International Journal of Agriculture, Environment and Bioresearch

Vol. 09, No. 01; 2024

ISSN: 2456-8643

EFFECTS OF HUMAN WILDLIFE CONFLICT (HWC) ON LIVELIHOOD OF THE COMMUNITIES: AN ASSESSMENT ON CROP DAMAGE BY WILDLIFE WITHIN THE WHITE-BELLIED HERON HABITATS ALONG PUNATSANGCHHU AND MANGDECHHU BASINS, BHUTAN

Tsheten Dorji
Chief, Sustainable Livelihood Division, Royal society for Protection of Nature, Thimphu, Bhutan

https://doi.org/10.35410/IJAEB.2024.5872

ABSTRACT

This study explores and identify possible solutions to reduce crop damages due to Human-Wildlife Conflict (HWC) in the study areas. The study also provides information on types, extent and periods of damages, as well as perceptions and potential solutions to lessen crop loss and combat HWC. The study is supported by information gathered through the distribution of a questionnaire to Gewog1 Officials, Extension Agents2 and communities. The study's conclusions indicate that increasing incidences of HWC is associated with fragmentated wildlife habitats caused by rapid urbanization and infrastructure development, expanding agricultural activities, and regeneration of forest in fallow farmlands. The impediments in combating HWC issues are due to lack of enduring and effective long-term intervention measures. The study recommends installation of electric/solar and chain-link fencing around agricultural fields, development of compensation plans for farmers affected by wildlife, promotion and diversification of crops, and fostering community-based conservation programs involving local communities will strengthen harmonious balance between human and wildlife.

Keywords: Impacts of HWC, mitigation measures and livelihood opportunities.

1. INTRODUCTION

Human-Wildlife Conflict (HWC) refers to the negative interactions between humans and wildlife that arise when the needs and behavior of wildlife overlap with human activities. The conflict between humans and wildlife is a global issue in the increasingly shared landscape, and HWC is often viewed as a threat to most of the rural populace of the world as crop damage and livestock predation by wildlife remove the household's food supply, and are an economic drain on the homestead (Wangchuk et al., 2023). HWC was once considered to be a natural occurrence and a problem with farming in rural areas. Today, the negative interface between human and wild animals have expanded into a global problem that has negatively impacted both social and economic development of people and protection of wildlife species (Wangdi et al., 2018).

Bhutan, a tiny landlocked nation in the Eastern Himalayas, is well known for its rich biodiversity with 69.71% (DoFPS, 2023) of land under forest cover and commitment to environmental conservation; however, like many other countries around the world, Bhutan faces the challenges of HWC.

1 Block Administration comprising a group of villages in Bhutan.
2 Agriculture, Livestock and Forestry Sector Officers based at the Block Administration to provide technical support for community development.
3 Bhutan's Total Fertility Rate (TFR) is project at 1.833% in 2022 as per the Population Projection for Bhutan 2017-2047 Report.

Vol. 09, No. 01; 2024

ISSN: 2456-8643

aIn Bhutan, conflicts between people and wild animals have become more frequent in the recent years as a result of the country's growing population3 and expanding agricultural activities into wildlife habitats, and forest regeneration inside the growing amount of fallow land in the rural areas. Further, the strong Buddhist beliefs that killing any living organism is immoral and enforcement of stringent rules on killing of wild animals by the government has favored the growth of wildlife resulting to increase in HWC problems in Bhutan (Yeshey et al., 2023).

Owing to the absence of a single national reporting system and database in Bhutan, it is difficult to accurately quantify the full extent of human and economic loss caused by HWC due to crop loss, livestock depredation and attacks on people (NPPC and WWF-Bhutan, 2016). However, HWC situation is common throughout the nation and instances have been reported from all the twenty Districts (Tshering, 2019); and HWC is recognized to worsen household psychological wellbeing, health, livelihoods, and food security, which can be classified as hidden social costs, indirect/opportunity and direct costs. In addition, the loss of crops, livestock and human lives to wildlife represents the social and economic cost that negatively impacts livelihoods, encourages poverty, and may ultimately prompt people to take action against conservation programs (Tobgay et al., 2019); yet crop depredation by wild animals remains as one of the main challenges of HWC faced by the farmers in Bhutan (Penjor et al., 2014). The issue of HWC still exist in Bhutan despite several attempts and initiatives to address them, and finding a way to balance the needs of protecting wildlife with the livelihoods and well-being of local communities will continue to be a difficult task for the country.

Owing to the absence of a single national reporting system and database in Bhutan, it is difficult to accurately quantify the full extent of human and economic loss caused by HWC due to crop loss, livestock depredation and attacks on people (NPPC and WWF-Bhutan, 2016). However, HWC situation is common throughout the nation and instances have been reported from all the twenty Districts (Tshering, 2019); and HWC is recognized to worsen household psychological wellbeing, health, livelihoods, and food security, which can be classified as hidden social costs, indirect/opportunity and direct costs. In addition, the loss of crops, livestock and human lives to wildlife represents the social and economic cost that negatively impacts livelihoods, encourages poverty, and may ultimately prompt people to take action against conservation programs (Tobgay et al., 2019); yet crop depredation by wild animals remains as one of the main challenges of HWC faced by the farmers in Bhutan (Penjor et al., 2014). The issue of HWC still exist in Bhutan despite several attempts and initiatives to address them, and finding a way to balance the needs of protecting wildlife with the livelihoods and well-being of local communities will continue to be a difficult task for the country.

4 Protected Areas are National Parks, Nature Preserves and Wildlife Sanctuaries in Bhutan and Protected Area covers 51.44% of Bhutan's land cover as per Bhutan's State of Parks Report 2016.

