

Problem Animal Control Strategies in Human – Elephant Conflict Areas of Dande Communal Lands, Zimbabwe: A Study in Sustainability

MUPANGWA, J. F., NYABADZA, T., MBERENGWA, I. and CHAIPA, I.

Abstract

The purpose of the research was to determine the levels of conflict between the Dande community of the Mid-Zambezi Valley in Zimbabwe and the elephants (*Loxodonta africana*), their points of conflict, the problem animal control (PAC) strategies employed by the villagers against elephants, and how sustainable these measures were. A total of six villages were sampled for the study. Four of these – Chadope, Museruka, Bwazi and Chikafa - were in Guruve Communal area, while the remaining two – Masawi and Chiwashira were in Muzarabani area. Information for the study was obtained by using both structured questionnaires and focus group discussions. The questionnaires contained enquiries about household characteristics, human – wildlife conflict and crop damage, and PAC methods. Focus group discussions sought further clarifications on these issues. The data were analysed using the SPSS programme. The study revealed that in all the six villages, the main point of conflict was the cropping field, followed by the vegetable gardens and the homesteads. The elephant was cited as the most difficult problem animal. Forty seven percent of the interviewed farmers reported that elephants prefer maize compared to other crops grown in their community. However, annual average acreage damaged by elephants in all the villages, with the exception of Bwazi village, has been decreasing since 2000. The farmers used a combination of both traditional and modern PAC strategies in an effort to curb the extent of conflict with elephants at the various conflict points as the elephants quickly habituate to the use of one method at a time hence reducing the method's effectiveness. According to the villagers, modern methods have proved to be more effective and sustainable resulting in reduced crop damage and thus improving household food security. Alternative or additional sustainable approaches that can be instituted to minimise the conflict and improve livelihoods of affected communities include fencing off the wild animals and compensating the affected communities.

Introduction

Wildlife is an integral natural resource of great ecological and economic importance in many parts of the world that needs to be managed and utilised to the best long-term advantage of the local population, the concerned nations and the international community as a whole (Roth & Merz, 1996). Current thinking, especially in Southern Africa, is that long term maintenance of the greatest possible diversity of this resource lies in ensuring that local populations and the nations concerned derive optimum economic benefit from their wildlife (Hulme and Murphree, 2001).

While the desire to conserve elephants is widespread, the havoc that some of these animals cause on local populations make them be considered as 'pests' rather than 'assets', an issue which militates against their conservation. The major question then is: What is the nature of human – wildlife relations? More specifically, how effective are current methods employed to reduce human – wildlife conflict in improving household food security? Further, what alternative or additional sustainable approaches can be instituted to minimize the conflict and improve the livelihoods of affected communities? These and other issues are at the centre of this investigation.

This study is based on a questionnaire survey designed to identify key areas of conflict between humans and elephants, and assess the problem animal strategies employed by farmers in six villages of Dande Communal Area, Mid – Zambezi Valley, Zimbabwe. It also makes use of focus group discussions to seek further clarifications on these issues.

Research Methodology

Study Area

The Mid-Zambezi Valley refers to lands lying north of the Zambezi Escarpment and bordered by Mozambique to the north and east, and Zambia to the north-west. The area is characterised by relatively level, undulating valley floor with an altitude ranging from 350 to 500m. The region experiences high temperatures and a long dry season of seven months that starts from May to November. The mean annual rainfall decreases from about 800mm along the base of the Zambezi Escarpment to about 650mm around Mozambique border in the north.

The greater proportion of vegetation in the area is *Colophospermum mopane* woodland. There are a number of perennial rivers draining to the north from the escarpment towards Mozambique, including the Musengezi, Kadzi and Manyame Rivers. Vegetation along the major rivers is tall, well-developed riparian woodland dominated by *Acacia species*, which is often modified by humans and elephants. The region is characterized by high ecosystem, plant and animals species diversity.

Primary Data Collection

The data were collected in six villages that were selected in Guruve and Muzarabani Communal areas. These were purposefully sampled, as they were involved in the Zimbabwe Trust/Mid-Zambezi Elephant Project (ZT/MZEP) - a community based project established in 2000, which among other things, experimented on the use of pepper to control elephants from raiding community fields. In Guruve, Museruka, Chadope, Bwazi, and Chikafa villages were sampled for household interviews. Chikafa was selected as the control village. In Muzarabani, the two villages

sampled were Chiwashira and Masawi with the latter selected as a control village. The control villages had not participated in the ZT/MZEP project.

A structured questionnaire was used for data collection and this investigated three main issues:

- (a) household characteristics
- (b) human – wildlife conflict and crop damage
- (c) PAC methods

It was administered to a total of sixty households from the six villages. Ten individuals each from a different household were sampled from each village. The average sampling intensity was 43%. Households interviewed were chosen at random in each village. Among these, were representatives of men, women and youths.

