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Full Length Research Paper

Wildlife crop damage valuation and conservation: conflicting perception by local farmers in the Luangwa Valley, eastern Zambia

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Wildlife conservation in Luangwa Valley depends on perception by local communities, and is affected by wildlife crop raiding. Perception of local farmers were elucidated between 2006/7 and 2008/9 farming seasons. Data collection was done using prescribed forms and semi-structured questionnaires by trained field assistants. The case study findings confirm that firstly, perceived and actual crop losses differed by 49.49 and 7.78% for mono-specific stands of maize and cotton, respectively. Secondly, opportunity costs incurred and perceived by local farmers were higher than direct costs. Most farmers (79.83%, n = 95) associated opportunity costs of wildlife crop damage with loss of sleep and loss of time for other chores, when providing crop protection. Thirdly, conservation objectives and local farmers' needs and aspirations were antithetical. Majority of local farmers (82.59%, n = 204) expanded or segregated crop fields, thereby degrading wildlife habitats. Ensuing negative perception posed high risks to wildlife conservation in Luangwa Valley. Incentivising performance conservation payments to local farmers are recommended, to increase their tolerance levels while incurring costs of living with wildlife. Implementation of improved environmental education and awareness creation, coupled with capacity building through appropriate trainings and facilitated infrastructure in resolving human-wildlife conflicts are critical.

Key words: Wildlife crop raiding, contingent valuation, opportunity costs, conservation, Luangwa Valley.

INTRODUCTION

Wildlife crop raiding is defined as occasion when wild animals cause damage to agricultural crops (Parker and Osborn, 2001). It is probably the most pronounced and widely spread form of human-wildlife conflicts in areas adjacent to National Parks, which are also „*refugia*" and relatively heavily settled areas by humans (Wittemyer et

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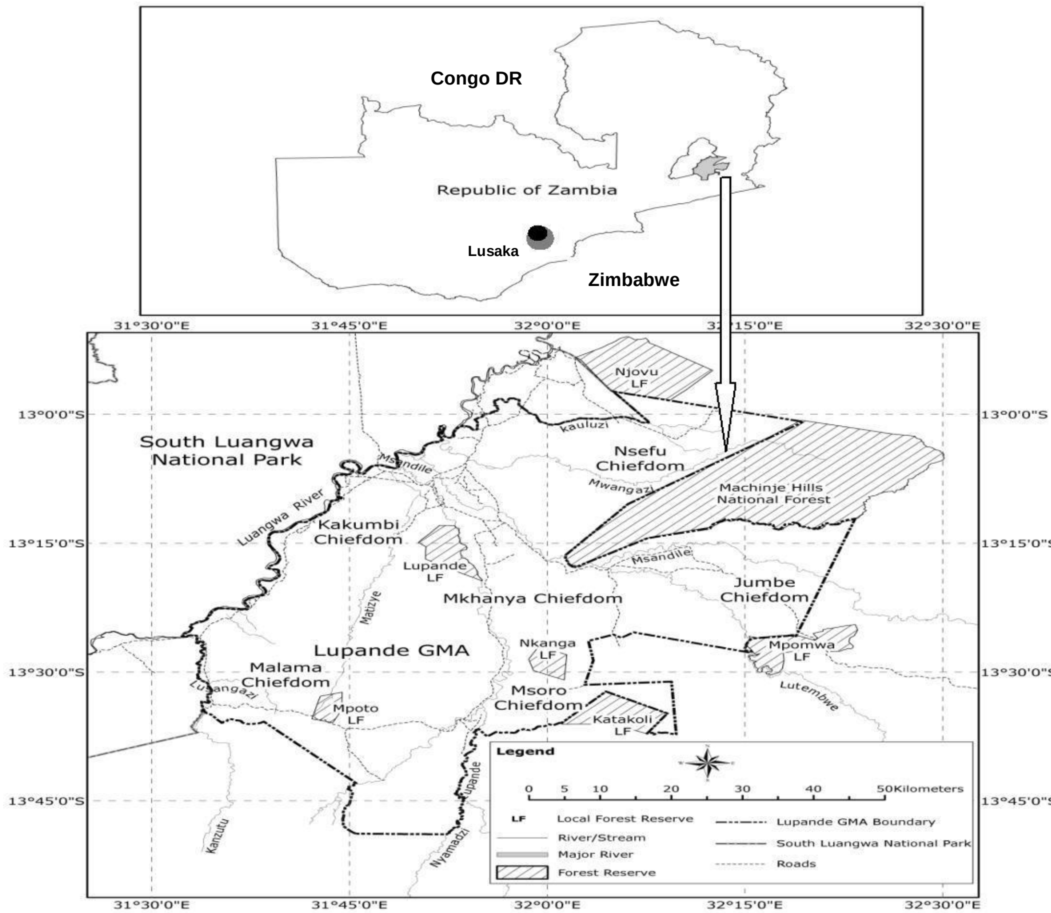

