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A pattern of human dhole interaction in the buffer area of Jigme Khesar Strict Nature Reserve

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Abstract
Human-wildlife conflict is a serious problem for conservation efforts worldwide. This is also true for Bhutan, where carnivores depredate livestock of farmers, affecting farmer's livelihood, however, there is sparse documentation on the extent of human dhole interaction in Bhutan's some of the important areas of conservation interest. Therefore this research was aimed to evaluate the extent of human dhole interaction, income lost due to depredation, and the perception of the farmers towards dhole conservation. Data were collected from 160 households within two strata of the rural and semi-urban areas in western Bhutan through semi-structured questionnaires and focused group discussions. Livestock depredation involved seven predators, which caused the loss of 5% of the total average annual income of the farmers; which were significantly different between the predators involved. Dhole killed significantly more livestock than other predators and maximum kills were made in the rural area than semi-urban area. 60% of the incomes lost due to wild predators were caused by dhole with major impact in rural areas. The majority of the respondents from rural areas exhibited a negative attitude towards dhole conservation. They suggested livestock depredation compensation schemes and other livelihood alternatives minimize the impact of conflict, whereas the majority of the respondents from semi-urban suggested electric fencing around their village as measures to reduce human-wildlife conflict. Livestock compensation and insurance schemes, integrated conservation development programs, educational outreach programs with other livelihood alternatives such as ecotourism are recommended as intervention strategies to minimize human dhole conflict and create harmonic co-existence.

Keywords: Conflict, depredation, income, perception, rural, semi-urban.

Introduction

Human dhole interaction involves where the human encroach the dhole habitat and dhole come into the human-dominated periphery and cause threat or competition to the livelihood of the farmers. An increase in dhole population causes the livestock depredation, which results in a negative attitude of the farmers towards dhole, thereby killing the dhole in retaliation and impacting the dhole conservation (Tshering and Thinley, 2017). 72% of the respondents in the protected area of Thailand believe that increase in human dhole conflict was due to its habitat destruction by the alignment of roads (Jenks et al. 2014). Wang and Macdonald also stated that the influential factor contributing towards human dhole conflict includes increasing human population, loss of natural habitat, less pray and in some regions and increased dhole population resulted from conservation program actions (2006).

Bhutan is an agrarian country where the majority of the population are dependent on agriculture and livestock for their livelihood and most of the settlements are located in the proximity of the forest (Sangay and Vernes, 2008). The major wild predators depredating livestock includes tigers, common leopard, black bear, and dhole (Wang and Macdonald, 2006). Livestock depredations are common in areas where livestock holding forms the an integral part of farmer's livelihood (Sangay and Vernes, 2014, Katel et al. 2014).

Among the wild predators, dhole caused a major negative impact on the livestock holding communities' livelihood (Dar et al. 2009, Sangay and Vernes, 2008). Human dhole interaction in form of livestock depredation has led to a threat to the dhole population by the farmers involved with the livestock rearing in its distribution ranges (Thinley et al. 2011). In Bhutan, dholes were nearly extirpated in the 1970s due to

perceiving as pest to livestock and mass poisoning campaign for the dhole. Due to the increase in the population of wild pigs, the Bhutan government initiated reintroduction of dhole in the early nineties and now the species has re-established and its population is on the rise (Johnsingh et al. 2007).
Many incidences of livestock depredation by dhole were reported from rural and semi-urban areas in Bhutan (Wang and Macdonald 2006, Johnsingh et al. 2007, Thinley et al. 2011, Katel et al. 2014, Tshering and Phuntsho 2017). However, no information on the human dhole interaction is available from the buffer area of Jigme Khesar Strict Nature (JKSNR). This research was aimed to evaluate the extent of human dhole conflict, income lost due to depredation, and the perception of the farmers towards dhole conservation.

1. Materials and Methods

1.1.Study area location

This study was conducted in the buffer zone of JKSNR including part of four blocks, which lies between latitude 27°22' N to 27° 1' N and longitude 89° 1'E to 89°23'E. It was located in western Bhutan covering 726.61 square kilometers (km^2) (Figure 1).

