People and Livelihood in Biological Corridor 4 (BC4)

A Socio-Economic Survey Report

Zhemgang Forest Division
Department of Forests and Park Services
Zhemgang : Bhutan

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The gratitude extends to GEF-LDCF NAPA III for funding this report's field survey and publication. Without the generous funding support, we would not have been able to conduct the socio-economic poll and come up with this report for further framing of the conservation management plan for the corridor.

ZFD management

Acronyms and Abbreviations

ac	Acres
BC 4	Biological Corridor 4
BFD	Bumthang Forest Division
BMPB	Biodiversity Monitoring Protocol of Bhutan
DoFPS	Department of Forest and Park Services
FCMB	Forest Management Code of Bhutan
HHs	Household (s)
HWC	Human-Wildlife Conflict
JSWNP	Jigme Singye Wangchuck National Park
Km	Kilometer
M	Mean
n	Count
NCD	Nature Conservation Division
NSB	National Statistical Bureau
NWFP	Non-wood Forest Products
PHCB	Population and Housing Census of Bhutan
PNP	Phrumsengla National Park
RMNP	Royal Manas National Park
SD	Standard Deviation
SE	Standard Error
SES	Socio-Economic Survey
ZFD	Zhemgang Forest Division

Glossary

Chiwog	The lowest administrative unit formed by the group for villages
Chuzhing	Wetland where paddy is cultivated
Dzongkhag	District
Gewog	Sub-district or a block
Kamzshing	Dryland
Sokshing	Forest area from where the leaf litters are collected
Tsamdro	Grazing pasture
Tshoesa	Kitchen garden

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Executive summary

The survey was designed and conducted using the Socio-economic and Biodiversity Monitoring Protocol of Bhutan 2020. Villages inside and in the buffer were considered sample frames, and 30% of the households from each village were interviewed with a semi-structured questionnaire. A questionnaire interview was conducted by visiting the sampled households and interviewing the head of the household.

The total population estimate of resident communities in BC4 is 3644, with a male to female ratio of 53:47. The household member living with the household is primarily occupied by those aged between 20 to 40 years. The construction and renovation of their residential homes encompass most of the annual expenses. The more significant portion of the land is dryland (58.97%), followed by wetland (21.96). Communities grow ten varieties of cereal crops, and maize is the most grown cereal crop, followed by wetland rice and bitter buckwheat. In addition, local communities grow 13 varieties of cash crops, including cardamon, ground apple, and sweet potato, at a larger scale. All the households are growing either type of vegetable among the 20 varieties of vegetables grown by the communities. The farmers in the corridor rear ten varieties of livestock; most practice tending in the agriculture field and sending them to the forest as livestock caring option. Most believe that insufficient fodder and low milk are the central problem of livestock rearing apart from human-wildlife conflict.

Communities collect 19 different types of forest resources. Fern and mushrooms are the most collected resources. Resident communities perceive that forest resource availability is decreasing. This average income is contributed from agriculture, livestock, and the sale of forest resources which is exclusive of revenue from the business. Agriculture, followed by livestock, and the least from forest resources contributed to the household's income. Cash crop contributed the maximum to the annual income.

Six different types of livestock were lost to seven wild predators in the past three years. Local cattle breed was lost significantly to the predators. Livestock depredation was contributed highest by the Royal Bengal Tiger, followed by Dhole, Common Leopard, and the rest were very minimal. Crop damage by wild herbivore and other species are typical in the corridor where 98% of the household reported incidences of crop damage. The majority of the crop damage incidences by the wild animal were reported for cereal crops (n=263) and vegetables (n=106) and least for cash crops (n=66). Ten species of wild animals contributed for crops damage. Wild Pigs, followed by Barking deer and porcupine, were among the top three pests to crop depredation.

The critical findings from this report are recommended under the four major categories. Four program categories include building community resilience, community adaptation program, building community stewardship, and research and development.

1. Introduction

Bhutan's commitment to biodiversity conservation is determined through the declaration of 51.4% of the total geographical areas under protected area networks. The enabling environment conservation enshrined in the constitution of Bhutan (Article 5(3)) states that the government shall maintain 60 percent of the total land under forest cover at all times. The constitution mandates all the Bhutanese citizens as trustees of natural resources and the environment to protect them for the benefit of the present and future generations. The local people are allowed to reside inside the protected areas and act as the custodian of resources within their geographical territory (DoFPS, 2020).

The protected area system in Bhutan includes national parks, wildlife sanctuaries, strict nature reserves, and biological corridors. Bhutan has declared 51.4% of its total area as a protected area for conserving rare and endangered flora and fauna. Of which 43% is contributed by National Parks, Wildlife Sanctuaries, and Reserves, and the rest 9% by the Biological Corridors. The Biological Corridors were established in 1999 as a "Gift to the Earth from the People of Bhutan" by Her Majesty the Queen Mother Ashi Dorji Wangmo Wangchuck. These biological corridors connect every protected area in Bhutan to ensure "…gene flow through uninterrupted wildlife movements and succession of habitats" (National Biodiversity Strategies and Action Plan, 2014).

There are 10 Biological Corridors connecting protected areas in Bhutan. The conservation focused on national parks, strict nature reserves, and wildlife sanctuaries since they have an independent administrative boundary and management staff with full-strength technical staff. Though the Biological Corridors were declared a long way back, there has been no proper management and implementation of conservation activities. This is because the area of the corridors was shared among the different territorial divisions, and there is no independent management for rendering and managing the biological corridors. No management plans were ever framed and implemented for any biological corridor management until recent years.

Biological Corridor 4 (BC4), which shares its boundary with Bumthang Forest Division (BFD), is managed administratively by Zhemgang Forest Division (ZFD) after rendering management responsibility for each Biological Corridors in Bhutan by Nature Conservation Division (NCD). BC4 is the most significant biological corridor in Bhutan, and it has communities living inside and within the buffer area. Acknowledging the importance of the resident community's livelihoods and nature conservation, we felt the need to carry out a socio-economic survey (SES). Based on the Biodiversity Monitoring Protocol 2020 (BMPB) of Bhutan, to better understand the community and their interaction with nature and Wildlife recommend better intervention strategies through the decentralization process. The survey was conducted with the following objectives:

- ✓ To determine the current socio-economic conditions of the resident communities.
- ✓ To assess the status of interaction between resident communities with nature.
- ✓ To determine possible conservation and livelihood synopsis for BC4 conservation management planning.

2. Materials and methods

2.1 Study area

The corridor with an area of 594.65sqkm is the largest among 8 Biological Corridors in Bhutan after the Department of Forest and Park Services' realignment of protected area boundaries in 2020. BC4 is mainly designed to provide a wildlife corridor between three national protected areas: Royal Manas National Park in the south, Phrumsengla National Park to the north, and Jigme Singye Wangchuck National Park towards the northwest. The corridor stretches to a length of 40 kilometers (km), and it has one chock point in the north, created due to scattered human settlements. The corridor covers Nangkhor gewog, Shingkhar gewog and small portion of Trong gewog under Zhemgang Dzongkhag and part of Langthel gewog under Trongsa Dzongkhag (Figure 1).

Communities living inside and in the buffer of the corridor are rural farmers. The livelihood of the communities in the lower and middle parts of the corridor depends on agriculture and livestock. In the upper part, agriculture and livestock are supported by business. Until the revision of the BC boundary, there was no settlement inside the corridor, and after the realignment of the corridor, we have eight villages within the corridor. Those communities living in the buffer also depend on the corridor's forestry resources.

