

Assessment of the Effectiveness of Chilling Method in Mitigating Human-Elephant Conflicts in Western Serengeti, Tanzania

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Abstract— This paper reveals the less known effectiveness of Chilling method in mitigating human elephant conflicts carried out in Western Serengeti, Tanzania. Two villages were involved namely Nyamburi and Bonchugu. Data were collected by using household questionnaire, focus group discussion and archive information. Data were analyzed by use of SPSS (Version 18) software. Field results indicates that; Chilling method is effective (83%) in mitigating human elephant conflicts. However, statistics for crop damaged by elephants before and after introduction of the method shows that the crops damage decreased by 25%. The most observable strengths of the method were; it control HEC without harm people and elephants, it is easy to apply (55%), it does not consume time and use appropriate technology. Despite the effectiveness of the method, major weaknesses observed to face the method were; insufficient used oil and pepper (61%), elephants observed to be a clever animal as sometimes they inter into the farms backwards and also during rain seasons, chill method observed to be ineffective as it can be washed/removed easily. However, the respondents recommended that; the challenges can be solved by local community to cultivate pepper and other stakeholders such as district, different NGO and companies to support farmers the provision of used oil, chill should be applied regularly once washed out by rain and for the effectiveness of the method community should be more trained on how to use the method.

Keywords— Human-elephant conflict (HEC), Chilling method, Crop raids.

I. INTRODUCTION

1.1 Background information

Protected areas (PAs) are important in the conservation of biodiversity, economic value of resources and their potential to contribute to sustainable development (URT, 2005). Despite this development, local people living adjacent to the PAs live in abject poverty and human wildlife conflict (Kaswamila et al, 2007). Human elephant conflict (HEC) is a growing global problem which is common to all areas where elephants and human population coexist as well as share resources (Distefano, 2005). HEC

occurs wherever people and elephants coincide, and poses a serious challenge to wildlife managers, local communities and elephants alike.

Human elephant conflicts are one of the major threats to conservation in Africa (Holmern & Anne, 2004). HEC occurs throughout the elephant range, and has been reported in most of the 37 elephant range states of the African continent in both savanna and forest situations (Parker et al., 2007). Hence, knowledge about human-elephant conflict in and around protected areas is crucial in wildlife management (Holmern & Anne, 2004; Kideghesho, 2006).

In several parts of East Africa Conflict between elephant and local communities are wide spread and are major concern for both elephant conservation and rural development (Distefano, 2005). HEC in East Africa is increasingly becoming significant as human populations and agriculture expand into elephant habitat (*ibid*). Elephants continue to threaten farmers' income and food security despite considerable research and resources that has been devoted to resolving this problem (Woodroffe et al., 2005). In Tanzania encroachment of protected areas by local communities has resulted into tremendous human wildlife conflict (Severre, 2000).

To mitigate HEC, farmers use both lethal and non-lethal measures such as fencing, scares, chilling, barriers, translocation and use of guard animals (Breitenmoser et al., 2005). In order to be conservation-effective, non lethal methods must be acceptable (in accordance with local traditions) and applicable on a large scale (cheap and easy to use) (Woodroffe et al., 2005). Furthermore, the implementation and application of non-lethal techniques must be considered in the context of the conservation goals and all other management action (*ibid*). 1.2

1.2 Statement of the Problem

Conflict between humans and African elephants occur wherever they coexist, especially in the interface between the elephants' range and agricultural land. Most HEC incidents involve crop-raiding animals that consume or destroy food crops and injure or kill those people trying to protect their fields (Distefano, 2005).

The Serengeti ecosystem in Tanzania embodies a variety of human elephant conflicts as evidenced both within and around the protected areas of the ecosystem (Homewood *et al.*, 2001).). The root cause of human-elephant conflict is the exploding human population growth and resultant pressure on elephant habitat (Parker *et al.*, 2007).According to Kaswamila (2009), HEC is more alarming in Serengeti district. Crop destruction by elephant impacted on both household food security and cash income. The annual crop loss is estimated to amounts to 390 tones from annual crop yields of 129,670 tones of various crops .

In trying to address the problem, the Tanzania Wildlife Research Institute in collaboration with Serengeti District Council intervened by introducing the use of chilli (pepper) in mitigating destruction of crops by elephants. However since its introduction in 2007, no study has been carried out to assess its effectiveness. This study is an attempt to that end.

1.3 Research Objectives

1.3.1 General Objective

The main objective of this study was to assess the effectiveness of chilling method in mitigating HEC in Western Serengeti.

1.3.2 Specific Objectives

Specifically this study intended to:

- (i) Assess effectiveness of chilling method
- (ii) Identify strengths and weakness of the method
- (iii) Suggest measures for improvement

1.4 Conceptual Framework

For effective control of Human Elephant Conflict, good application of chilling method will be very much needed. In order for the method to be applicable, there must be a positive community attitude towards control of elephants and community should be well trained on chill application. Furthermore, the control will be effective if the elephants will not be habituated and there is conducive environment for chill application such as absence of rain as chill is affected by rain.

