GEF Project:

Novel forms of livestock and wildlife integration adjacent to protected areas in Africa (GCP/URT/124/WBG)

Human-Wildlife Conflict (HWC) monitoring activity

Analysis of crop damage in Lolkisale, Naitolia and Loborsoit A villages (Monduli and Simanjiro Districts - Tanzania)

2006 - 2008

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1 Introduction

1.1 Background

Long temporal studies monitoring large herbivore populations in African rangelands such as in Kenya and in Tanzania have shown that wildlife outside national parks and game reserves has declined drastically over the last 2 decades (Caro et al. 1998). This is due to the fact that significant proportions of wildlife reside outside of protected areas (Hoare 1999a; Ottichilo et al. 2000a; Said 2003), where they are exposed to the possible effects of anthropogenic factors such as agricultural encroachment, competition with livestock, legal and illegal hunting and human population growth. Within these areas and specifically within communal lands the success of conservation efforts hinges upon the relationship between people and wildlife. Where the competition for space and resources between wildlife and humans increases and affects people's livelihood, conservation is at risk and large mammals face higher risk of extinction (Sitati et al. 2005). Often local communities are not involved in managing natural resources and wildlife and protected areas do not generate economic revenue to them. Indeed frequently they incur the costs of living with wildlife without receiving any benefit from it (Sibanda and Omwega 1996 and Naughton-Trevers 1998, cited on Thorton et al. 2006). These areas are at higher risk of human-wildlife conflicts with consequently negative effects for conservation. Conflicts arise from a range of direct and indirect negative interactions between humans and wildlife. Generally they arise from economic losses to agriculture, including livestock depredation and destruction of crops. In arid areas they often occur over access to water and competition for resources. Conflicts can culminate in potential harm to all involved (injury and death of people and wildlife) and lead to negative human attitudes, with potentially negative effects for conservation (Nelson et al. 2003).

Human-wildlife conflict is a common phenomenon also in the Tarangire-Manyara ecosystem. It is mainly due to crop raiding and livestock depredation caused by wildlife. It is becoming a serious problem for land managers and conservationists because it leads to negative human attitudes towards wildlife, with potentially negative effects for conservation. Few preliminary studies in and around the study area have showed that elephants are the major cause of crop raiding, followed by zebra, wildebeest and warthog (Meingataki 2005, Oikos 2002). The peak period of crop damage occurs during June-September which coincides with the maturation of crops and with the dry season where there is a shortage of food and water for wildlife. Livestock depredation occurs less frequently than crop damage. However, it has a bigger impact on the livelihood of the local communities.

Although the local communities of the study area face crop damage daily, particularly during the maturation of crops, the problem has not been monitored or managed by the Tanzanian Government so far. Nobody is appointed to monitor the phenomenon, identify the areas at higher risk of occurrence and experiment different prevention methods. Usually every time there is an occurrence of crop damage, the Control Animal Unit of the District is informed in order to act and chase the animals away. The rangers of the Tarangire National Park are also involved in this activity. However they cannot effectively cover the whole study area simultaneously and the farms remain vulnerable. Compensation schemes for the damaged farms are not applied in

Tanzania and the local communities are not yet directly involved in managing natural resources. Wildlife and protected areas are not generating economic revenue for the local communities yet. Actually the local communities incur the cost of living with wildlife without receiving any benefit from it. Therefore this area is at higher risk of human-wildlife conflicts with potentially negative effects on wildlife conservation.

One of the main purposes of the GEF project (titled Novel forms of livestock and wildlife integration adjacent to protected areas in Africa - GCP/URT/124/WBG) was to improve the coexistence between wildlife and human activities (i.e. agriculture and livestock) in the study area, with particular focus on 3 selected villages of Simanjiro and Monduli districts, namely Loborsoit A, Lolkisale and Naitolia. One of the activities developed by the project was to monitor human-wildlife conflicts in the 3 villages. The scope of the activity was to: 1) describe the phenomenon in the study area; 2) understand the driving factors of HWC and 3) identify the areas at higher risk of conflict. Specifically, crop damage and livestock depredation were monitored in these villages by 3 enumerators between June 2006 and August 2008. This report shows the results of the analysis of crop damages occurred in 2006, 2007 and 2008.

1.2 Objectives of the analysis

The objectives of this analysis were to:

1) describe the crop damages recorded from 2006 to 2008;
2) identify which crops were more vulnerable and damaged;
3) estimate the size of the damage and its proportion in relation to the size of the plot;
4) identify the species responsible for crop damage;
5) identify the time of the raiding;
6) detect the prevention system adopted by the farmers;
7) localize and map the damaged areas;
8) identify the driving factors of crop damage for the study area;
9) estimate the economic loss due to crop raiding.

2 Methods

2.1 Study area

The study was carried out in 3 villages adjacent to Tarangire National Park (TNP), namely Naitolia (Monduli district), Lolkisale (Monduli district) and Loborsoit A (Simanjiro district) in Manyara and Arusha regions. The villages are located in the northeast and east side of the park. The TNP is part of the Tarangire-Manyara ecosystem encompassing 35 000 km2 of the Masaai steppe, including lake Manyara National park, the Marang and Esimingor National Forest Reserves, the watershed of the Northern Highland Forest in the Ngorongoro Conservation Area and the Simanjiro plains. The Simanjiro plains are dispersal and calving areas of many migratory wildlife species such as zebra, wildebeest and elephants. They also host endangered species as the wild dog and the Greater Kudu. The ecosystem provides habitat for over 3,000 elephants - the largest population in northern Tanzania.

The villages are characterized with altitude ranging from 600 to 1200 meters above sea level, temperatures ranging between 23-30 centigrade and annual rainfall ranging from 400 to 600 mm. The villages have extensive plains covered with mixed bush lands, wooded grassland and open grassland. Dominant trees are acacia, ballanites, commiphora and combretum (AWF_LEAD 2005). The three villages are experiencing a rapid increase in human population (annual rate = 8.2%; Mwalyosi 1991) due to immigration. As a consequence, there is a rapid agricultural encroachment on rangeland areas.

2.2 Crop damage monitoring activity

Three villagers (one for each village) were selected by the village leaders and trained by the GEF project to enumerate crop raiding and livestock depredation occurrences. The farmers from the surrounding area were encouraged to report crop damage and livestock depredation occurrences to their local enumerator who then visited the farms to verify and quantify the damage. Details of the damage were recorded on a standard report form based on a modified version of the Human Elephant Conflict (HEC) protocol of the African Elephant Specialist Group (AESG) of the IUCN (Hoare 1999b). The form was modified to include other wildlife species responsible for crop damage. From June 2006 to September 2008 all farms that reported the occurrence of crop damage were visited by the enumerators who collected the following information: name of the farmer; period of establishment; date of the incident, date of the reported incident; number of incidents in previous seasons; GPS location of the raiding; type of the damaged crop(s); quality and age of the crop before the damage; size of the plot, extent of the damage; other types of damage (such as food destruction, water supply, human injury and human death); species responsible for crop damage; adopted prevention methods; main habitat type around the farm (see Annex A).

The sizes of the cultivated field (plot) and the extent of the damage were measured on the ground in paces according to IUCN-AESG protocol. The estimates in paces were therefore converted to acres. For the analysis the paces were firstly converted in meter (conventionally 1 pace is on average 0.74 cm); then length and width of the plot and of the damage have been multiplied respectively to get the total area of the

plot and of the damage in square meter. Lastly both have been converted in acres (1 acre = 4046.86 m^2).

The prevention methods employed by the farmers and recorded by the enumerators were: a) presence of a watchman; b) the use of various active deterrents, such as lighting fires on the boundary of the property, shouting, using torches and banging tins and drums, using smoke from hot chili and from livestock or elephant dung; c) presence of barriers such as vegetation fences, barbed wire fences, home made wire fences, rope fences.

The information collected about the species responsible for crop damage included the number of animals counted by the farmers during the raiding event and the type of signs spotted by the enumerator on the ground (such as footprints, rest of food, etc.). Only for the elephant the enumerators collected information on the composition of the family group.

The results of the analysis are shown by year.

2.3 Data handling and statistical analysis

Warthog and wild pig are two species ecologically similar and difficult to distinguish. For this reason they were analyzed together as a single group.

For the analysis, the prevention methods were grouped in passive and active methods (Sitati et al. 2005). The passive methods included the barriers and fences such as those made with vegetation, wire and/or rope. The active methods included those requiring the active presence of the farmers such as watchman, fire, loud noise, flash light, smoke from cattle and elephant dung and smoke from hot chili. Farms using a combination of both methods were classified as farms with mixed prevention methods.

Two measures of crop damage were used: 1) the damaged area per farm and 2) the proportion of the damaged area in each farm. These measures reflected actual and relative loss, respectively (Sitati et. al. 2005).

A recent study in Kenya (Sitati et al. 2005) found a significant association between the presence of fences and decrease of effectiveness of active prevention methods. In other words, watchmen seemed to decrease their alertness in farms delimeted by fences because they relied on the efficacy of the physical barriers against wildlife. In our study area, personal observations in the field already revealed that passive methods were mainly poorly developed and maintained, therefore not effective against wildlife. For instance, often fences were not delimiting the whole perimeter of the farm, indicating that they were used mainly to demarcate the farm and not against wildlife.

Based on the above information, we formulated and tested the following hypotheses: 1) the average size of the damage per occurrence was smaller for farms with active prevention methods (meaning an active patrolling of the territory) than for farms with mixed prevention methods (passive and active); 2) the proportion of damage per occurrence was smaller for farms with active prevention methods than for farms with mixed prevention methods; 3) the average size of the farms using active methods was larger than the size of the farms using mixed prevention methods. We

firstly transformed the data to approximate a normal distribution: plot size and damage size were $\log_{10}$ transformed while the proportion of damage was square root transformed. The Kolmogorov-Smirnov test was used to test for normality.

3 Results

3.1 Overview

Totally, 396 crop damage occurrences were recorded by the enumerators from 2006 to 2008 within Naitolia, Lolkisale and Loborsoit A villages. The crop damages occurred in 359 farms. Several farms (N=34) were repetitively damaged during the monitoring period. A total amount of 660.5 acres was damaged by wildlife over an overall surveyed area of 2456.72 acres. Totally 27% of the surveyed area was damaged between 2006 and 2008 (Table 1). Crop damage affected mainly small peasant farmers (average cultivated field = 6.6 acres; sd=10.18). On average 1.79 acres (sd=4.33) per farm was damaged equivalent to 33% of the size of the farm. Figure 1 shows the amount of surveyed and damaged area per year.

Table 1 Mean farm size, mean damaged area by farm and mean proportion of damaged area by farm between 2006 and 2008.

	N crop damage occurrences	Mean	Std. Deviation	Minimum	Maximum
Plot size (acres)	369	6.66	10.18	0.041	1200
Damaged Plot size (acres)	369	1.79	4.33	0.008	70
Prop. damage	369	0.33	0.297023	0.005	1

The average size of the farm for Loborsoit A, Lolkisale and Naitolia was 4.6, 8.52 and 5.88 acres respectively. The average size of the damage per farm was 0.87, 1.93 and 3.25 acres respectively. On average the proportion of damaged area per farm was higher in Naitolia (44%) and lowest in Loborsoit A (25%). In Lolkisale 35% of the farm was damaged by wildlife (table 2).

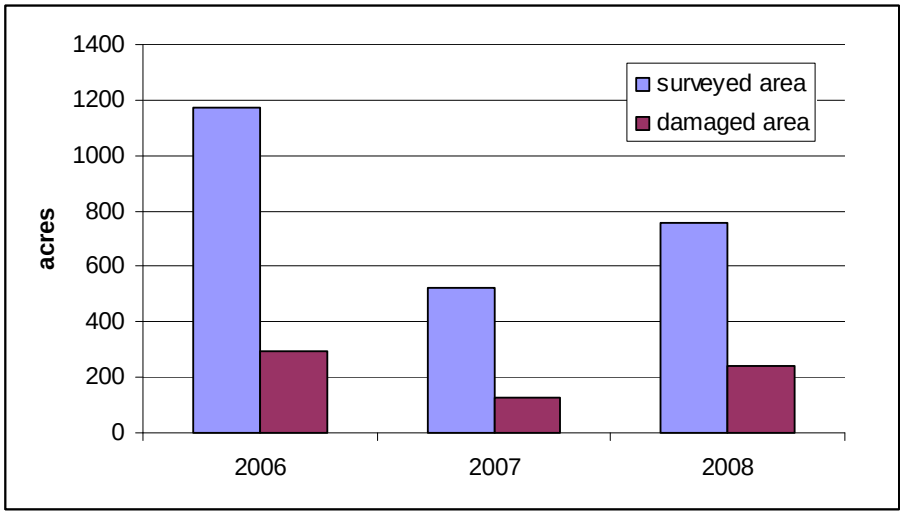

Figure 1 Total surveyed and damaged area in 2006, 2007 and 2008.

Table 2 Mean farm size, mean damaged area by farm and mean proportion of damaged area by farm in Loborsoit A, Lolkisale and Naitolia.

Village		Plot size (acres)	Damaged Plot size (acres)	Proportion of damage per farm
Loborsoit A	Mean	4.60	.87	.25
(N=131)	Median	2.65	.38	.13
	Std. Deviation	5.61	1.26	.29
	Minimum	.04	.01	.01
	Maximum	35.99	6.63	1.14
Lolkisale	Mean	8.52	1.93	.35
(N=172)	Median	6.00	1.21	.30
	Std. Deviation	12.41	2.24	.29
	Minimum	.48	.04	.00
	Maximum	120.00	12.86	1.13
Naitolia	Mean	5.88	3.25	.44
(N=66)	Median	2.85	1.00	.34
	Std. Deviation	10.00	9.27	.29
	Minimum	.50	.16	.05
	Maximum	70.00	70.00	1.00

The most damaged crops were (in descending order): maize (54.5%), lablab beans (21.6%), beans (9.1%) and green gram (6.8%). Crops marginally damaged were cowpeas, sunflower, finger millet, pigeon peas and Irish potatoes (figure 2).

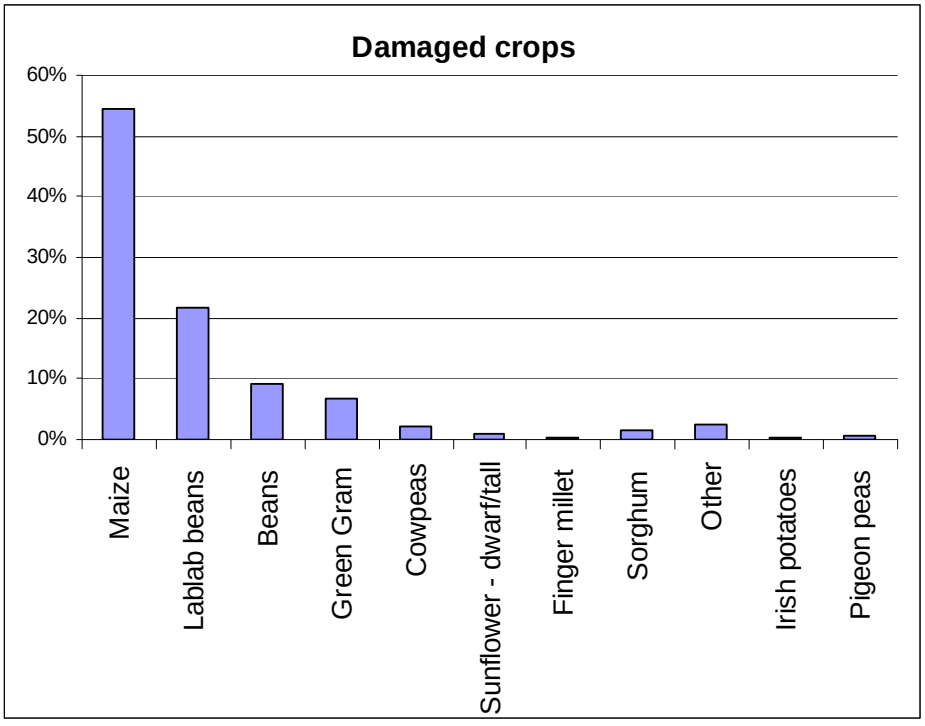

Figure 2 damaged crops in the study area

The wildlife species responsible for crop damage were in descending order: elephant (29.4%), warthog/wild pig (28.6%), zebra (14%), antelopes (7.7%), ostrich (4.8%) and giraffe (3.8%). Buffalo, baboon, vervet monkey, eland, wildebeest and porcupine caused crop damages only marginally (figure 3).

