

**EVALUATION OF THE EFFICACY OF TWO DETERRENTS
(HERBOLIV[®] AND BOREP[®]) AGAINST CROP RAIDING
WILD ANIMALS**

**ATHUL U.K.
(19-MSVP-13)**

DISSERTATION

Submitted in partial fulfilment of the requirement for the degree of

**MASTER OF SCIENCE
(Wildlife Studies)
2022**

**Faculty of Veterinary and Animal Sciences
Kerala Veterinary and Animal Sciences University**



**KVASU CENTRE FOR WILDLIFE STUDIES
KERALA VETERINARY AND ANIMAL SCIENCES UNIVERSITY
POOKODE, WAYANAD 673576
KERALA, INDIA**

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DECLARATION

I hereby declare that this dissertation entitled “**Evaluation of the Efficacy of Two Deterrents (Herboliv[®] And Borep[®]) Against Crop Raiding Wild Animals**” is a bonafide record of research done by me during the course of research and that the dissertation has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title, of any other University or Society.

Place: Pookode

ATHUL U.K.

Date:

(19-MSVP-13)

Dr. George Chandy

Special Officer

Centre for Wildlife Studies

Kerala Veterinary and Animal Sciences University

Pookode, Wayanad - 673576

CERTIFICATE

Certified that this dissertation, entitled “**Evaluation of the Efficacy of Two Deterrents (Herboliv[®] And Borep[®]) Against Crop Raiding Wild Animals**” is a record of research work done independently by **ATHUL U. K. (19-MSVP-13)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him/her.

Place: Pookode

Date:

Dr. George Chandy

Chairman

Advisory Committee

CERTIFICATE

We, the undersigned members of the advisory committee of **ATHUL U. K. (Roll no: 19-MSVP-13)**, a candidate for the degree of Master of Science in Wildlife Studies, agree that this dissertation entitled “**Evaluation of the Efficacy of Two Deterrents (Herboliv[®] And Borep[®]) Aganist Crop Raiding Wild Animals**” may be submitted by **ATHUL U. K. (Roll no: 19-MSVP-13)** in partial fulfilment of the requirement for the degree.

Dr. George Chandy
Special Officer
Centre for Wildlife Studies
Kerala Veterinary and Animal Sciences University
Pookode, Wayanad - 673576
(Chairman)

Dr. Biju S.
Assistant Professor
Department Livestock Production
Management
College of Veterinary and Animal
Sciences, Mannuthy
Kerala Veterinary and Animal
Sciences University
Pookode, Wayanad – 673576
(Member)

Dr. George Chandy
Special Officer
Centre for Wildlife Studies
Kerala Veterinary and Animal
Sciences University
Pookode, Wayanad - 673576
(Member)

EXTERNAL EXAMINER

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ATHUL U.K.

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INTRODUCTION

1. INTRODUCTION

1.1. HISTORY OF HUMAN-WILDLIFE INTERACTION

Human-wildlife conflict (HWC) has a long history, dating back to the beginnings of civilization yet, it is today causing a severe environmental threat to human civilization. Asia is especially vulnerable to this issue. The public perception is that the severity of HWC has increased over the last few decades (Anand *et al.*, 2017).

The early phases of our ultimate worldwide dominion as a "super predator" were powered by our capacity to endure in the face of competition from other species. Human evolution is basically a history of humans interacting with other animals. Interactions between humans and wildlife have occurred from the time of human existence. Ancient human ancestors may have been selected for predator avoidance traits like effective alertness, social adaptations like small group formation for protection, and intellect to create technology like weapons to reduce the threat of predation.

The expansion of early human populations was associated with significant changes in the number of huge mammals. Humans had a very big role in the extinction of large mammals, according to evidences. Close interactions with wildlife are documented in the historical records. People interacting with nature are seen in early cave paintings from throughout the world. The oldest records showing protection of crops and humanity from wildlife can be found in various literature from Egypt, Indus River Valley, China, Greece, and Christian Bible (Nyhus, 2016).

These interactions might be positive or negative. People have eliminated dangerous animals, co-opted and domesticated desirable species, and used a variety of social, behavioural, and technical ways to lessen unwanted interactions with wildlife. The number of HWC publications have been steadily increasing, and over 90 per cent of the country is presently affected by HWC (Nyhus, 2016).

Throughout evolution, humans have coexisted with and interacted with wild animals. Even though wild animals can cause property damage or injury to humans and domesticated animals, not all human-wildlife encounters are bad (Bhatia *et al.*, 2020).

1.2. HUMAN - WILDLIFE CONFLICT (HWC)

Interactions between humans and wildlife are a defining experience of human life. These interactions might be positive or negative and when it comes to negative impact, we can say that there is conflict happening between both. Human-wildlife conflict occurs when human-wildlife interactions result in negative outcomes such as loss of property, livelihood, or even life. (Nyhus, 2016). HWC occurs when the demands of wildlife and human populations collide, resulting in costs to both humans and wild animals. Human-wildlife conflict is a major concern across the world, and the problem is worsening as a result of both humans and wildlife's out-of-control behaviour (Jayson, 2016).

People and animals are increasingly interacting and competing for resources as human populations and demand for space expand, eventually leading to more human-wildlife conflict. It occurs when the needs and conduct of wildlife have a negative influence on human goals. Negative interactions may result in crop damage, cattle theft, human casualties, and property damage (Conover, 2002).

1.3. REASONS FOR HUMAN - WILDLIFE CONFLICT (HWC)

The increase in the human population, transformation of land use, habitat loss, degradation, and fragmentation of species, popularisation of ecotourism, exclusion of wild herbivores due to increasing cattle numbers, wild prey abundance and distribution, and conservation programs have resulted in an increase in the number of HWC incidents in addition to climate-related factors, and forest fire (Distefano, 2005).

The rapid growth of urban areas throughout the world is significantly increasing the number of human-wildlife encounters and is one of the major reasons for human wildlife conflict (Soulsbury *et al.*, 2015).

Due to land degradation caused by anthropogenic activities like deforestation, agriculture, and urbanization, animal habitats are becoming more encroached. In tropical areas, this is the most common source of conflict between humans and wildlife (Sharma *et al.*, 2021).

Though the majority of contacts are good or neutral, they can have negative consequences such as property loss or damage, pet loss, illness transfer, bodily harm, and human or wildlife mortality (Richardson *et al.*, 2020; Treves *et al.*, 2006). Conflicts between wild animals and humans may be found all over the world. Depending on the area, the reason, and the animals involved, these complicated competing relationships may be viewed in a variety of ways. Conflict between humans and animals has serious impacts on health, safety, and welfare, of humans as well as on biodiversity and ecosystem health.

1.4. IMPACT OF HUMAN - WILDLIFE CONFLICT (HWC)

Due to the development of civilization, the extinction of natural species has increased. The destruction of animal habitats for the expansion of urban areas, the construction of roads, trains, and dams, as well as agricultural and industrial operations, have resulted in the decline of wildlife populations (Das and Guha, 2003).

Human–animal conflict is one of the most serious threats to many wildlife species today, and conservation scientists are paying more attention to the issue. Direct wildlife harm is frequently identified as the primary source of conflict, and there are several techniques that has been found to reduce such damage. The human-wildlife conflict has also led to a drastic decrease in the population of various wild species. Many wild animals have been brutally killed in the field with various lethal mitigation measures by the farmers. Human-wildlife conflict, along with other

threats, has caused the decline of once-abundant species and is threatening the extinction of others. Wildlife suffers the consequences of habitat destruction and they lose access to food and breeding sites, making it more difficult for them to raise their young. As a result of habitat destruction, wild animals have no choice other than to migrate or perish. The study found that in India around 40 mammals species, 71 birds species and 1,256 higher plants are in threat (Das and Guha, 2003).

Habitat loss and fragmentation caused by agricultural development, timber cutting, livestock, and urban sprawl have had a major influence on terrestrial ecosystems which has led the decline in terrestrial ecosystems (Fahrig, 2003; Fischer and Lindenmayer, 2007).

The most important problem today is disease transmission from wild animals to humans. The wild animals act as the reservoir for various zoonotic diseases which poses great threat to humanity (Thirgood and Woodroffe, 2005).