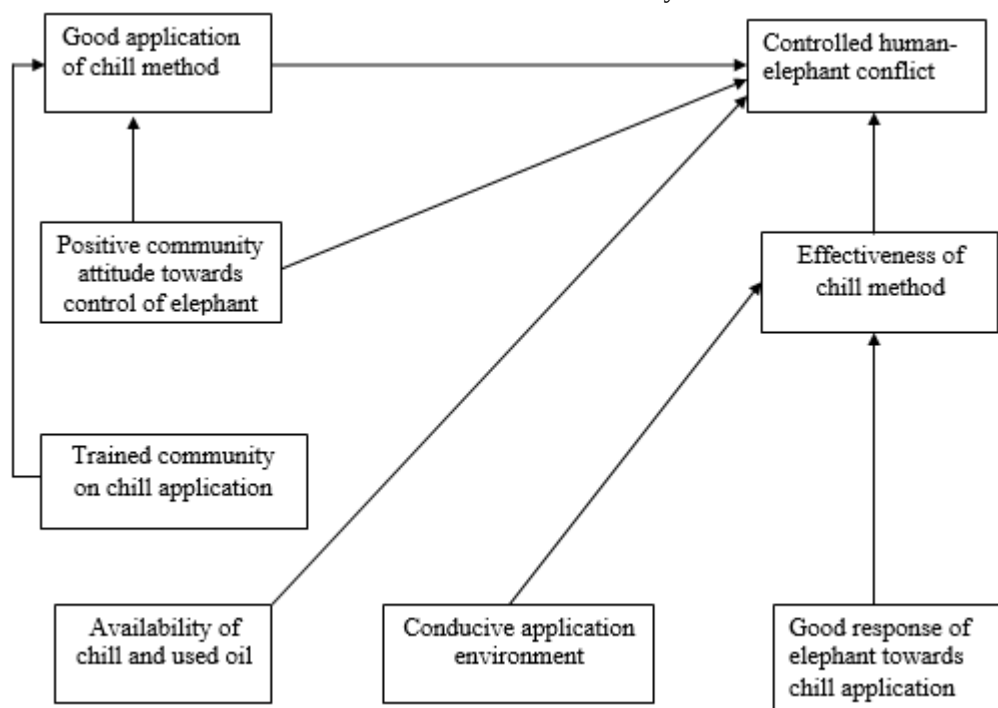


Fig.1: Conceptual Frame work

1.5 The Study area

1.5.1. Location

Nyamburi and Bonchugu are among villages in Serengeti District. (See figure 1). Nyamburi villagelies between 34° 40" E and 1° 47" S while Bonchugu village lies between

34° 45" E and 1° 50" S with an average altitude of 1480 m (SDC, 2011). Nyamburi has a total population of 3865 people and 787 households while Bonchugu has total population of 6114 and 579 households.

