD thesis. Department of Anthropology and Geography, Oxford Brookes University, Oxford.

Warren, Y. (2003). *Olive Baboons (Papio cynocephalus anubis): behaviour, ecology and human conflict in Gashaka Gumti National Park, Nigeria*. PhD thesis. School of Life and Sports, University of Surrey, Roehampton.

Warren, Y., Buba, B. and Ross, C. (2007). Patterns of crop-raiding by wild and domestic animals near Gashaka Gumti National Park, Nigeria. *International Journal of Pest Management* 53(3): 207-216.

Webber, A. D (2006). *Primate crop raiding in Uganda: actual and perceived risks around Budongo Forest Reserve*. PhD thesis. Department of Anthropology and Geography, Oxford Brookes University, Oxford.

Weladji, R. B., and Tchamba, M. N. (2003). Conflict between people and protected areas within the Bénoué Wildlife Conservation Area, North Cameroon. *Oryx* 37: 72-79.

Western, D. and Waithaka, J. (2005). Policies for reducing human-wildlife conflict: a Kenya case study. In Woodroffe, R., Thirgood, S. and Rabinowitz, A. (Eds) *People and wildlife; conflict or coexistence?* Cambridge: Cambridge University Press, pp. 357-372.

Woodroffe, R., Thirgood, S. and Rabinowitz, A. (2005). The impact of human-wildlife conflict on natural systems. In Woodroffe, R., Thirgood, S. and Rabinowitz, A. (Eds) *People and wildlife; conflict or coexistence?* Cambridge: Cambridge University Press, pp. 1-12.

Yamakoshi, G. (2002). *The village in Guinea where chimpanzees live alongside humans*. The Toyota Foundation Occasional report No 32 pp 1-4. Tokyo.

Yihune, M., Bekele, A. and Tefera, Z (2008). Human-gelada baboon conflict in and around the Simien Mountains National Park, Ethiopia. *African Journal of Ecology* 47: 276-282.

Yngstrom, I. (2002). Women, wives and land rights in Africa: situating gender beyond the household in the debate over land policy and changing tenure systems. *Oxford Development Studies* 30(1): 21-40.

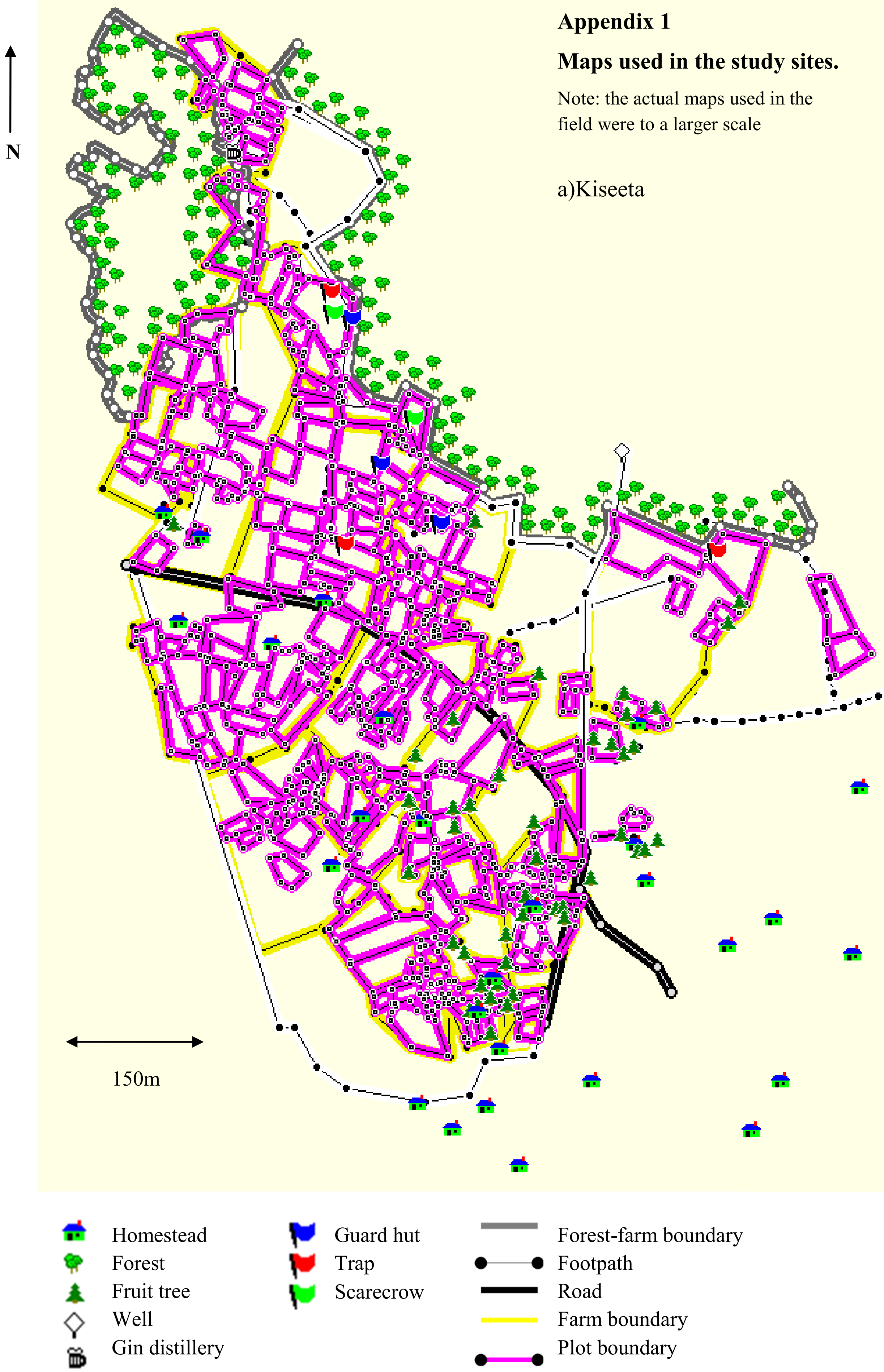
Yoder, J. (2002). Deer-inflicted crop damage and crop choice in Wisconsin. *Human Dimensions of Wildlife* 7: 179-196.