Predatory, territorial, or defensive instincts often lead wild animals to attack humans (Conover, 2002). Every year, bears, particularly black bears, are estimated to attack around 30 individuals in North America. A study of puma (cougar) attacks in the United States and Canada indicated that there were 58 victims between 1890 and 1990, 64 per cent of them were children, and in 78 per cent of those cases children were not accompanied by adults or other children (Beier, 1991).

Attacks by sharks are another conflict that happens around the world. Shark attacks on humans may be characterized as either provoked or unprovoked attacks. Unprovoked attacks occur in the natural environment and are not initiated by the human victim (Ryan *et al.*, 2021). Venomous species like snakes, scorpions, spiders also cause conflict with humans from early days of human history. Although most of the attacks are accidental, and the frequency of this type of conflict is alarming, many people are attacked by poisonous animals every year all throughout the world, resulting in numerous human deaths. Every year, over 1,000 people in Mexico die as a result of scorpion stings (Cheng, 2016).

According to a study report, snakebites cause at least 4,21,000 cases and 20,000 deaths each year throughout the world. The majority of snakebites are thought to occur in southern and southeast Asia, sub-Saharan Africa, and Central and South America, with India having the highest number of bites and deaths (Kasturiratne *et al.*, 2008)

Many wild animal species acts as pathogen reservoirs, and zoonotic and vector-borne diseases pose significant health risks to cattle, humans, and wildlife. Zoonotic diseases have a long history and continue to be one of the world's most serious public health challenges. The spreading of various new zoonotic diseases has been rapidly been reported from various parts of our country in recent times. The Kyasanur Forest Disease (KFD) has been first reported from Karnataka which is adjacent to Wayanad district, and the majority of the people of Wayanad district live in the fringes of protected areas where the chance of spreading disease is very high.

Rural residents, and people who own lands near the forest are the ones who face more severe issues with the wild animals (Messmer, 2009). Agriculture damage by the wild animals is one of the main problems faced by people around the world. A majority of urban families have encountered wildlife challenges, and even more (69 per cent) say they actively manage to control wildlife (Conover, 1997; Messmer *et al.*, 1999).

Human attitudes and values towards animals vary between and within sections of the community. Farmers' attitudes on wildlife keeps on changing when compared to those of other stakeholders (Kellert, 1980).

Destruction and damage to property and infrastructure (e.g. agricultural crops, orchards, grain stores, water connections, fences, pipelines), livestock depredation, and transfer of domestic animal diseases such as foot and mouth disease can all have an economic impact on humans. Human diseases and mortality caused by wildlife-related diseases, wildlife bites, attacks, deer–automobile collisions, and

bird–aircraft collisions are other common human–wildlife conflicts. According to research, around 5,000 people are injured or become ill each year in the United States, and 415 people die as a result of wildlife-related incidents (Conover *et al.*, 1997; Conover, 2002).

1.5. HWC IN KERALA

Wildlife damage to crops has emerged as a new challenge to crop production throughout the world (Madhusudan, 2003). Kerala is one among the places where the human wildlife conflict is severe and shows an increasing trend.

Crop damage studies were conducted extensively in Kerala and showed that wild animals destroyed forty-five varieties of crops, with elephants causing the most damage (Veeramani *et al.*, 1995; Jayson, 1999).

The major crops destroyed by wild animals in Kerala include, coconut palm (*Cocos nucifera*), paddy (*Oryza sativa*), plantains (*Musa* sp.), arecanut palm (*Aareca catechu*), tea (*Camellia sinensis*), rubber (*Havea braziliensis*), cashew (*Anacardium occidentale*), coffee (*Coffea arabica*), oil palm (*Elaeis guineensis*), sugarcane (*Saccharum officinarum*), and pepper (*Piper nigrum*).

The agriculture loss due to crop raiding wild animals is reported around the year in Kerala. Elephant (*Elephas maximus*), Porcupine (*Hystrix indica*), wild boar (*Sus scrofa*), sambar (*Cervus unicolor*), gaur (*Bos gaurus*), bonnet macaque (*Macaca radiata*), and common langur (*Presbytis entellus*) were the major animals involved in crop damage. Maximum crop damage was reported from Wayanad Wildlife Sanctuary, followed by Wayanad north, Waynad south, Kozhikode and Munnar forest division and the least crop damage was reported from Mankulam, Thenmala, Palakkad, Vazhachal, Chalakudi, Thrissur and Malayatoor forest divisions (Veeramani and Jayson, 1995).

There are number of different mitigation measures used by the farmers in order to mitigate human- animal conflict in Kerala. Mitigation measures may

include lethal as well as non-lethal measures and can harm the wild animals as well as the farmers to a great extent. Hence, proper understanding of this kind of various mitigation measures should be carefully observed and studied, and implemented, which can help to reduce these serious issues into a great extent. Watch and ward along with crackers are the most common mitigation measures used throughout the state. Beehive fence is one of the common mitigation measures used in Kerala (Jayson, 2016).

For elephants, mitigation measures like, sound with glass bottles or metallic objects, trench, spot light, electric fence, stone wall, are used. For wild pig and crested porcupine, bright coloured clothes, sound with glass bottles, barbed wire fence with concrete bar, neem cake, bamboo fence, fish net, cracker with stone setup are used (Jayson, 2016). For Bonnet Macaque and Hanuman Langur, watch and ward with dogs have commonly been used as a mitigation measure.

1.6. CHEMICAL DETERRENTS

One of the most selective techniques to minimize wild animal damage to agricultural crops is the use of repellents. Several repellent combinations have been developed and tested to see how effective they are. Popular organic repellents like Big Game Repellent (BGR) and Deer Away contain putrescent egg-based ingredients. Other chemical repellents include garlic and putrescent egg-based compounds, which have been shown to reduce white-tailed deer grazing damage to ornamental plants typically used in landscapes in the south eastern United States under controlled conditions (Coker *et al.*, 2001). Repellents can cause anxiety or fearful behavioural responses. Anxiety is a state of persistent fear of impending danger, which is more likely to be triggered by indirect cues (Grillon, 2008). In the animals separate neurochemical mechanisms regulate anxiety and terror and this is how the chemical repellents work (Tovote *et al.*, 2015). Repellents have the benefits of simple stimulus response pathways, ease of application, and environmental friendliness (Sayre *et al.*, 2001).

Non-lethal techniques for wildlife control may have environmental, ethical, and legal advantages over lethal control (Baker *et al.*, 2005). There are different kinds of chemical as well as bio repellents used to deter wild animals. Chemical repellents are divided into two types, odour and taste based. The former is more effective in the summer, whereas the other, which only works after an animal has eaten, is more effective in the winter. These repellents are designed to mimic natural compounds that discourage animals to use that area to forage and when they get the smell or taste, they usually avoid the area. Chemical repellents are potentially a non-lethal approach. However, they haven't been extensively researched in natural environments. Chemical repellents could be a more efficient alternative to culling (Baker and Macdonald, 1999). Toxins have induced a variety of behavioural responses in animals (Garcia and Hankins, 1977). Generally, repellents work by using an animal's natural aversion to a specific element which animals normally tends to avoid. Pepper, tarragon, garlic, peppermint, specific essential oils, and castor oil are just a few examples of plant-based repellents. Some chemical repellents work by making the target animal uncomfortable. Animal urine, dried blood mixtures, and hair are some of the combinations used in chemical repellents. Some animals will avoid anything that smells like their predators' urine. An ideal repellent is completely specific for the targeted animal, it repels only certain animal without affecting or harming any other animals or people.

Chemical repellents, physical obstacles, scare tactics, and hunting are options for animal control. Fences are costly and might be seen as an obtrusive addition to the landscape. Animals become habituated to scare tactics, and they are only effective for a short time. In highly populated urban regions, hunting is frequently an undesirable or unpopular alternative (Coker *et al.*, 2001).

The Western Ghats are a mountain range, that runs parallel to the western coast of the Indian peninsula, covering 1,60,000 km² (62,000 sq mi) and extending through the states of Goa, Karnataka, Maharashtra, Gujarat, Kerala, and Tamil Nadu. Western Ghats are one of the biodiversity hotspots around the world and it

covers the country's large proportion of flora and fauna. They have a very great impact on the Indian monsoon weather patterns.

Due to unscientific land use patterns, and unplanned developmental activities, this mountain ranges which is rich in biodiversity has diminished, resulting in habitat loss and fragmentation. As a result, the natural habitat of the wild animals have been reducing and further it leads to the human animal conflict.

