

ASSESSMENT OF CROP RAIDING BY WILD BOAR (*Sus scrofa*) IN DHORPATAN HUNTING RESERVE, NEPAL



Entry 92

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DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

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This is to recommend that the thesis entitled "**Assessment of crop raiding by Wild Boar (*Sus scrofa*) in Dhorpatan Hunting Reserve, Nepal**" has been carried out by Ms. Yamuna Gharti Magar for the partial fulfillment Master's Degree of Science in Zoology with special paper Ecology and Environment. This is her original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institutions.

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CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Yamuna Gharti Magar entitled "Assessment of crop raiding by Wild Boar (*Sus scrofa*) in Dhorpatan Hunting Reserve, Nepal" has been accepted as a partial fulfillment for the requirement of Master's Degree of Science in Zoology with special paper Ecology and Environment.

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LIST OF ABBREVIATIONS

Abbreviated form	Details of Abbreviations
CNP	Chitwan National Park
DHR	Dhorpatan Hunting Reserve
HWC	Human wildlife conflict
KTWR	Koshi Tappu Wildlife Reserve
SNNP	Shivapuri Nagarjun National Park
ShNP	Suklaphanta National Park
PAs	Protected Areas

Abstract

Human-wildlife conflict arises when human and wildlife species come under the same niche leading to competition for available natural resources. The conflict increases particularly near the protected areas. The conflict between human and wildlife is closely linked to the economics, social welfare and resource availability. This study envisaged to access the crop damage by Wild Boar (*Sus scrofa*) and its effects on the livelihood of local people in Dhorpatan Hunting Reserve (DHR). Direct field measurements on the damaged area from Wild Boar, a questionnaire survey to the local people and key informant interviews were used for data collection during August 9 to September 9, 2022. A total 268 households were selected for questionnaire survey. Wild Boar was the major crop raider, and Potato (*Solanum tuberosum*) was the major crop loss. The yearly loss is 8.59% (98568.38 kg) of Potato and 5.75% (4110.62 kg) of Oat (*Avena sativa*) of total production. Total average annual economic loss in DHR was NRs. 62113.39 (USD 472.27) per household including Potato and Oat. Majority of local people had negative attitude towards wildlife conservation. Commonly shouting, scaring by biting tin boxes, guarding and releasing dog, stone wall and wooden bar were the main preventive measures applied by local people in DHR, which are not effective. So, this study suggest that to minimize the crop loss form Wild Boar, adapting alternative crop like hot pepper, using repellents (chemical sprays and natural deterrents), regulate hunting and proper relief funds might be helpful.

1. INTRODUCTION

1.1. Background

Globally, conflict between the human and wildlife is a serious issue that has been getting worse over the recent decade, which is one of the biggest threats to wildlife (Bharathy et al. 2022). This conflict has emerged as one of the major challenges currently faced by the biodiversity conservationists (Konig et al. 2020). Due to increasing human population and peoples encroach towards the protected lands creating the pressure on wildlife population (Barua et al. 2013). When wildlife and human compete for food and space they frequent interact, which increases the conflict around the protected area (Siljander et al. 2020). Generally, conservation of wildlife in human-dominated landscapes faces difficulties as conflict between human and wildlife increases (Baral et al. 2022). These conflicts have adverse effects on both human and wildlife (Bista and Song 2021). Conflicts can causes significant economic losses for related rural households, such as crop raiding, forest damage, property damage, vehicle collisions, harming native vertebrates, and spread of zoonotic diseases (Brown et al. 2018, Su et al. 2020, Wang et al. 2020, McDonough et al. 2022). These economic losses can have severe impacts on people's livelihoods, particularly for those who heavily rely on farming or forestry and this can worsen poverty and food shortages (Wang et al. 2023).

Worldwidely, certain mammals such as Asian Elephants (*Elephas maximus*), Wild Boars (*Sus scrofa*), Nilgai (*Boselaphus tragocamelus*), Rhesus Monkeys (*Macaca mulatta*), Rein deer (*Rangifer tarandus*) are considered significant threats to agricultural crops and human (Bargavi et al. 2022). Among them, Wild Boar is widely known for crop damage due to their vast distributional range and adaptability to various habitats (Barrios-Garcia and Ballari 2012, Jhala et al. 2020). In Nepal, Wild Boar is the primary conflict animals around the protected parks (Pandey et al. 2016, Sapkota et al. 2014). While the population status of most wildlife species in Nepal remains uncertain, the Wild Boar appears to be increasing due to government protection (Rothley et al. 2004, Carter et al. 2012).

Wild Boars are highly destructive to crops, causing significant damages (Schley et al. 2008, Barrios-Garcia and Ballari 2012). Most conflict occurs near the park boundaries (Sijapati et al. 2021, Pant et al. 2023). Deforestation and the increase in monoculture

croplands are factors stimulating damage caused by Wild Boars (Lombardini et al. 2017). Moreover, the hunting bans in adjacent forests lead to more agricultural damaged (Fonseca 2008, Amici et al. 2012). In fragmented landscapes with small farms, such as rural Nepal, Wild Boar pose a significant problem due to their large foraging groups, opportunistic diets, crop trampling behavior (Schley and Roper 2003, Morelle and Lejeune 2015), and preference for forest edges (Pandey et al. 2016). The density of Wild Boar correlates with the extent of crop damaged (Piekarczyk et al. 2021, Bobek et al. 2017). Especially agricultural damaged by wild Boar has significant economic impact for individual farmers (Rutten et al. 2019).

The reduction in preferred habitats and hunting has caused the Wild Boar population to become fragmented, leading to local abundance and have forced them to depend upon crops (Ohashi et al. 2012). Globally, significant economic losses have resulted from Wild Boars, mainly through directly crop yields reduction and livestock disease transmission (Wang et al. 2023). Wild Boars can cause substantial damage to various agricultural crops, such as Paddy (*Oryza sativa*), Potato (*Solanum tuberosum*), Wheat (*Triticum aestivum*), Maize (*Zea mays*), Oats (*Avena sativa*), and Barley (*Hordeum vulgare*), fruits, such as Bananas (*Musa paradisiaca*), Watermelons (*Citrullus lanatus*) and Sugarcane (*Saccharum officinarum*) through consumption and trampling, to animal production by disease transmission (Brown et al. 2018, Bolds et al. 2022).

Wild Boars are attracted to crop fields due to the strong smell of crops (Sridhara 2006, Sing and Kumar 2018). They raid the crops more frequently during flowering and fruiting seasons, and continue until all crops are destroyed (Thapa 2010). In developing regions like African and Asian, where a large human population depends on agriculture (Khattak et al. 2022), Wild Boar crop raiding has led to the abandonment of farmland near wildlife habitats, forcing farmers to focus on growing non- susceptible crops (Hua et al. 2016, Acha et al. 2018). This shift and land abandonment has negative implications for national food security (Salerno et al. 2016, Xu et al. 2019).

To effectively address HWC, it is essential to understand the adverse effects of wild animals on human and vice-versa (Mekonen 2020). When human and wildlife coexist in the same ecosystem, it is impossible to prevent the wildlife damaged, however, when both land sharing and land sparing are equally emphasized in the management

of HWC, it can result in improved sustainability from ecological and economic perspectives (Dahal et al. 2022). In Nepal, most of the farmers using watchtowers with flaming stick and making noise, fencing and trenches for deter the wild animals (Dhakal and Thapa 2019). Nylon net, safflower as a border crop and sarees placed around the crop border proved to be most effective treatments in wild boar damaged (Mohan and Basavadarshan 2020). However traditional active crop guarding techniques are declining due to resource shortages and associated threats (Pandav et al. 2021). Many of the physical, chemical, traditional, biological, and sonic methods are innovated (Row et al. 2013) for the management of wild boar in which they are inaccessible to economically disadvantaged farmers (Pandav et al. 2021). Certain plants with strong odor-producing compounds can deter vertebrates including Wild Boar (Rao et al. 2019). Understanding the impact of certain agricultural practices like crop selection, fertilization, crop variety etc. on damage risk can help farmers in crop planning and implementing preventive measures (Rutten et al. 2019) leading to reduce human wildlife.