Appendix 1

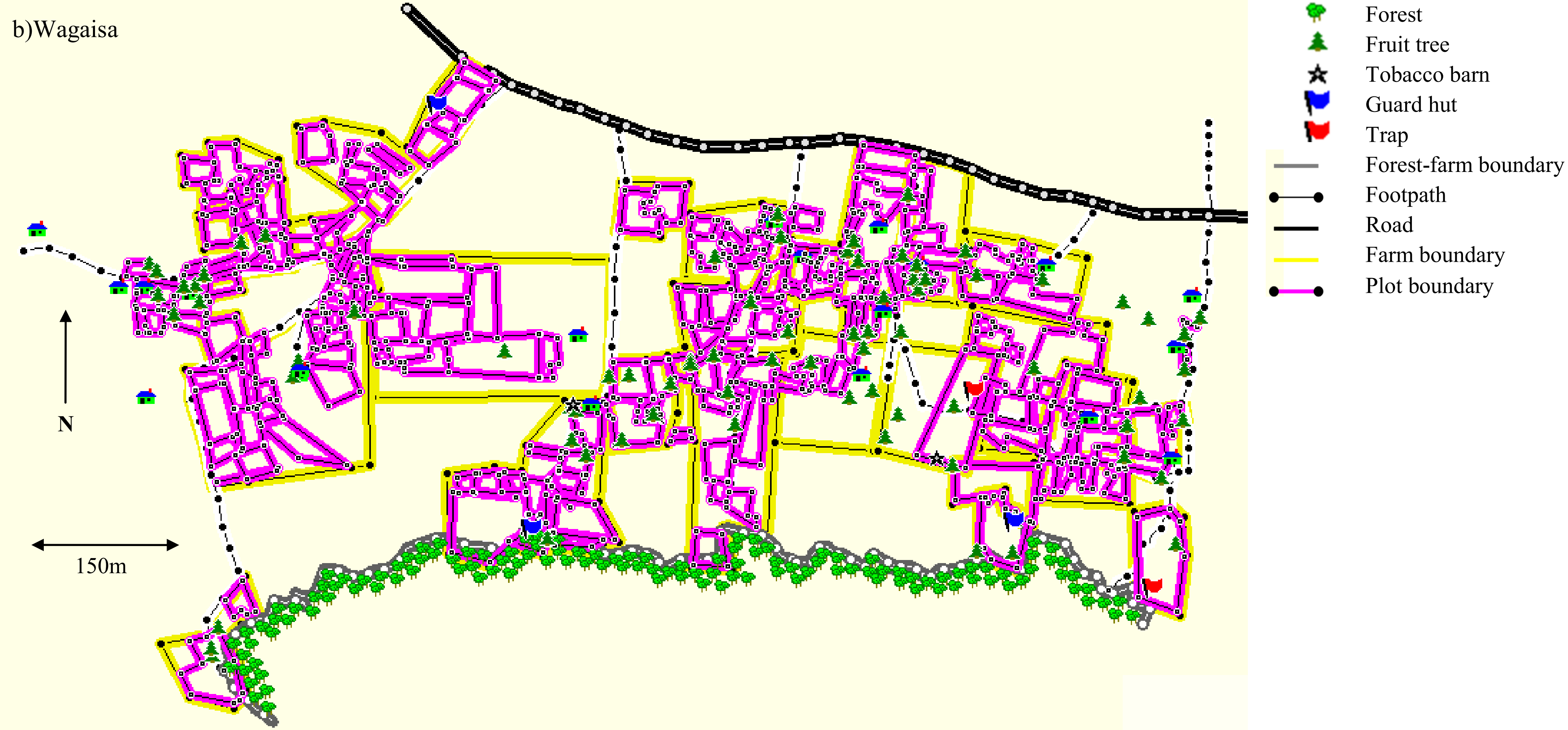
Maps used in the study sites.

