Policy Recommendations for Human-Wildlife Conflict Mitigation in Uttarakhand Himalayan Regions: an Agricultural Scenario

Jaya Rai, Prem Kumar, Shweta, Sarad Yadav, Arbind K. Thakur, Harshulika

Abstract— **In hilly terrain, human-wildlife conflict (HWC) has become a significant problem due to wild animals raiding the crops. India being an agricultural economy, human wildlife conflict poses serious hardships on the livelihoods of the population as the majority part relies on agriculture for sustenance. This paper is an attempt to highlight the nature of human wildlife conflict encountered by the residents of Uttarakhand, their response and suggest mitigation measures to protect crops from HWC in the study area. Besides, this also includes a policy recommendation for the state of Uttarakhand inculcating the comparative scenario with other Himalayan states. The human wildlife conflict can be attributed to negative interaction between the two as a consequence of shared common resources. On the human side, the consequences may lie in form of possible financial losses, such as loss of property, crops, livestock, and human life, hence reducing the farmers' physical and mental well-being and causing them to suffer. While, the biodiversity suffers heavy loss in form of indiscriminate killing of the animals. The Indigenous farmers in Uttarakhand produce a wide range of crops ranging from paddy to tomato. Therefore, safeguarding these crops against animal menace is crucial for enhancing the farmers' livelihood and economy. Several traditional methods, although with limited success, have been adopted to protect the crops from animal raids. However, nowadays modern techniques such as solar fencing and installation of acoustic devices are also being implemented in coupling with the traditional methods to improvise the mitigation strategies against the HWC.**

***Index Terms*— Animal Invasion, Crop Loss, Human Wildlife Conflict, Livelihood, Policy**

I. INTRODUCTION

Human wildlife conflict is one of the most controversial issues arising due to the sprawling anthrosphere, as people are tendered only towards the losses incurred by the human community. They endow highly feeble perception regarding the loss that is being endured by the biodiversity and the detrimental down fall in the biotic equations. Globally, crop raiding, livestock predation and life loss by the wild life are the major notorious expressions of HWC. India is a country with a heavy reliance on agriculture because 80% of the population makes their livelihood from agriculture [20]. Human-wildlife conflict is a frequent occurrence in India these days due to a decline in forest cover and the encroachment of forest land for residential and agricultural purposes. Since the human and wildlife populations share the same natural resources, these conflicts always have a significant negative impact on the livelihood and security of the local community [4]. Such conflicts are often evidenced due to the overlapping of the wildlife's requirements with human populations creating costs to residents and wild animals [17]. Lack of an effective HWC mitigation approach has affected both humans and the animals.

Several methods/practices have been adopted in India to deal with the animal menace on croplands. Few notable and effective mitigating practices are fencing and barrier construction, producing distressing stimuli, setting traps, guarding and regulated crop management [26], [11]. However, these have not been very successful, mostly because some primates are successful crop raiders due to their social nature and adaptability, especially in the Himalayan region. Researches have shown that due to cooperative behavior, flexible lifestyle and dietary habits, primates such as baboons [3], [6], vervets [25], and macaques [23] take readily to living alongside humans in rural or sometimes urban and sub-urban settings. When living around people, their highly adaptive nature and capacity for rapid learning and behavior modification make them both highly successful and possibly problematic [5].

An effective human–primate conflict resolution requires multifaceted and sustainable approaches involving the entire community, which acknowledges that the conflict results not only in economic loss but also social disharmony among the human groups with different interests and cultural values [5]. In HWC management, success is likely to be achieved only if the outcome is acceptable to the entire community so that parties do not assert their interests to the detriment of others. In addition, any management approach would also need to take into consideration the cultural and religious values of the local community with respect to the wildlife with which they interact on a regular basis [12]. A community approach with a proactive involvement of the stakeholders would ensure effective implementation of the technology as well as its sustainability [21].