Offering compensation for wildlife induced damaged is a crucial approach to reduce HWC and enhances the community's level of tolerance (Subedi 2020). In Nepal, the compensation for crop damage has been set at NRs. 10,000, while NRs. 1,000,000 is allocated for human losses, but insufficient and lengthy compensation process, peoples are dissatisfied towards the government's rule (Timsina and Ranjitkar 2014). Due to inadequate communication between park management and community, HWC victim experienced financial burdens (Dahal et al. 2022). However, residents living near the PAs may develop a greater tolerance towards wildlife as a result of the benefits from ecotourism and community development program (Karanth and Nepal 2012).

The local community's involvement is crucial in conserving biodiversity, if local people have negative perception toward the wildlife due to conflict, it can complicate conservation efforts (Pokharel and Aryal 2020). Local support and cooperation are crucial in emerging economics for successful conservation efforts because communities often bear the burden of human-wildlife conflicts, and additionally, Wild Boar, besides causing crop damage can also foster a negative attitude towards wildlife among the public (Khattak et al. 2022). In Nepal's PAs have implemented different measures to meet the subsistence requirements of local communities such as buffer

zone programs, revenue sharing, and allowing limited collection of thatch grass within PAs (Heinen et al. 2019). Despite these efforts, long-term mitigation measures were not sustainable due to behavioral changes in human and wildlife (Pudasaini 2020). Additionally, even though different HWC mitigation measures, such as fences, trenches, chemical repellents and scare devices have been used (Jayson 2016, Delger et al. 2011), but they are rarely effective on a wider scale over a long time (Karanth and Nepal 2012). Still we have little information on the trends of crop loss by Wild Boar and their existing control measures in Dhorpatan Hunting Reserve (DHR) to minimize the conflict.

1.2. Objectives

1.2.1. General Objective

The general objective of this study was to assessment of crop raiding by Wild Boar in Dhorpatan Hunting Reserve, Nepal.

1.2.2. Specific Objectives

I. To assess the crop loss from Wild Boar in DHR.

II. To identify the causes of crop raiding and existing control measures in DHR.

III. To identify the local people's attitudes towards the Wild Boar conservation in DHR.

1.3. Significance of study

Haman-Wildlife Conflict is common in protected and non-protected areas of Nepal (Pudasaini 2020). Lot of research on HWC has been carried out in different conservation areas of Nepal adequately but few related research has been done in DHR. However, intensive study in this area on the effects of wildlife is little known to the people inhabitants of the adjutant areas. Therefore, it is realized to carry-out this study in DHR to understand the impact of wildlife on local people. Data of crops loss only get from the local people and annual report of DHR. Regular data of HWC is required for successful conservation and management wildlife. This study was conducted to add some information about impact of wildlife around the local people of DHR. Therefore, this proposed research aims to provide the baseline data on crop loss and existing protective measures, and this also suggest the effective methods to minimize the impact of wildlife along with biodiversity conservation around DHR.

1.4. Research Hypothesis

H_0 - There is no association between people's attitudes towards wildlife and different demographic variables in DHR.

H_1 - There is association between people's attitudes towards wildlife and different demographic variables in DHR.

2. LITERATURE REVIEW

Due to the decline in dense forests, wild animals are more likely to enter human settlements and agricultural areas, leading to a range of HWC such as crop damage, livestock predation and Incidents of injuries or fatalities involving both humans and wildlife (Bharathy et al. 2022). The agro-pastoral community residing in close proximity to protected areas is increasingly alarmed by the issue of HWC (Dahal et al. 2021). HWC is affected by various factors, including ecological, human-related and social aspects (Gross et al. 2021). The complexity of wildlife behavior, ecological dynamics, human actions, seasonal changes, agricultural practices, livestock management and resource availability makes it challenging to identify patterns of HWC (Sapkota et al. 2014). Human-wildlife conflicts start with the beginning of human civilization, but most of the studies were done after 1996 (Anand and Radhakrishna 2017). First time in Chitwan National (CNP), balance between human and conservation organized in 1982 (Mishra 1982).

2.1. Crop damage

Most of the crop loss occurs near the protected areas (Milich et al. 2021, Shah et al. 2021). Crop damaging wild animals are different according to geographical features, for example, in European countries, Wild Boars were the main crop raider in Luxembourg area (Schley et al. 2008), in Africa, Baboons (*Papio Anbis*) were major crop raider (Warren 2009), in Jigme Singye Wangchuk National Park, Bhutan, recorded major crop damaged wildlife was Wild Boar, followed by Barking Deer (*Muntiacus muntjak*), Macaques and Sambers (*Cervus unicolor*) (Wang et al. 2006), while in Southwest Ethiopia, major crop raider were Olive Baboon (*Papio Anubis*), Vervet Monkey (*Chlorocebus pygerythrus*), Bush Pig (*Potamochoerus porcus*), and Crested Porcupine (*Hystrix cristate*) (Mamo et al. 2021), but in North western Ethiopia, Gelade Monkeys (*Theropithecus gelada*), Crested Porcupine, Rabbit (*Lepus starcki*), and birds were major crop raiders and Potato, Barley (*Hordeum vulgare*) and Wheat were the most damaged crops (Ayechechew and Tolcha 2020). Asian Elephants, Rhesus Monkeys, Wild Boar and Peacocks (*Pavo cristatus*) were the conflicting animals in Sri Lanka (Bharathy et al. 2022). In Kerala, frequent crop

raiders were Wild Boar and Indian Crested Porcupine (*Hystrix indica*) (Govind and Jayson 2018).

In Nepal, major crop raider around the protected areas is Wild Boar, for example annually around USD 24,000 with 0.28 km² crop land damaged within in Shivapuri Nagarjun National Park (SNNP), with major crop loss were Potato, Maize and Paddy where most of crops were raided by Wild Boar out of seven groups of damaging animals (Pandey et al. 2016). Similarly, Thapa (2010) reported the Chital (*Axis axis*), Asian Elephant and Wild Boar are responsible for crop damaged in Bardia National Park. Wild Boar was the most crop damaged animal in Buffer Zone area of Banke National Park, where major crop lost were Maize, Paddy, Wheat, Potato, Mustard (*Brassica juncea*) with average crop loss NRs. 11243 per year per household (Subedi et al. 2020). In Shuklaphata National Park (ShNP), major crops Paddy, Wheat and Maize raider are Wild Boar and then Asian Elephant (Bhatta and Joshi 2021).

Greater One-horned Rhinos and Wild Boars was the main crop raider where economic loss was 115.2 kg and NRs. 9211.4 per year per household in buffer zone area of CNP (Ghimire 2019), according to Dhakal (2020), the main crop raiders in the Buffer Zone of CNP were Greater One-horn Rhinos, Wild Boar, Asian Elephant and Spotted Deer were the main crop raider where Maize, Rice, Wheat, Mustards were the most damaged crops. The major conflicting animals were Wild Asian Elephant, Wild Boar and Wild Water Buffalo and most damaged crops were Paddy (63.83%), Maize (19.15%), Potato (17.02%) and Wheat in adjacent area of Koshi Tappu Wildlife Reserve (KTWR) (Dahal et al. 2022, Karki et al. 2022). According to Ghimire et al. (2022), Greater One-horned Rhino, Wild Boar, Asian Elephants, Spotted Deer and Birds were the responsible for causing the most damage to Rice (NRs. 1776 per household), Wheat (NRs. 2583 per household) and Maize (NRs. 2019 per household) in CNP. In buffer Zone of ShNP, Asian Elephant and Wild Boar were the primary wildlife causing most damaged to Rice, Sugarcane (*Saccharum officinarum*) and Wheat damaging wildlife with USD 103,335 economic loss during 2016-2021 (Pant et al. 2023).