Note: the actual maps used in the field were to a larger scale

a)Kiseeta

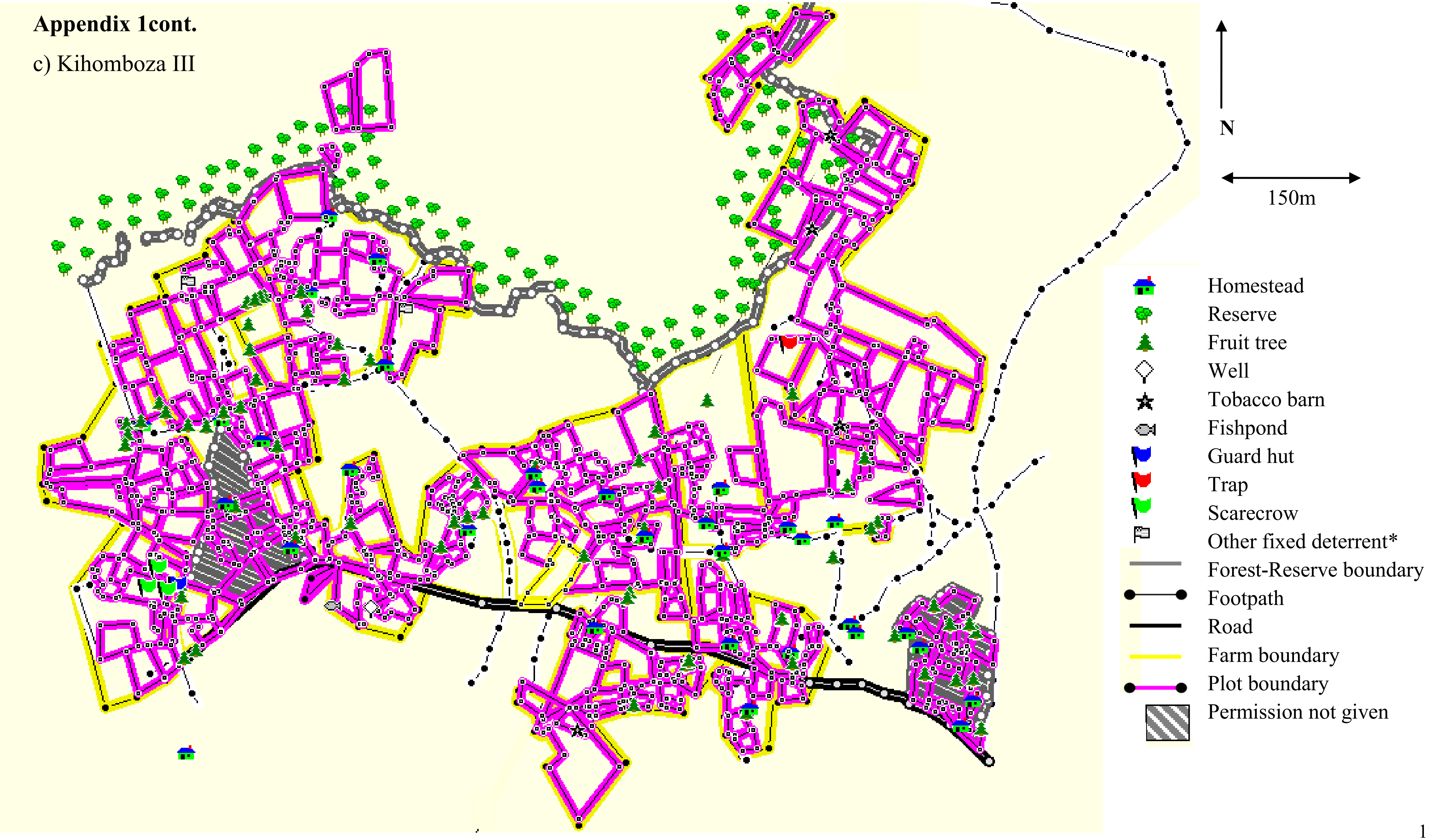