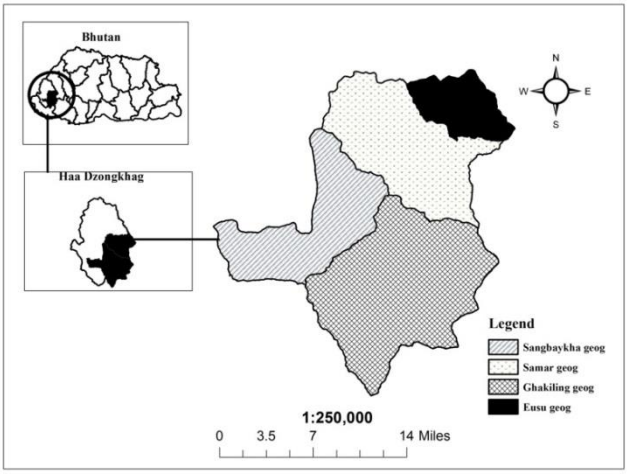

Figure 1: Study area location

1.2.Sampling design

Stratified random sampling was carried out (Wangyel, Lassoie, & Curtis, 2006). The target population was households rearing livestock within the past five years because not all the households were rearing livestock (Alexander et al. 2015). From the target population, 50% of the households from each village were randomly selected, which were treated as sampling units (Khan and Abbasi, 2015). Random selection of households was carried based on the random number generation against total households in the village using Microsoft excel. A total of 160 households were interviewed.

1.3.Area stratification

Four blocks were stratified into two strata based on the ecological zone, altitude, vegetation type, and proximity of the village to the urban zone. The principal criteria for the stratification of the survey area were the proximity of the settlements to the forest and national highway and town. Strata I was stratified as a rural area, as it is far away from the motor roads and there are no modern developmental activities taking place, whereas, strata II was stratified as semi-urban because the villages are within proximity to the national high way and all the villages are connected by motor road (Table 1).

Table 1: Study area stratification

Strata	Agro ecological zone	Vegetation type	Blocks	Category	Elevation range (meter above sea level (masl)
Strata I	Subtropical zone	Broad-leaved forest	Gakiling and Sangbaykha	Rural area	491-2,183

Strata II	Cool temperate zone	Conifer forest	Samar and Eusu	Semi-urban area	2,476-4,597

The idea behind stratification of the study area was to compare the significance, intensity, and prevalence of human dhole interaction in the different ecological zone and within the rural and semi-urban area with the hypothesis stating that the dhole population will be more with increasing distance from the national high way or in the rural area. This hypothesis was based on the assumption that the dholes avoid areas where there are high chances of human encounter and thus, will result in less livestock depredation (Borah, Deka, Dookia, & Prasad Gupta, 2009).

1.4.Data collection

Data were collected using a semi-structured questionnaire (Jenks et al. 2014). Pre-testing of the questionnaire is pivotal in the enhancement of required and quality data collection (Woodroffe et al. 2005); therefore, pre-testing was carried out for six households, three each from two strata. Data collected during the pre-testing of the questionnaire were not included for analysis.

Interviews were carried out by visiting the household identified and respondents were interviewed separately to avoid the override information by the other respondent. The Head of the households was interviewed.

1.5.Data analysis

Stastical analysis of data was carried out using Statistical Package for Social Science (SPSS) Ver.23, ArcGIS 10.2, and Microsoft excel. Coding of the questions and the responses were done before analyzing the data. Both descriptive and inferential statistics were used for data analysis.

Data were tested for normality using a histogram with its normal curve and Kolmogorov normality test. Normal parametric data such as income from agriculture and income from livestock were analyzed using ANOVA to compare the income contribution between two strata.

Mann-Whitney U test was used to see the significant difference in mean annual income between two strata, average annual income from different income sources between two strata, mean annual income from livestock between two strata, mean livestock kill between two strata and mean income lost due to dhole in two strata.

Income lost due to livestock depredation by wild predators and dhole were non-parametric in nature, therefore Kruskal-Wallis and Mann-Whitney *U* test were used to compare the difference within the predators and between the strata. A correlation was used to compare the relationship between the income and livestock lost to wild predators and dhole.

2. Results and Discussions

2.1.Socio-economic characteristics

Out of 160 respondents, 47.5% (n = 76) were men and 52.5% (n = 84) were women. Respondents from strata I comprises of 75.4% (n = 44) male and 43.6% (n = 34) female and strata II comprising of 40% (n = 32) male and 60% (n = 50) female. The mean age of the respondents was 45.11 ± 14.09 with oldest respondent age of 82 and youngest of 19.

