Asian Journal of Basic Science & Research
Volume 8, Issue 3, Pages 61-73, July-September 2026

Mammalian Agricultural Pests and Their Management in the Arki Hills of Himachal Pradesh, India

Dr. Hem Raj[1*]

[1]*Government College Arki, District Solan, Himachal Pradesh–173208, India.*
Corresponding Author Email: suryahemraj@gmail.com[*]

DOI: https://doi.org/10.38177/ajbsr.2026.8304

Article Received: 26 May 2026 *Article Accepted: 27 July 2026* *Article Published: 11 August 2026*

ABSTRACT

Studies on mammalian pests of agriculture were conducted in the Arki hills situated in mid-hills of Himachal Pradesh. The soil of this region is suitable for growing cereals viz. wheat, maize, rice, barley and millets as well as pulses like brown chickpeas, horse gram, black gram, red beans, cowpeas, soybeans and lentils. In recent decades, farmers of this region have been demoralized by the destruction of their crops by wild mammalian pests and stray animals, resulting in a significant decline in agricultural cultivation. Crop raids by these animals have reduced the productivity of major crops by nearly 25%, causing a significant loss in yields. In this region, 19 mammalian pests of agriculture have been recorded are: House mouse (*Mus musculus*), Indian long-tailed Tree Mouse (*Vandeleuria oleracea*), House Rat (*Rattus rattus*), Large Bandicoot Rat (*Bandicota indica*), Lesser Bandicoot Rat (*Bandicota bengalensis*), Indian Gerbil (*Tatera indica*), Northern Palm Squirrel (*Funambulus pennantii*), Porcupine (*Hystrix indica*), Monkey (Rhesus macaque- *Macaca mulatta*), Langur (*Semnopithecus entellus*), Wild Boar (*Sus scrofa*), Nilgai (*Boselaphus tragocamelus*), Barking deer (*Muntiacus muntjak*), Sambar deer (*Rusa unicolor*), Indian Hare (*Lepus nigricollis*), Rabbit (*Oryctolagus ciniculus*), Red Fox (*Vulpes vulpes*), Asiatic Black Bear (*Ursus thibetanus)* and Indian Flying Fox (*Pteropus giganteus*).

Farmers in this region have adopted various management strategies to control mammalian pests, often employing an Integrated Pest Management (IPM) approach. These methods include agricultural fences, repellants, scaring devices, guarding and killing. In future, the modern farm technology such as the use of cameras, computers, drones and even robotics will prove the best solution to protect the crops from wild animals.

Keywords: Mammalian Pests; Arki Hills; Animal Menace; Integrated Pest Management; Stray Animals; Decline in Productivity; Management Strategies; Rodent Pests; Modern Farm Technology.

1.0. Introduction

Mammalian pests of agricultural crops are the animals that damage crops by feeding on plants, seeds, fruits, roots or by trampling fields. Major groups of mammalian pests of agricultural crops are: *Rodents* (most destructive group) e.g. rats, mice, squirrels, porcupines, gophers; *Primates* e.g. monkeys, baboons; *Ungulates* (hoofed mammals) e.g. deer, wild boar, antelope, nilgai; *Lagomorphs* e.g. rabbits, hares; *Large Mammals* e.g. elephants, wild buffalo; *Carnivores* (indirect pests) e.g. foxes, jackals; and *Chiropterans* e.g. bats. Common agricultural crops attacked by these mammalian pests are cereals (rice, wheat, maize), fruits (banana, mango and guava), vegetables, sugarcane, pulses and oilseeds. The persistent infringement of human beings in forests, common lands and other natural inhabitations of wild animals have created a severe competition for natural resources between wild animals and the local communities [1], [2].

Due to hilly terrain, the majority of inhabited villages and agricultural lands in Himachal Pradesh are adjacent to forests, streams, rivulets, etc. which act as hideouts for wild animals. The density of flora and fauna in forests and common lands has declined due to infestation by the obnoxious weeds and frequent fires. Thus, during the last decade, the frequency of raids and crop damages by wild animals has increased to a greater extent. Regmi et al. (2013) and Mamo et al. (2021) [3], [4] had reported that the frequency of crop raiding increases with the proximity of fields to forests. Monkeys, wild boar, sambar, nilgai and stray cattle are among the major animal species responsible for the crop raids and damaging in different parts of the state. Tripathi and Rao (2016) [5] also reported increasing problem of higher vertebrates like blue bull, wild boar, monkeys, etc. in agriculture in many regions

across the country. About 71% of the total Panchayats in Himachal Pradesh are suffering from the problem of monkey menace. Moreover, the problem of stray cattle is also emerging as a serious concern in Himachal Pradesh with Kangra district having the highest population.