Appendix 1 cont

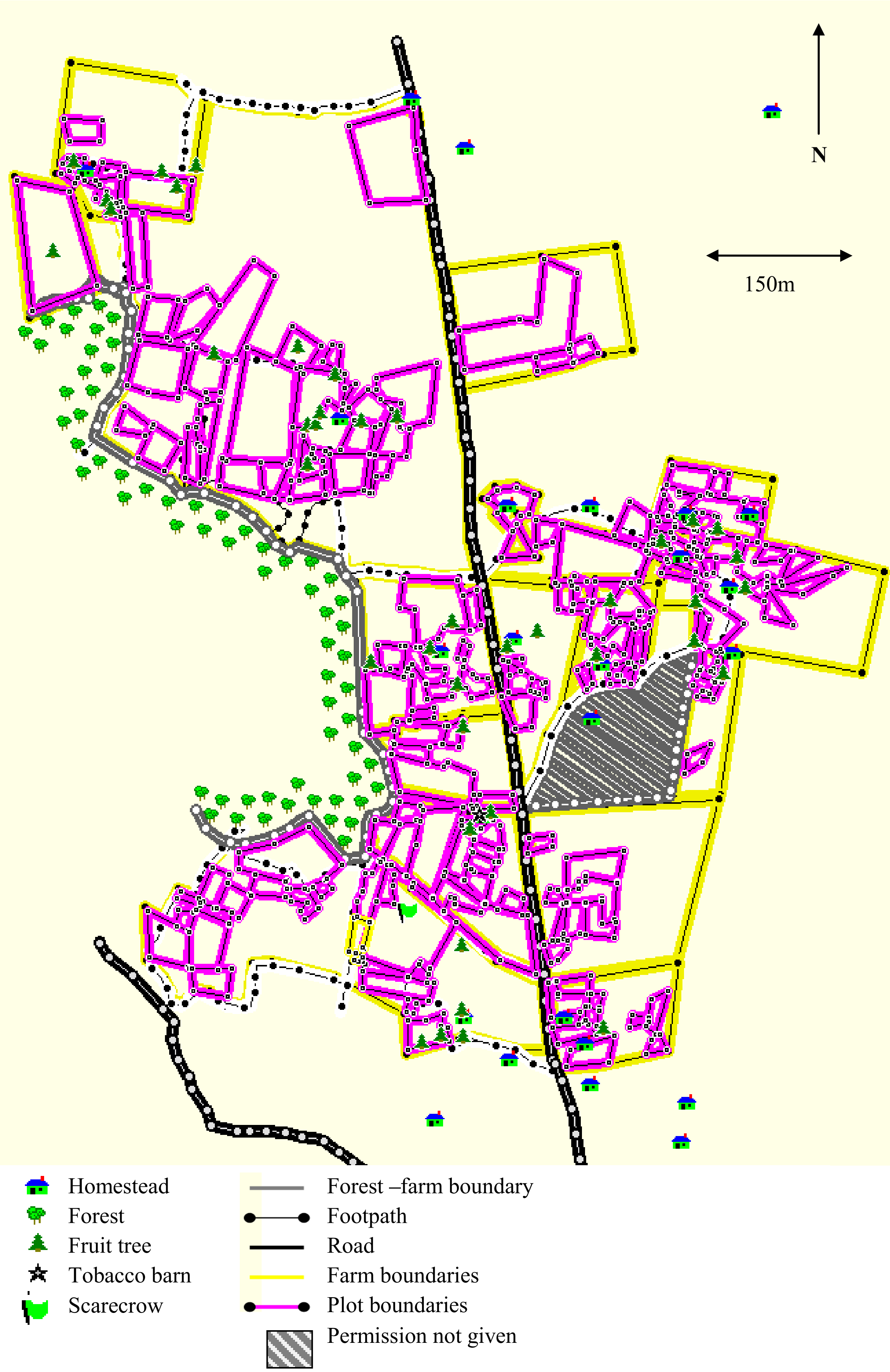


Appendix 1cont.