The average household member living at home was (5 ± 2.25) and household member's living at home in strata I (4.910 ± 2.07) was lower than in strata II (5.22 ± 2.15) with both the strata having a minimum of two and maximum of 12 members. The study conducted by Johnsingh *et al*., 2007 at Toebisa geog also found that the mean family members' size living in the semi-urban area (right bank) (M = 8.42) was higher than in the rural area (M = 5.78).

2.2.Income source

Residents are primarily subsistence farmers. Agriculture (61%) and livestock (22%) are the main sources of livelihood supplemented by non-farm activities. The non-farm activities include Non-Wood Forest product collection (3%), remittance from the employee (3%), business (6%), and casual labor (4%).

The average annual cash income of household from all sources including livestock was US$ (1720.51 ± 700.5) which was 91% higher than that of farmers in JSWNP (Wang and Macdonald, 2006) and 71% higher than farmers in Toebisa geog (Katel et al. 2014) and the reason could be because in strata I farmers were growing cardamom as their main cash crop and in strata II farmers mean annual income was contributed by

a combined force of agriculture, livestock, business, forest produce collection and casual labor, which provided better opportunities than farmers in Toebisa geog and JSWNP.

The average income of the respondents from strata I was US$ (1808.46 ± 647.94) and strata II was US$ (1845.26 ± 750.67). There was no significant difference in mean annual income per household between strata I and strata II (U = 3180, z = -.061, p>.05), because in strata I the average annual income from agriculture contributed 77.6% (15215.55 ± 437.95) by the cultivation of cardamom as their main income source, whereas in strata II both agriculture (841.72 ± 427.13) and livestock (526.58 ± 616.24) contributed equally to the overall mean annual income per household followed by income from other non-farm activities. Katel et al. (2014) found that the average income of the farmer decreases as they move further away from the national highways and it contradicts the current finding because of the lucrative cardamom cultivation in a rural area in the current study site.

Average annual income from agriculture (U = 961.5, z = -7.64, p<.05), livestock (U = 1,801.5,z = -4.78, p<.05),forest produce collection (U = 1,340, z = -7.41, p<.05), business (U = 2,813, z = -2.52, p<.05), and casual labor (U = 2582.5, z = -3.27, p<.05) between two strata were significantly different, but it showed no significant difference in average annual income from employee support between two strata (U = 3,088,z = -.67, p>.05).The average income from agriculture was US$ (1116.08 ± 515.23), however, livestock contributed only US$ (399.78 ± 577.94) towards the average annual income per household of the farmer. Therefore, in both, the strata income from agriculture contributed the maximum to the mean annual income. The result was consistent with the farmers in Arunachal Pradesh, where 66% of the household depends on subsistence agriculture (Lyngdoh, Gopi, Selvan, & Habib, 2014). This is because farmers of these study sites shared similar economic zone.

The income of the farmers from agriculture was significantly high in strata I, H (1) =22.81, p<.05, this was because the higher income from agriculture in strata I was highly contributed by cash from lucrative cardamom because of the agro-ecological zone. The sale of potato and vegetables were the main cash crop that contributed towards income from agriculture in strata II, which was minimal when compared to the cardamom.

Livestock contribution was only 14.73% towards farmer's livelihood in strata I and 28.5% in strata II (Table 2). The mean annual income from livestock between the two strata was significantly different, U = 1,801.5, z = -4.776, p<.05. This was because farmers in strata II has the easy excess to the market and in the semi-urban, there are demands for livestock product, whereas farmers in strata I keeping livestock mostly for their household consumption and not for income because there was no market for their livestock products. Non-farm activities contributed only 6% of the total average income in strata I and in strata II, it contributed 25.9%, this was because in the semi-urban areas peoples were engaged in business, which alone contributed to 10% of the average annual cash income.

Table 2: Mean annual income contributors (%)

	Strata I		Strata II	
Income contributor	Mean	%	Mean	%
Agriculture	91,293.3± 28467.4	77.7	54,712 ± 27763.4	45.6
Livestock	17,320.7 ± 32830.5	14.7	34,227.8 ± 40055.9	28.5
NTFP collection	1,072.7 ± 6074.7	0.9	6,965.5 ± 8636.6	5.8
Employee support	3,611.1 ± 9479.3	3.1	4,471.5 ± 14705.3	3.7
Business	2,606.8 ± 13209.9	2.2	12,012.2 ± 32981.5	10
Casual labor	1,645.3 ± 6565.8	1.4	7,552.9 ± 15372.4	6.3

2.3.Livestock holding

Farmers in the study area were raising seven different types of livestock including cat and dog but yak had not raised in strata I because of its geographical location in lower elevation area. The cow was highest among other livestock types in both the strata (Strata I 37.4%, n = 516, Strata II 60%, n = 834) (Table 3).