II. INDIAN SCENARIO OF ANIMAL INVASION WITH SPECIAL FOCUS ON UTTARAKHAND

In the past few decades, due to fast depletion of forest cover, an increment in HWC, mainly in the form of crop raiding by

Jaya Rai[1], Prem Kumar[2], Shweta[3], Sarad Yadav[4], Arbind K. Thakur[5], Harshulika[6]
[1] National Institute of Disaster Management, Ministry of Home Affairs, Rohini, New Delhi, 110042
[2] Department of Geology, University of Delhi, India, 110007
[3] Vinoba Bhave University, Hazaribagh, Jharkhand, India, 825301
[4] Shaheed Bhagat Singh College (Evening), University of Delhi, New Delhi, India, 110007
[5] Department of Environmental Studies, University of Delhi, New Delhi, India, 110007
[6] Environmental Resources Management (ERM), Gurugram, Haryana, 122002.

animal species specially Rhesus macaque (monkey), porcupine and wild boar has been reported from all over India [7]. The population of monkeys in India has grown at an alarming rate during the last decade. According to the last count, there were 50 million monkeys in India which has migrated from the forest areas towards towns and cities and to the cultivated areas. There is no centralized data bank on monkey raids in the country. However, according to official and media reports, 20 States/UTs have reported significant crop damages due to monkey attacks. Sometimes in severe attack, they cause damage up-to 90% in agriculture and horticulture [9]. They raid crops and utilize the agro-ecosystems for food resources and shelter. Hence monkeys are considered pests in the areas of massive agriculture, horticulture, and other plantations. Crops damaged by the Monkeys are a matter of grave concern. Monkeys have an extended dietary range including roots, shoots, leaves, fruits, even grasses. The large tracts/chunks of agricultural lands in several regions of India have been left barren due to huge armies of defiant monkeys. India also has more than 100 rodent species and vertebrate species which are harmful for crops; they include porcupines, squirrels, gerbils, bandicoots, rats, mice, voles, wild boars, nilgai and monkeys [8].

Monkeys of different species have become a major crop destroyer in Uttarakhand. There are three major threats to the crops in the study area. The main crop raiders are wild boar, monkeys and porcupines. In 2016, the wild boar (*Sus scrofa*) has been declared as a vermin in 13 districts of Uttarakhand [26]. Various studies have reported wild boars to be serious threats to some specific crops such as rice, jawar, potato, bajari, wheat, sugar cane, maize, pulse, etc. [10]. These crop fields are more prone to raiding by wild boars due to higher nutritive values and preferential feeding patterns. In addition to this availability of ample amount of water in areas proximal to crop fields is one of the major attractive factors for crop raiding. The inhabitants of Uttarakhand possess consequential discontent due to crop depredation by the wild lives [10].

III. Study Area

The area selected for the study comprises the Uttarakhand state of the Indian Himalayan Region. Climate change, notably altered rain patterns that result in extreme events, has slowed down the agricultural activity in Uttarakhand's mountainous terrain in recent years. The agricultural productivity in the region has evidenced a downfall due to the adverse impacts caused by the changing climate. Despite the governmental support, the region fails to meet the expected potential ultimately resulting in declining economy and livelihood generation for the local inhabitants [26]. Currently farmers are engaged in sourcing sustenance based livelihood generation resulting in migration to urban areas offering the additional sources of employment. This rapid urbanization has led to ghosting of the villages in the Kumaon region leading to abandoning of the traditional houses in the region. The very few population left behind encounters additional issue in form of the human wildlife conflict manifesting heavy crop loss due to raiding by the wild animals. The wild life imposing such conflict in the area includes boars, monkeys, porcupines and rodents (Fig1). Climate change in association with HWC has decreased the agricultural productivity eventually demotivating the farmers towards agriculture [10]. This results in increase of fallow land leading to fluctuation in the land use land cover of the area. The topography of the state significantly covered by forest cover offers easy access to the primates for raiding the crop lands. In addition to the revival of agricultural practices by reducing the human wildlife conflict, effective utilization of the resources is an important necessity. The state has highly undulating and variable topography with varying distribution of water resources. The state is home to numerous large and small streams and waterfalls offering good sources of irrigation for agriculture [1]. Also the state encounters flat land agriculture fields as well as terraced hill slop croplands. With such diverse agro-climatic features, the 75% of the population derives its livelihood from agriculture with subsistence farming as their main practice [24].