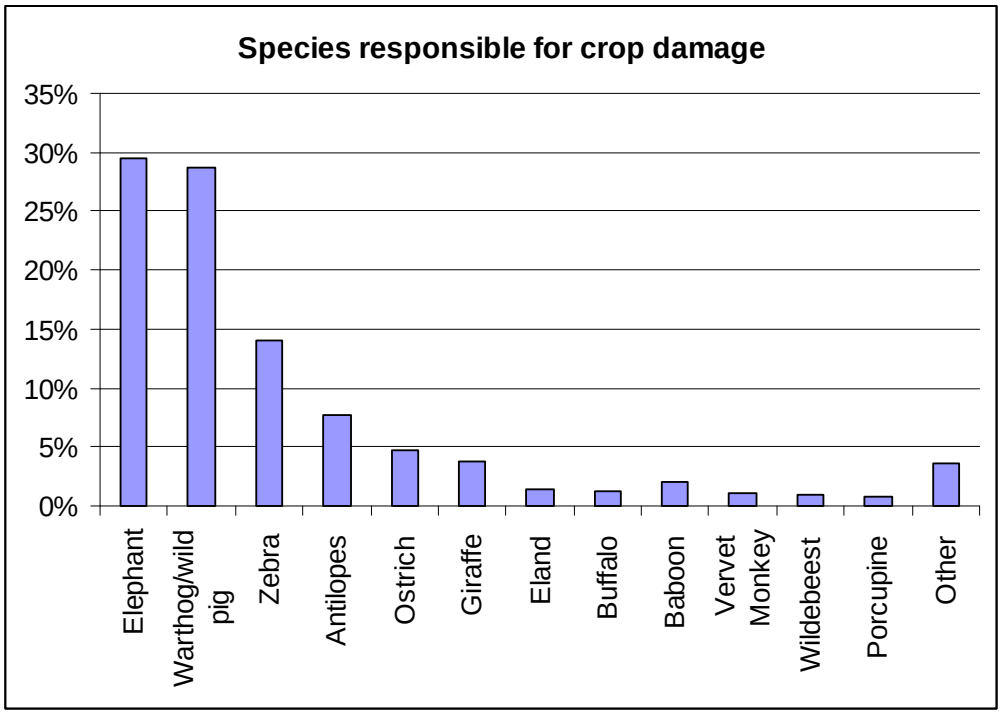

Figure 3 Species responsible for crop damage

3.2 Crop damages occurred in 2006

One-hundred and forty-seven (147) farms were damaged between 17 April and 28 August 2006 in Loborsoit A (n=20), Naitolia (n=61) and Lolkisale (n=66)(figure 4 and 5). Seventy-nine (79) percent of these farms started cultivating more than 10 years ago. Nine farmers had damage in more than one plot. One farmer in Lolkisale was damaged two times within few days in a big single plot of 80 acres. Many farms reported more than one damaged crop per damage occurrence (mean=1.9; sd=0.86). These farms were located mainly in Naitolia and Lolkisale (72% and 50% respectively). The total amount of crop damage occurrences was 272.

Few farms (N=9), besides the destruction of crops, reported destruction of the food store (containing maize), water supply and human death. These damages were caused by elephants.

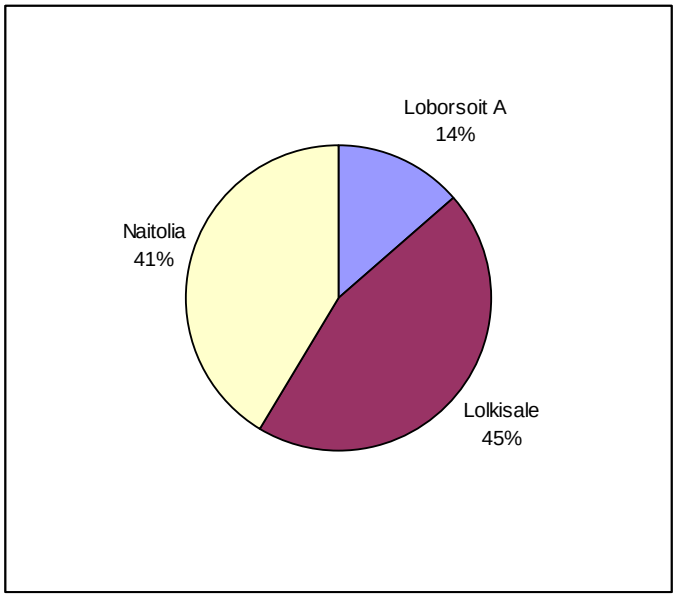

Figure 4 Percentage of crop damage occurrences by village

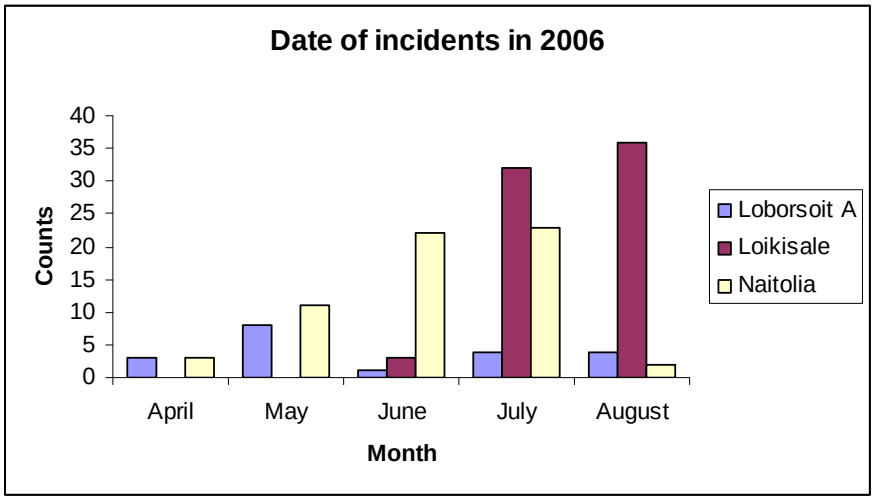

Figure 5 Date of incident in 2006

3.2.1 Damaged crops: type, quality and age

A total of 272 incidents of crop damage were recorded in 147 farms. The most damaged crop was maize (47%), followed by lablab beans (32%), green gram (8%), beans (4%), cowpea (3%) and sorghum (3%). Maize was the most damaged crop also at village level (figure 6). Lablab beans were the second damaged crop in Lolkisale and Naitolia. Beans were the second damaged crop in Loborsoit A. Green gram was damaged almost exclusively in Naitolia. Other damaged crops were sunflower and sorghum but at limited extent (less then 1%). According to the assessment of the enumerators, the quality of the crops before the damage was good (37%) and medium (41%). Only 18% of the damaged crops were considered poor. Specifically, in Loborsoit A and in Naitolia most of the crops were considered of medium (52% and 45% respectively) and good (32% and 24% respectively) quality.

In Lolkisale 53% of the damaged crops was evaluated good. The highest percentage of poor quality was evaluated in Naitolia (26%) and the lowest in Loborsoit A (6%).

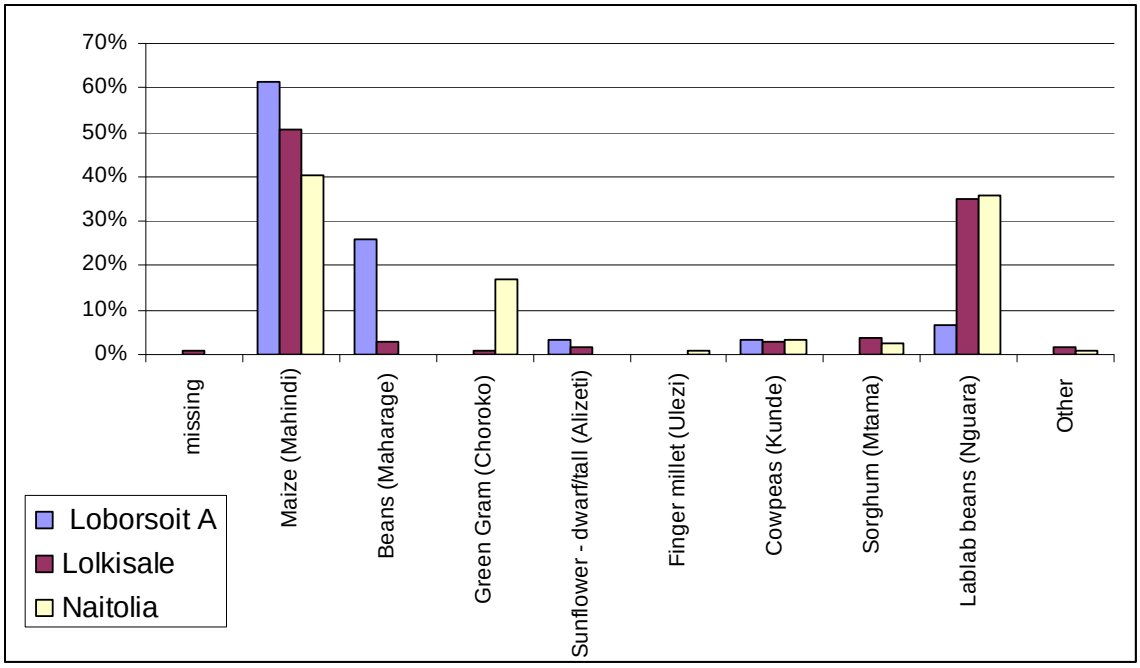

Figure 6 Percentages of incidents of crop damage by crop type at village level

In 2006 the crop damage was mainly monitored during the summer season (dry season) when the crops reach the maturation. Out of 272 crop incidents, 56% of the crops were mature and 23% at intermediate stage. Often the enumerators did not evaluate this parameter (21%), indicating that this task was overlooked.

In Lolkisale the damage mostly occurred during the maturation of the crops (85%). In Naitolia the crops were damaged during the intermediate (45%) and the mature stage (35%). This is due to the fact that some crop damages were recorded during April-May 2006 as explained in the methods. In Loborsoit A 55% of the damages were not classified. Thirty-five percent of the damaged crops were mature.

3.2.2 Plot size and damage

Out of 147 damaged farms monitored by the enumerators, 137 farms were correctly recorded with information on plot size and damage. As shown in table 3, totally 1170.64 acres were visited after the damage and measured by the enumerators. The average size of the farms was 8.5 acres (sd=14.5) with the smallest one in Naitolia (0.25 acres) and largest in Lolkisale (120 acres). Totally 295.64 acres were damaged by wildlife, equivalent to 25% of the surveyed area. On average, 2.15 acres (sd=6.5) were damaged per farm. The smallest damage occurred in Loborsoit A (0.01 acres) while the largest in Naitolia (70 acres).
In Loborsoit A, totally 65.54 acres were visited by the enumerators; 12.2 acres (18.7%) were damaged by wildlife. The average size of the plot and of the damage was 3.44 acres and 0.64 acres respectively. The largest damage was 2 acres.

In Lolkisale out of 744.35 acres surveyed, 77.14 acres (10%) were damaged by wildlife. The average plot size was 12 acres and the average damaged size was 1.24 acres. The largest damage was 5.32 acres.
In Naitolia out of 362.5 acres surveyed, 206.64 acres (56.9%) were damaged by wildlife. The average plot size was 7.28 acres, while the average damaged plot size was 2.83 acres. The largest damage was 70 acres caused by 7 big elephants.

Table 3 Total surveyed and damaged area and average size of the plots and of the damaged crops per incident at village level.

Village name	Total surveyed area (acres)	Total damaged area (acres)	Average plot size (acres)	Average size of damaged crops (acres)
Loborsoit A	65.54	12.2 (18.7%)	3.44	0.64
Lolkisale	744.35	77.14 (10%)	12	1.24
Naitolia	362.5	206.64 (56.9%)	7.28	2.83
Total	1170.64	295.64 (25.2%)	8.5	2.15

3.2.3 Species responsible for crop damage

The species responsible for crop damage were recorded in 135 farms. Most of the incidents were caused by more than one single species simultaneously (61%). Specifically 55% of the farms were damaged by 2 - 4 species simultaneously. In one occasion, one farm located in Loborsoit A was damaged by 7 species during the same night (see figure 7).

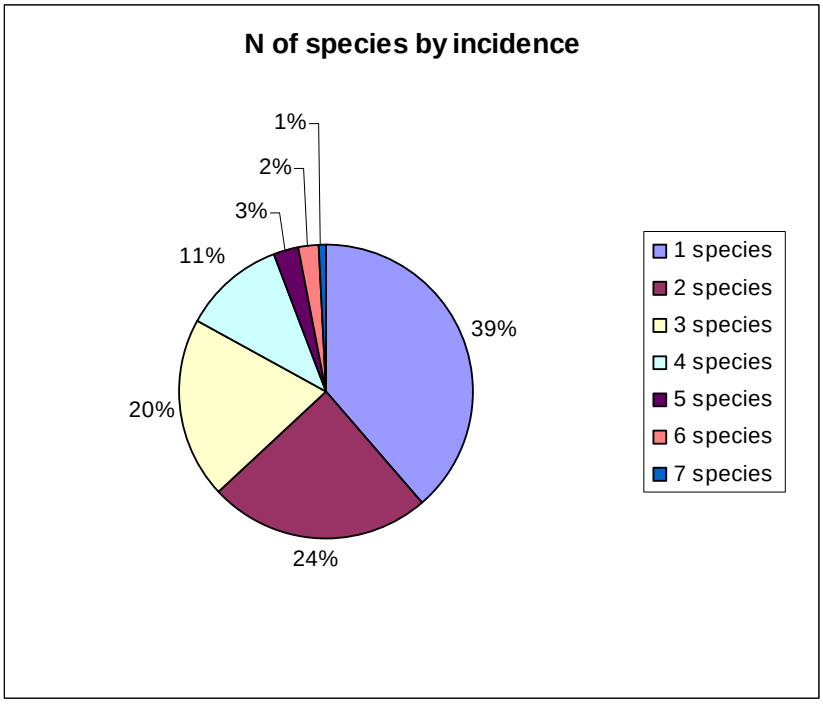

Figure 7 Number of species responsible for crop damage per occurrence.

At village level, 62 farms in Lolkisale reported details on the species responsible for crop damage. Figure 8 shows that most farms (58%) were damaged by one species at the time. Thirty-seven percent of the farms were damaged by 2-3 species simultaneously. Three farms (5%) were damaged by 4 species at the same time. In Loborsoit A, the farms (totally 18) were mainly damaged by more than 2 species. Specifically 34% of the farms were raided by 3-4 different species. Similarly in Naitolia, most of the farms (59% out of a total amount of 55 farms) were damaged by 2-3 species simultaneously. In one occasion, one farm was damaged by 6 species during the same night.

The species that most frequently caused crop damage was elephant (31%), followed by warthog/wild pig (27.6%) and zebra (13.1%). The species that raided the cultivated fields less frequently were giraffe (6.5%), ostrich and antelope (both 5%). Other species such as baboon, porcupine, buffalo, eland and vervet monkey accounted for about 2% each. The wildebeest was never recorded within the species causing crop damage.

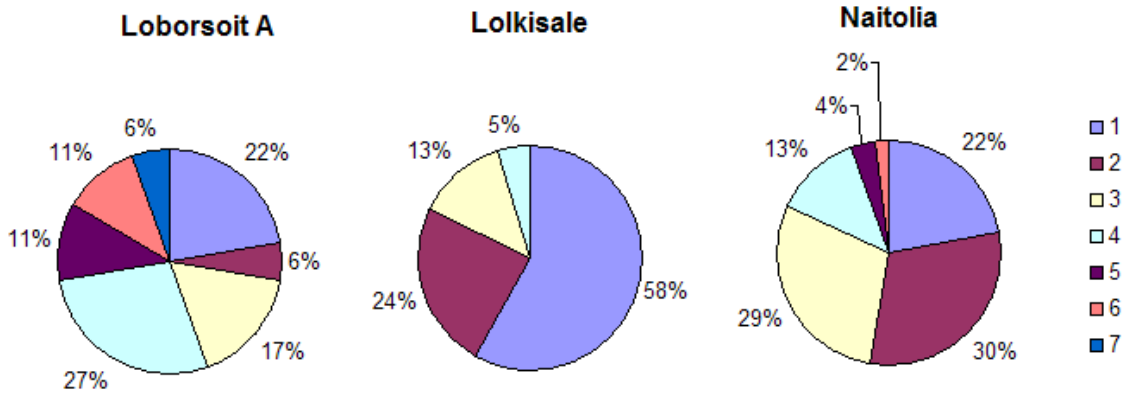

Figure 8 Percentages of damage occurrences caused by one (cyan) to seven (blue) species during the same night in Loborsoit A (N=18), Lolkisale (N=62) and Naitolia (N=55).

