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Original Article

Identification and crop damage assessment of indian crested porcupine *(Hystrix indica)* in selected zones of Abbottabad, Pakistan

Avaliação de identificação e dano de cultura de porco-espinho indiano (Hystrix indica) em zonas selecionadas de Abbottabad, Paquistão

Ehtisham[a], A. Akhtar[b], K. A. Khan[c], M. Iqbal[d,e], S. A. Bano[f], M. Hussain[a], N. Munawar[g], U. Habiba[a*]

[a]The University of Haripur, Department of Forestry and Wildlife Management, Haripur, Pakistan
[b]The University of Haripur, Department of Psychology, Haripur, Pakistan
[c]Shandong Normal University, College of Life Sciences, Jinan, China
[d]Mugla Sitki Kocman University, Department of Chemistry, Mugla, Turkey
[e]The University of Agriculture, Department of Agricultural Chemistry and Biochemistry, Peshawar, Pakistan
[f]The University of Haripur, Department of Microbiology, Faculty of Basic and Applied Science, Haripur, Pakistan
[g]PMAS Arid Agriculture University Rawalpindi, Department of Wildlife Management, Rawalpindi, Pakistan

Abstract

Indian crested porcupine is the largest rodent pest that damages a wide variety of crops, vegetables, and tree species which ultimately causes huge economic loss in Pakistan, which is an agricultural country. It prefers to live in hilly terrain but common in temperate and tropical forests, shrublands, and grasslands. This study focused on the identification and assessment of crops damaged along with the main precautionary measures used by the local farmers. The data was collected from twenty-four villages of two union councils i.e. Chamhad and Slahad of district Abbottabad. Two types of data (primary and secondary) were collected from the study area. Primary data was collected for identification and estimation calculation of total crop damaged through direct field observation by taking random quadrates in each village of the study area. The damage in the crop was assessed by randomly selecting a quadrate of 1x1 m^2 for the wheat, pearl millet, and Sorghum fields. While 4x4 m^2 quadrates were taken for maize and vegetables. At least three quadrate samples were taken from each field including one quadrate taken from the center of the field area. In union council Chamhad, damage to maize (11.31%) and wheat (0.73%) by the Indian crested porcupine while in union council Salhad, damage of maize (6.95%) and wheat (1.6%) was observed. In the entire study area, overall damage to maize crop (8.01%) and wheat (0.88%) was calculated. Based on information obtained from the farmers, the Indian porcupine inflicted damage to potato, tomato, cauliflower, chili pepper, turnip, radish, pea, and onion, etc. Secondary data obtained through a questionnaire survey to explore the human porcupine conflict and precautionary measures used by the farmers and landowners. Open and close-ended questionnaires (159) highlighted the presence of Indian crested porcupine in the study area and 96% of the respondents have seen porcupine directly. Many types of precautionary measures were used by the farmers such as fencing, night stay, night firing, and dogs to decrease the crop damage, respondents (63.91%) use guns for hunting. however, due to the largely agricultural area and nocturnal behavior of Indian crested porcupine majority of the respondents (51.57%) did not use any precautionary measure. Biological control of Indian porcupine is recommended in the study area. Farmers should be encouraged and provide incentives and killing through current should be banned while proper hunting license should be issued to overcome overhunting. Scientific studies are required to control the reproduction of porcupine specifically in the more damaged areas.

Keywords: identification, indian crested porcupine, damage assessment, Abbottabad.

Resumo

O porco-espinho indiano é a maior praga de roedores que danifica uma grande variedade de culturas, vegetais e espécies de árvores, o que acaba por causar enormes perdas econômicas no Paquistão, que é um país agrícola. Prefere viver em terrenos montanhosos, mas comuns em florestas temperadas e tropicais, arbustos e pastagens. Este estudo concentrou-se na identificação e avaliação das lavouras danificadas, juntamente com as principais medidas de precaução utilizadas pelos agricultores locais. Os dados foram coletados de 24 aldeias de dois conselhos sindicais, ou seja, Chamhad e Slahad, do distrito de Abbottabad. Dois tipos de dados (primário e secundário) foram coletados da área de estudo. Foram coletados dados primários para identificação e cálculo de estimativa do total da cultura danificada por meio da observação direta do campo, tomando quadrantes aleatórios em cada aldeia da