Figure 1. Location of Lupande Game Management Area in the Luangwa Valley, Eastern Zambia.

al., 2008;Lamarque et al., 2009). Due to competition for space and resources (Balmford et al., 2001), increasing interactions between people and wildlife heighten human-wildlife conflicts (Sillero-Zubiri and Switzer, 2001; Balfour et al., 2007).

Wildlife crop damage has negative impacts on rural food and livelihood security, resulting from shortages of nutritional supplements and inadequate food reserves. Consequently, crop losses form negative perceptions in local farmers about invading wildlife species, which lead to retaliatory killings of wildlife. Farmers" perceptions are, therefore, a critical social dimensional component of human-wildlife conflicts (Hill, 1998). Though several past studies have investigated farmers" perspectives on social dimensions of human-wildlife conflicts (Lahm, 1996; De Boer and Baquete, 1998; Naughton et al., 1999; Lamarque et al., 2009), there are still information gaps relating to wildlife crop damage valuation and its relevance to wild-life conservation.

This article focuses on the difference between perceived and real crop damage, value of conducting interviews for investigating complex issue like human-wildlife conflicts, and particularly, it investigates reasons for intractable wildlife crop raiding conflicts in the Luangwa Valley, eastern Zambia. We hypothesise that opportunity costs outweigh direct costs for wildlife crop raiding.

MATERIALS AND METHODS

Study site location

Wildlife crop damage valuation was conducted in Lupande Game Management Area (4, 840 km^2) in the Luangwa Valley, eastern Zambia, located at 12°57"00"S to 13°49"05"S and 31°32"00"E to 32°23"23"E (Figure 1). The study area had six chiefdoms (Jumbe, Kakumbi, Malama, Mnkhanya, Msoro and Nsefu) of Kunda people, adjacent to South Luangwa National Park and was one of the crop raiding „hotspots".

Human demography and socio-economic characteristics

There were approximately 68, 918 inhabitants in Lupande Game Management Area (CSO, 2012). The people of Luangwa Valley interacted with wildlife for a long period of time as evidenced by animal and plant fossils. Another anthropogenic evidence of Luangwa Valley people"s interactions with wildlife was through their culture, demonstrated by songs and dances, dressing and to some extent culinary habits. Subsistence agriculture was the mainstay of the people in Luangwa Valley, as a source of revenue and food (Dalal-Clayton and Child, 2003). Crops were mostly cultivated in mono-specific stands and crop varieties were predominately maize (*Zea mays*) and cotton (*Gossypium hirsutum*). Others included millet (*Eleusine sp.*), sorghum (*Sorghum vulgare*), beans (*Phaseolus vulgaris*), pumpkin (*Curcubita maxima*) and sweet potato (*Ipomoea batatas*). Crop production was constrained firstly by, crop raiding, wild animals (Balakrishnan and Ndhlovu, 1992; Simasiku et al., 2008) and secondly, by climate variability in the Luangwa Valley reflected by above 60% drought occurrence (Gilvear et al., 2000). Other economic activities in the Luangwa Valley were timber harvesting, charcoal production, photographic tourism and safari hunting businesses.