Figure 9 shows the results at village level. It can be observed that the elephant was the major cause of crop raiding only in Lolkisale (61%). The warthog/wild pig was responsible for 23% of the occurrences. Other species such as porcupine, antelopes, zebra, buffalo and baboon damaged the crops less frequently (less than 4% each). In Loborsoit A warthog/wild pig caused most of the occurrences of crop damage (44%). The elephant was responsible for 16% of the occurrences. Baboon (9%), antelopes (8%), buffalo (6%), vervet monkey (6%), zebra (5%), eland, ostrich and porcupine (2%) were less frequent. In Naitolia, 2 main species were responsible for crop raiding: zebra (25%) and warthog/wild pig (24%). The elephant and the giraffe caused 16% and 12% of the occurrences respectively. Ostrich (10%), antelope and eland (4% both) were less frequent.

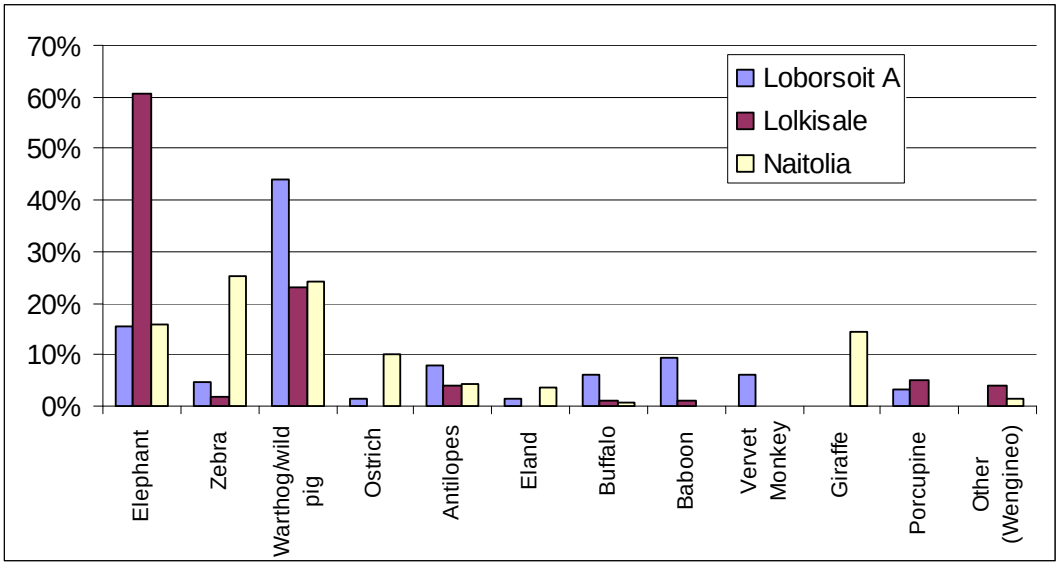

Figure 9 Percentages of incidents of crop damage caused by wildlife species at village level

3.2.4 Group size of wildlife species

The average group size of the elephant was 8.3, ranging from 5-6 animals in Loborsoit A and Naitolia to 10 animals in Lolkisale. The minimum number of elephants per crop damage occurrence was recorded in Naitolia (3 animals) while the maximum was registered in Lolkisale (24 animal). The average group size of warthog/wild pig was 5.5. Large average group sizes were observed in baboon, zebra, ostrich and antelopes (table 4).

Table 4 Average group size of the main species responsible for crop damage

Species	Average group size	Min	Max	N
Elephant (Tembo)	8.3	3	24	47
Zebra (Pundamilia)	15	15	15	1
Warthog (Ngiri)/Wild Pig (Ngurue Pori)	5.5	1	12	19
Ostrich (Mbuni)	12.9	5	20	7
Antilopes (Swala)	13.5	12	15	2
Buffalo (Mbogo)	4	4	4	1
Baboon (Nyani)	21. 7	18	25	3
Vervet Monkey (Tumbili)	8	7	9	2
Giraffe (Twiga)	3	2	4	5

3.2.5 Relation between group of species and size of the damage per occurrence

Most of the incidents were caused by 2-4 species or more. The measure of the damage was reported by the enumerators for all species. As a consequence it was not possible to quantify the amount of damage per occurrence caused by each species. Instead a relation between the number of species per incident and the amount of damage caused by them was statistically investigated. The size of the plot, the size of the damage and the number of wildlife species per incident were $\log_{10}$ transformed to approximate to a normal distribution (Kolmogorov-Smirnov test, $p>0.05$). The proportion of the damaged area was square-root transformed as explained in the methods. The results showed that the number of species were significantly positive correlated with the proportion of damaged area (Pearson correlation test, $p=0.016$, $r=0.849$) and significantly negative correlated with the size of the plot (Pearson correlation test, $p=0.02$, $r=-0.83$). In other words, the proportion of the damaged area was higher when caused by more species simultaneously. Larger farms were also damaged less frequently by larger number of species.

3.2.6 The elephant

Forty-three farms were damaged exclusively by elephants for a total amount of 105.6 acres out of 433.6 acres. On average the animals damaged about 20.4% of the farm. In two cases the plots were totally damaged. A relation between the group size of the elephants and the size of the damage was not found. Instead, a negative power relationship between the proportion of damaged plot and the size of the plot was observed ($y = 0.5213x^{-1.0199}$; $R^2 = 0.53$). In other words the smaller the cultivated field, the larger the damage caused by elephants. This confirms that small cultivated fields are more vulnerable to crop raiding by elephants than larger fields.

These damaged farms were located mainly in Lolkisale (n=36). Here the most damaged crops were maize (53%) and lablab beans (40%). Sunflower, beans and sorghum were damaged by elephants only occasionally. The data for Loborsoit A and Naitolia were not enough to be analyzed.

3.2.7 Time of damage

One hundred eighteen (118) damaged farms reported the time of the damage. Figure 10 shows that most of the damage occurred at night (85.5%). In few cases crop raiding occurred during the day (morning and afternoon) and at any time (2 cases in Loborsoit A). In Naitolia the damage occurred during the night and the afternoon.

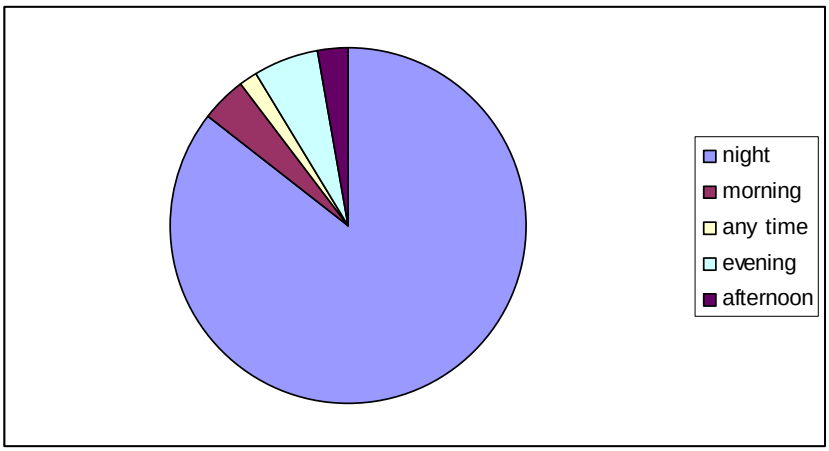

Figure 10 Pie chart of the time of the damage

3.2.8 Prevention methods

Out of 60 farms which reported data on adopted prevention system, size of the damage and species responsible for crop damage, only 4 farms (6.6%) did not use prevention methods at all. These farms were all located in Lolkisale. The average size of the farms was 11.25 acres. The damage by occurrence was 0.51 acres. On average, 6% of the farm was damaged by wildlife. Totally 2.5 acres was damaged over 56.25 acres of cultivated land. The farms were damaged only by the elephant.

No farms used passive methods alone. Twenty-six (26) farms combined passive and active methods over a total amount of 208.3 acres. Totally 114.7 acres were damaged by wildlife, equivalent to 55.1%. The average size of these farms per damage occurrence was 8.01 acres (sd=14.3; median=2.5). The average size of the damage per occurrence was 4.4 acres (sd=13.5; median=1). On average, 45.3% of the farm defended by a combination of passive and active methods was damaged by wildlife per occurrence (median=39.5). The average number of species per occurrence was 3.1 (sd=1.6; median=3). These farms were fenced mainly with rope and vegetation. Only 3 farms were fenced with wire fences: one farm located in Loborsoit A was delimited with conventional wire fence. This farm was damaged only by baboon for a total area of 0.3 acres. The other two farms used a man-made wire fence. Both of them were damaged by a big group of elephant causing a large damage. One of them, located in Loborsoit A, was defended by wire fence, loud noise, flash light and smoke from dung. However the farm was damaged by a group of 7 elephants over 0.18 acres (22% of the plot size). The other farm located in Lolkisale was fenced with vegetation and rope, guarded by a man and defended with loud noise, flash light and smoke from dung. The entire plot of 70 acres was damaged by 6 big elephants. A detailed analysis of the 26 farms which adopted a combination of passive and active methods revealed that 8 farms were fenced only with rope accounting for 18.4 acres of damage, equivalent to 16% of the total damage caused to farms using mixed prevention methods. The average number of species entering in these cultivated fields was higher (3.18). All these farms were located in Naitolia.

Thirty (30) farms used active methods only over a total amount of 389.14 acres. The total amount of damage was 40.53 acres (10.4%). The average size of the plot was 13 acres (sd=22.6; median=6) and the average size of the damage was 1.35 acres (sd=1.08; median=0.9). On average, 28.3% of the farm (sd=0.29; median=21.2%) was damaged per incident. The average number of wildlife species was 2.1 (sd=1.06). Thus the farms adopting active methods only, appear to suffer less damage than the farms adopting mixed prevention systems. The results of the statistical analysis are shown in table 5. It can be noted that the average size of the farms using only active methods was significantly larger than the average size of the farms adopting mixed methods (1 tailed t test, $p>0.05$). Although the average amount of damage was not significantly different between the two types of farms, the proportion of damage was significantly higher for farms adopting mixed prevention methods. We also found that the number of species entering the farms per damage occurrence was significantly higher for farms with mixed prevention methods than for farms with active prevention methods (1 tailed Mann-Whitney test, $z=-2.07$, $p=0.015$). In other words, the active methods were more efficient than mixed methods and were adopted mostly by larger farms. It was also noted that the absolute size of the damage per occurrence was not significantly different between the two types of farms. Therefore, although we may expect a higher damage in larger farms due to higher availability of food, the active prevention methods (such as watchmen, fire, loud noise, etc.) were able to chase the animals away and reduce the amount of damage.

The farms that adopted only active methods were located in Lolkisale (82.7%) and in Loborsoit A (17.3%). It is interesting to notice that only one farm located in Lolkisale used vegetation fences besides the active methods. All other farms in Lolkisale did not use barriers or fences. No farms located in Naitolia adopted active prevention methods only. In Loborsoit A the farms adopted as mixed as well as active prevention methods only. No significant differences however were found between the size, damage, proportion and number of species between the two types of farms in this village (Mann-Whitney test, $p>0.05$).

Table 5 Results of the t test between active and mixed methods regarding plot size, damage size and proportion of damage per occurrence

	Levene's Test for Equality of Variances		**t-test for Equality of Means**						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Upper	Lower
lg10 average plot size	0.02	0.889	2.227	52	0.03*	0.3262	0.1465	0.032	0.620
lg10 average damage	0.018	0.894	-0.62	52	0.538	-0.10048	0.16208	-0.425	0.224
Sqrt average proportion of damage	3.183	0.08	-2.674	52	0.01*	-0.17855	0.06677	-0.312	-0.044

*1-tailed p values is 0.015 and 0.005 respectively

3.2.9 Dominant habitat type surrounding the damaged cultivated fields

Agriculture was the dominant habitat type around the majority of the damaged farms (41%). Forest and mixed agriculture were recorded for 18% and 10% of the farms. Open savannah surrounded only 7% of the farms (table 6).

Table 6 Percentages of dominant habitat type around damaged farms

Dominant habitat type around the damaged farms	N (%)
Forest (Misitu ya asili)	26 (18%)
Open savanna (Nyasi)	10 (7%)
Agriculture (Kilimo cha kisasa)	61 (41%)
Mixed agriculture	15 (10%)
Other (Wengineo)	11 (7%)
Missing data	24 (16%)
tot	147

In Loborsoit A mixed agriculture and forest were the dominant habitat around the farms (41% and 47% respectively). In Lolkisale and in Naitolia the cultivated fields were surrounded mainly by forest (38%) and by agriculture (98%) respectively. The location of the damaged farms in opens savannah was recorded only in Lolkisale (19%) and Loborsoit A (6%).

The majority of the damaged farms were in proximity of other farms (69%), while 13% were isolated and 8% scattered. In Loborsoit A the farms were mainly isolated (59%), while in Lolkisale and Naitolia they were in proximity of other farms (79% and 95% respectively)(table 7).

Table 7 Distribution of the damaged plot in relation to others plots

Plot distribution	N
Continuous	101 (69%)
Scattered	12 (8%)
Isolated	19 (13%)
missing	15 (10%)
Total	147

3.2.10 Geographic location of crop raiding occurrences in 2006

The geographic locations of the crop damage occurrences were recorded with a GPS by the enumerators. They were mapped to visualize their spatial distribution in relation to the Tarangire National Park, wildlife dispersal areas, grazing areas and corridors, roads and land use types derived from the participatory land use planning activity of the villages (FAO_LEAD 2007)(figure 11).

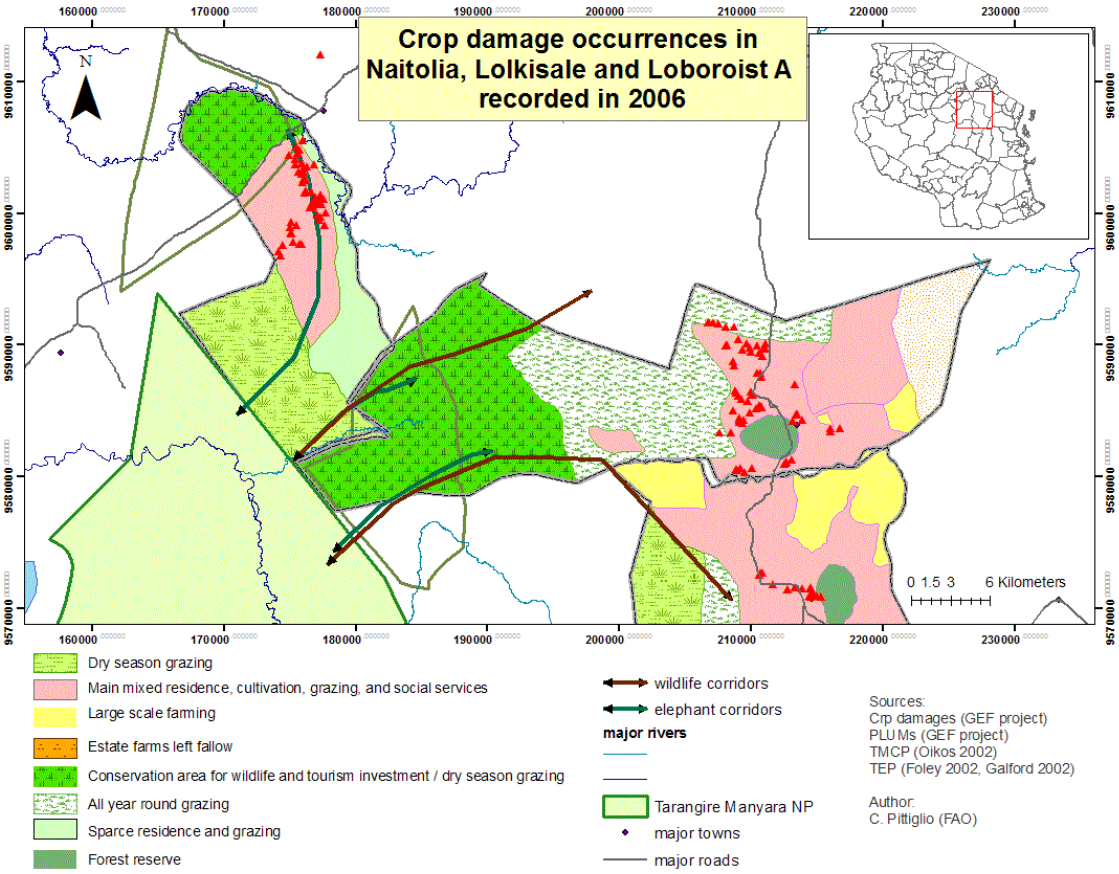

Figure 11 Crop damages (red triangles) occurred in Naitolia, Lolkisale and Loborsoit A in 2006. The land use categories are derived from a simplification of the categories reported in the PLUMs of the villages (FAO-LEAD 2007).