According to the Directorate of Agriculture, Himachal Pradesh, the problem of animal menace has forced the farmers to abandon crop cultivation in 19,563-hectare area. The wildlife wing of the state has estimated an annual loss of worth Rs. 300 to 450 crore in the agriculture and horticulture sectors due to crop raiding. This estimate can rise up to 1500 crore, if expenditure on surveillance and fencing is also taken into consideration. The problem of animal menace is causing negative impact on the farming community. Therefore, increasing the scientific understanding of the extent of animal menace, crop raiding behaviour and its impact on social-economic conditions of the farmers is important as it has negative impact on people's livelihoods and can lead to farmer reprisal [6].

2.0. Materials and Methods

A Field Survey was conducted at different localities in Arki hills of Himachal Pradesh i.e. Arki, Hanuman Barog, Darlaghat, Kashlog, Kandhar, Bhumti and Kunihar. The data prepared for the present study is primary as well as of secondary nature. Primary data was collected with the help of a questionnaire prepared for the purpose. Farmers were asked about the various types of animals damaging and destroying their crops. They were also asked about different management strategies adopted to control these mammalian pests. Finally, farmers were questioned about different problems they faced in agriculture and whether they got some kind of institutional support. The secondary data was collected from different agencies like Krishi Vigyan Kendra, Solan, The Agricultural Directorate Office, Solan and Agricultural Technology Management Agency, Solan (H.P.). Elaborate interactions were made with the district and state level officials of Agriculture Department, Govt. of Himachal Pradesh.

3.0. Results and Discussion

In the recent years, farmers are demoralized by climate change and the havoc caused by different wild as well as domestic animals. Many farmers in Arki hills have abandoned the agriculture and many have restricted the cropping fields to nearby areas. It has resulted about 25% reduction in agriculture land.

This article summarizes the species involved, damage pattern and existing methods of management of these mammalian pests in Arki hills of Himachal Pradesh.

3.1. Diversity of Mammalian Agricultural Pests

3.1.1. Rodents

Rodents feed on cereals (rice, wheat, maize) pulses, sugarcane, vegetables, seeds, grains, seedlings, and bore into roots as well as stems and also damage stored produce. Rodents are significant agriculture pests in India contributing to substantial crop losses in both standing crops and stored grains. Rodents are responsible for approximately 6% of pre-harvest crop damage and 6 to 8% of post-harvest storage losses in India. An overall annual food grain loss due to rodents estimates between 2.4 -26 million tons. These are nuisance in houses, damage in storage, and pest of sugarcane and groundnut [7].

1) House mouse (*Mus musculus* Linnaeus, 1758): Damage occurs throughout the crop cycle from digging up seeds, at planting and cutting young settings to damaging developing heads (inflorescences) and maturing grains. Major impacts are observed in cereal crops like wheat, rice, maize, barley and millet as well as oilseeds like sunflower [7].

2) Indian long-tailed Tree Mouse (*Vandeleuria oleracea* Bennett, 1832): Long-tailed climbing mice are nocturnal and arboreal creatures. These spend most of their time in vegetation and build bird-like nests in trees or tall bushes to rear their young. They eat fruits, buds and flowers [8].

3) House Rat (*Rattus rattus* Linnaeus 1758): It causes severe agricultural damage by consuming seeds, cutting young seedlings, chewing developing buds and damaging ripping grains. They are major pre and post-harvest pests particularly impacting maize, paddy, vegetables and fruit orchards. These cause losses in godowns, poultry, livestock facilities, cocoa, coconut and field crops in North-East India [9], [10].

4) Large Bandicoot Rat (*Bandicota indica* Bechstein, 1800): Damage paddy, wheat, maize, vegetables and also aquaculture [11].

5) Lesser Bandicoot Rat (*Bandicota bengalensis* Gray, 1835): Very serious pest of cereals, pulses, sugarcane, oilseeds and almost all vegetables but selectively commensal in godowns. Burrowing activity affects fruit trees like apple etc. [8], [12].

6) Indian Gerbil (*Tatera indica* Hardwicke, 1807): Major pest of rain fed agriculture, consuming almost all crops at every stage [12], [13].

7) Northern Palm Squirrel (*Funambulus pennantii* Wroughton, 1905): It damages fruits and vegetables [14], [15]. Burrow fumigants, poison baits and traps are the current means of control [16].

8) Porcupine (*Hystrix indica* Kerr, 1792): Feeds on tubers, bulbs, tree barks, and damage is severe at forest edges [17].

