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Short Communication

Scaling-up the use of chili fences for reducing human-elephant conflict across landscapes in Tanzania

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Abstract

Elephants (*Loxodonta africana*) raiding crops around Tanzanian national parks threaten farmers' lives and livelihoods, thus contributing to negative local attitudes towards wildlife. As a result, there is often tacit support for poaching among local communities, and elephants suffer through reprisal poisoning or wounding or through being shot as 'problem animals' by game wardens. Human-elephant conflict (HEC) is growing as the wildlands that still have elephants, especially around national parks, reserves, and wildlife corridors, are increasingly being settled. Sisal string fences soaked in engine oil mixed with ground chili (*Capsicum* spp.) can dissuade elephants from entering fenced fields. For the last nine years, farmers around Mikumi National Park in Tanzania have been constructing these fences around ripening crops, and there have been no incidents of fences being broken by elephants. Community-based organizations (CBOs) that manage members' savings through village micro-credit associations help ensure the costs of materials and fence construction are met. Chili fences are rapidly becoming widespread, facilitated through farmer-to-farmer exchanges where teams of farmers demonstrate both the fences and the CBOs needed to support the project. We argue that promoting the use of chili fences, coupled with supporting CBOs, as a best practice within communities and government programs and budgets, will help reduce the need for HEC compensation, protect livelihoods, empower rural women, increase the food security of rural farmers, and help conserve elephants.

Keywords: *Loxodonta africana,* human-elephant conflict, chili fences, *Capsicum*, community-based, micro-finance, Tanzania

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Introduction

Elephants (*Loxodonta africana*) raiding crops in Africa can lead to crop damage or loss and human injury or even death. Resulting negative attitudes towards wildlife are evident in the tacit support for poaching among many farmers [1-5]. Reprisal poisoning and wounding by farmers, and the killing of 'problem' elephants by game wardens, makes human-elephant conflict (HEC) a serious and growing conservation issue. In Tanzania, reported crop damage by elephants increased from 37 ha in 2002 to 15,125 ha in 2009 (unpublished data, Tanzania MNRT Wildlife Division). The number of elephants killed as 'problem animals' in Tanzania also increased from 199 in 2005 to 822 in 2009, while the number of people killed by elephants increased from two in 2005 to 12 in 2009 (unpublished data, Tanzania MMNRT Wildlife Division).

Reducing elephant crop-raiding is thus a mounting priority for African farmers and wildlife managers [5-8], especially as more and more of the land surrounding protected areas and in wildlife corridors is settled and farmed [9, 10]. Crop protection measures used to deter elephant crop raiding include fires, drums and other noise-making tactics, projectiles, electric fences, chili bombs, burning chili briquettes, powerful torches and strobe lights, fireworks, and both beehive and chili (*Capsicum* spp.) fencing [4, 8, 11-20]. Some mitigation tactics cost more than rural farmers can afford, forcing them to rely on traditional deterrents, such as lighting fires and making noise, to try to scare away elephants [16]. Traditional techniques typically require being close to elephants, which is dangerous for both farmers and elephants, and often involves farmers and their children having to be awake throughout the night during the harvest season, disrupting schools and daily routines. Thus, effective tactics to deter elephants must employ locally available materials, be low cost, and not be burdensome on farmers' lives.

An important goal of elephant conservation is the rapid and widespread adoption of cost-effective HEC mitigation tactics. The benefits to both elephants and farming communities include reductions in the mortality of elephants in HEC incidents, improved attitudes and tolerance of farmers towards wildlife, and marked reductions in crop losses and human death and injury [21, 22]. According to a survey conducted in Tanzania in 2009, although HEC was widespread in 23% of Tanzania's districts, only 10% were using effective deterrents, such as chili fences [23]. The need for increased awareness and the adoption of

effective and sustainable mitigation tactics is great. Improving local people's tolerance towards wildlife is the only way to ensure the long-term survival of wildlife populations and to establish humane interactions between people and elephants.

At present, the main methods used by Game Officers to assist farmers include awarding them consolation payments (that is, financial compensation given to affected farmers by the government but which is not based on the value of lost crops); firing guns into the air; scaring elephants away with vehicles; flashbangs and lights; and killing problem elephants. However, these methods cannot be used on a large scale and are not sustainable because Game Officers cannot respond to all reported cases of HEC and consolation processes are slow and complex.

Given the pace of expansion of settlements and farming into remaining elephant habitats and the concomitant escalation of conflicts between farmers and elephants throughout Africa, it is imperative that effective means of reducing HEC in the near future are employed extensively throughout wildlands and farming zones or, at least, in HEC hotspots within priority elephant landscapes, rather than remaining restricted to a few localized pilot projects.