Vol. 09, No. 01; 2024

ISSN: 2456-8643

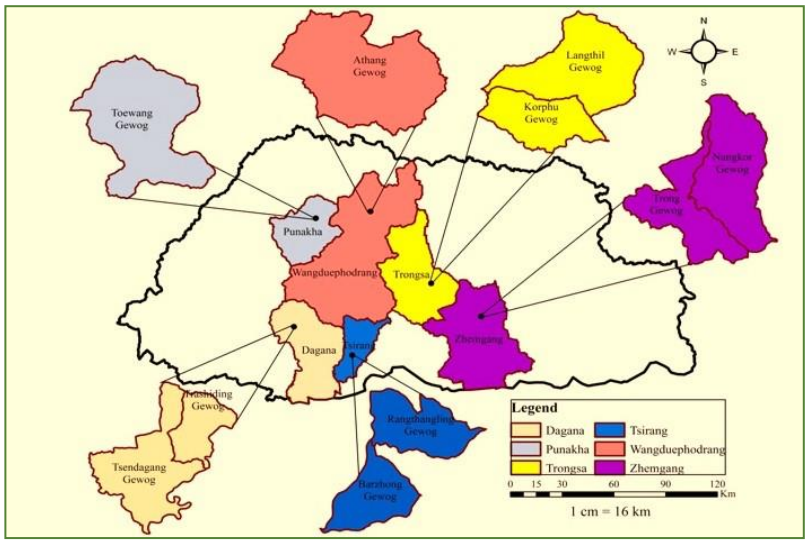

Figure 1: Map of Study Areas

Study Area and Objectives

The assessment was conducted in 10 Gewogs within the White-bellied Heron habitats along Punatsangchhu and Mangdechhu

Basins (refer Figure 1). The Gewogs are located within or periphery to protected areas4 and most of the villages are surrounded by rich forests. Subsistence agriculture and livestock rearing are the main source of livelihood for the people of the study areas (RSPN, 2022). Despite continuous support, people encountered great challenges for their livelihood, and HWC is one of the major problem in the study areas.

The main objective of the study is to assess and identify possible measures to mitigate HWC. The specific objectives are:

- To assess type and extent of damages caused by HWC.

- To comprehend rural communities' attitudes and perceptions about HWC.

2. METHODOLOGY

The study used a combination of quantitative and qualitative methodologies, collecting primary data through in-person interviews and secondary data via desk analysis of past research publications and studies. The author assembled all the information with assistance from Project Officers of RSPN. Key Informant Interviews (KII) and Focused Group Discussions (FGD) were used to gather information from the Gewog Administrations, Extension Agents and communities.

The primary data were obtained via a field visits to 10 Gewogs from November 2022 to November 2023. The data was recorded, clusterzd, grouped, summarized, and analysed with

Vol. 09, No. 01; 2024

ISSN: 2456-8643

SPSS, Microsoft Excel and Microsoft Word 2010 versions, and is presented descriptively and graphically.

3. RESULTS AND DISCUSSIONS

'HWC is a complicated phenomenon that is the end result of several interrelated elements, including institutional, demographic, social, economic, and technological, and their interactions' according to WWF Bhutan Program Office (WWF, 2012). It is more prevalent in areas where wildlife and humans cohabit and share scarce resources. While it is difficult to completely eradicate HWC problems within short timeframe, yet it is possible to mitigate if researchers, planners and decision makers have a better understanding of dynamics of conflicts and apply appropriate management options.

Status of HWC in Bhutan: Distribution as of 2020

Figure 2 shows that there is a record of 10 wildlife species, which are the major destructors of crops and domestic animals, and
threats to human lives throughout Bhutan. It is further established that the wildlife such as wild-pig, deer, primates, bear, tiger, common-leopard, dhole and rodents are extreme in all the 20 Districts, while elephant and snow-leopard are extreme in only 3 Districts in the country.

While there is a report of wildlife damaging the crops throughout Bhutan, but the map in figure 3 shows that hotspot areas of crop damage by wildlife in Bhutan are in and around the national parks, wildlife sanctuary, strict nature reserves and along the southern foothills of the country. It is indicated that a greater number of wildlife inhabits within the national parks, wildlife sanctuary, strict nature reserves and along the southern foothills due to rich and undistributed natural habitat, availability of abundant food and water, and no poaching of wildlife due to stringent conservation rules and persistent monitoring by the Forestry Officials.

Figure 2: Conflict level of various conflicting wildlife species across 20 Districts based on Conflict Hotspot Mapping (extent of occurrence). Source: NCD, 2020

Vol. 09, No. 01; 2024

ISSN: 2456-8643

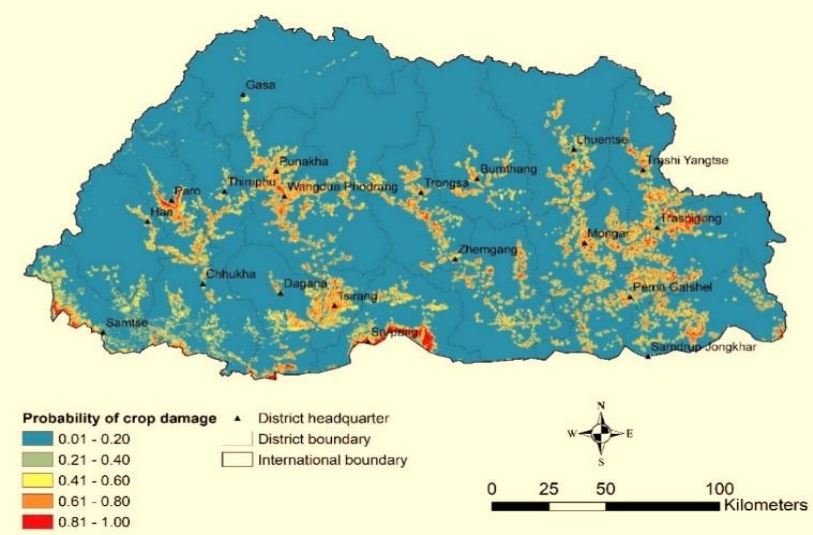

Figure 3: Hotspot areas of crop damage by wildlife in Bhutan. Source: NCD, 2020

Effects of HWC and Interventions in Bhutan

HWC is a complex issue, and agriculture and livestock sectors are affected the most in Bhutan. HWC is transboundary and very common, and wild herbivores including wild-pig, elephant and monkeys, and carnivores such as tiger and common leopard are common destroyers of crops and killer of livestock according to Nature Conservation Division of the Department of Forest and Park Services (Wangdi, 2022). There is a report that farmers in Bhutan on average lose about 8,250 metric tonnes of crops worth Ngultrum5 171.75 million every year to wild animals, and wild predators killed about 155 livestock every year (Wangdi, 2022). Likewise, 7 people were mauled by bears since 2016 according to records maintained by the DoFPS (Yangdon, 2016) where the victims suffered major face disfigurement and eye damage; and a 38 years old ex-monk from Jigmecholing village was trampled by and elephant to death in the forest above Gelephu Domestic Airport and 1 person was also killed by an elephant early 2022 (Bhutan Today, 2022).