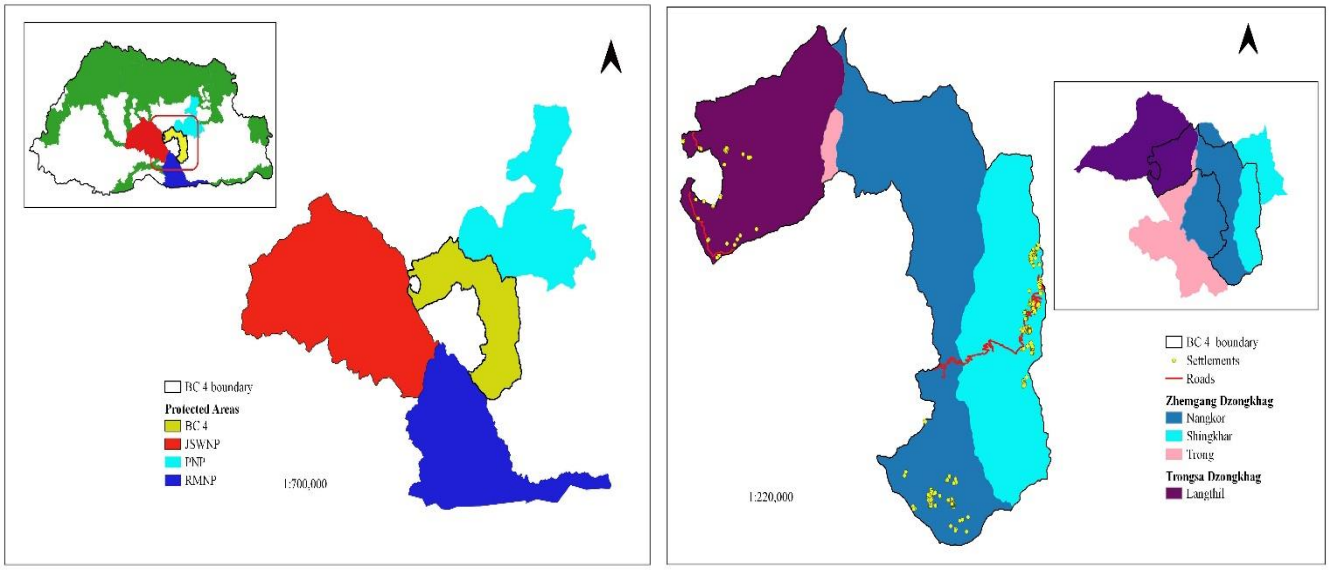

Figure 1. Map showing the location of BC4 and its administrative jurisdiction

2.2 Data collection

The survey design, questionnaire, and data collection method were based on the protocol prescribed in the Forest Management Code of Bhutan, 2020 (FCMB 2020). The village of the communities was considered the sample frame, and we took the sample intensity of 30% for the questionnaire survey (Dorji, 2021). We used a set of structured questionnaires (Annexure 1) aided by open-ended questions for data collection (Katel et al., 2014). Data collection questionnaires were coded in the Epicollect5 server, and household interviews were conducted using the epicollect5 mobile app. Data collection was conducted at two levels; household questionnaire interview and focused group discussion. The data collection was carried out in January 2022 with a team of three comprising five enumerators each.

2.3 Data analysis

We used Epicollect 5 for data entry and storage. Data compilation and cleaning were conducted using SPSS version 23 and MS Excel. The population data were collected from National Statistical Bureau, Bhutan. Descriptive analysis including the central tendency of the variables was determined using SPSS 23. Results of the data were presented in form of proportions, frequencies, graphs, and plots.

3. Results and discussions

3.1 Population

3.1.1 Demographics

Population estimates of the corridor as per the PHCB 2017 is 3644 people covering 5 chiwogs under three gewogs. The male population is slightly higher than the female population and the sex ratio of male to female is 53:47. The population density of the corridor is 6 people per square kilometer and the upper part of the corridor has the highest population and Shingkhar gewog has the lowest population (Table 1).

Table 1. Population estimates of communities inside BC4 as per PHCB 2017

Chiwog	Gewog	Male	Female
Buli	Nangkhor	629	539
Ngakhar	Nangkhor	177	190
Duenmang	Nangkhor	126	153
Nangkhor total		**932**	**882**
Radhi	Shingkhar	55	59
Nimshong	Shingkhar	200	129
Shingkhar total		**255**	**188**
Dangdung	Langthel	525	461
Baling	Langthel	226	175
Langthel total		**751**	**636**
Total		1938	1706

In general, the population of the corridor is dominated by young people and children between the age of 10 to 19 years and we also have a larger number of old age people above 75 years (Figure 2).

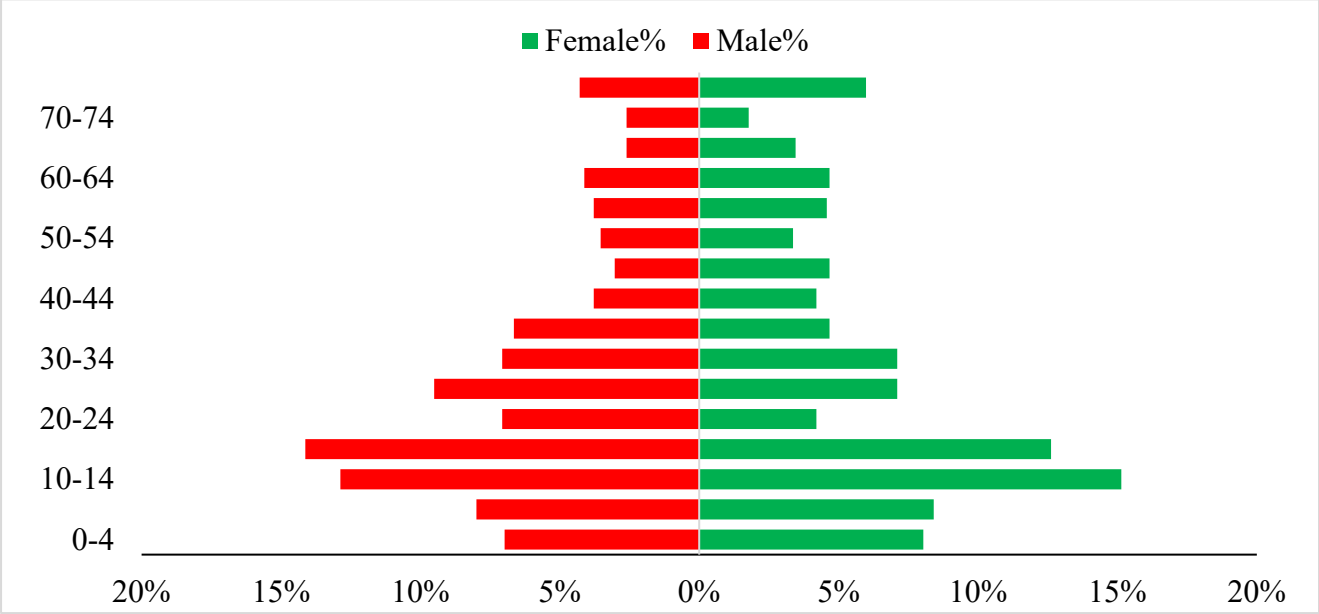

Figure 2. Distribution of population according to age group and gender

The data was collected from 161 households, which is 30% of the total household. Out of 161 respondents, 70.8% (*n*=114) were women and 29.2% (*n*=47) were female. The family member of the households were having a majority of productive citizens who are between the age of 20 and 40 years old followed by youths below 20 years (Figure.3).