'Problem animal' population sizes

According to McIntyre (2004), Luangwa Valley was one of the areas in Africa with high species diversity and large population sizes of wild fauna. Simukonda (2008) estimated population sizes of selected animal species in the Lupande Game Management Area as follows: African elephant (2, 107), Yellow baboon (424), Cape buffalo (6, 221), Lesser kudu (83), Warthog (244) and Roan antelope (42). Other „problem animals" such as Bushpig, Porcupine, African civet and Eland were not surveyed and as such their population esti-mates were not available. In the case of African elephant, Luangwa Valley supported 72% (n=18, 634 ± 3, 592) of Zambia"s elephant population (CITES, 2010).

Vegetation communities

Vegetation communities formed units of wildlife habitats. Phiri (1994) and Smith (1998) characterised vegetation types of Luangwa Valley, as being predominantly Miombo woodland on the plateau and a mosaic of vegetation types on the valley floor constituting Miombo-Mopani, *Acacia-Combretum*, *Faidherbia-Combretum*, Mopani and riparian woodlands. These vegetation communities occupied six distinguishable topographic units of relief and topography in the Luangwa Valley, from escarpment zone, hill zone, ridges and high undulating surfaces, plains and pans, old alluvial zone to floodplains (Gilvear et al., 2000).

Climate

There were three distinct climatic seasons: hot wet season from late November to April; a cool-dry season from May-August; and a hot-dry season from September to early November. The study area was situated in agro-ecological zone I of Zambia, with mean annual rainfall ≤830 mm per annum in the valley trough whereas records of excess of 1 220 mm per annum, were noted in the northern sector of Luangwa Valley. The mean daily maximum temperatures ranged from 32 to 36°C in the hot season. The minimum mean temperature in the cold season (June - July) was 15°C and maximum mean temperature in hot season (October) was 36°C on the valley floor. On the escarp-ment and surrounding areas, it was colder and less arid than on the valley floor (Archer, 1971).

Assessing opportunity and direct costs of wildlife crop raiding

Field data on opportunity and direct costs of wildlife crop raiding was collected during the 2006/7 and 2007/8 farming season. Contingent valuation (CV) methods were adopted for determination of the nature and extent of the cost of crop damage to wildlife crop raiders in Luangwa Valley. Willingness to Pay (WTP) and Willingness to Accept (WTA) were elucidated to reveal values of opportunity costs. According to Phillips (1998), survey participants would reveal their value for environmental benefits or costs through their WTA compensation for foregoing benefits while incurring costs or WTP for anticipated benefits. Affected local farmers would reveal their values through WTP to prevent the loss and their WTA compensation to tolerate it. In order to eliminate potential problems of the local farmers giving hypothetical responses and having zero responses on WTP as described by Carson (1997), local farmers were asked a series of probing questions. Such questions included required labour input and willingness to contribute to own preventive and mitigation measures and number of bags of maize and bales of cotton towards imple-mentation of counter-measures.

Field data was gathered by six trained field assistants. They received reports from local farmers, verified them by conducting field observations and measurements, and made records on prescribed human-wildlife conflict forms (Annexure 1), adopted and modified based on protocols recommended by Hoare (1999). Prior to and during the study, local communities were sensitized and instructed to report all crop damage incidents to field assistants.

Nyirenda et al. (2011) reported on crop damage assessment methods employed in Luangwa Valley. Direct costs at nett present value were given by making comparison of spatial dimensions of perceived and actual crop losses. These direct costs were derived from area dimensions in respect to crop type (cultigens) grown. At the base level, the spatial dimensions of the damage were associated with the amount of yields expected to be harvested if not impacted upon by natural hazards, including crop raiding, as suggested by Bell and McShane-Caluzi (1986) and O"connell-Rodwell et al. (2000). Based on indigenous knowledge by local farmers, perception on magnitude of damage incurred was obtained.