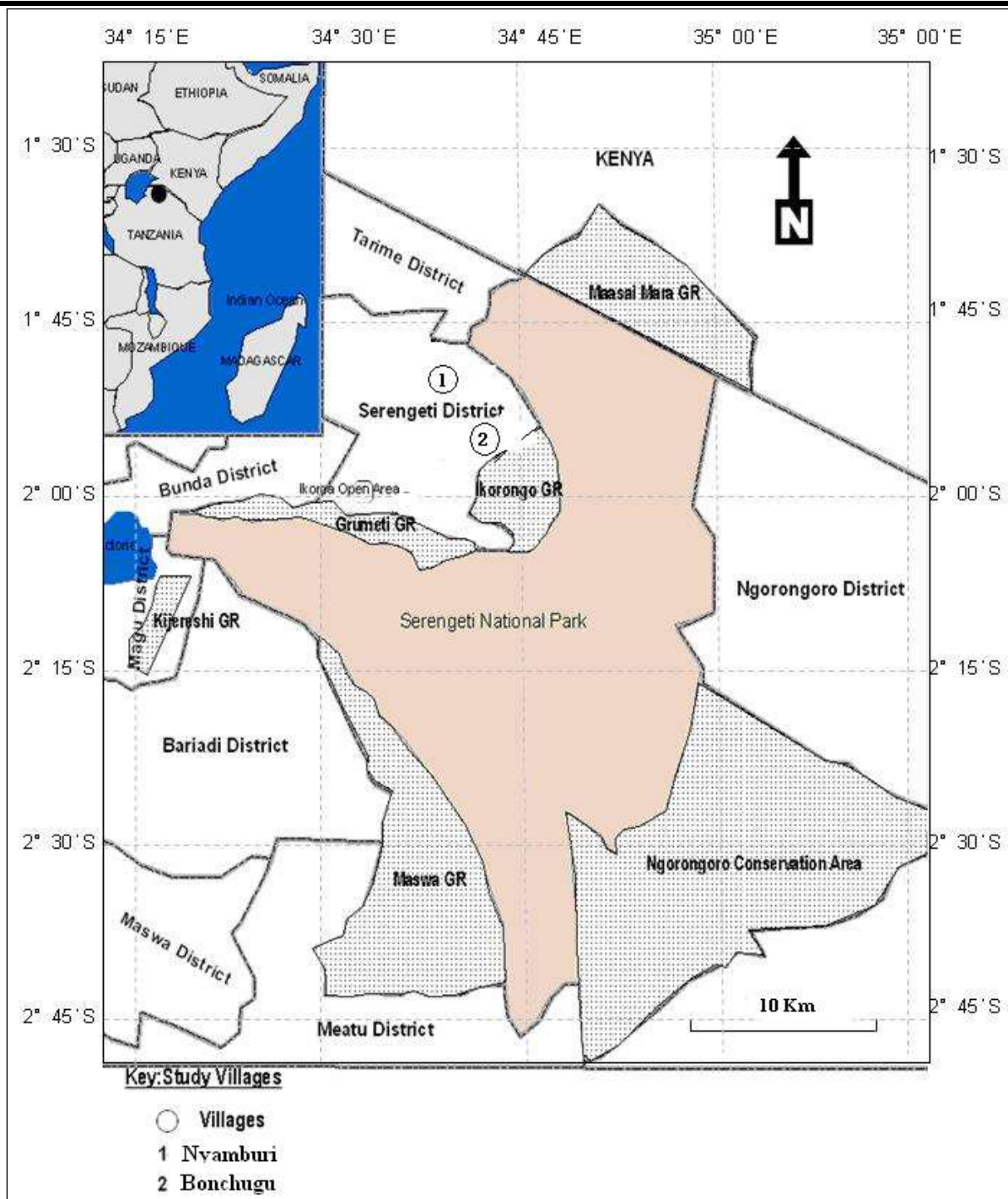


Fig.2: Map of the study area

1.5.2 Climate and topography

The study villages are part of the high interior plateau of East Africa. It slopes to its highest part (1850 m) on the eastern plains near the Gol Mountains towards Speke Gulf (920m) along Lake Victoria. The temperature shows a relatively constant mean monthly maximum of $27^{\circ}\text{--}28^{\circ}\text{C}$. The minimum temperature varies from 16°C in the hot month of October-March to 13°C during May-August (SDC, 2011). Rain typically falls in a bimodal pattern with the long rains during March-May and the short rains during

November-December. Rainfall varies from 1200 mm in the north to 600 mm on the south-eastern plains and the Rift Valley (*ibid*).

1.5.3 Economic activities

About three quarters of the population in the study villages are mainly small-scale farmers who, to a varying degree complement with livestock keeping (Holmern, *et al.*, 2004). Livestock (cattle, sheep and goats) which is kept by 61% of the population is seen both as a source of income and a

source of meat for consumption and some 73% earn income from the sale of animals or meat (*ibid*). Wildlife-induced damage to crops and domestic animals is a major problem in the area (SDC, 2011).

II. RESEARCH METHODOLOGY

2.1 The Study Area Selection

The study was conducted in Bonchugu and Nyamburi villages adjacent to Western Serengeti. These villages were selected because the problem of HEC is more alarming due to human elephant interaction and proximity to Serengeti National Park.

2.2 Sample size and Sampling technique

A total of 82 respondents were picked. Sample size composition included (68) households respondents, (2) Village chairperson, (2) VEO, (1) DGO, (1) DALDO, (2) SENAPA Ecologist, (2) Elders, (2) Youth and (2) women. In determining the sample size two factors were considered: required level of precision in the results and the available budget.

According to Hennem *et al.*, 2006, it is worth mentioning that, it is the absolute size of the sample, which is important in determining the sample size, not its size relative to the population. Sixty eight households from each Village were sampled from the Village register list using a simple random sampling method. Where a candidate happened to come from the same household, one was dropped. The age from 18 and above was picked from each household using a table of numbers following the procedures described in Bouma (2000). Simple random sampling is considered to be simpler and more cost effective system (Henn *et al.*, 2006). Key informants and group discussion members were selected purposively to meet the objectives of the study.

2.3 Data collection methods

2.3.1 Questionnaire survey

Face-to-face semi-structured questionnaires were administered to the sampled households. Semi-structured questionnaire survey was preferred to structured because it normally yields better quality data than the latter. According to Gillham (2005), Semi-structured questionnaire allows the interviewer greater flexibility at the expense of possibly incurring greater bias as the same questions may be asked in the same order but supplementary questions (probes) may be allowed to clarify the responses. The household questionnaire contained aspects such as: socio-economic characteristics, crop destruction, and assessment of chilling method, strengths and weaknesses of the method and suggestions for improvement.