As an intervention measures, HWC Committees known as Gewog Environment Conservation Committees consisting of 46 committees across 15 Districts were formed by the government with an initial seed money of Ngultrum 0.5 million from the government to compensate the loss of livestock and crops to wildlife between 2010 to 2017, and government disbursed Ngultrum 300,000 to each Gewog to compensate farmers on HWC instances (Palden, 2019). In addition, the government also established a HWC Endowment Fund of Ngultrum 2 million in 2012 with fund support from WWF. RSPN6 in collaboration with DoFPS and Kangpara Gewog

Vol. 09, No. 01; 2024

ISSN: 2456-8643

Administration in Trashigang has piloted a community-based Sustainable Institutional Mechanism for HWC Management and supported a crop compensation seed money of Ngultrum 200,000 to Passangphu HWC Management Group in 2012 (RSPN, 2012). The government supported Electric Fence with a length of 6,484 kilometers, benefitting 30,526 households in the country as of June 2021 (Dema, 2021), and government has supported Chain-Link Fence in Nabji in Trongsa, Uzorong in Trashigang, Haybesa in Wangdue, Labtsakha and Nyenyul in Sarpang, Tali, Buli and Thrisa in Zhemgang as of 2023, and government will install Chain-Link Fence, which may completely prevent animals from entering cultivated farmland except for monkeys and bears (Yuden, 2022).

Socio-economic Status of Study Areas

The status refers to the current social and economic conditions such as household demography, livelihood activities, sources of income, HWC and the state of natural resources information of the study areas collected from the household interviews, KIIs and FGDs with respondents.

Characteristics of the respondents

A total of 425 respondents were interviewed of which 52.9% were females and 47.3% were males. The respondents consisted of Ngalops7, Lhotshampas8, Khengpas9 and Mangdibs10 ethnic groups from 10 Gewogs under 6 Districts. All the respondents were between the age of 18-60 years.

Majority of the households in the study areas are headed by females. All respondents' households in Punakha, Wangdue, Trongsa and Zhemgang are headed by women with 40.3%, but in Dagana and Tsirang, majority of the households are headed by men with 28.8% (Refer to Table 1).

5 Ngultrum is a Bhutanese legal tender currency.

6 RSPN is an environmental CSO based in Thimphu, Bhutan.

7 Ethnic group of Bhutan settling in the western region of the country who speaks Ngalopkha, a polished version of Dzongkha.

8 Ethnic group of Bhutan settling in the southern region of the country who speaks Nepali. 9 Ethnic group of Bhutan settling in the central region in Zhemgang who speaks Khengkha. 10 Ethnic group of Bhutan settling in the central region in Trongsa who speaks Mangdikha.

Vol. 09, No. 01; 2024

ISSN: 2456-8643

Table 1: Information of the Respondents

Chiwogs	Gewogs	Districts	Female	In %	Male	In %	Total
Norbuling	Tashiding	Dagana	11	2.6	47	11.1	58
Samarchu	Tsendagang	Dagana	5	1.2	33	7.8	38
Tshachuphu-Kewana	Toewang	Punakha	18	4.2	14	3.3	32
Zawa-Jargang	Athang	Wangdue	27	6.4	4	0.9	31
Toiesang-Balwani	Barshong	Tsirang	26	6.1	29	6.8	55
Sunkush	Rangthangling	Tsirang	12	2.8	13	3.1	25
Nimshong	Korphu	Trongsa	45	10.6	25	5.9	70
Ngormey-Bayzam	Langthel	Trongsa	25	5.9	10	2.4	34
Goling	Nangkor	Zhemgang	37	8.7	18	4.2	55
Berti	Trong	Zhemgang	19	4.5	8	1.9	27
Total			**225**	**52.9**	**201**	**47.3**	**425**

Livelihood Sources: Livelihood Activities and Sources of Income

Elsewhere in the developing nations in the world, farming is the prevalent source of livelihood for rural communities in Bhutan as about 60% of the population relies on subsistence agriculture and livestock farming for livelihood. Likewise, respondents in the study areas pursue a variety of activities such as agriculture, livestock and business/off-farm for existence as shown in figure 4.

Furthermore, **figure 4** indicates that 86% and 11% of respondents respectively consider agriculture and livestock as very important, while 11% of respondents believe business/off-farm as very important. Despite some variations, most of the communities in the study areas focus primarily on subsistence agriculture and livestock farming as the main source of livelihood activities supplemented by diverse small-scale income generating ventures based on existing and emergent opportunities.