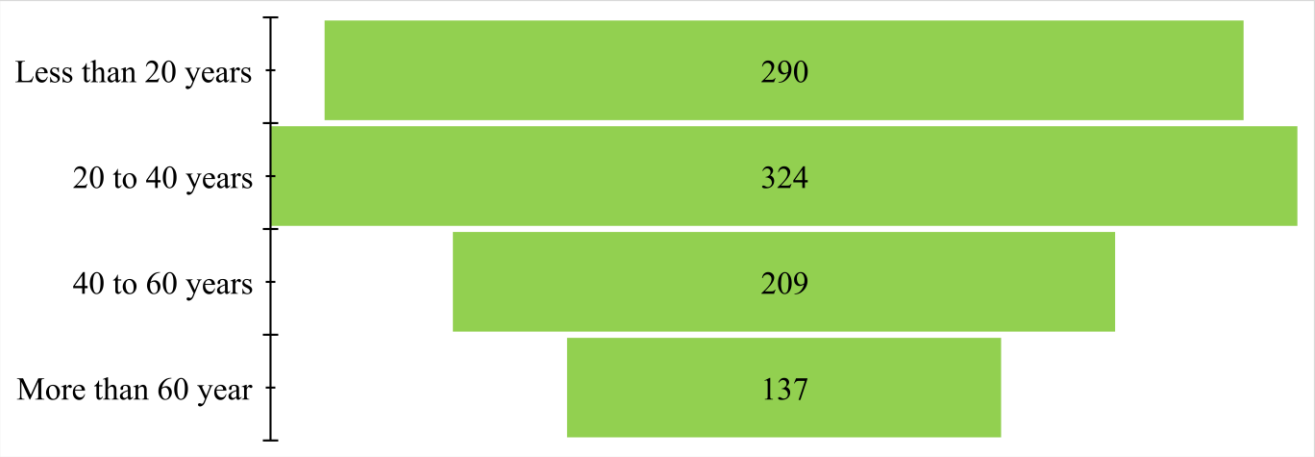

Figure 3. Family member age distribution

3.1.2 Household annual expenses

Annual expenses of the household were categorized under 11 different categories. Communities living inside the corridor were spending a mean of Nu.195427.59 (SD±278126) for the annual livelihood expenses. Households were spending maximum on the construction and renovation (M=228622, SD±304551) of their houses and other living structures followed by vehicle purchase and maintenance, and purchase and maintenance of farm machinery. Expenses on agriculture and livestock were similar with a mean of Nu.10211.00 for agriculture and Nu. 12554.00 for livestock (Table 2).

Table 2. Household expenses categories

Category of Expenses	Mean	Sum	SD	Mode
Taxes (Land, household, Insurance)	1612	254715	2384	2000
Agriculture expenses	10211	898590	15476	5000
Livestock expenses	12554	703030	18905	10000
Pilgrimage	23571	660000	22646	15000
Medication	25182	1561300	52041	15000
Household expenses	29416	4618300	27854	10000
Rituals	35267	5184208	31457	50000
School expenditure	36668	4363500	42208	20000
Farm Machinery	39749	1629700	52146	20000
Vehicles	173844	2781500	415900	15000
Construction/Renovation	228622	8459000	304551	15000

Among the four gewogs, Langthel was having the highest (M=Nu.42057 SD±127319, Mode 20000) annual expenses followed by Shingkhar (M=37190, SD±100187, Mode 15000) and least with Nangkhor (M=25290 SD±46742, Mode 10000). These expenses in Langthel gewog are exacerbated by the construction and renovation work by the communities of Dangdung.

3.2 Agriculture

3.2.1 Landholding

Landholding of the communities in the corridor is broadly categorized into two; registered land and land with traditional right of resource use. Categories of land under registered land are; *Chuzhing* (wetland), *Kamzhing* (dry land), Tshoesa (kitchen garden), and orchards. Land with traditional right of resources use includes Tsamdro (grazing land). The data revealed that 920.88 acres of land are owned by the local communities. Among the broad category of land holding 83 acres are *Tsamdro* and the rest 837.40 acres are registered land. The majority of the land holding categories are dominated by dry land (58.97%) and next by wetland (21.97%). The kitchen garden and orchards are almost in the same quantity (Table 3).

Table 3. Composition of landholding types by the communities

Land use type	Acres	%
Chhuzhing, wetland	192.50	21.96
Kamzhing, dry land	516.99	58.97
Orchard	49.17	5.61
Tsamdro	83.00	9.47
Tsesa, Kitchen Garden	35.10	4.00

From the total registered land, 519.72 acres are under effective cultivation by the land owners which accounts for 50.85% of the land type utilization category, and 403 acres which is 39.39% are left fellow without cultivation, which is very significant and cause of concern. The rented-in land for cultivation is 88.59 acres which is much higher than lands rented out with 11.20 acres.

3.2.2 Types of crops grown

Communities living inside and in the buffer of the corridor are growing 10 varieties of cereal crops. Maize is one of the most abundantly grown cereal crops followed by wetland rice and bitter buckwheat (Figure 4).

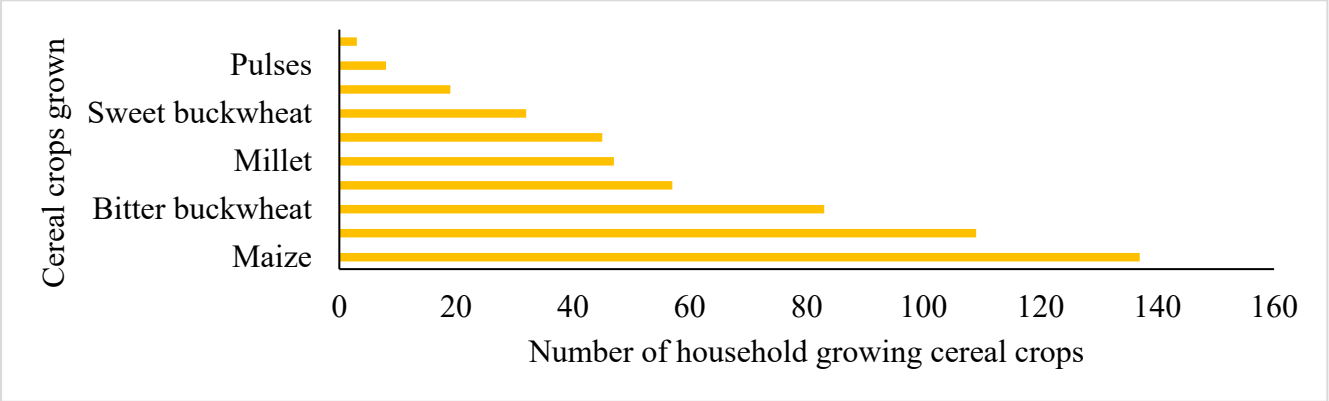

Figure 4. Varieties of cereal crops grown by the household

Maize is grown by all the communities and it is the most preferred cereal crop for the communities living in the lower part of Nangkhor gewog and the communities in the Nangkhor gewog. Communities living in the northern part of the corridor are growing maize, wetland rice, and bitter buckwheat in equal quantity. Upland rice is mostly grown by the communities of Nangkhor gewog. Nangkhor and Langthel communities have started to grow Quinoa, which is one of the most nutritious cereal crops (Figure 5).