In 2009, World Animal Protection (formerly World Society for the Protection of Animals), Tanzania's Problem Animal Control Unit, and Tanzania Wildlife Research Institute initiated the testing of promising HEC tactics being used in Southern Africa for their potential use in Tanzania (Biodiversity & Wildlife Solutions of RESOLVE Inc., joined the effort in 2015). In particular, a strategy was sought to promote the widespread adoption and sustainable use of community-supported chili fences [1, 4, 11, 15, 24] to mitigate against crop-raiding elephants in HEC hotspots around national parks and in wildlife corridors in Tanzania. For this purpose, we evaluated the efficacy of a combination of (1) farmer-managed chili fences, (2) the support of Community-Based Organizations (CBOs), and (3) the introduction of these strategies to new farming communities through farmer-to-farmer exchanges. We selected the fences as a mitigation tactic based upon findings that, properly constructed and maintained, chili fences are an effective deterrent to crop-raiding elephants [4, 15, 25-27]. Furthermore, there have been very few instances reported of chili fences being broken by elephants anywhere in Africa [4].

Methods

Site selection

In 2006, Tanzania's MNRT Wildlife Division recommended that chili fences be tested on the borders of Mikumi National Park, where HEC was frequent and intense. An estimated 50% of crops bordering the northern half of the park were damaged by elephants that year, despite farmers guarding fields from observation huts, beating tins and lighting fires, and game wardens shooting five elephants. Eight years later, in 2014, the chili fence program was expanded from three initial sites in villages around the northern border of Mikumi to all farming communities around the northern half of the park and to communities adjacent to the northwest border of Tarangire National Park where HEC was also intense. Demonstrations of the chili fence project have since been conducted in communities with high HEC around Serengeti National Park, Ruaha National Park, and Maasai Mara National Reserve in Kenya.

Chili fence construction

For a 0.4 ha (1 acre) field to be fenced, farmers need approximately 10 liters of spent engine oil, 2.5 kg of dried ground chili (roughly 10 to 15 handfuls), 32 pieces of mutton cloths or rags (0.6 x 0.45 m), a bundle of sisal rope (5 kg), and 36 wooden poles about 3 m long and at least 8 to 12 cm in diameter [27]. To construct the fence, wooden poles at least 2.5 m in height are set up around a field, spaced approximately

7 to 10 m apart. Two strands of oiled sisal rope are tied to poles with the lower strand about 2 m above the ground and the upper at about 2.5 m (Fig. 1). A third strand can be added lower down to deter young elephants from entering fields, or thorny branches can help form a barrier under the fence. Oil-soaked cloths are then tied between the two sisal ropes equidistant between two poles. Chili oil is re-applied by cloth or brush to both the sisal and the cloths after 5-7 days if it is raining heavily, and after three weeks if there is no rain. The cost of the materials for fencing a hectare of crops was approximately $14 in 2015 ($35 per acre), though recurring costs can be reduced by recycling fence poles, cloths, and ropes over several harvest seasons. Farmers commonly clear brush around the fence to avoid the breakage of sisal strands and to allow access for fence maintenance. They usually construct fences several weeks before harvest and take them down immediately afterwards. We found that farmers who erected fences typically used no other HEC mitigation tactics for those fields.

Between 2006 and 2015, over 800 farmers in high HEC areas worked with the *Tembo-Pilipili* (Kiswahili for 'elephant-chili pepper') program to construct 110 chili fences of different sizes encompassing roughly 1,174 ha of maize (*Zea mays*), sorghum (*Sorghum bicolor*), and watermelon (*Citrullus lanatus*) fields. In 2015 alone, approximately 70 ha of crops were fenced along the Mikumi National Park border and 65 ha along the northwest border of Tarangire National Park. The Mikumi *Tembo-Pilipili* team introduced chili fences to farmers around Tarangire National Park in 2015, with one new CBO. A *Tembo-Pilipili* team was established and multiple fences were constructed.

Fig. 1. Chili fences and community-based organizations (CBOs): (top left) a farmer-to-farmer exchange demonstrates chili fences construction; (top right) chili fences are made of locally available and inexpensive materials; (bottom left) the Mikumi *Tembo-Pilipili* team in front of Africa's first solar chili-dryer made of local materials; (bottom right) a Mikumi chili Mikumi chili fences protecting maize and chili crops. Photo credits: RESOLVE Inc (http://www.resolv.org/site-BiodiversityWildlifeSolutions/).

Community-based organizations to support chili fences

Communities living in wildlife dispersal areas and protected area buffer zones, which tend to comprise land of low agricultural productivity, typically have little income to buy the materials needed to construct chili fences, especially at the height of the raiding season when the crops are still in the fields and not in the markets. Thus, the project encouraged farmers to establish Community-Based Organizations (CBOs) and integrated micro-credit finance schemes [27, 29] as a way to support the use of chili fences. These CBOs enabled villagers to draw on their savings at critical times to purchase essential materials to protect their crops.