3.2.11 Summary of the results of crop damages for 2006

The results of the crop damage analysis can be summarized as follows:

1) Maize and beans (including lablab beans) were the crops mostly damaged in the study area. These are the crops most cultivated by the farmers and therefore more abundant and accessible to wildlife;
2) The time of crop raiding was mainly occurring during the dark hours (evening and night).
3) The species that caused the highest number of incidents were elephants, zebra and warthog/wild pig. However at village level, elephants were the major cause of crop raiding only in Lolkisale. In Loborsoit A and in Naitolia warthog/wild pig and zebra were responsible for the highest percentage of crop damage. The crop damage was mainly caused by different species per occurrence, namely more than 3-4 species per night.
4) The analysis on the composition of the elephant group size showed that on average the group size was 6-9 animals when the damage occurred.

5) Twenty-five percent of the total cultivated area surveyed by the HWC activity was damaged by wildlife. Naitolia was the village having the highest percentage of acres damaged by wildlife.
6) The analysis on the plot size and on the damage of the plot revealed that the farms monitored in this activity were mainly practicing subsistence agriculture. In fact the average size of the plot was less than 10 acres. These small farms were also those incurring higher level of damage (as shown by the relation between proportion of damage and plot size). In other words, small farms appear to be more vulnerable to wildlife, especially to elephants.
7) In few cases, elephants caused destruction of food stores, water supplies and human death (totally 9 cases).
8) Regarding the prevention methods, the analysis revealed that farms adopting active methods (which include watchman, fire, laud noise, smoke etc) were significantly less damaged than farms using a mix of active and passive methods (e.g. including also fences and barriers). Furthermore, the number of wildlife species per occurrence was significantly lower for farms with active prevention methods than for farms with mixed prevention methods. In other words, active prevention methods appear to be more effective in preventing crop raiding than mixed active/passive methods. In addition it was found that active methods were significantly more used by larger farms. A recent study on HWC in Kenya (Sitati et al. 2005) showed a significant association between the presence of fences and the decrease of active prevention methods (such as fire, noise and the presence of a watchman,) of the farm, resulting in a higher probability of crop damage. Our result confirms the findings of Sitati et. al. (2005). In addition a personal observation of author in the fields corroborates this result: the fences used in the study area are not effective against large herbivores, especially against elephant. Often they are even not fencing the whole perimeter of the plot. The presence of a watchman and other activities related to the presence of humans (such as fire, loud noise, smoke etc.) is more successful in chasing the animals approaching the plot, thus preventing crop damage.

3.3 Crop damages occurred in 2007

In 2007 the HWC occurrences were monitored in Loborsoit A and Lolkisale from January to August. Naitolia was not monitored. Totally, 103 farms were damaged between 1st of January 2007 to 15th August 2007 (figure 12). Sixty-nine percent of these farms were located in Loborsoit A (n=71) and 31% in Lolkisale (n=32).

Twenty-eight percent of the farms started cultivating less than 5 years ago and 40% between 5 and 10 years ago. Most of them were located in Loborsoit A, confirming the recent phenomenon of conversion to agriculture in this village.

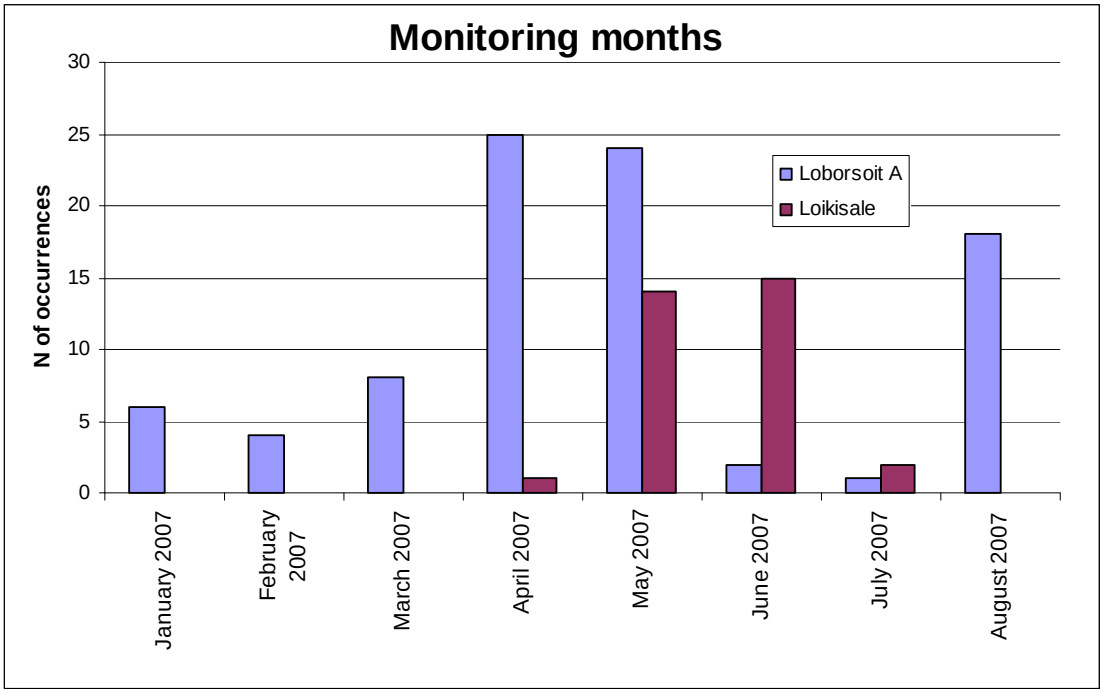

Figure 12 Occurrences of crops damage in 2007

Only one farm reported human injury besides the destruction of crops. This farm was located in Lolkisale and was damaged by a group of 24 elephants.

Eight farms were damaged two times during the monitoring activity. They were located in forest and open savannah, far from other farms and therefore very vulnerable. Other 4 farms were damaged also in 2006.

3.3.1 Damaged crops: type, quality and age

A total of 133 incidents of crop damage were recorded in 103 farms. Most of the farms reported one damaged crop per damage occurrence (74.2%). 19.8% of the farms reported 2 damaged crops and 6% 3 damaged crops. These results were different from those collected in 2006, where most of the farms reported 2-3 damaged crops per damage occurrence (58.6%). Indeed these results reflect the situation in Loborsoit A, where most of the farms had one damaged crop as in 2006 as well as in 2007.

The most damaged crop in both villages was maize (62.5%), followed by beans (25%). In Lolkisale cowpeas and lablab beans were marginally damaged (1.4%). Other crops were damaged but unfortunately the enumerators did not specify the name (22.5%).

In Loborsoit A most of the damaged crops were at the intermediate phase of maturation (55.4%), while in Lolkisale in the mature phase. This difference between the villages is due to the fact that in Loborsoit A the HWC monitoring activity included the wet season, while in Lolkisale it was concentrated during the dry season, when the crops are mature.

The quality of the crop before the damage was estimated by the enumerators as of medium (55%) and good (35.3%) quality. In Lolkisale 3% of the damaged crops were considered poor.

3.3.2 Plot size and damage

The analysis on the plot size and damage was based on 102 farms. Out of 525.8 acres surveyed by the enumerators immediately after the damage, 126.4 acres were damaged by wildlife. Totally 24% of the surveyed area was damaged in 2007. The proportion of damaged area in 2007 was similar to the proportion of damaged area in 2006 (25.2%). However the amount of surveyed and damaged areas in 2007 was lower than in 2006, approximately half than in 2006 (see table 3 and table 8).

Table 8 Total surveyed and damaged area and average size of the plots and of the damaged crops per incident at village level in 2007.

Village name	Total surveyed area (acres)	Total damaged area (acres)	Average plot size (acres)	Average size of damage per farm (acres)
Loborsoit A (n=71)	400.8	80.4 (20%)	5.65	1.13
Lolkisale (n=31)	125	46 (36.8%)	4.03	1.48
Total (n=102)	525.8	126.4 (24%)	5.15	1.24

The average size of the surveyed farms was 5.15 acres (sd=5.17). The smallest and the largest farms were located in Loborsoit A (0.62 and 24 acres respectively). On average the size of the damage per farm was 1.24 acres (1.37). The smallest damage (0.05 acres) was located in Loborsoit A while the largest damage was in Lolkisale (6.2 acres). In Loborsoit A, out of 400.8 acres surveyed, 80.4 acres were damaged by wildlife, equivalent to 20% of the surveyed area. This proportion of damage was similar to the one estimated in 2006. The average size of the farm was 5.65 acres (sd=5.56), almost double than the average cultivated fields surveyed in 2006 (3.44 acres). The average size of the damage per farm was 1.13 acres (sd=1.37), double larger than the average damage estimated in 2006. In Lolkisale the average size of the farm was 4.03 acres (sd=4.02). The average size of the damage was 1.48 (sd=1.35). The average size of the damage in 2007 was slightly larger than that in 2006. However the average size of the farms was 3 times smaller than in 2006. In other words, the proportion of damage occurred in 2007 was 3 times larger than that occurred in 2006. These differences between the data of 2006 and 2007 in the two villages can be explained by the fact that in 2006 Loborsoit A was monitored only in a few farms (totally 20 farms). While in 2007 a large sample of 71 farms was monitored. Similarly Lolkisale was largely surveyed in 2006 (n=66), but not in 2007 (n=31).

3.3.3 Species responsible for crop damage

The species responsible for crop damage were recorded in 101 farms. Most of the damage occurrences were caused by more than one single species. Specifically 75% of the damage occurrences were caused by 2-3 species during the same night. The damages caused by more than 4 species were less frequent (14%)(figure 13).

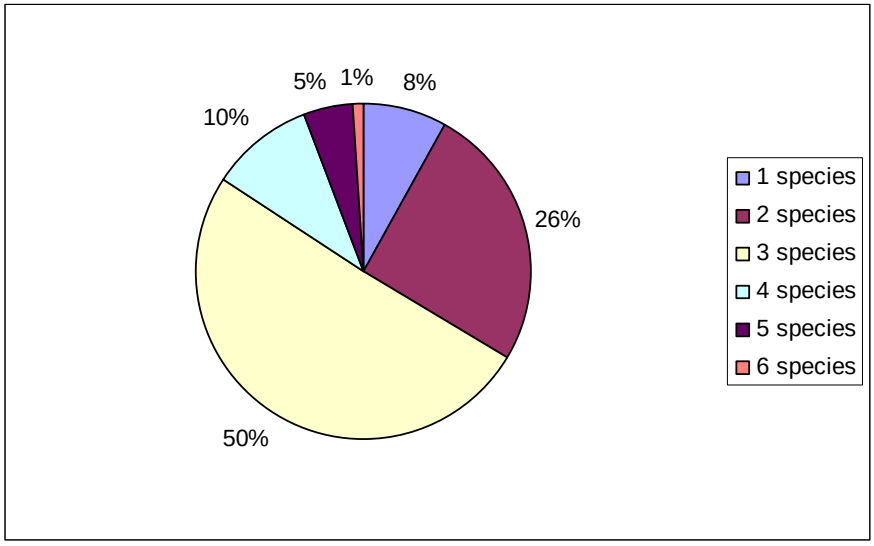

Figure 13 Number of wildlife species responsible for crop damage per occurrence.

In Loborsoit A no damages were caused by one species only. Most of the crop damage occurrences were caused by 3 species (53%) and 2 species (24%). In one case, the damage was caused by 6 species during the same event. In Lolkisale, 26% of the occurrences were caused by one species only. While 45% of the occurrences were caused by 3 species and 29% by 2 species (figure 14).

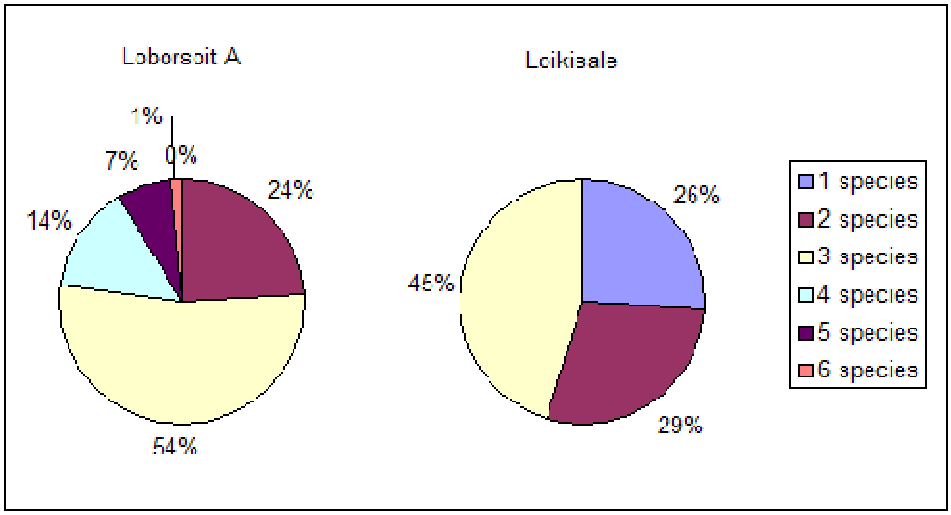

Figure 14 Percentage of damage occurrences caused by one (cyan) to 6 species per damage event in Loborsoit A (70) and Lolkisale (31) in 2007.

The species that most frequently caused crop damage was warthog/wild pig (36.8%, followed by zebra (16.5%), elephant (15.8%) and antelopes (13.7%). Eland, ostrich, buffalo and wildebeest marginally caused crop raiding (less than 2.5% each) (figure 15). Other species accounted for 9% of the crop damage. Unfortunately their name was not recorded.

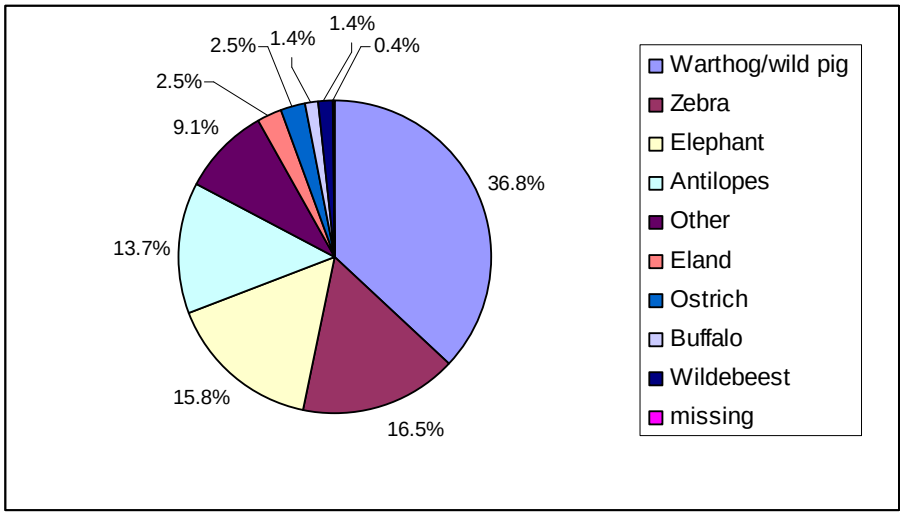

Figure 15 Percentage of crop damage occurrences per wildlife species in 2007.