2.3.1.1 Questionnaire pre-testing

Questionnaire pre-testing aimed to test questionnaire wording, sequencing and layout; to train fieldworkers; and to estimate response rates and time. Pre-testing also assessed whether the questions are clear, specific,

answerable, interconnected and substantially relevant. The exercise helped to fine-tune the questionnaire. Some ambiguous questions were removed and others were re-phrased. After revision, the questionnaires were duplicated ready for use in the social survey.

2.3.1.2 Questionnaire administration

Face to face household semi-structured questionnaire surveys were administered by the researcher and research assistants to interview sample local residents in Villages. Research team visited the selected household sample at their residential areas. The questionnaire consisted both open and closed end questions. The open-ended questions were intended to give respondents an opportunity to express their views more freely and to increase the level of interaction between the two subjects.

2.3.2 Focus group discussion

Focus group discussion (FGD), help researcher tap many different forms of communication that people use in day to day interactions, including jokes, anecdotes, teasing and arguments (Morgan, 1998). FGD needs to comprise 5 to 10 people so as to have effective and participatory group discussion (Krueger *et al.*, 2004). In this study FGD comprised 6 people. A checklist was used to obtain information's from villages elders, women and youths (group members). During discussion the researcher acted as a facilitator to make sure that every one participates effectively.

2.3.3 Archive information

Documented information in Village, ward and District offices related to average crops destroyed by elephants, Introduction of chilling method to the district, location and population of the study villages. Similar information was also obtained from Village experts (agriculture and wildlife officials). This information supplemented data collected from interviewed households.

2.3.4 Direct field Observation

Field observation was made for the purpose of observing farms located adjacent to protected areas to compare the incidence of destruction as compared to distant villages. Also field observation was made to observe the way chilling method was applied by the farmer. Using physical visit as a tool for data collection, the observer goes to the field and makes the study of the phenomena and once observes things in a scientific manner, he or she thoughtfully studies the fact (Rwegoshora, 2006).

2.4 Data analyses

Data collection using questionnaire survey, group discussion and archive information were mainly qualitative in nature. As pointed out by several social science researchers, qualitative data analysis has no one right way to proceed with analysis (Hesse-Biber & Leavy, 2004) and this necessitated use of coding and memoing for narrative information and/or secondary data. Coding is the reading

the text line by line and carefully coding each line, sentence and paragraphs thereby describing themes/ideas (Punch, 2000). Memoing (memo writing) on the other hand is the theorising write up of the ideas about codes, which assist researchers to illuminate ideas and relationships in the data (*ibid.*).

Before the detailed data analysis, questionnaires were thoroughly examined, variables coded and then imported into SPSS version 18 software package. This examination process will be done to all questionnaires used in the survey. The data analysis then followed the two main stages of reduction and display (Coffey & Atkinson, 1996). Data reduction involved editing and summarizing of data through coding. With data already entered into SPSS and secondary

data from government offices and group discussion, data analysis to answer research questions were carried.

III. RESULTS AND DISCUSSION

3.1 Social economic characteristics of respondents

The socio-economic characteristics of the study area are presented in Table 1 below. Overall, in the two villages combined, the majority of the respondents were males (60%; N=68). As for age most of the respondents (68%) were between 18 and 54 years. This shows that the majority of the populations at study villages are still economically productive. Regarding social economic activities of the study villages, about 78% of the population depends on crop-based agriculture.

Table.1: Social economic characteristics of respondents

Village	N =68	Sex (%)		Age (%)			Education (%)			Socio-economic activities (%)		Household size%		
		M	F	18 - 34	35 - 54	>54	NF	P	S & A	A	L	1-5p	6-10p	>10p
Nyamburi	34	61	39	30	36	34	41	55	4	76	24	10	53	25
Bonchugu	34	58	42	32	38	30	38	57	5	80	20	12	50	50
Average	34	50	40.5	31	37	32	40	56	4.5	78	22	11	51.5	37.5

Keys: N =sample size M=Male F=female >=Above NF=Non Formal P=Primary S & A =Secondary and AboveA=AgricultureL=Livestock p=person

The literacy level in these two villages is low as only (4.5%) have attained secondary education. This implies that, the illiteracy level in terms of formal education is high. Education is a necessary condition for social economic and technological development in any society (Author, pers. Obs.). With education one can easily learn new technological advancement, adapt to change environmental conditions and learn new skills.

Regarding household size, findings reveals that, the average size of household is 8 people. The higher number of family size could probably be due to polygamy culture of the people in the area. In Mara region, particularly Serengeti and Tarime districts the culture of marrying many wives is rampant (Author, pers. Obs.). Having many wives increases the probability of having many children when compared to monogamy families and hence increased poverty level. This is in agreement by Kaswamila (2007) where he observed that income in the study area ranged between TZS784,000 and 930,000.

3.2 Human Wildlife Conflict (HWC) status

Local communities were asked to assess the current status of HWCs in their areas. Answers were limited to Yes or No.