Generally, *B. bengalensis*, *T. indica*, *Millarida meltada*, *Mus platythrix*, *M. booduga* and *M. musculus* are the agricultural pests throughout the country. Amongst these, *B. bengalensis*, *M. booduga* and *N. indica* predominantly infest irrigated fields [8]. Almost all cultivated crops are vulnerable to rodent depredation at some stage or the other of the crop growth and maturity. The damage caused is extensive and varied and has been extensively summarized by Parshad (1999) and Sridhara and Tripathi (2005) [8], [10]. It was 2.7 to 21.3% in wheat, 3.28 to 24.4% in rice, 10.7 to 80% in maize at seedling stage, 1.9 to 24% in maize at cob formation and maturation stage and 4 to 10% in sorghum.

3.1.2. Primates

Primates are the pests of fruits, maize, groundnut, vegetables etc. These pluck and eat fruits, uproot plants and cause heavy losses in orchards, farms and fields near forests.

1) Monkeys (Rhesus macaque- *Macaca mulatta* Zimmermann, 1780): Damage fruits, vegetables and cereals by plucking, breaking branches and eating produce. It lives close to human beings in villages, towns, cities, temple

sites, parks, gardens, orchards, etc. Out of 0.3 million monkeys reported to live in India, around 48.5% are *M. mulatta,* which are true commensals [18]. The problem associated with rhesus monkey is three-fold, namely, possible transmission of fatal diseases, nuisance to people and pestiferous activities. With their natural habitat destroyed, fragmented or shrunk, rhesus monkeys are forced to raid human habitat to procure food and water. They invade crop fields and settlements damaging property, gardens, household items, etc. They are abundant in temples, hospital premises and schools. Angry citizens threaten nuisance monkeys, hit them with stones and even shoot at them, which makes monkeys defensive and over aggressive.

In response, they threaten human beings with snarls, snatch food boxes, handbags umbrellas and spectacles. Monkey bites have been increased alarmingly about 200 bites a day in New Delhi alone [19]. In the temple town of Vrindavan, they entered homes stealthily, stole food, uprooted seedlings and tuberous vegetables, pulled out electric wires and TV antennae, threatened and attacked people and often bit viciously.

2) Langur (*Semnopithecus entellus* Dufresne, 1797): Langur causes significant agriculture damage, particularly in India by raiding crops like maize, wheat, potatoes, vegetables and pulses. They frequently damage high value fruits (apples, pears, mangoes) and due to their protection status and religious significance, it is hard to manage, often causing severe economic losses to farmers. They have started feeding on ripe fruits, green twigs, green leaves, flowers, seeds, fleshy fruits of mango, pigeon pea, *Zizyphus*, *Brassica* spp. (cabbage), citrus, guava, banana, Jackfruit and gooseberry (*Embelica*), resulting in considerable losses in orchards [20].

3.1.3. Ungulates (Hoofed mammals)

Ungulates are pests of paddy, wheat, sugarcane, vegetables and harm the crops by grazing and browsing, trampling and root digging.

1) Wild Boar (*Sus scrofa* Linnaeus 1758): Wild boars cause damage by eating crops, rooting (digging), trampling and wallowing, which can destroy plant roots and damage agriculture machinery. Maize is highly vulnerable and studies showing 21% to 45% of plants are affected in some regions. Other affected crops include potatoes, Sorghum, rice and wheat.

Wild boar damage also occurred in crop fields around national parks of Sariska [21], Nanda Devi Biosphere [22] and Kumbhalgarh Wildlife Sanctuary [23]. Hanging polythene bags containing thimet granules and sand along the edges of rice fields [24], growing dwarf rice with long auricles on panicle [25], guarding fields [23] and cultivating non-edible crops [22] are some of the measures adopted to check wild boar damage.

2) Nilgai / Blue Bull (*Boselaphus tragocamelus* Palla, 1766): Blue Bull is indigenous to India with its distribution restricted to Western and Northern India. It is the biggest antelope in the country (2m in length and 1.5m in height), inhabiting areas with open shrubs and scarce vegetation in and around wildlife sanctuaries but avoids dense forests. An adult animal is reported to consume 13 to 15 kg plant material per day [26]. Crop depredation by blue bull has become a serious problem in the states of Rajasthan, Haryana and Punjab.

Nilgai cause damage from dusk to dawn, utilizing a herd structure where a dominant female leads. They consume crops at all stages but cause severe widespread destruction through trampling, destroying more than they eat.

Damage is severe in both ravi and khrif seasons particularly to wheat, lentils, chicken pea and moong. In high density areas, losses for gram and moong can reach 50 to 70%. Several reasons are attributed to the activities of blue bull such as rapid increase in population, consequent to a ban on hunting and trapping, protection bestowed by the Wildlife Act, 1972 [27], lack of natural predators, deforestation, overgrazing of grasslands by livestock and religious protection given by Bisnoi Hindus.

