Short communication

Investigating the potential for chilli to reduce Human-Wildlife Conflict in Zimbabwe

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Word count: 1,992

Abstract

Human-wildlife conflict has negative implications for wildlife conservation and current crop protection methods are not sufficient to address the problem. Alternative livelihood strategies may provide the ultimate solution to this conflict, but they are not always feasible in the short-term. We test the viability of using chilli as an unpalatable cash crop to reduce wildlife conflict. Our trials indicate that chilli is less vulnerable to wildlife than other crops and is also economically viable.

Key words

Human-wildlife conflict, crop damage, chilli, Zimbabwe.

Human-wildlife conflict (HWC) is a critical issue in conservation, as it creates intense animosity between the rural poor and the wild animals that destroy their crops and threaten their livelihoods (Adams & McShane, 1992; Naughton-Treves, 1997). Such negative interactions have the potential to undermine long-term biodiversity goals, as local people express their anger through encroachment on protected areas, poaching, and excessive resource use (Mehta & Kellert, 1998).

In response, wildlife managers have relied on centralised crop protection measures, such as disturbance shooting and electric fencing, to reduce HWC (Taylor, 1999). However, these can be impractical for remote locations in developing countries. Instead, there is a growing awareness that community-based programmes may be more appropriate (Osborn & Parker, 2003). However, present approaches focus on crop protection measures, which attempt to reduce the incidence of crop raiding. These short-term approaches alleviate, rather than eradicate, the problem (O'Connell-Rodwell *et al*., 2000) and may be considered nothing more than a palliative (Barnes, 2002). Interventions such as land-use planning, or promoting a shift away from agriculture-based livelihoods, may provide solutions that deal with the root causes of conflict (Barnes, 2002; Sitati *et al.,* 2003). However, alternative livelihoods may not be available in many developing countries. In light of this we explore a different approach: that of reducing the vulnerability of crops to wildlife damage.

Many food crops are attractive to wild animals because selective breeding has reduced their physical and chemical defences (Purseglove, 1972). In contrast, some crops, such as tea and sisal, are much less palatable and these have been used to create buffers at the edge of the fields, with mixed results (Seidenstecker, 1984; Thouless, 1994). Ideally, such crops require two key properties. Firstly, these buffers should be unpalatable to crop-raiding animals. Secondly, the crops used should be economically valuable to the farmer.

As yet, little quantitative research exists in the field of unpalatable crops. Chilli pepper is known to be an effective HWC deterrent (Osborn & Parker, 2002; Walpole & Sitati, *in prep*), but its palatability to wild animals remains untested. Here we compare the palatability of chilli, maize, cotton and sorghum to mammalian pests in Zimbabwe's mid-Zambezi Valley. We then examine the income generated from each crop to determine the viability of chilli as an alternative cash crop.

The mid-Zambezi Valley experiences low annual rainfall (650-850 mm), which falls between December and mid-March. There is a long dry season from April to November. Most farming is small-scale dry land cultivation, with crops being planted in November and harvested between April and June. Crops include maize *Zea mays,* sorghum *Sorghum vulgare,* and cotton *Gossypium hirsutum*. Wildlife depredations exert pressure upon an agricultural system that is already heavily constrained by low rainfall and poor soils (Cumming & Lynam, 1997). Elephants (*Loxodonta africana*), kudu (*Trangelaphus strepsiceros*), bush pigs (*Potamochoerus porcus*) and baboons (*Papio cynocephalus* ursinus) are known to damage crops during the wet season (Zamsoc & MZEP, 2000).

To test the palatability of different crops we planted forty trial plots, ten each of chilli, cotton, maize and sorghum, in the wet season of 2003. Plots were located in unprotected bush land 100m from the edge of agricultural fields in Mseruka village, Lower Guruve District (Fig. 1). Each plot was c. 10x10m and was planted with 100 propagated seedlings of 10cm height. The plots were established at the onset of the rainy season and were abandoned at the end of May, in synchrony with local agricultural activities.

Each plot was visited five times a week. On every visit the total number of living plants was counted. The cause of each plant death was determined from spoor and plant remains. The cause was then categorised as 'mammal', where any mammal >5kg had eaten plants, or 'other', which included all other forms of death. Statistical analysis was conducted using SPSS version 11.5. We compared the number of deaths caused by mammals between all crop types (Kruskal-Wallis test), following this with bivariate comparisons between chilli and every other crop in turn (Mann-Whitney *U* test). We used a reduced significance threshold of $p < 0.016$, which was determined by using Bonferroni's adjustment for multiple statistical tests. We also investigated differences in the frequency of deaths by 'other' causes between crop types (Kruskal-Wallis test).

We examined the earnings of 27 farmers who each grew some combination of maize, cotton, sorghum and chilli. We measured the crop area and total yield for each farmer and calculated the crop value using the domestic market price as of June 2001. Finally, we calculated mean income and income per hectare for the four crops. We compared the income per hectare between crop types (Kruskal-Wallis test). We then compared chilli to every other crop in turn (Mann-Whitney *U* test), using Bonferroni's adjustment for multiple statistical tests.