*E-mail: ume.habiba8@gmail.com
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área de estudo. O dano na cultura foi avaliado pela seleção aleatória de um quadrante de 1x1 m^2 para os campos de trigo, milheto pérola e sorgo, enquanto quadrantes de 4x4 m^2 foram tomados para milho e legumes. Pelo menos três amostras de quadrante foram colhidas de cada campo, incluindo um quadrante retirado do centro da área do campo. No Conselho Sindical de Chamhad, houve danos ao milho (11,31%) e ao trigo (0,73%) pelo porco-espinho indiano, enquanto no Conselho Sindical de Salhad, danos ao milho (6,95%) e ao trigo (1,6%) foram observados. Em toda a área do estudo, danos gerais à cultura do milho (8,01%) e ao trigo (0,88%) foram calculados. Com base em informações obtidas dos agricultores, o porco-espinho indiano infligiu danos à batata, tomate, couve-flor, pimenta, nabo, rabanete, ervilha, cebola, etc. Dados secundários foram obtidos por meio de um questionário para explorar o conflito suíno humano e as medidas de precaução utilizadas pelos agricultores e proprietários de terras. Questionários abertos e fechados (159) destacaram a presença de porco-espinho indiano na área de estudo e 96% dos entrevistados viram o porco-espinho diretamente. Muitos tipos de medidas de precaução foram utilizados pelos agricultores, como esgrima, estadia noturna, fogo noturno e cães para diminuir os danos na lavoura. Dos entrevistados, 63,91% usaram armas para caçar. No entanto, devido à área ser em grande parte agrícola e ao comportamento noturno da maioria dos porcos-espinhos indianos, 51,57% não usaram nenhuma medida de precaução. O controle biológico do porco-espinho indiano é recomendado na área de estudo. Os agricultores devem ser encorajados e fornecer incentivos, e o uso da corrente para matar os animais deve ser banido, assim como deve ser emitida a licença de caça adequada para superar a caça excessiva. Estudos científicos são necessários para controlar a reprodução de porco-espinho, especificamente nas áreas mais danificadas.

Palavras-chave: identificação, porco-espinho indiano, avaliação de danos, Abbottabad.

1. Introduction

Indian crested porcupine belongs to the order Rodentia of Mammalia class (Khan et al., 2014). It is widely distributed in central and south East Asia and some regions of the Middle East including Pakistan, Afghanistan, Iran, India, Nepal, Bhutan, Bangladesh, Sri Lanka, Israel, and Saudi Arabia (Hafeez et al., 2011). In Pakistan, it is found up to the elevation of 3,200 m, the highest point of its occurrence (Awan et al., 2004). They favor rocky hills but common in the temperate and tropical forest, scrublands, plantations, and gardens (Amori et al., 2008). Indian porcupine has a very broad and generally herbivorous diet. They use a range of agricultural and natural plant materials, including roots, fruits, grains, tubers, and bulbs (Amori et al., 2008).

Indian porcupine is a large rodent pest, destroys a wide range of wild and cultivated plants and agriculture crops, devours both surface and subsurface vegetation at any growth stage (Khan, 2013). Crops mainly maize, potatoes, groundnuts, sugarcane, and melon were extremely damaged by Indian porcupine (Roberts, 1997). According to the survey conducted in different parts of Punjab Pakistan Indian Porcupine caused damaged to maize and a calculated loss of 6.37% in Faisalabad and 5.51% in Shiekhupura, damage to wheat was 4.58% in Faislabad, 2.03% in Quaidaabad and 1.53% in Sheikhupara (Hafeez et al., 2011). In the hilly area of Azad Kashmir, severe damage to maize crop was observed and estimated damage was 10.7% of the yield (Khan et al., 1997. In Pothwar Punjab damage to wheat due to Indian porcupine was 0.96% (Mian et al., 2007).

In the Negev desert of Israel, about 0.6% of the potatoes were damaged by Indian porcupine counting US$ 30/ha (Alkon and Saltz, 1985). The damage was investigated two weeks before harvesting in potato harvesting and estimated a loss of 17.6% of the total yield (Khan et al., 2000). In Baluchistan, 4- 36% damage to sweet potatoes and 2-20% damage to potatoes were recorded (Pervez, 2006).

Indian porcupine also destroyed groundnuts in Punjab Pakistan and about 3.19-11.92% of the yield was damaged (Hafeez et al., 2011). About 30-40 plants of groundnuts were uprooted by Indian porcupine and 0.21% of the cultivation was destroyed (Brooks et al., 1998). However, in Chakwal it was estimated that 7.2% to 20.2% damage was caused to groundnuts by Indian porcupine. In Bakhar Punjab about 1.15-1.82% of onion, 2.28-5.51% of sugarcane, and 3.39-4.44% of melon were damage by a porcupine (Hafeez et al. 2011). Earlier than in 2004, onion damage in Bakhar was estimated as 0.9%-5.4% mainly at the earlier growth stage (Mian et al., 2007). In Mastung, Baluchistan Indian porcupine damaged saffron (*Crocus sativa*) bulbs by digging, from 15 to 20 digs per day, and a total of 20-40ha per season loss was recorded (Khan et al. 2000).