In outside Rhesus Monkey were the main conflicting animals (Ghimire and Chalise 2018). Rhesus Monkey, Asian Elephant and Wild Boar were the most crop raiders in Udayapur (Pokharel and Aryal 2020). Rhesus Monkey, Asiatic Black Bears, Spotted

Deer, Wild Boars, foxes, and Leopards were the destructive animals with average annual monetary loss USD 24 per household in Mid-hills of Nepal (Bista and Song 2021). Baral et al. (2022) reported Rhesus Monkey (74%) and followed by Indian field Mice (*Mus booduga*) (12%) were main crop raiders causing damaged to Rice, Maize, Millet (*Paspalum scrobiculatum*) and Potatoes in Mid-Hills of Nepal. The most problematic animals were Rhesus Monkey, Rabbit and Wild Boars and Paddy, Maize, Peanuts (*Arachis hypogaea*) and Mustard were the most damaged crops in Kailari Rural Municipality (Joshi et al. 2022).

In Chitwan Annapurna Landscape, Rhesus Monkey, Muntjac Deer (*Muntiacus vaginalis*), and Porcupine were the responsible for crop damaged with economic loss USD 29.56 per household per year (Adhikari et al. 2018). Assamese Monkeys (*Macaca assamensis*) caused significant crop loss such as Maize (47.14%), Wheat 11.13%, Millet (5.72%), rice (4.85%), Potato (4.27) in Kaligandaki river basin at Ramdi of Palpa and Syanja district of western Nepal (Ghimire and Chalise 2018). In Sunsari district, Asian Elephant, Wild Water Buffalo and Wild Boar were the main crop raider where major crops loss were Paddy (18.8%) and Sugarcane (16.8%) with NRs. 1,530,927.4 (USD 14,175.3) economic loss per year (Shah et al. 2021).

Asiatic Black Bear, Wild Boar and Rhesus Monkey were the main crops raider with Maize (47.35%), Potato (5.76%) and Millet (46.88%) during 2007, in DHR, Nepal (Yadav et al. 2009).

2.2. Causes of crop raiding

Lamarque et al. (2009) reported that the human civilization and HWC started same time in Africa, due to over population of human, development project, industrial activities; deforestation increases the conflict in recent decades. Similarly, lack of food, water in in forest, vicinity of farmland causes the conflict (Thapa et al. 2020). Across the world Human-wildlife conflicts are increases, when the primary causes of conflict are not fully understood, the situation can become even worse the situation, traditional intervention are scrutiny and criticism from society (White and Ward 2011).

Conflict between human and wildlife get worse when preventive and control measures are insufficient (Subedi et al. 2020). In Shuklaphanta Wildlife Reserve,

Kanchanpur, Nepal, crop loss emerged as the most significant impact from wildlife, followed by property damaged, livestock depredation, and human injuries and primary animals causing damaging were Asian Elephant and Wild Boar and main factors contributing to conflict were deforestation, increase in wildlife population, food scarcity, lack of fencing (Pant et al. 2023). Simirlaly, the main reason for crop raided was scarcity of food in the forest in CNP (Ghimire 2019). Additionally, Bhatta and Joshi (2021) recorded the main cause of crop raided is food deficiency in the forest for increase population in ShNP. Shah et al. (2021) reported the habitat disturbance, deforestation, sandy area, seasonal flooding and illegal poaching were the main reason for conflict in Sunsari.

In the Gaurishankar Conservation Area, local people hold negative perception towards the damaging animals due to crop losses and livestock depredation (Awasthi and Singh 2015). Similarly, in Sunsari, local people have negative perception towards the wildlife because of crop loss (Shah et al. 2021). Despite the conflict and challenges faced, respondents have positive attitudes towards the wildlife conservation although conflicts were increased; this can be result of awareness program in Kumroj Buffer Zone Community Forest of CNP (Ghimire 2019). The presence of wildlife attracting tourists and tourism is important for livelihoods have contributed positively response towards the wildlife conservation in KTWR (Dahal et al. 2022), similarly, from adjacent area of KTWR, Karki et al. (2022) educated peoples were more positive towards the wildlife.

Different mitigation measures have been employed, in Buffer zone of Bardia National Park, participatory method, shouting, following with fire, making noise, hitting tin boxes, construction scary crow in crop field, dog releasing and guarding day night were used where making noise and following with fire were effective for crop protection than other (Subedi et al. 2020). In KTWR for control crop raiding solar electric fencing, shouting, flashlight and throwing stones, following with fire was the most used mitigation measures (Dahal et al. 2022, Karki et al. 2022).

In Human-Wildlife Conflict lots of researches were conducted, it should be studied in all affected region because the nature of interaction between human and wildlife, and their solution are varied with geographical and ecologically. For better management of protected areas, it is crucial to record cases of crop damaged and its impact on

regular basis. Studied on human and wildlife interactions have been adequately carried out in different protected areas of Nepal but related research has been rarely carried out in DHR. Yadav (2009) conducted the Black Bear and Human conflict in DHR in 2007, and regular basis data of Human-wildlife interactions is lack, so, this studied will be helpful for understand the situation of local people and wildlife in DHR.

3. MATERIALS AND METHODS

3.1. Study area

This study was conducted in DHR (23°3'N-28°50'N, 82°50'E-83°15'E), which is situated at Rukum, Myagdi and Baglung Districts in Gandaki Province, Nepal. It is the only hunting reserve in Nepal and provides opportunities for seasonal blue sheep hunting (Aryal and Kreigenhofer 2009). It was established in 1983 and was officially declared in 1987. This reserve covers an area of 1325 km² between the elevation ranges of 3000-7000 m. above sea level. The reserve has seven blocks which includes Surtibang, Fagune, Barse, Ghustung, Dogari, Seng and Sundaha.

In DHR monsoon season occurs between June and October, with annual precipitation of less than 1000 mm (Aryal and Kreigenhofer 2009). Temperature range in this location is from average low of 1.4°C during the winter to an average high of 24.8°C during the summer. Throughout the years, strong winds at high elevation and snow fall can be seen at lower level until early April. Climate is very cold and dry during the dry season, with heavier snow into late spring and light snow in midwinter.

Because of climatic variation and elevation changes varied flora and fauna can be found in DHR. Flora in the Reserve includes Fir (*Abies spectabilis*), Blue pine (*Pinus wallichina*), Birch (*Betula utilis*), Rhododendron (*Rhododendron spp.*), Hemlock (*Tsuga domusa*), Oak (*Quercus semicarpifolia*), Juniper (*Juniperus indica*), Spruce (*Picea smithiana*), Maple (*Acer caesium*), Walnut (*Juglans regia*), Taxus (*Taxus baccata*) and Chir Pine (*Pinus roxburghii*), (Aryal and Kreigenhofer, 2009). In addition, the fauna in DHR are Blue Sheep (*Pseudois nayaur*), Himalayan Goral (*Naemorhedus goral*), Barking Deer (*Muntiacus vaginalis*) Himalayan Tahr (*Hemitragus jemlahicus*), Wild Boar (*Sus scrofa*), Himalayan Musk Deer (*Moschus chrysogaster*), Himalayan Serow (*Capricornis sumatraensis*), and carnivores include, Snow Leopard (*Panthera uncia*), Leopard (*P. pardus*), Lynx (*Felis lynx*), Red Fox (*Vulpes vulpes*), and Grey Wolf (*Canis lupus*), Himalayan Black Bears (*Ursus thibetanus*) and Red Panda (*Ailurus fulgens*) (Aryal and Kreigenhofer 2009, Regmi et al. 2023). Among 164 Avifauna, Cheer Pheasant (*Catresus wallichill*), Koklass Pheasant (*Pucrasia microlopha*), Himalayan Monal (*Lophophorus impejanus*), Himalayan Giffon Vulture (*Gyps himalayensis*) and Satyr tragopan (*Tragopan satyra*) are major bird species in DHR (Kandel et al. 2022).