Determination of costs assumed homogeneity of crops and prices in the Luangwa Valley landscape as there was uniformity in crops and their associated prices. For instance, maize cost USD 8.00 per 50 kg bag and cotton cost USD 25.00 per 100 kg bale. Maize was sold by local farmers locally and to agents of millers in nearby towns of Chipata and Katete while cotton was traded to a number of local companies.

Local farmers' perceptions solicited using questionnaires

Semi-structured questionnaires (see Annexure 2 for list of questions) were administered to 247 local farmers affected by crop raiding for their perception, relating to wildlife crop damage vis-á-vis conservation. These questionnaires were developed and pre-tested to respondents, following the protocols derived from Düvel (1987), Arrow et al. (1993), Randall (1997) and Bradburn et al. (2004). They emphasised pre-testing, conducting of triangulation to confirm crop damage estimates and crop prices, and explaining and obtaining consent on confidentiality of responses.

Statistical analysis

The pricing was based on profit function that would be estimated for undamaged crop fields in the area, under similar conditions. The loss in maize and cotton that were raided during the farming seasons 2006/7 and 2007/8 were compared by perceived damage (median) and actual damage (median) using Wilcoxon Exact Test (WET) and following analysis procedures postulated by Fowler et al. (2006). Descriptive and inferential statistics were conducted using Minitab (2004), version 14 statistical software for analyses.

RESULTS

Direct cost of wildlife crop raiding

The average (mean ± SE; n = 106) financial loss in revenues on mono-specific maize fields was USD 415.83 ± 61.92 (range: USD 8.57 to USD 2 285.71) from perceived damage by local farmers. On the same farming plots USD 205.79 ± 36.89 (range: USD 2.14 to USD 1 020.21) were lost from actual damage at nett present value for

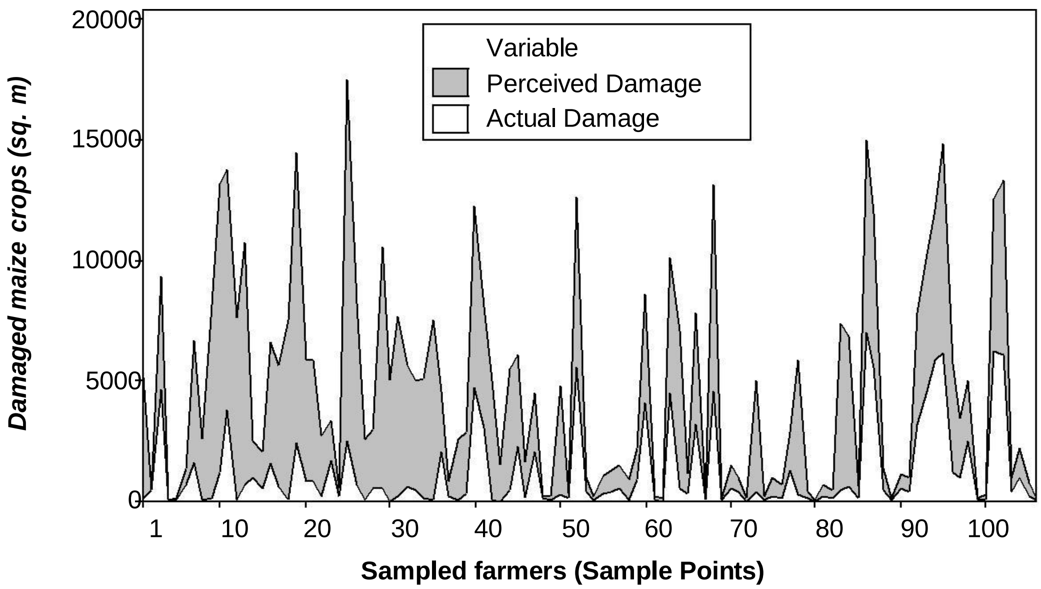

Figure 2. Comparison between the perceived and actual damage by wildlife in sample points for maize crop in the Luangwa Valley, Zambia, 2006/7 and 2007/8.