In Baluchistan Pakistan Indian porcupine feed on bark and root of succulent plants specifically bulbs of *Eremurus auranhiacus* (Chaudhry and Ahmad, 1975). In Punjab Pakistan, they prefer bark of mulberry (*M. alba*), *Persian Lilac* knew as Bakain (*M. azedarach*), and mango (*M. indica*) (Roberts, 1997), and in India onion and carrot were consumed (Agrawal and Chakraborty, 1992). The porcupine diet in the middle of Punjab (Pakistan) comprises of agricultural crop (maize cobs and seeds, wheat, sugar cane, and rice) vegetables (potatoes, melon, chilies bitter-gourd, beans, and pumpkin), fruit and grasses, leaves, bark and roots of various trees (Sarwar, 1990). Indian porcupine also feeds on the parts of xerophytic plants in lower Sindh Pakistan (Ahmad et al., 2003). It was reported that this species feeds on 37 species of wild and cultivated plants, apart from cultivated palms and also debark cultivated and wild palms such as phoenix palms and coconut (Girish et al., 2005).

Indian porcupine is listed as the Least Concern by IUCN because of its adaptability to an extensive variety of habitats and food types. This species has stable populations and is not fragmented as much, while population size fluctuates from ranges; in various locations, it is frequent enough to be considered as a pest. However, in some areas due to human settlement, urbanization, and the use of pesticides, appropriate porcupine habitat is now decreasing. Indian porcupine is frequently hunted as they damaged agriculture

crops, forest trees, and nurseries. A massive trade of porcupines occurs mainly for bushmeat and medicinal value (Amori et al., 2008).

Indian porcupine is a serious agricultural pest and is widely distributed in the study area. No study has been conducted in the region so far. This research study will provide valuable information about the type and intensity of crop damage by Indian porcupine as this is the first study conducted on crop damage by Indian porcupine in Abbottabad. This study will also highlight existing lethal and non-lethal controlling methods used by the farmers. All this information will be important for Porcupine management, crop protection, and future research workers.

2. Material and methods

2.1. Study area

This study was conducted in two zones (union councils) Salhad and Chamhad of district Abbottabad situated in the Hazara Division of Khyber Pakhtunkhwa province, Pakistan (see Figure 1). It is located 120 kilometers in the North of Islamabad. Lying in the lower Himalayan mountain range, between 34^0 04 to 34^0 10 north and 73^0 04 to 73^0 11 easts. The total area of district Abbottabad is approximately 178,000 ha of which almost 63,000 ha (35%) under cultivation, main crops grown in the area are wheat and maize. Apart from these crops in some areas potatoes, rice, apples, and few other crops, vegetables, and fruit varieties are also grown in the district (Pakistan IUCN, 2004).

Union Council Chamhad is located in the west of the Abbottabad district, where it touches the borders with Haripur District. Comprises of 14 villages namely Chamhad, Kasaki, Bhuraj, Btangi, Daruban, Bagahti, Bia Gojri, Mihal, Ghori Sharif, Shidyal, Baghdara, Mangal Darra, and Totni. Union council Salhad has situated about 2 km from the city on the south side. The main villages of union council Salhad are Salhad, Thanda Myra, Muslimabad, Khokhar myra, Deheri, Danna, Jabriyan, Kotakiyan, Dhyri Myra, Shah de Galli, and Goriyan (Pakistan Bureau of Statistics, 2018).

Abbottabad falls in a humid subtropical climatic zone. Summers are mild to hot, winter is cold and snowfall occurs in the coldest months, and autumn and spring seasons Abbottabad having mild to warm temperature. The average maximum and minimum temperature is 2.4 ^{0}C and 33.7 ^{0}C. Average annual rainfall range from 29 to 244mm (Khan et al., 2015).

Abbottabad district consists of three main forest types namely moist temperate forest, Subtropical Chir pine forest, and subtropical broad-leaved scrub forest (Pakistan IUCN, 2004). However, the study area consists of two main forest types i.e. subtropical pine forest (Rainfall varies from 1,250 to 1,500 mm. Climatic conditions favor the growth of principal species i.e. *Pinus roxburghii*, *Quercus incana*, *Myrsine Africana*, *Berberis lyceum*, *Dodonea viscosa,* and *Carissa spinarum* and subtropical broad-leaved evergreen scrub forest Rainfall varies from 750 to 1250 mm. The area supports mixed open scrub vegetation comprising *Acacia modesta, Cassia fistula, Olea ferruginea, Desmostachya bipinnata, Dodonea viscosa, Carissa spinarum, Adhatoda vasica, Woodfordia floribunda, Cynodon dactylon, Saacharum spontaneum* (Khatoon et al., 2019).