At village level, warthog/wild pig was the major caused of crop damage in Loborsoit A (40.5%), followed by zebra (20.2%) and antelopes (14.7%). In this village the elephant accounted only for 7.3% of crop damage. These results are similar to those obtained in 2006 for Loborsoit A, where warthog/wild pig accounted for 44% of the damage occurrences. In 2006 however the elephant caused more damage than in 2007, accounting for 16% of the damage against 7% in 2007. In Lolkisale, the elephant was the major caused of crop damage (42.6%), followed by warthog/wild pig (25%) and antelopes 10.2%, confirming the results obtained in 2006. However the crop raiding caused by elephants in 2007 were less than in 2006, while those caused by warthog/wild pig were more in 2007 than in 2006. In addition it is interesting to notice that in 2007 the wildebeest was recorded among the species causing crop damage (although only marginally), while in 2006 it was never recorded. These results are shown in figure 16.

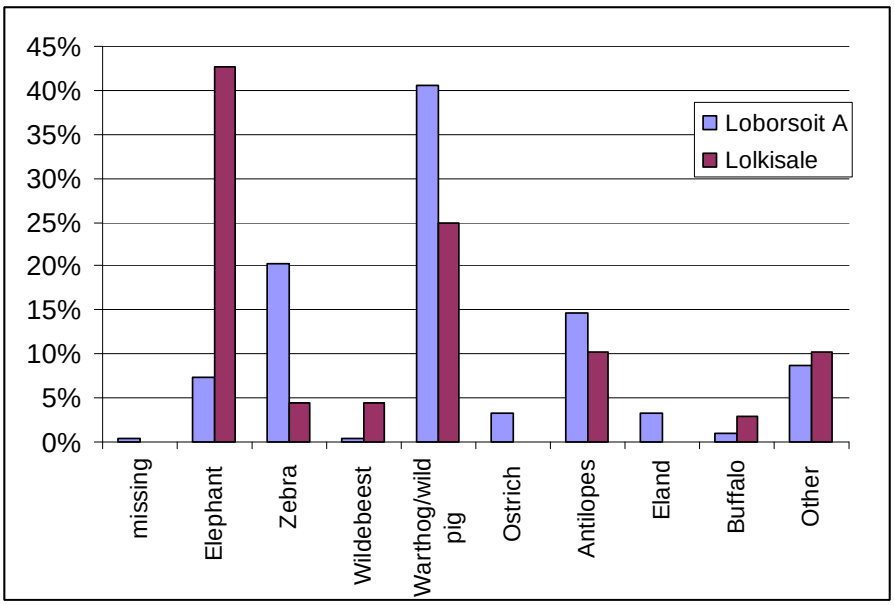

Figure 16 Percentages of crop damage occurrences caused by wildlife species

3.3.4 Group size of wildlife species

The average group size of elephants was 8.3, ranging from 4 animals in Loborsoit A to 10 animals in Lolkisale. The minimum number of animals per crop damage occurrence was recorded in Loborsoit A (2 individuals) while the largest group size was recorded in Lolkisale (24 animals). These results were similar to those obtained in 2006. The average group size of warthog/wild pig was 5.2 as in 2006. The average group size of antelopes and zebra was 23.3 and 17.5 respectively, larger than those registered in 2006. These results are shown in table 9.

Table 9 Average group size of the main species responsible for crop damage in 2007

Species	Average group size	Min	Max	N
Elephant (Tembo)	8.3	2	24	30
Zebra (Pundamilia)	17.5	5	40	14
Warthog (Ngiri)	6.07	2	16	14
Ostrich (Mbuni)	10	10	10	1
Antilopes (Swala)	23.33	18	30	6
Eland (Pofu)	6	6	6	1
Buffalo (Mbogo)	16	16	16	1
Wild Pig (Ngurue Pori)	4.53	1	10	15
Other (Wengineo)	21.43	2	40	7

3.3.5 Relation between group of species and size of the damage per occurrence

The size of the plot, the size of the damage and the number of wildlife species per incident were $\log_{10}$ transformed to approximate to a normal distribution (Kolmogorov-Smirnov test, $p>0.05$). The proportion of the damaged area was square-root transformed as explained in the methods. The results reported in table 10 showed that there were no significant correlation between mean log10 number of species, mean log10 damaged areas (Pearson test, $p>0.05$, $N=6$), mean log10 plot size (Pearson test, $p>0.05$) and the mean square root of the proportion of damage (Pearson test, $p>0.05$). A significant positive correlation was found between: a) the mean log10 damaged area and the mean log10 plot size (Pearson test, $r=0.393$, $p=0.00$, $N=6$); b) the mean log10 damaged area and the mean square root proportion of the damage (Pearson test, $r=0.669$, $p=0.00$, $N=6$). Furthermore a significant negative correlation was found between the mean log10 plot size and the mean square root proportion of damaged area (Pearson test, $r=-0.354$, $p=0.00$, $N=6$). In other words, the larger the farms, the larger the damage caused by wildlife species. The results also confirmed that smaller farms suffered high crop raiding as found in 2006. Differently from 2006, the number of species was not correlated with the proportion of damaged area and with the size of the plot.

Table 10 Results of Pearson correlation test between N of species (log10), damaged area (log10), plot size(log10), proportion of damaged area (square root transformed)

		lg10_Nspecies	logplotsize	logdamage	sqrt_prop
lg10_Nspecies	Pearson Correlation	1	.277	-.232	-.412
	Sig. (2-tailed)		.595	.659	.417
logplotsize	Pearson Correlation	.277	1	.393(**)	-.354(**)
	Sig. (2-tailed)	.595		.000	.000
logdamage	Pearson Correlation	-.232	.393(**)	1	.669(**)
	Sig. (2-tailed)	.659	.000		.000
sqrt_prop	Pearson Correlation	-.412	-.354(**)	.669(**)	1
	Sig. (2-tailed)	.417	.000	.000	

** Correlation is significant at the 0.01 level (2-tailed).

3.3.6 The elephant

In Lolkisale, 8 farms were damaged exclusively by the elephant. A total amount of 17.5 acres were surveyed immediately after the damage. The average plot size was 2.19 acres with a minimum of 0.72 and a maximum of 6.22 acres. Thirty percent of the surveyed area was damaged by the elephant. On average the damaged area per farm was 0.64 acres with a minimum of 0.20 acres and a maximum of 1.13 acres. A positive relation between the number of elephants (group size) and the size of the damage was found ($y = 0.0286x + 0.2901$, $R^2 = 0.4132$). The crop mostly damaged by elephants was maize (53.3%).

3.3.7 Time of damage

Ninety-three damaged farms reported the time of the damage. Figure 17 shows that most of the damages occurred at night (76%) confirming the results obtained in 2006. In Loborsoit A, 70% of the crop raiding occurred at night and 12.3% of the crop raiding occurred also in the afternoon. In Lolkisale 89% of the damages occurred at night.

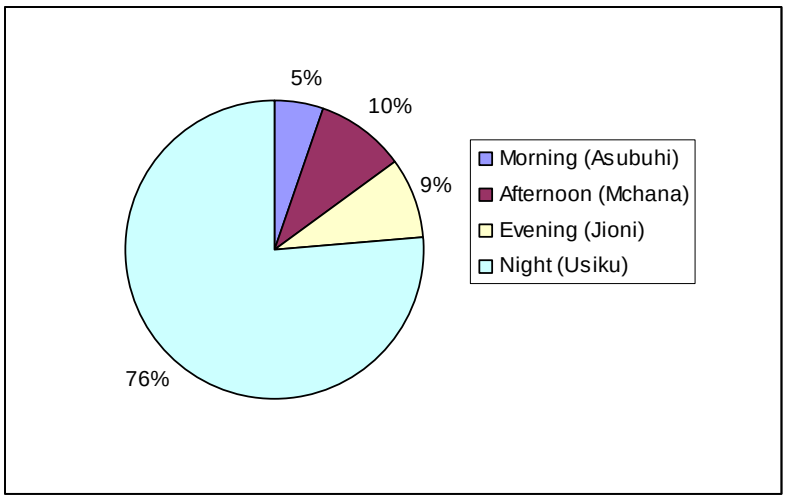

Figure 17 Time of the crop damage occurrences

3.3.8 Prevention methods

Out of 101 farms which reported data on adopted prevention systems, size of the damage and species responsible for crop damage, only 6 farms (5.9%) did not use prevention methods at all. These farms were all located in Lolkisale. The average size of the farms was 2.72 acres. The average damage by occurrence was 0.83 acres. On average, 39.9% of the farms were damaged by wildlife. Totally 5 acres were damaged over 16.3 acres of surveyed cultivated land. The farms were mainly damaged by two species simultaneously, namely by elephant and warthog/wild pig. These farms were not the same farms recorded in 2006.

No farms used passive methods only. Sixty-nine (69) farms combined passive and active methods over a total amount of 377.4 acres. Totally 77.18 acres were damaged by wildlife, equivalent to 20.5%. The average size of these farms per damage occurrence was 5.5 acres (sd=5.5; median=3.8). The average size of the damage per occurrence was 1.12 acres (sd=1.36; median=0.53). On average, 26.7% of the farm defended by a combination of passive and active methods was damaged by wildlife per occurrence (median=16.7). The average number of species per occurrence was 3.04 (sd=0.95; median=3). All these farms were fenced exclusively with vegetation, with the exception of two farms which were fenced with home made wire fences. Rope was used only in one case together with vegetation barriers. The active methods used in combination with the passive methods were the presence of a watchman (in 68 farms out of 69), loud noise, flash light, and smoke from livestock and/or elephant dung (all more than 90% of the farms). Fire was used only by 10% of the farmers. Eight farms located in Loborsoit A were totally damaged by wildlife species. The species responsible of the damage were elephant, warthog/wild pig, antelopes and zebra. These farms did not use fire as a prevention method.

Twenty-six (26) farms used active methods only over a total amount of 128.77 acres. The total amount of damage was 40.87 acres (31.7%). The average size of the plot was 4.95 acres (sd=4.83; median=2.54) and the average size of the damage was 1.57 acres (sd=1.46; median=1.23). On average, 45.7% of the farm (sd=0.29; median=44.8%) was damaged per incident. The average number of wildlife species was 2.3 (sd=0.84). All these farms used fire to prevent crop raiding. On the contrary, the presence of a watchman was used only by 38.5% of the farmers.

The statistical analysis showed that the farms adopting active methods only suffered larger damages than the farms adopting mixed prevention methods (t test, t=-2.7, df=58.9, p=0.009). The size of the farms were not statistically different (t test, p>0.05). This may be explained by the higher presence of a watchman (98.5%) in farms adopting mixed prevention methods than in farms using active methods only (42%). It appears that the combination of the presence of a watchman, the vegetation barriers and the use of smoke was more effective in chasing the animals away once they entered the farm than the use of fire (which was the method most used within the farms of active prevention methods).

These results appear to contradict the results obtained in 2006, where farms with mixed prevention methods suffered damages larger than farms with active prevention methods only. However the mixed prevention methods used in 2006 were characterized almost exclusively by the use of rope, which is a weaker fence against wildlife than the vegetation barrier. In addition, the presence of a watchman was

lower in 2006 than in 2007: for instance, from a detailed analysis in Loborsoit A, it emerged that in 2006 only 25% of farms using mixed prevention methods had a watchman, against 98.5% of the farms in 2007. On the other hand, a detailed analysis of active prevention methods adopted in Lolkisale revealed that in 2006 75% of the farms had a watchman against 47% of farms in 2007. This could explain the increased amount of damage in 2007 for farms with active prevention methods. Moreover it indicates that the presence of a watchman is an efficient prevention method.

3.3.9 Geographic location of crop raiding occurrences in 2007

Figure 18 shows the location of crop damages (red triangles) occurred in 2007 in relation to wildlife protected and dispersal areas, infrastructures, land use of the villages. The land use categories are derived from a simplification of the categories reported in the PLUMs of the villages (FAO-LEAD 2007).

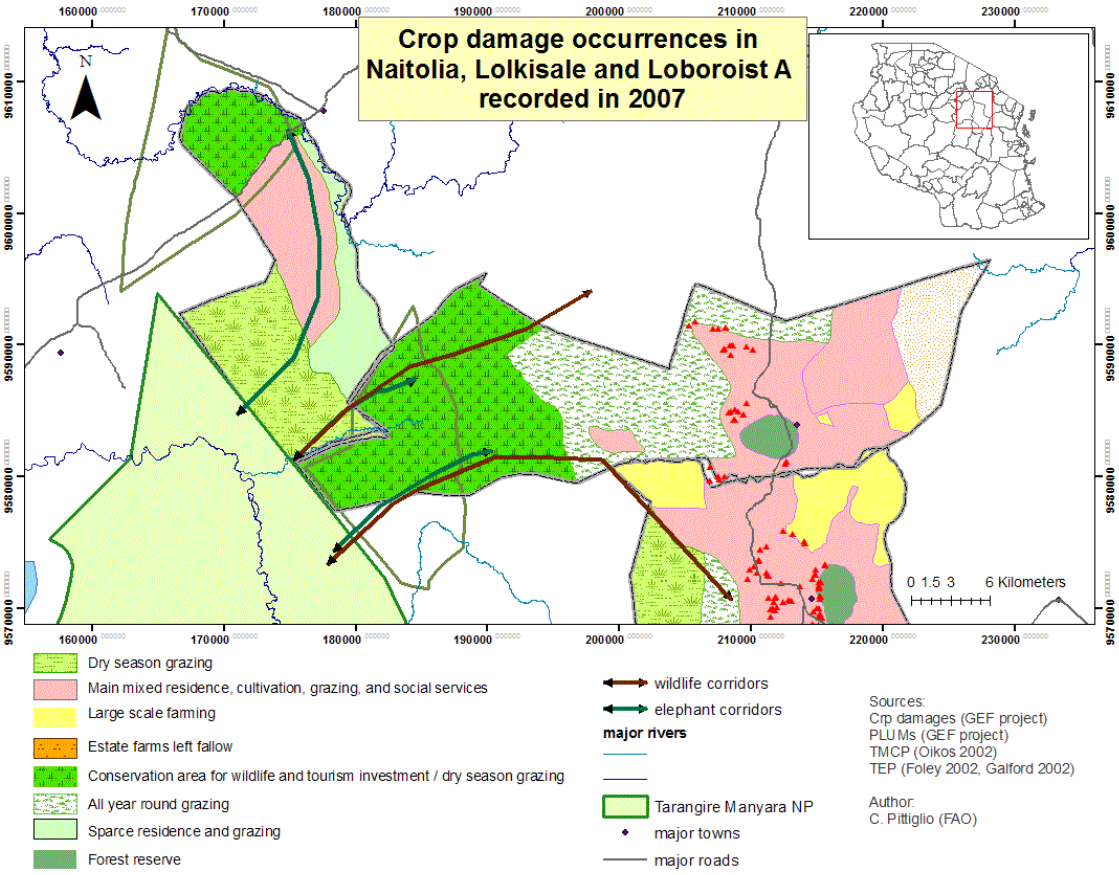

Figure 18 Crop damages (red triangles) occurred in Naitolia, Lolkisale and Loborsoit A in 2007.

3.3.10 Summary of the results of crop damages for 2007

The analysis of the crop damage occurrences in 2007 showed the following results:

1) Maize and beans are confirmed to be the most cultivated crops in the study area. As a consequence, they are the most damaged crop by wildlife;
2) The time of crop raiding is confirmed to occur at night;
3) The crop damages were mainly caused by more than 2-3 species per night. The species causing the highest number of incidents in 2007 were in descending order: warthog/wild pig, zebra, elephant and antelopes. This is slightly different from 2006, where most of the damages were caused by elephant, followed by zebra and warthog/wild pig. However at village level there are not significant differences between 2006 and 2007: in fact elephant and warthog/wild pig are confirmed as the main cause of crop damages in Lolkisale and Loborsoit A respectively; it is interesting to notice that in 2007 elephants caused less damage than in 2006;
4) Twenty-four percent of the total surveyed area was damaged in 2007. This result was similar to 2006, although the amount of surveyed and damage area in 2007 was half than in 2006;
5) The size of the cultivated fields was smaller than in 2006, while the damage was two or three times larger than in 2006. This difference is probably due to the fact that in 2007 more farms were monitored in Loborsoit A while less farms where monitored in Lolkisale; the size of the cultivated fields in Loborsoit A is generally smaller than in Lolkisale as it emerges from the socio-economic survey of 2005-2006;
6) The average group size of elephants (8.3) in 2006 was similar to 2007 (8.3), suggesting that the elephant population did not change over time;
7) Regarding the prevention methods, the analysis revealed that the farms adopting mixed prevention methods in 2007 suffered smaller damage than those adopting active methods only. These results appear to contradict the results of 2006. However detailed analysis at village level showed that the farms with mixed prevention methods used a combination of vegetation barriers, smoke, loud noise and moreover the presence of a watchman. In particular the presence of a watchman was higher in farms with mixed methods than in farms with active methods only. This made the farms more effective in chasing the animals away and reducing the damage. On the other hand, in 2006 the presence of a watchman was higher in farms with active methods only. This result suggests that the presence of a watchman and the use of vegetation barriers around the cultivated fields are effective prevention methods.