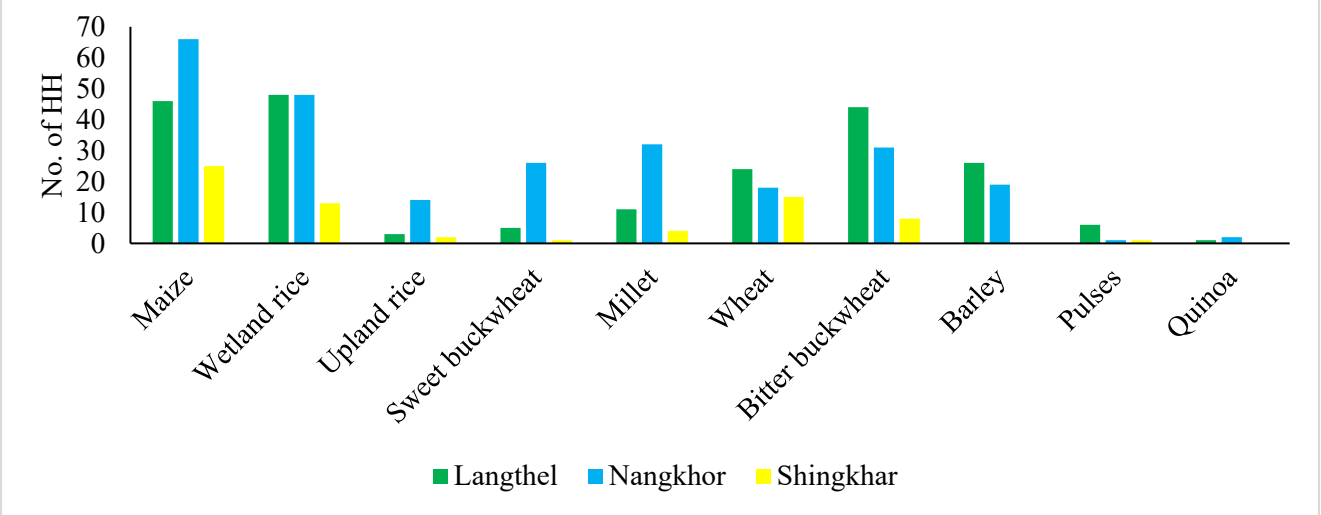

Figure 5. Varieties of cereal crops grown by the communities in each gewog

Figure 6. Grinding maize for food

The cash income of the local communities is supplemented by 13 varieties of the cash crop. Mostly grown cash crop includes Cardamon, Ground apple, sweet potato, Guava, and Avocado. Cardamom is the most prominent cash crop and is cultivated by communities all around the corridor and with a much higher focus by Nangkhor gewog. Avocado, Guava, and sweet potato are also cultivated by all the communities, where Avocado is mostly grown by communities of Nangkhor and Langthel gewog. Nangkhor communities also cultivate sweet potato and walnut in comparison to the other two gewogs. Kiwi is only cultivated in Nangkhor gewog at present and Cassava is grown only by the communities of Langthel gewog (Figure 7).

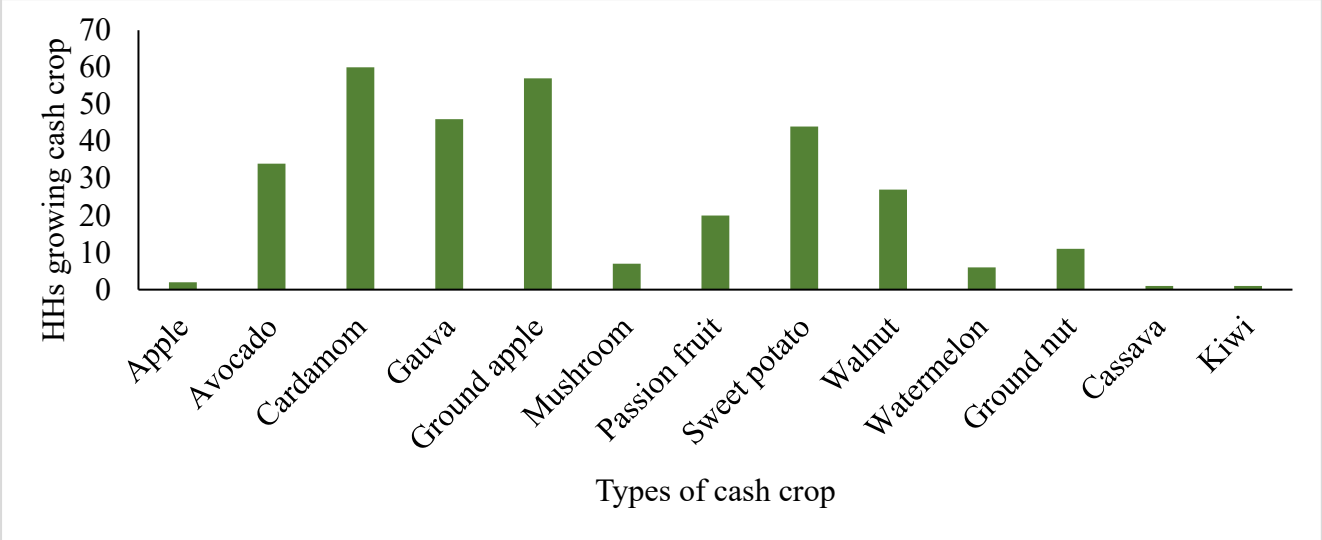

Figure 7. Varieties of cash crops grown by the communities

All the households are growing either variety of the vegetables among the 20 varieties of vegetables grown by the communities. Among the varieties of vegetable grown, majority of the household are growing Cabbage (n=144), Chilli (n=143), Potato (n=133), Sag (n=132) and Beans (n=129). Nangkhor gewog has the highest vegetable cultivation composition of the household with 45.3% followed by Langthel with 38.3% and Shingkhar gewog with 16.4% (Table 4).

Table 4. Varieties of vegetable crops grown by the communities

Vegetable varieties	Gewogs		
	Langthel (n)	Nangkhor (n)	Shingkhar (n)
Potato	41	69	23
Cabbage	50	70	24
Cauliflower	45	60	20
Chilli	52	66	25
Sag	50	57	25
Beans	49	58	22
Brocolli	44	38	18
Garlic	36	39	16
Pumpkin	49	60	17
Tree tomato	32	48	13
Brinjal	35	34	12
Carrot	29	45	14
Onion	32	29	11
Turnip	17	16	8
Radish	41	56	23
Ginger	40	42	15
Coriander	39	28	12
Crow beak	27	41	15
Turmeric	11	9	0
Chayote squash	28	18	7

3.3 Livestock

3.3.1 Livestock type and population

Farmers in the corridor rear 10 different types of livestock including beekeeping, cats, and dogs. The average livestock holding per household is 10 (SD±15), where the maximum household rear 4 numbers (mode) of livestock. The maximum number of livestock kept by a household is 132 numbers who is from Khikhar under Nangkhor gewog. Communities keep more local breed than improved breed cattle. Three households reported beekeeping and one household reported rearing pigs (Table 5).

Table 5. Livestock type holding by the communities

Livestock type	Mean	SD	Sum	HH
Local breed	5	10	798	108
Improved breed	1	3	173	50
Horse		2	64	29
Beekeeping			5	3
Goat			3	2
Cat	1	1	186	118
Dog	1	1	120	67
Sheep			5	1
Poultry	2	8	321	42
Piggery			3	1

3.3.2 Livestock tending options

Type of livestock tending is important in determining the conflict of their livestock with the wildlife with their neighbor (Tshering & Thinley, 2017). Farmers in the corridor practice five different types of livestock tending. The majority of the farmers practice tending their livestock in the agriculture field

and sending in the forest and the next majority practice tethering and stall feeding. Local communities also send their livestock to the forest. In all the gewogs farmers practice tending in the agriculture field and sending in the forest (Figure 8).

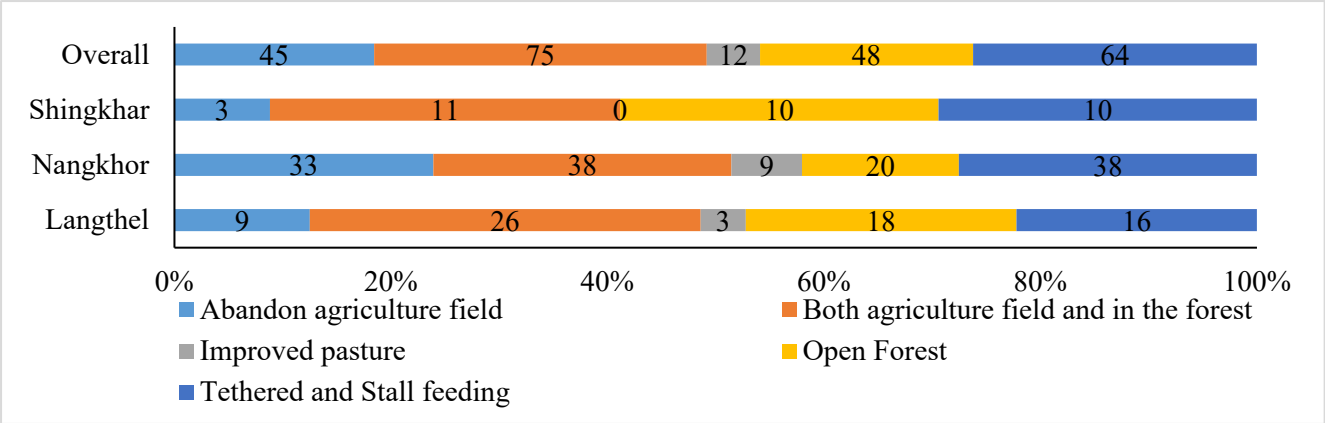

Figure 8. Livestock tending types practiced by the communities in the corridor and each gewog

3.3.3 Importance of livestock to the household

Apart from the source of income for the household, livestock rearing helped plow the field, organic manure production, means of transportation, and supplements in their food source. The majority of the household believe that livestock rearing helped the majority in the production of manure for their agriculture and food source for the family. Livestock is used as a means of transportation only in Nangkhor and Shingkhar gewog (Table 6).