Wayanad is a district of Kerala, India, located in the state's north-east region. Wayanad is located on the Western Ghats, with heights ranging from 700 to 2,100 meters. The name Wayanad is derived from the name "Vayalnadu" which means the land of paddy fields. Geographically, Wayanad comparable to the Karnataka districts of Kodagu and Mysore, as well as the Tamil Nadu district of Nilgiris. Agriculture is the district's main source of revenue. Crop raiding by the wild animals is more in the areas of Wayanad district due to the abundance of wildlife.

Paddy is the most frequent crop, and it is grown in the swamps. Crops like ragi and chama were grown on the dry elevated land. These are frequently cultivated on a shifting system. The other majority crops grown are coffee, tea, cardamom, pepper, cocoa, plantain, ginger, vanilla, rice *etc.* And the majority of the people of Wayanad district live in the fringes of protected areas where the chance of spreading disease is very high. Hence, to control this kind of wild animals which comes into close contact with the people, various non-lethal mitigation measures should be carefully studied and implemented (Easa and Sankar, 2001). Study regarding the human- wildlife conflict is very much needed in the area.

The study mainly focused to evaluate the efficacy of wild animal deterrents (HERBOLIV[®], BOREP[®]) which are olfactory repellents. BOREP[®] is an olfactory repellent which is mainly used to deter wild boar (*Sus scrofa*). HERBOLIV[®] is a bio liquid with various herbal extract and other organic product which gives an odour to the crops when sprayed and makes the crop non-palatable for wild animals which is mainly used against deer.

The study was undertaken in selected areas in Vythri panchayath, where the crop raiding by wild animals is regular. The study area was selected after conducting a pilot survey and information collected from the panchayath elected representatives. The main objective of the study was as followed.

1. To evaluate the efficacy of two deterrents (HERBOLIV[®], BOREP[®]) against crop-raiding by wild animals.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. STUDIES ON MAN-ANIMAL CONFLICT

2.1.1. Global Studies

Newmark *et al.* (1994) reported human-animal conflict in the Lake Manyara, and Mikumi National Parks, as well as the Selous Game Reserve, in Tanzania. Over 71 per cent of the public in the area said they had issues with animals. They reported more problems by the wild animals with the people living adjacent to the protected areas. Most significantly, in places with low human populations, large animals were more problematic, whereas at high human densities, small animals were much more problematic.

Gillingham and Lee (1999) studied human-wildlife interactions in settlements along the northern border of Tanzania's Selous Game Reserve. This region has been the focus of an initiative to encourage community wildlife management (CWM) since 1989. Many respondents were either unaware of the compensation programs and had negative opinions on the compensation work of wildlife management institutions. The secondary data of an attitudinal questionnaire survey, of 202 families in four villages were used to examine local perspectives of wildlife crop damage and management. During a 6 months program of crop-damage monitoring in one of the survey villages, data on the frequency of crop-damage incidents and the estimated severity of impacts were collected and utilized to explain on-farm patterns of crop-damage. The study found that 95.5 per cent of the 198 families surveyed said wild animal crop damage was a factor affecting crop yields, and 34.8 per cent said it was the major constraint on their agricultural production. The study also found that Bush pigs, Vervet monkeys (*Cercopithecus aethiops*), and rodents were the most regularly identified animals causing agricultural damage in MRBZ villages.

Messmer (2000) examined the pattern of human-wildlife conflict management, as well as how public and private wildlife conservation agencies and

organizations can use these new problems to boost public support for professional management.

Distefano (2005) listed the important case studies on HWC in Africa. Apart from the human-elephant conflict, this is a detailed study of the existing literature on wild animal-human conflict produced in the previous 10 years. He reported that the causes and consequences of conflicts are similar. The greatest challenges appear to be the dense human populations in close proximity to nature reserves, and where livestock and agriculture are significant parts of rural livelihoods, conflicts grow more intense. The competition for natural resources between rural communities and wild animals is more severe, and the local human population suffers higher. HWC is a rising worldwide issue that is not limited to certain geographic regions or climatic conditions, but affects all areas where animals and humans coexist and share limited resources. The study suggested short-term mitigation methods with longer-term prevention initiatives. The study also suggests that, short-term mitigating methods must be combined with longer-term preventative initiatives in order to resolve HWC. The study also recommended that when traditional low-cost deterrents and low-impact methods fail, more invasive approaches such as regulated harvesting, wildlife translocation, or human relocation should be considered.

Treves *et al.* (2006) carried out research work in Bolivia, Uganda, and Wisconsin in order to develop a strategy for reducing human-wildlife conflict. They suggested use of participatory approaches and co-management, with two goals, such as animal conservation and human security. The study was conducted by incorporating various local stakeholders for planning and for implementation, which helps to win space for wildlife outside the protected areas. The findings also demonstrate why systematic research into local people's risk perceptions and participant-led intervention design are major elements of such programs.

Manfredo and Dayer (2004) reported that the personal and cultural level components provide the fundamental knowledge of the intellectual, social, and biological impacts of human-wildlife conflict.

Zimmermann *et al.* (2005) studied carnivore conflict in Brazil. The most significant finding of the study was that the majority of people supported broad conservation efforts in the region. However, jaguar conflict was difficult to predict because the attacks were happening in such a way that they could not take any preventive measures beforehand. They noted that the factors such as the respondents' age, and relative income were predictors of attitudes of people. The results showed that the majority of respondents supported Pantanal conservation, but the attitude toward jaguars was mixed and difficult to predict based on socioeconomic characteristics. Changes in the husbandry practice of loose grazing, as well as awareness programs, were proposed as mitigation measures to encourage a good attitude towards conservation.

Tiller *et al.* (2021) studied the seasonal, temporal, and regional patterns of elephant crop-raiding in the Trans Mara, Kenya. They reported that temporal changes like crop raiding patterns have changed extensively between 1999 and 2015, and also there was 49 per cent rise in incidents, but an 83 per cent decrease in the amount of damage per farm in the human-elephant conflict study area. Though there was an increase in the frequency of raids, fewer areas were damaged. Hence, there was less economic impact, but farmers in fringe areas needed to invest more in crop protection. The study also found that a new elephant group type that engages in crop raiding is comprised of mixed groups. Crop-raiding patterns have also changed, with more incidents occurring near the protected region in 2014–2015, especially by bull groups.

Sitati and Walpole (2006) studied human-elephant conflict in the Trans Mara area, Kenya. Among different crop protection methods, front-line early warning from watch towers with communal guarding was shown to be the most effective method. The crop-raiding elephants were repelled from the crop fields by thunder flashes, crackers, and chilly oil on ropes.

Bisi *et al.* (2007) reported the process of developing a wolf management strategy in Finland. Reforming the damage compensation system and establishing

a better interpretation of the conservation status of wolves are among the proposed changes in the study. The traditional chasing of wild animals with hunter dogs was also proposed to prevent livestock lifting.

Neupane (2018) studied human-elephant conflict in Nepal in terms of human casualties and injuries, as well as crop and property damage. The study also examined the various mitigation measures which were commonly been practiced by the local people in the study area through a questionnaire survey. According to the study, villages near the Jalthal forest had a greater risk of elephant attacks. In terms of HEC, agricultural damage was the most common damage in the study area. The study found that among the crops, paddy had more damage when compared to other crops. Shouting and the use of fire were the most regularly adopted mitigation techniques in the study area, although people were dissatisfied with the current conflict management strategies due to their ineffectiveness.

Dhungana *et al.* (2018) studied human-tiger conflict in the Chitwan National Park, Nepal. According to the study, the buffer zone had a greater proportion of human casualties.

2.1.2. Studies from India

Venkataraman *et al.* (2005) studied the use of satellite telemetry to reduce human-elephant conflict in West Bengal, India. On the elephant, a platform transmitter was put in place to give the animal's location. This allowed researchers to examine animal activity and predict conflict, which serves as an early warning system.

Devi and Saikia (2008) studied crop damage by Rhesus macaque at the Guwahati college campus in Assam. They have assessed the population and conflict in the study area. They also evaluated the extent of the damage and reasons for conflict using the survey and existing data. They found that improper waste management was the main reason for the damage by the monkeys in the college campus.