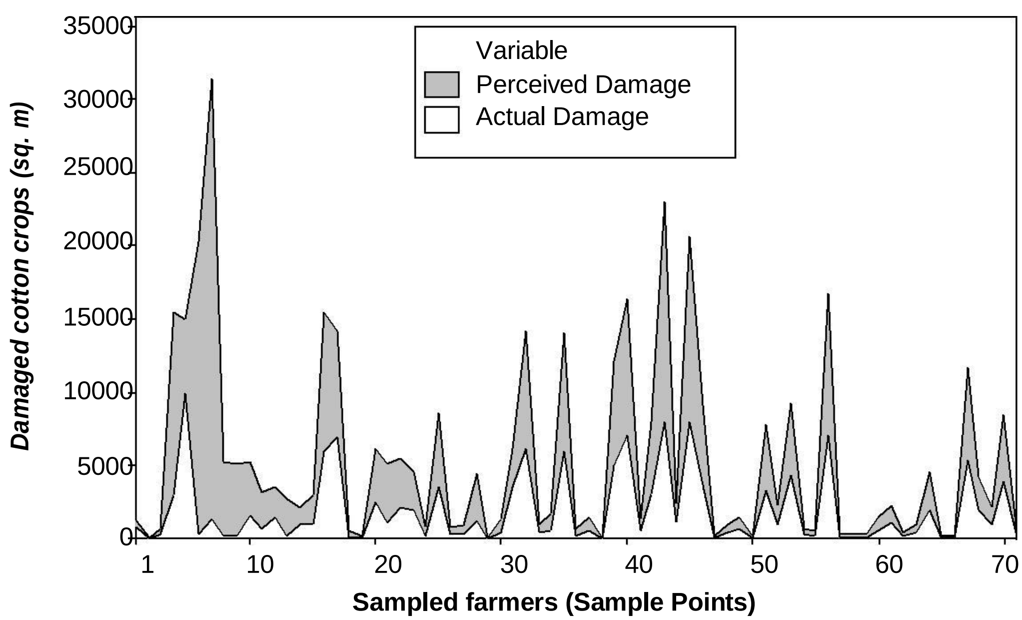

Figure 3. Comparison between the perceived and actual damage by wildlife in sample points for cotton crop in the Luangwa Valley, Zambia, 2006/7 and 2007/8.

2006/7 and 2007/8 farming seasons in Luangwa Valley. The perceived median damage was significantly higher than the actual median damage (WET, n=48, p<0.05). Figure 2 illustrated the difference between the perceived and actual maize production losses, with approximate departure of 49.49%.

Similarly, there were differences between actual and perceived cotton damage (Figure 3). The average (mean ± SE; n = 71) financial loss in revenues on mono-specific cotton fields was USD 683.57±249.77 (range: USD 5.71 to USD 2 857.14) from perceived damage.

Actual damage was rated USD 53.17±13.08 (range: USD 2.40 to USD 123.60) at nett present value on the same farming plots. The perceived median damage was significantly higher than the actual median damage (WET, n = 12, p < 0.05). Difference from the cost of

Table 1. Opportunity costs, projected gain for anticipated change of crop and willingness to pay by local farmers in the Luangwa Valley, Zambia, 2007/8.

Opportunity cost	Sample size (n)	Rank	Loss (USD) Mean ± SE	Projected gain for change of crop (USD) Mean ± SE	Willingness to pay (USD) Mean ± SE
Loss of sleep	60	1	501.20± 81.00	959.00 ± 134.00	583.80 ± 96.40
Malaria, bodily harm and medical costs	11	4	353.80± 99.10	955.00 ± 323.00	506.00 ± 233.00
Loss of time for other chores	35	2	1057.00± 248.00	1521.00 ± 355.00	416.00 ± 124.00
Travel restriction	13	3	229.90± 25.00	474.70 ± 97.30	243.30 ± 67.00
Total	119				

actual damage as compared to perceived damage by local farmers was approximately 7.78%.