The Village Savings and Loans (VSL) micro-credit system allows members of a self-selected group to voluntarily form a VSL Association and save money through purchasing VSL shares. The savings are invested in a loan fund from which members can borrow, repaying with a service charge added. These Associations are a form of SACCO (Savings and Credit Cooperative Organizations), small-scale, community-managed financial institutions. To ensure sustainability, the micro-finance component is a revolving fund that, by earning interest, grows year on year. This provides the community with extra funds that can be used to compensate members who suffer from HEC. The amount that the community has saved can also be used as a benchmark to prove their commitment to the scheme and enable external agencies to build on the effectiveness of the fund by providing top-up donations through matching grants or other contributions.

Nationally-registered CBOs can also serve to organize village communities which helps them to network with potentially useful organizations and government institutions. Many bodies, such as local government, central government, NGOs, business people, banks, and other micro-finance organizations find it easier to work with registered CBOs. For example, *Mtandao wa Vikundi vya Wakulima Tanzania* (MVIWATA) is a small-hold farmers' organization that works primarily with registered CBOs.

Tembo-Pilipili *teams introduce chili fences to farmers*

Farmer-to-farmer exchanges encourage farmers to share with peers their knowledge about the use of chili fences and supporting CBOs as a method to reduce elephant crop raiding. For example, in 2014 and 2015, two teams: the Mikumi *Tembo-Pilipili* team and a Tarangire team, each comprising 5 women and 5 men, all local farmers, gave presentations on both activities to new farming communities that were experiencing conflict with wildlife. The teams built demonstration fences and made follow-up visits to each village to demonstrate fence maintenance and the running of CBOs and VSLs.

Before the farmer-to-farmer exchanges took place, we invited relevant stakeholders to a meeting to help promote broader buy-in, including the traditional leadership of the communities and national wildlife authorities (Ministry of Natural Resources and Tourism–Wildlife Division, Tanzania National Parks (TANAPA), and Tanzanian Wildlife Research Institute), as well as the relevant District Councils, District Executive Directors, District Game Offices, and Agricultural Extension Offices. Official government support and participation in the presentations conveyed to the farmers that the mitigation tactics were viewed favorably by the government, and this facilitated the adoption of the approach as a best practice strategy among government agencies. Awareness activities, such as school and district staff presentations, were coordinated with district wildlife, education, and agricultural officers and TANAPA Outreach Program officers.

Results

During the nine-year project period, there were no reports of any chili fences around either park being broken by elephants, even though elephants regularly raided nearby unfenced crops. Two chili fence CBOs were active at Mikumi from 2006 to 2012. After farmer-to-farmer exchanges were initiated in 2012, three more CBOs were created in 2013. Twenty-four new chili fence CBOs were established along Mikumi's northern border after initial and follow-up demonstrations by the Tembo-Pilipili team in 2014 and 2015 (Fig. 2). The rapid increase in the number of CBOs and the proportion of park border fields protected by chili fences occurred after we expanded the farmer-to-farmer exchange program in 2014. All CBOs initiated through this project were still functioning at the time of writing, using chili fences during harvest seasons paid for entirely by their own VSLs.