In both villages the findings reveals that, HWC is a problem (Figure 3). In Nyamburi all respondents perceived HWC a problem whereas in Bonchugu the proportion was 97%. The most destructive game being elephants (*Lexodonta Africana*), other problem animals included wild pigs (*Potamochoerus porcus*), porcupine (*Potamochoerus porcus*), vervet monkeys (*Cercopithecus aethiops*), wildebeest (*Connochaeta taurinus*), warthog (*Phacochoerus aethiopicus*) and gazelle (*Gazella grant*). The most affected crops were maize, sorghum and finger millet which are basically the main staple food in the study area. The reasons for favouring these crops could not be established. However, probably thereasons could be the nature of the crops and elephants prefer succulent crops. Results from Focus Group Discussion (FGDs) revealed that, crop damage by elephants not only affect farmer's ability to feed his or her family, but also reduces cash income and has repercussions for health, nutrition, education and ultimately, development. As farmers depends on crops for selling to obtain cash for school fees

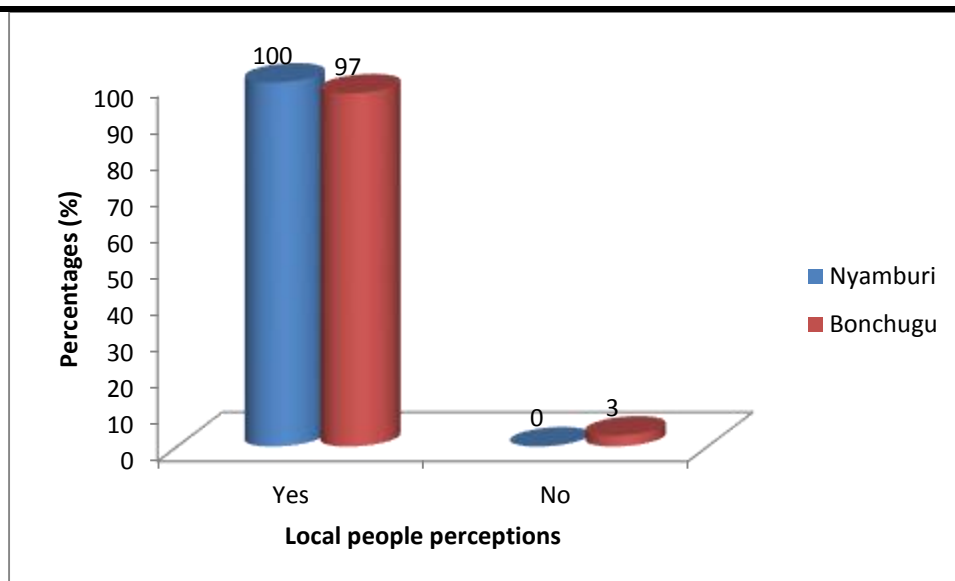


Fig.1: Local community perception on HWC status

3.3 Assessment of effectiveness of chilling

The effectiveness of the method was assessed through local people perception and through the status of crop destruction by elephants before the introduction of chill and after the use of the method.

Table.2: Households perception on effectiveness of chilling method

Village	Sample size (N)=68	Perceptions %	
		Chilling is effective	Chilling is not effective
Nyamburi	34	77	23
Bonchugu	34	90	10
Average	34	83.5	16.5

They argued that, the incidence of destruction by elephants has gone down. For example one respondent had this to say: "We thank the government and Tanzania Wildlife Research Institute (TAWIRI) for introducing this method of deterring elephants, we were not happy with the situation." Jones & Elliott (2006), in their study in Namibia found that; chilling method is effective because it worked as olfactory deterrent for elephant.

Focus group discussant's view on the effectiveness of the method was that, the method is effective because it has improved food security through reducing crop raids. Interview with District Game Officer (DGO) on the matter revealed that chilling has been instrumental in mitigating HEC. When asked to give reasons for, he argued that; elephants have a highly sensitive olfactory system and chillies therefore cause them pain. This argument is

3.3.1 Local Communities perception

Local communities were asked to assess if the method is effective or not. Results indicate that more than 80% were of the opinion that chilling method was effective in mitigating HEC (Table 2).

supported by Hoare (2001), who argues that chilli is effective in deterring elephants due to its irritant properties.

3.4 Status of destruction by elephants before and after introducing chilling method

The status of destruction of crops (crop raids) by elephants before and after the introduction of chill was assessed. Data were obtained from District Game Officer (DGO).

3.4.1 Status before introduction of chilling method in Nyamburi village

In Nyamburi village, crop destruction over years (2003-2006) fluctuated (Figure 4). The average destruction was about 367ha/annum. This seems to be extremely high. Taking into the account, the total arable land of the area which is 2450ha; the destruction is about 15% of the total arable land. Assuming the destruction was for maize which is the most preferred crop by elephants and which is also a staple food in the area. This situation has two implications; that is, in food security and cash income. In the study area the crop is of multipurpose nature. That means it is used as cash crop as well as food crop. For example assessing maize yield/ha in the area which is 5bags/ha; this implies that the loss of 367 ha/annum is equivalent to 182 tones of maize/annum which could feed a large number of families. According to Kaswamila (2007) one family consumes 0.72tone/year therefore the loss of 182 tones means food shortage for 2000 people.