3.2. Socio-economy

The study area was conducted in Surtibang block where most of people live and use resources from reserve and cropping seasonal crop. Intensive study was conducted at Surtibang block in Dhorpatan Municipality of Baglung District. In the Dhorpatan Municipality 30,068 people are living with 7485 households, among these 16147 were female and 13921 were male (CBS 2023). Only 5193 households are in the Patan of DHR with female 13121 and male 11351 (Kandel et al. 2022).

Ethnic groups have been inhabited around the DHR, major ethnic people of this area include, Kami, Magar, Nauthar, Chhantyal, Thakali and Bhotias (Tibetan Refugee) with a few Brahimin and Chhetri. In the lower elevation people are relayed on traditional agricultural practices and in the higher elevation of reserve major sources of livelihood are animal husbandry and trans-boundary trade. The major occupation is agriculture and livestock, but Tibetan is also involved in business in Tibet. Potato (*Solanum tuberosum*), Oat (*Avena sativa*) and Buckwheat (*Fagopyrum esculenum*) are the main crops produced.

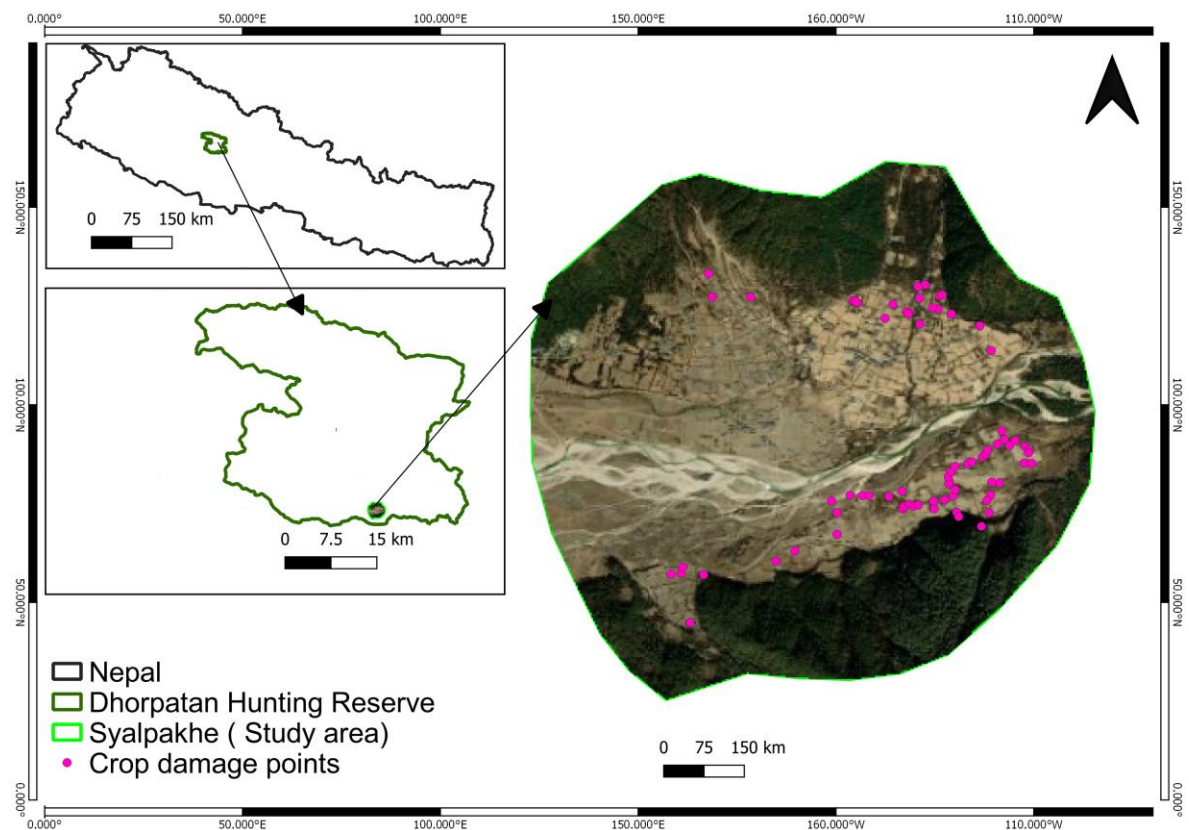


Figure 1. Dhorpatan Hunting Reserve and study area Shelpakhe with crop damaged area in Surtibang block.

3.3. Methods

3.3.1. Primary data collection

Primary data were collected through the field measurements and semi-structured questionnaire survey including the key informant interviews.

3.3.1.1. Household survey

Survey was conducted from August 9 to September 9, 2022 with people living near the DHR and field measurement for identifying the actual loss around DHR. For sample size determination, minimum required households were estimated for questionnaire survey using a 95% confidence interval at a 6% margin of error from the household data available from the DHR. The sample size (n) for the questionnaire survey was calculated by using the Slovin's formula.

$$\text{Sample size (n)} = N / 1 + Ne^2$$

Where, n = sample size

N = total population

e = margin of error (i.e., 1-confidence interval) now at 95% confidence interval, margin of error = 0.06)

Face to face questionnaire survey was conducted in highly affected region by wildlife with random sampling. Total 268 households were interviewed. Mainly, with the head of family but in absence of head of the family, the interview was taken from the other adult >18-year-old. While taking interview, a demographic data including age, gender, education, and occupation were collected, and interviewee was not be discriminated based on education level, gender, religion, ethnicity, and occupation. We asked the people weather they experienced wildlife conflict and characterize the conflict (e.g. frequency and timing). In addition, we asked them the type of crops they cultivate and amount of crops losses, which is the major crop damage, major season of conflict, which wild animal is the major crops damage, what are the local techniques they used to protect the crops, how are the local people perception and attitude towards wildlife conservation.

3.3.1.2. Key Informant Interview

Five key informant interviews were carried out with teacher, DHR officials, two villager, and president of ward, to collect the information about impact of wildlife and compensation scheme. Open-ended pre-structure questionnaires were used for key informants. These interviews centered on to address overall issues of adjacent area of DHR.

3.3.1.2. Field measurements of crop damage

To assess the crops damaged by wild animals, one 1 m × 1 m plot for each of the two major crop types (Potato and Oat) were taken in controlled area where wildlife did not damage the crops. To calculate the optimal crop production in kg from these controlled plots, the maximum crop production during ripen time were reported. The total damaged areas of crop in each field were measured by measuring tape during field survey. Coordinate points of damaged areas were noted.

3.3.2. Secondary data collection

Secondary data, such as number of households to determine the sample size and compensation provided were collected from Dhorpatan Municipality and Reserve office.

3.3.3. Data analysis

The qualitative and quantitative data were collected and descriptive statistics, e.g., percentage and frequency of count were used to analyze. The economic value of crop loss was calculated on the basis of local market rate. Chi-square test was used to determine whether perception of local people towards wildlife conservation varied with socio-economic variables such as gender, age, occupation, age group, education, source of livelihood, ethnicity, landholding size, and annul income. All analysis was performed in R program (R Core Team, 2022).

Crop loss calculation

Crops loss (kg per household) = total crop loss in kg / total number of affected household

Economic loss (NRs. per household) = total loss of crop in NRs. / total number of affected household

Total crop loss (NRs.) = price of crop (NRs.) × total crop loss (kg)

4. RESULTS

4.1. Demographic characteristics of respondents

The households' interviews were conducted with older than 18 years old. Majority of respondents were male (81%, n = 216) and Nauthar group (81%, n = 216); majority respondents, 153 (57%) were literate, only 28 (10%) were employed. Agriculture was main source of livelihood and 207 (77%) had less than 5 ropanies land (Table 1).

Table 1. Demographic information of respondents living in Dhorpatan Hunting Reserve in 2022.

Variable gender (male and female), age (year), ethnicity (Nauthar, Dalit, Magar), education (literate: people who attended school through grade five or above; illiterate: did not attend school), occupation (employment, unemployment), annual income (<200000, >200000), and landholding size (<5 ropanies, >5 ropanies) used for data analysis.

