

Institution: University of Oxford
Unit of Assessment: UOA5
Title of case study: Using honey bees as an effective deterrent for crop-raiding elephants
1. Summary of the impact <p>In many parts of Africa, farmers and African elephants have to share the same land, and crop-raiding by elephants leads to serious conflict. A simple, but highly effective, solution to this problem has been developed on the basis of research at the University of Oxford's Department of Zoology. The research identified that elephants are frightened of bees and will actively avoid them. Since 2010 this discovery has led to the construction of protective beehive fences around farmers' fields, which have reduced human-elephant conflict, improved food security and provided farmers with additional income from honey. The concept is being applied in five countries across the continent.</p>
2. Underpinning research <p>The increase in numbers of African elephants in the last 20 years has been hailed as a conservation success story. However, elephants cannot easily be contained within national parks, and their roaming behaviour means that they come into frequent contact with farmers outside protected areas. Arable farms provide an easy source of nutritious food and crop-raiding by elephants is a serious problem, threatening farmers' lives and livelihoods. Competition for space is intensifying as Africa's population grows. In many African countries the elephant is the most significant conflict species; in Tanzania, for example, elephants kill around 40-50 people and injure a further 30-40 every year. A three year study into elephant movements in relation to protected areas, led by Professor Fritz Vollrath of the University of Oxford Department of Zoology, noted that 'the areas required by elephants are so large that it would often be unsustainable to plan for their conservation solely within officially protected areas. This realisation underscores the importance of reducing conflict and planning human-elephant coexistence'¹.</p> <p>It is difficult to keep elephants off farmland because of their size and intelligence: electric fences can be very effective, but are unaffordable for most farmers; trenches can be filled in and crossed by elephants; and traditional thorn-bush barriers offer little protection. Incidents of elephant deaths by shooting or poisoning are an increasing concern, and there is a need to find effective farmer-managed deterrents that are socially and economically suitable.</p> <p>Anecdotal evidence from local people had suggested that African elephants have an aversion to bees. Professor Vollrath, in conjunction with Dr Iain Douglas-Hamilton (CEO of the charity 'Save the Elephants', and also Associate Researcher at the University of Oxford) was the first to investigate and identify this behaviour formally. A study conducted in Kenya and published in 2002 demonstrated that elephants avoided feeding on acacia trees hung with beehives. At this stage it was not clear whether sound, smell or other factors repelled the elephants².</p> <p>A subsequent study by Vollrath, Douglas-Hamilton, and Dr Lucy King of the University of Oxford's Department of Zoology, aimed to identify the factors from beehives that deterred the elephants. 17 elephant families at rest were played recordings of disturbed wild African bees; 94% of the elephants moved away from the source of the sounds within 80 seconds, and eight families moved within 10 seconds. Elephants thus respond with alarm to the buzz of aggressive bees and move away from the sound source. The evidence suggested that elephants can identify bees by sound alone, indicating that they may associate the sound with a negative historical event³. This research was further developed by King in collaboration with Dr Joseph Soltis (a bioacoustician from Disney's Animal Kingdom). The results demonstrated that elephants emit a low frequency, infrasonic rumble in response to disturbed bee sounds that warns other elephants in the area to retreat. Alarmed elephants also engage in head-shaking and dusting, reactive behaviours that may</p>

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help to prevent bee stings⁴.

These behavioural discoveries broke new ground and encouraged the researchers to develop and test a novel application. A small pilot study at Laikipia, Kenya, investigated whether beehives might be used as an effective means of protecting crop-raided farms. Two farms were studied, one partially protected by a 90 metre wire fence hung with nine beehives. Over a six week period, the farm with the beehive fence experienced fewer raids and consequently had higher productivity; the unprotected farm lost 90% of its crops⁵. A subsequent larger study involved 34 communally-run Kenyan farms. Over two years, 45 different raids (or attempted raids) by elephants were monitored, during which only one incident of an elephant crossing a beehive fence was recorded. This showed that the beehive fence was considerably more effective as a barrier than traditional thorn-bush⁶.