Focus group discussions facilitated the verification of some of the data. At each meeting, the participants were divided into four groups to discuss issues falling into their thematic areas:

- (a) PAC and Crop Damage
- (b) Problem Animals
- (c) Natural Resource Management
- (d) Project and Livelihoods

The groups were given twenty minutes to discuss their topics with minimal intervention from the facilitators. This was later followed by preliminary presentations whereby all the participants reach a common consensus on the findings of each group.

Data Analysis

The data were analysed using a Statistical Package for the Social Sciences Version 10.0.5 program (SPSS, 1999). All the data collected on the PAC Questionnaires were coded and then entered into the database.

Results

Demographic Characteristics

Household sizes range between 3 and 15 members. About 90 % of households interviewed in the two districts were male-headed while female-headed households accounted for the remaining 10%. In Guruve the average household size was 6 whilst in Muzarabani it was 7. The average age of household heads was 43 and 49 years for Guruve and Muzarabani, respectively. More than 30 % of household heads in Chikafa, Bwazi, Chiwashira and Gutsa are above 50 years, whilst in Chadope and Museruka, less than 20 % are above 50 years of age. About 21 % of people interviewed in Guruve settled in the villages after 1999. In Muzarabani only 6 % of the respondents settled in the area after 1999. In Chadope and Museruka 50 % and 20 % of the

respondents, respectively, established settlement in the two villages after 2000. A greater proportion of respondents in the other villages established settlement before 2000.