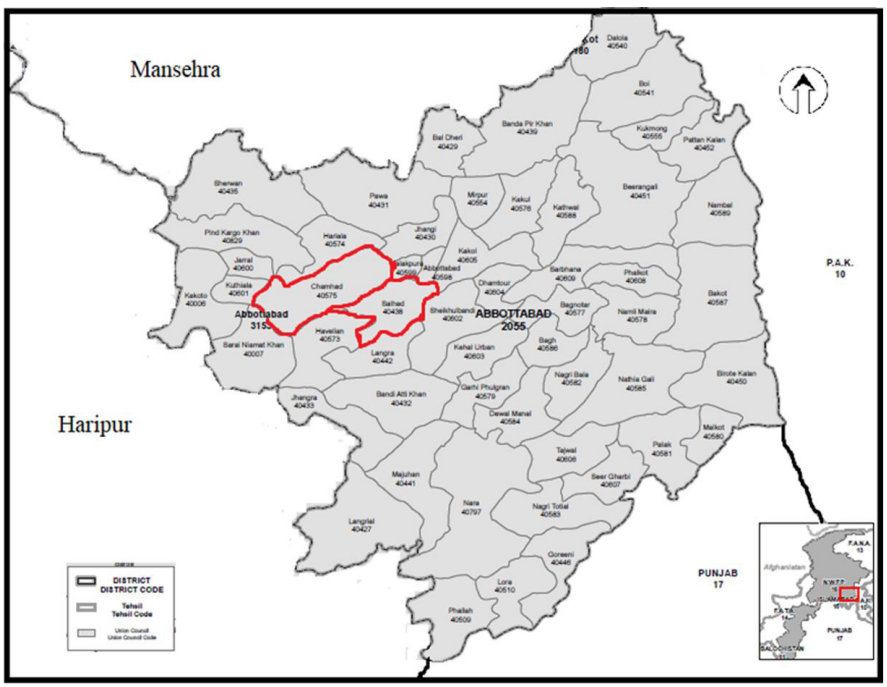

Figure 1. Map of the study area.

The main fauna of the Study area includes Golden jackal (*Canis aureus*), Red fox (*Vulpes vulpes*), wild boar (*Sus scrofa*), Indian crested porcupine (Hystrix *indica*), Mongoose (*Herpestes edwardsii*), Jungle Cat (*Felis chuas*), Cape hare (*Lepus capensis*), House crow (*Corvus splendens*), Jungle crow (*Corvus macrorhynchos*), Black partridge (*Francolinus francolinus),* House sparrow (*Passer domesticus*), Common myna (*Acridotheres tristis*), Red-vented bulbul (*Pycnonotus cafer*), Asian koel (*Eudynamys scolopaceus*), Oriental magpie robin (*Copsychus saularis*), and Black kite (*Milvus migrans*) (PAKISTAN IUCN, 2004).

2.2. Study design

Based on the objective of the study, data were collected by using two types of methodologies i.e. Damage Assessment Survey (Primary: direct data collection) and questionnaires survey (Secondary: indirect data collection). The study was conducted in a hilly area, and the local community depends upon rainwater for cultivation. There were two main crops grown in the study area i.e. maize and wheat along with other crops and vegetables that were grown on a small scale. The study was conducted from June 2018 to May 2019. The study period was divided into two seasons i.e. Rabi (November to May) and Kharif (June to October), mainly based on the cultivation of crops. Data were collected from 24 villages (study sites) of the study area and each village was visited two to three times in a single cropping season. However, quadrates were taken at the ripening stage of crops.

2.3. Damage Assessment Survey (Primary: Direct Data Collection)

This method was used to know the type, intensity, and extent of crops that were damaged by Indian porcupine. A preliminary survey of the study area was conducted. Study sites were selected from two union councils based on cultivatable agriculture land and Indian porcupine damage. General information on the damage caused to different types of the crop was obtained from the local farmers. The data on the status of the level of damage and loss was collected with the help of direct field observations from the study site of the study area. The survey was carried out by randomly selected agricultural crop fields from each village. At least three quadrate samples were taken from each field and a minimum of one quadrate was taken from the center. The damage in the crop was calculated by randomly selecting a quadrate of 1x1 m^2 for the wheat, pearl millet, and Sorghum fields. While 4x4 m^2 quadrates were taken for maize and vegetables (Drew, 1944). The normal and damaged plants were directly counted within the quadrate. The data was also collected on part and stage in which damage took place. The damage percentage was calculated using the following formula (Hafeez et al., 2011).

$$\text{Damage } \% = \frac{\text{Number of Damage plants in each quadrat}}{\text{Total number of plants in each quadrat}} \times 100$$

2.4. Community Survey (Secondary: Indirect Data Collection)

The questionnaire survey was conducted from the local community present inside and surrounding the study area. The main purpose of the survey was to analyze the causes and nature of crop damaged and the behavior and perception of the local community toward porcupine conservation (Campbell-Smith et al., 2010). From the twenty-four villages of two union councils, 159 questionnaires were filled mainly by farmers and landowners. Open and close-ended questionnaires were filled to explore information on distribution and various aspects of porcupine damage to crops as well as major controlling methods used in the study area. The questionnaire consists of four parts of main questions of socioeconomic status of the respondent (education, age, literary status, profession), Porcupine encounter (have they seen Indian porcupine in the study area?, where they encountered the most?), Agriculture loss due to porcupine damage (which species are most damaged by Indian porcupine), Killing and controlling measures use (what kind of methods are used to control Indian porcupine in the study area and which is more useful?)

