

# PRELIMINARY STUDY ON CROP ECONOMIC LOSS, MITIGATING MEASURES AND PEOPLE'S PERCEPTIONS ON HUMAN-WILDLIFE CONFLICT ESPECIALLY IN AGRICULTURAL FIELDS IN THE UPPER REACHES OF THE NILGIRIS, TAMIL NADU, SOUTHERN INDIA

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## ABSTRACT

Human-wildlife conflicts occurred when human beings take negative actions on wildlife and vice-versa. These research works are aimed to investigate the driving forces for human-wildlife conflict and mitigating measures to support policymakers and conservationists from October 2019 to March 2020. Two sets of questionnaires namely 'precise and closed' and 'broad and open-ended' were developed to assess crop economic loss, mitigating measures and people's perceptions of Human-wildlife conflict in Upper reaches of the Nilgiris. A total of 120 agricultural peoples were interviewed of which 81% (n=97) of the males. The literacy profile revealed that (41%) were illiterate. Crop cultivation result shows that mostly cultivated crops are carrot (n=58) followed by potato (n=46) beetroot (n=10) and Green Peas (n=6). Most of the respondents were opined that the wild boars are responsible for heavy crop damage than other wild animals and also wild animal populations increased is the most important reason for crop depredation (n=80). There are five different measures used by the peoples as a deterrent to drive away wild animals. Among the measures, the Battery charged power fencing incurred a huge amount (Rs. 50000/acre) for installation. CEBI result showed that tuber crops such as Carrot and Potato were severely damaged and benefit to the farmers was very low according to their CEBI values 0.46 and 0.52 respectively. In a nutshell, this present study found that this is a time to bring new policy level management plans to resolve the crop depredation caused by wild boars in the Upper Nilgiris. Also, this study is a pioneer attempt in the upper Nilgiris to throw light on the wild animals menace, especially on crop depredation.

**Keywords:** Agricultural, Crop, Economic loss, Human-wildlife conflict, Nilgiris

## INTRODUCTION

The conflict is occurring everywhere in the world. Although the problem of human-wildlife conflicts has existed everywhere, the situation is more severe for the Indian region where the majority of the people depend on agriculture. The expansion of the human population into or near to areas inhabited by wildlife and modification of the natural environments for agricultural or other economic activities escalate human-wildlife conflicts (Hockings and Humle, 2009; Knight, 2000). Residential and commercial development, agriculture and aquaculture expansions into forest areas are the main challenges that affect the life of wildlife. Understanding drivers of human-wildlife conflicts is a prerequisite for developing effective and cost-efficient conservation strategies. Agricultural lands close to forest areas are often face crop raiding by wild herbivores, which can be a serious problem for farmers whose livelihoods depend on agricultural produce (Naughton-Treves, 1997; Treves et al.2006; Graham et al.2010; Mathur, 2015). In order to avoid economic loss, farmers apply a range of protective measures. They include manual guarding, various types of fences, trenches and other devices (Jayson, 1999; Osborn et al.,2006; Jackson et al.,2008; Graham and Ochieng, 2008; King et al., 2009; Rangarajan

et al.2010; Delger et al.2011; Mehta, 2014). However, these measures often come with high associated costs (Woodroffe, 2014) and risks (Rangarajan, 2010; Sukumar, 1989; Nepal and Weber, 1999; Sitati, 2003; Fernando et al., 2005; Sitati et al., 2005). The traditional fences are made using wooden poles and thorny branches lopped from nearby forests causing substantial damage to the forest. Destructive measures such as traps can kill or injure animals. Highly sophisticated means such as electric fences are expensive and need continued maintenance (Woodroffe, 2014; Karanth, 2012). Although a number of measures have been developed and shown to be effective on an experimental scale, there are reasons why they achieve limited success when employed on a wider spatial scale. To date, there has been comparatively very little systematic research carried out to investigate patterns of crop-raiding activity by wild animals, its potential impact on farmers' food and household economic security and ways and means to manage them. The majority of the research that exists at present has focused on the issues related to crop damage by wild animals in the upper reaches of the Nilgiris. These research works are aimed to investigate the driving forces for human-wildlife conflict and mitigating measures to support policymakers and conservationists from October 2019 to March 2020.