3) Barking deer (*Muntiacus muntjak* Zimmermann, 1780): They are known to cause damage to a variety of crops often browsing on young plants and fruits, which can have a substantial impact on local small-scale farming. *Muntiacus muntjak* is an omnivorous browser that feeds on fruits, young shoots and leaves. They are documented to cause damage to maize, potatoes, peas, cardamom, soybeans and cabbage. Electric or high robust fencing is the most effective method for excluding it from agriculture fields and gardens. Local farmers often use guard dogs or make loud noises to deter them though these are less effective than physical barriers.

4) Sambar deer (*Rusa unicolor* Kerr, 1792): Sambar is a major source of agriculture crop damage with 61.8% to 66% of farmers in affected areas reporting significant economic loses. These deer primarily raid crops near forest edges during the night, feed on of wide variety of cultivated plants. Common damage includes grazing, trampling and eating crops like maize, wheat and vegetables.

Deer can completely defoliate young trees. They can distort or kill a tree by repetitive browsing. Buck deer rub their antlers on trunks and lower limbs can severely scare the bark of young trees. Deer may browse on old trees but the damage to them is usually less severe than that caused to young trees [16].

3.1.4. Lagomorphs

Lagomorphs feed on vegetables, pulses, young plants and damage seedlings by cutting and feeding on leaves and bark.

1) Indian Hare (*Lepus nigricollis* Cuvier, 1823): Hares are crepuscular and nocturnal, performing most of their crop raids in darkness. They primarily target germinating seeds, soft leaves of seedlings and young shoots preventing a crop from ever reaching maturity.

2) Rabbit (*Oryctolagus ciniculus* Linnaeus 1758): Rabbits along with other wild animals are known to target various crops including cereals and vegetables causing significant damage in the mid hill regions. They can cause damage by eating the tender tops of young maize plants and creating gaps in fields. Rabbits chew on young plants, especially tender and juicy ones. They are also known to feed on vegetables and in some cases can affect pasture availability which impacts local livestock. Their activity is often indicated by digging holes and the presence of droppings in the field, with damage often being more severe near hedges.

Lagomorph's control in fields includes exclusion, repellents, shooting and poisoning. The choice of method should depend on the urgency of the problem. Manage rabbit populations before severe damage occurs [16].

3.1.5. Carnivores

These are indirect pests of root crops and fruits. These harm the crops by digging fields and feeding on produce occasionally.

1) Red Fox (*Vulpes vulpes* Linnaeus, 1758): Foxes forage on berries, nuts, acorns and maize but damage to landscape plants is uncommon. Foxes may cause significant damage to turf, notably golf courses, when digging for grubs or rodents [28].

2) Asiatic Black Bear *(Ursus thibetanus* Cuvier, 1823): It is particularly the subspecies of Himalayan black bear. It is a significant agricultural pest in Himachal Pradesh with conflicts arising from crop raiding, fruit orchard damage and livestock predation. These bears often venture into human dominated landscapes especially in areas where agriculture borders forests. Rapid development leads to habitat degradation and increased human-bear conflicts [29].

3.1.6. Chiropterans

Bats are flying mammals. Order Chiroptera is divided into two suborders i.e. megachiroptera and microchiroptera [30]. Chiropteran species behaviour is social, aggressive, gregarious, solitary and friendly. Mega bats eat fruit, pollen, leaves, corns and animals. Micro bats eat insects. Bats are playing an important role in ecosystem such as pollination, seed dispersion, insect control, guano etc. In this way chiropteran play excellent services in ecosystem [31].

1) Indian Flying Fox (*Pteropus giganteus* Brunnich, 1782): *P. giganteus* commonly known as Indian flying Fox or fruit bats are second most abundant group which comprises 25% of all living mammals. Under schedule V of Indian Wildlife Protection Act, 1972 and International Union for Conservation of Nature(IUCN), this species is labeled ‘vermin’ as it poaches ripe fruits from orchards and defecates in public places and cause heavy economic lost to different horticultural crops which ranged from 12- 30% [32].

