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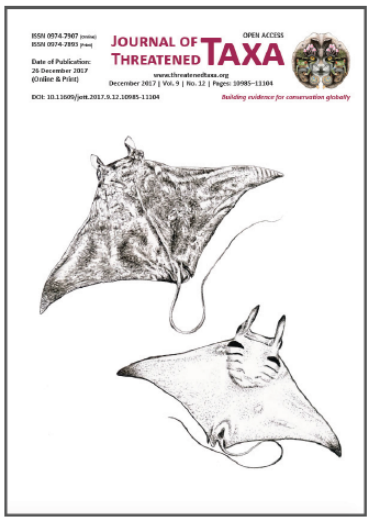

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COMMUNICATION

STATUS OF CONFLICT MITIGATION MEASURES IN NILAMBUR, WESTERN GHATS OF KERALA, INDIA

C.K. Rohini, T. Aravindan, K.S. Anoop Das & P.A. Vinayan

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Status of conflict mitigation measures in Nilambur, Western Ghats of Kerala, India

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Abstract: Mitigation measures are one of the best strategies for the management of human-elephant conflict. An assessment of the effectiveness of existing crop protection methods in 17 forest fringe villages of Karulai and Vazhikadavu ranges of Nilambur South and North Forest Divisions was carried out during June 2015 to May 2016. Mitigation methods found in the study area include electric fences (EF), combined electric fence and trench (EPT+EF), and elephant-proof stone wall (EPSW). Barriers were surveyed by foot and mapped with the help of global positioning systems (GPS). Number of elephant crossing points per kilometre along the length of the barrier was highest for EPT+EF and least for EF. About 86% of the barrier surveyed was located at an average distance of 14.47m from the villages and 13.63% of the barrier located at an average distance of 55.33m from the village. Damage caused by elephants to EF was primarily due to lack of maintenance of the fences. In EPT+EF, natural weak spots and gateways created for the passage of people and cattle were the main locations of elephant crossing points. Damage to the EPSW was caused by elephants by breaking the top portion of the wall. Areas outside damaged spots primarily contained agricultural land, water bodies and forests, with human habitations being least likely. Crossing points were located primarily in moderate vegetation zones. Encouraging local communities to take a primary role in the maintenance of barriers is essential in this context. Information on the current status of mitigation measures will help to improve the efficiency of barriers and facilitate better management of human-elephant conflicts.

Keywords: Barriers, crossing points, electric fence, Elephant proof trench, human-elephant conflict, mitigation measures, Nilambur, stone fence, Western Ghats.

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INTRODUCTION

Elephants are often considered to be a problem by residents living near conservation areas whose livelihood primarily depends on agriculture (Naughton-Treves 1997; Woodroffe et al. 2005). Conflicts leading to crop and property damage, attacks or deaths can provoke retaliatory responses. This scenario demands a balance between elephant conservation and necessities of people living adjacent to forest fringes (Nelson et al. 2003).

Habitat restoration through landscape-level strategies is essential for the long-term management of damage caused by elephants. Focusing on long term solutions is not realistic in the present context, where poor tolerance towards wildlife is apparent (Sinu & Nagrajan 2015). Conflict mitigation methods play a significant immediate role in preventing further reduction in community tolerance towards wildlife. In addition, this will be helpful to gain more time for the development of long-term solutions for conflict management (Zimmermann et al. 2009).

Establishment of mitigation measures is one of the best strategies for elephant conservation. Mitigation measures play a significant role in reducing the intensity of conflict (Bell 1984; Sukumar 1990; Tchamba 1996; Smith & Kasiki 1999) by minimizing elephant intrusion into human habitations. Government-sponsored conflict mitigation measures particularly encourage people's tolerance towards the problem species (Varma et al. 2009). As the efficiency of mitigation measures is site specific, it is not logical to generalize that any single mitigation measure will work in all situations (Osborn & Parker 2003). Site-specific evaluation of mitigation measures will provide information on the factors influencing its efficiency and thereby facilitate the establishment of barriers logically. People's participation in the establishment of barriers, regular monitoring and information exchange between farmers, together with economic and technical support from government, will likely improve the efficiency of barriers.