Opportunity costs and willingness to pay

About half of sampled local farmers (50.42%, n=60) experienced loss of sleep as the greatest incurred opportunity cost and had forgone economic activities during the time they were making up for the lost sleep (Table 1). The loss of sleep was valued at USD 501.20 ± 81.00 but with the perceived change of crops, the projected gain would be higher than the loss at USD 959.00±134.00. As such, local farmers were prepared to contribute in the range of USD 583.80 ± 96.40, including in-kind contributions towards crop raiding preventive and mitigation measures. Loss of time for chores other than securing field crops in general was second in nominal rank order (29.41%, n = 35) of the opportunity costs. However, the loss was highest for all opportunity costs associated with wildlife crop raiding at USD 1057.00 ± 248.00 and the projected gain, if crops were changed to alternative crop that were perceived less vulnerable which was USD 1521.00 ± 355.00. WTP towards counter-measures was modest at USD 416.00 ± 124.00. Travel restriction was a third ranked (10.29%, n = 13) perceived opportunity cost. Nonetheless, losses, projected gain for change of crop and WTP were all at their lowest; USD 229.90 ± 25.00, USD 474.70 ± 97.30 and USD 243.30 ± 67.00 respectively. Travel restrictions were not only limiting local farmers from gaining external assistance for their livelihoods but also hindering their ability to engage in other productive economic activities. The malaria, bodily harm and medical costs were the fourth ranked (9.24%, n = 11) perceived opportunity cost. Although loss during the farming season was modest at USD 353.80 ± 99.10, the projected gain (USD 955.00 ± 323.00) was relatively high if there was a change in the crop but local farmers preferred traditional counter-measures to any other counter-measure that they were willing to pay a higher price of USD 506.00 ± 233.00 to improve them.

Needs and aspirations of local farmers

Local farmers" needs and aspirations expressed through expansion and segregation of fields were antagonistic to wildlife conservation in Luangwa Valley, which was primarily wildlife management area (Figure 4). To compensate for crop damage, most local farmers (57.08%, n = 141) expanded their crop fields. Some farmers (25.51%, n = 63) spatially segregated fields by cultivating several smaller fields (median n = 2; range: n = 1-5) in various locations in order to spread risks of crop damage. Other local farmers (9.31%, n = 23) avoided cultivating in wildlife inhabited zones altogether. Some local farmers (5.67%, n = 14) employed options which included *status quo,* maintaining same fields while conducting crop rotation. Direct compensation to local farmers by way of receiving meat from problem animal control operations was less preferred by local farmers (2.43%, n = 6) because even owners of unscathed crop fields benefited from distribution of such meat.

Alongside coping strategies, local farmers distinguished the alleviation strategies. Respondents (n=247; 80.04%) preferred excluding wildlife by fencing them out. Others perceived relocation from "hotspot" areas to alternative farming land or changing of farming systems practice would be alternative alleviation strategy, 3.28 and 6.23%, respectively. The rest (10.45 %) preferred varied options, including retribution killing of wildlife by local farmers although a great deal of wild animals were killed during problem animal control operations in the Luangwa Valley, for crop invasions (Table 2). Information to ascer-tain total number of problem animals killed by local far-mers in retaliation was not available. Table 3 also depicts a number of people killed on encounter with problem animals during the crop farming season.