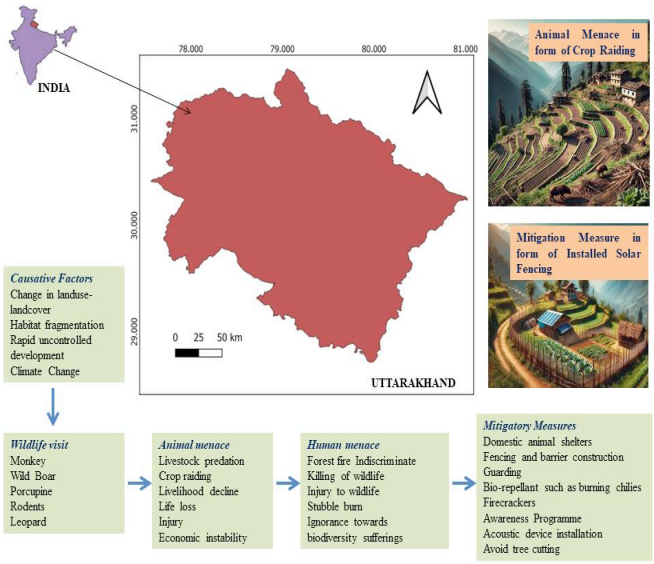

Fig 1: Map depicting human-wildlife conflict in Uttarakhand State—animals and human menace and measures suggested to reduce conflict.

IV. Methods Used for Mitigation of HWC Problem

Human wildlife conflict is serious threat for the inhabitants of various Indian states like Uttarakhand. However human wildlife conflict management and mitigation is a monotonous and long-lasting process that requires smart involvement of the local inhabitants of an area. The success of the mitigating techniques is subject to integrated implementation of various techniques and awareness of the inhabitants as well [2]. There are traditional as well as modern methods to minimize the crop loss due to wildlife invasion. Integrated implementation of traditional and modern methods would enhance the success ration of HWC mitigation. To enlist few significant traditional techniques are guarding, use of scare crows, development of trenches and stone walls. Since long times, people have been also using string fences with metallic and glassy objects to keep the wild boars away from their crop lands [22]. Apart from these people have been opting burning of chilies, bone fire and fire crackers as most preferable modus operandi for deterring the wild lives [1]. However, with technological advancement and increased environmental awareness,

people are shifting their interest towards adopting modern technologies as mitigating methods [22]. Habitat management, use of acoustic and visual deterrents, olfactory deterrents, infra-red sounds and rays, etc. are few preferential notable modern technologies (Fig 1). Biofencing has been used by the Uttarakhand government as an effective technology for mitigating HWC. *Capsicum sp.* and turmeric are very effective olfactory deterrents [1]. Power fencing such as solar fencing, barbed wiring and electrical wiring are significant non-lethal methods that create psychological fear among the wild animals [16]. Apart from the above measures cultivation of non-palatable crops is also an option to minimize the animal menace. Various infrared alarms and rays irradiant are also available that are effective in conflict minimization. For successful combat of human-wildlife conflict few state governments have also allowed selective killing of vermin animals in some cases and their sterilization in other cases to avoid their population growth [1].

