Short Communication

Investigating the potential for chilli *Capsicum* spp. to reduce human-wildlife conflict in Zimbabwe

Guy E. Parker and Ferrel V. Osborn

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 *Capsicum* spp. as an unpalatable cash crop to reduce human-wildlife conflict. Our trials indicate that chilli is less vulnerable to wildlife than other crops and is also economically viable.

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

Human-wildlife conflict is a critical issue in conservation as it creates intense animosity from amongst the rural poor towards 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 because 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 centralized crop protection measures, such as disturbance shooting and electric fencing, to reduce human-wildlife conflict (Taylor, 1999). However, these can be impractical for remote rural locations in developing countries. Instead, there is a growing awareness that community-based programmes may be more appropriate (Osborn & Parker, 2003). Present approaches focus on crop protection measures, which attempt to reduce the incidence of crop raiding. These approaches alleviate, rather than eradicate, the problem (O'Connell-Rodwell *et al.*, 2000) and may be considered nothing more than a palliative (Barnes, 2002).

In contrast, 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 and increased their nutritive value (Purseglove, 1972). In contrast, some crops, such as tea and sisal, are much less palatable. They have been used to create buffers along the edge of the fields, with mixed results (Seidenstecker, 1984; Thouless, 1994). Ideally, unpalatable crops require two key properties. Firstly, they should be unpalatable to crop-raiding animals and, secondly, they should be economically valuable to the farmer.

Chilli *Capsicum* spp. pepper is known to be an effective deterrent (Osborn & Parker, 2002; Sitati & Walpole, 2006), 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 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).

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Fig. 1 The location of Mseruka village within Guruve District, northern Zimbabwe. Protected areas are coloured grey.

To test the palatability of different crops we planted 40 trial plots, 10 each of chilli, cotton, maize and sorghum, in the wet season of 2003. Plots were located in unprotected bush land 100 m from the edge of agricultural fields in Mseruka village, Lower Guruve District (Fig. 1). Each plot was *c.* 10 * 10 m and was planted with 100 propagated seedlings of 10 cm 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 per 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 categorized as mammal, where any mammal >5 kg had eaten plants, or other, which included all other forms of death. Statistical analysis was conducted using *SPSS v. 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 ha for the four crops. We compared the income per ha 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 predation 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 ($\chi^2 = 3.47$, $P = 0.32$, 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 1.4% of crops and cane rats, 0.2%. No incidents were attributed to elephants (Fig. 2).

More income per farmer was earned on average from cotton, followed by chilli, maize and sorghum (Table 1). There was a difference in the yield per ha of the four crops ($\chi^2 = 30.82$, $P < 0.001$, 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 predation than either cotton or maize. Ten farmers chose to grow chilli and it generated the greatest

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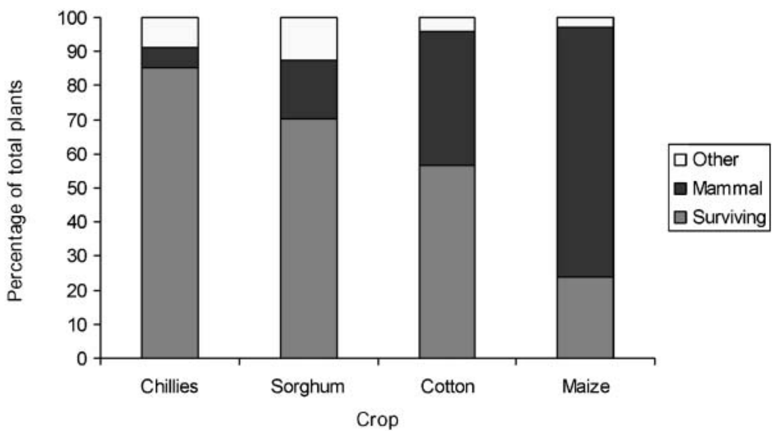

Fig. 2 Percentage survival rates for each crop type. Cause of death is displayed as two factors: mammal, which includes herbivory by all large mammals, and other, which includes small mammals, birds, invertebrates, desiccation, disease and all other causes of death.

Table 1 Number of farmers (of a total number of 27) growing maize, cotton, chilli and/or sorgum in Mseruka village in 2001, showing the total weight of each crop harvested, mean weight of each crop harvested per farmer, price per kg for each crop, mean income per farmer for each crop, and mean income per ha of each crop.