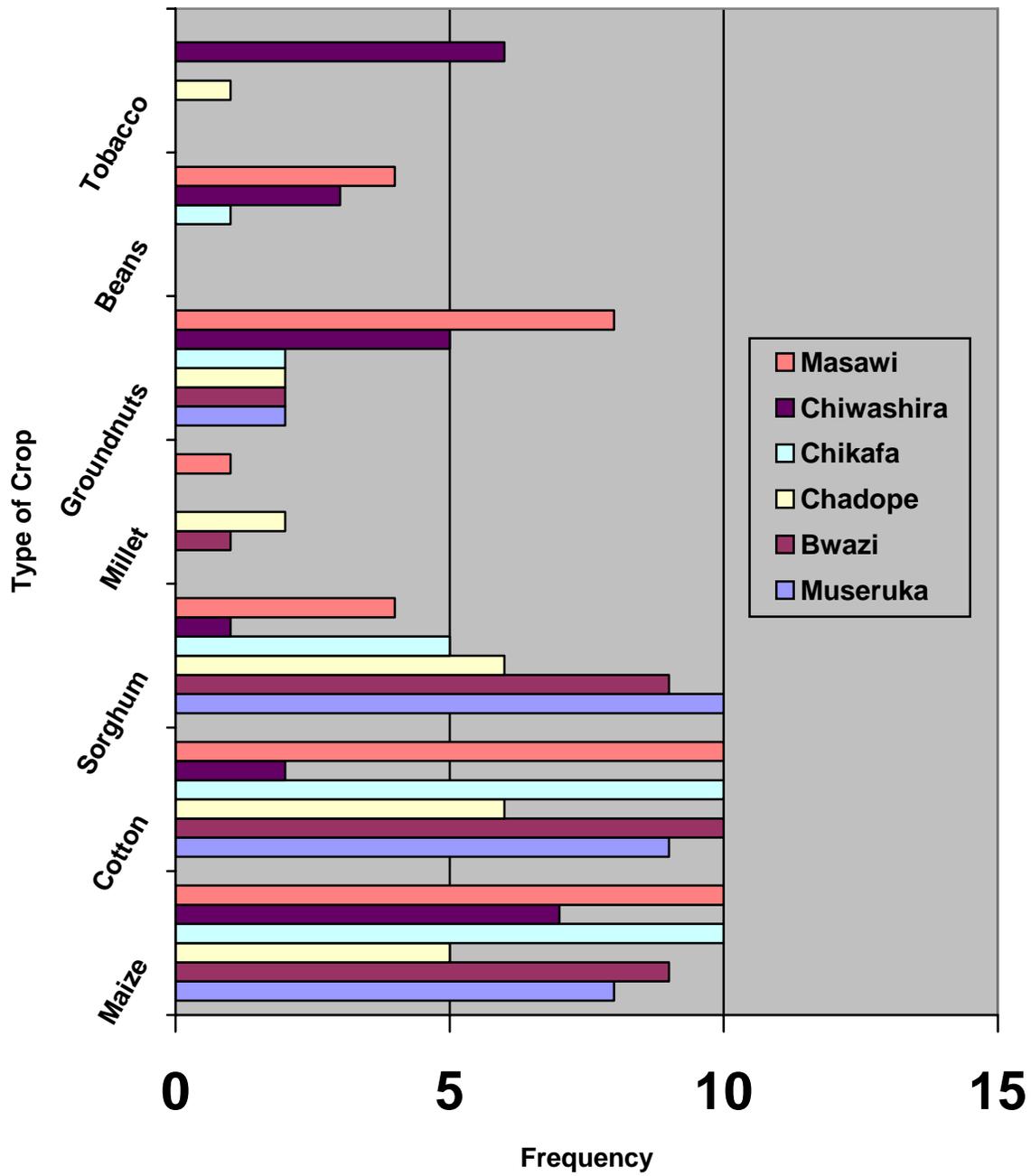
Production Activities

The results of the survey indicate that the main cash crop grown by farmers in the area is maize. Other crops also grown include cotton, sorghum, groundnuts and millet (Figure 1). In the community gardens, there is cultivation of vegetables, chilli peppers and maize. Green vegetables and tomatoes are maintained all year round for family subsistence.

The group discussions revealed that the ZT/MZEP project helped the villagers to establish community gardens. The villagers were taught how to grow chillies, supplied with irrigation equipment, seed and fertiliser. The ZT/MZEP project also provided a market for their produce. Chillies were identified as a major source of village income, as there was no significant harvest over the last season in all the other field crops. The chilli peppers also helped, as they were useful and effective in elephant PAC. Another aspect highlighted during group discussions was that previously, usually only women used to work in the gardens while men worked in the fields. With the coming of the project, men have also become involved in gardening hence improving the household food security.

Nearly all the farmers interviewed (89%) use a certain cropping pattern in their arable lands while 11 % do not use any particular pattern in their fields. The various reasons given for the use of a cropping pattern include using certain patterns as PAC methods. An example of this is planting a 2 to 3m belt of chilli pepper (buffer crop) in the perimeter of the cropping field. Farmers were taught to arrange their crops in a way that promotes visibility of crop raiding elephants. At the boundaries of fields, closer to the forestry area, farmers were encouraged to grow buffer crops such as chilli pepper. Farmers were encouraged to grow shorter crops such as cotton closer to field boundaries and taller crops such as sorghum at the central parts of the fields or located at the opposite direction frequently used by crop raiding elephants. Eighteen per cent of those farmers who use cropping patterns use them for PAC.

Figure 1: Crops Grown by farmers in Dande



Problem Animals

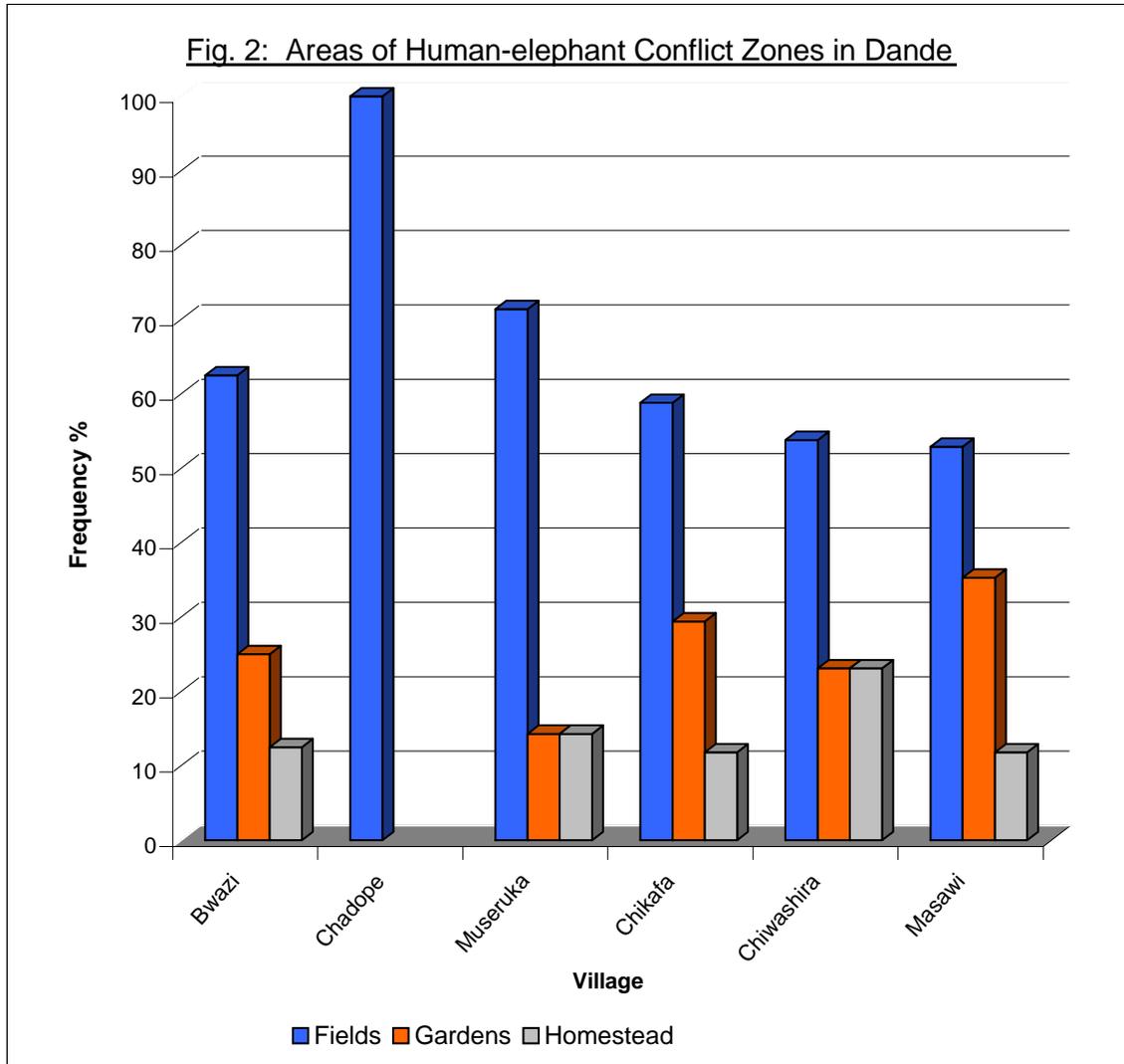
Results of the survey indicate that in Guruve, all four villages identified elephants as the most problematic animal. In terms of the intensity of the problem as compared to other animal problems, respondents in Bwazi and Chikafa indicated that elephants constitute at least 50 % of the problems encountered. Other animals identified as problematic in the villages include bush pigs, baboons, buffaloes and porcupines. In Muzarabani district, Masawi village farmers identified elephants as the main problem animal whilst in Chiwashira bush pigs were the most problematic animal in the arable lands.