Table 6. Importance of Livestock to the communities

	Gewog			
Livestock importance	Langthel	Nangkhor	Shingkhar	N
Draught power	18	7	16	41
Manure	44	61	15	120
Means of transportation	0	28	2	30
Source of food	41	61	17	119

3.3.4 Livestock farming challenges

Local communities in the corridor perceive that livestock rearing is challenged by eight different types of problems. The majority believe that insufficient fodder and low milk are the major problem of livestock rearing apart from human-wildlife conflict. Lack of manpower is also perceived as the higher valued problem to livestock rearing. Farmers in Nangkhor and Langthel gewogs are challenged largely by insufficient fodder and farmers in Shingkhar gewog perceive that lack of manpower is the major challenging problem in livestock rearing (Figure 9).

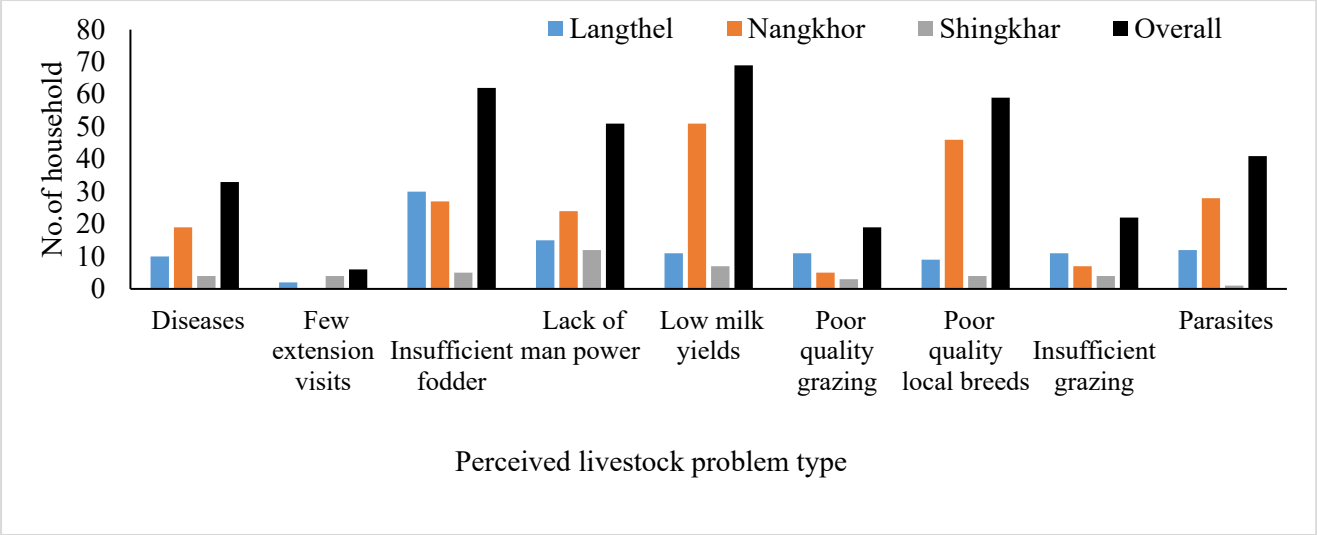

Figure 9. Perceived livestock rearing problems by the communities

3.4 Forest Resources use by the communities

3.4.1 Types of forest resources collected

Communities inside the corridor collect 19 different types of resources from the forest. Fern and mushroom are the most collected resources for income and self-consumption. Fodder collection from the forest is also at a larger majority. Wood bur collection was reported only by one household (Table 7).

Table 7. Varieties of forest resources collected by the communities

	Gewog			
	Langthel	Nangkhor	Shingkhar	Overall
Fern	39	47	24	110
Mushrooms	35	53	21	109
Fodder	27	46	19	92
Canes	23	47	18	88
Elastotema	31	30	19	80
Agricultural tools	29	24	21	74
Bamboo	6	46	20	72
Wild yam	11	22	10	43
Orchid	18	10	12	40
Piper	30	4	2	36
Fern/leaves for bedding	10	10	9	29
Top soil/leaf moulds	10	6	1	17
Thatch grass	1	6	8	15
Medicinal plants	1	1	3	5
Paris	0	1	4	5
Religious drums	3	1	0	4
Daphne	1	3	0	4
Incense	1	1	1	3
Wood burr for Dhapa	0	1	0	1

3.4.2 Forest resources availability trend

Farmers were asked about their perception of the trend of three main types of forest resources that they depend on. The majority of the farmers believe that all these forest resources that they depend on are decreasing and very few believe that it is increasing or no change. Communities of Nangkhor gewog are expressing more decrease in all these three types of forest resources compared to communities of the other two gewogs. The majority of the communities in Shingkhar and Langthel perceive that river bed materials availability has not changed over the year (Figure 10).