Ogra and Badola (2008) had done a questionnaire survey in Uttarakhand on Human-wildlife compensation. They reported the space for improvement in terms of communicating compensation programs. The study clearly showed that villagers perceive HWC to be a major problem but the study could not clearly find actual crop loss. Despite the fact that HWC was a big issue in village 7, participation in the compensation scheme was unexpectedly low according to the study. The study found that lack of information, social status, gender, and poverty all are the barriers which made the local people not to participate in various compensation programs. Kumara and Diandra (2018) studied human-macaque conflict in the Shivamoga district of Karnataka. They quantified the impact of the man-monkey conflict in the region. They assessed the causative factors and observed mitigation measures practiced by people to minimize the conflicts such as the use of dogs, which is the most widely used measure (90.47 per cent). And nearly every home, there was at least one dog. All respondents set up nets or fencing (85.71 percent) and/or Ixobrycon fences (66.66 per cent), which serve the dual purpose of keeping animals away and also as a boundary. Other techniques of chasing monkeys away include throwing stones and making loud noises. Guns are the least popular method used, with only 19.04 per cent of respondents owning one.

Das and Mandal (2015) conducted a study on man monkey conflict in Tripura, North East India. The study mainly focused on the population estimation of Rhesus macaque. The data regarding the conflict were evaluated through a questionnaire survey. Theft, garbage littering, aggressive threats, property damage, and biting were discovered to be major problems caused by monkey.

2.1.3. Studies from Kerala

Veeramani *et al.* (1996) studied human-wild animal conflict in Kerala during the year 1983-1993. The study revealed that the cattle lifting was mainly due to leopard (*Panthera pardus*) and wild dog (*Cuon alpinus*). And the human casualties were due to elephants. They reported compensation details for cattle lifting. The compensation reports found that Wayand district registered the highest number of

cattle lifting cases. And the lowest number was claimed by Mannarkkad and Idukki divisions. Among the different protection methods studied, solar fencing with energizers were seemed to be effective in reducing the conflict due to elephants.

Veeramani *et al.* (2004) investigated the socio-economic status of farmers and their interactions with wild animals in the Marayur forest range in Kerala. Analysis of the socio-economic status of these people revealed that 77.78 per cent of individuals owned their property and agriculture was their primary source of income. According to the data taken from the respondents, paddy, plantains, vegetables, sugar canes were the crops which was highly raided by elephant, gaur, and wild boar. The study showed that the majority of Marayur's cultivators used a combination of guarding and regular fence as a means of protection.

Jayson (1999) studied wild animal damage in the crop lands of Idukki district of Kerala. The crop species, planting months, and wild animal's details were reported in the study. Elephant mitigation strategies such as guarding and solar fencing have been proven to be successful. In addition, washing soap was proven to be an effective short-term management technique against Sambar deer.

Govind and Jayson (2021) carried out a questionnaire survey to understand the human-wildlife interaction and to assess the attitude of the local people towards conservation in Kerala. The study found that most of the damage happened due to Wild pig (*Sus scrofa*). People's attitudes toward wildlife conservation were positive due to increased public knowledge and better understanding of the value of wildlife.

Rohini *et al.* (2016) studied human-elephant conflict in the Nilambur Forest division. The purpose of the study was to learn about people's attitudes regarding compensation programs, and the secondary data for the study was collected from the North and South Forest divisions of Nilambur. The study mainly focused on the type of conflict, and looked the animals involved in conflict, date of applications made by applicants, and also about the decisions made by the authorities. The study found that crop damage was the most common type of conflict and was mainly due

to elephants. And more than half of the people surveyed were not satisfied in compensations programs and suggested that they are not effective due to more time required to get the compensation money.

Greeshma and Jayson (2016) looked on the overall crop damage and the effects of human conflict in the Peechi- Vazhani wildlife sanctuary. Quadrat method, questionnaire survey were the methods used in the study. It was found that crop damage is caused by different factors, such as ineffective protection measures, increase in animal population, and cultivation of crops in the forest boundary.

Chelliah, *et al.* (2010) conducted a study on the use of chilli-based repellents on ropes to repel elephants. For three months, the effect of the ropes was evaluated. The study found that mixture of chilli and tobacco-based repellent was only effective in the area where the rainfall is less. The study also found that the elephants were afraid of the unfamiliar smell, and the rope functioned as a physical barrier. Altogether the outcome of the research was positive.

2.2. CHEMICAL WILDLIFE DETERRENTS

Baker *et al.* (2005) studied the efficacy of chemical deterrents used against European badger and also to test the hypothesis about the relative preference of baits chosen by the badger. The deterrents used for the study were capsaicin, cinnamamide and ziram and the observations were recorded with the help of video surveillance. The study found that the badgers precisely discriminated different deterrents and found that they feed the baits with no deterrents without any particular order. The study also found that the badgers developed conditioned taste aversion gradually.

Le Bel *et al.* (2010) conducted a study in Zimbabwe, to evaluate the preliminary results of two newly developed capsicum dispenser which were developed as a result of economic and social request for a reliable and low-cost repellent for wild elephants. A clay ball catapult and a ping-pong ball gas dispenser were designed and its efficacy was checked. The study found that the average

shooting range was 46 meters. Chilli oil extract was discharged on the selected animal in 54 per cent of the gunshots. Following the gunfire, 46 per cent of elephants ran, 29 per cent continued walking, and 25 per cent remained unchanged in their behaviour. The success of spreading chilli oil in the elephants' body was the factor which decided the success of the dispenser.

Osborn and Rasmussen (1995) conducted study on free ranging wild African elephants at two locations in Hwange National Park in Zimbabwe. The study period was between July 1993 and May 1994. The study was to evaluate the effectiveness of capsicum-based aerosol as an elephant repellent. Around 22 tests were conducted. In all the test, it was found that elephants were able to smell the testers. The study found that capsicum oleo-resin based repellent were cost effective but possess only short term repellence towards elephants.

Sreeja and Chellappan (2017) conducted a study on chemical deterrent Borep[®], an olfactory repellent and about the physical barriers during the period between 2013 - 2015. The field experiment was done at Palakkad, Kerala. In the month of June, 15 cm stem cuttings of Chinese potato var. local were planted on ridges (60cm/90cm width) at a spacing of 30 cm. In a randomized block design, physical barrier with nylon net, physical barrier with GI wire, physical barrier with nylon rope, olfactory repellent (Borep[®]) and unprotected or untreated plot, were the five different treatments done with four replications. The study found that comparing to other treatments, the olfactory repellent (Borep[®]) and physical barrier of nylon net was found to be most effective. And the year wise data of the yield of Chinese potato was increasing and found to be very effective. And similar trend of the increase in the yield was shown in the next years.

Dieter *et al.* (2014) conducted a study to evaluate the crop damage by Canada geese. The purpose of the study was to see whether there was a commercially available chemical that might be used to prevent geese from damaging soyabeans under the conditions observed in eastern South Dakota, Canada. The study also examined the effectiveness of chosen primary and secondary chemical deterrents

and make preliminary management suggestions on the viability of using chemical deterrents. They tested the effectiveness of grazing deterrents such as Rejex-It, Migrate Turfguard, Bird Shield, Avian Control, and Avipel between 2011 and 2012. For application of deterrents into field, they used ground sprayer for seven days in soya bean field. The activity was monitored using time lapse photography. The study found that Rejex-It, Bird Shield, and Avian Control, all methyl anthranilate products, proved ineffective in minimizing crop damage but Avipel-treated plots had reduced soybean damage and more economical to the plots and found to be more effective.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

3.1. STUDY AREA

The study was conducted in Wayanad district of Kerala India, which is located on the Western Ghats, with heights ranging from 700 to 2,100 meters. Wayanad is surrounded by the Karnataka districts of Kodagu and Mysore, and Tamil Nadu district of Nilgiris. The name Wayanad is derived from the name “Vayalnadu” which means the land of paddy fields. Agriculture is the district's main source of revenue apart from tourism. Paddy is the most frequent crop, and it is grown in the swamps in the district. Crops like ragi and chama were grown on the dry elevated land. These were frequently cultivated on a shifting system. The other majority crops grown are coffee, tea, cardamom, pepper, cocoa, plantain, ginger, vanilla, rice etc.

Being located on Western Ghats and with rich vegetation, Wayanad host a great diversity of wild animals. Thus, human and wildlife shares the area which often result in HWC.