## STUDY AREA

Nilgiri hills (11° 08' to 11° 37' N and 76° 27' E to 77° 4' E) is a range of mountains with at least 24 peaks above 2,000 meters (6,562 ft). It is the part of the larger Western Ghats mountain chain making up the South Western edge of the Deccan plateau. The hills are separated from the Karnataka plateau to the North by the Moyar river and from the Anamalai hills, Palani hills of the South by the Palghat gap. Nilgiris Hill is a well-conserved area and has several endemic and rare fauna and flora. A reconnaissance survey was conducted in eight villages especially in the Nattuvattam and Pykara forest ranges in Nilgiris Forest Division. The upper reaches of the Nilgiris to identify the fringe village posing the problems of Human-Wildlife Conflict (HWC). A detailed questionnaire was prepared for the survey and the results were analyzed. Based on the survey the eight sampling sites were selected for the detailed study. A detailed study was conducted in the selected sampling sites.

## MATERIALS AND METHODS

The detail of crop damage caused by wild-animals was collected using questionnaire survey method. Interviews were conducted and discussions were made with the agricultural people's data pertaining intensity of crop damages caused by wild animals, cropping pattern, control measures and effectiveness of mitigating measures used by the people against wild animals damages, etc. Two sets of the questionnaire was prepared and used for data collection namely "Precise and Closed" has a set of questions such as Name of the Respondent, Name of the Village, Cropping pattern, etc. This particular type of question was asked to the respondent to answer anything which is not relevant or otherwise this questionnaire was said as "one-word answer" type and not allowed the respondent to express his views freely, and the second set questionnaire was "Broad and Open-ended" where the questions were asked to the respondent to express his views freely without any hesitation or the answer would be the descriptive type or one question may have multiple answers as described by Ramakrishnan (2008).

### Assessment of Crop Economic Benefit Index

Crop Economic Benefit Index (CEBI) is an indicator to study the crop damage assessment caused by wild animals using a simple arithmetic calculation. The economic loss incurred by the farmers due to crop depredation by wild animals was assessed using the questionnaire method and also by inspecting the recently damaged sites. In the recent past data i.e. up to October 2019 to March 2020 before the date of the interview was also collected. Information such as mean expenditure per acre (E), expected revenue per acre (Rex), total loss per year per acre (Ltot), actual return per year per acre (Rac) and compensation status (C) were collected to estimate Crop Economic Benefit Index (CEBI) to the farmers. Based on the CEBI values crops that are of economic benefit to the farmers were estimated using the following equation.

$$CEBI = (E - Rex + Ltot) / Rac + C$$

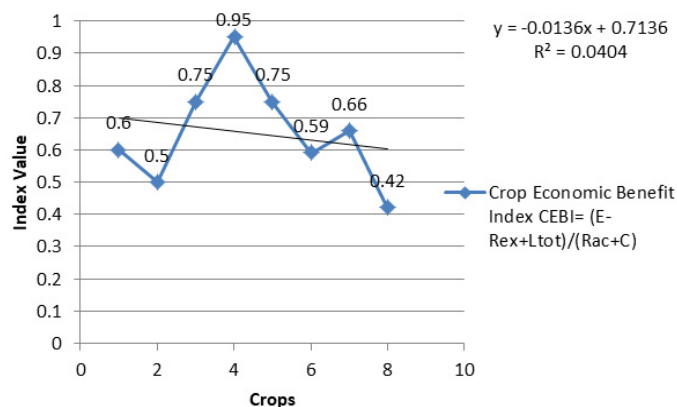
## RESULTS

A total of hundred and twenty agricultural peoples were interviewed of which 81% (n=97) of the males and 19% (n=23)

of the females were involved during the survey and the average age of the male respondents was 47.24±1.63 and the female were 44.22±3.91 and most of the respondents were under the age class category of 41-60 (n=56) followed by 21-40 (n=48) and 61-80 (n=16). The literacy profile of the respondents revealed that most of them were (41%) were illiterate which was followed by 37% of them were completed secondary education (5th STD to 10th STD) and 16% of them were primary education (1<sup>st</sup> STD to 5<sup>th</sup>STD). Just 6% of the respondents were completed the degree. Landholding structure results show that overall 148 acres of land were own by the hundred twenty respondents among the 148 acres 130 acres under cultivation purpose. Crop cultivation results shows that mostly cultivated crops are carrot (n=58) followed by potato (n=46) beetroot (n=10) and Green Peas (n=6). Beans, Garlic and Tea were less cultivated in the region. Most of the respondents (n=32) were opined that the wild boars are reasoned for heavy crop damage than other wild animals. Which was followed by Sambar deer (n=23) and Bonnet macaque (n=20). Apart from these, other wild animals such as Nilgiri langur (n=15), and Porcupine (n=10) also caused crop damage in agricultural fields. Reasons for wild animal's crop depredation were quantified. Most of the respondents 35% of them were opined that the wild animal population increased is the most important reason for crop depredation. 23% of responded that Food availability decreased inside the forest is the main reason for wild animals crop depredation. Agricultural area increased and the Forest area decreased is a major reason was opined by 13% of persons respectively. Just 6% of persons were opined that invasion of exotic weed inside the forest areas resulted from depletion of food for wild boars reasoned for crop depredation of wild animals. There are five different measures used by the local people as a deterrent to drive away wild animals. Among the measures, the Battery charged power fencing incurred a huge amount (Rs. 50000/acre) for installation followed by Hampton fencing (Rs. 40000/acre) and Net fencing (Rs. 30000/acre). Other measures such as Making sound using local instruments used coloured saree fencing and post fencing incurred a comparatively lower amount than others. Most of the respondents (n=65) have opined that Battery charged power fencing is the most effective method to prevent crop depredation by wild animals followed by Hampton fencing (n=24) and Net fencing (n=15). Very few people were responded that coloured saree fencing (n=6) is also an effective method to prevent wild animals.