Fruit bats cause significant loss in commercial crops such as apples, bananas, dates, grapefruits, litchi, mandarins, pears and pomegranates [33]. The spectacled flying fox’s natural diet is rainforest fruits, riparian zone flowers and flowers from Myrtaceae family (primarily *Eucalyptus* and *Syzygium* species) and fruits from the Moraceae (figs). The most practical and harmless method of bats’ management is netting entire trees with fine mesh fishing net. In larger orchards mist nets are used to capture them. Eco-friendly and economical method for grapes protection include covering grape bunches with dry sprigs of foliage, leaving bat damaged bunch is on the vine intact [34] and using firecrackers [35]. Kumar at al. (2022) [36] assessed the extent of animal menace and its impact on economic losses of crops in mid hills of Himachal Pradesh. The study was conducted in Kangra district of Himachal Pradesh and the distribution of total losses among different crops was highest in case of wheat i.e. 8237/farm accounting for 32.48% of total crop losses followed by paddy (13.27%) and maize (12.22%). The study indicated that there had been a considerable decline in the productivity levels of major crops and it ranged between 16 to 24% in case of cereals and 17 to 22% in case of fodder crops.

A total of 44 species of edible plants in Kerala were reported to be destroyed by wild vertebrates such as elephants, wild bison, sambar, wild boar, bonnet macaque, common langur, black napped hare and pea fowl but wild boar causing the maximum damage [37].

3.2. Methods Adopted to Control Mammalian Pests in Agriculture Fields

Mammalian pest may damage the plants by feeding on plant parts or simply by running over and trampling over the crop fields. Therefore, these animals may easily cause significant yield losses and provoke additional financial problems. Preventing access to crop fields is mainly by rendering fields unfit for fresh burrows, erecting barriers and reducing vegetation cover so that exposure to predators is increased. Changes in tillage practices such as deep tillage, crop rotation, ploughing the vacant bunds and land around wheat fields [10] and keeping bunds low and narrow [38] are some of the measures advocated to prevent rodent access. Similarly, placing screw pine leaves along the edges of paddy fields repelled rats [39]. The various management practices in vogue are mostly preventive and are meant to check the entry of wild animals into the agricultural fields. These practices involve traditional techniques, acoustic deterrents, physical barriers, vegetative barriers, fencing, chemical deterrents, scare devices and community watching mechanisms [40].

Every farmer should be aware and take into consideration the fact that animals are living beings and need to be protected from any potential suffering. Successful farmers always seek to determine the satisfactory level of wild animal crop protection using one of the following methods:

3.2.1. Agricultural fences

Fencing is a popular wild animal deterrent that can last for many years. Agricultural fences are quite effective wild animal protection methods. However, utilising fences as a practice is often regulated. Some local and state entities may restrict the use of certain types of fences. Therefore, before deciding on a suitable fence, it is important to check local laws and regulations. The quality of fencing depends on the material and structure. Some permanent fences can last up to 30 years. Farmers usually use the following types of fences:

1) Wire fences- Wire fences are constructed of metal wires woven together forming a physical barrier. The fences are effective, long lasting and require relatively little maintenance. However, they are expensive and recommended only for the protection of high value crops.

2) Plastic fences- Polypropylene fences are generally less expensive and easier to install and repair than other types. Additionally, these fences are widely acceptable and meet every regulation. Their disadvantage includes their short life span (up to 10 years) and meager effectiveness in areas with the higher possibility of wild animal crop damage.

3) Electric fences- Electric fences are constructed to inflict an electric shock to animals that come in contact with the fence, thus preventing animals from crossing the fence. The fences are long lasting and an effective crop protection measure. Cost vary depending on the specific type and size of an area. Additionally, electric fences are marked with warning sign to prevent any possible human contact.

3.2.2. Natural repellents

Some farmers prefer using natural resources instead of mechanical or chemical protective practices. There are various ways to minimize crop loss from wild animals, including:

1) Smoke- In some areas farmers burn cow dung or other materials that smolder and create heavy smoke.

2) Fish or garlic natural emulsion- It repels rabbits and deer.

3) Beehive fencing- Elephants are repelled by the sound of honey bees. This practice is beneficial as it serves as an extra source of income.

4) Chili peppers- The Chemical Capsaicin makes chili peppers hot and excellent repellent against elephants, monkeys, squirrels and some other wild animals. Farmers who plant chili peppers will also benefit from an extra source of income.

5) Lavender, soybean, peas and beans are excellent repellents against rabbits and are also an additional source of income.

6) Egg based repellents are used against deer.

7) Castor oil is a natural repellent that keeps away burrowing animals such as moles.

8) Chemical repellents which include active substances such as Anthraquinone, Butanethione and Methyl Anthranilate can be used to keep wild animals away from crops.

3.2.3. Biophysical barriers

Similar to traditional fences, but made of natural easily renewable materials like bamboo sticks, coconut tree bunches or some other available shrubs. It is low-cost practice but also low efficiency in protecting crops against wild animals.

3.2.4. Electronic repellents

An effective, long lasting and eco-friendly method for crop protection that repels animals without harming them. Farmers use one of the following two types of electronic repellents:

1) Ultrasonic electronic repellent- Silent to humans but high frequency sound waves repel wild animals.