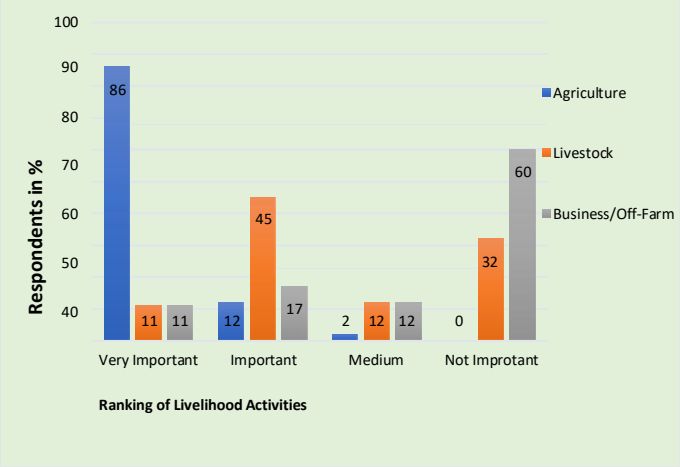

Figure 4: Types of Livelihood Activities and Importance

Vol. 09, No. 01; 2024

ISSN: 2456-8643

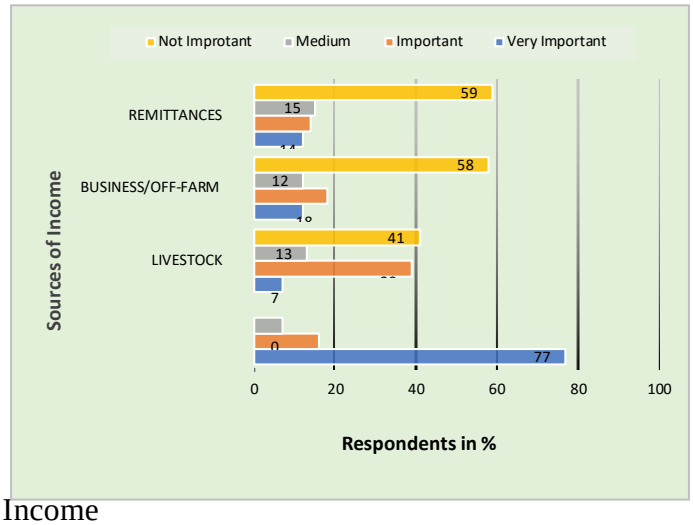

Figure 5: Sources of Income

Similar to most of the rural areas in developing countries, Bhutan's rural livelihood is complex, predominantly agriculture supplemented by livestock with some households depending on small-scale business/off-farm activities to earn additional income and ensure a sustainable standard of living. In this respect, **figure 5** specifies that the primary sources of income of the households in the study areas include agriculture, livestock, small-scale business/off-farm activities, and remittances from family members who work in the country and overseas.

Figure 5 further establishes that 77% of respondents rate agriculture as very important source of income, followed by 7% of respondents consider livestock as very important source of income, while small-scale business/off-farm ventures and remittances are regarded as very important source of income by 12% of respondents. However, the multiple subsistence activities pursued by the households make it difficult to clearly distinguish between the various sources of income.

Impacts of Human-Wildlife Conflict

Given that 60% of people in Bhutan depend directly on the production of crops and animals for their livelihoods, HWC has emerged as a major concern in the country. As a result, the majority of respondents in the study areas expressed the significant effects of HWC on crop loss.

As shown in figure 6, 37% of respondents reported that crops were damaged by wildlife very frequently resulting to reduction in crop yield, and 7% of respondents expressed that shifting in livelihood activities also occurs very frequently. However, only 4% of respondents felt reduction in cultivation area, 3% of respondents reported in abandonment of farmland and 2% of respondents expressed changes in cropping pattern to adjust and combat the HWC. While the impacts are not very significate, yet it is evident that HWC has distinct effects on rural areas; as a result, HWC and its detrimental effects on crop productivity continue to be a long-standing unresolved national concern.

Vol. 09, No. 01; 2024

ISSN: 2456-8643

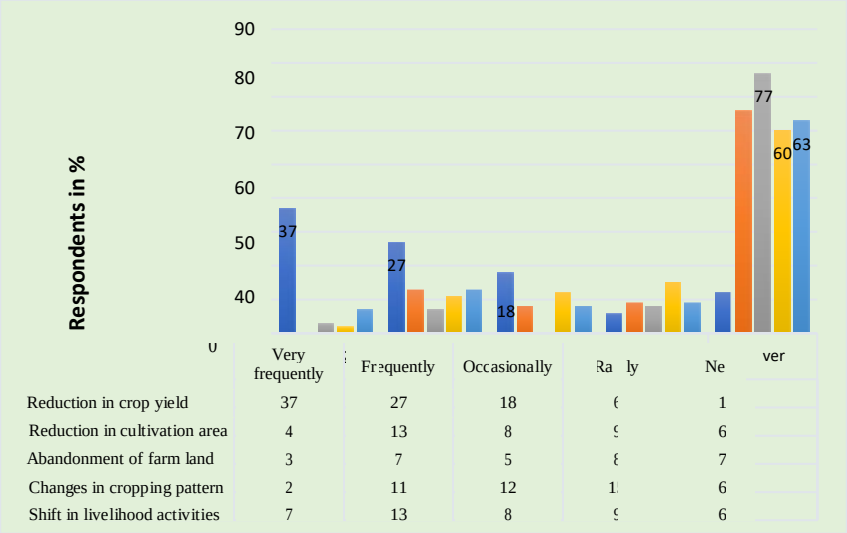

Figure 6: Impacts of Human-Wildlife Conflict

Major Crops Grown and Crop Preferences by Wildlife Species

Notwithstanding some minor variations between the study areas, the majority of the respondents practice agriculture as their primary farming activity. As a result, farmers in the study areas commonly grow crops such as paddy, maize, wheat and millet along with cash crop vegetables like chili, potato, beans and cabbage as shown in table 2. In addition, table 2 indicates 8 significant wildlife species that damage crops of the farmers in the study areas.

Furthermore, table 2 presents the crop and vegetable preferences of each damaging wildlife species in the study areas, and 42.4% of respondents stated that wild boar is the most destructive wild animal, followed by 21.2% of respondents on monkey and 20% of respondents on porcupine respectively. Similarly, 7.1% of respondents and 5.9% of respondents regarded barking deer and sambar as moderate damaging wild animal, while respondents expressed rodents, bear and elephants11 as less destructive wild animals. However, most farmers in the study areas do not maintain records, it is challenging to determine the numbers of crop damaging wildlife and intensity of crop damage in terms of quantity and value lost.

11 Presence of elephants and crop damage by elephants is reported in Samarchu villages under Dagana District of the study area.