The Crop Economic Benefit Index (CEBI) has arrived from the crop damage caused by wild animals. The result showed that tuber crops such as Carrot and Potato were severely damaged and benefit to the farmers was very low according to their CEBI values 0.46 and 0.52 respectively. On the other hand, the crops which are produced their yielding above the ground surface such as Cabbage and Green Pea benefit to the farmers with their CEBI values of 0.65 and 0.62 respectively. Other crops such as Beetroot (0.68) Brucolli (0.59) are seemed to highly beneficial to the farmers because they are being cultivated in small areas by few farmers (Figure 1).

The result on the extent of crop damage caused by wild boars revealed that about one-fourth of the area was damaged by wild animals irrespective of the crops. Of which Carrot was heavily



**Figure 1:** Showed the Crop Economic Benefit Index vales of the crop damage caused by wild animals.

damaged followed by Potato and tea. It is very important to note that the one-fourth of the area's damage cost itself about Rs. 13,76,000/-. Among the crops tuber crops such as Carrot and Potato were severely damaged by wild boars in the upper reaches of the Nilgiris.

## DISCUSSION

In recent years HWC in agricultural landscapes is an increasing factor of concern for managers. India is the seventh-largest country in the world and the second largest nation of Asia having 10 different biogeographic zones, encompassing varied landscapes with rich natural resources. All the animals and birds listed in India are not problematic in causing HWC. In agricultural production in India is mainly affected by insect pests, plant diseases and weed plants to a greater extent. In recent times wild animals mainly consisting of mammals with special reference to rodents, wild boars, blue bulls and monkeys started gaining pest status and in certain cases, a huge damage is being encountered due to some of these vertebrate pests.

This present study found that the wild boars (*Sus scrofa*), Nilgiri Langur (*Semnopithecus johnii*) Porcupine (*Hystrix indica*), Bonnet macaque (*Macaca radiata*), Barking deer (*Muntia muntjac*) Sambar deer (*Rusa unicolor*) and monkey (*Macaca mulatta*) caused severe damage on tuber crops such as Carrot (*Daucus carota*) and Potato (*Solanum tuberosum*). This is mainly because of the habit and anatomical structure of wild boar to feed on tubers. Chhangani and Mohnot (2004) stated that the wild boar has an elongated head with an abruptly truncated mobile snout that ends in a flat disk containing the nostrils. The head is very strong and used in fighting, digging and bulldozing vegetation. Allwin et al. (2015) found that the manner of rooting was dependent not only upon the food being sought but also on the moisture content of the soil. As a consequence, crop damage is a growing problem, bringing concerns concerning the control of boar numbers. A similar problem also arose in the Basin of Geneva in 2002 (Fischer et al. 2004; Fattebert 2005). Wild boar has become a regular menace for farmers in major crops resulting in enormous damage (Tisdell, 1982). Unlike other pests, wild boars generally cause damage right from seedling to till the maturity of the crop (Roberts, 1977; Groot-Bruinderink et al. 1994). Primates can pose a particular problem to farmers and are often cited as a major crop pest (Horrocks and Baulu,

1994; Mascarenhas, 1971; Strum, 1994). Members of the genera *Macaca*, *Papio* and *Cercopithecus* are amongst the most frequently cited primate pest species. Their highly social nature and co-operative behaviors and communication skills, combined with intelligence, dietary and behavioral flexibility, manual dexterity and extreme agility make certain species particularly difficult for farmers to protect their crops against (Else, 1991). For example, traditional and non-traditional protection strategies such as creating barriers (e.g. electric fences, living fences, walls, and ditches) between wildlife and farming areas are ineffective where primates are concerned. They can climb over and through most forms of fencing and quickly learn how to negotiate electric fences with impunity (Strum, 1994).