Focus group discussions revealed that the frequency of human/elephant conflict and the extent of crop damage had been on the increase, were highest during the period 1990 to 2000, and have since 2001 started to decline. The production statistics of the area in the last four decades have also been influenced by the erratic rainfall the district has been receiving especially over the 2002/2004 growing seasons. The farmers want the elephants to be kept enclosed somewhere where they do not disrupt their lives.

Points of Conflict

The main centre of human-elephant conflict in all the six villages was the cropping field, followed by conflicts around the community gardens and homesteads as shown in Figure 2. While 84% of the participants put an effort in controlling problem elephants in the fields, gardens and homesteads, the majority of the villages in Masawi admitted to having given up on trying to control problem elephants. They do not take any action against the crop raiders.

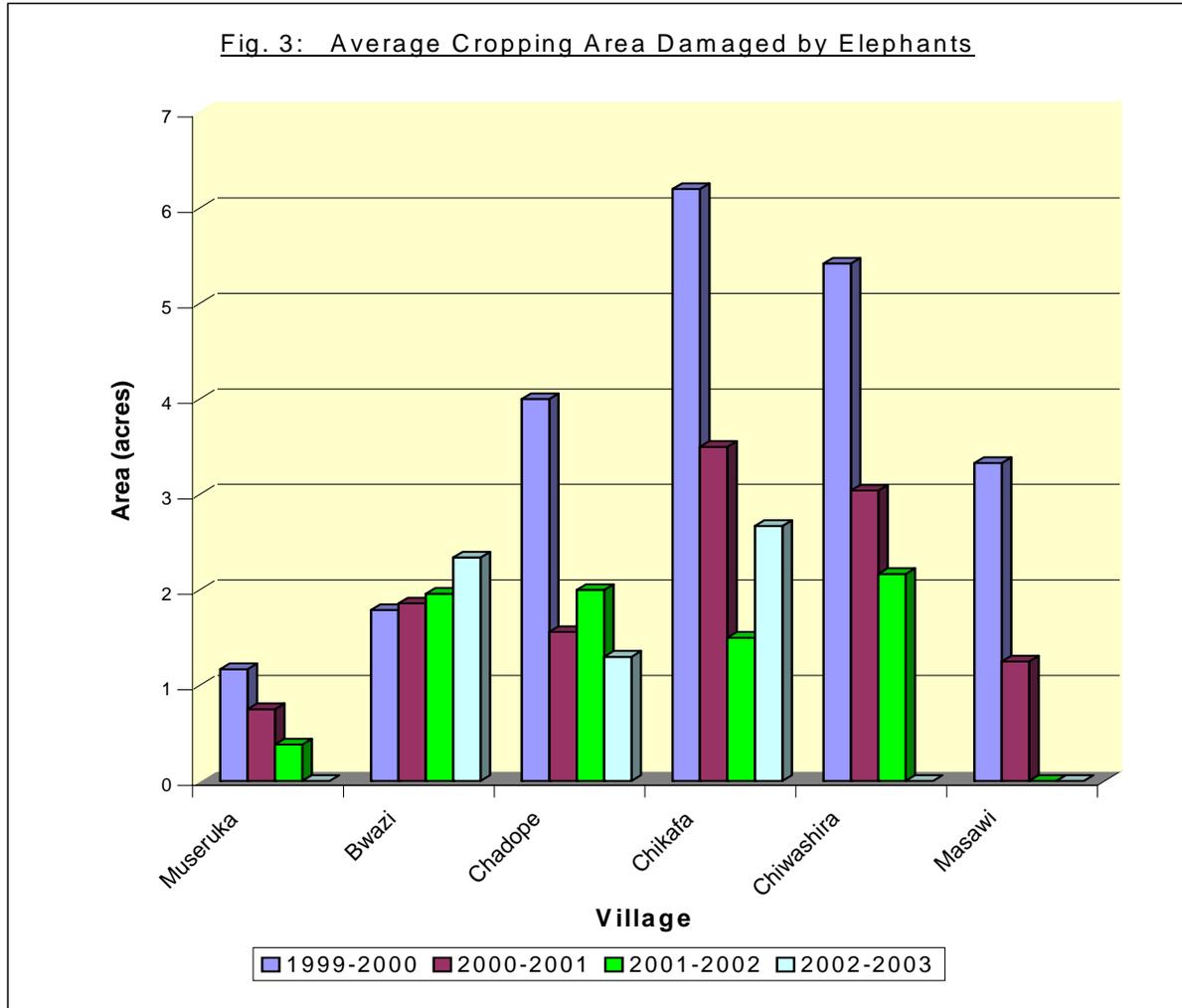
During the 2002/03 growing season, 51 % of the interviewed farmers did not experience any problems with elephants in any location. Of those who did experience conflicts with elephants in the last cropping season, 96 % experienced the conflicts in the cropping fields whilst the remainder experienced the conflicts in the community gardens.