DISCUSSION

Perceived and real crop damages

Crop damage in the Luangwa Valley was caused largely by elephants (Nyirenda et al., 2011). Quantum of variations

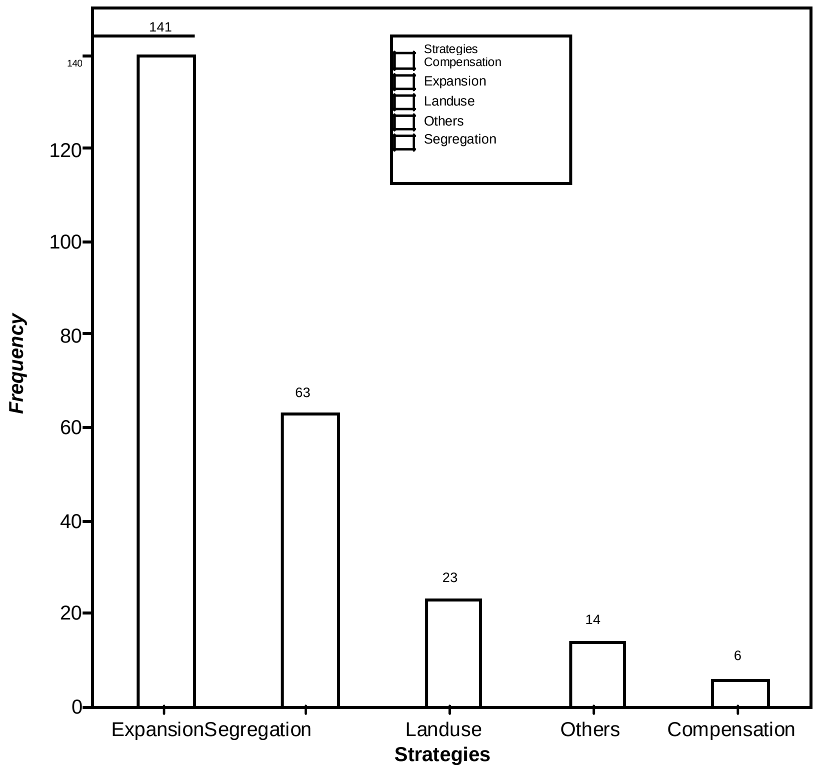

Figure 4. Coping strategies by local farmers for wildlife crop raiding in the Luangwa Valley, Zambia, 2007/8 and 2008/9 farming seasons.

Table 2. Wildlife killed on problem animal control operations in the Luangwa Valley, Zambia, 2004-2009.

Specie	Year						
	2004	2005	2006	2007	2008	2009	Total
Elephant	18	1	16	20	12	11	78
Bushpig	1	-	4	-	-	-	5
Baboon	10	-	1	4	2	-	17
Monkey	-	-	4	-	-	-	4
Total	29	1	25	24	14	11	104

Table 3. People killed on encounter with elephants in the Luangwa Valley, Zambia, 2004-2009.

Species	Year						
	2004	2005	2006	2007	2008	2009	Total
Elephant	10	1	12	3	5	2	33

between direct costs determined by independent researchers and opportunity costs elucidated by local farmers were likely to be site specific, due to socio-political, economic, cultural, ecological and psychological factors. As a result of local farmers‟ expectation of compensation by government and developmental agencies for crop losses and perception that opportunity costs were more futuristic in nature than direct costs as farmers constantly incurred costs in implementing anticipatory counter-measures for crop raiding. Further, it is not surprising that opportunity costs were overlooked in similar previous studies (Sekhar, 1998; Naughton-Treves et al., 2003; Nyhus et al., 2005; Jones and Elliott, 2006; Lamarque et al., 2009), because direct costs were more obvious and easier to assess than opportunity costs due to their complexity (Hoare, 2001). Conducting well structured interviews, nevertheless, could be useful tool for investigating complex issues like human-wildlife conflicts.

Reasons for intractable crop raiding in the Luangwa Valley

Poor landuse practices by local farmers coupled with antagonistic objectives between conservation and agriculture were among underlying causes of intractable crop raiding in the Luangwa Valley. Conservation objectives included protection of wildlife and its habitats while local farmers‟ needs and aspirations in agriculture were to expand crop production, even in wildlife habitats (Lewis, 2007; Nyirenda et al., 2011).