3.4 Crop damages occurred in 2008

In 2008 the crop damage occurrences were monitored in Loborsoit A, Lolkisale and Naitolia from 12th of April to 4th of September (figure 19). Out of 146 damaged farms, 28% were located in Loborsoit A, 54% in Lolkisale and 18% in Naitolia.

Most of the farmers (65%) started to cultivate their land more than 10-15 years ago. However in Loborsoit A the majority of the farmers (85%) started between 5 and 10 years ago and 12% of the farmers less then 5 years ago. None in Loborsoit A started to cultivate more than 10 years ago. This confirmed that in Loborsoit A the conversion from rangelands to agriculture is a recent phenomenon. On the other hand, in Naitolia and in Lolkisale the majority of the farmers started to cultivate long time ago. In Naitolia it is interesting to note that all monitored farmers started more than 10 years and none less than 5 years ago. In other words, the conversion to agriculture in Naitolia is not an ongoing process and started long time ago. Differently from Naitolia, in Lolkisale the conversion of grazing areas to agriculture is still an ongoing process as shown by the number of new farms recently settled (6% in the last 5 years). These results corroborate what emerged from the socio-economic survey of 2006 regarding the agriculture encroachment in Loborsoit A, Lolkisale and Naitolia (Socio-economic survey FAO-LEAD 2009).

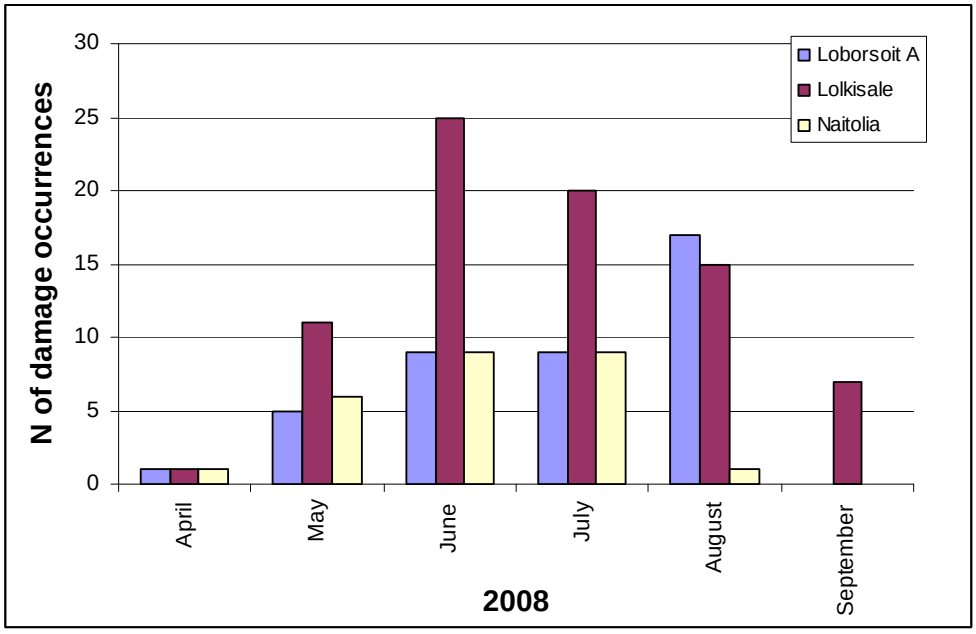

Figure 19 Months of crop damage occurrences in 2008

Four farms were damaged two times during the monitoring period of 2008. Three farmers were damaged in different plots. Twelve farmers were damaged also in 2006 and in 2007.

3.4.1 Damaged crops: type, quality and age

A total of 226 incidents of crop damage were recorded in 146 farms. Most of the farmers reported one damaged crop per damage occurrence (57%). Thirty-one (31%) percent of the farmers reported 2 damaged crops and 12% 3 damaged crops per occurrence. Differently from 2006, no farmer reported more than 3 damaged crops per occurrence. Generally, the results of 2008 were slightly different from those obtained in 2006, where most of the farmers reported 2 damaged crops per damage occurrence (45.4%). However at village level the results are consistent among the years as shown in table 11.

Table 11 Proportion of damage occurrence in Loborsoit A, Lolkisale and Naitolia.

		1 crop	2 crops	3 crops	4 crops	5 crops
Loborsoit A	2006	0.526316	0.368421	0.052632	0.052632	
	2007	0.927536	0.072464			
	2008	1				
Lolkisale	2006	0.4375	0.421875	0.078125	0.03125	0.015625
	2007	0.34375	0.46875	0.1875		
	2008	0.468354	0.443038	0.088608		
Naitolia	2006	0.2	0.516667	0.216667	0.066667	
	2007					
	2008	0.192308	0.423077	0.384615		

The most damaged crop was maize (57.1%), followed by lablab beans (22.1%), green gram (8.8%), beans (6.2%), cowpeas (1.8%), sunflower (1.3%) and sorghum (1.3%). At village level, maize was the most damaged crop in Loborsoit A (92.5%) and in Lolkisale (57.4%). In Naitolia, maize and green gram were the most damaged crops (31.6% each). In descending order, the most damaged crop was lablab beans in Lolkisale (31%) and Naitolia (17.5%) and beans (5%) in Naitolia (figure 20).

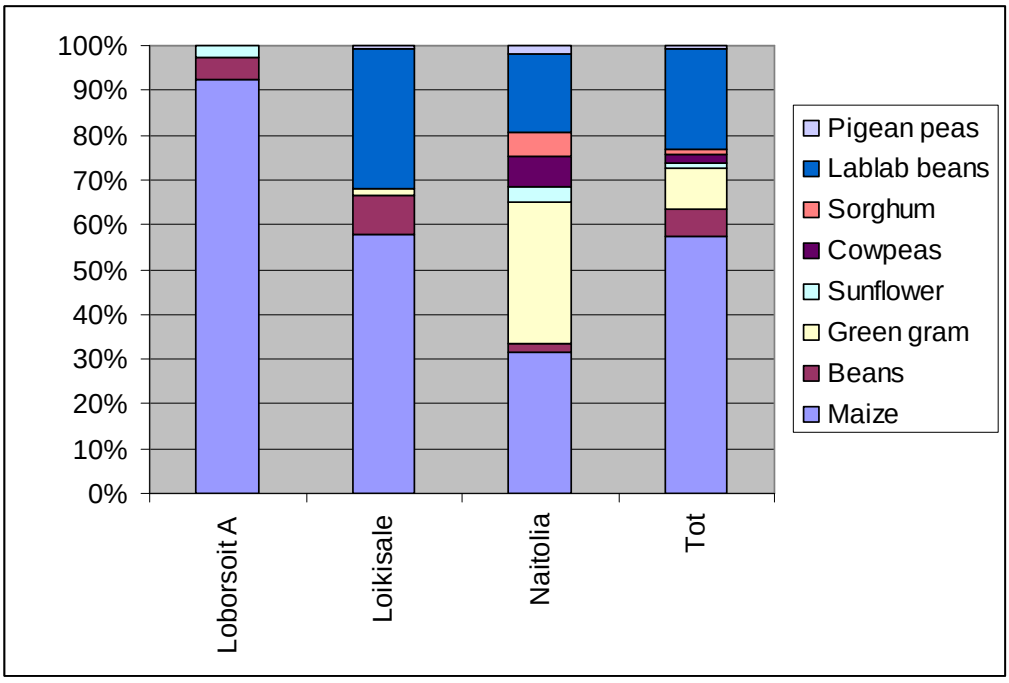

Figure 20 Proportion of damaged crops in the 3 villages.

Because the crop damage occurrence was monitored from April to September 2008, the damaged crops were of intermediate (22.2) and mature age (62.2%).

The quality of the crop before the damage was estimated by the enumerators as of medium (60.2%) and good (32.3%) quality. In Lolkisale 2.2% of the damaged crops were considered poor.

3.4.2 Plot size and damage

Out of 146 farms surveyed by the HWC monitoring activity, 130 farms were statistically analyzed in relation to the plot size and the amount of damage. Sixteen (16) farms, all located in Naitolia, were excluded from this analysis because they did not report correct information about the size of the plot and the amount of damage.

Out of 760.28 acres surveyed by the enumerators immediately after the damage, 238.49 acres were damaged by wildlife. Totally 31.4% of the surveyed area was damaged in 2008. The proportion of damaged area in 2008 was higher than the proportion of damaged area in 2006 (25.2%) and in 2007 (24%). The total surveyed area in 2008 was smaller than in 2006 and larger than in 2007 (see figure 1).

The average size of the surveyed farms was 5.85 acres (sd=6.82). The smallest and the largest farms were located in Loborsoit A (0.04 acres) and in Lolkisale (37.19 acres) respectively. On average the size of the damage per farm was 1.83 acres (sd=2.55). The smallest damage (0.008 acres) was located in Loborsoit A while the largest damage was located in Lolkisale (12.86 acres)(table 12). In Loborsoit A, out of 136.7 acres surveyed, 21.21 acres were damaged by wildlife, equivalent to 15.5% of the surveyed area. This proportion of damage was lower than the one estimated in 2006 and 2007. The average size of the farm was 3.33 acres (sd=5.86), similar to the one estimated in 2006 (3.44 acres) but almost half than the average cultivated fields surveyed in 2007 (5.65 acres). The average size of the damage per farm was 0.52 acres, slightly smaller than the one estimated in 2006 (0.64 acres) and almost half than the one measured in 2007 (1.13 acres).

In Lolkisale out of 596.5 acres surveyed, 209.16 acres were damaged, corresponding to 35% of the total surveyed area. The average size of the farm (7.55 acres; sd=7.15) was larger than the one estimated in 2007 (4.03 acres) and smaller than the one measured in 2006 (13 acres). The average size of the damage (2.65; sd=2.88) was larger than the one estimated in 2007 and 2006 (1.48 and 1.24 acres respectively).

In Naitolia out of 27.1 acres surveyed, 8.12 acres were damaged corresponding to 30% of the surveyed area. The average size of the farm (2.71 acres; sd=2.23) was smaller than the one estimated in 2006 (7.28 acres). The average size of the damage (0.81 acres; sd=0.64) was smaller than the one estimated in 2006 (2.83 acres).

Table 12 Total surveyed and damaged area, average size of the cultivated plots and of the damage per incident at village level in 2008.

Village name	Total surveyed area (acres)	Total damaged area (acres)	Average plot size (acres)	Average size of damage by plot (acres)	Average Proportion of damage by plot
Loborsoit A (n=41)	136.7	21.21 (15.5%)	3.33	0.52	0.195
Lolkisale (n=79)	596.5	209.16 (35.06%)	7.55	2.65	0.41
Naitolia (10)	27.1	8.12 (30%)	2.7	0.81	0.33
Total (n=102)	760.28	238.49(31.4%)	5.85	1.83	0.34

3.4.3 Species responsible for crop damage

The species responsible for crop damage were recorded in 130 farms. Most of the damage occurrences were caused by one species (56%) per night. Differently from 2006 and 2007, the crop damage occurrences caused by 2-3 species were not frequent in 2008. Specifically only 29% of the surveyed farms were damaged by 2 species per night and 8% by 3 species. In one occasion, one farm located in Naitolia was damaged by 6 species during the same night (figure 21). These percentages were similar also at village level.

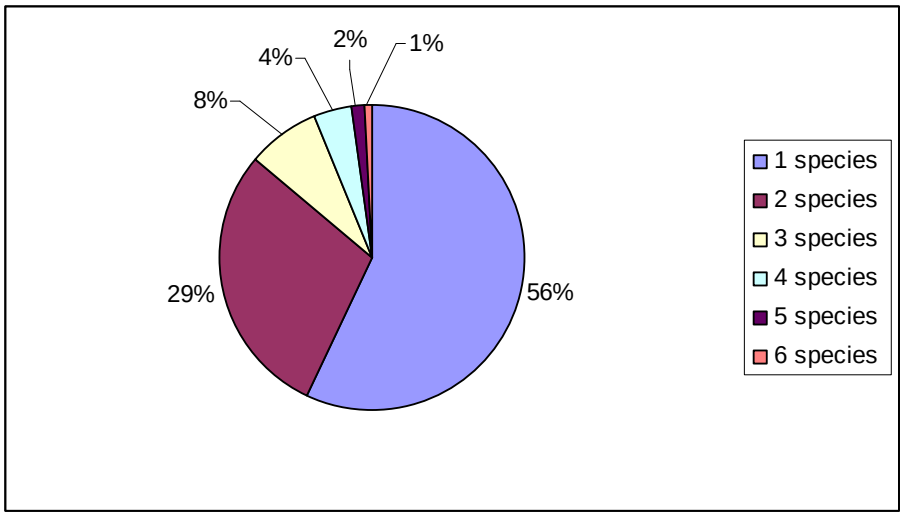

Figure 21 Number of species responsible for crop damage per occurrence

The species that most frequently caused crop damage was the elephant (47.5%), followed by warthog/wild pig (21.7%), zebra (10.1%), baboon (5.5%), ostrich (5%). Giraffe, vervet monkey, antelopes and wildebeest caused crop raiding only marginally (less than 3% each) (figure 22).

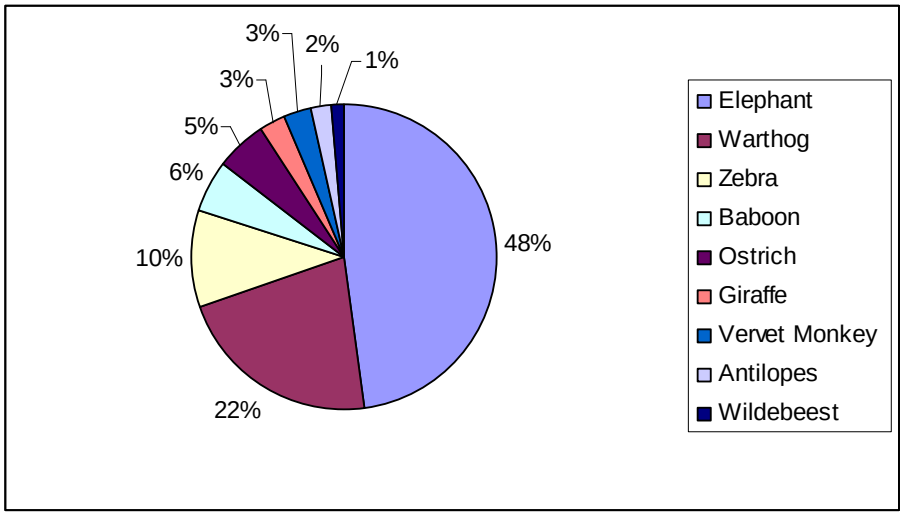

Figure 22 Percentage of crop damage occurrences caused by each wildlife species in 2008.

At village level, the elephant was the main cause of crop damage in Loborsoit A (26%), followed by baboon (22.2%), zebra (20.4%) and warthog (16.6%). These results are different from those obtained in 2006 and 2007, where warthog/wild pig was the main cause of crop raiding. In Lolkisale, the elephant was responsible of most of the crop damage occurrences (63.7%), followed by warthog (26.6%). These findings confirmed the results obtained in the precedent years. In Naitolia the species responsible for crop raiding were in descending order: elephant (26%), zebra and ostrich (both 23%), warthog (13%) and giraffe (8%). The elephant caused more damage than in 2006, where the main species responsible for crop raiding were zebra and warthog/wild pig. These results are shown in figure 23.