Vol. 09, No. 01; 2024

ISSN: 2456-8643

Table 2: Major Crops Grown, Wildlife Crop Damage and Crop Preferences of Wildlife

Crops Grown	Crop Preferences of Wildlife	Wililife Species	Respondents in %
Paddy	Paddy, Maize, Wheat, Millet, Potato	Wild Boar *(Sus scrofa)*	42.4 (180)
Maize	Paddy, Maize, Wheat, Millet, Potato, Chilli	Monkey *(Macaque/Macaca)*	21.2 (90)
Wheat	Paddy, Maize, Potato, Chilli, Cabbage	Barking Deer *(Muntiacus mutjak)*	7.1 (30)
Millet	Paddy, Maize, Potato	Sambar *(Cervus unicolor)*	5.9 (25)
Chili	Paddy, Maize, Potato	Porcupine (*Hysterix*)	20.0 (85)
Beans	Maize, Wheat	Bear *(Ursus)*	1.7 (7)
Potato	Paddy, Maize, Potato	Rodents: Rat and Squirrel *(Rattus and Sciuridae)*	0.7 (3)
Cabbage	Paddy, Maize, Wheat, Millet, Potato, Cabbage	Elephant *(Elephas maximus)*	1.2 (5)
Total			**100.2 (425)**

Extent and Period of Crop Damages and Crop Guarding

Bhutanese people generally view HWC as a significant problem, and this perception appears to be higher in the study areas as majority of the areas are either inside or adjacent to protected areas. According to figure 7, over 82% of respondents viewed crop destruction by wildlife as one of the most serious issues since it significantly reduces crop yield, and it is further supported by the State of the Nation Report (RGoB, 2023), which states that 'HWC remains one of the leading issues faced by farming communities. However, a relatively small proportion of respondents: 11.8% and 5.9% respectively perceived that crop damage caused by wild animals as moderate or not serious.

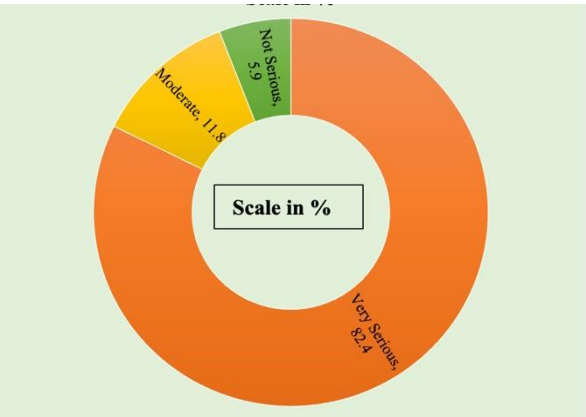

Figure 7: Scale of Crop Damage by Wildlife

Furthermore, majority of the respondents stated that there is an increasing trend in crop damage incidents, despite a decline in livestock predation by wildlife. This trend is attributed to fragmentation of wildlife habitats due to rapid urbanization and infrastructure development, the expanding agricultural activities, and regeneration of forest in fallow farmlands.

To further substantiate the effects of HWC, figure 8 displays seasons, period and people engaged in guarding. Likewise, 90.6% of respondents shared

Vol. 09, No. 01; 2024

ISSN: 2456-8643

that crop damages mostly happens in the summer and autumn, whereas 9.4% reported that crop damage pertaining to vegetables occurs in the winter and spring. In terms of duration of crop guarding, 88.2% of respondents said they had to guard for 2 months, while only 11.8% said they had to guard for

3 months during which a significant amount of productive time is lost. In addition, 91.8% of respondents expressed that women and man guard the crops equally, while 5.9% and 2.4% respectively stated that only men and women guard the crops.

Figure 8: Period of crop damage and duration of guarding

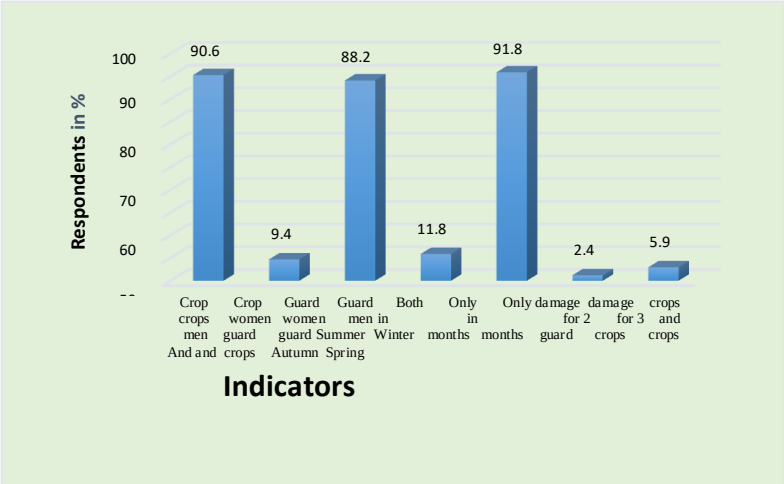

Figure 8: Period of crop damage and duration of guarding

Existing Mitigation Measures and Expected Mitigation Measures

Farmers in Bhutan regularly implemented number of conventional measures such as guarding, fencing, netting and scare-crows to protect their

crops from wildlife damage. Likewise, figure 9 shows that about 47% of respondents practiced guarding, 13% of respondents install fence, 3% of respondents bang tins and 1% of respondents host scare-crows, which are conventional methods of keeping wildlife away from crops. With government and donor assistance, over 35% of respondents relied on an electric/solar fence to prevent wildlife damage their crops.

In addition, table 3 displays the crop protection measures currently in use and their efficacy About 290 respondents shared that electric/solar fence is most effective as it can contained all the wildlife except elephant. Further, almost 92 respondents expressed that barbed-wire/stone/wood/bamboo fencing works well against wild boar, barking deer and sambar. While 43 respondents indicated that guarding is effective only during day, and respondents acknowledged that scare-scows and banging tins are somewhat effective at first; but once the wildlife becomes accustomed to the techniques, its ineffective for any kind of wildlife.