An assessment of the effectiveness of existing crop protection methods in 17 forest fringe villages of Karulai and Vazhikadavu ranges of Nilambur South and North Forest Divisions was carried out during June 2015-May 2016. Of 17 villages abutting the boundaries of Vazhikadavu (11.45525 N & 76.27142 E) and Karulai Range (11.28179 N & 76.3241 E) of Nilambur Forest Division, functional elephant-proof barriers were present in 13 villages. The barriers include electrified fence (EF), combined elephant proof trench and electrified fence (EPT+EF) and elephant proof stone wall (EPSW). The study attempted to understand the presence of weak spots along the entire length of the barriers (such as EF, EPT, EPSW, EF+EPT) and factors associated with formation of weak spots, to evaluate the distance of the weak spot from the village, status of vegetation (dense, medium and sparse) at the weak spot and layout outside the weak point. The results will possibly help to improve the efficiency of mitigation measures and thereby the management elephant conflict.

METHODS

Evaluation of the efficacy of mitigation measures was carried out during June 2015 to May 2016, in the pre-selected sites covering the entire forest boundary of each village. The barriers were monitored once a month by the direct evaluation of damage caused by elephants, and also by discussion with villagers about crossing points. The different barriers were surveyed by foot and mapped with the help of the global positioning system (GPS). During the course of mapping, at each breakage/damage point, a geo-coordinate was taken and marked as GPS waypoints. Visible signs of barrier failure were observed and recorded in the field. Information such as the distance to human habitation from the barrier, cause of damage, type of layout at weak point next to the barrier and status of vegetation cover near the weak point were recorded from each weak spot or crossing point.

Cause of damage was categorised under six categories that include breakage caused by elephant, natural weak spot (NWS), gateway for movement, presence of road, manufacturing defect and man-made weak spots. Status of vegetation at each weak spot was noted and categorised as dense, medium or sparse through visual observation. Waypoints from the barrier were taken at 500m intervals to calculate the distance from the barrier to the village. The layout outside the break point was examined and included in one of four classes: cultivation area, forest, water body or human habitation. The data collected were processed in the Geographical Information System (QGIS) environment. The methods followed were based on studies by Varma et al. (2009) in Bannerghatta National Park, Bengaluru, southern India.

RESULTS

Status of barriers

The total perimeter of the forest boundary abutting the village extends up to 49.8km. Of which 45% of the perimeter was marked by the absence of any mitigation measures. Completely damaged or non-functional electric fences encompass 20.3%. The damaged fence spans the boundaries of five villages. Total negligence towards the maintenance of the fence, logistical difficulties experienced to carry out fence maintenance, daily intrusion of cattles through the fence lines for grazing in forest, human pathway created through the fences for fuel wood collection together with manufacturing defect lead to a complete damage of the fence lines within a short period since it was erected. Functional barriers cover 34.9% (17.48km) of the total surveyed perimeter, which includes 29.6% (14.82km) electric fences, 3.1% (1.55km) combined electric fence and trench and 2.2% (1.11km) stonewall.

Government built and private electric fences were present along the forest boundary. Government built fences were erected along the forest. Whereas fences owned by farmers were erected along the farm land. Government built EF covers a length of 8.45km and private EF covers a length of 6.36km. EF+EPT encompasses a length of 1.55km, and it was constructed within the forest region. A stream was observed across the barrier, leading to the formation of gaps. Trenches and fences were damaged at several points, indicating poor maintenance. A stone fence spans along the perimeter covering 1.1km length. It was constructed within the forest. The stone wall was built with rough cut pieces of stone and rock held together with cement. The stone wall was continuous with one gap which allows human passage.

Weak spots (crossing points)

Several breakages were found along the length of these barriers that lead to the formation of weak spots or crossing points. These weak spots are either elephant crossing points (ECP) or potential crossing points (PCP). ECP are the points through which elephant cross the barrier and move into human habitations inferred through direct or indirect evidence of breakages and elephant passage. The points across the barrier which are vulnerable to elephant crossing were marked as a potential crossing points.

Through the entire length of the government-built electric fence, 22 weak spots were found. This indicates the presence of 2.6 weak points /km for the government built EF. A total of 11 weak spots were noted in a private electric fence, indicating about 1.7 weak points/ km. The number of crossing point per kilometre was lower for private EF than the government built fence. Three crossing points were observed along the entire length of the stone fence during the study period. Number of weak spots per kilometre is 2.7, which is higher than the electric fence. A total of seven crossing points were observed along the perimeter of EF+EPT. The damage per km is 4.5, the highest observed among the barriers surveyed in this study. The weak spots across the different barriers in the study villages are represented in Images 1 & 2.