c) Kihomboza III



Appendix 1 cont. Nyakamwaga



Appendix 2

Interview questions

IDENTIFICATION CODE:

DISTANCE FROM FOREST:

0 – 100m	101 - 200m	201 – 300m	301 – 400m	401 – 500m	over 500m

<u>Ethnic group, history and ownership</u>

1. I am from the UK so I am English. How would you describe yourself?
2. How long have you lived here?
3. Why did you move here?
4. How long have you owned your land (who owns your land)?
5. Who works on your land? Do you hire help?

<u>Details of crops planted</u>

6. What type of crops do you grow?
7. Why do you grow these particular crops and not other types?
8. Is there significance to whereabouts on your land you plant these crops?
9. What is it?
10. Do you usually plant particular types of crops closer to the forest and some further away?
11. Which ones and why?

<u>Significance of income and security</u>

12. From the most important to the least, what crop is most important to you?
13. Why?
14. What crop is most important to you for eating?
15. Why?
16. What crop is most important to you for selling?
17. Why?
18. Can you list your crops from the easiest to the most difficult to grow?
19. Can you list your crops from the easiest to the most difficult to harvest?
20. Can you list your crops from the easiest to the most difficult to cook?
21. Do you sell or eat your crops?
22. Who do you sell to?
23. Has the type of crops that you grow changed?
24. How?

Appendix 2 cont.

25. Why has it changed?
26. Has this changed life in general for you?
27. How?

<u>Problems with farming</u>

28. What are the problems you have with growing crops on your farm?
29. Can you list these problems from the biggest to the least significant:

Weather	Insects	Livestock	Wildlife	Disease

30. What do you do to cope with these problems?

31. Can you list these vermin from the biggest problem to the least significant on your crops:

Vervet	Colobus	Chimpanzee	Baboon	Porcupine	Squirrel	Rat	Other

32. Is it good having your farm near to the forest or not?
33. Why (not)?
34. Do you get things from the forest that you use?
35. Has the forest changed since you have been living/working here?
36. Why do you think the forest has changed?
37. How has this affected how you use the forest?
38. Has the change in the forest had any effect on your crops at all?
39. Do you prefer it now or how it used to be?

<u>OTHER NOTES:</u>

Appendix 3

Focus group questions: women

1. How does crop loss affect your household budget?

- *How much does it cost you in terms of money/crops?*

2. How does crop raiding affect your children?

- *Does it affect what they do each day? Would they be doing something different if there was no crop raiding?*

3. What is the significance of fruit for the family food security?

- *How important is fruit to your family?*

4. How important is fruit as a food compared to cultivated crops?

5. How often does your family eat fruit?

- *Every day? Every other day? Less often?*

6. In your households, who mostly grows the crops you or your husband?

- *Is there a difference between between the role of husband and the role of wife?*

7. Who mostly harvests crops – you, your husband, your children?

8. Is there a difference between who works on cash crops and who works on subsistence crops?

- *Husband/wife/kids?*

9. What animals are most likely to raid from the forest?

10. What animals from the forest are most likely to do most damage?

(NOTE: if the answer given is an animal not around now: *which animals that visit now are likely to do most damage?*).

11. What could make the problem better?

11a. If you could not kill them and you could not chase them away, what could you do to make the problem better?

12. What forest animals do you like least? Why?

13. What forest animals are you fearful of? Why?

14. Are you afraid of chimps? Why?

15. (If) you say you are afraid of chimps. How do they make you change the way you work in the field? How does this affect your production?

16. Which animals are protected by law/the Government? Why?

Appendix 3 cont.

Focus group questions: men

1. What crops are most vulnerable to raiding from the forest?

2. What animals are most likely to raid from the forest?

3. What animals from the forest are most likely to do most damage?

(NOTE: if the answer given is an animal not around now: *which animals that visit now are likely to do most damage?*).

4. What could make the problem better?

4a. If you could not kill them or chase them, what would make the problem better/make these animals more tolerable?

7. What forest animals do you like least? Why?

8. What forest animals are you fearful of? Why?

9. Are you afraid of chimps? Why?

5. What do you think of forest animals that mainly take fruit?

(Question for Wagaisa men: chimps seem to take jackfruit over anything else. Does it matter?)