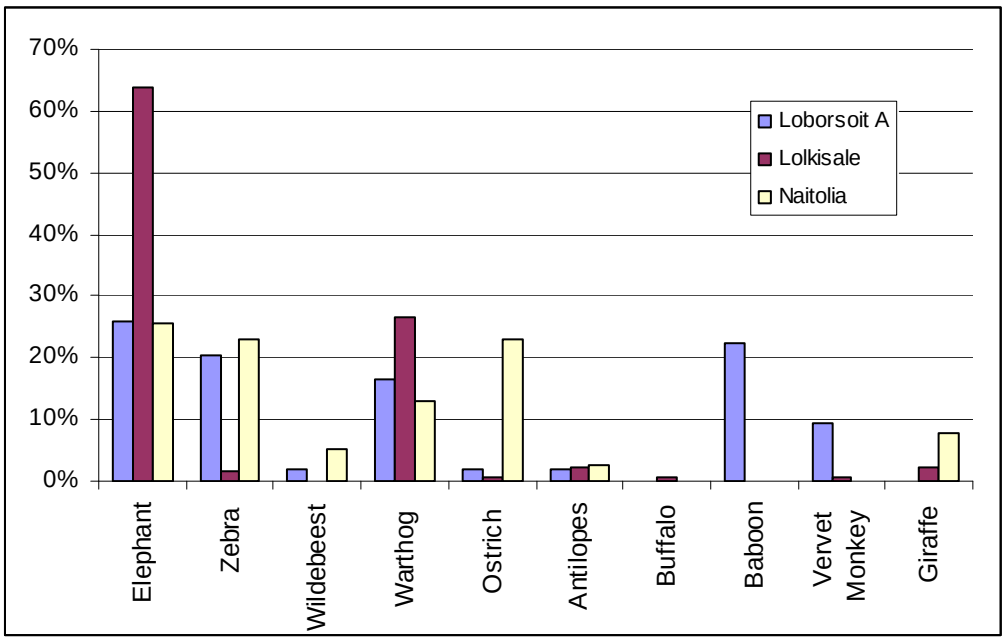

Figure 23 Percentages of crop damage occurrences caused by wildlife species in each village in 2008.

3.4.4 Group size of wildlife species

The average group size of elephants was 18, ranging from 1 to 70 animals in Loborsoit A (table 13). The minimum and the largest number of animals per crop damage occurrence were recorded in Loborsoit A (1 and 70 individuals respectively). The average group size recorded in 2008 was larger than in 2006 and 2007 (8.3 animals). The average group size of warthog/wild pig was 10.2, double than that estimated in 2006 and 2007 (5.2 animals). The average group size of antelopes was 13 as in 2006. The average group size of zebra was larger (70.3 individuals) than what recorded in the previous years (15 and 17.5 respectively).

Table 13 Average group size of species responsible for crop damage in 2008

Species	Average group size	Min	Max	N
Elephant (Tembo)	17.939	1	70	68
Zebra (Pundamilia)	70.29	7	200	14
Wildebeest (Nyumbu)	150	150	150	1
Warthog (Ngiri)	10.21	2	100	34
Ostrich (Mbuni)	10.36	5	13	11
Antilopes (Swala)	13	10	14	4
Buffalo (Mbogo)	16	16	16	1
Baboon (Nyani)	62.25	7	150	12
Vervet Monkey (Tumbili)	53.4	27	70	5

3.4.5 Relation between group of species and size of the damage per occurrence

The size of the plot, the size of the damage and the number of wildlife species per incident were $\log_{10}$ transformed to approximate to a normal distribution (Kolmogorov-Smirnov test, $p>0.05$). The proportion of the damaged area was square-root transformed as explained in the methods. The results reported in table 14 showed that there were significant correlation between: 1) the number of species and the mean log10 damaged areas (Pearson test, $r=0.92$ $p=0.01$, $N=6$); 2) the number of species and the mean log10 plot size (Pearson test, $r=0.93$ $p=0.007$, $N=6$)); 3) the mean log10 damage and the mean log10 plot size (Pearson test, $r=0.83$ $p=0.004$, $N=6$). In other words, the damage area per occurrence was larger when caused by more species per night and for larger plots.

Table 14 Results of Pearson correlation test between N of species(log10), damaged area(log10), plot size(log10), proportion of damaged area (square root transformed)

		Nspecies	meanlg_damage	mean_lg_plot	mean_sqrt_prop
meanlg_damage	Pearson Corr.	.915(*)	1	.825(*)	.794
	Sig. (2-tailed)	.010		.043	.059
Nspecies	Pearson Corr.	1	.915(*)	.929(**)	.491
	Sig. (2-tailed)		.010	.007	.323
mean_lg_plot	Pearson Corr.	.929(**)	.825(*)	1	.367
	Sig. (2-tailed)	.007	.043		.474
mean_sqrt_prop	Pearson Corr.	.491	.794	.367	1
	Sig. (2-tailed)	.323	.059	.474	

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

3.4.6 The elephant

Fifty-one farms were damaged exclusively by the elephant. A total amount of 353 acres were surveyed immediately after the damage. The average plot size was 5.27 acres with a minimum of 0.48 and a maximum of 37.18 acres. Thirty-six percent of the surveyed area was damaged by the elephant. On average the damaged area per farm was 2.21 acres with a minimum of 0.008 acres and a maximum of 12.86 acres. Most of these farms were located in Lolkisale (N=45). A positive logarithmic relation between the number of elephants (group size) and the size of the damage was found ($y = 0.476Ln(x) - 1.1099$; $R2 = 0.4641$). The crop mostly damaged by elephants was maize (62.5%), followed by lablab beans (28%).

Most of the damages occurred at night (83%) confirming the results obtained in 2006 and 2007. In Loborsoit A, 19% of the crop raiding occurred during the day. In Lolkisale and Naitolia they occurred almost exclusively at night.

3.4.7 Prevention methods

Out of 130 farms which reported data on adopted prevention systems, size of the damage and species responsible for crop damage, 18 farms (14%) did not use prevention methods at all. These farms were located in Lolkisale and Loborsoit A. The average size of the farms was 2.63 acres. The average damage by occurrence was 0.61 acres. On average, 32.2% of the farms were damaged by wildlife. Totally 11 acres were damaged over 47.4 acres of surveyed cultivated land. The farms were mainly damaged by elephants.

Only 2 farms, located in Lolkisale and Loborsoit A, used passive methods only. One of these farms was totally damaged by 28 elephants. Thirty-five (35) farms combined passive and active methods over a total amount of 329.5 acres. Totally 98.6 acres were damaged by wildlife, equivalent to 30%. The average size of these farms per damage occurrence was 10 acres (sd=9.67; median=7.3). The average size of the damage per occurrence was 3 acres (sd=3.4; median=1.22). On average, 33.5% of the farm defended by a combination of passive and active methods was damaged by wildlife per occurrence (median=33.7). The average number of species per occurrence was 2.5 (sd=1.35; median=2). It is interesting to notice that the farms located in Naitolia were fenced with rope while those located in Lolkisale were fenced with vegetation. The active methods used by all these farms in combination with the passive methods were the presence of a watchman, flash light, fire and smoke from livestock and/or elephant dung.

Seventy-six (76) farms used active methods only over a total amount of 370.7 acres. The total amount of damage was 118.7 acres (32%). The average size of the plot was 4.9 acres (sd=5.21; median=3.9) and the average size of the damage was 1.56 acres (sd=2.06; median=1.03). On average, 34.2% of the farm (sd=0.3; median=26%) was damaged per incident. The average number of wildlife species was 1.5 (sd=0.84). These farms used a combination of fire, loud noise and presence of a watchman.

The statistical analysis showed that the farms adopting active methods only were significantly smaller and significantly less damaged than farms adopting mixed prevention methods (Mann-Withney test, U=865, p=0.02 for plot size; t=998, p=0.002 for the size of damage per plot). The number of species entering the farm

per night was also significantly lower than for farms with mixed methods (Mann-Withney test, U=792.5, p=0.00).

3.4.8 Geographic location of crop raiding occurrences in 2008

Figure 24 shows the crop damages (red triangles) occurred in Naitolia, Lolkisale and Loborsoit A in 2008 in relation to wildlife protected and dispersal areas, corridors, infrastructure, land use of the villages. The land use categories are derived from a simplification of the categories reported in the PLUMs of the villages (FAO-LEAD 2007).

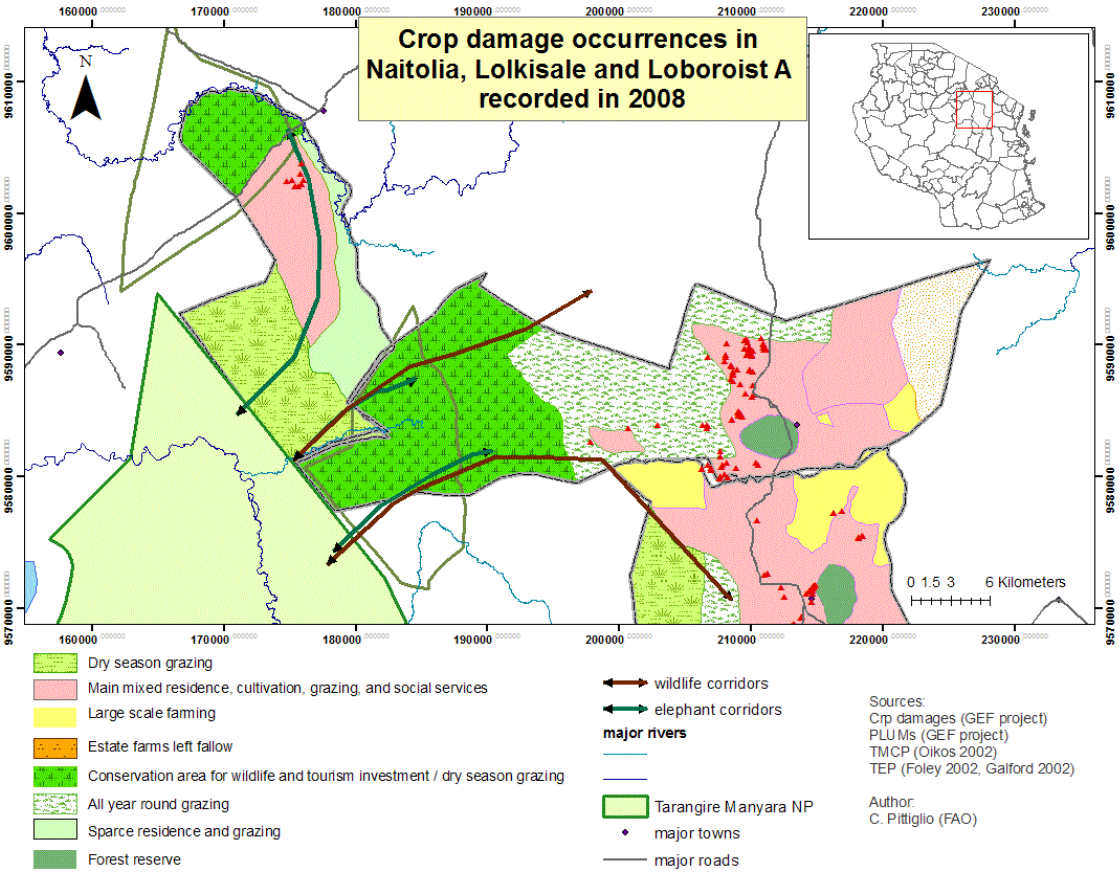

Figure 24 Crop damages (red triangles) occurred in Naitolia, Lolkisale and Loborsoit A in 2006. The land use categories are derived from a simplification of the categories reported in the PLUMs of the villages (FAO-LEAD 2007).

3.4.9 Summary of the results of crop damages for 2008

The analysis of the crop damage occurrences in 2008 showed the following results:

1) Maize, lablab beans and beans are confirmed to be the most cultivated crops in the study area. As a consequence, they are the most damaged crop by wildlife. Green gram is cultivated mainly in Naitolia where it is highly damaged by wildlife;
2) The time of crop raiding is confirmed to occur at night;
3) The crop damages were mainly caused by one species per night. The species causing the highest number of incidents in 2008 were in descending order: elephant, warthog/wild pig and zebra. This pattern is consistent with the results obtained in the previous years. In 2008 crop damages by elephants seem to increase and being the first cause of crop raiding also in Loborsoit A.
4) Thirty-four percent of the total surveyed area was damaged in 2008. This percentage was higher than the previous years (25.2% in 2006 and 24% in 2007;
5) The size of the cultivated fields was 5.85 acres, similar to the average size of the farms surveyed in 2007 and smaller than those surveyed in 2006.
6) The average group size of elephants (18) was higher than in the previous years (8.3 both in 2006 and in 2007); large herds were observed in Lolkisale and Loborsoit A (e.g. one group of 70 individuals in Loborsoit A);
7) Regarding the prevention methods, the analysis revealed that the farms adopting mixed prevention methods in 2008 suffered larger damage than those adopting active methods only. These results appear to contradict the results of 2007. However detailed analysis at village level showed that the farms with mixed prevention methods were larger than those using active methods only (almost double). As explained by Sitati et al. (2005), it may be possible that the watchmen were not able to patrol and defend such large area, relying to much on the efficacy of the physical barriers.

3.5 Driving factors of crop damages for the study area

The geographic locations of the crop damage occurrences were mapped to visualize their spatial distribution in relation to the Tarangire National Park, wildlife dispersal areas, grazing areas and corridors, roads, wildlife distribution data and agricultural areas. This data (with the exception of the PLUM maps), were derived from different sources such as Institute OIKOS, TAWIRI, AWF, Tarangire Elephant Project (TEP). In particular, the wildlife grazing/pasture, dispersal areas, the elephant corridors and the agricultural areas in 2000 were derived from OIKOS (TMCP, 2002) and TEP (Foley 2002; Galford 2002); the infrastructures from AWF and OIKOS; the wildlife distribution data were derived from the aerial total counts of elephants. These aerial censuses were carried out by TAWIRI from 1995 to 2005.

From figure 25, it can be noted that:

1) Crop damages occurred close to wildlife corridors, migratory routes and wildlife dispersal areas. For instance the crop damages in Naitolia were located close to two wildlife corridors, Daraja and Naitolia. These are elephant migratory routes from Manyara Ranch to Tarangire NP, merging into one single corridor (lower Naitolia corridor) when entering the Lolkisale GCA (Golford 2002; Foley 2002);
2) Crop damages occurred mainly at night; this may explain why the elephants located by TAWIRI aerial surveys (e.g. total counts in figure 25) are not overlapping the crop damaged areas;
3) Water sources accessible to wildlife increase the risk of crop damage in the surrounding area (de Beer & van Aarde 2008). Most of the farms in the study area are close to rivers (ILRI- Land use change analysis 2009);
4) According to Lolkisale villagers (TMCP 2002), Emandas dam in Loiborsoit A, (Lemooti area) is accessible to wildlife throughout the year and has increased the presence of wildlife in the village; the area around the Emandas dam is therefore at higher risk of crop raiding;
5) Comparing agricultural fields in 2000 (TMCP 2002) and crop damages occurrences between 2006 and 2008, it emerges that agriculture has increased and expanded in grazing/dispersal areas for wildlife and livestock; these farms are therefore at higher risk of crop raiding;

Our results suggest three main driving factors for crop damage:

a) distance to areas with high wildlife density (such as TNP, wildlife grazing and dispersal areas, migratory routes, corridors);
b) distance to water sources (especially in the dry season);
c) availability of palatable food during the dry season where forage is scarce and of low quality.

In addition food crops such as maize and beans are more attractive for wildlife than cash crops. This increases the vulnerability of small subsistence farms in the study area compared to large scale farms that cultivate cash crops.

Our findings confirm what already emerged in other researches (Hoare 1999a; Osborne 2004; Meingataki 2005). Nevertheless, further investigation is needed to

better understand the spatial and temporal distribution of crop damage by wildlife in relation to physical, environmental and socio-economic factors in the study area.