Distance of barrier from the village

Stone fence was located in the forest with an average distance of 12m from the human habitation. About 94% of EF is located very close to village with an average distance of 15.23m from human habitation. The entire length of combined EF+EPT passes through the forest at an average distance of 53m from the human habitation.

As a whole, 86.36% of the barrier surveyed was located at a distance less than 50m from the villages with an average distance of 14.47m (SD=8.73, N=19) from the village and 13.63% of the barrier surveyed was located at an average distance of 55.33m from the village (SD=5.85, N=3) (Fig 1).

Status of crossing points/weak spots along the barriers

The leading causes for the formation of weak spots along the barriers are depicted (Fig. 2).

Electric Fence: Damage caused by elephants to electric fences was most importantly due to lack of maintenance of the fences and subsequent damage by elephant (40.9%). Failure in the removal of the undergrowth adjacent to the fence will cause power loss through the touching of plants to fence lines; the elephant can break such fences easily as an electric shock would be missing. Habituated elephants learn to break the fence by different ways such as bending the iron pole and pushing down the fence with leg or by break the fence lines by tusks or by putting trees or branches over the fence lines. In addition, if the voltage is low due to the improper charging of batteries as a result of cloudy weather in solar powered EF or otherwise by a power failure, elephants can easily cross the fences. Improper charging due to manufacturing defect was also noted. People fail to close the gates along the EF at night and elephants enter into the village through this path (27.27%). Erection of fences at the natural weak spots like stream or water body causes increased

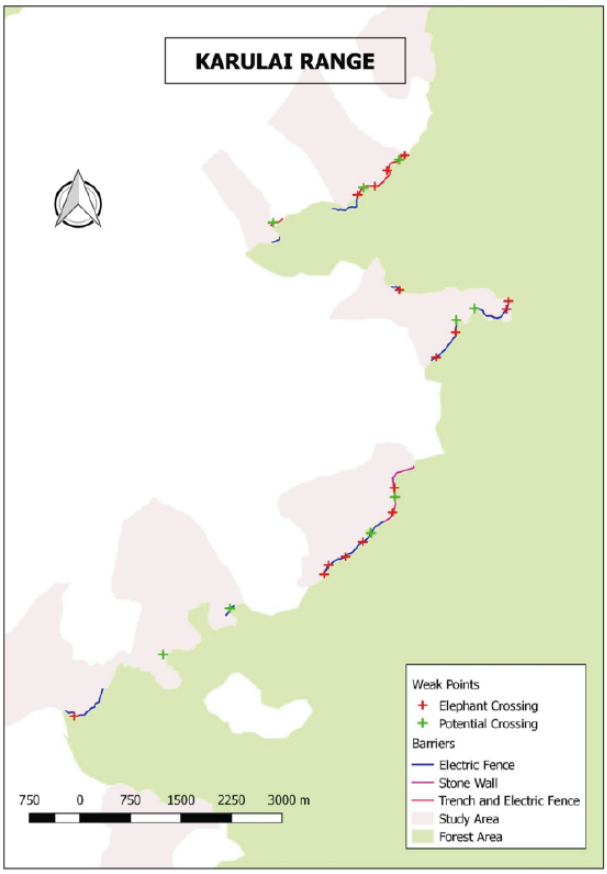

Image 1. Predicted locations where elephants can access the farms across the barriers in selected forest fringe villages near the Karulai Range

damages to electric fencing (22.7%). Erecting fences in areas adjacent to the road also cause elephants to pass through the road to enter into villages (9.09%).

Combined electric fence and elephant proof trench

Presence of natural weak spots was one of the main reasons for the formation of crossing points in this type of barrier (42.8%). Erosion by waterlogging and subsequent destruction of trench and gap left due to the presence of the stream lead towards the formation of weak spots. Electric fences were not maintained and not tight and some of them have fallen to the ground. The gateways created for the passage of people and cattle, which are left open carelessly at night, act as another cross point through which elephant cross the forest (42.8%). Elephants kick soil from sides into EPT and cross the barrier in regions where electric fences are not maintained well (14.28%).