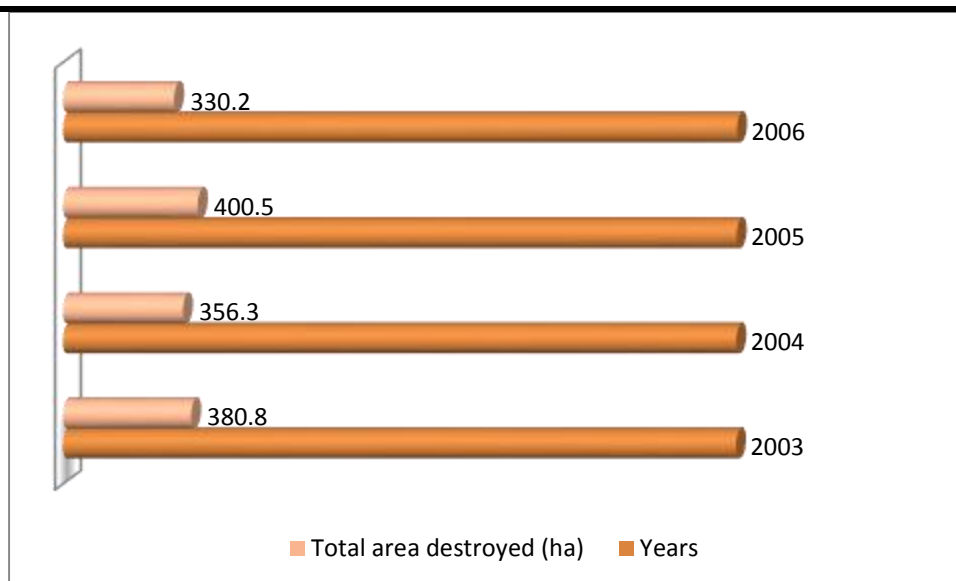


Fig.2: Extent of elephant destruction at Nyamburi village before introduction of Chilling method (2003 - 2006)

3.4.2 Status after introduction of chilling method in Nyamburi village

The situation of elephant's crop destruction status at Nyamburi village after the introduction of chill was also assessed (Figure 5). Results indicate that the trend of crop destruction in general decreased. This could be argued

that, among other things, probably the method has been instrumental in deterring elephants. On average only 231ha was destroyed between 2007 and 2010 which was 25% lower compared to the situation before chill introduction. Therefore the method is effective in mitigating HEC.

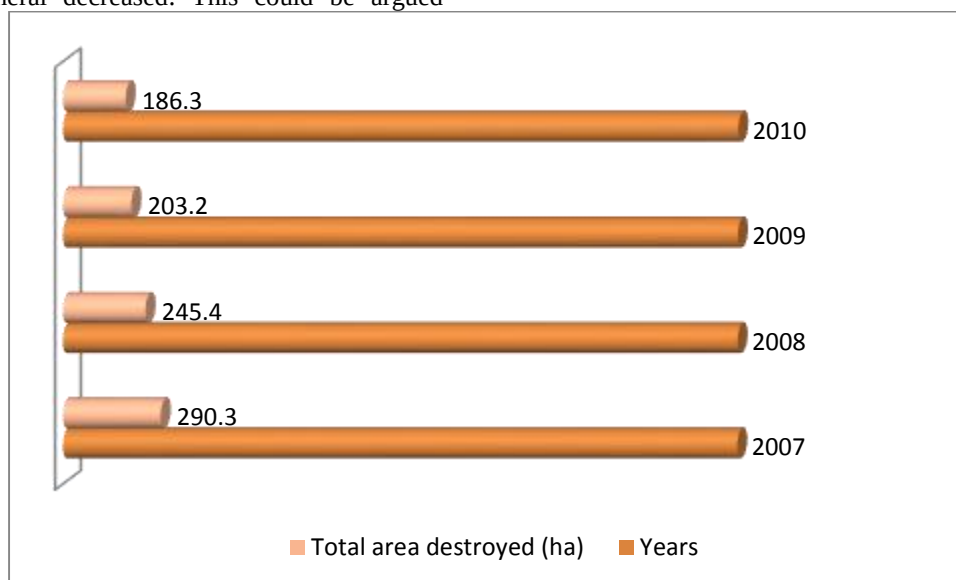


Fig.3: Extent of elephant destruction at Nyamburi village after introduction of Chilling method (2007 – 2010)

3.4.3 Status before introduction of chilling method in Bonchugu village

In Bonchugu results show that, crop destruction over years (2003-2006) also fluctuated (Figure 6). However, by all

standards the average destruction of 401ha/annum. This was relatively higher compared to Nyamburi. Taking into the account, the total arable land of the area which is 1273.8 Ha; destruction was about 32% of the total arable land.