3. Results and Discussions

3.1. Crop damage assessment

The extent and nature of damage of different crops by Indian porcupine in the study area are described below.

3.2. Maize

Maize is one of the important cereal crop grown in the study area before the monsoon and harvested in October and November. During the survey 58 fields of Maize were damaged by Indian porcupine out of 84. In Union council Chamhad the damage was 11.31% (37 fields out of 48 were infected by the Indian porcupine), while in union council Salhad damage was 6.95% (21 fields were damaged out of 36). Maximum damage was recorded in Kasaaki (13.008%), and Durubban (11.18%) However, minimum damage was recorded in Totni (3.01) of Union council Chamhad, while Maximum damage was recorded in Danna (13.81%) and Dehri (10.9%) and lowest in Dheri myra (2.65%) of Union council Salhad. The overall damage percentage was 8.01% in the entire study area (as shown in Table 1). Maize was more damaged by the Indian porcupine due to a highly succulent and nutritionally rich nature. During the study, the damage pattern by Indian porcupine was also noted. Due to its smaller size, Indian porcupine could not reach the cobs of maize crop, so they first cut the stem from the base and when the plant fell and cobs were in reach, porcupine ate them.

3.3. Wheat

Wheat is widely cultivated as a staple food. The data showed that Indian porcupine damage was observed in 8 fields of wheat out of 53 of the study area. Out of 8 damaged fields, 5 fields were observed in union council Chamhad, and 3 damaged fields were observed in union council Salhad. The damage was 2.35% in village Kassaki, 2.5% in Battangi and 2.03 in Mangal dara (Union council Chamhad), and 2.41% in Kotakiyan, 1.9% in Dehri and 4.64 in

Table 1. Estimates of maize crop damage by Indian crested porcupine in the study area.

Village name	Union Council	Total fields	Damage fields	Total quadrates	Total plants	Damaged plants	Damage %
Kassaki	Chamhad	5	4	15	1253	163	13.008
Mangal dara	Chamhad	4	2	12	1065	112	10.51
Bhuraj	Chamhad	4	3	12	958	106	11.06
Batangi	Chamhad	4	3	12	887	89	10.03
Bagahti	Chamhad	4	2	12	1083	52	4.801
Bian Gojra	Chamhad	3	3	9	826	74	8.95
Duruban	Chamhad	4	4	12	912	102	11.18
Chamhad	Chamhad	5	5	15	1292	98	7.66
Shidyal	Chamhad	3	3	9	799	74	9.26
Mihal	Chamhad	3	2	9	803	58	7.22
Ghori Sharif	Chamhad	3	2	9	891	56	6.28
Totni	Chamhad	3	1	9	762	23	3.01
Baghdara	Chamhad	3	3	9	892	91	10.38
Jabriyan	Salhad	4	3	12	1110	98	8.82
Kotakiyan	Salhad	4	3	12	1072	93	8.67
salhad	Salhad	3	0	9	719	0	0
Khokhr Myra	Salhad	3	1	9	763	0	0
Muslim-abad	Salhad	2	0	6	579	0	0
Dehri	Salhad	4	3	12	953	102	10.9
Danna	Salhad	4	4	12	1042	144	13.81
Thanda myra	Salhad	3	2	9	825	90	10.7
Dheri myra	Salhad	3	1	9	829	22	2.65
shah de galli	Salhad	3	2	9	762	51	6.69
Goriyan	Salhad	3	2	9	897	63	7.02

Danna (union council Salhad) (as shown in Table 2). Mostly damage has occurred at the boundaries and the walking track made by the farmers rather than the center of the field. Overall damage to wheat was 0.88%. Indian porcupine occasionally feeds on wheat as the natural preferred vegetation such as *Pinus roxburghii*, *Melia azedarach,* etc. is abundant in the area at the same time.

3.4. Vegetables and fruits

In the study area, many types of vegetables were cultivated such as potato, tomato, radish, cauliflower, chili pepper, turnip, pea, pumpkin, cucumber only for domestic use in a small and fully fenced area, covered either by plastic, bushes, or wire fences to restrain the pests. It was reported by the farmers that previously the cultivation of potatoes, peas, tomatoes, turnip, and other vegetables had occurred on a commercial basis but due to massive damage caused by the pest farmers start growing other crops that were less susceptible to pest damage. Based on information obtained from the farmers, the Indian porcupine inflicted damage to potato, tomato, cauliflower, chili pepper, turnip, radish, and pea, etc.

3.5. Sorghum and pearl millet

Sorghum and pearl millet were cultivated rarely in the study area. These crops were cultivated mainly for fodder purposes. 7 fields of sorghum and 3 fields of pearl millet were visited but no damage was observed in these crops by Indian porcupine.

SPSS (Statistical Package for Social Sciences) (18.0.2) software was used to check data statistically.