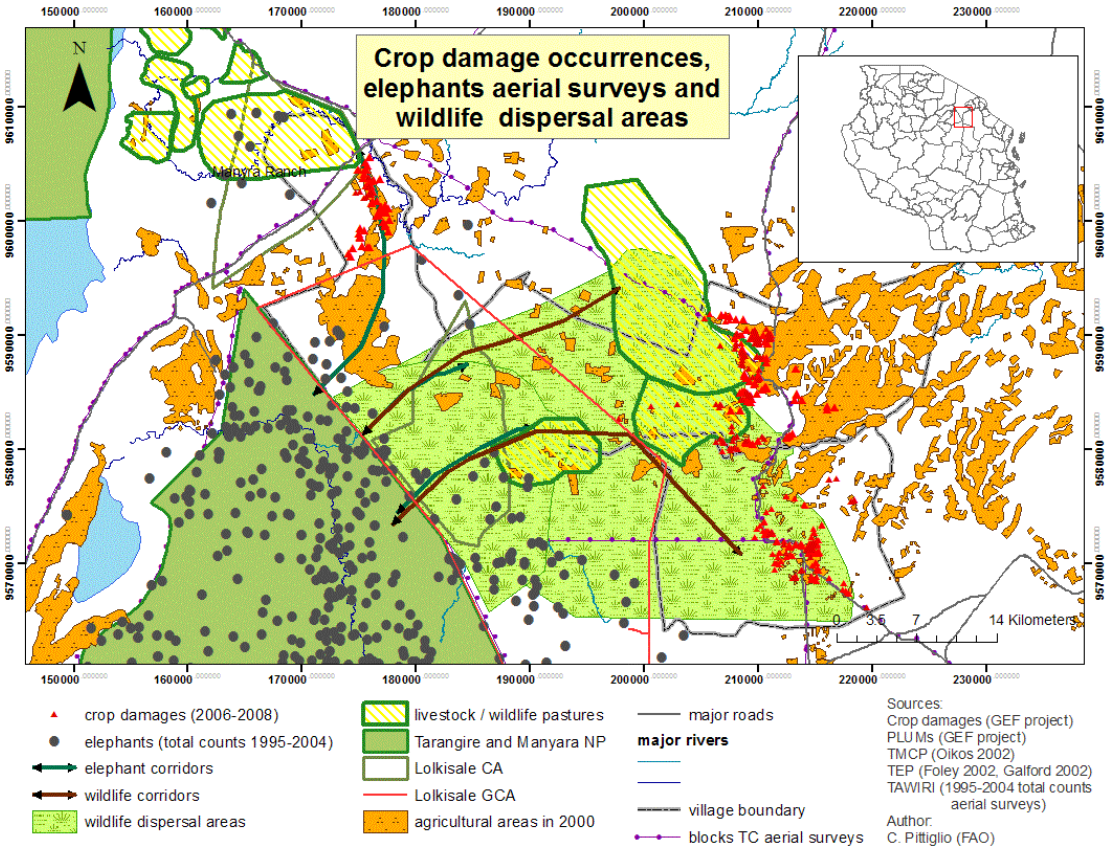

Figure 25 Crop damages (red triangles) occurred in Naitolia, Lolkisale and Loborsoit A in 2006, 2007, 2008 in relation to elephant's wildlife distribution (total aerial survey counts), wildlife grazing/dispersal areas, corridors, infrastructure, agricultural fields in 2000.

3.6 Management techniques

Crop damages can be reduced and minimized by using a combination of passive and active prevention methods, ad hoc management techniques and land use plans. However as underlined by Hoare (1999a) conflicts can never be eliminated in areas where wildlife and humans need to coexist.

This study has revealed that the traditional methods adopted by the local farmers are not effective against wildlife especially against elephants. They should be improved and potentiated. Within the passive prevention methods, which include fences of various materials, only the electric fences are effective against large wild animals such as elephants. Unfortunately they are very expensive and require high maintenance. Therefore electric fences may not be suitable for the study area. However the cost of their set up and maintenance could be paid by the Government, TNP or covered by the revenue to the village generated from alternative eco-compatible activities (such as WMA, CBS, trophy hunting's fee, etc). Active methods

are more effective in preventing crop damage than passive methods. Fire, loud noise, smoke from elephant or livestock dung are successfully used to scare animals away in short terms. However, in long term, animals become habituated and are not scared by them anymore. The presence of a watchman in the field during the night is the most successful strategy. The construction of watchtowers can increase the vigilance capacity and alert other farmers. Furthermore the presence of a cleared buffer zone around the farms can increased the vigilance. Chili is a deterrent against elephant. Buffer zones of chili at the edge of the cultivated crop keep animals away. In addition chili is a cash crop with high market value. Another important factor is the location of the farms in relation to protected areas and areas with high wildlife density. An effective land use plan should avoid cultivations close to protected areas, grazing pastures and corridors and remove and relocate the existent farms in different areas. In addition the farming area of the village should be surrounded by a buffer zone cleared from vegetation to increase vigilance capacity.

3.7 Estimated economic loss

The enumerators did not measure the amount of each damaged crop for farms that cultivated more than one crop. For this reason, it was not possible to calculate the economic loss caused by crop damage from the HWC monitoring activity. Nevertheless a coarse estimate of the economic loss was derived by combining the information of the 2006 household survey (HHS)(FAO-LEAD 2009) and the crop damage data. Specifically, it was assumed that the damage to the crops was proportional to their availability; in other words, the damage to crop *a* was proportional to the amount of land under crop *a*. The proportion of cultivated land under each crop was derived from the 2006 HHS (FAO-LEAD 2008). The proportion of each cultivated crop was multiplied by the total area damaged by wildlife (660.6 acres) to estimate the amount of damaged crop in acres. Then the estimated damaged area for each crop was multiplied by the average productivity (kg/acre) for that crop (derived from the 2006 HHS) to estimate the loss in kg. Finally this data was multiplied by the mean prize per kg for that crop (2006 HHS) to get an estimate of the economic loss in Tsh. The analysis focused on three main cultivated crops (namely maize, beans and green gram), which together account for 99% of the produced crops in the study area. Table 15 shows the economic loss calculated for each crop from 2006 to 2008 and includes: a) the percentage of cultivated land; b) the average productivity (kg/acre); c) the mean prize (Tsh/kg) derived from the 2006 HHS.

Table 15 Estimate of economic loss (in Tsh) calculated over 660.5 acres of damaged crops from 2006 to 2008.

	% damaged crop[1]	Mean productivity (kg/acre) [1]	Mean prize (Tsh/kg) [1]	Total loss (Tsh)
Maize	66 (435.93 acres)	401	173.2	30 276 733.48
Beans	30 (198.15 acres)	253	471.9	23 657 267.21
Green gram	3 (19.815 acres)	161	499	1 591 917.29
Other	1 (6.605 acres)	na[2]	na[2]	na[2]
Total	100 (660.5 acres)	815		55 525 917.98

[1]Data from 2006 HHS (FAO-LEAD 2009)
[2] na = Not available

The estimated economic loss due to wildlife between 2006 and 2008 was 55 525 918 Tsh, equivalent to 42 480.8 USD.

3.8 People perception on wildlife

Discussions with key informants and information derived from 2006 HHS were used to examine the people perception on crop damage in the study area. The results showed (figure 26) that out of 117 respondents, 51 respondents (43.5%) suggested a control of the wildlife population by TNP (including killing problem animals, increase the hunting pressure and remove the park boundary). Forty-five respondents (38.5%) suggested compensation from the Government and TNP for the economic loss due to crop damage. Eighteen (15.4%) respondents suggested an improvement of the prevention methods such as using robust fences and improving the guarding of the farms. Three respondents asked for advises from the Agricultural Department and training for managing crop damage.

More than half of the respondents (53%) believed that wildlife density is increasing in TNP. They considered it as the main reason for crop raiding.

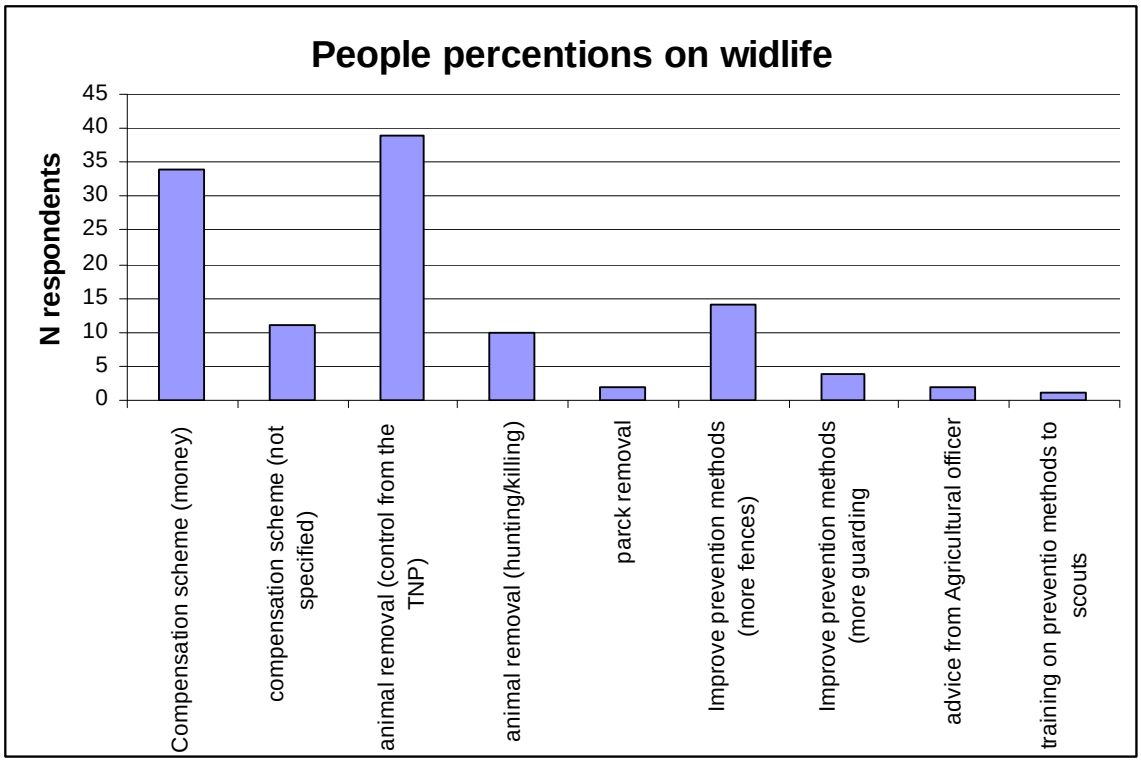

Figure 26 People perceptions on crop damage (2006 HHS).

These results suggest that crop damage is perceived by local people as a serious problem that needs to be managed and controlled by the Authority.

4 Conclusions and recommendation

This study has shown that crop damage by wildlife seriously affects the livelihoods of the farmers around Tarangire National Park which are mainly peasant farmers. This can lead to an increased negative human attitude towards wildlife with potentially negative effects for conservation.

This study has also shown that the problem has a peak in the dry season (May-August) coinciding with the availability of alternative food (maturation of the crops) and the low quality / scarcity of the forage. The accessibility of water to wildlife especially during the dry season is known to play an important role in crop damage. In the study, farms are close to rivers (GEF-ILRI 2009) and therefore are highly vulnerable to crop raiding. Furthermore, our results have shown that many farms are located close to areas of high density of wildlife (such as wildlife dispersal areas, corridors, grazing areas). This obviously increases the vulnerability of the farms to crop raiding. Finally the measures adopted by the local farmers to prevent crop damage are not effective against wildlife, particularly against large herbivores such as elephants.

Based on the above findings, the following recommendations are suggested:

1. Develop and implement community based natural resources management programs, Wildlife Management Areas (WMA) and Communities Based Ventures (CBV) in order to value natural resources, provide economic benefits to local people and alternative economic activities;
2. Utilize the revenues from TANAPA, Wildlife Division, Districts and Trophy Hunting companies to financially support the cost of improving and maintaining prevention methods against wildlife (e.g. crop damage and livestock depredation) for farmers and pastoralists;
3. develop and implement strategies to reduce crop raiding and 'problem animals' by combining alternative crop systems and deterrent methods;
4. develop and update the land use plan of the villages considering the seasonal spatial distribution of the main wildlife species responsible for crop damage such as elephants, zebra, warthog and wild pig;
5. remove and relocate the farms within or close to areas at high risk of crop damage such as corridors, migratory routes, grazing area;
6. regularly monitor the wildlife population in the study area to predict the spatial and temporal patterns of crop raiding;
7. increase the patrolling from TNP and establish a problem animal control (PCA) unit to monitor crop damage in the study area.

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Annex A Crop Damage Form

FOMU YA KUTOLEA TAARIFA ZA UHARIBIFU WA MAZAO (Crop Damage)

Namba ya Fomu: 12

Jina la mtoa taarifa/Muorodheshaji matukio: GABRIEL

KIJIJI: LOLKISALE "A" KITONGOJI: OLMOTOO

Tarehe ya matukio ya uharibifu: 7/08/06 (Mwezi/Tarehe/Mwaka)

Tarehe Mlalamikaji/Mkulima aliporipoti uharibifu: 7/09/06 (Mwezi/Tarehe/Mwaka)

Jina la Mlalamikaji/Mkulima: LEPARAKUO

Aina ya Mkulima: ☑ Mkulima mdogo wa kijijini ☐ Mkulima wa mashamba makubwa

Jumla ya malalamiko ya uharibifu mwaka huu: _____

Kipindi ambacho shughuli za kilimo zimeendelea kufanyika: _____

☐ Miaka 5 iliyopita ☑ Miaka 5 hadi 10 iliyopita ☐ Miaka 10 iliyopita

GPS ID: D6A

Location

S 03, 86 32.9

E 036, 40 246

Uharibifu wa mazao shambani	**Hali ya mazao shambani wakati uharibifu ulipotokea**			**Kipindi cha kukomaa kwa mazao**		
Aina ya zao	Nzuri	Ya wastani	Mbaya	Yameanza kuota	Yapo katikati	Yamekoma a kabisa kwa kuvunwa
1: [illegible]	☑	☐	☐	☐	☐	☑
2: [illegible]	☐	☐	☐	☐	☐	☐
3: _____	☐	☐	☐	☐	☐	☐
4: _____	☐	☐	☐	☐	☐	☐

Ukubwa wa shamba (in acres)
Urefu: 70
Upana: 90

Ukubwa wa kiasi cha shamba kilichoharibiwa (Kwa vipimo vya hatua)
Urefu: 70
Upana: 15

Uharibifu mwingine uliofanyika

☐ Mazao yaliyokuwa yamehifadhiwa ghalani/nyumbani
☐ Matukio ya kuhatarisha maisha tokana na wanyamapori
☐ Matuko ya binadamu kujeruhiwa
☐ Matukio ya binadamu kuuwawa
☐ Mabomba ya maji
☐ Wengineo (Elezea) _____

>> ENDELEA NA UKURASA WA PILI

Aina ya wanyama wanaosababisha uharibifu wa mazao

	Idadi yao	Walioneka mashambani wakila ndyo	hakuna	Walionekana nyayo, vinyesi vyao au mabaki ya mazao yaliyoliwa ndyo	hakuna
☑ Tembo	8	☐	☐	☐	☐
☑ Pundamilia		☐	☐	☐	☐
☐ Nyumbu		☐	☐	☐	☐
☑ Ngiri		☐	☐	☐	☐
☐ Mbuni		☐	☐	☐	☐
☑ Swala		☐	☐	☐	☐
☐ Pofu		☐	☐	☐	☐
☑ Mbogo		☐	☐	☐	☐
☑ Ngurue Pori		☐	☐	☐	☐
☐ Wengineo_____		☐	☐	☐	☐

Kama tembo walikuwaje

Kundi la tembo wangapi N. 2 | Madume mangapi N. — | Majike mangapi N. — | Ndam wangapi N. —

Muda walipoharibu mazao

☐ Asubuhi ☐ Jioni
☑ Mchana ☑ Usiku

Utaratibu unaotumika kulinda mashamba

☐ Hakuna
☑ Kujenga wigo/sariko wa mimea
☑ Uzio wa seng'nge au waya za kienyeji
☑ Ujenzi wa uzio wa waya na seng'enge
☑ Kuweka uzio wa waya za umeme
☐ Kuweka usio wa kamba
☑ Kuwek walinzi shambani
☑ Wanakijji kupiga makelele na madebe
☑ Kuwasaha moto
☑ Kutumia tochi zenye mwanga mkubwa
☐ Kuchoma mabiwi ya nyasi na pilipili
☑ Kuchoma samadi ya ngombe na tembo
☐ Aina nyingine za ulinzi
Kuweka boya Shambani

Hali ya mtawanyiko wa mashamba:

☐ Yamepangana sehemu moja
☑ Yametawanyika
☑ Yametengan sehemu mbalimbali

Aina na wingi wa uoto:

☑ Misitu ya asili
☑ Nyasi
☑ Kilimo cha kisasa
☐ Wengineo_____