3. References to the research

1. Douglas-Hamilton I, Krink T, Vollrath F. (2005) Movements and corridors of African elephants in relation to protected areas. *Naturwissenschaften* 92: 158–163. doi: 10.1007/s00114-004-0606-9 **Study examining the complexity of elephant ranges, which are not confined to protected areas.**
2. Vollrath F, Douglas-Hamilton I. (2002) African bees to control African elephants. *Naturwissenschaften* 89: 508–511. doi: 10.1007/s00114-002-0375-2 **First study establishing that beehives can protect trees from being foraged by elephants.**
3. King LE, Douglas-Hamilton I, Vollrath F. (2007) African elephants run from the sound of disturbed bees. *Current Biology* 17: R832–R833. doi: 10.1016/j.cub.2007.07.038 **First study identifying that elephants react with alarm to bee sounds.**
4. King LE, Soltis J, Douglas-Hamilton I, Savage A, Vollrath F. (2010) Bee threat elicits alarm call in African elephants. *PLoS ONE* 5: e10346. doi: 10.1371/journal.pone.0010346 **First evidence of warning calls made by elephants in response to bees.**
5. King LE, Lawrence A, Douglas-Hamilton I, Vollrath F. (2009) Beehive fence deters crop-raiding elephants. *Afr J Ecology* 47: 131–137. doi: 10.1111/j.1365-2028.2009.01114.x **Pilot study investigating how beehive fences might work to protect farms from elephants.**
6. King LE, Douglas-Hamilton I, Vollrath F. (2011) Beehive fences as effective deterrents for crop-raiding elephants: Field trials in northern Kenya. *Afr J Ecol.* 49: 431–439. doi: 10.1111/j.1365-2028.2011.01275.x **Report on the first 2-year field trials of beehive fences on 34 farms in Kenya, demonstrating how effective this method is in deterring elephant raids.**

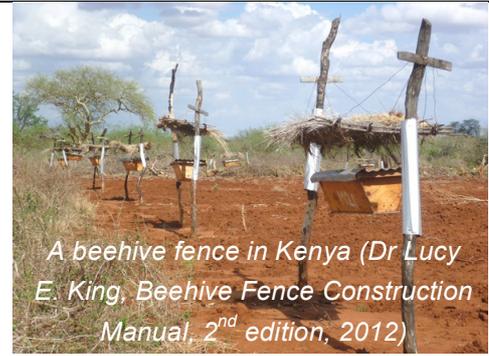
Funding for research: Grants in the region of £300,000 have been received for this work from the Disney Worldwide Conservation Fund, ESRC/NERC, the St Andrews Prize for the Environment, The Future for Nature Award, the Rufford Foundation and a number of smaller trusts and foundations.

4. Details of the impact

From 2010, following the successful University of Oxford field trials, farmers and wildlife managers in Kenya and other parts of Africa have been quick to show interest in this innovative but simple idea which provides a practical solution to an Africa-wide problem. Building on field trials in several countries, beehive fences have been implemented widely across swathes of Southern and Eastern Africa. The field trials developed a model of how to build an effective beehive fence using low-tech, straightforward methods and materials that can be obtained locally; the fence is easy both to

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maintain and to mend in the event of damage by elephants. Low-income farmers benefit from better crop production through reduced damage from raids, thus improving their own food security and helping to provide surpluses that they can sell. They also benefit from sales of 'elephant-friendly' honey and other bee products such as beeswax candles; sales of this kind can offset the costs of building a fence. There is also some evidence that bees may help to improve crop yield through increased pollination. Bees are kept in many parts of Africa, so the necessary beekeeping expertise is readily available. Dr Lucy King, now working for 'Save the Elephants', has written a comprehensive *Beehive Fence Construction Manual* which has been in production since July 2011 and is freely available for download from the project website⁷. The manual is crucial for promoting the idea of using beehive fences and, because it is free, the beehive fence concept has been taken up, often spontaneously, in several African countries. The following examples provide evidence of the impact across the continent.



*A beehive fence in Kenya (Dr Lucy E. King, *Beehive Fence Construction Manual*, 2nd edition, 2012)*

Kenya. The influential Kenyan Wildlife Service (KWS) has been particularly interested in adopting the beehive fence idea, and it has influenced their long-term planning. The successful Kenyan trials led directly to the adoption of beehive fences being included in the *2012-2022 Conservation and Management Strategy for the Elephant in Kenya*⁸. This publication outlined the first comprehensive, independent, strategy for elephant conservation for Kenya for two decades, and was endorsed by the United Nations Environment Programme. Beehive fences are listed as a proactive mitigation strategy to help reduce human-elephant conflict, requiring on-going action from KWS, communities, landowners, and researchers. Many photos from the beehive fence project appear in the document, also indicating how highly regarded it is by the KWS. There are now at least 29 farms in three districts in Kenya using the fences. Elephants are extremely destructive to property as well as to crops; raids often happen at night while families are sleeping in the same hut as the crops they have harvested, leading to a high risk of being trampled when the elephant knocks down the building. A 2010 account from a farmer near Tsavo West National Park gives a description of the trauma caused by raids and also confirms that the part of his farm that has a beehive fence is the only area that elephants will not enter⁹.