The mean annual livestock holding per household was (17.29 ± 17.97), including cat, dog, and poultry, which was 17.2% more than farmers in JSWNP Wang and Macdonald, 2006). This was because farmers in

JSWNP were rearing the majority of the improved breed than in the current study site. Farmers in Kashmir were having a lower of 28.9% of livestock per household when compared with the current study site; it was because they never kept a wide variety of livestock, the majority were sheep and goats (Mir et al. 2015).
Both the strata were having similar numbers of livestock holding in the year 2016 (Strata I; n = 1,378, Strata II; n = 1,389). Farmers in the northern part of Nepal which were in proximity to the developmental zones holds 20% of livestock less than the farmers living further away from the urbanization, where, livestock and agriculture were the main means of rural livelihood sustenance (Thapa, 2015). The mean number of livestock holding per household in strata I was (17.6 ± 14.7) and in strata II was (16.9 ± 13.3%).

Table 3: Type of livestock holding of the respondents

	Strata I	Strata II
Livestock type	Total (%)	Total (%)
Yak		160 (11.5)
Horse	90 (6.5)	67 (4.8)
Cow	516 (37.4)	834 (60)
Ox	238 (17.3)	174 (12.5)
Goat	9 (0.7)	1 (0.1)
Poultry	410 (29.8)	31 (2.2)
Cat	55 (4)	43 (3.1)
Pig	17 (1.2)	3 (0.2)
Dog	43 (3.1)	76 (5.5)

2.4.Livestock holding characteristics and their protection measures

Farmers in the study area were practicing four different types of livestock herding practices as stables or enclosures feeding, tethered in the field, send in the natural pasture or forest, and itinerant herding. Out of 160 households, more than half 58.1%, (n = 93) send their cattle in the forest during daytime and 25% (n = 40) of households tether their livestock in an enclosure or field. The reason for those who send their livestock in the forest and never look after was because 57.1% (n = 114) of households reported labor shortage as their problem for looking after the cattle, whereas in Toebisa geog, maximum (57%) of the farmers never leave or keep their livestock in the forest. The difference in herding practices between the two study sites could be explained by the availability of labor to look after the cattle (Katel et al. 2014).

Relatively strata-wise livestock rearing mechanism showed that 76.9% (n = 60) of households in strata I were sending their livestock in the natural pasture or forest during the daytime and never look after the livestock for a whole day. They were engaged only in sending their livestock to natural pasture or forest in the morning. In strata II, 40.2% (n = 33) of households were engaged in sending their livestock in the natural forest during day time followed by 34.1% (n = 28) tethering their livestock in their fields.

Stall feeding and keeping (3.8%, n = 3) in the enclosure was least practiced in strata I and even in strata II (9.8%, n = 8). Farmers in both the strata reported fodder shortage as one of the livestock rearing challenges and they could not stall-feed the livestock.

Respondents in strata I preferred compensation schemes with 46.2% (n = 36) for livestock killed and in strata, II farmers would prefer electric fencing around the village with 41.5% (n = 34) to reduce the impact of human dhole conflict. In Australia, ranchers were keeping livestock guarding dogs to prevent their livestock from depredation by a wild dog, where 65.7% of respondents asserted that depredation ceased after obtaining livestock guarding dogs (Van Bommel & Johnson, 2012), so such measures can also be practical in Bhutan.

2.5.Livestock depredation by dhole

From the total of 233 livestock depredation by dhole, 54.2% (n = 134) were cow followed by ox with 40.1% (n = 89), this result is consistent with Katel *et al*. (2014), who reported that local cattle kill by dhole was highest 89%, (n = 141) in Toebisa geog. In JKSNR, livestock predation by dhole was maximum in strata I

with 72.9% (n = 170) kill while in strata II with 37.1% (n = 63). The mean livestock lost to depredation by dhole in strata I was (3.7 ± .59) numbers per household per year and in strata II it was (1.9 ± .62). In both, the strata dhole depredation was highest among the other predators with maximum depredation on cow in both the strata (Strata I, 55.9%, (n = 95), Strata, II 61.9%, n = 39) and followed by ox (strata I 39.4%, n = 67, strata II 34.9, n = 22).