2) Sonic electronic repellent- Audible loud noise that scares animals.

3.2.5. Scaring devices and guarding

Aside from the aforementioned strategies, some farmers rely on scarecrows, firecrackers, bright lights, fire, beating drums and dogs. Along with practicing certain crop protection measures, the most successful farmers will monitor their fields as often as possible. After all constant monitoring is the best way to make sure that everything on the field goes as planned.

3.2.6. Killing/ Shooting

The only method of crop production from nilgai was the guarding of fields by humans and dogs during vulnerable stages of crop growth. Although, culling was suggested, it was strongly opposed by Bishnois. In view of strong demands by affected farmers the Governments of Haryana and Rajasthan have relaxed rules of hunting even though the animal is a protected species. Other methods such as containing them in enclosures, fencing crop fields

including power fencing, translocation and sterilization are not practical and economical for the marginal formers of India.

Density reduction measures employed in Himachal Pradesh are physical (hunting and trapping) and chemical (lethal) usage. Hunting is by flooding and smoking. The burrows are flooded or smoked to force rats, rabbits and porcupines out which are caught by hand or by using nets or killed by sticks or dogs are allowed to hunt them. Several tribes in south India, Bihar and north-east India catch rats to use them as food [41]. Chemical control using rodenticides continues to be the most widely used method for rodent control in India as elsewhere in the world. Seven rodenticides are registered but only 4 are marketed, namely zinc phosphide, aluminium phosphide, coumatetralyl and bromadiolone [15].

3.2.7. Removing feeding and breeding habitats

With the religious sentiments associated with monkeys, managing them is a sensitive issue. Southwick and Siddiqui (1994) [18], suggested three measures to reduce monkey menace: reducing supplemental feedings, translocation and fertility control. However, supplemental feeding by religious Hindu's will never stop in India and fertility control is yet to find a safe, successful technology. The translocating becomes the only feasible and practical method to manage monkeys' problem [42].

Prophylactic control for rodents in the months of May to June and November through December, which are the fallow periods between summer and winter crops, is advocated. During this period, rodents are confined to reservoir habitats such as bunds, dykes, borders of water channels, uncultivated lands or inside long duration crop such a sugarcane, orchards and plantations. In the absence of adequate natural food resources rodents are easily attracted to baits and mortalities are high. Such a control breaks the natural breeding cycle of rodents preventing population build up later during the cropping season. Control during May through June is also economical and more effective as the population is minimum and non-breeding [12]. Discouraging infestation by eliminating or reducing sources of food and harbourage was achieved by synchronised cropping, clean cultivation and by weed control [43]. But attempts to raise rodent resistant varieties are non-existent in India.

The use of modern techniques such as computers, drones, thermal sensors and AI- applications to monitor wild life movements may be promoted to provide real time alerts. These techniques will provide real time alerts and assessment of the damaged crops. It will reduce economic vulnerability and help the farmers to claim insurance and compensation in short period of time [44], [45].

4.0. Conclusion

Although, the soil of Himachal Pradesh is suitable for agricultural and horticultural crops but the mammalian pests (wild and stray) are causing much damage to these crops throughout the state. Therefore, the farmers here are living agriculture due to regular crop damage. Crop fields near forests are severely damaged by raids and attacks of wild animals. Keeping in view the ecosystem and biodiversity, the appropriate measures should be used to control these animal pests. Farmers should take the advantage of Govt. schemes for fencing and threatening devices. Restricted killing under law should be the last option.

Declarations

Source of Funding

This study did not receive any grant from funding agencies in the public, commercial or not-for-profit sectors.

Competing Interests Statement

The author declares that he has no competing interest related to this work.

Consent for Publication

The author declares that he consented to the publication of this study.

Informed Consent

Not applicable for this study.

Availability of Data and Materials

Data are available upon request from the author.

Research Ethics Board Statement

Not applicable

Acknowledgement

The author is thankful to Department of Higher Education, Govt. of Himachal Pradesh and Principal, Govt. Degree College, Arki, District Solan, Himachal Pradesh, India for providing facilities and encouragement during the present research work.

Declaration of Artificial Intelligence

Artificial Intelligence tool was used solely for the linguistic corrections of manuscript.

References

[1] 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.

[2] Mehta, P., Negi, A., Chaudhary, R., Yasmin, J., & Thakur, P. (2018). A study on managing crop damage by wild animals in Himachal Pradesh. International Journal of Agriculture Sciences, 10(12): 6438–6442.

[3] Regmi, G.R., Nekaris, K.A.I., Kandel, K., & Nijman, V. (2013). Crop-raiding macaques: Predictions, patterns and perceptions from Langtang National Park, Nepal. Endangered Species Research, 20: 217–226.