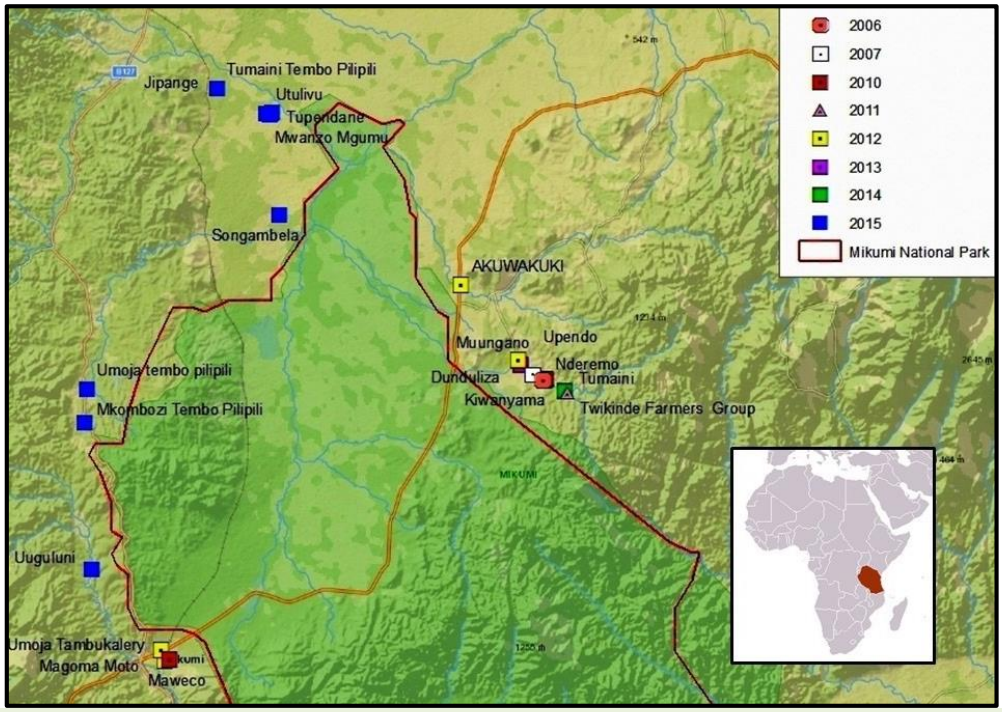

Fig. 2. Community-based organizations (CBOs) established from 2006 to 2015 around the northern border of Mikuni National Park, Tanzania (Latitude 7°00'–7°50' S, Longitude 37°00'–37°30' E). The number and distribution of CBOs employing chili fences for HEC mitigation increased markedly after farmer-to-farmer exchanges began in 2014.

Although the program no longer provides funds for chili fence materials in farming communities, farmers continue to use chili fences for HEC mitigation. This suggests that they have found that the fences effectively deter elephants, and that the value of both the fences and the CBOs outweigh their costs. Though we did not formally assess tolerance shifts regarding elephants around Mikumi or Tarangire, anecdotal reports suggest that some farmers are increasingly proud to be involved as champions for wildlife, and reprisals within the target communities have decreased.

Sufficient interest generated by the approach (that is, the combination of chili fences to deter elephants, CBOs to support their sustained use, and farmer-to-farmer exchanges to rapidly spread the practice) among farming communities, government partners, and donors has set the stage for future expansion. More *Tembo-Pilipili* team exchanges are underway or planned for more farming communities along national park borders and wildlife corridors in southwest Mikumi, western Tarangire, Serengeti, Ruaha national parks in Tanzania, and Maasai Mara National Reserve in Kenya in 2016.

Discussion

While no single mitigation tactic provides a panacea for HEC [5, 28], our work has shown that in the region and communities where the project was implemented: (1) chili fences effectively deter crop raiding by elephants at the scale of individual farms; (2) CBOs and VSLs can sustainably and independently support the use of chili fences over time; and (3) farmer-to-farmer exchanges introduce the concept rapidly, widely, and cost-effectively to new communities in HEC hotspot areas. Deployment of HEC mitigations [5, 28] across elephant landscapes will require local and national government institutions to adopt best practice strategies and ensure ongoing support for HEC programs within existing community support programs and budgets. Existing community support programs within Tanzanian districts, such as Community-Based Natural Resource Management Schemes and the Tanzania National Park Outreach Program, could potentially support the establishment of CBOs and cover or contribute to the running costs of chili fences. CBOs and farmer-initiated chili-based HEC mitigation strategies are supported through the Wildlife Conservation Act [30] and Wildlife Regulations (Dangerous Animals Damage Consolation) [31, 32]. The program can also achieve a broader reach by integrating the concept and tools [27] into the agendas and awareness programs of relevant international bodies, such as the East African Farmers Federation, IUCN African Elephant Species Specialist Group HEC manuals [1,13],
the Association for Strengthening Agricultural Research in Eastern and Central Africa, Alliance for a Green Revolution in Africa, USAID, TERRA NOVA, and influential Regional Economic Communities, such as the East African Community, COMESA, SADC, IGAD, and AU-IBAR.

Implications for Conservation

Over time, the ability of communities to effectively mitigate HEC at the local level may lead to a change in attitudes and a growth of tolerance towards elephants in priority elephant landscapes [6]. Over 70% of all wildlife in East Africa lives outside protected areas [23], so achieving policies and programs that accommodate elephants within shared landscapes is a key objective for conserving wildlife in the wild. Hoare [8] argues that the disconnect between local communities dealing with conflict and the fixed policies and slow response at higher levels of government, hinders solutions from scaling rapidly across landscapes. Our results show that the CBO and VSL model can be used effectively to organize farmers and sustainably support a wide range of community-based mitigation strategies, while operating within current government programs. We believe the quickest way to achieve a continent-scale shift in attitudes is to work closely with key wildlife countries, such as Tanzania and Kenya, to integrate HEC solutions that incorporate the three key elements we recommend here—cost-effective mitigation strategies that work well; community-based organizations to sustainably support them; and farmer-to-farmer exchanges—into their conservation and development programs, and to share these best practices with their counterparts throughout Africa.

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