Implications for management

More research is required with use of interviews and other related survey tools on local community perceptions in relation to human-wildlife conflicts. Situated and independent researchers are recommended to minimise personal biases. The outcome of such research could be useful for wildlife management policy change and strategy development.

Further, through increased legal benefits (Gibson and Marks, 1995; Barrow and Murphree, 200; DeGeorges and Reilly, 2009), there is need for capacity building in local farmers to sufficiently protect their crops. Capacity building can be achieved by financial support from conservation payments. Though paying communities for conservation performance could be a simpler and more effective approach than paying individuals to mitigate crop damage (Ferraro, 2001), on the basis of higher overheads and bureaucracy (Nyhus et al., 2005; Schwerdtner and Gruber, 2007), conservation payments would be more meaningful to individual farmers if they directly benefit them.

High capital investments such as solar powered electric fences may be, however, supported for communal use as it may not be affordable by individual impoverished local farmers. Performance payments should be viewed as reward to local communities living with wildlife (Nyhus et al., 2005) and should not necessarily be aimed at compensating local farmers that incurred crop losses from wildlife (Jackson et al., 2008). Since funds from locally generated revenues from natural resources are often limited for distribution to individuals (Degeorges and Reilly, 2009), other innovative payments for ecological services such as Common Markets for Conservation, COMACO model (Lewis et al. 2011) and carbon trading need to be explored.

CONCLUSION

This study suggests that direct costs of crop damage were significantly lower than opportunity costs incurred and perceived by local farmers in Luangwa Valley. It further validates that needs and aspirations of local farmers could be different from conservation objectives. There-fore, local farmers‟ levels of tolerance for wildlife and their support to conservation risk diminishing due to disagreement between actual and perceived wildlife crop damage.

Data driven planning and implementation of interventions, facilitating collective action by local farmers is important. In addition, we suggested that targeted environmental education and awareness creation be considered in resolving human-wildlife conflicts in Luangwa Valley. By building capacity, through facilitated trainings and infrastructure such as wildlife restraining solar powered electric fences, and incentivising financial benefits, conflicting perceptions would be further reduced and local conservation support marshalled.

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Annexure 1. Generic crop damage data form used for data collection in the Luangwa Valley, Zambia, 2006-2008.

CRB:……………………..			Date of damage:……………………..				Village:………	
VAG:……………………………………………..			Date of report:……………………...				Location (GPS	
Evaluator:……………….			Complainant:…………………………					
Problem animal species								
Species	Number	Sex (If known)	Age	Action Taken		Location(GPS)	Action date	M (If
Crop damage assessment								
Crop Type	Quality* (G,M,P)	Stage** (S,I,M)	Area Grown	Damage Area 1	Damage Area 2	Damage Area 3	Damage Area 4	
Human damage					Livestock damage			
Names of victims	Age	Damage	Sex	Marital Status	Animal	Number	Damage	
1								
2								
Other types of damage								
Type***	Details							

* Good, Medium or Poor
** Seedling, Intermediate or Mature
*** Food store, Water supply, Threat to human life or Others (specify)

Annexure 2. List of questions as excerpt from questionnaire administered to local farmers to elucidate their perceptions on human-wildlife conflicts in the Luangwa Valley, Zambia, 2006-2008.

1	What was the main crop you cultivated during the last farming season?
2	How many crop fields did you cultivate?
3	Estimate the average size (in m^2) of your fields?
4	If you previously suffered loss from crop damage, how much did you lose to crop raiding in area (m^2) and monetary (ZMK) terms per crop type?

Annexure 2. Contd.

5	How did you make up for the loss?
6	Which is your greatest opportunity cost for your growing crops?
7	Indicate the last farming season‟s loss in monetary terms as a result of the opportunity cost stated in (6).
8	How much would you have gained in the last farming season if you cultivated a different and less vulnerable crop type to invading wild animals?
9	How much would you be willing to pay to improve protection against crop raiding?
10	What do you suggest should be done to alleviate or reduce crop raiding?