3.2. HUMAN-WILDLIFE CONFLICT (HWC) IN WAYANAD

Wayanad is one among the district of Kerala where HWC has increased considerably. Due to the unscientific land use patterns, and unplanned developmental activities, this mountain ranges which is rich in biodiversity has diminished, resulting in habitat loss and fragmentation. As a result, the natural habitat of the wild animals is been reducing and further it leads to the man animal conflict. The various studies found that Thirunelli, the most vulnerable panchayath in the Waynad district, had a serious HWC (Sumitha and Shaharban 2022). Due to the HWC in the district, the chance of spreading zoonotic disease is very high.

Kyasanur Forest Disease (KFD) is a tick- borne haemorrhagic disease which is a serious disease that has been spreading in a very great extent. And the KFD disease has been first reported from Karnataka which is adjacent to Wayanad

district, and the majority of the people of Wayanad districts lives in the fringes of protected areas where the chance of spreading disease is very high (Sadanandane *et al.*, 2017). A population of more than 25,000 people live in and around the forest which can leads to a severe HWC.

3.3. SITE SELECTION

The present study was conducted in the Olivumala (11.55246°N, 76.05477°E) in Vythiri (11.5517°N, 76.0403°E) panchayath, of Wayanad (11.6854°N, 76.1320°E) district, where the crop raiding was severe. The study area was selected based on the discussion with elected panchayat representatives and local residents.

3.3.1. Major Crop in Selected Sites

The major crops grown in the selected sites includes, coffee, cardamom, pepper, and areca palm. These crops are been grown commonly by the farmers in the selected areas. There are plantations, which are adjacent to the selected sites. And the major crop grown as plantation incudes, tea and cardamom. Crop raiding by the wild animals were frequently been observed in the selected sites. And it was found that the elephants attacks in the crops were commonly been observed during the rainy seasons.

Three sites were selected in Olivumala for the study; Plot 1 (N-11.55530 E-076.05400), Plot 2 (N-11.55246 E-076.05477) and Plot 3 (N-11.55449 E-076.05530) to test the efficiency of chemical deterrents.

3.4. CHEMICAL DETERRENTS USED

3.4.1. Herboliv[®]

HERBOLIV[®] is a bio liquid with various herbal extract and other organic product which gives an odour to the crops when sprayed and makes the crop non-palatable for wild animals which is mainly used against deer. Herboilv[®], is suitable

for a wide range of crops which includes vegetables, fruits, flowers, coffee, tea, and other spice crops. Herboliv[®] was also suggested to increase crop productivity.

3.4.2. Borep[®]

BOREP[®] is an olfactory repellent which is mainly used to deter wild boar (*Sus scrofa*). Borep[®] is an organic deterrent, which has a pungent smell. And this helps in deterring the wild animals which enters into the field. This organic based repellent is in powdered form and were tied in cotton balls along the fences.

3.5. METHODOLOGY

Camera trap (CAMPPARK TRAIL CAMERA, 120⁰, detecting range motion and activated night vision, 2.4" LCD 42pcs) was placed in each plot from 10-12-2021 to 11-01-2022 prior to the application of the deterrents and evaluated the presence of wild animals.

The camera trap was placed in the field from 5 PM in the evening and were taken back at 8 AM next day morning. This was done daily to understand the species of wild animal that utilize the plots during the night and to understand that peak activity time of the wild animals. The camera traps were not placed during the morning hours because the study plots were having the presence of farmers throughout the day for their work. Hence the chance of animal entry into the field was very scarce in all the three plots. In order to confirm the animal presence in the field before the deterrent application, the three selected plots were daily ploughed and levelled in order to get the foot prints of the animals which are entering into the field.

3.5.1. Application of Deterrents

After the evaluation of the camera trap study, both the deterrents Herboliv[®] and Borep[®] was applied in all the three plots. For the application of both the deterrents, one acre was further divided into two halves of 50 cents each. The

application of the both the deterrents was done for 5 days from 15-01-2022 to 20-01-2022 in all the 3 plots respectively.

For the application of Borep[®], 10 gm of Borep[®] powder was wrapped in cotton cloths and tied to the fences in boundaries with 1-meter gap from each ball and 50 cm height from the ground.

The Herboliv[®] was mixed with water and are sprayed on the crops with the help of knapsack sprayer of 20-liter capacity operated with the help of battery.

For 1 acre of land around 10 litre of Herboliv[®] was used. After the application of both the deterrents in the field, camera traps were again placed in the three plots to study the wild animal movement and efficiency of deterrents.

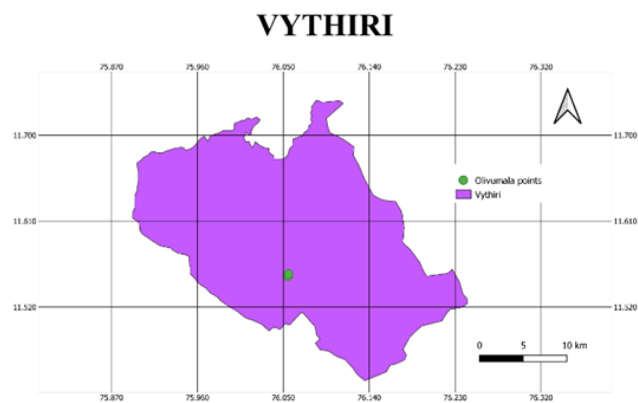
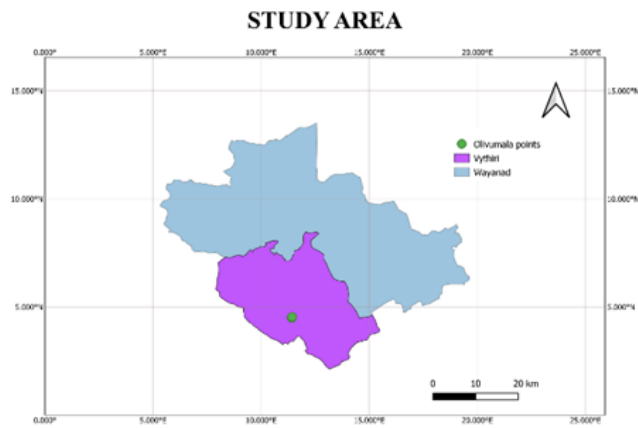
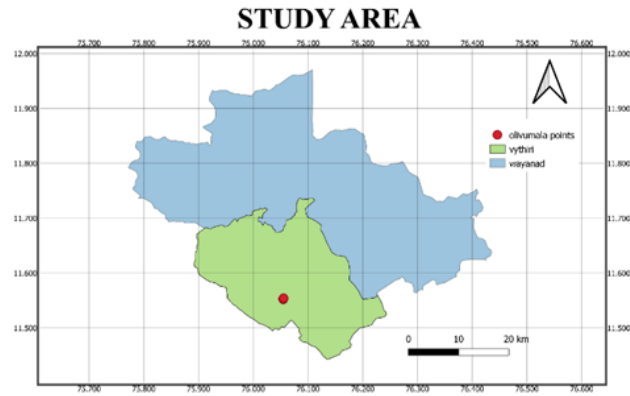


Plate 1. Location and map of study area (A & B) Selected study areas. (C) Selected study plots at Olivumala.



A



B



C



D



E



F

Plate 2. Preparation of study area (A) Consulting with local residents and elected representatives for selection of study area. (B) Installation of camera trap. (C) Herboliv[®] (D) Borep[®] (E & F) Clearing plots for observing animal movement.



A



B



C



D



E



F

Plate 3. Application of deterrents (A &B) Borep[®] powder wrapped in cotton cloth (C &D) Dilution of Herboliv[®] with water (E &F) Herboliv[®] spraying using knapsack sprayer.

RESULTS

4. RESULTS

4.1. CAMERA TRAP IMAGES

Camera trap images revealed sambar deer to be the most frequent animal to use the study area (N=7) followed by civet (N=4), wild boar (2), porcupine (1) and barking deer (1). We also found domestic animals such as dogs (3) and cats (2) in the study area.