Variable	Category	Respondents (%)
Gender	Male	81
	Female	19
Age Group	21-40 years	37
	41-60 years	45
	above 60 years	18
Ethnicity	Nauthar	81
	Dalit	18
	Magar	5
Education	Illiterate	43
	Literate	57
Occupation	Employment	10
	Unemployment	89
Annual income (NRs.)	<200,000	66
	>200,000	34
Landholding size in ropani	<5	77
	>5	23

4.2. Socio-economic characteristics of respondents

This chapter includes the economic aspects of the household's viz. income sources and livestock population.

4.2.1. Occupation

Agriculture is the main income source in the study area so, almost all engaged in agriculture, as well as some of them are employed (10%, n = 28) and labor (48%, n = 48%) as in additional occupation (Figure 2).

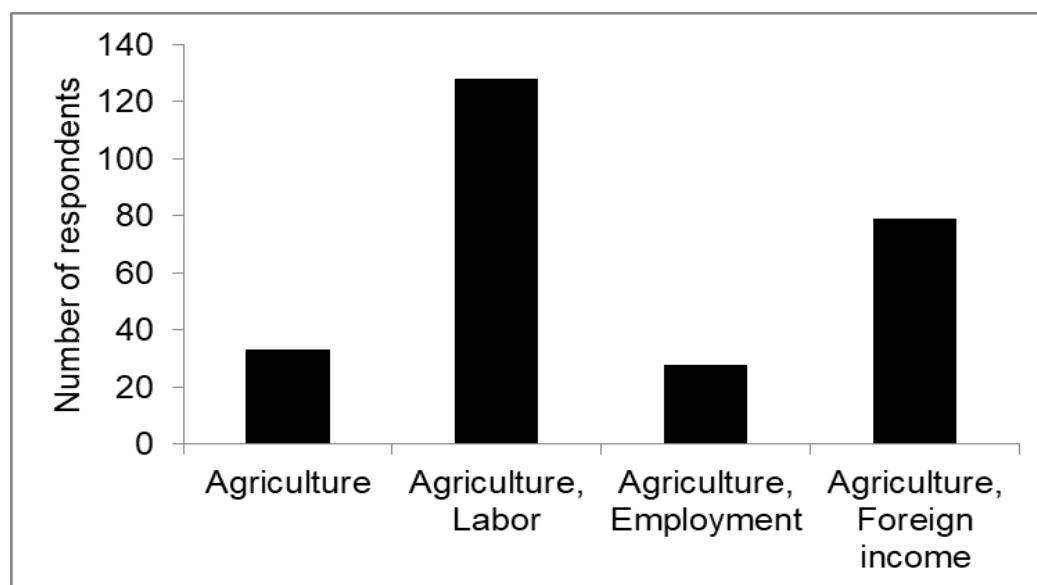


Figure 2. Respondent's income sources in Dhorpatan Hunting Reserve, Nepal, 2022.

4.3. Animal responsible for crop damaged

This study reported that almost all individuals experienced crop damaged caused by Wild Boar in DHR.

4.4. Crops production and raiding

4.4.1. Crops production

Potato and Oat were the main crop cultivated in the study area. Majority of the respondents (56%, n = 150) cultivated Potato (*Solanum tuberosum*) only, 41% (n = 110) cultivated both Potato and Oat, and only 3% (n = 8) cultivated Oat. The total Potato produced by respondents in DHR was 11,48,035 kg in 32.8 ha. and for Oat was 71,528 kg in 8.94 ha. The annual income in this year from Potato was NRs. 5,74,01,770 (USD 436,449) and followed by Oat (NRs. 17,88,221.2; USD 13,596.57). (1 USD = NRs. 131.52, May 9, 2023).

4.4.2. Crop raiding

All 268 respondents cultivated the crops, among them only 30.22 % (n = 81) of the respondents crops were raided by wildlife. Potato is the most crops raided by wildlife followed by Oat in the study area. The annual Potato lost was 98,568.38 kg and Oat was 4,110.62 kg of total production. Total crop production was 4,550.61 kg per household and total lost was 1,269.64 kg per household. Total annual crop loss was 1,02,679 kg (1,267.64 kg per household). Based on the economic value Potato (NRs. 49,28,419; USD 37,472.77) was the most damaged and then Oat (NRs. 1,02,765.46; USD 781.36). Total annual economic loss due to wildlife was NRs. 50,31,184.46 (USD 38,254.14), which was 8.59% loss of total potato production and NRs. 62,113.39 (USD 472.27), which was 5.75% loss of total oat production per HHs. All respondents said that wildlife raided the crops mostly at night. Almost all respondents mentioned that wildlife raided crops from sowing up to harvesting time.

4.5. Causes of crops raiding

Majority of the respondents (51%, n = 136) mentioned that the main reason for crop raiding was due to presence of the village near to the forest, 32% (n = 86) of respondents believed that food scarcity in the forest, and 17% (n = 46) said that increase in wild population was responsible for crop raiding in adjacent area of Reserve (Figure 3).

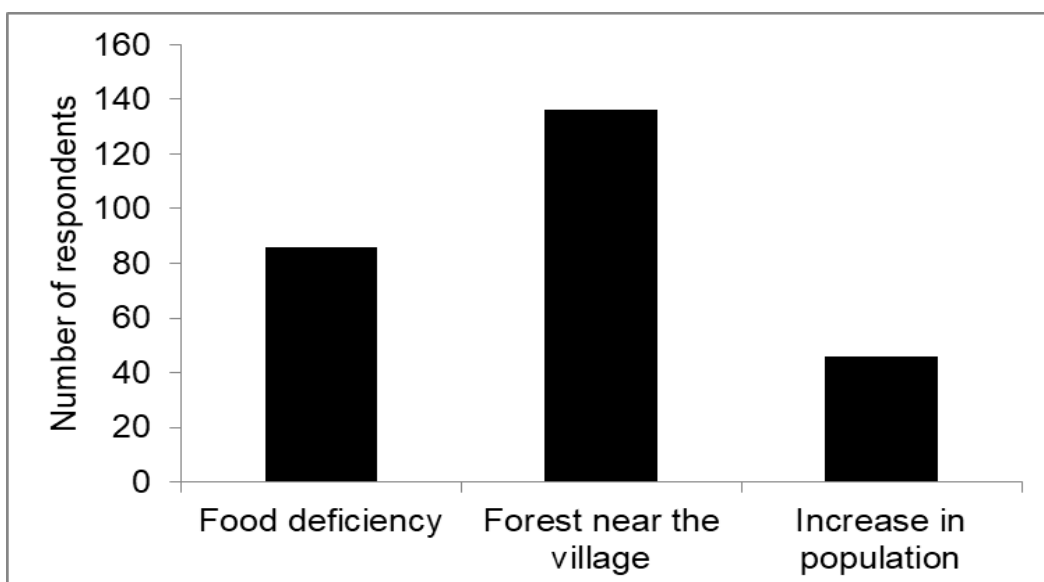


Figure 3. People's responses on the causes of crop raiding in Dhorpatan Hunting Reserve, Nepal in 2022.

4.6. Crop damaged time and frequency

The majority of victims (25%, n = 68) reported that their crop was damaged prior to harvesting, while 5% (n = 13) victims reported damaged occurring both before and during harvesting period (Figure 4). Remaining respondents (70%, n = 187) stated that their crops were never damaged (Figure 4). Majority of victim respondents (26%, n= 69) reported that frequency of wildlife visited their crop land on daily basis (Figure 5).