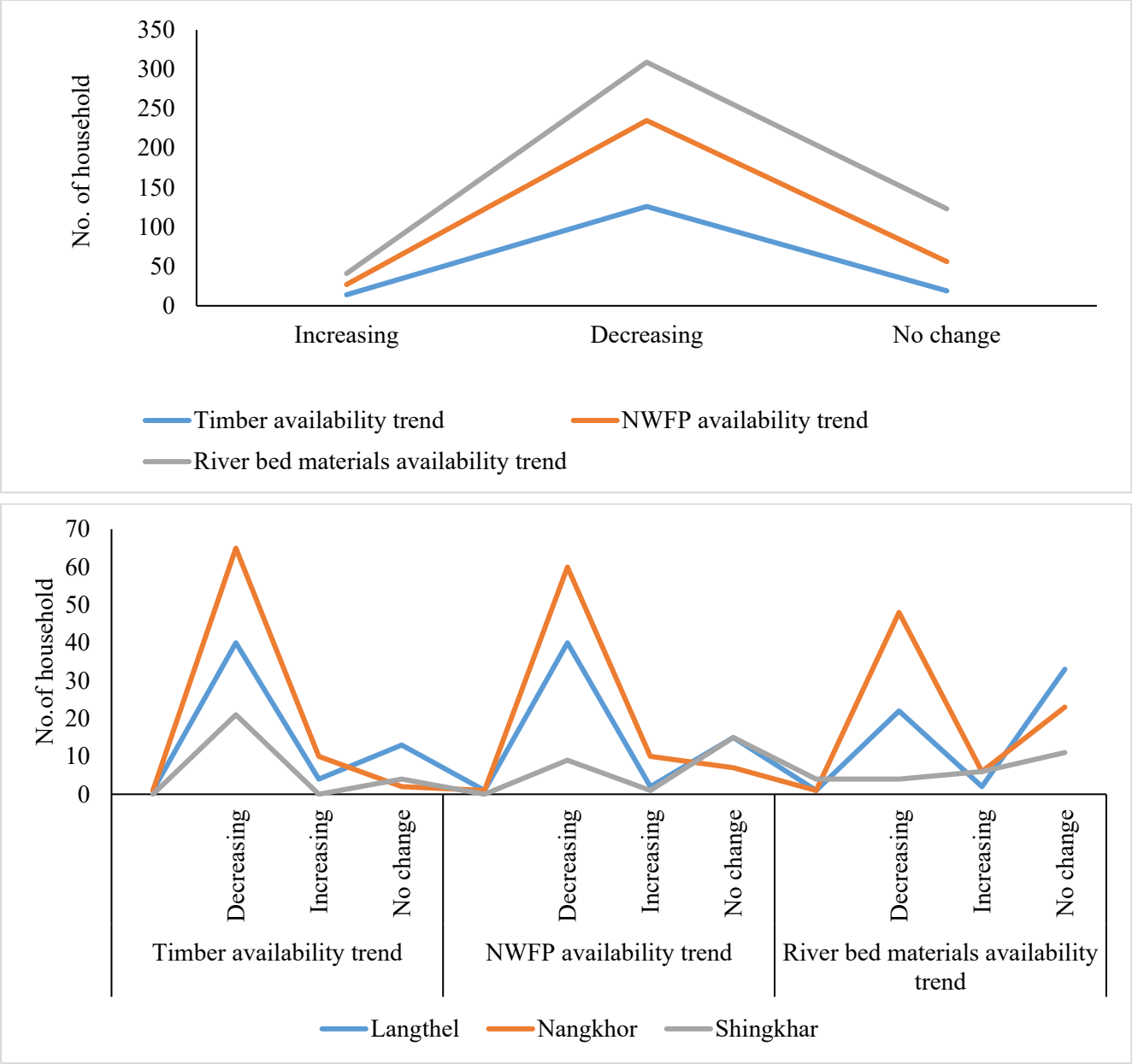

Figure 10. Perceived trend of forest resources collected by the communities

3.5 Annual income of the communities

The income generation of the household is crucial in determining the livelihood status of the communities. The average annual income of the communities in the corridor is Nu.39336.36 (SD=72793, SE=5736.9) which is reported by 138 households and 28 households reported they were not earning any income. This average income is contributed from agriculture, livestock, and the sale of forest resources which is exclusive of income from the business. Among the three types of income, the majority were contributed from agriculture followed by livestock, and the least from forest resources. Cash crop contributed the maximum to the annual income next to the sale of vegetables and cereal crop contributed less among these three contributors. This indicates that cash crop is the main source of income for the communities. Income from the livestock is contributed from four different categories. Income from the sale of livestock products is the highest followed by the sale of animals and the other two categories. Income from the forest produce was reported by 30% (n=30) of the respondent. The highest was provided by the sale of NWFP (M=Nu.2419.0) and less by the sale of timber (M=Nu.155.0) (Table 8).

Table 8. Income sources of the communities

Income source	Mean	SD	Total (Nu)
Income from agriculture	22277.0	58617.9	3586598.0
Income from livestock	14484.8	29681.9	2332056.0
Income from forest resources	2574.5	16271.4	414500.0
Income from agriculture			
Income from sale of cereal crop	2585	8576	416200
Income from sale of vegetables	9332	48198	1502449
Income from sale of cash crop	10360	30399	1667949
Income from livestock			
Income from hire of cattle for dough plow	235	1083	37800
Income from hire of livestock for transportation	472	2351	76000
Income from sale of animal	4466	20935	719008
Income from sale of livestock products	9312	18371	1499248
Income from forest resources			
Income from sale of timber	155	1622	25000
Income from sale of NWFP	2419	16127	389500

3.6 Human-wildlife conflict

3.6.1 Livestock depredation by wild animals

A total of 107 numbers of livestock were lost to wild predators in the last three years, which was caused by seven predators belonging to 67 households. Six types of livestock were lost to wild predators in the past three years. The majority (71.06%) of the depredation was involved with local breed cattle followed by horses (12.15%) (Table 9).

Table 9. Livestock type lost to wild predators

Livestock type	N	%
Dog	1	0.93
Horse	13	12.15
Improved breed	6	5.61
local breed	76	71.03
Pig	3	2.80
Poultry	8	7.48

Livestock depredation was contributed highest by the Royal Bengal tiger followed by Dhole and common leopard and the rest were very minimal (Figure 11).

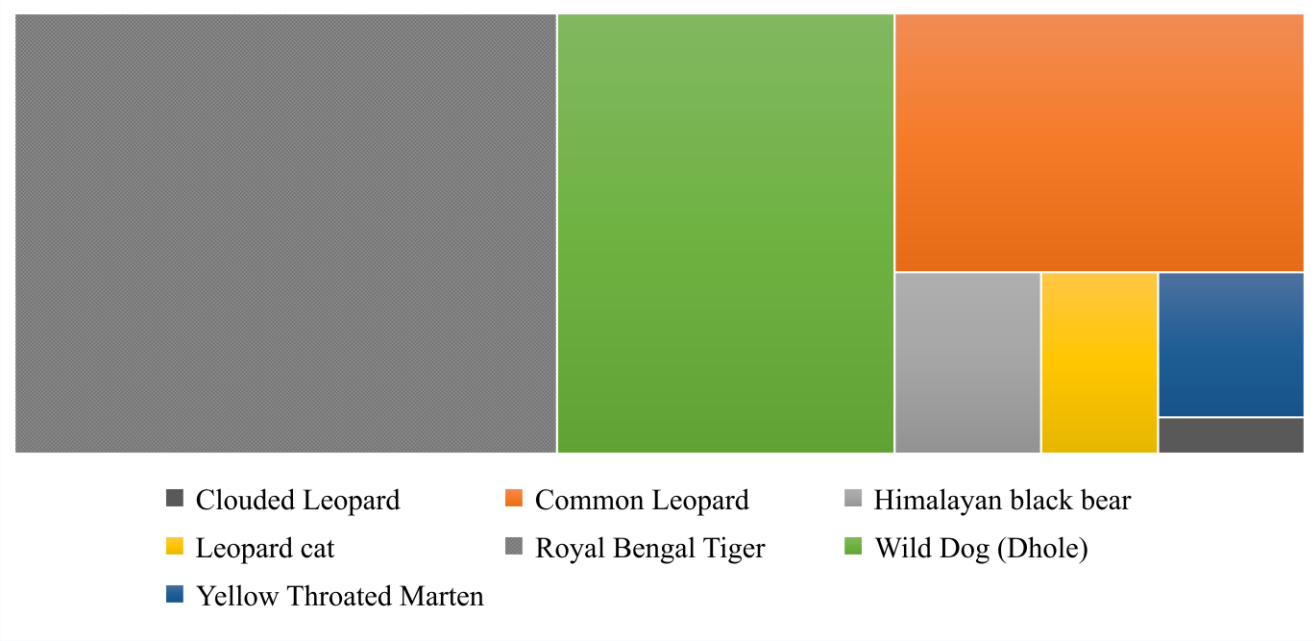

Figure 11. Wild predator types and their proportion of livestock depredation

Among the wild predator's Common Leopard killed six types of livestock. Royal Bengal Tiger killed three types of livestock and the maximum was with local breed cattle (Table 10).

Table 10. Predator and types of livestock depredation by each predator

	Clouded Leopard	Common Leopard	Himalayan black bear	Leopard cat	Royal Bengal Tiger	Wild Dog (Dhole)	Yellow Throated Marten
Dog		1					
Horse		3			10		
Improved breed		3			2	1	
local breed	1	9	5	1	33	27	
Pig		1		2			
Poultry		3		1			4

The majority (n=63, 58.9%) of the adult cattle followed by the juvenile (n=24, 22.4%) and less with young (n=20, 18.7%) were lost to wild predators. Royal Bengal Tiger depredated more on the adult animals which is similar to Dhole. Common Leopards and Himalayan Black Bears have not much different in the age category of the livestock kill (Table 11).