In terms of crop damage, Figure 3 shows that Bwazi and Chikafa suffered a higher crop loss in the 2002-3 season, as compared to all other villages having recorded an average acreage loss above 2 acres. In Museruka, Chiwashira and Masawi villages no crop damage cases were recorded during the 2002/3 season. However, the average acreage damaged by elephants in all the villages, with the exception of Bwazi village, has been going down in subsequent seasons since 2000. Of interest to note is that the control villages show the same trend as the experimental villages.

The crop preference of the crop raiders was seen by 47 % of the interviewed farmers to be maize. Also 22 %, 7 %, and 6 % of the farmers think that among all the crops, elephants prefer sorghum, cotton and pumpkins, respectively. Fifteen percent are of the opinion that elephants do not have any particular preference as they eat/destroy anything that they come across.

Focus group discussions further revealed that new immigrants and new household formations have been settled where elephants frequently pass through. The settlements are in a linear pattern along the rivers which is where their cropping fields are also located for easy access to water in the drier seasons. Thus, these water points are also major source of conflict as well because elephants and other animals source water from these rivers.



PAC Strategies

The farmers use a wide range of PAC methods in an effort to control problem elephants. The methods were listed as in Table 1. The PAC methods are divided into traditional methods and modern methods. Traditional methods are those that the farmers have always been using which were being passed down through the generations, while modern methods, are those that farmers were taught through ZT/MZEP project. In the control villages especially Masawi, the range of PAC methods are basically traditional and in the experimental villages, the range is a combination of both the traditional and the modern methods. The traditional methods that are predominantly

used include noise making (76%), lighting fires (36%) and throwing of fire (35%). Among the modern methods used, the predominant techniques included burning chilli in dung or chilli bombs (35%), clearing buffer zones around fields (27%) and using bangers (20%).

Table 1: Problem animal control methods used by villagers.

Type of PAC Method	PAC Method	% of people who use them	Rank by use and category	Rank by use overall
Traditional methods	Noise making ¹	76 %	1	1
	Throwing fire	35 %	3	3
	Lighting a fire	36 %	2	2
	Gun shots/ gun imitations	18 %	4	7
	Burning tyres	5 %	6	9
	Throwing stones	4 %	7	11
	Catapult	7 %	5	10
	Use of dogs	2 %	8	12
Modern methods	Clearing buffer zones around fields	27 %	2	5
	Using bangers	20 %	3	6
	Pepper spray	16 %	4	8
	Use of Sisol	2 %	5	12
	Fencing around the fields	2 %	5	12
	Burning chillies in dung/chilli bombs	35 %	1	3

¹Noise making includes beating drums, tins, shouting, and beating on metal objects.

Discussion

Demographic Characteristics

The participating households are large and generally male headed in both districts. The average age of the household heads is 46 for both Guruve and Muzarabani, and according to the Central Statistical Office (CSO) is within the peak activity age group. Activity rates are higher in rural areas than in urban areas. However, for both rural and urban, the rates are peak in the age group 45 – 49 years (CSO, 2003). More than 30 % of the heads are over 50 years of age, showing a generally less active ageing population in both districts.