Elephant proof stone wall (EPSW)

Damage to the stone wall was caused in two different spots along the stone fence. It was caused by elephants breaking the top portion of the wall (66.6%). One potential weak spot was also observed, where the stone wall was broken due to human activity (33.3%). If not repaired, this point will be vulnerable to elephant crossing.

Layout outside the weak spot in different mitigation methods

Outside the damaged spots of the barrier, the layout observed was mainly agricultural land (54.5%, N=24) followed by forest region (22.72%, N=10) and water body (13.63%, N=6). Damages to the barriers were comparatively lesser in regions where human habitations (9.09%, N=4) were found adjacent to the

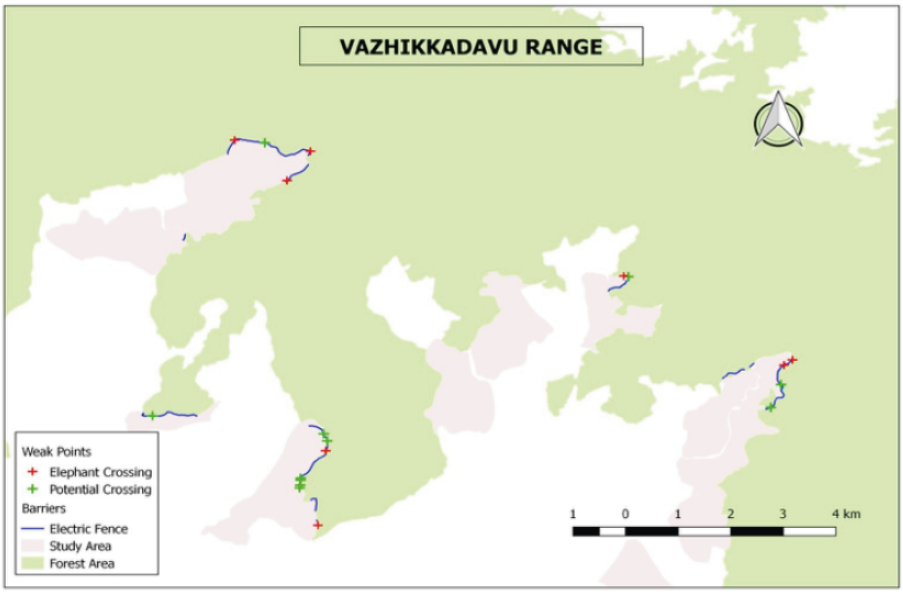

Image 2. Predicted locations where elephants can access the farms across the barriers in selected forest fringes villages near the Vazhikadavu Range

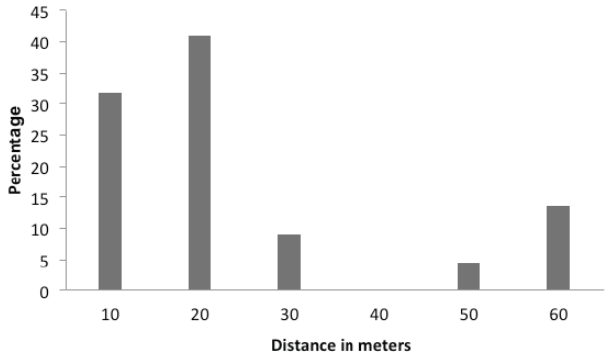

Figure 1. Distance (in meters) of all barriers (considered together) from the village

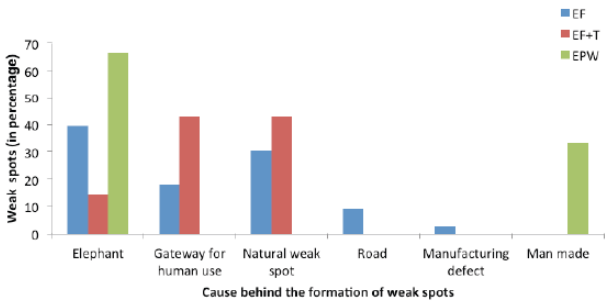

Figure 2. Causes lead to the formation of weak spots along the different barriers