A T-test was performed to check the damage percentage of two union councils of the study area (as shown in Table 3). The result of the test showed that union council Chamhad reported statistically to be more damaged as compared to union council Salhad because of low human population and settlements, however, union council Salhad was less damaged due to more urbanization and CPEC

Table 2. Estimates of wheat crop damage by Indian crested porcupine in the study area.

Village name	Union council	Total fields	Damaged fields	Total Quadrates	Total plants	Damage plants	Damage %
Kassaki	Chamhad	3	2	9	2055	54	2.35
Mangal dara	Chamhad	3	1	9	1913	38	2.03
Bhuraj	Chamhad	2	0	6	1371	0	0
Batangi	Chamhad	3	2	9	1909	49	2.5
Bagahti	Chamhad	2	0	6	1192	0	0
Bian Gojra	Chamhad	2	0	6	1247	0	0
Duruban	Chamhad	2	0	6	1198	0	0
Chamhad	Chamhad	2	0	6	1398	0	0
Shidyal	Chamhad	2	0	6	1297	0	0
Mihal	Chamhad	2	0	6	1223	0	0
Ghori Sharif	Chamhad	2	0	6	1189	0	0
Totni	Chamhad	2	0	6	1277	0	0
Baghdara	Chamhad	2	0	6	1306	0	0
Jabriyan	Salhad	2	0	6	1202	0	0
Kotakiyan	Salhad	3	1	9	2029	49	2.41
salhad	Salhad	2	0	6	1277	0	0
Khokhar Myra	Salhad	2	0	6	1291	0	0
Muslimabad	Salhad	2	0	6	1173	0	0
Dehri	Salhad	2	1	6	1197	24	1.9
Danna	Salhad	3	2	9	1875	87	4.64
Thanda myra	Salhad	2	0	6	1413	0	0
Dheri myra	Salhad	2	0	6	1287	0	0
shah de galli	Salhad	2	0	6	1148	0	0
Goriyan	Salhad	2	0	6	1201	0	0

Table 3. T-Test Results for Comparing Union council Chamhad and union Council Salhad on Crop damaged.

	Group Statistics			t-test for Equality of Means		
	Union council	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Crop Damaged	Chamhad	1.89	1.039	2.111	157	.036
	Salhad	1.58	.687	2.191	150.107	.030

(China Pakistan Economic Corridor) and Silk route pass from the many villages of the Union council.

3.6. Community survey

The crop damaged by Indian porcupine is an important agricultural issue and the basic cause of human porcupine conflict. To investigate the level and intensity of human porcupine conflict causes, and the nature of crop damage, behavior, and perception of the local community toward porcupine conservation, a community survey was conducted in the study area. A total of 159 respondents from twenty-four villages were interviewed. About six to seven questionnaires were filled from each village of two union councils (see Figure 2).

3.7. Age of the respondents

The respondents of different age groups were interviewed. Based on age, the respondents were divided into seven categories. The maximum questions were asked from the respondents having ages between 41 to 50 years (42%) followed by respondents having aged, between 31 to 40 years (33%). While the minimum number of respondents having age less than 20 years (5%) (See Figure 3).

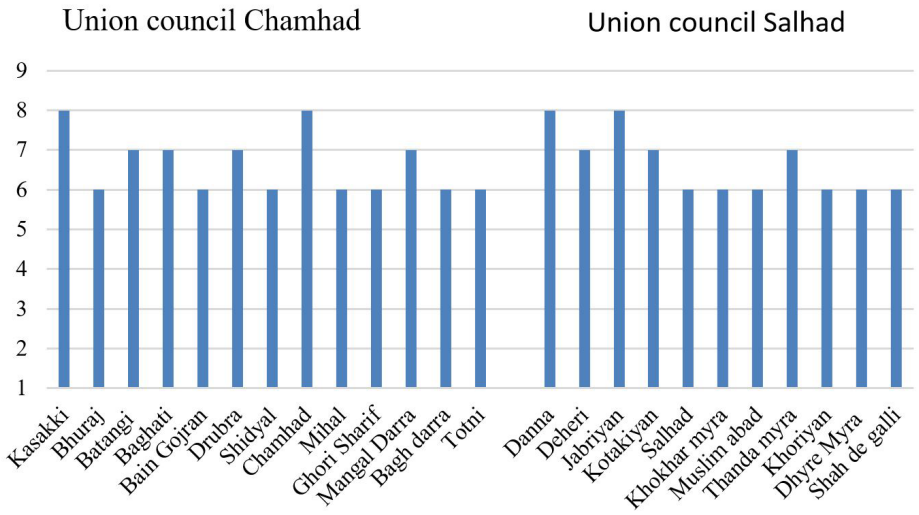

Figure 2. Number of respondent investigated from the study area.