On average, less than 15 % of the interviewed farmers in both Guruve and Muzarabani having settled in their respective villages after 1999, yet in Chadope and Museruka villages of Guruve, 50 % and 20 % respectively of the respondents settled in the villages after 2000. These statistics may indicate that Chadope and Museruka villages have experienced a high influx of settlers in the period beginning 2000. Among the reasons given by respondents for settling in the area include an attraction of rich farming soils as well as loss of employment in the farming areas.

Crop Production Activities

The households in the area are largely dependent on small-scale subsistence farming and cash crop production. The main crop grown is maize as it forms the main component of the staple diet. Other crops grown include cotton, sorghum and millet. According to a livelihood survey conducted by Chaipa (2003) in Guruve and Muzarabani, the main source of income for the villagers in crop production. Cotton sales contribute more than 80% of the total income that comes from crop production.

Drought and erratic rainfall patterns over the 2002/04 growing season, as identified by respondents in Chadope, Bwazi and Museruka, constitute the main externally induced problem that affects livelihood systems in these communities. Drought has adverse effects on household food security and income. In this context, Ngara and Rukobo (1999) reported that Zimbabweans in the rural areas depend entirely on tilling the land under rain-fed agricultural systems. Rainfall has the greatest influence on crop yields. The lack of crops due to the drought seems to explain the appearance of the water points as opposed to the cropping field as points of conflict between the elephants and the community.

The study established that above all the other crops, elephants prefer to raid maize. This is in line with the establishment of Prins, Grootenhuis and Dolan (2000) who reported that in Laikipia (Kenya) maize fields accounted for 45 % of crop damage complaints. Between 60 and 66 % of complaints of farmers in Nyami Nyami District in Zimbabwe reported wildlife conflicts in maize fields. In Malawi, maize fields were raided even more frequently and it appears that crop raiding

animals have specific preferences for crops as they raid specific crops compared with other crops in the cultivated area. Prin et al., (2000) argue that elephants appear to prefer hybrid maize over local maize in Malawi.

Problem Animals

The focus group discussions revealed that the intensity of the problem with elephants was quite high in the period 1990 to 2000 and has since 2001 started to decline. This is consistent with recorded cases at the district level. In 2002 out of 18 cases of problem animal incidents recorded by Guruve Rural District Council, 15 were caused by elephants. By mid 2003, 12 out of 24 reported incidents were caused by elephants (Guruve RDC, 2003). This decline may be attributed to the low productivity of the forests and cropping fields in the last two growing seasons caused by drought and erratic rainfall patterns. Also to some extent, the decline may also be viewed as a testimony of the effectiveness of the chilli based PAC methods the farmers have been using in combination with the traditional methods of PAC.

The crop damage assessment indicates a fall in average cropping area damaged by elephants in the six villages studied. Barnes (1996a) states that crop raiding is seasonal, occurring mainly in the harvest season. He then concludes that the crop raiding issue is a man made problem. The farmers in the focus group discussions confirmed this. They attributed the highest crop damage to the harvesting period of the rainy season, acknowledging that the fields have the most crops at this time, as will the forests. The farmers also highlighted the fact that hunters at times wound animals and then kill a new target leaving the wounded animal to roam angrily raiding and at times killing other animals or even people. This is in line with findings reported by Mvuriye (1999).

When there is nothing in the cropping fields then there is no conflict experienced in this location, and the reverse is true. As stated by Parker & Osborn (2001), crop damage is at its height during the wet season (December-April) when the majority of crops are grown. In the study, the farmers testified that the elephants raid close to the harvesting period prompting most of the farmers to harvest their produce prematurely. Moreover, increase in human settlements and expansion of arable land over the years meant some important wildlife habitats were destroyed in the process. The increase in human population and the population of elephants means an increase in competition over the scarce land resources. With an increase in human population there is a related increase in land cleared for arable farming (Nyenda, 2004). This reduction of the forests results in loss of biodiversity, both flora and fauna, habitats of wildlife animals (Dale et al., 1994; Katsvanga et al., 2005) leading to increased human – wildlife conflicts as animals search for feed, water, and shelter. The clearing of tropical forests has created a highly modified landscape where remnant patches of native flora are set in a matrix of agricultural lands (Holl, 1999). Thus the changes in land cover and ecological functioning of tropical forests will have long term socio-

economic and environmental impacts that influence the sustainability of both the agricultural and wildlife production systems

However, with increased awareness and use of improved methods of PAC, human elephant conflicts have been reduced and as a result crop damage is significantly minimized. Most respondents argued that elephants were then not a bigger problem as compared to the CAMPFIRE years and still advocate that killing elephants is one of the most effective ways to reduce conflict.

Problem Animal Control (PAC) Strategies

The costs imposed by elephants need to be reduced and the benefits to rural populace increased as suggested by Barnes (1996b). In this case, the Dande community has received assistance in mitigating crop damage through capacity building in problem elephant issues inclusive of elephant corridors, elephant behaviour patterns and PAC methods. This intervention has proved to have had a positive impact on the Dande community's interactions with problem elephants.