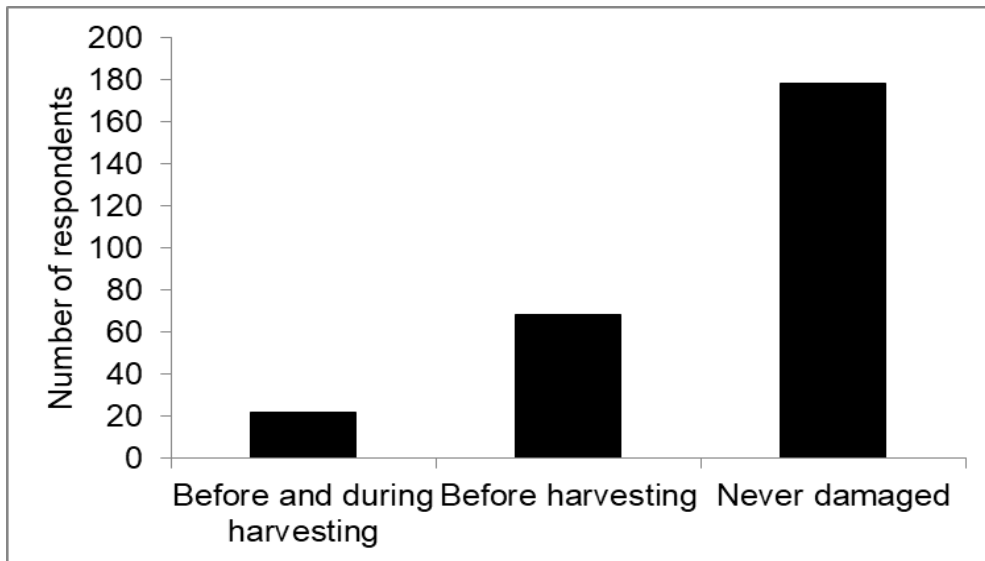


Figure 4. Crop damaged time by wildlife in Dhorpatan Hunting Reserve, Nepal in 2022.

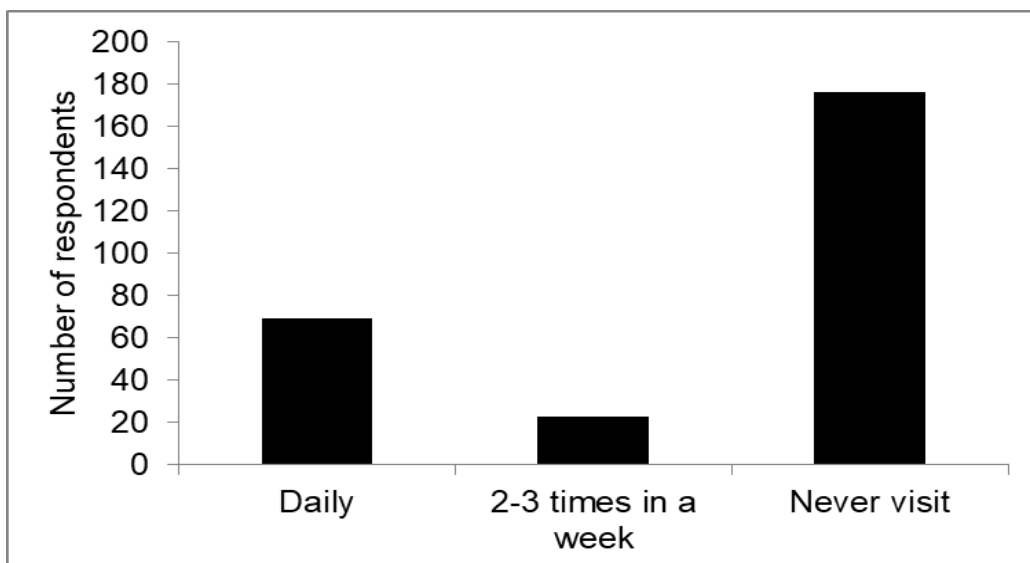


Figure 5. Frequency of wild animals visit in crop land in Dhorpatan Hunting Reserve Nepal in 2022.

4.7. Existing protection measures

In the study area for crops protection from wildlife, most of the respondents used the stone wall (79%, n = 211) followed by wooden bar (17%, n = 45) and fencing wire (4%, n = 12) (Figure 6).

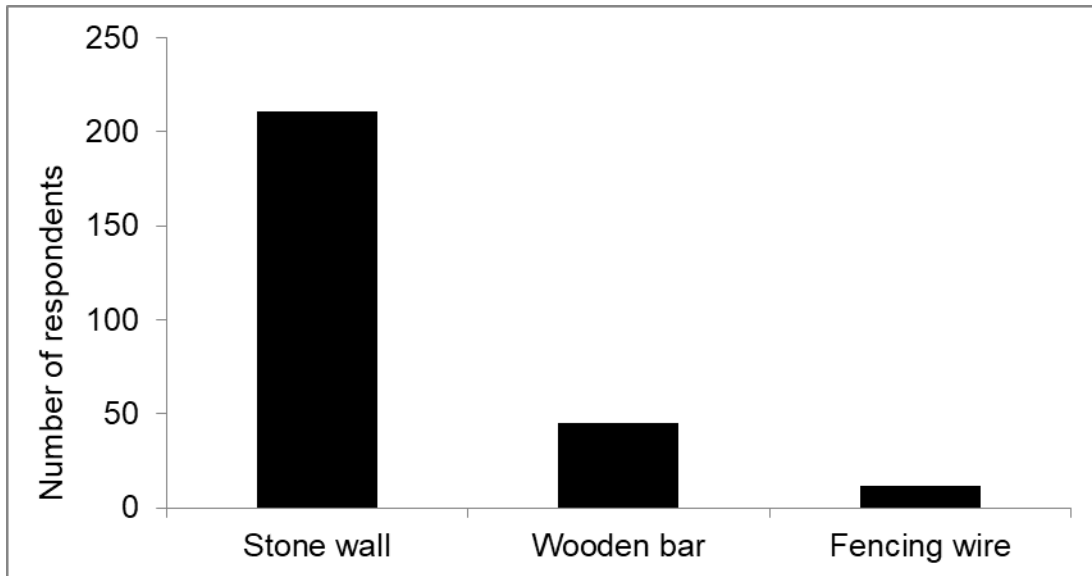


Figure 6. Protective measures used by respondent's in Dhorpatan Hunting Reserve, Nepal in 2022.

4.8. Compensation Schemes

In the study area, most of respondents were aware about the compensation schemes. Among 268 respondents, 159 respondents were known about compensation (Figure 7). The knowledge about compensation for age group, gender and education were not varied between male and female $\chi^2 = 3.57$, $df = 1$ and $p = 0.06$, and educated and uneducated $\chi^2 = 1.56$, $df = 1$ and $p = 0.21$).

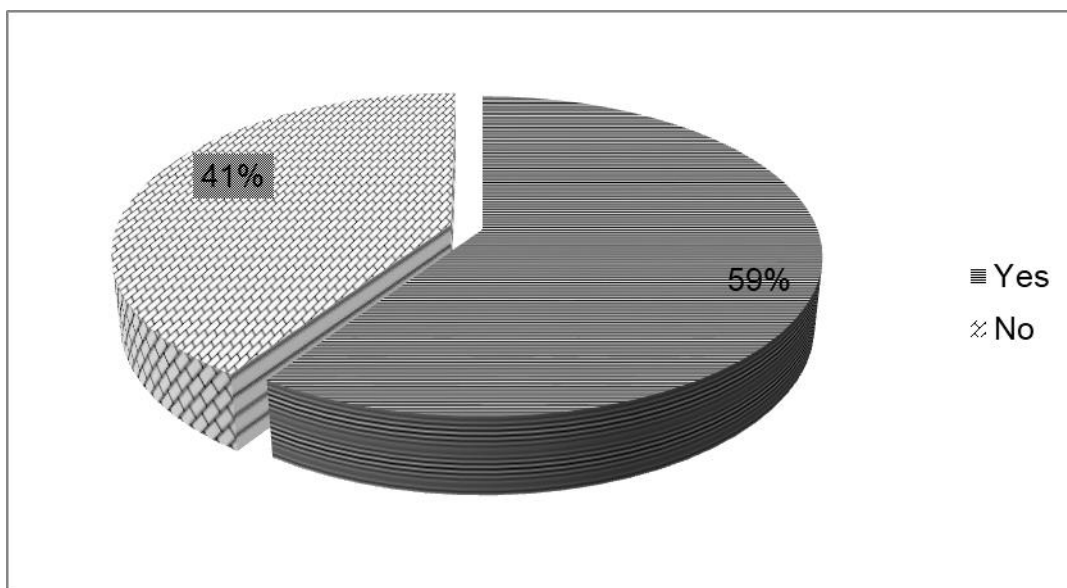


Figure 7. Number of respondents aware about of compensation scheme in DHR, Nepal in 2022.