Seven types of livestock were lost to wild predators and dholes were responsible for four types of livestock such as cow, ox, horse, and yak. Livestock depredation by dhole comprises 52.6% (n = 233) belonging to 88 households. This result conformed to the number of livestock killed by dhole with 34.7% (n = 51) in Toebisa geog as the highest kill, as reported by Katel *et al*. (2014) and Tshering and Thinley (2017), also reported dhole to kill amongst the highest (49.9%) but the result contradicts with Wang and Macdonald (2006) study in JSWNP, where leopard contributed 53%, tigers 26% and dhole with 13% followed by bear 8%. Thus, it is assumed that where there is the presence of top predators like tiger and leopard, dholes are less present. Dholes were also top predators in the neighboring regions like Arunachal Pradesh (70%) (Lyngdoh, 2014) where there are no top predators like tiger.

2.6.Age category of livestock kill and livestock depredation distance from the village

From the total livestock kill by dhole, 55.8% (n = 130) were adult (>2 years) and 44.2% (n = 103) were young (<3 years). The kill age category of livestock by dhole showed no significant difference, H (1) =.2210, p>.05, which indicates that dholes have no preferences over the age of the livestock for the kill.

The majority of dhole depredation was made within one km (52%, n = 167) from the village (Figure 2), because the majority of farmers free-range their livestock in the nearer forest and never look after the cattle. They were engaged in sending in the morning and cattle come back to their shed in the evening, in which livestock become easy prey for the dhole within proximity to the village without attended (Johnsingh et al. 2007).

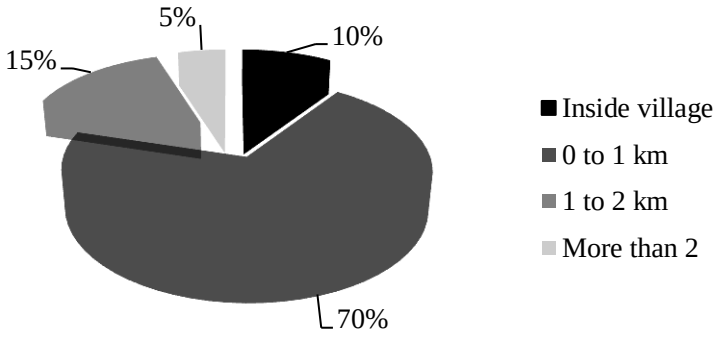

Figure 2: livestock kill distance of dhole from the village

2.7.Farmer's income lost due to depredation by dhole

From the overall income lost due to wild predators, dhole was responsible for 60% of the income loss. The average monetary value lost due to livestock predation by dhole for the last five years was US$ 8872.6, which was 3% of the total income holding during the last five years (US$ 292371.12) of the respondents. The mean annual income lost due to dhole (60%) was more in comparison with the mean annual income lost due to dhole (32.9%) in Toebisa geog (Katel et al. 2014) and the mean annual income loss due to dhole (13%) by the farmers in JSWNP (Wang and Macdonald, 2006). This was because in these two areas tiger also added to the livestock depredation, whereas no record of tiger kills was reported in the current study area.

The average value of livestock lost to dhole in strata I (US$ 79.41) was much higher than in strata II (US$ 32.65) (Figure 3) and in both the strata dhole contributed maximum to the income lost due to depredation (strata I=74.2%, strata II=41.9%). When we compared the income lost due to livestock depredation by dhole in two strata, dhole contributed 69.2% in strata I and only 30.2% in strata II, which was significantly higher in strata I (U = 2,964.00, z = -.436, p<.05).