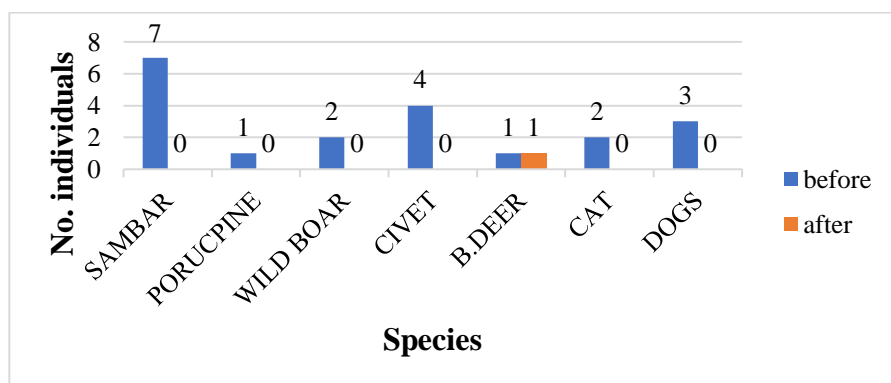


Figure 1. Species abundance and diversity observed through camera trap.

4.2. PRESENCE OF ANIMALS AFTER USAGE OF CHEMICAL DETERRENTS

No animals used the study area immediately after the usage of chemical deterrents. But we recorded an individual barking deer on 12th day and pellets of sambar deer on 17th day after using deterrents.

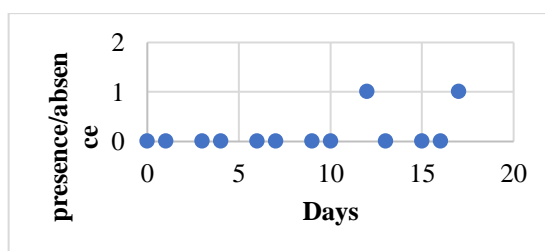


Figure 2. Scatter plot showing the presence of animals in the study area after the application of deterrents.

4.3. ACTIVITY PATTERNS OF ANIMALS

Activity of animals in the study were more frequently observed during the time 12:00 AM to 01:00 AM. Temporal partitioning was found among species.

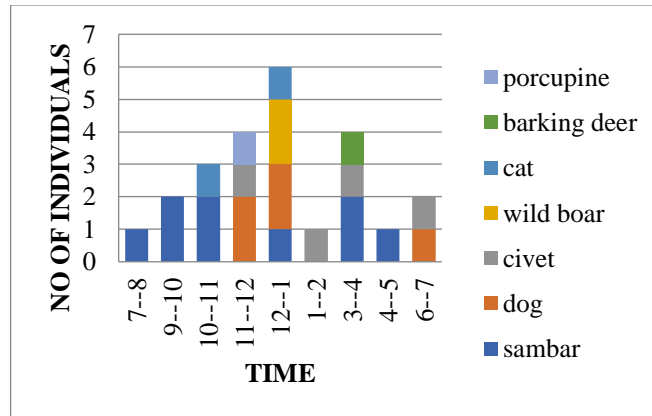


Figure 3. Activity pattern of animals in the study area.

4.4. EFFECTIVENESS OF CHEMICAL DETERRENTS

Usage of chemical deterrents was found to be effective in preventing animal movement in the study area. The animal movement was found to be significantly low after the usage of Borep[®] and Herboliv[®] ($X^2=20.96$, $df=1$, $p<0.005$).

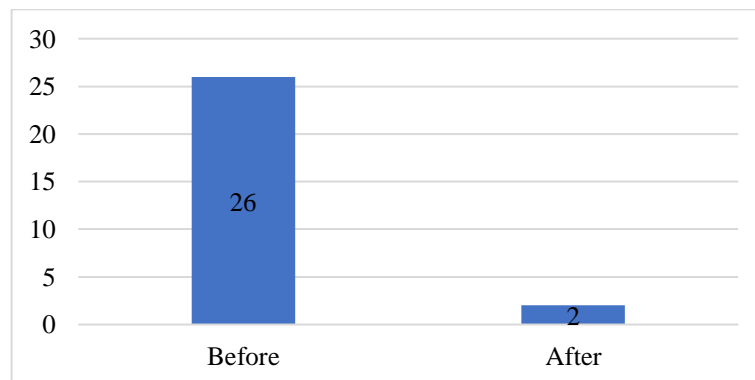


Figure 4. Presence of animals in the study area before and after the application of deterrents.



Plate 4. Camera trap images of animals entering the study area.

DISCUSSION

5. DISCUSSION

The main objective of the study was to find out the efficacy of the two deterrents Herboliv[®] and Borep[®], which are commercially available and are used against the wild animals which attack farm crops. This study looked at the long-term efficacy of the organic items that contained various natural ingredients that helps in reducing the crop-raiding by wild animals. When compared to untreated land previous to the trial, the two selected deterrents Herboliv[®] and Borep[®] showed good damage control by lowering browsing damage by wild animals. Chi index analysis was used to measure the overall efficacy of the deterrents. The study found that both the deterrents were very much effective in controlling the wild animal movement through the study plots.

The repellents are being used to keep predators away from a specific location or object (Oppel, *et al.*, 2011). Plant secondary metabolites and naturally irritating or unpleasant scents can therefore be used as repellents. Essential oils and terpenes (e.g. pulegone, capsaicin, piperine), acetophenones and methyl nonyl ketone, are all potential plant-derived repellents. Predator scents from urine, body, and hair, as well as warning pheromones and specialized glandular secretions, are all chemical repellents. While these odours can trigger defensive responses, smells from known predators have not been proven to be effective repellents in the field. Usage of chemical deterrents was found to be effective in preventing animal movement in the study area. The animal movement was found to be significantly low after the usage of Borep[®] and Herboliv[®]. The data showed a significant reduction in the number of animals which were entering into the plots after the application of the two deterrents.

During the study, around 26 number of camera trap images were found from all the three plots before the deterrents were applied. And this included wild and domestic animals. Sambar deer, barking deer, porcupine, wild boar and civet were the wild animals found in the camera trap. The domestic animals found in the camera trap included dogs and cat. After the application of the deterrents Herboliv[®]

and Borep[®], only two individual animals were found in camera trap. This clearly indicates that the two deterrents were very effective in preventing the wild animal entry into the field. This is mainly because both the deterrents were having smell and taste aversion which made the wild animals to not choose the plots.

Similar to the Herboliv[®], it was found that Borep[®] was very good in preventing the wild animal entry into the field and this was due to the pungent odour produced from the Borep[®] after this was placed. A previous study on Borep[®] had also proved its efficiency against wild boar attack in the field (Sreeja and Chellappan, 2017). The natural repellent "trump guard" is an excellent way to keep wild pigs from attacking the crops, as repellent's unique odour deterred wild pigs away from the crop field, and it was found that applying the repellent to the field twice a week was critical to keep it active against crop raiders (Jayson, 2016).

Non-lethal animal control techniques often have environmental, ethical, legal, and economic benefits over lethal wildlife control (Baker *et al.*, 2005). And these non-lethal deterrents found to be more efficient alternatives than culling (Baker and Macdonald, 1999). In this study also, the result was positive and suggest that it is more efficient and more alternative than any other lethal method.

Camera traps are an important technique for determining the presence of elusive animals and helps in verifying the presence of a species. This method is hence one of the widely used methods to identify the animals during the study. In all the other sampling methods there is chance of having errors and the species can be missed during the sampling period. But, method of camera trap helps to identify the species in a precise way (Sollmann, 2018). Camera trap images found, Sambar deer to be the most frequent animal to use the study area prior to the application of the deterrents. Around 7 camera trap images of Sambar deer were found in the study, followed by 4 camera trap images of civet, 2 images of wild boar and 1 porcupine. The study also found that barking deer was the animal which was found in the camera traps prior to the deterrent's application, and also after the application of deterrents. Domestic animals were also found in the camera trap images, which

included 2 domestic cats and 3 domestic dogs and this was due to human habitations near the study plots. It was found that mostly, the peak activity of the Sambar deer, was during the dawn and dusk. The civet was found to be more active during the early morning time. The study plots were under the foothills of Chembra Peak, which results in high movement of wild animals through the human settlements.

The people living in the study area also responded that the elephant movement was very high throughout their farm lands. They also responded that the peak elephant movement was during the rainy season. This is mainly due to the availability of jack fruits and other seasonal fruits which are easily available in the farm lands.

One of the most effective techniques for minimizing wild animal damage to agricultural crops is chemical repellence (Coker *et al.*, 2001). The study found that after the application of the deterrents the wild animal entry was very much reduced. And shows that both the deterrents were found to be very effective in preventing the animal entry into the field. The study showed that the efficacy of the deterrent, Herboliv[®] was reduced with the time. This is because, for the deterrent Herboliv[®] a super dose has to be applied after the first week. If this was not done, the effectiveness of the first dose of Herboliv[®] get reduced. In this study, we also observed that after the application of the deterrent Herboliv[®], its odour was reduced from the field which resulted in animal entry. We recorded an individual barking deer in the study plot on the 12th day after the deterrents were applied. We also found the pellets of Sambar deer in another plot on the 17th day after the deterrents were applied. This clearly indicates that the effectiveness of both the deterrents gets reduced with time and the animal presence was seen again in the plots.