[4] Mamo, A., Lemessa, D., Diriba, O.H., & Hunde, D. (2021). Pattern of crop raiding by wild large mammals and the resultant impacts vary with distances from forests in Southwest Ethiopia. Ecology and Evolution, 11: 3203–3209.

[5] Tripathi, R.S., & Rao, V.V. (2016). Vertebrate pest management in agriculture. In Human–Animal Conflict in Agro-Pastoral Context: Issues and Policies, Indian Council of Agricultural Research, New Delhi.

[6] Findlay, L.J., & Hill, R.A. (2020). Baboon and vervet monkey crop-foraging behaviors on a commercial South African farm: Preliminary implications for damage mitigation. Human–Wildlife Interactions, 14(3): 505–518.

[7] Rao, A.M.K.M., & Balasubramanyam, M. (1992). The mice, *Mus* spp. In Prakash, I., & Ghosh, P.K. (Eds.), Rodents in Indian Agriculture, Pages 147–164, Scientific Publishers, Jodhpur, India.

[8] Sridhara, S., & Tripathi, R.S. (2005). Distribution of rodents in Indian agriculture. Technical Bulletin No. 13, Indian Council of Agricultural Research, Central Arid Zone Research Institute, Jodhpur, India.

[9] Bhat, S.K. (1992). Plantation crops. In Prakash, I., & Ghosh, P.K. (Eds.), Rodents in Indian Agriculture, Pages 271–278, Scientific Publishers, Jodhpur, India.

[10] Parshad, V.R. (1999). Rodent control in India. Integrated Pest Management Reviews, 4: 97–126.

[11] Chakraborty, S. (1992). The larger bandicoot rat, *Bandicota indica* (Bechstein). In Prakash, I., & Ghosh, P.K. (Eds.), Rodents in Indian Agriculture, Pages 193–210, Scientific Publishers, Jodhpur, India.

[12] Sridhara, S. (1999). Quarter century of research on rodent control (1973–98) in the University of Agricultural Sciences, Bangalore: Highlights and recommendations. University of Agricultural Sciences, Bangalore, India.

[13] Jain, A.P. (1992). Indian gerbil, *Tatera indica* Hardwicke. In Prakash, I., & Ghosh, P.K. (Eds.), Rodents in Indian Agriculture, Pages 31–47, Scientific Publishers, Jodhpur, India.

[14] Prakash, I., Kashyap, N., & Mathur, M. (1992). The five-striped northern palm squirrel, *Funambulus pennantii* (Wroughton). In Prakash, I., & Ghosh, P.K. (Eds.), Rodents in Indian Agriculture, Pages 17–24, Scientific Publishers, Jodhpur, India.

[15] Parshad, V.R., & Malhi, C.S. (1994). Rodents. In Gill, G.S., & Mangat, I.S. (Eds.), Handbook of Field Problems of Vegetable Crops of Punjab, Pages 217–224, Punjab Agricultural University, Ludhiana, Punjab, India.

[16] Clark, J.P. (1986). *Vertebrate pest control handbook*. California Department of Food and Agriculture, Division of Plant Industry, Sacramento.

[17] Sharma, D. (1994). The damage by Indian crested porcupine. In Workshop on Wildlife Damage Problems and Control (Abstracts), Dehradun, India.

[18] Southwick, C.H., & Siddiqi, M.F. (1994). Primate commensalism: The rhesus monkey in India. Revue d'Ecologie (La Terre et la Vie), 49: 223–231.

[19] Malik, I. (2001). Monkey menace – Who is responsible. In Gupta, A.K. (Ed.), *Non-Human Primates of India*, Wildlife Institute of India, Dehradun, India.

[20] Bhattacharjee, T.P., & Chakravarthy, D. (1992). Group structure and home range of Phayre's langur in Sepahijala Wildlife Sanctuary, Tripura. Tiger Paper, 19(3): 31–33.

[21] Sekhar, N.V. (1998). Crop and livestock depredation caused by wild animals in protected areas: The case of Sariska Tiger Reserve, Rajasthan, India. Environmental Conservation, 25: 160–171.

[22] Rao, K.S., Maikhuri, R.K., Nautiyal, S., & Saxena, K.G. (2002). Crop damage and livestock depredation by wildlife: A case study from Nanda Devi Biosphere Reserve, India. Journal of Environmental Management, 66(3): 317–327. https://doi.org/10.1006/jema.2002.0587.

[23] Chhangani, A.K., & Mohnot, S.M. (2004). Crop raid by Hanuman langur, *Semnopithecus entellus*, in and around Aravalli Hills (India) and its management. Primate Report, 69: 1–18.