6. Would the jobs that you do, and the jobs that your wife does on your fields be different if there was no crop raiding? How?

10. Most people have said the forest has got smaller. Has this affected the number of raids you get from the forest?

11. Are there more raids now, or is it less than it was before?

12. Is more damage done in each raid now, or is it less than it was before?

12a. Do you benefit from people cutting the forest at all?

13. What do you think about people who cut the forest for timber?

14. Do you think you live near the forest?

Note: if answer is no, ask -Why don't you think you live near the forest?

15. Which animals are protected by law/ the Government? Why?

Appendix 4

Mean plot sizes of each crop type

	Size of plots (m^2)				
	Mean*	Rank of mean	Minimum	Maximum	Number of plots**
Cocoa	3707	1	500	6914	2
Mango	3047	2	3047	3047	1
Soya bean	2126.7	3	162	4609	2
Guava	2011.2	4	206	2665	3
Tobacco	1810.3	5	71	7848	41
Rice	1716	6	126	5391	53
Sorghum	1608.3	7	240	2276	4
Passion fruit	1510	8	1510	1510	1
Sesame	979	9	979	979	1
Millet	949.7	10	27	2755	40
Pigeon peas	913.2	11	68	4455	125
Eggplant	867	12	867	867	1
Maize	863.2	13	42	6991	346
Cassava	843.7	14	39	6804	384
Banana	797.3	15	25	3930	63
Beans	768.6	16	36	6546	273
Groundnuts	737.1	17	57	12663	145
Sweet potato	519.9	18	41	3259	220
Coffee	490.8	19	310	737	3
Tomato	426.6	20	111	1192	8
Sugarcane	285.2	21	4	1630	31
Pineapple	244.3	22	68	401	7
Yam	236	23	20	737	6
Pumpkin	235.2	24	10	552	5
Irish potato	234.3	25	36	1812	20
Cow peas	166.4	26	52	325	10
Cabbage	77	27	77	77	1
Onions	54.2	28	35	128	2
Total					1798

***The mean size of plots is derived from the number of plots in each of the four seasons (i.e. plots were usually counted four times. This is because a single plot was likely to alter in size and crop assemblage during the year).**
****The number of plots supporting each crop during the year. i.e. if one crop remained in the same plot for the duration of the study, this was counted as one plot, despite continuing across four seasons.**

Appendix 5

Area of crop damaged by all animals, and ranking of damage at each of the four study sites.

	Kiseeta m^2	*Kiseeta ranked*	Wagaisa m^2	*Wagaisa ranked*	Kihomboza III m^2	*Kihomboza III ranked*	Nyakamwaga m^2	*Nyakamwaga ranked*	*Mean rank all sites*
Cattle	1034.4	*4*	2017.82	*1*	2486.54	*1*	2569.73	*1*	*1.75*
Vervet	1120.51	*2*	693.95	*2*	254.57	*4*	675.09	*2*	*2.5*
Bird	1057.03	*3*	410.96	*3*	938.46	*3*	309.9	*4*	*3.25*
Colobus	2922.88	*1*	277.29	*4*	88.4	*10*	53.85	*7*	*5.5*
Chicken	665	*5*	104	*7*	154.79	*6*	148.19	*6*	*6*
Goat	88.99	*10*	70.4	*8*	232.68	*5*	572.87	*3*	*6.5*
Rat	149.11	*7*	162.54	*6*	128.26	*8*	38.62	*8*	*7.25*
Squirrel	126.15	*8*	47.03	*10*	125.11	*9*	153.14	*5*	*8*
Domestic pig	21.2	*13*	163.26	*5*	132.5	*7*	19.96	*9*	*8.5*
Chimp	206.49	*6*	52.55	*9*	30.77	*11*	2.78	*10*	*9*
Baboon	0	*15*	0	*13.5*	1217.28	*2*	0	*14*	*11.1*
Porcupine	68.1	*11*	0	*13.5*	8.33	*12*	0	*14*	*12.6*
Bush pig	100	*9*	0	*13.5*	0	*15.5*	0	*14*	*13*
Civet	27.3	*12*	0	*13.5*	5.77	*14*	0	*14*	*13.4*
Guinea	0	*15*	0	*13.5*	0	*15.5*	1.67	*11*	*13.8*
Sheep	0	*15*	0	*13.5*	8	*13*	0	*14*	*13.9*
Total area	7587.16		3999.8		5811.46		4545.8		21944.22