Table 11. Age category of livestock depredation by each predator

Age category	Clouded Leopard	Common Leopard	Himalayan black bear	Leopard cat	Royal Bengal Tiger	Wild Dog (Dhole)	Yellow Throated Marten
Adult		7	2	2	39	12	1
Juvenile		5	2	2	4	8	3
Young	1	8	1		2	8	

The majority of the livestock depredation by the wild predators was made within less than 5 km and it is a cause of concern for the communities living on the periphery of the forest. (Figure 11). The majority of the livestock predation by the Royal Bengal Tiger, Common Leopard, and Dhole was made within 5 km of the settlement (Table 12)

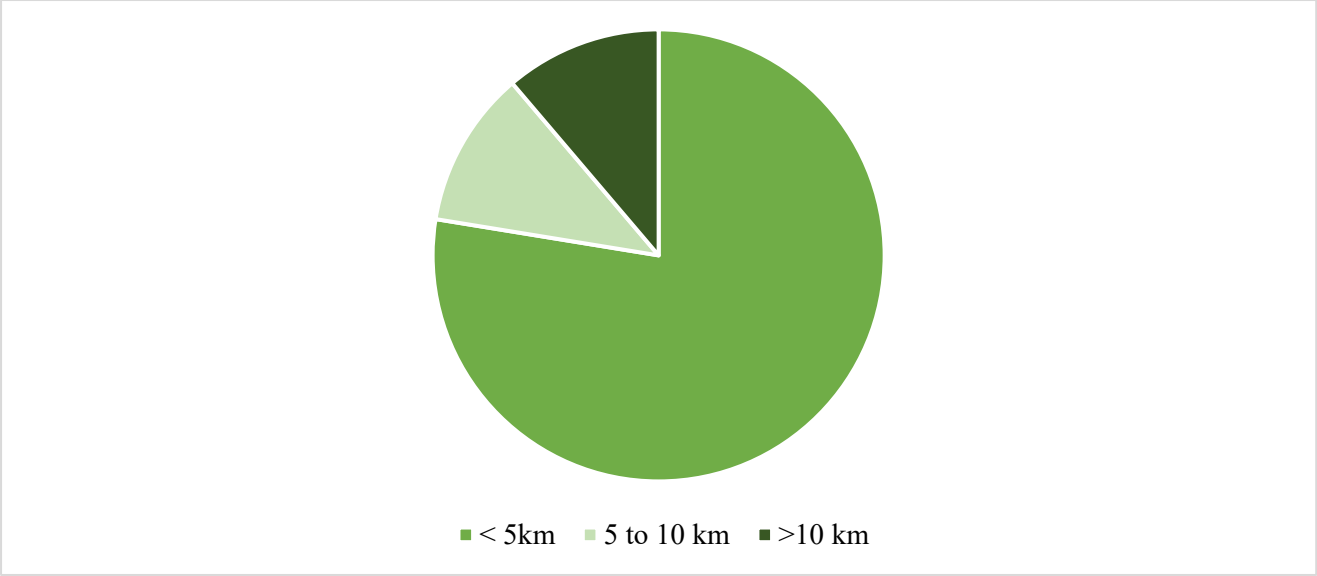

Figure 12. Livestock depredation distance from the settlement

Table 12. Livestock predators and their predation distance from the settlement

	Clouded Leopard	Common Leopard	Himalayan black bear	Leopard cat	Royal Bengal Tiger	Wild Dog (Dhole)	Yellow Throated Marten
< 5km	1	20	1	3	32	16	3
5 to 10 km	0	0	1	0	8	3	0
>10 km	0	0	3	0	5	4	0

In the past three years, local communities lost around 107 cattle and the mean cost lost to livestock predation by wild predators accounts for Nu.16550.93 and the majority of the lost cost per animal were less than Nu.20000.00 (Figure 13).

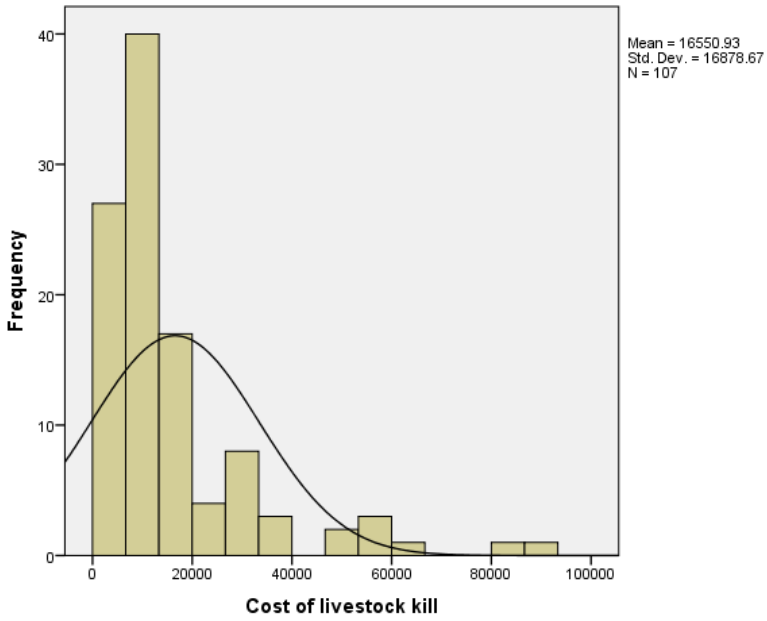

Figure 13. Distribution of cost lost due to livestock depredation

Local communities perceive that livestock depredation is mainly contributed by the free-ranging of livestock (23%), an increase in forest cover (18%), an increase in wildlife population (15%), and no proper fencing (21%) and because no proper pasture land. Local communities believe that livestock depredation can be minimized if they take up or get the support of solar/electric fencing (n=28) and livestock insurance schemes (n=23). The majority of the household believe that guarding (n=56) can

reduce changes in livestock depredation by wild predators, while they also believe that the use of scarecrows (n=13), snare trapping of wildWildlifethe field (n=24), and hunting of wildWildlife10) can help them to reduce their livestock depredation by the wild predators.

3.6.2 Crop damage by wild animals

Crop damage by wild herbivore and other species are common in the corridor where 98% of the household reported incidences of crop damage by the wild animals. The majority of the crop damage incidences by the wild animal were reported for cereal crops (n=263) and vegetables (n=106) and least for cash crops (n=66). Crop damage by the wild animals was contributed by 10 major wild animal species in the corridor. Wild Pigs followed by Barking Deer and porcupines were among the top three pests to crop wild animal species. There are reports of crop damage by three monkey species which include Assameses Macaque, capped langur, and golden langur (Figure 14).

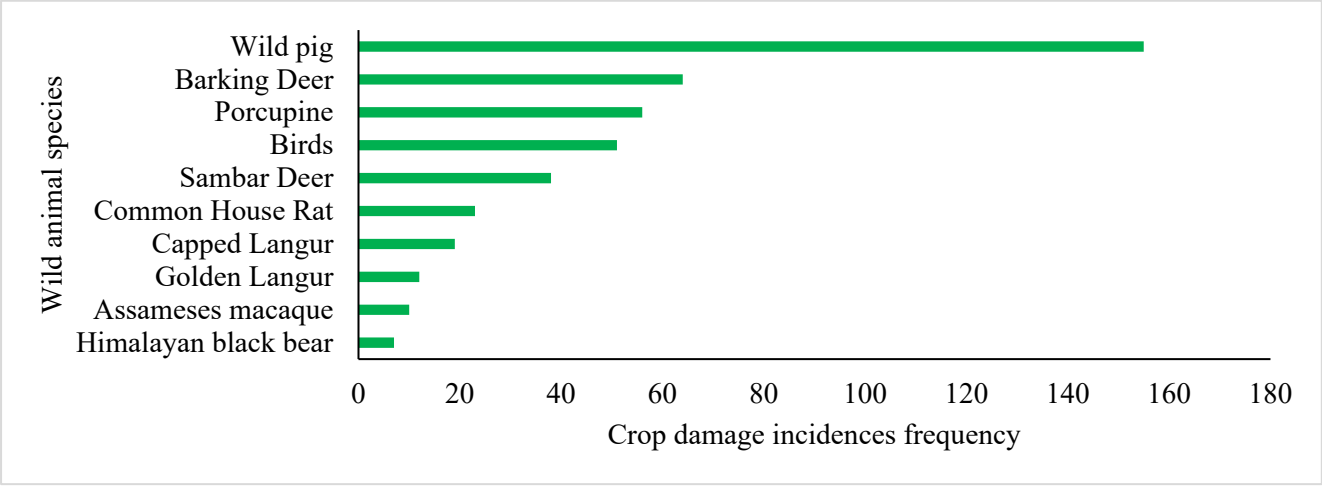

Figure 14. Crop damage frequencies by each wild animal

During the last year, 163.481 acres of agricultural crop farmlands were damaged by wild animals. The majority of the households whose farmland was damaged by the wild animals were 0.2 acres and the maximum number of agricultural croplands damaged by the wild animals amount to 25 acres by a household in Khikhar under Nangkhor geog (Table 13).