The strategies were broadly classified into three categories: (i) Vigilance methods, (ii) Passive P A C methods, and (iii) Active P A C methods. These encompass both traditional and modern methods. It was observed that no single method is entirely effective on its own without combining it with other methods of P A C. The vigilance methods which include buffer zone, watchtowers, whistles and cowbells were designed to alert farmers of crop raiding elephants and increase the chance of farmers spotting elephants as they approach the fields. Whilst watchtowers and buffer zones increase the visibility of crop raiding elephants, whistles and cowbells alert other farmers of the impending danger. As reported by Parker and Osborn (2001), by improving vigilance, it was possible for the farmers to be prepared for the elephants and conduct PAC as they reached the crops.

The advantage to the vigilance methods is that they offer an early alarm system for the farmers to implement the active methods before the elephants enter the fields. The methods encourage corporation among the farmers as the farmer on night watch alarms all the other farmers of the close proximity of the elephants to the fields. Watchmen have an immediate effect and they are able to use a combination of methods when being raided. However, the disadvantage of the vigilance methods is that not all farmers are willing to incorporate and this poses a difficulty to the system of problem elephant control. Also, elephants become habituated to the methods.

The passive methods are designed to impede crop-raiding elephants' passage into the field using simple physical barriers and deterrents. These methods are often established at the onset of the

rains and require no further attention besides maintenance. These methods include burning elephant dung mixed with chilli pepper, string fences tied around the buffer zone and an irritating mixture of grease and hot pepper oil smeared on the strings and also on pieces of cloths tied at 5m intervals along the string. The advantage to using these methods is that once installed, they only require maintenance thus they are a one off expense. These methods do not need nearly as much manpower as that needed for the effective implementation of vigilance and active methods. Passive methods in one way or another delay or hinder the entrance of crop raiders into fields/gardens. However, if the crop raiders are wounded animals, the barriers put in place may be totally destroyed further wounding the animal. Furthermore, the mere construction of the physical barriers may have detrimental effects on the environment.

In order to actively chase away crop-raiding elephants farmers use a number of active methods that include capsicum-based chemical deterrents and noisemakers. Other active methods used by farmers are whips, lighting fires, throwing fires, ammonium (fertiliser) explosions, disturbance shouting, burning chilli pepper in elephant dung, burning goat droppings, and beating drums and tins. The project also made use firecrackers and pepper sprays. There are several advantages in using active methods. There is the direct participation of the farmer in the implementation of active methods. This makes the methods more reliable as the farmer can use his discretion when using a method, if he sees that one method is not being effective, he can try implementing another active method. Thus, these methods are usually more effective as the use of a combination of methods at one time confuses the elephants and eventually makes them leave the cropping field/gardens.

The major disadvantage of using active methods is that they are strenuous to implement and require considerable manpower, time and commitment. They are also the most dangerous of all as they expose the farmer to direct danger. The elephants may charge on the farmer while he is implementing active methods at the point of conflict. The chilli pepper dung method depends on the direction of the wind (Osborn, 2002). The dung has to be burnt in a situation where the smoke is blown in the direction of the elephants. Thus this method may not be applicable everyday, which is its limitation. The disadvantage of using alternative deterrents like the olfactory agent found in chilli peppers, skilled/trained personnel are required to operate these methods, and animals habituate to most of them (Hoare, 1995; Osborn and Rasmussen, 1995).

Conclusions and Recommendations

Generally, those villages that were exposed to the modern methods of PAC incorporating the use of chilli peppers rank them higher than the traditional methods. Of particular interest are the results from Chikafa village. The farmers are of the opinion that these methods are effective and are keen to be taught how to grow the chilli pepper and receive the seeds and fertilisers to start

their own programme in order to make it a sustainable method for the community. They are therefore just experimental and cannot be practically implemented in the community as methods for everyday use unlike pepper dung, buffer zones and chilli grease. The traditional methods continue to be used in all the villages as they are based on resources that are readily available and hence have proved to be sustainable.

Alternative or additional sustainable approaches that can be instituted to minimize conflict and improve livelihoods of affected communities.

While the above strategies go a long way in achieving sustainable relationships between man and wildlife, there is still need to have them buttressed by more human oriented measures that can motivate local communities to conserve their wildlife. Additional sustainable approaches that can be used include: adaptive management approaches, use of buffer cash crop, compensation of affected households, fencing off the wildlife,

Adaptive management approach

Project interventions in rural communities of Zimbabwe today, should seek to strengthen local adaptive and coping strategies rather than seek to introduce completely new survival strategies. It had been noted that due to the 2002 famine in the two districts, a number of households could not actively participate in field preparations for the oncoming season due to hunger. This scenario would confine the poor households to an eternal poverty cycle characterised by acute food shortages. This situation could be used to explain the dependency tendency within some households at Museruka who hardly see any brighter future without the project. From this evaluation, the concept of community-irrigated gardens should be explored further as this has great potential in promoting sustainable livelihoods.