In this study, the camera trap images show that the animals had temporal partitioning among them. Camera traps often record the date and time of each image, providing far more precise analysis of activity patterns than physical traps used for small animals, which are only examined occasionally and typically pinpoint activity only within a few hours (Rychlik, 2005). The capture timings of

camera traps are frequently reported by dividing them into hourly, two-hourly, or occasionally irregular intervals (Jacomo *et al.*, 2004).

From these camera trap data, the peak activity of wild animals was observed during the midnight hours, especially from 12 AM to 01 AM. This peak activity of animals can be due to the low human persecution and nocturnal behaviour shown (Ogurtsov *et al.*, 2018). Another reason for the animal peak activity was, that there was no watch and ward guarding by the farmers during the night period.

Again, it was found that the Sambar deer had the highest number of visits in the study plots during the early evenings and also during the midnight periods. In all the 3 plots, Sambar deer had the highest number of visits during the period from 07 PM to 11 PM. And on some days, the Sambar deer was also found during the midnight period, between 12 AM to 01 AM and wild boar was found during the same period. The sambar deer was also seen during the early morning periods between 03 AM to 05 AM. The other individual species found in the early morning period was the civet. They were mostly caught in the camera trap during the period between 06 AM to 07 AM. The porcupine was seen during the period between 11 PM to 12 AM. Activity time for barking deer was 03 AM to 04 AM.

The study also collected the public opinion on the cost of deterrents and cost of solar fencing. The farmers who had done solar fencing in their field against the wild animals, suggested that the solar fencing was very effective for preventing human animal conflict. They also mentioned that, there was no crop raiding by the wild animals after the installation of the solar fencing. The drawback of solar fencing is its high initial installation cost and maintenance expenses. Especially in the rainy season, the solar cables are damaged by tree or branch falling due to wind. It was found that an approximate amount of 1,02,000₹/acre was needed for the installation of 3-line solar fencing while a 5-line solar fencing an approximate amount of 1,12,000₹/acre.

The deterrent Borep[®] costs around 100₹ per kilogram and around 2 kg of Borep[®] is needed for one acre of land. Borep[®] was found to be very effective against the wild animal's attacks, especially against wild boar (Sreeja and Chellapan, 2017). The study found that an approximate amount of 1200₹ per acre was needed annually for Borep[®]. Herboliv[®] cost around 115₹ per litre and around 10 litres of Herbloiv[®] is required for 1 acre of land. The study found that an approximate amount of 30,577₹ is needed annually for the treatment with Herboliv[®]. Due to its organic extract and other plant-based ingredients, Herboliv[®] was found to have fewer or no side effects and is claimed to improve the crop's production. Ants were feeding in the left-over packets of Borep[®] and even presence of weaver ants (*Oecophylla*) were found all over the areas where the Borep[®] was tied in cotton balls. This could be due to the presence of various organic ingredients present in Borep[®].

The study found that the Borep[®] was very cost-effective when compared to Herbloiv[®] for short term preventions. The effectiveness of Herboliv[®] lasts only for a week and hence a booster dose has to be applied in the same field for better results. The effectiveness of Borep[®] lasts for one month. And there were no animals found in the plots treated with Borep[®]. And during the study, the cost of two deterrents were compared with the cost of solar fencing method. This showed that, when looking into long term mitigation management, solar fencing method was more cost effective.

SUMMARY

6. SUMMARY

HWC has a long history, dating back to the beginnings of civilization. Today, it is a major concern across the world, and the problem is worsening as a result of the out-of-control behaviour of humans and wildlife. Wildlife damage to crops has emerged as a new challenge to crop production throughout the world. India is especially vulnerable to this issue due to the rich diversity of animals and increasing human population. Although the public perception is that, the severity of HWC has increased over the last few decades. The interactions between animals and humans are known from the time of human existence which can be positive or negative. And when the interactions are negative, it leads to conflict. Nowadays the human-animal conflict is increasing tremendously due to unscientific land use patterns and unplanned crop management. This HWC negatively affects both the humans as well as the wild animals.

Kerala is one among the places where the human wildlife conflict is severe and shows an increasing trend. Extensive crop damage studies conducted across Kerala showed that wild animals destroyed forty-five varieties of crops, with elephants causing the most damage in the cultivating areas, and the HWC is increasing in all the parts of the state. Wayanad is one among the districts of Kerala located in the northern part where the HWC is severe. This is mainly because of the larger population of wildlife in the region. In addition, the most of the people lives in the forest fringes and the chance of human wildlife interactions are very high.

In order to mitigate the HWC, different measures are used. And this mitigation measures include both lethal and non-lethal methods which are used by the farmers to keep away the crop raiding wild animals. Some of them include the use of dogs, bright coloured cloths as fence, usage of solar fencing, crackers, watch and ward etc.

Nowadays the use of chemical deterrents is commonly seen to prevent wild animals' entry into the field. This study mainly focused to evaluate the efficacy of

two chemical deterrent's Herboliv[®] and Borep[®], which are commercially available in the market. The entry of wild animals into the field was studied using the camera trap. The peak time of activity of the wild animals was recorded. The camera trap data was analysed and interpreted to understand the number of wild animals which were entering in the field. And after the camera trap study, the two selected deterrents were applied in the selected plots. In the study it was found that, both the deterrents were effective in controlling the wild animal entry. The study showed that after the application of the deterrents Herboliv[®] and Borep[®], the wild animal's entry into the field was minimized and suggest that both the deterrents are effective in controlling the wild animals.

The cost of both deterrents and the other common mitigation measures used by the farmers in the field were compared. Borep[®] was more cost effective and last for longer period of time whereas the deterrent Herboliv[®] needs a booster dose for better result.

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**EVALUATION OF THE EFFICACY OF TWO DETERRENTS
(HERBOLIV® AND BOREP®) AGAINST CROP RAIDING
WILD ANIMALS**

**ATHUL U K.
(19-MSVP-13)**

DISSERTATION

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF SCIENCE

(Wildlife Studies)

2022

**Faculty of Veterinary and Animal Sciences
Kerala Veterinary and Animal Sciences University**



**KVASU CENTRE FOR WILDLIFE STUDIES
KERALA VETERINARY AND ANIMAL SCIENCES UNIVERSITY
POOKODE, WAYANAD 673576
KERALA, INDIA**

8. ABSTRACT

The study evaluated the efficacy of wild animal deterrents (Herboliv[®], Borep[®]) which are olfactory repellents available in the market. Borep[®] is an olfactory repellent which is mainly used to deter wild boar (*Sus scrofa*). Herboliv[®] is a bio liquid with various herbal extract and other organic product which gives an odour to the crops when sprayed and makes the crop non-palatable for wild animals and is mainly used against deer.

The study was undertaken in the selected areas in Vythiri panchayath, of Wayand district, where the crop raiding by wild animals are regular. The study area was selected after conducting a pilot survey and based on the information collected from the elected panchayath representatives. Three plots were selected for the study. All the three selected plots were having same crops grown and the major crops in the three plots included coffee and areca palm. Prior to the deterrent application in the plots, camera trap was used to monitor the wild animal entry into the field. This was also done to understand that activity pattern of the animals in the plots. It was found that the Sambar deer had the highest number of visits in the plots. It was also found that the peak activity of the wild animals in the field was during the late midnight hours. After the camera trap study in all the respective plots, the deterrents Herboliv[®] and Borep[®] were applied. And again, the camera trap was placed in the three plots to know the efficacy of the two deterrents. It was found that the number of wild animal entry into the three plots was reduced to a significant level.

The study also evaluated the cost of the deterrents and found that the deterrent Borep[®] was more cost effective when compared to Herboliv[®]. This was because for the deterrent Herboliv[®], a super dose should to be done in the field for better results.