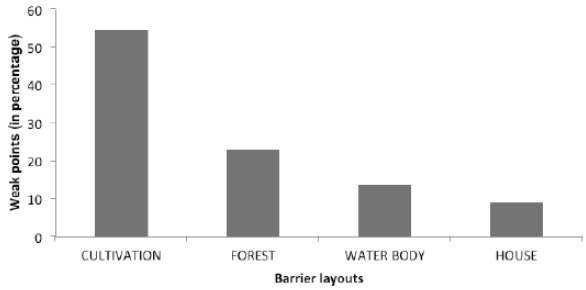

Figure 3. Layout outside the weak points of the barriers

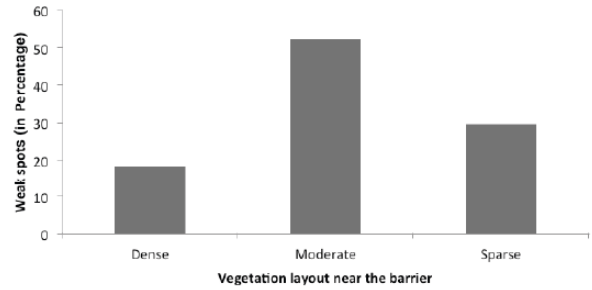

Figure 4. Vegetation cover near the weak spot of barriers

fences. The elephant crossing points were observed in regions where both sides of the barrier was forest especially in the case of EPT+EF (Fig. 3).

Vegetation cover near the mitigation measures

Vegetation cover immediately adjacent to the weak spots varies. Majority of weak spots were found in barriers passing through the regions adjacent to moderate vegetation cover (52.27%, N=23) followed by areas with sparse vegetation cover (29.54%, N=13). Weak spots to barriers were least in regions closer to the dense vegetation cover (18.18%, N=8,) (Fig. 4).

DISCUSSION

Mitigation strategies are helpful in order to strike a balance between human interests and elephant conservation in areas where people and elephants coexist (IUCN 2006). Mitigation methods have been used in many parts of Asia and Africa to manage elephant conflict (Hoare 1995; Tchamba 1996). Of the different mitigation measures, EF is the most commonly used barrier to mitigate HEC in Asia (Desai & Riddle 2015). Several studies have identified EF as the most effective tool for preventing crop depredation by elephants (Hoare 2003; Fernando et al. 2008). Apart from being effective, an intervention method also should be sustainable (Treves et al. 2006) which can be achieved via regular maintenance.

Number of elephant crossing points per kilometre was found to be less for privately owned EF compared to government-owned EF, indicating a better performance for private EF similar to other studies (Nath & Sukumar 1998; Parker et al. 2007). The difference in performance was largely due to the absence of people's cooperation in monitoring the fence for checking breakages and removing undergrowth in government-owned EFs. Presence of undergrowth was very common along the government-built barriers. Regular monitoring to clear the undergrowth over the fence line will prevent power loss by earthing. This will minimise the formation of weak spots up to a great extent.

The significance of exploiting the interface between EF and human habitation has been recognised (Desai & Riddle 2015). There are several advantages in placing EF at the interface between elephant habitat and human areas instead of placing in forests. It will enable residents to maintain the fences, and the probability of elephant to challenges the fence will be reduced if fences are placed closer to human use areas (Hoare 2012). Here it was observed that complications for the regular monitoring of EF established inside forest were added

by the presence of stream in the interface between forest and village, causing the complete damage of the five kilometre fence within a couple of years after it's construction.

Most of the damage found in the fence was caused by elephants, followed by natural weak spots that are exploited by elephants for crossing the barrier. Several methods are used to breach the fence, and once it was breached the elephant will do it again by habituation (Chong & Norwana 2005). Therefore, erection of fences at the natural weak spots like swampy areas, streams or water body increases the chance of its failure. Elephants cross underneath the fence line put across a deep stream.

Efficacy of electric fence also depends on land use patterns, agricultural practices, geographical variations, social factors, learning capacity and behavioural response of crop raiding elephant coupled with the temperament of resident herds (Sukumar 1989; Gunaratne & Premarathne 2006). Local elephant demography; specifically the number of males, reaction to fence breakers, and the type and distribution of crops grown within the fence are important factors affecting the efficiency of EF (O'Connell-Rodwell et al. 2000). Maintenance stands out as the most important proximate factor determining the success of an electrified fence (Nelso et al. 2003) which was emphasised in most of the studies.