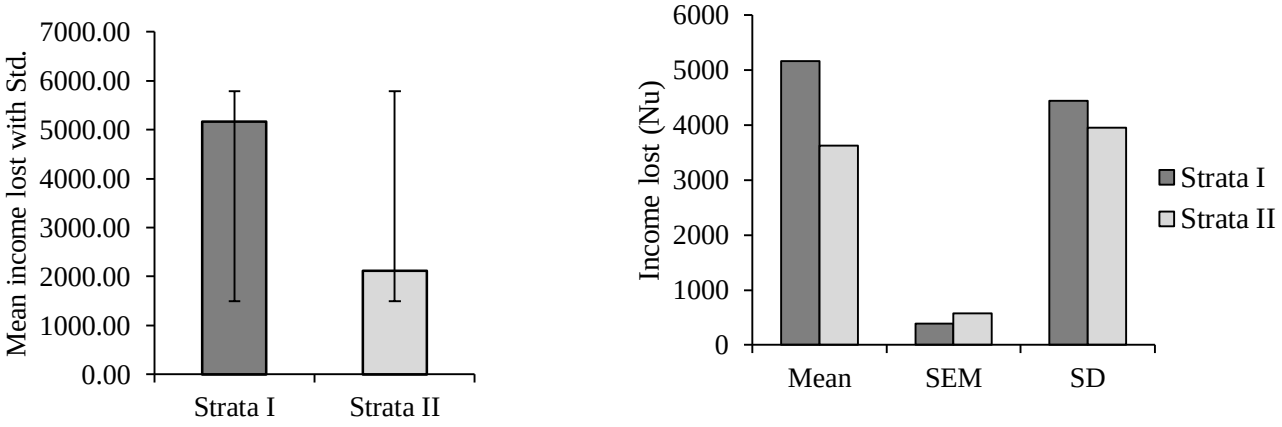

Figure 3: Mean income lost due to livestock depredation by dhole

2.8.Farmer's attitude towards dhole conservation

Out of 160 respondents, 99.3% (*n* = 159) respondents knew dhole, where 90.6% (*n* = 145) of the respondent have sighted dhole and 3.7% (*n* = 6) have seen only in television. 38.1% (*n* = 61) of respondent believes that the dhole population was increasing followed by 36.9% (*n* = 59) with decreasing, 10% (*n* = 16) believes that the population trend is not changing and 14% (*n* = 24) of the respondents are not sure about the population trend of dhole.

The reason for the change in population trend as per respondent's opinion was that 17.5% (*n* = 28) of the increase were due to reintroduction of dhole by the government in the 1970s, followed by 8.8% (*n* = 14) claiming for more breeding and no predator to kill dhole. 4% (*n* = 4) of the respondents reported that habitat destruction and encroachment by a human were the cause for a decrease in dhole population and 5% (*n* = 8) were not sure of the reason for population change.

Farmers have their different perception on the presence of dhole in their locality. The maximum number of respondents from both the strata (strata I, 48.7%, *n* = 37; Strata II, 52.4% *n* = 43) believed that present dholes were native to their locality, while 32.9% (*n* = 25) from strata I and 17.1% (*n* = 14) from strata II believes that both the native as well as introduced are present in their locality. 17.7% (*n* = 28) respondents from the study site comprising 14.5% (*n* = 11) from strata I and 20.7% (*n* = 17) from strata II believe that the government had reintroduced dhole and reintroduced dholes are currently present in their locality (Table 4). This was supported by the statement made by Johnsingh et al. (2007) asserting that poisoning of dhole in the 1970s nearly extirpated the dhole existence and subsequently for last thirty years dhole problem was forgotten and absence of dhole bought enormous damage to crops by wild pig and dhole reappeared in most of Bhutan in late 1990s, which was assumed to be reintroduced and again started causing damage to livestock.

Table 4: Respondents perception on present dhole presence (% in the parenthesis)

	Strata 1	Strata 2	Total
Native	37 (48.7)	43 (52.4)	80 (50.6)
Introduced	11 (14.5)	17 (20.7)	28 (17.7)
Both present	25 (32.9)	14 (17.1)	39 (24.7)
No idea	3 (3.9)	8 (9.8)	11 7)

Conclusion

Depredation by dhole not only made a significant impact on farmers' livelihood but also changed peoples' attitude towards dhole conservation effort. Livestock in the rural area is more vulnerable to dhole predation when they are free range in proximity to the villages. Dholes were the principal predator responsible for livestock depredation and causing a significant impact on farmer's livelihood. Cows were more vulnerable to dhole depredation in both strata because they are the most preferred livestock type in Bhutan.

Dholes showed no preferences over the age category of the livestock for the kill. The attitude of the farmers towards the conservation of dhole is significantly associated with the degree of livestock loss, where the majority of farmers in rural are not in support of dhole conservation.

One of the reasons for not tethering the livestock on the farm was a shortage of fodder; this could be managed through providing fodder seeds and planting fodder trees in their unproductive agricultural lands. Initiating better alternative livelihoods such as improved agriculture and ecotourism initiatives can create a better livelihood in the village, where they don't have to depend on livestock for their livelihood. In the face of the fact that educational conservation projects can be used to mitigate human dhole clashes, literate farmers tend to be comparatively more conducive to conservation behavior. The reduction in the risk of destruction of livestock and the development of a harmonious dhole coexistence with farmers will contribute to one pillar of Bhutan's Gross National Happiness.

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