4.9. Perception of respondents towards the crops damaging wildlife

Based on the data obtained from households survey, it was found that 53% (n = 142) of respondents had negative attitude towards wildlife conservation, however, 31% (n = 83) had positive attitude and 16% (n = 43) were neutral towards the crops raids animals (Figure 8).

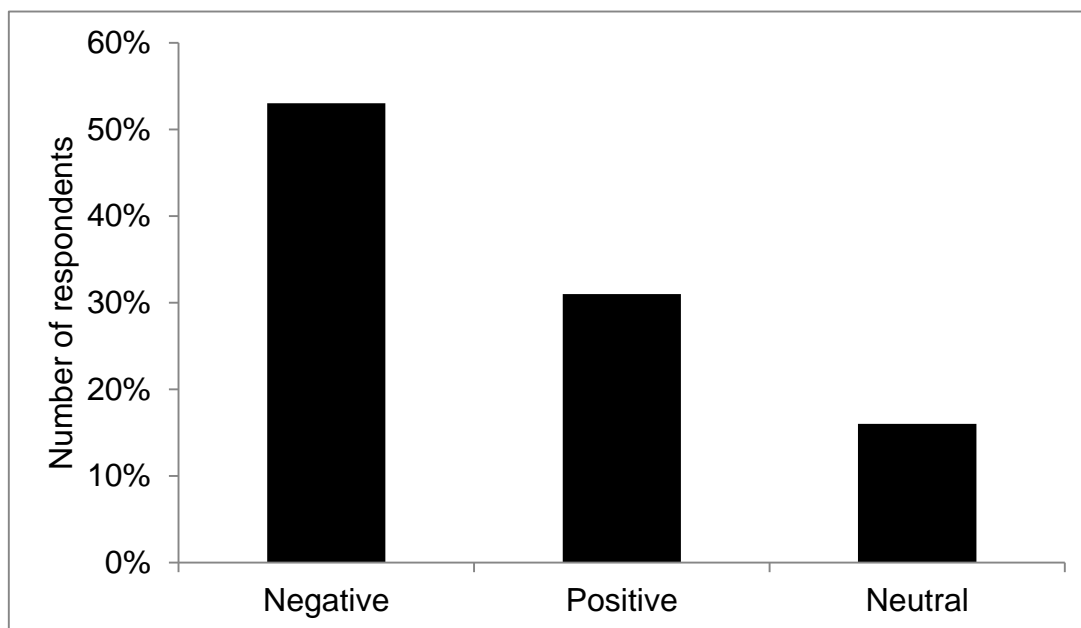


Figure 8. Respondent's attitude towards the wildlife conservation in Dhorpatan Hunting Reserve, Nepal in 2022.

In the study area, the attitude of respondents towards wildlife conservation was significant association with age group ($\chi^2 = 62.29$, $df = 2$, $p < 0.001$), and also between educated and uneducated respondents ($\chi^2 = 78.71$, $df = 1$, $p = 0.00$) (Table 2). However, there was no differences between male and female respondents ($\chi^2 = 0.24$, $df = 1$, $p = 0.62$), ethnicity ($\chi^2 = 5.75$, $df = 2$, $p = 0.06$), occupation ($\chi^2 = 0.031$, $df = 1$, $p = 0.86$), income source below and above NRS 200,000 ($\chi^2 = 1.85$, $df = 1$, $p = 0.17$), and land owner having less and greater than 5 ropani agricultural land ($\chi^2 = 3.55$, $df = 1$, $p = 0.06$) (Table 2).

Table 2. Socioeconomic status of respondents in relation to their support in wildlife conservation in DHR, Nepal in 2022.

Variables	Categories	PAinCov		χ^2	df	P value
		Yes	No			
Gender	Male	94	122	0.24	1	0.62
	Female	19	33			
Age Group	21-40 years	71	28	62.29	2	0.00*
	41-60 years	37	83			
	above 60 years	5	44			
Education	Illiterate	25	90	78.71	1	0.00*
	Literate	118	35			
Occupation	Employment	15	13	0.031	1	0.86
	Unemployment	98	99			
Source of livelihood	Agriculture, Labor	62	99	1.85	1	0.17
	Agriculture, Employment, Foreign income	51	56			
Annual income (NRs.)	50000-200000	69	108	1.80	1	0.18
	above 200000	44	47			
Landholding size in ropani	<5	95	121	3.55	1	0.06
	>5	18	43			
PAinCov = People's attitude in conservation, df = degree of freedom, *Significant at $p < 0.05$						

5. DISCUSSION

The Wild Boar (*Sus scrofa*) is the main crop raider in the study area; not only at DHR, the crop raiding problem from this species is common to other areas, such as Sivapuri Nagarjuna National Park, Bardia National Park, Shuklaphanta National Park, and Banke National Park (Thapa 2010, Pandey et al. 2016, Subedi et al. 2020, Bhatta and Joshi 2021). However, outside the protected areas the Wild Boar was not noticed as main crop raiders (Baral et al. 2022). It was probably due to local loss of Wild Boar outside PAs, and becoming as a one of the major crop raiders in and around the PAs might be due to its increased population due to strict restriction on hunting from the park, decreasing wildlife habitat and food deficiency for wildlife into the cultivated fields (Milda et al. 2023, Pandey et al. 2016). Wild Boar was likely responsible for most extensive damage because they can be found in all types of habitats, including highly degraded and fragmented ones (Subedi et al. 2020). The agricultural land was naturally connected to a forest that served as habitat for different animals especially Wild Boar (Thapa et al. 2020).

Human-wildlife conflict is common in DHR. Not only this time it is common, since the human-wildlife conflict occurred between the human and wildlife (Dar and Mir 2018). The Human-Wildlife Conflict is getting worse as a result of increased competition for some natural resource, habitat and niches; consequently, this poses a threat to both human welfare and wildlife conservation (Gross et al. 2021). This study was conducted to assess the crop loss and its impact on local people of DHR. Agricultural practices are the main source of livelihood of the respondents living near the hunting reserve. HWC is frequent in the proximity of protected areas due to the substantial interaction between human and wild animals in that region (Milupi et al. 2023).

Multiple studies have highlighted that crop raiding is a major problem in Nepal (Karki et al. 2022). Generally, wildlife caused more damage to Potato (*Solanum tuberosum*) crops compared to other crops because the Potato is extensively cultivated on a large scale, highly palatable than other crops grown in the study area (Bhatta and Joshi 2021). Due to insufficient fencing and security measures allow crop raiders easy access to crops; however, options like electric wire fencing were effective for crop protection (Sapkota et al. 2014), but their installation and maintenance costs are too

expensive for most local farmers (Baral et al. 2022). In this study, total annual economic loss was NRs. 50,31,184.46 (USD 38,254.14) with 98,568.38 kg of Potato and 4,110.62 kg of Oat which is major problem for the livelihood of rural people living in the remote areas. So, government needs to take responsibility to save people from these losses. Wild Boar mostly approaches the edges of the forest (Linkie et al. 2007, Thurfjell et al. 2009), which makes them easy to access the farmland near the protected areas. Interestingly the degree of damaged decreased as the distance from the protected area increase, which show reverse relation between crop raiding and distance (Bhatta and Joshi 2021).