There was a difference in the frequency of mammalian damage between the four crop types ($\chi^2 = 15.26$, $p = <0.01$, Kruskal-Wallis test). Fewer chillies died from mammalian causes than cotton (z = -2.85, p = 0.004, Mann-Whitney *U* test) or maize (z = -3.59, p = 0.001, Mann-Whitney *U* test), but not sorghum (z = -2.09, p = 0.037, Mann-Whitney *U* test). There was no difference in the frequency of deaths caused by 'other' factors between the different crops (χ^2 = 3.47, p = <0.32, Kruskal-Wallis test).

In terms of damage by mammals, livestock were responsible for 63% of all mammal-related plant mortalities, as compared to 19% for bushbuck and 17% for baboons. Pigs destroyed just 1.4% of crops and cane rats, 0.2%. No incidents were attributed to elephants (Fig 3).

More income per farmer was earned on average from cotton, followed by chilli, maize, and finally sorghum (Table 1). There was a difference in the yield per hectare of the four crops (χ^2 = 30.82, p = <0.001, Kruskal-Wallis test). Chilli produced more income per hectare than maize (z = -3.59, p = <0.001, Mann-Whitney *U* test) and cotton (z = -3.78, p = <0.001, Mann-Whitney *U* test) and sorghum (z = -4.08, p = <0.001, Mann-Whitney *U* test).

In these trials, chilli was less vulnerable to large mammalian predations than either cotton or maize. Ten farmers chose to grow chilli and it generated the greatest income per hectare of all the crops, due to its high yield and high market value. The mean income was limited only by the small area currently under cultivation. These results indicate the potential of chilli as a wildlife-resistant cash crop for farmers living in high conflict areas.

The crop-raiding wild animals identified here are all notorious crop pests elsewhere, including livestock, whose impact can be considerable (Bell, 1984; Naughton-Treves, 1997). Elephants did not visit the trial site despite being a significant crop predator in the area, but their crop-raiding patterns are notoriously unpredictable (Naughton-Treves, 1998) and so little can be inferred from this result.

Whilst the indications from the trials are positive, we recommend wider trials to confirm these results under other conditions. In addition, this paper deals with only two aspects of the complex issue of introducing a new cash crop. Further research must consider such issues as local market accessibility and input costs. This research should also address issues associated with increasing the viability of agriculture in marginal areas, which has the potential to fuel habitat loss through a rapid expansion of cultivation.

Ultimately the long-term solutions for HWC may be borne from shifts in agriculture-based livelihoods to other forms of income. Such a tactic has been adopted in communities close to Mombassa, who abandoned cultivation for nature tourism (Sitati *et al*., 2003). But alternative means of income may not always be available, especially in developing countries, and tourism may not always be the best alternative (Walpole & Thouless, 2005). In such cases we advocate the improvement of agricultural practices by reducing the vulnerability of crops to conflict. However, we recommend this should form part of a broader land-use planning approach.

The potential conservation benefits of a crop such as chilli are considerable. Growing chilli as a cash crop can produce raw materials for community-based wildlife deterrents (Osborn & Parker, 2002). Introducing unpalatable crops will not only reduce the costs of conflict borne by the farmer, but may also improve livelihood security. Reducing the costs of wildlife conservation to communities will enhance the conservation of wild animals outside protected areas (Walpole & Thouless, 2005; Leader-Williams & Hutton, 2005).

Acknowledgements

The authors thank Bob Smith, Matt Linkie, Matt Walpole, Val Anderson, Nigel Leader-Williams and two anonymous reviewers for their comments to this manuscript. We would like to thank Mike Hearn for his inspiration and express great sorrow for his untimely death. He will be greatly missed. This research was funded by the Wildlife Conservation Society and the US Fish and Wildlife Service.

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Biographical sketches

Guy Parker and Loki Osborn have researched techniques for reducing conflict between rural farmers and wildlife in the mid-Zambezi Valley for the past eight years. Guy Parker is currently completing his PhD on human-elephant conflict at the Durrell Institute of Conservation and Ecology, whilst Loki Osborn is developing a WCS-funded human-wildlife conflict research hub in Livingstone, Zambia.