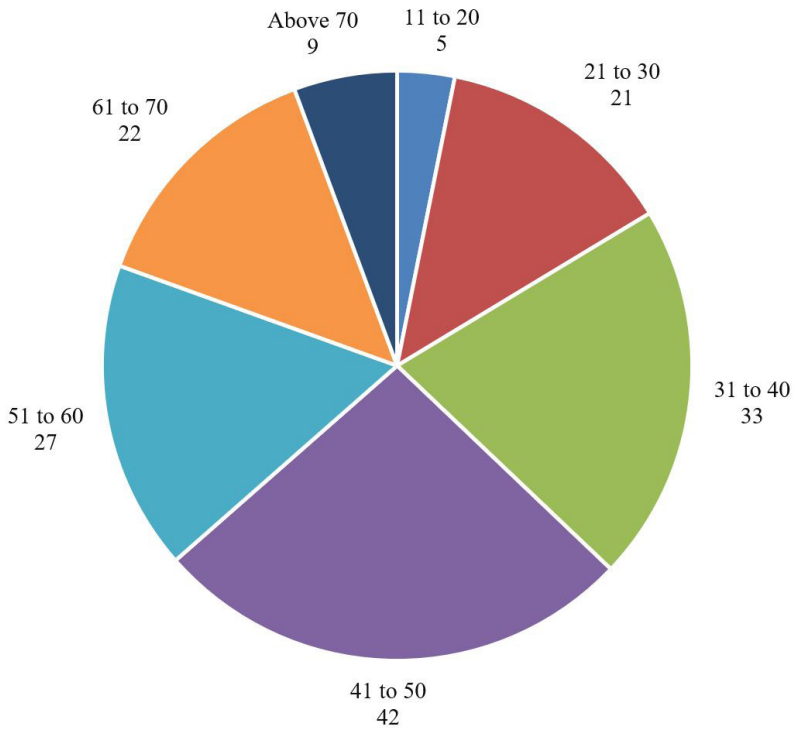

Figure 3. Different age classes of the respondents, interviewed from the study area.

Correlation between age of respondent and porcupine encounter was statistically checked (as shown in Table 4) ($r = 0.293$, $p = 0.000$). The result showed that there is a positive significant correlation between the age of respondents and porcupine encounter. Older age people had a more sighting record of porcupine than the younger ones.

3.8. Agriculture land possession

Due to sloppy terrain and the dread of wild pests, people cultivate crops in a small area. The agricultural land owned by local people had great variations. The maximum number of respondents (38.84%) had 11 to 20 Kanal land used for the agricultural proposes. While some respondents (4.40%) have more than 50 Kanal of agricultural land.

One Way Analysis of Variance (ANOVA) test was applied to check the relation between damage percentage done by Indian porcupine and agriculture land (as shown in Table 5) on which crops were grown, the test showed ($d.f = 2$, $F = 0.55$, $P = 0.577$) that no significant difference between agriculture

Table 4. Correlation between respondent's age and porcupine encounter.

		Porcupine saw
Respondent Age	Pearson Correlation	.293**
	Sig. (2-tailed)	.000
	N	159

Table 5. One Way Analysis of Variance (ANOVA) by agriculture area and damage percentage.

Damage percentage					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	.449	2	.224	.552	.577

Multiple Comparisons			
(I) Agriculture Area	**(J) Agriculture Area**	**Mean Difference (I-J)**	**Sig.**
1-30 kanals	31-50 kanals	.009	.951
	51 Kanal and above	-.257	.300
31-50 kanals	1-30 kanals	-.009	.951
	51 Kanal and above	-.266	.337
51 kanals and above	1-30 kanals	.257	.300
	31-50 kanals	.266	.337

area and damage percentage observed. Indian porcupine damaged equally small and large agricultural land.

The study area is comprised of mountains region and the majority of the farmers depend upon rainwater for the cultivation of maize and wheat. However, in some areas vegetables were also grown along with maize, wheat. While very few numbers of the respondents cultivated sorghum (8.17%) and pearl millet (4.40) along with wheat and maize.

According to the community survey, maize was the most susceptible crop to porcupine damage. The majority (49.68%) of the respondents reported that both maize and wheat were damaged by a porcupine, fifty-two respondents (32.70%) reported that only maize was damaged, and seventeen respondents (10.69%) response that different types of vegetables were also damaged along with wheat and maize by Indian porcupine in the study area.

The majority of the respondents claim that porcupine causes huge damage to crops during a single growing season. About forty-six respondents reported that 21 to 30% of their yield was destroyed by the Indian porcupine, followed by 39 who reported that damage percentage was 31-40%, other thirty-two reported that the damage was 41-50%. These percentages reported by the local community was relatively higher as compared to data collected through field surveys in the study area. One of the reasons is that farmers were unable to differentiate the damage caused by Indian porcupine from other pests like wild boar which cause a huge loss to the agricultural economy.

The correlation between the type of crop grown and crop damage percentage was statistically checked (as shown in Table 6). Results showed that there is a significant correlation between crop type damaged and crop damage percentage ($r = 0.213$, $P = 0.007$). Results showed that porcupine damaged a specific crop more drastically.