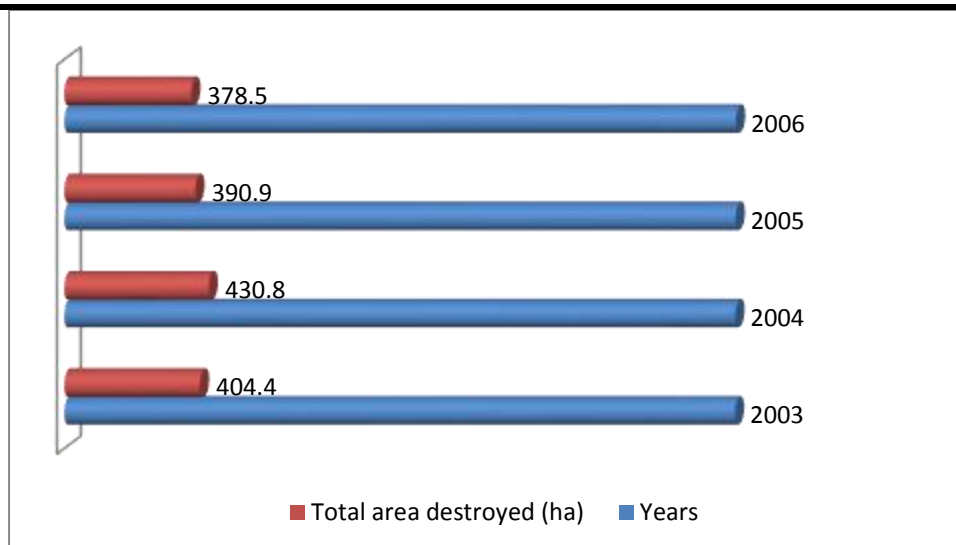


Fig.4: Extent of elephant destruction at Bonchugu village before introduction of Chilling method (2003 - 2006)

3.4.4 Status after introduction of chilling method in Bonchugu village

The situation of elephant's crop destruction status at Bonchugu village after the introduction of chill was also assessed (Figure 7). Results indicate that the trend of crop destruction was decreasing at a decreasing rate. The decline

trend could probably be due to the effectiveness of the method. On average only 291ha was destroyed between 2007 and 2010, which was 25 % lower compared to the situation before chill introduction. This could be argued that, among other things, the method is instrumental in deterring elephants.



Fig.5: Extent of elephant destruction at Bonchugu village after introduction of Chilling method (2007 - 2010)

A study made by Jackson *et al.* (2008) shows that, the chill method definitely works as crop raids from elephants every year in Zambia witnessed to decrease after farmers received training from Zambian trainers on how to use chili pepper to stop elephants raiding farmers' fields. According to Parker and Osborn (2006), it is estimated that in 2001, farms close to the eastern wing of Kakum National Park (Ghana) where elephant activities were highest, recorded between 0.5 bags of maize/ha during the main season depending on the number of wildlife damage the farm had. In 2003, such farms recorded up to 7 bags/ha after chilling crop raiding deterrents were put in place to scare off elephants.

3.5 Strengths of chilling method

Perception of local communities on the strengths of chilling was sought through questionnaire survey and group discussions (Table 3). Questionnaire results show several strengths. In order of importance, the strengths viewed by households in both villages were easiness to use in the field. Other strengths were cost effectiveness of the method and its user-friendliness. During FGDs, the most observed strengths were for the chill to be harmless to both human and elephants and that it is simple to use. In Zambia, Jackson *et al.* (2008) found that, when the crops supply with chillies, as an olfactory deterrent for elephants, it was sufficient, without harm to both human and elephant.

Table.3: Strengths of chilling method

Villages	N=68	Views		
		Households	%	FGD
Nyamburi	34	Easiness in use	58.6	Control HEC without harming people and elephant
		Cost effective	22.3	
		User friendly	19.1	
Bonchugu	34	Easiness in use	51.2	Its use is simple and use appropriate technology
		User friendly	31.4	
		It use simple technology	17.4	

3.6 Weaknesses of Chilling method

Research findings from households revealed several weaknesses (Figure 8). The most notable one was the tendency of elephant to enter in the farm backwards after recognition that, chill deter them by generating unpleasant smell. Other weakness observed by households was the effect of heavy rainfall. They revealed that, insufficient used oil and chill. During FGDs they revealed that during rain seasons the pepper can be removed easily hence the method becomes ineffective. Results from FGD do not differ with that of households. They argued that, elephants are clever animals, they soon learn that, they pose no real threat

and then ignore them, with time they entering in the farms/field backwards. Muruthi, (2005), argument on weaknesses of chilling method were similar with FGDs. He pointed out that, chilling method like other modern method face the same problem of elephants to overcome their fear by becoming habituated and less effective overtime. DGO argued that, the availability of pepper and used oil does not match with the high demands. In northern Mozambique for instance, in a region where chili-pepper has been tried, villagers very rapidly lost confidence in the method, due to difficult in maintaining the deterrent (FAO, 2005).