V. Legislative Rules and Policies for Wild Life Conservation Against HWC

The Indian government imposes strong legislative control over wild life conservation against the rising biodiversity decline due to urban sprawling and anthropogenic interference in the biosphere. The Section 144 of CPC imposes coordinated action of local police, civil and forest administrations to enunciate actions regarding any harm caused to wildlife while human-animal conflict. Wildlife conservation and peaceful coexistence of human beings with animals are the one of the foremost concerns took care of in the Indian constitution [1]. The articles 48A and 51g ensure the duties of citizen and states respectively towards environmental protection [8]. Besides these the forest and wild life have been also enlisted in concurrent list of the country to emphasize more on biodiversity conservation. Project snow leopard (2006), Project tiger (1973), integrated wild life habitats (2010), etc. are few centrally sponsored schemes for wildlife conservation. Addressing wild life conflicts is one of the major objectives of these schemes. The National Wildlife Action Plan 3 program launched in 2021 has special focus on minimizing human-wildlife conflict thereby increasing the shrinking population of various life forms [15]. However, the state government of Uttarakhand, have declared wild boars as vermin for the local farmers. The government has forbidden the killing of these wild boars in serious circumstances as a part of HWC combats [26]. However, there are few government organizations and NGO's such as WII, Dehradun and Friends of Doon (Uttaranchal) that are intended towards peaceful and sustainable co-existence of humans and wildlife.

VI. Policy Recommendations

Seventy five percent population of Uttarakhand depend on agriculture for livelihood generation [24]. This dependency on agriculture makes the crop raiding one of the most noxious impacts of HWC suffered by the people. According to research by Karanth et. al., 2019, out of the 29 Indian states (excluding of the union territories), 28 are provided with compensation for human injury or death, 26 for livestock, 22 for crop loss, and 18 for property damage [18].

The central government of India provides few financial assisting schemes to the farmers across the nation for combating HWC effectively. To mention them the most notable contribution of the GOI is the The Pradhan Mantri Fasal Bima Yojana (PMFBY). The Pradhan Mantri Fasal Bima Yojana (PMFBY) launched from Kharif 2016, was mainly focused to provide support to farmers in terms of an affordable crop insurance for an assured risk cover for crop damage against all natural risks [14]. In order to pursue the financial aid through this scheme the farmers are meant to get their crops insured so that they may claim the loss due to wild life conflict as an add on coverage. Apart from this the central government also provides 40% and 50% subsidies of maximum permissible amounts for adopting various HWC mitigating techniques like installation of Bird Scarer, Solar operated/electric operated animal deterrent bioacoustics equipment (with solar panel and without solar panel).

In Uttarakhand there are government policies regarding human life loss due to wild life attack but there are no such reported financial supports regarding crop loss due wild life invasion. The farmers of Uttarakhand state are genuinely deprived off of proper financial support from government regarding the combat of HWC issues. There are only few assisting aids that the government provides to these farmers which merely turns to be boon to these famers. The state government of Uttarakhand with the state forest department as enacting body has provided the scheme of bio-fencing in crop lands proximal to forest regions. Bio-fencing is an innovative and economically environment friendly measure of mitigating the HWC issues. The officials have stated chilly, turmeric, lemongrass and agave as few animal repellant species to be highly recommendable for the purpose of bio-fencing. Apart from this there is a nation-wide financial aid provided by the central government to farmers of all states facing pre-sowing to post-harvest crop loss due to wild life attack. The farmers of Uttarakhand can claim very few financial assistance for crop loss against the schemes sanctioned by central government only. Ex-Gratia Payment for Loss Caused to Human Life and Property like crop damage by Wild Animals has been incorporated in the 12th plan of Uttarakhand by the central government. Man-animal conflict has been dealt as an important matter of concern in this plan outlay and a total amount of 3600 lakh rupees has been sanctioned to the forest department of Uttarakhand for successful HWC mitigation.