The incidences of crop raiding is common in the study area from the beginning of crop planting to harvesting because the Wild Boar pose a continuous thereat to crops throughout the year and widespread nature (Joshi et al. 2022). So, management measures need to be implemented throughout the crop cycle (Naik and Basavadarshan 2020). The frequency of wildlife visit to crop land was more frequent during spring season. It might be the food deficiency in the forest for increasing population of wildlife at that time. The Wild Boar would repeatedly raid the same field until they completely destroyed all crops (Panday et al. 2016).

Most respondents said that forest near the village and food scarcity was the main causes of crop raiding and it will increase in the future. This indicates that when natural forest unable to meet their need wildlife enters the cultivated fields. As the consequences of conservation efforts, the wildlife population has grown, causing a scarcity of food within the forest (Bhatta and Joshi 2021), however increased the food availability in the forest edges (Nikhil et al. 2023), lead the more crop rides around the parks. To minimize this problem, it is necessary to explore alternative solutions.

It was found that wild Boar raid the crop during night time, which could be related to nocturnal behavior of this species to avoid the human presence and hunting pressure (Amici et al. 2012) so, that people spend most of the sleeping time. In Nepal, most of the farmers using watch towers with flaming stick and making noise, fencing and tranches for deter the wild animals (Dhakal and Thapa 2019). Almost all respondents implemented protective measured such as stone wall, wooden bar, and scarecrow were seen in the agriculture field. Other methods shouting, scaring by hitting tin boxes, guarding during night and dog releasing were observed for chasing the wildlife

from crop fields. Similar results reported from Banke National Park (Subedi et al. 2020), which was effective for short time.

Majority of people in the adjacent area of DHR were knowledgeable about the government's compensation schemes as a result of an awareness program conducted by Reserve officials. But till now nobody receive the relief fund from government for crop loss. However, compensation relief fund was distributed only for livestock depredation around the DHR. Most of the respondents were dissatisfied because of lengthy process and lack of information flow from DHR, and compensation system has a limit of NRs. 10,000 (Timsina and Ranjitkar 2014), even though damaged exceeds that amount, similar response was reported from ShNP (Pant et al. 2023). The knowledge about compensation was not varied between male and female and educated and uneducated. Because both male and female work in agricultural fields and equally participated in the awareness program. A holistic management plan that is balance with clear administrative processes is required urgently to address the issues of HWC (Baral et al. 2022).

Local people perception is important to ensure the efficacy of wildlife management policies (Sharma et al. 2021). The attitude of respondents towards wildlife conservation was significant association with age group and also between educated and uneducated respondents. Because educated and young age group people know about importance of wildlife. Male respondents showed a higher positivity rate towards the wildlife than females. It might be due to male were more engaged in outdoor activities than female. The 21-40 age group, educated and employment were more positive towards the wildlife. Because of they were aware about the importance of wildlife conservation. The respondents with smaller agricultural land holding showed higher negative attitudes towards the wild boar as compared to the respondents with larger agricultural land holding. It might be that smaller landholders experienced lower agricultural outputs per ropani relative to the crops and orchard damages caused by the wild boar (Khattak et al 2022). However, overall most of the households had negative attitude toward the wildlife. It may be due to frequent crop loss. Negative opinions were developed when exceed of damaged suppress the tolerance level towards the wildlife (Hill 2021). Ecotourism and awareness programs play a vital role to change the perception of local communities towards wildlife (Ghimire 2019, Dahal et al. 2022).

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusions

Crop raiding by Wild Boar is the main problem faced by the respondents of DHR and Potato is the most damaged crop by Wild Boar, it has created problem to the livelihood of local people. Village near the forest is the main cause of crop riding in adjacent area of DHR. In the study area the crop protecting methods such as shouting, scaring by hitting tin boxes, building scary crow, guarding during night, dog releasing and stone wall, wooden bar are the common practices. Most of the respondents have negative attitude towards the wildlife conservation due to massive crop loss. Local people are knowledgeable about government relief fund scheme but dissatisfaction with compensation system. The lack of mitigation measures around the DHR. Therefore, improved management plans are necessary and give priority to hunting Wild Boar in DHR for control the population of Wild Boar.

6.2. Recommendations

1. Effective mitigation measures such as electric fences around the perimeter of crop fields can be an effective deterrent for Wild Boar.
2. Adaptive alternative crop like hot peppers, garlic and onions should be production near the park area which is unpalatable to Wild Boar.
3. Using repellents, such as chemical spray or natural deterrent can discourage Wild Boar from feeding on crops.
4. Wildlife population should be monitor regularly by hunting in DHR.
5. Provide proper compensation for crop loss by wildlife and make easier procedure.

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Appendices I: List of photographs



Potato production in 1*1 m² of controlled area



Potato production in 1*1 m² wildlife damaged area



Potatoes land damaged by wildlife



Footprint of Wild boar in farmland

17



Remaining of Oats after chewing by Wild Boar



Oats field damaged by Wild Boar



Fecal matter of Wild Boar



Dig and pull off Oats by Wild Boar¹⁸

Protective measures



Wooden bar



Stone wall



Fencing wire



Stone wall + Wooden bar

19



Scare crow



Barbed fencing wire



Pictures of household interview

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Appendices II: Questionnaires

Household questionnaire survey

Basic information

Respondent Name:

Municipality: Ward No: Age: Gender: M F

Education: No education/primary/secondary/high school/college and University

Family size: Ethnicity: Occupation:

General information

1. What is your major income source?
2. Annual income of the household?
3. Do you have your own land? If yes, how much land do you have?
4. What kinds of crops do you grow in your field?
a) Potato b) Buckwheat c) Oat d) Other

Crop production

	Potato	Buckwheat	Oat	Other
Amount				

Crop damage

	Damaged by	lost month	Amount lost (kg)	Damaged area	By others
Potato					
Buckwheat					
Oat					

5. What is the amount of crop damaged by wild animals?

Major crops	Total production if not damaged (per year) A	Total production after damaged (per year) B	Total damage A-B

6. Do you know in the last 12 months when local people encounter with wildlife any wild animal are killed? If yes, name the species and number.

7. Was anybody in your family harassed by wild animals in the last 5 years? When does it happen?

8. Have you complained about the crop losses due to wildlife? If yes, where did you complain?

9. Do you think Human-Wildlife conflict will increase in the future?

a) Yes () b) No ()

10. Have you encountered the wild animals in your territory?

a) Yes () b) No (), if yes, which wild animals?

11. When did the animal reach your house or cropland?

a) During day time () b) At night () c) Any time ()

12) How often do they visit?

a) Daily () b) once a week () c) Twice a week () d) Any time ()

13. Which wild animals reach your house or cropland? (Prioritize it)

14. Which is the major crop damage?

15. Which wild animal cause the major crops damage?

16. When does the crop damaged occur?

- a) Before harvesting () b) At harvesting ()

17. How much crops damaged per year?

Perception of wildlife

1. Do you like wildlife? If yes, why..... If No, why.....

- a) Kills livestock b) attacks human c) crop damage d. diseases

2. Where should be wildlife be conserved?

- a) Protected area b. Community Forest c) Where they are found now

3. I support wildlife conservation even if my crops are damaged.

- a) Strongly agree b) Agree c) Neutral d) Disagree e) Strongly disagree

Mitigation/Adaptive measures against wildlife damages

1. Do you apply some techniques to chase wild animals from the field?

- A) Yes B) No If yes, what kind of technique do you apply?

- a) Shouting and following b) Following with fire c) Following with fire and shouting
d) Dog releasing e) Scaring by hitting tin boxed f) Others

2. Do you apply other techniques rather than those three? If yes what?

.....

Checklist for Key Informant Survey

1. What are the main causes of the conflict?

2. Dose the government has any new kinds of plan under consideration for the future?

3. What are the solutions to reduce the conflict?

4. How should go conservation and natural resource management with the fulfillment of the necessity of local people?

4. What are the major agricultural problems in the village?