The influence of landscape factors, such as the presence of forest and vegetation cover are recognised as important in determining the effectiveness of electric fences (Hoare 1995; Kioko et al. 2008). Here it was observed that weak spots are formed more at regions near moderate vegetation cover, followed by areas surrounded by sparse and dense vegetation. The fences located near the forest that provide suitable foraging areas for elephants as well as vegetation cover that will help them to hide from humans or provide shelter from the high temperatures during the day in hot areas (Kinaha et al. 2007) were preferred by the elephant. Forest cover adjacent to EF play important role in fence management (Hoare 1995) and such areas should be marked and intensely managed since the possibility of crossing will be higher here. The proximity of forest cover to agricultural areas is a strong predictor of heavy crop raiding by elephants (Nyhus et al. 2000).

The shortcomings of EF are related to expensive installation, constant maintenance and necessity for some technical expertise of the owners (Hoare 2003; Gunaratne & Premarathne 2006; Fernando et al. 2008). Considering the high installation and maintenance cost of electric fencing, there is a need for more research to recognize the factors that determine the effectiveness of electric fences for its long term functioning. Community electric fences have been very successfully implemented in areas such as Ehetuwewa, Sri Lanka, formerly a region with the highest level of HEC (Fernando 2015). Private sector participation coupled with education of the local people on the importance of fence maintenance is critical to the success and sustainability of fencing projects (Hoare 2001).

Widespread application of stone fence is generally limited due to a lack of construction materials and expensive construction costs. Only a small portion of the area contain stone fence as a barrier to prevent elephant entry. Stone fence has been used in Laikipia District, Kenya, with varied success (Thouless & Sakwa 1995). The combination stone fence and EF was assessed in studies where a stone fence with a concreted top or an electrified wire running along the top were proposed to be significantly effective (Thouless & Sakwa 1995; Hoare 2003). The stone fence was damaged by elephants twice during the study period by pushing down the walls with their chests, similar to the observation reported by Thouless & Sakwa (1995). A little maintenance is required for a properly built stone fence making it advantageous (Veeramani et al. 2004).

Several studies illustrated the combination of EPT+EF as one of the best methods, as long as they are maintained well (Sukumar 1985; Santiapillai & Jackson 1990; Bist 1996; Nyhus et al. 2000; Desai 2002). Problems with trenches are the massive investment required both for construction and maintenance (Nelson et al. 2003). Recurrent maintenance is essential for the efficiency of EPT+EF because of their extreme vulnerability to soil erosion during rainy season, moreover elephants are known to kick soil in the sides into EPTs (Blair et al. 1979) causing an easy crossing through it.

The number of weak spots per kilometre was highest in EPT+EF due to the natural weak spots formed by a gap left in trenches due to the crossing of a stream and presence of gateways. Similar results were found in a a study at Way Kambas National Park in Sumatra by Nyhus et al. (2000). In addition, elephant learn to kick in the sides of trenches and cross, similar to observation by Hoare (2003) in Africa. Generally, a combination of trenches with EFs is unsuitable for sloping terrain, across steams or wet areas, or in a region where the soil is prone to erosion. Presence of roads and pathways that cross barriers defeats the very purpose of barriers (Kulkarni & Mehta 2011). In several instances, elephants crossed the barrier through the gate ways causing crop

and property damages. Fernando et al. (2008) observed that the efficiency of trenches is negatively correlated with the age and number of roads and paths that cross the trench. Compared to other barriers, EPT+EF was located within the forest, causing a higher probability of damage across it.

Providing necessary information, motivation and training activities on different aspects of conflict will facilitate the involvement of local communities to take a prime role in construction and maintenance of electric fences (Perera 2009). Along with this, the government needs to provide funding for technical assistance, monitoring and ensuring the proper functioning of fences. Short term methods are not the final solution for crop damage, they merely buy time until long term strategies can be developed (Barnes 2002; IUCN 2006). Information on the current status of mitigation measures will help to improve the efficiency of mitigation measures and thereby will be helpful for the management of elephant crop raiding. Long-term strategies for reducing conflict with elephants include modification of natural habitat, maintenance of habitat corridors by linking existing reserves or forest areas through reforestation or other changes in land use, which could allow elephants to move along their traditional migration routes and minimize the spread of conflict. Moreover, the causes of conflicts must be communicated to politicians, decision-makers and local communities. Long term and large scale solutions are needed to lessen impacts on local residents.

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