[24] Chakravarthy, A.K., & Srihari, K. (2000). Vertebrate pests of cardamom (*Elettaria cardamomum* Maton) in hill region of Karnataka, South India. Pest Management in Horticultural Ecosystems, 6(2): 139–148.

[25] Thomas, M., & Naidu, A.K. (1995). Indian wild boar, *Sus scrofa* L.: A rice pest in Madhya Pradesh, India. IRRN, 20(1): 28.

[26] Goyal, S.K., & Rajpurohit, L.S. (2000). Nilgai (*Boselaphus tragocamelus*) – A mammalian crop pest around Jodhpur. Uttar Pradesh Journal of Zoology, 20(1): 55–59.

[27] Chauhan, N.P.S., & Sawarkar, V.B. (1989). Problems of overabundant populations of nilgai and blackbuck in Haryana and Madhya Pradesh. Indian Forester, 115(7): 488–493.

[28] Ginsburg, J.R., & MacDonald, D.W. (2023). *Foxes, wolves, jackals and dogs*. Page 58.

[29] Kumar, G., Bharti, S., & Kapoor, G. (2025). A review of bears in Himachal Pradesh: Distribution, conflict with humans and their mitigation strategies. Asian Journal of Biology, 21(3): 18–33.

[30] Soni, P. (2019). Roosting behavior and social organization of bats (Chiroptera), Barmer District, India. International Journal of Research and Analytical Reviews, 6(2): 1170–1176.

[31] Soni, P. (2021). A significant role of Chiroptera (micro and mega bats) in ecosystem. Journal of Emerging Technologies and Innovative Research, 8(11): 594–596.

[32] Hassan, M.U., Jones, M.G., & Deitz, C. (2009). The bats of Pakistan: The least known creature. Edited by S. Mullar, Verlag.

[33] Chakravarthy, A.K., & Girish, A.C. (2003). Crop protection and conservation of frugivorous bats in orchards of hill and coastal regions of Karnataka. Zoos' Print Journal, 18: 1169–1171.

[34] Verghese, A. (2006). Frugivorous birds and their management. In Sridhara, S. (Ed.), Vertebrate Pests in Agriculture – The Indian Scenario, Pages 63–76, Scientific Publishers, Jodhpur, India.

[35] Srinivasulu, B., & Srinivasulu, C. (2001). Magnitude of depredation on grapes by short-nosed fruit bats, *Cynopterus sphinx* Vahl, 1797, in Secunderabad. Current Science, 80(1): 14–15.

[36] Kumar, R.T., Walia, A., Mehta, K., Kumar, V., & Lal, H. (2022). Economic assessment of crop damages by animal menace in mid-hill regions of Himachal Pradesh. The Indian Journal of Animal Sciences, 92(4): 484–491. https://doi.org/10.56093/ijans.v92i4.124173.

[37] Jayson, E.A. (1999). Studies on crop damage by wild animals in Kerala and evaluation of control methods. Research Report No. 169, Kerala Forest Research Institute, Peechi, Kerala, India.

[38] Sharma, P.K., & Rao, A.M.K.M. (1989). Effect of bund dimensions on rodent infestation in rice. IRRI Newsletter, 14: 40.

[39] Subiah, K.S. (1978). Some prevalent methods for eradicating rats adapted in a Tamil Nadu village. Rodent Newsletter, 2: 3–4.

[40] Baishya, A., Rao, T.K.S., Singh, A.K., & Parmer, A. (2025). Human–wildlife conflict and management with special reference to India. Annual Research & Review in Biology, 40(5): 133–144. https://doi.org/10.9734/arrb/2025/v40i530045.

[41] Whitaker, R. (1979). Biocontrol of rodents by direct capture. Rodent Newsletter, 3: 6.

[42] Imam, E., & Malik, I. (1997). Translocation of monkeys from National Zoological Park, New Delhi to Tughlaqabad Fort, South Delhi. Report submitted by Vatavaran to National Zoological Park, New Delhi, India.

[43] Pasahan, S.C., & Singal, R.K. (1994). Burrowing patterns of lesser bandicoot rat (*Bandicota bengalensis*) in wheat (*Triticum aestivum*) crop in sandy loam soil. Indian Journal of Agricultural Sciences, 64(10): 717–722.

[44] Reddy, P., Singh, A., & Sharma, S. (2021). Community perspectives in mitigating wild animal conflict in India. Journal of Wildlife and Ecology, 9(2): 17–26.

[45] Chaudhary, V. (2025). Managing higher vertebrate pest problem in Indian agriculture: Time to rethink. Annals of Arid Zone, 64(3): 309–312.