This present study has recorded that there were seven different mitigating measures used by the local people against crop depredation by wild boars. Of which Battery charged power fencing has been identified as one of the best effective mitigating measures than others. The installation and maintenance cost of solar-charged power fencing may be higher than battery charged power fencing and also very poor sunlight in most of the days in the upper Nilgiris thus did not allow the farmers to go for solar-charged power fencing. Battery charged electricity fencing was found as a good deterrent to keep away the wild animals from the agriculture areas. Gopakumar et al (2012) stated that the electrical (solar-powered too) fencing was an ultimate successful deterrent for wild boars in and around Aravalli in Rajasthan. They were also found that in the rubber plantations of central Kerala, white-colored plastic sheet fences create panic in the herds and 'Field patrolling' by farmer groups on a regular rotation basis can also be a successful crop protection strategy. This present study also found that there are many mitigating measures which include psychological, electrical and physical (night guarding) methods were used by local people to protect their crops from wild boars depredation in the upper Nilgiris of the Nilgiri South Forest Division.

This present study has recorded that the population increase was the major reason for ever increased crop depredation by wild animals through the questionnaire to the farmers. Similarly, a considerable number of people have also opined that loss of forest cover and food inside the forest due to exotic weed invasion resulted in crop depredation by wild boars. The upper Nilgiris was generally covered by grasslands and shola forests. During the 1850s the British people had introduced many exotics such as *Acacia spp.*, *Pinus sp.*, *Eucalyptus spp.*, etc. thus resulted in the loss of forest cover and food availability of wild boars in the forest areas. Moreira (1997) stated that the basic reason for such an unexpected abrupt raise in the wild boar population was attributed in the escalating rate of deforestation. Deforestation also resulted in the decline of Tigers, Panthers, Wild dogs, Wolf, and Jackal, which are the natural predators for wild boars (Khokhar and Rizvi, 1998) thereby indirectly contributing to the phenomenal rise in the wild boar populations. The exploitation of forest resources by mankind forced wild boars out of their natural habitat and compelled them to depend on cultivated crops such as rice, maize, sorghum, pulses, oilseeds, fruits and vegetables. Besides crops, it causes damage to ground vegetation, orchards, forest plantations and possibly acts as a carrier of some infectious diseases (Chauhan et al. 2009; Schley

and Roper, 2003).

This present study has identified that the tuber crops such as Carrot and Potato did not have the Crop Economic Benefit Index (CEBI) to the farmers due to severe damage caused by wild boars. The other crops such as Cabbage, Green pea, Beans and Broccoli are beneficial to the farmers. Still, the mitigating measures have the role to play on it. The local people at least use saree fencing as one of the mitigating measures against wild animal's crop depredation even in low investment crops. Vasudeva Rao et al. (2015) stated that the erection of used coloured sarees is farmer's innovation, which has a behavioural background as far as wild boar is concerned. By arranging used sarees of different colours around the crop will make wild boars assume human presence in the area thereby not preferring to enter into such areas. Even though, not feasible in all situations it has some marginal benefit in the areas of human movement. By using this, the extent of damage by wild boar can be minimized to the level of 30-55% at Telangana state (Vasudeva Rao et al. 2015). This present also found that the farmers in the Nilgiris used coloured sarees as a deterrent to wild boars crop depredation with the same psychological background as like Telangana farmers

The damage caused by wild boar is more alarming than their actual feeding in the crop. Over 400 species of plants have been recorded in the wild boar's diet, among which, 40 species were crop plants (Chauhan and Rajpurohit, 1993). Wild boar damage is more pronounced in crop fields which are near adjoining forest areas. Wild boar is a major problematic species in the crops in many parts of India, raid crops and utilizes the agro-ecosystem for food and shelter (Chauhan et al. 2009). This present study also corroborates with the earlier studies that the agricultural crops are more preferable raided plants than others in the Nilgiris Forest Division.

Resolving the crop damage caused by wild animals was questioned by the local people by this study. Most of them were opined that the wild animals should be inside the forest. Few of them were suggested that shooting permits may be provided like Kerala especially in good cropping areas or heavy crop economic loss areas. Some of them were suggested that castration for adult males may be attempted for a gradual reduction of the wild boar population. In Australia hunting dogs were used for the removal of pigs from the croplands (Caley and Ottley, 1995). But for the Indian situation, this may not be permitted. In a nutshell, this present study found that this is a time to bring new policy level management plans to resolve the crop depredation caused by wild boars in the Nilgiris South Forest Division. Also, this study is a pioneer attempt in the upper Nilgiris to through light on the wild animals' menace, especially on crop depredation.

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