Vol. 09, No. 01; 2024

ISSN: 2456-8643

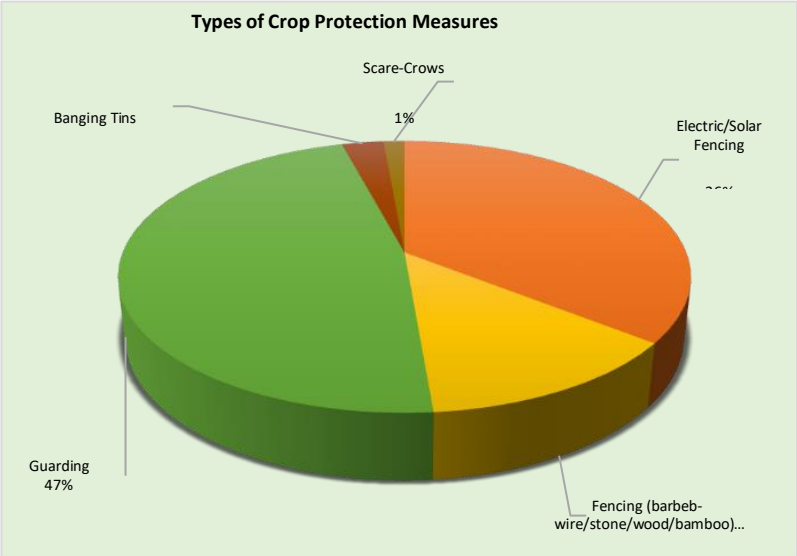

Figure 9: Crop Protection Measures Practices by Farmers

Table 3: Types of Crop Protection Measures and Effectiveness

Existing Crop Protection Measures	Respondents in %	Effectiveness	Respondents
Electric/Solar Fencing	35.5	Very effectiveness to all the wililife except elephant	290 (68.2%)
Fencing (barbeb-wire/stone/wood/bamboo	13.1	Effective for wild boar, barking deer and samber	92 (21.6%)
Guarding	47.1	Effectiveness during day time only	43 (10.)
Banging Tins	2.8	No effective	0
Scare Crows	1.4	Not effective	0
Total	**100.0**		**425 (100.0)**

In relation to the efficacy of current crop protection measures, figure 10 illustrates farmers' expectations regarding the necessity for adequate protection measures to mitigate and reduce HWC.

About 220 respondents prefers chain- link fence, followed by 124 respondents on need of HWC Management Endowment Fund as long-term measures to combat HWC. Similarly, 70 respondents still prefer electric/solar fencing and only 11 respondents feel crop diversification would somewhat mitigate their crop damage by wild animals.

Vol. 09, No. 01; 2024

ISSN: 2456-8643

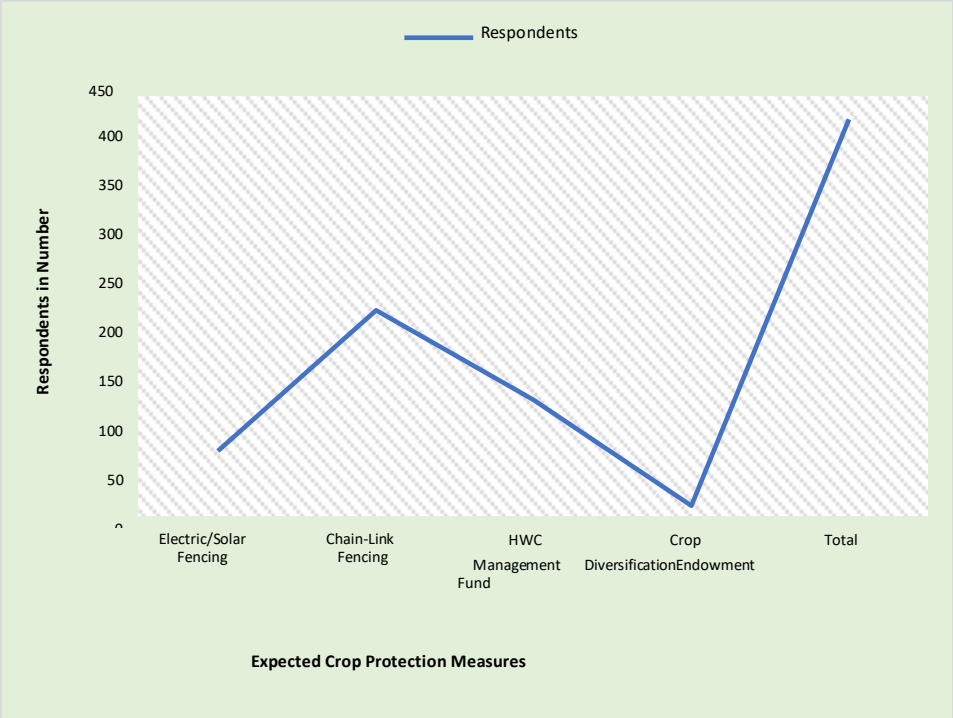

Figure 10: Expected Effective Crop Protection Measures by farmers

Knowledge of communities on conservation rules and regulations

Bhutan, a nation known for its commitment to environmental conservation and preservation of its rich biodiversity, has number of enabling rules and regulations that ensure the sustainable management of natural resources and protection of wildlife without jeopardizing the livelihood of rural communities. Local communities are actively engaged in the conservation of wildlife, and knowledge of these conservation rules and regulations is primarily disseminated through participatory education and awareness programs.

The communities' awareness of the existing conservation rules and regulations is illustrated in figure 11. The majority of respondents: 70.1% said they are moderately aware of the positive aspects of the existing conservation rules and regulations, which is encouraging for the nation's conservation efforts. However, only 20% of respondents are well aware and 9.9% of respondents are not aware, which may be related to the respondents' limited literacy knowledge