If we compare the scenario of the state with other Himalayan states then we figure out that there is very poor condition of the farmers in the state both due to lack of legislative financial assistance and absence of advanced technologies in agricultural practices. In particular if we talk about Himachal Pradesh, Mukhyamantri khet sanrakshan yojna has been proposed. This scheme provides assistance to the farmers to install solar power fencing to avoid their crop loss due to wild life raiding. Individual farmers are awarded with a subsidy of 80% while the community farmers are provided with a subsidy of 85% for installing the solar fences [13]. Whereas a subsidy of 50% is provided for installing barbed wired and 70% subsidy for composite fences. So, it is a grave need of the farmers to be assisted with some better legislative assistance in terms of

financial aids and policies to mitigate HWC in the state. Since people in Uttarakhand possess small farmlands thus the state government of Uttarakhand should promote community farming by providing special subsidy offer on HWC mitigating techniques for community farmers. However, if we talk about Jammu and Kashmir then there also the similar scenario as in Uttarakhand prevails. Here also the farmers are deprived off from the governmental assistance for mitigation of HWC effects. The farmers are mostly reliant on the schemes sanctioned by the central government for mitigating the impact of man-animal conflict.

The majority of compensation plans involve extremely convoluted administrative procedures for evaluating, submitting, and disbursing compensation. The absence of accountability and perhaps poorly designed systems can be problematic for victims and claims. Damage assessment is another issue with the compensation plans. People typically report receiving less compensation than the actual damage in most cases. Additionally, the package does not take into account indirect expenses such as hidden costs in the form of socio-cultural demands, transaction costs and psychological well-being. The state government as well as central government in coordinated fashion should propose ideal compensation packages and policies incorporating the highlighted issues like accurate damage assessment, rate evaluation in synchronized fashion with market trend, on time sanction of funds and revision of rates for compensation.

VII. Suggestions

1. Proper crop management is foremost important advice to the farmers thriving in these areas. The croplands in proximity with forest are meant to be managed with special emphasis. For instance, in the time periods of mating and gestation of the wild boars the agricultural fields must be sown with unpalatable and animal repellant crops such as turmeric, ginger, chilly, wild rose, cocoa, etc. [1].
2. Since in the study area the villagers have stated that along with wild animals few times their herds also manage to cause crop raiding, so proper herd management is one of the mandatory requirements [1].
3. Traditional methods like trenching around large crop fields can also be practiced in some fields to avoid invasion by wild boars [10].
4. Guarding with scare crows and night visits in fields are suggested to regulate the raiding by the wild boars during night [19].
5. The farmers are suggested to incorporate modern technologies as well as their traditional methods to combat HWC more effectively.
6. The farmers are suggested to grow more cash crops for better revenue generation in order to practice more sustainable and scientific agricultural practices. Also, the farmers should adopt community farming practices so that they shall be able to manage the crop fields more effectively.
7. In addition to these measures the farmers are suggested to get their crops insured so that they can claim their crop loss due to wild life conflict through the Pradhan Mantri Fasal Bima Yojana (PMFBY).

Authors Contributions

Material preparation, conceptualization, writing original draft, editing, and policy analysis were performed by Jaya Rai and Prem Kumar. *Shweta and Sarad Yadav contributed in drafting and reviewing the concept*. Arbin K. Thakur and Harshulika have commented and reviewed on previous versions of manuscript.

Declaration of Competing Interests

"The authors have no relevant financial or non-financial interests to disclose."