Crop	No. farmers	Total harvest (kg)	Mean harvest ± SE (kg)	Price per kg (USD)	Mean income ± SE (USD)	Mean income ± SE per ha (USD)
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

income per ha of all the crops because of 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 animals identified in this study, including livestock, are all notorious crop pests 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 human-wildlife conflict may come 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 (Leader-Williams & Hutton, 2005; Walpole & Thouless, 2005).

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References

Adams, J.S. & McShane, T.O. (1992) *The Myth of Wild Africa*. W.W. Norton, New York, USA.

Barnes, R.F.W. (2002) Treating crop-raiding elephants with aspirin. *Pachyderm*, **33**, 96–99.

Bell, R.H.V. (1984) The man-animal interface: an assessment of crop damage and wildlife control. In *Conservation and Wildlife Management in Africa* (eds R.H.V. Bell & E. McShane-Caluzi). Proceedings of a workshop held at Kasungu National Park, October 1984, US Peace Corps, Lilongwe, Malawi.

Cumming, D.H.M. & Lynam, T. (1997) *Land Use Changes, Wildlife Conservation and Utilization, and the Sustainability of Agro-ecosystems in the Zambezi Valley*. Unpublished report, WWF MAPs Project, WWF, Harare, Zimbabwe.

Leader-Williams, N. & Hutton, J. (2005) Does extractive use provide opportunities to offset conflicts between people and wildlife? In *People and Wildlife: Conflict or Coexistence?* (eds R. Woodroffe, S.J. Thirgood & A. Rabinowitz), pp. 140–161. Cambridge University Press, Cambridge, UK.

Mehta, J.N. & Kellert, R. (1998) Local attitudes towards community-based conservation policy and programmes in Nepal: a case study in Makalu-Barun Conservation Area. *Environmental Conservation*, **25**, 320–333.

Naughton-Treves, L. (1997) Farming the forest edge: vulnerable places and people around Kibale National Park, Uganda. *Geographical Review*, **57**, 27–46.

Naughton-Treves, L. (1998) Predicting the patterns of crop damage by wildlife around Kibale National Park, Uganda. *Conservation Biology*, **12**, 156–158.

O'Connell-Rodwell, C.E., Rodwell, T., Rice, M. & Hart, L.A. (2000) Living with the modern conservation paradigm: can agricultural communities co-exist with elephants? *Biological Conservation*, **93**, 381–391.

Osborn, F.V. & Parker, G.E. (2002) A community-based system to reduce crop damage by elephants in the communal lands of Zimbabwe. *Pachyderm*, **33**, 32–38.

Osborn, F.V. & Parker, G.E. (2003) Towards an integrated approach for reducing the conflict between elephants and people: a review of current research. *Oryx*, **37**, 80–84.

Purseglove, J.W. (1972) *Tropical Crops*. Longman, London, UK.

Seidenstecker, J. (1984) *Managing Elephant Depredations in Agricultural and Forestry Projects*. Technical Report, The World Bank, Washington, DC, USA.

Sitati, N.W. & Walpole, M.J. (2006) Assessing farmer-based measures for mitigating human-elephant conflict in Transmara District, Kenya. *Oryx*, **40**, 279–286.

Sitati, N.W., Walpole, M.J., Smith, R.J. & Leader-Williams, N. (2003) Predicting spatial aspects of human-elephant conflict. *Journal of Applied Ecology*, **40**, 667–677.

Taylor, R.D. (1999) *A Review of Problem Elephant Policy and Management in Southern Africa*. Report for the Human-Elephant Conflict Task Force, IUCN/SSC African Elephant Specialist Group, Nairobi, Kenya.

Thouless, C.R. (1994) Conflict between humans and elephants on private land in northern Kenya. *Oryx*, **12**, 119–127.

Walpole, M.J. & Thouless, C.R. (2005) Increasing the value of wildlife through non-consumptive use? Deconstructing the myth of ecotourism and community-based tourism in the tropics. *People and Wildlife: Conflict or Coexistence?* (eds R. Woodroffe, S.J. Thirgood & A. Rabinowitz), pp. 122–139. Cambridge University Press, Cambridge, UK.

Zam Soc & MZEP (2000) *Elephant Research and Management in Muzarabani and the Mid-Zambezi Valley of Zimbabwe*. Zambezi Society, Harare, Zimbabwe.

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 8 years. Guy Parker is currently based at the Durrell Institute of Conservation and Ecology, Canterbury, UK, completing his studies of human-elephant conflict, and Loki Osborn is developing a human-wildlife conflict research hub in Livingstone, Zambia, funded by Wildlife Conservation Society.