Buffer cash crop

Farmers in both Muzarabani and Guruve eagerly received the introduction of chilli pepper as an alternative cash crop. The crop was considered as less labour intensive and less costly but has good returns compared to cotton and quite effective in problem elephant control. The only drawback was poor coordination and monitoring by field officers and project technical staff, particularly the Chilli Pepper Company.

It is recommended that the Company works with partners experienced in community development issues to ensure that the project runs smoothly following laid down community development protocols. Otherwise, there should be an establishment of a legitimate market for the crop produced by the farmers.

Compensation of affected households who suffer crop damage

The current arrangement that allows animals to reek havoc on households' crops yet not to be compensated, is unsatisfactory. To overcome this, a levy can be charged to all those that benefit from wildlife, and proceeds from this money can be used to develop infrastructure that can minimize the conflict between animals and humans. Fencing off the animals and compensating the affected households becomes possible that way.

Need to stamp out poaching activities.

The community can further enhance the management of its wildlife by co-operating in stamping out of poaching activities by both local community and outsiders. They can be coerced into doing this through receiving (or not receiving) their annual dividends and meat from safari operation (in the case of CAMPFIRE). If they do not benefit from such acts, then it will be difficult to receive their cooperation.

REFERENCES

- Barnes, R. F. W. 1996a. Facing the Storm: Five years of Research in and around Kakum National Park, Ghana. Proceedings of a course in elephant biology and management: Ghana Wildlife Dept, Conservation International and University of Cape Coast.
- Barnes, R. F. W. 1996b. The conflict between humans and elephants in the central African forests. *Mammal Rev.* Volume 26, Number 2/3, 67-80. Great Britain.
- Central Statistical Office. 2003. Census 2002: Zimbabwe Preliminary Report. Government Printers, Harare, Zimbabwe.
- Chaipa, I. 2003. Improving Livelihood Security By Establishing An Integrated Programme To Reduce Human-Elephant Conflict. Zimbabwe Trust, Harare, Zimbabwe.
- Dale, H. V. H., O'Neil, R. V., Southworth, F. and Pedlowski, M. 1994. Modeling the effects of land management in the Brazilian Amazonian settlement of Rondonia. *Conservation Biology* 8 (1):196 – 206.
- Guruve Rural District Council. 2003. District Problem Animal Records. Guruve, Zimbabwe.
- Hoare, R. 1995. Options for the Control of Elephants in Conflict with People. *Pachyderm* 19, 54 – 63.
- Holl, K. D. 1999. Factors limiting tropical rainforest regeneration in abandoned pasture: Seed, rain, seed germination, microclimate and soil. *Biotropica* 31 (2): 229 – 242.
- Hulme, D. And Murphree, M. W. 2001. (Eds.). *African Wildlife and Livelihoods. The Promise and Performance of Community Conservation.* James Currey Publishers.
- Katsvanga C.A.T., Mukwewa O., Mupangwa. J. F. and Buzuzi. G. 2005. Land use impacts on miombo woodland species in Wenimbi Resettlement Area of Macheke, Zimbabwe. *Journal of Sustainable Development in Africa* 7 (1).
- Mvuriye, D. 1999. Problem Animal Control: Towards a Central P.A.C Unit. CIRAD/BIODIVERSITY Project.
- Ngara, T. and Rukobo, A. 1999. Environmental Impacts of the 1991/92 Drought in Zimbabwe: An extreme event. Radix Consultations (Pvt) Ltd, Belvedere, Harare, Zimbabwe.
- Nyenda, T. 2004. Land use and cover changes for Lower Guruve in Zambezi Valley, Zimbabwe, B. Sc. Dissertation, Bindura University of Science Education, Zimbabwe.
- Osborn, F. V. 2002. Capsicum Oleoresin as an Elephant Repellent: Field Trials in the Communal Lands of Zimbabwe. *Journal Of Wildlife Management* 66 (3): 674

Osborn, F. V. and Rasmussen, L. E. L. 1995. Evidence for the effectiveness of an oleoresin capsicum aerosol as a repellent against wild elephant in Zimbabwe. *Pachyderm* 20: 55-64.

Parker, G. E. and Osborn, F. V. 2001 *Community-Based Methods to Reduce Conflict between farmers and elephants, Version 5.2*. Mid-Zambezi Elephant Project, Harare, Zimbabwe.

Prins, H. T. H., Grootenhuys, J. G. and Dolan, T. T. 2000. *Wildlife Conservation by Sustainable Use*. Kluwer Academic Publishers, Netherlands.

Roth, H. H and Merz, G. 1996. *Wildlife Resources: A Global Account of Economic use*, Springer-Verlag, Berlin, Heidelberg, New York.