Botswana. In Botswana, the World Bank has made a donation through the Global Environment Facility (GEF) to the *Northern Botswana Human-Wildlife Co-Existence Project* run by the Government's Department for Wildlife and National Parks¹⁰. Within this five year programme, a budget of US \$90,000 has been set aside to test beehive fences as one human-elephant conflict mitigation strategy for 40 farmers living with elephants in three districts. Dr King provided training for all three districts at the end of 2012 and at least half the proposed fences have already been built. The project has required, and obtained, cooperation between the two different government departments responsible for agriculture and wildlife.

Tanzania. In Tanzania, beehive fences are used in at least three localities. UNESCO has funded a project in the Udzungwa Mountains, in response to increased human-elephant conflict and a rise in elephant deaths¹¹. On another site in the Western Serengeti, one subsistence farmer reports that in 2013 he achieved his first proper surplus for 18 years as a result of the beehive fence built around his farm. He is using the profits to build a brick house to replace his traditional grass-covered hut, and aims to transform his subsistence farming to business farming¹².

Mozambique and Uganda. The simplicity of the beehive fence design lends itself to local innovation and adaptation; in Mozambique, the Niassa Carnivore Project have redesigned the fence to use rope made from old tyres because wire is locally prone to theft for hunting snares. In an area of very high risk for elephant raids, two farms protected by fences have experienced only one raid in 2013, in contrast to 32 successful raids on six neighbouring farms¹³. In Uganda, a well-established beekeeping project, Malaika Honey, is supporting local farmers to build beehive fences and also training them in beekeeping skills¹⁴. Farmers who live on the edge of the Ugandan Queen Elizabeth National Park have suffered from serious crop-raiding by elephants; one farmer is quoted

as saying that after a series of raids ‘we had nothing to eat and nothing to sell – they ate or destroyed all we had’. Installing beehive fences is at an early stage but has already made a major difference to a number of farms that have built them.

The Disney Worldwide Conservation Fund has funded Dr King’s work since 2008; their Conservation Programs Manager confirms that throughout the funding period they ‘have seen this project grow and expand, creating tangible conservation impacts that benefit both communities and wildlife, with numerous high-profile publications and communications as a result of the project’¹⁵.

5. Sources to corroborate the impact

7. Beehive Fence. http://www.elephantsandbees.com/research_project/Beehive_Fence.html
Online version of the Beehive Fence Construction Manual.
8. Kenya Wildlife Service. Kenya launches 10-year National Elephant Strategy (2012). Available from: http://www.kws.org/info/news/2012/21_feb_2011_elephant.html **Launch of the KWS Elephant Strategy Document (download link at bottom of page), beehive fences are featured within Action Plan 4.2 on page 50.**
9. Letter from a farmer in Tsavo West National Park, Kenya (held on file), **confirming improvements to farming and safety since installing a beehive fence.**
10. The World Bank. Projects: Northern Botswana Human Wildlife Coexistence Project Report, 2009. <http://documents.worldbank.org/curated/en/2009/08/11008295/botswana-northern-botswana-human-wildlife-coexistence-project> **Details of the World Bank GEF project in Botswana; the report lists beehive fences under Component 2 on page 2.**
11. UNESCO. World Heritage Centre: Human-Elephant Conflict, May 10 2011. Available from: <http://whc.unesco.org/en/news/744/> **Details of the UNESCO scheme to use beehive fences in conjunction with chilli, another elephant deterrent.**
12. Email and report from the Director of the Serengeti Development, Research and Environmental Conservation Centre (SEDEREC) (held on file), **confirming the benefits to local farmers of beehive fences.**
13. Niassa Carnivore Project Beehive Fence project report, April 2013 (held on file), **confirming local adaptation of fence construction to avoid the use of wire, and the reduction in elephant raids since installing fences.**
14. Jones P. Western Uganda: crop-raiding elephants call for plan bee. The Guardian [Internet]. 6 Jun 2012. Available from: <http://www.guardian.co.uk/global-development/2012/jun/06/western-uganda-crop-raiding-elephants-bees> **Guardian report on successful beehive fence work in Uganda.**
15. Letter from the Conservation Programs Manager at the Disney Worldwide Conservation Fund (held on file) **confirming their positive view of the beehive fence work and continued funding.**