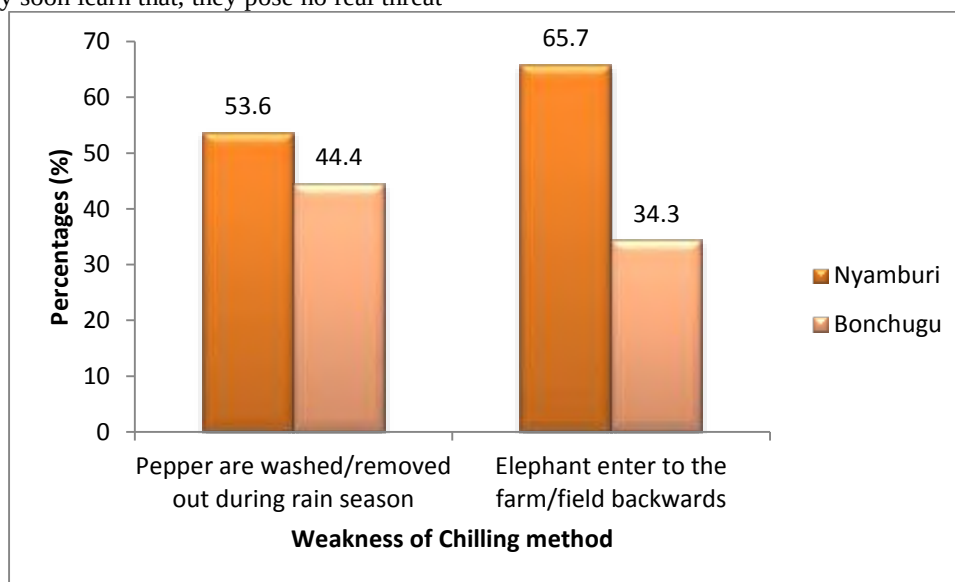


Fig.6: Weaknesses of Chilling method

3.7 Suggested measures for Improving Chilling Method.

Suggestions for local communities on the improvement of the method were sought through Questionnaire survey, group discussions and government officials (Table 4).

Table.4: Suggestions for improving chilling method

Villages	Suggestions		
	Households	FGDs	Officials
Nyamburi	Chill pepper cultivation by community and provision of used oil	Provision of used oil from different organizations and more training of community on chill application	Chilli pepper cultivation by community and provisions of used oil from surrounding companies and institutions
Bonchugu	Chill pepper cultivation and provision of used oil	Regular application of chill once washed out by rain and Provision of used oil from different organization	Positive community attitude towards the control of the elephant

The most suggested measures by household's respondents and FGDs were about the farmer to cultivate chill pepper and availability of used oil from surrounded companies and different institution. However the study made by Kioko *et al.*, (2006), show that cultivation of chill will depend on farmer investment, climate and soil suitability, as well as the ability to market such crops. The benefits of having elephants living close to communities must exceed the cost of daily or constant exposure to people and their arable land (*ibid*).

It was also suggested that, chill should be applied regularly once washed out by rain and for the effectiveness of the method community should be well trained on how to use the method.

DGO suggested that, farmers should cultivate peppers, and he has already involved Districts authorities and Barick Company Limited as the supplier of used oil to the farmer to improve the method. He also suggested that for the method to be more effective, community should have positive attitude towards the use of the method. FAO, (2005), suggestions on improvement of chilling method does not differ with that of households' perceptions and DGO. They suggested that, government or NGO support is required to maintain the deterrents over most of the more remote areas where human-elephant conflict occurs.

IV. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The results of the study revealed that; chilling method is effective in mitigating HEC. The most observable strengths of the method was that; it can deter elephants without harming people and elephants, it is easy to apply, it does not consume time and use appropriate technology. Despite the effectiveness of the method, major challenges which observed to face the method were; insufficient used oil and pepper, elephants observed to be a clever animal as sometimes they inter into the farms/field backwards and also during rain seasons, chill method observed to be ineffective as it can be washed/removed easily. However, the respondents recommended that; the challenges can be solved by local community to cultivate pepper and other

stakeholders such as district, different NGO and companies to support farmers the provision of used oil, chill should be applied regularly once washed out by rain and for the effectiveness of the method community should be more trained on how to use the method.

4.2 Recommendations

- ✓ Community should cultivate more peppers to simplify the exercise of chilling method.
- ✓ Government officials such as VEO or WEO should have to report immediately to game officers once elephants destruct crops.
- ✓ Districts Authorities should have to collaborate with other companies outside the district such as Barick Company Limited to support the provision of used oil to the farmer.
- ✓ Capacity building of local wildlife managers to deal with HEC
- ✓ The government should have to develop substantial benefits for local communities living adjacent to the protected areas to increase local tolerance of HEC.
- ✓ Frequency application of the method should be intensified particularly during rain season.
- ✓ Capacity building on how to use the method particularly on the ratio required.

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