Vol. 09, No. 01; 2024

ISSN: 2456-8643

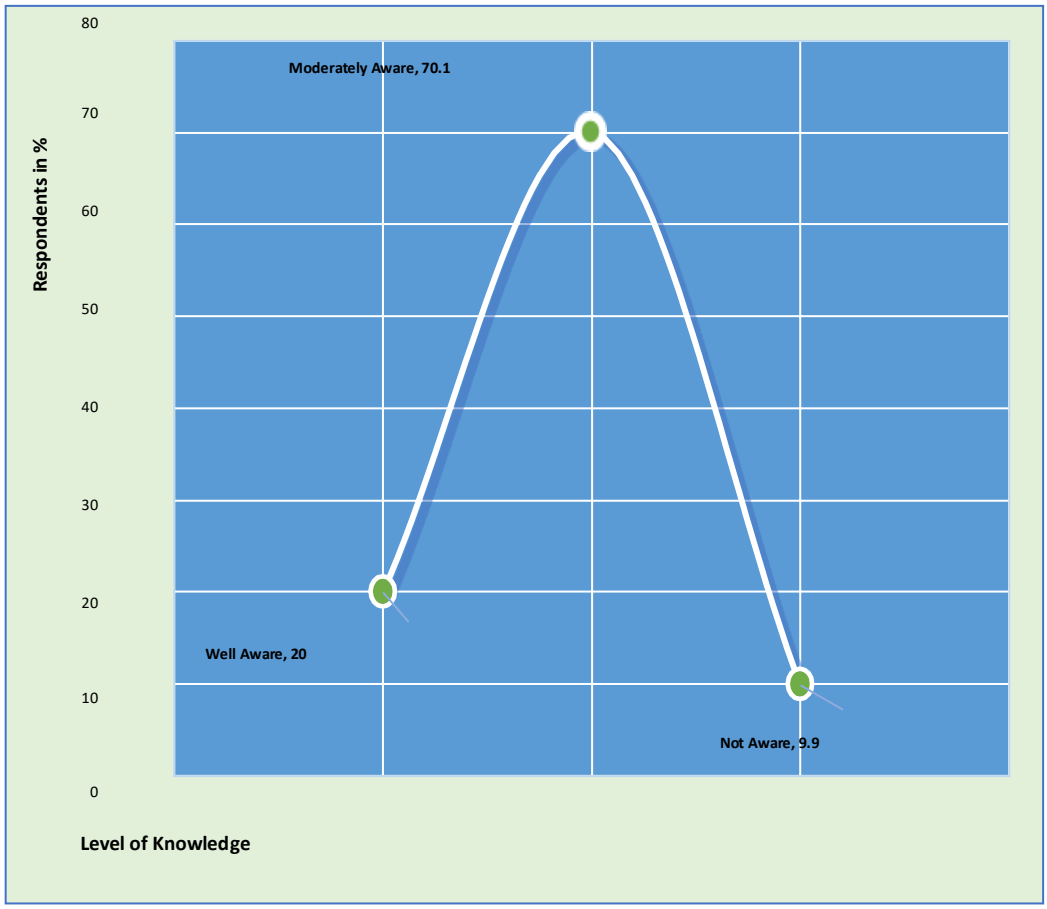

Figure 11: Communities' knowledge on conservation rules & regulations

4. CONCLUSION AND RECOMMENDATIONS

Human-Wildlife Conflicts have intensified in recent years in the Hindu Kush Himalayas (HKH); and Bhutan, a country in the Himalayas known for its rich biodiversity has observed a similar trend (Sharma et al., 2021). Thus, Bhutan continues to face the difficult challenge of striking a balance between the needs of wildlife conservation and the livelihoods and general well-being of local communities. This study elucidated a common view that HWC is the main cause of obstacles to rural communities' ability to produce adequate food for themselves. The study also established information on kind, extent and periods of damages, as well as perceptions and potential solutions to lessen crop loss and combat HWC. The study observed that government and agencies have supported interventions to reduce HWC, yet the issue remains as one of the most serious problem due to inadequate long-term and reliable intervention strategies. The study concluded that rising HWC incidences are linked to fragmented wildlife habitats brought by accelerated urbanization and infrastructure development, expanding agricultural activity, and forest regeneration on fallow farmlands. Therefore, the study suggested that support of adequate and sustainable long-term interventions would enhance the harmonious coexistence of humans and wildlife.

Vol. 09, No. 01; 2024

ISSN: 2456-8643

The following recommendations for possible HWC reduction strategies may be advantageous for the study regions and the nation at large:

The majority of the villages in the study areas are either inside or adjacent to protected area system of the country where greater number of wildlife inhabits, which results in higher incidences of HWC. Therefore, establishment of HWC Management Groups and Community-based Endowment Fund to compensate the affected farmers through a Sustainable Management Framework (refer figure 12) will strengthen the harmonious coexistence of human and wildlife.

The study found that electric/solar fencing is very effective in containing different wildlife amongst other measures; therefore, support of electric/solar fencing with plastic poles and maintenance guideline would be long-lasting and effective deterrent to wildlife. Further, majority of the farmers prefer chain-link fence around their farmland since they believe it to be more effective than other measures. However, requires a clear cost-benefit analysis, effectiveness and its negative impacts to natural ecosystem since chain-link fence requires huge installation cost, is not a nature-based solution, and does not completely protect crops from all wildlife.

The study observed that agriculture farming is and will continue to be a reliable source of livelihood for farmers in the study areas and HWC may continue until the farmers adopt an alternative farming practices that is less palatable to wildlife. Therefore, it is imperative that farmers diversifying their crops and investing in alternative income-generating activities such as ecotourism and other small-scale enterprises with improved rural amenities and financial services would be a push factor for balance socio- economic development and conservation.