A high sighting of porcupine was recorded in the study area. About 96% of the respondents have seen Indian porcupine directly. According to respondent's Indian porcupine was sighted maximum in agricultural land (61.63%) followed by the forested area (28.30%) and little sighting records of porcupine were observed near the water bodies (4.40%) in the study area.

The local community in the study area showed a strong negative response against the Indian porcupine in the form of hunting (61.00%) as it was responsible for huge economic losses. Similarly, the local community used different strategies and tools for the hunting of Indian porcupine by guns (63.91%), dogs (8.24%), both guns and dogs (7.54%), and current (1.88%) for the killing of Indian porcupine in the study area. Due to the large area and nocturnal behavior of Indian porcupine maximum number of the respondents said that they did not use any precautionary measure (51.57%) followed by those who used fencing (11.94%) and a minimum number of respondents used statue (6.28%) as a precautionary measure for the safeguarding of the crops in the study area.

Correlation between precautionary measured used and damage percentage was statistically checked (as shown in Table 7) ($r = -0.031$, $p = 0.694$). The result showed that there is a negative correlation between precautionary measures used and crop damage percentage done by a porcupine. It showed that porcupine damaged more those agricultural fields where no precautionary measure used to protect crops

Table 6. Correlation between Crop type damage and damage percentage.

		Damage percentage
Crop Type Damaged	Pearson Correlation	.213**
	Sig. (2-tailed)	.007
	N	159

Table 7. Correlation between precautionary measured used and damage percentage.

		Damage percentage
Precautionary Measures used	Pearson Correlation	-.031
	Sig. (2-tailed)	.694
	N	159

4. Discussion

In the current study damage due to Indian porcupine was mainly found in maize, wheat, and some vegetables. Porcupine severely damaged maize (8.01%). It is linked with the study (Khan et al., 1997) estimated damage to maize crop (10.7%) in Azad Jammu and Kashmir while (Hafeez et al., 2011) reported in Punjab Pakistan Indian Porcupine inflicted damaged to maize was 6.37% in Faisalabad and 5.51% in Shiekhupura. Before this 0.83% damage was recorded in central Punjab (Ahmad et al., 1987).

Indian porcupine damage to wheat crop was estimated as 0.88% in the current study (Mian et al. 2007) reported a similar finding in Pothwar damage to wheat due to Indian porcupine was 0.96%. According to (Hafeez et al., 2011) the survey conducted in Punjab, damage to wheat was 1.14 to 4.58% in Faislabad, 2.03% in Quaidabad, and 1.53% in sheikhupara. The finding of (Alkon and Saltz 1985) in the Negev desert of Israel was about close to the current study which was 0.6% of the potatoes were damaged by Indian porcupine.

In the study area, the vegetables were grown in a small area for domestic use according to information obtained from the farmers, the Indian porcupine damaged potato, tomato, cauliflower, chili pepper, turnip, radish, and pea, etc. A similar study conducted by (Khan et al., 2000) in Attack Punjab, reported that Indian porcupine damage 17.56% of potatoes.

Some more studies linked to results obtained by the current study are in different areas of Baluchistan, it was reported that Indian porcupine caused damage to sweet potatoes 4-36% and potatoes 2.20%, apart from that damage to different vegetables (carrot, cabbage, and pea) was assessed at 1-4% (Pervez, 2006). In Punjab Pakistan, Indian porcupine reported damaged onion (1.15 to 2.72%), groundnut (3.19 to 11.92%), melon (3.39 to 4.44%), and sugarcane (2.28 to 5.51%) (Hafeez et al., 2011). In Chakwal Indian porcupine caused damage to onion (0.9 to 5.4%) and groundnut (7.2 to 20.2%) (Mian et al. 2007).

According to the community survey, Indian porcupine was abundant in the hilly area of the study area and 96% of the respondent had seen Indian porcupine. A similar study reported by (Amori et al., 2008) that Indian porcupine prefers hilly rocky terrain. According to farmer most of the encounter of Indian porcupine was made at night while (Bruno and Riccardi, 1995) also reported that Indian porcupine is nocturnal and shy species.

Many precautionary strategies were used by the local community, however, the maximum number of respondents killed Indian porcupine through a gun. This study is linked with the study of (Sarwar, 2018) that hunting through the gun is the easiest way to eliminate the pest and decrease damage. However, due to the large area and nocturnal behavior of the species, many farmers didn't use any type of precautionary measure to stop the pest.

5. Conclusion

In the study area, the Indian porcupine has been identified as a serious pest of crops. To avoid damage caused by Indian porcupine, the measures should be adopted by the agriculture and wildlife department for its control. Farmers should be encouraged and provide incentives to use proper controlling methods to decrease crop damage. Killing through current should be banned because it affects not only target species but also other non-target animals. Many people hunt it for bushmeat and sports so the proper hunting license should be issued to overcome overhunting. Scientific studies are required to control the reproduction of porcupine specifically in the more damaged areas. Biological control of Indian porcupine is recommended in the study area.

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