KERALA VETERINARY AND ANIMAL SCIENCE UNIVERSITY
Faculty of Veterinary and Animal Sciences
PROGRAMME OF RESEARCH WORK FOR DISSERTATION FOR
MASTER OF SCIENCE DEGREE

1. Title of dissertation: Evaluation of the efficacy of two deterrents (Herboliv[®] and Borep[®]) against crop raiding wild animals

2. a) Title of the department /KVASU research:
NIL
b) Project of which this forms a part:
NIL
c) Code No. if any, and order by which the departmental/KVASU research project is approved:
NIL

3. a) Name of student: ATHUL U. K.
b) Admission No: 19-MSVP-13
c) Name of the programme: Master of Science (Wildlife Studies)

4. a) Name of Guide: Dr. George Chandy
b) Address: Special Officer
Centre for Wildlife Studies
Kerala Veterinary and Animal Sciences University
Pookode, Wayanad - 673576

5. Objectives of the study:
To evaluate the efficacy of two deterrents (HERBOLIV[®] and BOREP[®]) against crop raiding wild animals.

6. Practical /Scientific utility:
Human-wildlife conflict (HWC) has a long history, dating back to the beginnings of civilization, yet it causes a severe threat to human civilization at

present. Asia is especially vulnerable to this issue. The public perception is that the severity of HWC has increased over the last few decades (Anand *et al.*, 2017).

HWC occurs when the demands of wildlife and human populations collide, resulting in costs to both humans and wild animals. Human-wildlife conflict is a major concern across the world, and the problem is worsening as a result of both humans and wildlife's out-of-control behaviour (Jayson, 2016).

Due to the development of civilization, more species have become extinct. The destruction of animal habitats for the expansion of urban areas, the construction of roads, trains, and dams, as well as agricultural and industrial operations, has resulted in the diminishing of wildlife population (Das and Guha, 2003).

Wildlife damage to crops has emerged as a new challenge to crop production throughout the world (Madhusudan, 2003). Crop damage studies across Kerala showed that wild animals destroyed forty-five varieties of crops, with elephants causing the most damage (Veeramani *et al.*, 1995; Jayson, 1999).

One of the most selective techniques to minimizing wild animal damage to agricultural crops is the use of chemical repellents. Several repellent combinations have been created and tested to see how effective they are. Popular organic repellents like Big Game Repellent (BGR) and Deer Away contain putrescent egg-based ingredients. Other chemical repellents include garlic and putrescent egg-based compounds, which have been shown to reduce white-tailed deer grazing damage to ornamental plants typically used in landscapes in the south eastern United States under controlled conditions (Coker *et al.*, 2001). Repellents can cause anxiety or fearful behavioural responses. Anxiety is a state of persistent fear of impending danger, which is more likely to be triggered by indirect cues (Grillon, 2008). In animals, separate

neurochemical mechanisms regulate anxiety and terror and this how the chemical repellents work (Tovote *et al.*, 2015). Repellents have the benefits of simple stimulus response pathways, ease of application, and environmental friendliness (Sayre *et al.*, 2001).

The study mainly focuses to evaluate the efficacy of wild animal deterrents (HERBOLIV[®], BOREP[®]) which are olfactory repellents. BOREP[®] is an olfactory repellent which is mainly used to deter wild boar (*Sus scrofa*). HERBOLIV[®] is a bio liquid with various herbal extract and other organic product which gives an odour to the crops when sprayed and makes the crop non-palatable for wild animals which is mainly used against deer.

7. Important publications on which the study is based:

Newmark *et al.* (1994) reported human-animal conflict in the Lake Manyara, and Mikumi National Parks, as well as in Selous Game Reserve, in Tanzania. Over 71 per cent of the public in the area said that they had issues with animals. More problems by the wild animals were reported by the people living adjacent to the protected areas. Most significantly, in places with low human populations, large animals were more problematic, whereas at high human densities, small animals were also problematic.

Manfredo and Dayer (2004) reported that the personal and cultural level components provide the fundamental knowledge of the intellectual, social, and biological impacts of human-wildlife conflict.

Devi and Saikia (2008) studied crop damage by Rhesus macaque at the Guwahati college campus in Assam. They have assessed the population and conflict in the study area. They also evaluated the extent of the damage and reasons for conflict using the survey and existing data. They found that

improper waste management was the main reason for the damage by the monkeys in the college campus.

Veeramani *et al.* (1996) studied human-wild animal conflict in Kerala during the year 1983-1993. The study revealed that the cattle lifting was mainly due to leopard (*Panthera pardus*) and wild dog (*Cuon alpinus*). And the human casualties were due to elephants. They reported compensation details for cattle lifting. The compensation reports found that Wayand district registered the greatest number of cattle lifting cases. And the lowest amount was claimed by Mannarkkad and Idukki divisions. Among the different protection methods studied, solar fencing with energizers were seemed to be effective in reducing the conflict due to elephants.

Jayson (1999) studied wild animal damage in the crop lands in the Idukki district of Kerala. The crop species, planting months, and wild animal's details were reported in the study. Elephant mitigation strategies such as guarding and solar fencing have been proven to be successful. In addition to that washing soap was proven to be an effective short-term management technique against Sambar deer.

8. Outline of the technical programme:

The study will be conducted in Wayanad district of Kerala India, which located on the Western Ghats, with heights ranging from 700 to 2,100 meters. Wayanad is surrounded by the Karnataka districts of Kodagu and Mysore, and Tamil Nadu district of Nilgiris. The name Wayanad is derived from the name "Vayalnadu" which means the land of paddy fields. Agriculture is the district's main source of revenue apart from tourism. Paddy is the most frequent crop, and it was grown in the swamps in the district. Crops like ragi and chama were grown on the dry elevated land. These were frequently cultivated on a shifting

system. The other majority crops grown are coffee, tea, cardamom, pepper, cocoa, plantain, ginger, vanilla, rice etc.

Being located on Western Ghats and with rich vegetation, Wayanad host a great diversity of wild animals. Thus, human and wildlife shares the area which often result in Human- Wildlife Conflicts.

Camera trap will be placed in each plot prior to the application of the deterrents and evaluated the presence of wild animals. The camera trap will be placed in the field from 05 PM in the evening and will be taken back at 08 AM next day morning. This is done daily to understand the species of wild animal that utilize the plots during the night and to understand that peak activity time of the wild animals. The camera traps will not be placed during the morning hours because the study plots were having the presence of farmers throughout the day for their work. Hence the chance of animal entry into the field was very much restricted in all the three plots. In order to confirm the animal presence in the field before the deterrent application, the three selected plots will be daily ploughed and levelled in order to get the foot prints of the animals which are entering into the field.

After the evaluation of the camera trap study, both the deterrents Herboliv[®] and Borep[®] will be applied in all the three plots. For the application of both the deterrents, one acre will be further divided into two halves of 50 cents each.

After the application of both the deterrents in the field, camera traps will be again placed in the three plots to study the wild animal movement and efficiency of deterrents.

9. Main items of observations to be made:

1. Frequency of animal entry before and after the application of deterrents determined by camera trap images and pug marks.

10. Duration of research work:

One Semester

Signature of the Student

Project coordination group proposed: NIL

Place:

Date:

Signature of Guide

Name, address and signature of members of the Advisory committee

1. Dr. Biju S.

Assistant Professor

Department Livestock Production Management

College of Veterinary and Animal Sciences, Mannuthy

Kerala Veterinary and Animal Sciences University

Pookode, Wayanad – 673576

2. Dr. George Chandy

Special Officer

Centre for Wildlife Studies

Kerala Veterinary and Animal Sciences University

Pookode, Wayanad - 673576

11. References:

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Veeramani, A., Jayson, E. A., and Easa, P. S. 1996. Man-wildlife conflict: cattle lifting and human casualties in Kerala. *Indian Forester*. **122** (10): 897-902

CERTIFICATE

Certified that the research project has been formulated observing the stipulations laid down under the Prevention of Cruelty to Animals Act (Amendment, 1998).

Place: Pookode

Date:

Dr. George Chandy

(Major Advisor)

CURRICULUM VITAE

1. Name of the candidate : Athul U. K.
2. Date of Birth : 15-01-1996
3. Place of Birth : Kalpetta, Wayanad
4. Marital Status : Unmarried
5. Permanent Address : Modeth (H), Mele Arrapetta,
Meppadi (P.O.), Wayanad- 673577

6. Major field of Specialization : Wildlife Studies
7. Educational Status : Master of Science
8. Professional Experience : NIL
9. Publications Made : NIL
10. Membership in Professional Societies : NIL