References

1. Anwar, R., Saralch, H. S., & Kumar, S. (2015). Human–wildlife conflict: issues versus mitigation. Indian For, 141(12), 1305-1314.
2. Balasubramanian, M., Baskaran, N., Swaminathan, S., & Desai, A.A. 1995. Crop raiding by Asian Elephant (Elephas maximus) in the Nilgiri Biosphere Reserve, South India in A week with elephants, J.C. Daniel & H. Datye eds. 1995, Bombay Natural History Society
3. Catherine M. Hill, Conflict of Interest Between People and Baboons: Crop Raiding in Uganda. International Journal of Primatology volume 21, pages299–315 (2000).
4. Distefano E. 2005. Human-Wildlife Conflict Worldwide: Collection of Case Studies, Analysis of Management Strategies and Good Practices. Initiative Report, FAO, Rome, Italy
5. Else, J. G. (1991). Nonhuman primates as pests. In Primate responses to environmental change (pp. 155-165). Dordrecht: Springer Netherlands.
6. Forthman-Quick, D. L. (1986). Activity budgets and the consumption of human foods in two troops of baboons (Papio anubis) at Gilgil, Kenya. In Primate Ecology and Conservation.
7. Gemeda, D. O., & Meles, S. K. (2018). Impacts of human-wildlife conflict in developing countries. Journal of Applied Sciences and Environmental Management, 22(8), 1233-1238.
8. Gopal R. (1992). Fundamental of Wildlife Management (1 Ed). Justice Home Publisher, India.
9. Gorjian, S., Singh, R., Shukla, A., & Mazhar, A. R. (2020). On-farm applications of solar PV systems. In Photovoltaic solar energy conversion (pp. 147-190). Academic Press.
10. Gureja, N., Kumar, A., & Saigal, S. (2019). Human-Wildlife Conflict in India. Report prepared for National Biodiversity Strategy and Action Plan (NBSAP), New Delhi.
11. Habib, A. (2016). Human-wildlife conflict-causes, consequences and mitigation measures with special reference to Kashmir. Journal of Zoology Studies, 2(1), 26-30.
12. Hoare, R.E. (2001a). Management implications of new research on problem elephants. Pachyderm 30:44–48.
13. http://hpagriculture.com
14. https://pmfby.gov.in/
15. https://wii.gov.in/nwap_2017_31
16.https://www.nabard.org/demo/auth/writereaddata/ModelBankProject/1612162331Solar_Fencing_(E)_in_Himachal_Pradesh.pdf
17. International Union for the Conservation of Nature (IUCN). 2003. Benefits beyond boundaries: Proceedings of the Vth IUCN World Parks Congress. Durban, South Africa, 1–17 September 2003. Gland, Switzerland & Cambridge, UK.
18. Karanth, K. K., Gupta, S., & Vanamamalai, A. (2018). Compensation payments, procedures and policies towards human-wildlife conflict management: Insights from India. Biological Conservation, 227, 383-389.
19. Kumar, A., Bargali, H. S., David, A., & Edgaonkar, A. (2017). Patterns of crop rading by wild ungulates and elephants in Ramnagar Forest Division, Uttarakhand. Human–Wildlife Interactions, 11(1), 8.
20. Manral, U., Sengupta, S., Hussain, S. A., Rana, S., & Badola, R. (2016). Human wildlife conflict in India: a review of economic implication of loss and preventive measures. Indian Forester, 142(10), 928-940.
21. Osborn, F. V., & Parker, G. E. (2003). Towards an integrated approach for reducing the conflict between elephants and people: a review of current research. Oryx, 37(1), 80-84.
22. Oswin P.B.M.A. (2009). The human-elephant conflict: A review of current status and mitigation methods. Gajaha, 30: 41-52.

23. Raghubir Singh Pirta Madhav Gadgil A. V. Kharshikar, Management of the rhesus monkey Macaca mulatta and Hanuman langur Presbytis entellus in Himachal Pradesh, India, Biological Conservation Volume 79, Issue 1, January 1997, Pages 97-106.
24. Rana, K., Kameswari, V. L. V., Chaudhary, S., & Kumar, D. (2019). Livelihood opportunities through agriculture and allied field in the mid-hills of Uttarakhand. Journal of Pharmacognosy and Phytochemistry, 8(5S), 81-86.
25. Simon J. Boulton and Stephen P. Jackson (1996), Identification of a Saccharomyces Cerevisiae Ku80 Homologue: Roles in DNA Double Strand Break Rejoining and in Telomeric Maintenance, Nucleic Acids Research, Volume 24, Issue 23, 1 December 1996, Pages 4639–4648. https://doi.org/10.1093/nar/24.23.4639
26. Sushmita, Sharma Babita and Kumar Ashok, Human wildlife conflict and its implications (2022). Scope and Challenges of Science Engineering and Technology (pp.59-83) Publisher: ANVI BOOKS & PUBLISHERS