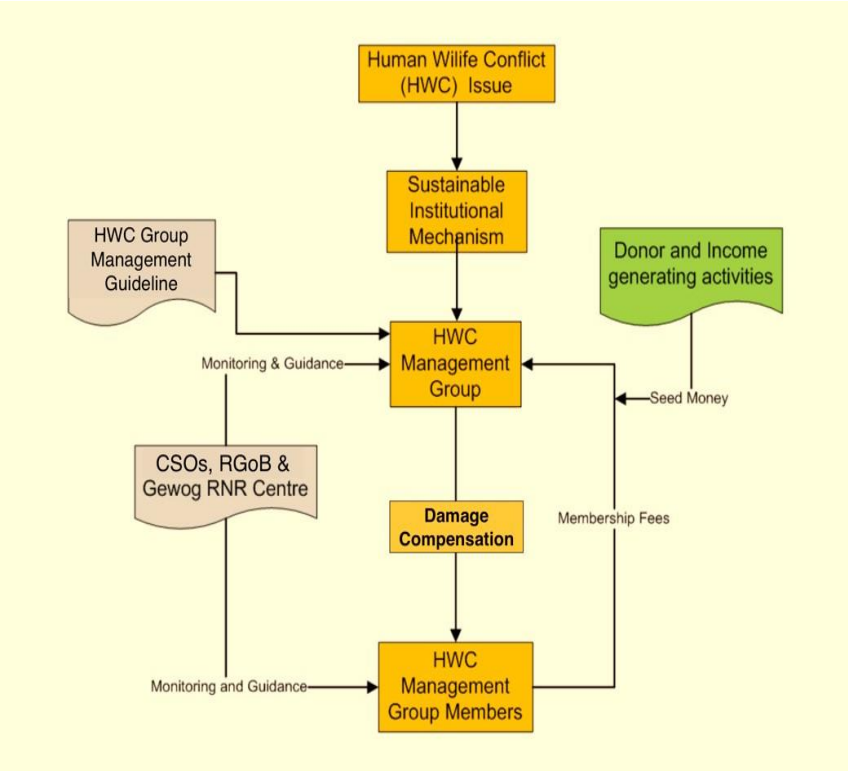

Figure 12: Community-based HWC Management Framework in the study areas

Vol. 09, No. 01; 2024

ISSN: 2456-8643

Disclaimer/Author's Note: The information acquired through this study may not be sufficient to produce representative results as the findings and observations are made solely based on the responses of respondents and field observations.

REFERENCES

Dema, C. (2021). Community support critical for effective electric fencing. Kuenselonline.com news, Thimphu, Bhutan.

DoFPS. (2023). National Forest Inventory Report. Thimphu, Bhutan: Department of Forest and Park Services (DoFPS), Ministry of Energy and Natural Resources (MoENR).

NPPC and WWF-Bhutan. (2016). Human Wildlife Conflict Strategy: Nine Gewogs of Bhutan. Thimphu: National Plant Protection Center (NPPC) and WWF-Bhutan.

NSB. (2019). Population Projection for Bhutan 2017-2047. Thimphu: National Statistics Bureau of Bhutan, Royal Government of Bhutan, ISBN 978-99936-28-72-9, pp. 1-87.

Palden, T. (2019). HWC endoment fund targets USD35M. Kuenselonline.com news, Thimphu, Bhutan.

Penjor, T., Dorji, L., Nima, C., Yangzom, D., Chhetri, P.B., Norbu, T., and Dorji, L. (2014). Fabricated Electirc Fencing (FEF) System: A new approach to mitigate Human-Wildlife Conflict in Bhutan. Thimphu, Bhutan: SAARC Foresty Center.

RGoB. (2023). State of the Nation, Tenth Session, Third Parliment of Bhutan. Thimphu: Royal Government of Bhutan.

RSPN. (2012). Sustainable Institutional Mechanism for HWC Management: pilot-initiatives-to-reduce-human-wildlife-conflict-management-in-kangparaq, RSPN, Thimphu, Bhutan.

RSPN. (2022). Ecosystem and Socio-economic Resilience Analysis and Mapping: A pilot assessment in White-bellied Heron habitats along Punatsangchhu and Mangdechhu basins, Bhutan. Thimphu, Bhutan: Royal Society for Protection of Nature (RSPN).

Sharma, P., Chettri, N., & Wangchuk, K. (2021). Human-wildlife conflicts in the roof of the world: Understanding multidimensional perspectives through a systematic review. Ecology and Evaluation, 11, https://doi.org/10.1002/ece3.7980, pp. 11569-11586.

Today, B. (2022). Wild elephant tramples a man to death, making it second incident of HWC this year in Gelephu, Sarpang. Bhutan Today, bhutantoday/facebook post, Thimphu, Bhutan.

Tobgay, S., Wangyel, S., Dorji, K., and Wangdi, T. (2019). Impacts of crop raiding by wildlife on communities in buffer zone of Sakteng Wildlife Sanctury, Bhutan. International Journal of Scientific Research and Management (IJSRM), Volume 07, Issue-4, ISSN (e): 2321-3418, pp. FE-129-135.

Tshering, T. (2019). Human-Wildlife Conflict: Sustainability of Electric Fencing as Mitigating Measures in Paro Dzongkhag; A Thesis submitted to the Graduate School in Partial Fulfillment of the Requirements for Master of Science in Geographic Information Science. Thailand: Naresuan University.

Wangchuk, S., Bond, J., Thawaites, R., and Finlayson, M. (2023). Exploring Human-Wildlife Conflicts and Implications for Food Self-Sufficiency in Bhutan. Sustainability 2023, 15, 4175. https://doi.org/10.3390/su15054175, pp. 1-16.

Wangdi, N. (2022). Wild animals damage 8,250MT of crops annually. Kuenselonline.com news, Thimphu, Bhutan.

Wangdi, S., Norbu, N., Wangdi, N., Yoezer, D., Choden, K., and Wangchuk, J. (2018). Demystifying the Link Bewteen Rural Migration and Human Wildlife Conflict: A case of

Vol. 09, No. 01; 2024

ISSN: 2456-8643

Gangzur and Khengkhar, Eastern Bhutan. Ugyen Wangchuk Institute for Conservation and Environment Research (UWICER) Press, Lamai Goenpa, Bumthang, pp. 1-48.

WCD. (2016). Summary: Bhutan's State of Parks Report 2016. Thimphu, Bhutan: Wildlife Conservation Division (WCD), Department of Forest and Park Services (DoFPS), Ministry of Agriculture and Forest (MoAF), Royal Government of Bhutan.

WWF. (2012). Strengthening harmonious balance between human and wildlife: WWF-supports-Human-wildlife-Conflict-Management-Endowment-Fund-with-Nu-Two-Million. WWF Bhutan Program Office, Thimphu.

Yangdon, S. (2016). Seven bear attacks since 2016. The Bhutanese, thebhutanese.bt news, Thimphu, Bhutan.

Yeshey, Rodney, J., Keenan, Rebecca, M., Ford, Craig, R., and Nitschke. (2023). How does conservation land tenure affect economic impacts of wildlife: An analysis of subsistence farmers and herders in Bhutan. Elsevier - Trees, Forests and People 11 (2023) 100378, pp. 1-13.

Yuden, K. (2022). Government to spent a billion on chain link fencing to protect crops from animals. The Bhutanese, thebhutanese.bt news, Thimphu, Bhutan.