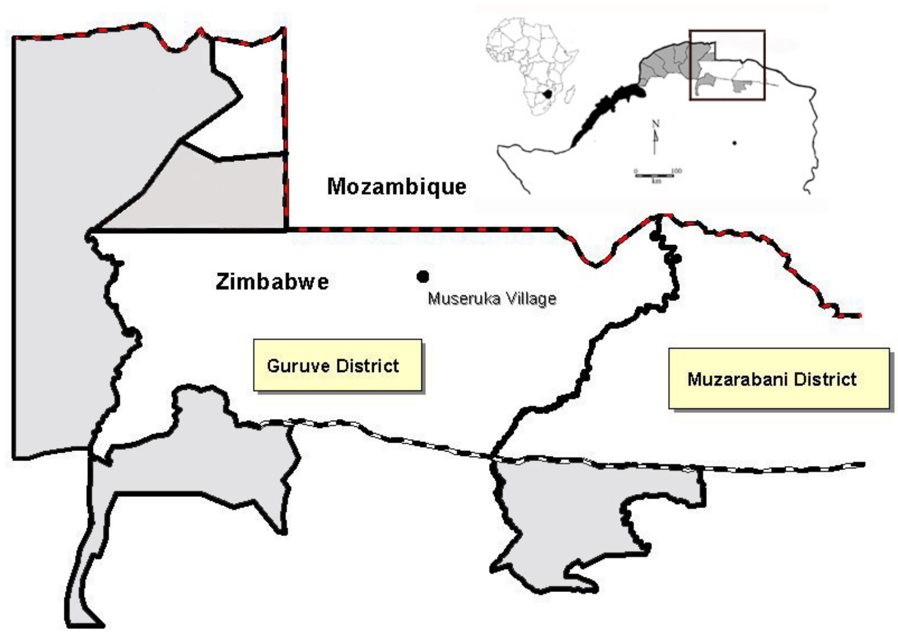
Table 1. Harvest data for 27 farmers in Mseruka in 2001.

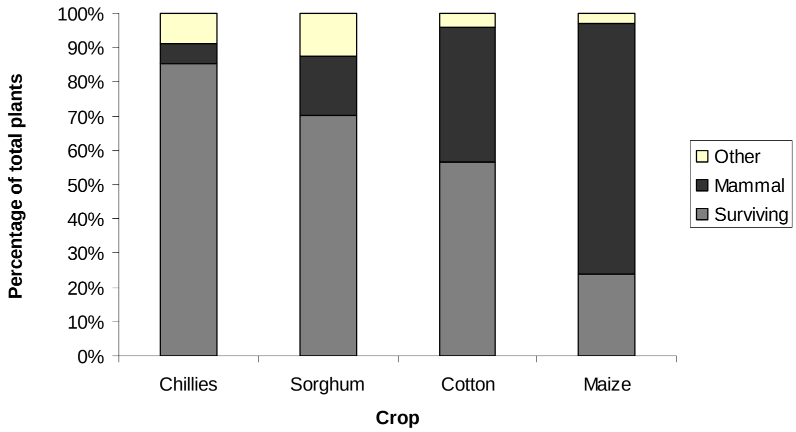
Crop	No. farmers	Total harvest (kg)	Mean (+/-SE) harvest (kg)	Price per kg (US$)	Mean (+/-SE) income (US$)	Mean (+/-SE) income per ha
Maize	18	8,092	449 +/- 103	0.20	89.91 +/- 20.64	102.50 +/- 7.56
Cotton	20	6,795	339 +/-78	0.45	152.89 +/- 35.05	102.10 +/- 7.33
Chilli	10	1,520	152 +/- 84	0.70	106.40 +/- 58.99	665.00 +/- 68.71
Sorghum	18	3,062	170 +/- 43	0.20	34.02 +/- 8.60	70.38 +/- 3.60

Fig 1 Map of the study area showing its location within Northern Zimbabwe and the position of Mseruka village.

Fig. 2 Percentage survival rates for each crop type. Cause of death is displayed as two factors: ‘mammal’, which includes herbivory by all large mammals; and ‘other’, which includes small mammals, birds, invertebrates, desiccation, disease and all other causes of death.

Fig. 3 Percentage of plant deaths caused by each mammalian crop predator. ‘Livestock’ includes cattle and goats and the ‘pig’ category includes both bush pigs and warthogs.




100%
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Chillies
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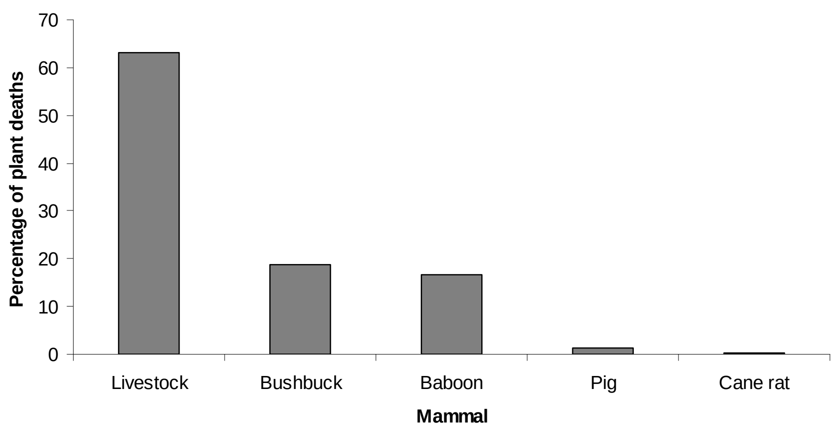
Maize
Crop
Other
Mammal
Surviving


70
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Percentage of plant deaths
Livestock
Bushbuck
Baboon
Pig
Cane rat
Mammal