Table 13. Quantity of farmland damaged by wild animal

Mean	.376
Std. Error of Mean	.059
Mode	.200
Std. Deviation	1.226
Minimum	.001
Maximum	25.000
Sum	163.481

Communities of Nangkhor gewog have the highest (65.24 acres, M=0.47 cares) cropland damaged by the wild animal followed by Langthel (65.34 acres, M=0.31 acres) and the least (17.2 acres, M=0.3 acres) at Shingkhar (Figure 15).

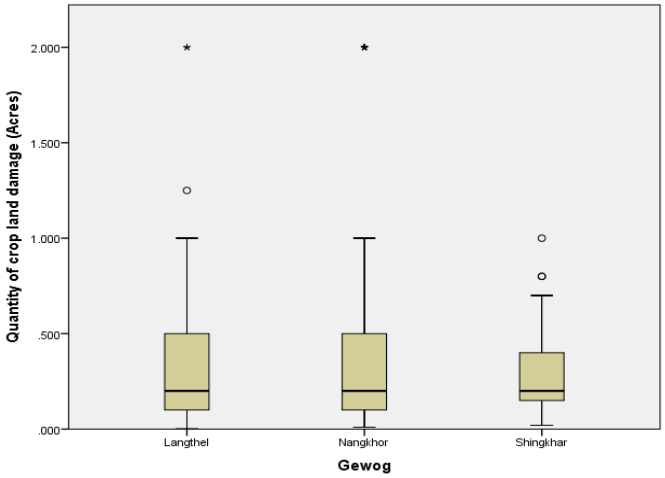

Figure 15. Box and whisker for crop damaged by wild animal in each gewog

The money value lost due to crop damage by the wild animal amounts to Nu.43,98,125.00 in one year by the communities living in the corridor. The maximum of the household lost Nu.5000.00 (mode) in a year to crop damage by the wild predators (Figure 16). cash crop damage by Sambar Deer from one household from Khikhar amounting to Nu. 283000.00 in one year was the highest loss due to damage by wild animals.

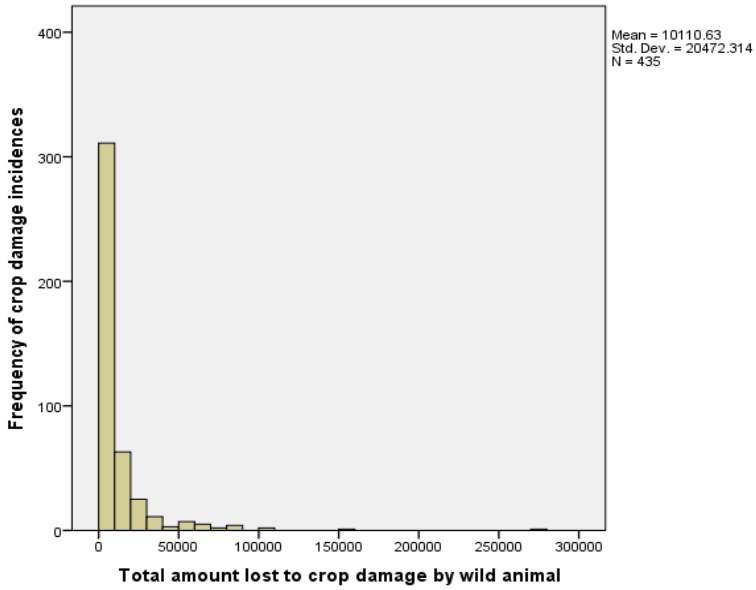

Figure 16. Distribution of mean amount lost due to crop damage by wild animals

Only one incidence of Himalayan Black Bear damage to the property was reported from Baling under Langthel gewog and there is no report of wildlife damage to the property and humans during the past three years.

3.7 Knowledge of awareness on BC4

The people's knowledge on awareness of BC4 was tested using a questionnaire and the majority of the communities are not aware of being inside the corridor. The majority of the communities of Nangkhor and Shingkar gewog are not aware of being inside the corridor but farmers of Lanthel are very much aware that they are residing inside and in the buffer area of the corridor (Figure 17).

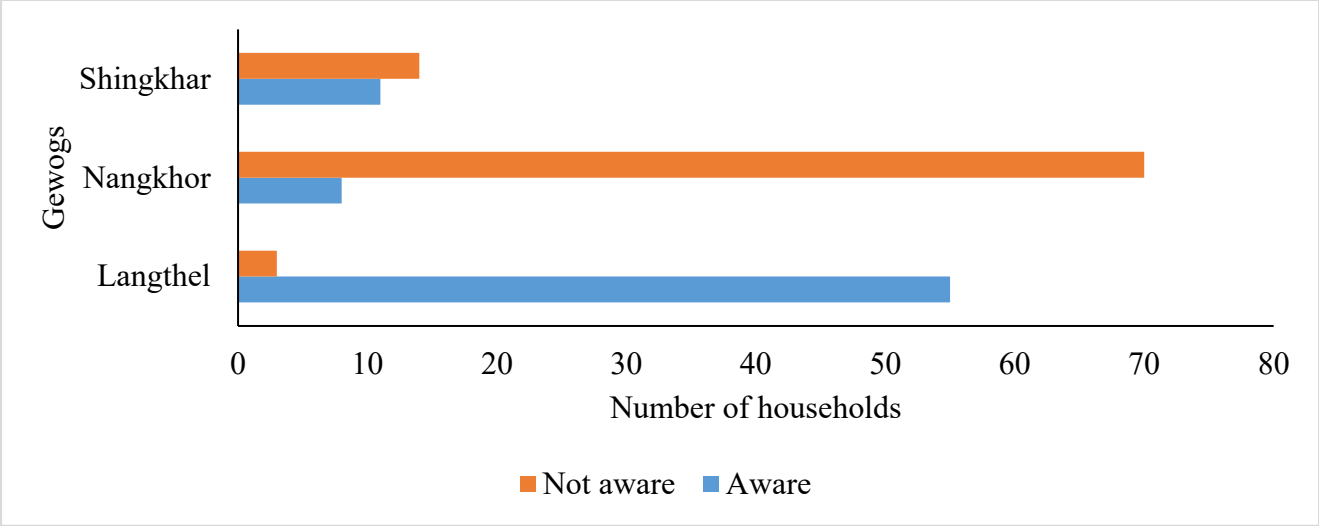

Figure 17. Community awareness on BC4

4 The way forward and recommendations

This section highlights and proposes activities and programs which are specifically targeted toward enhancing the livelihoods of the communities, which will have a positive impact on conservation. Enhancing the livelihood of the communities and making them more resilient through food security, energy, and more awareness of the benefits from the environment will help to better utilization of the natural resources sustainably and thus leading to better conservation and better livelihood. Following activities/programs recommendations are derived from the current socio-economic survey, which is to be incorporated into the conservation management plan for implementation.

4.1 Building community resilience

4.1.1 Mechanizing agriculture farming

The majority of the population are between the age of 20 to 40 who are living in the village and this age category is one of the most productive age groups, where they can work efficiently but by looking at the land kept as fellow it is concerning that people are less interested in farming. Therefore, mechanized agriculture farming technologies and methods should be imparted to the local farmers through training and providing improved seeds. A larger area of the community landscape holds better cultivation of horticulture fruit trees and cultivation of improved fruit trees should be imparted to the local communities.

4.1.2 Intensification of livestock farming

The largest cattle type owned by the communities is the local breed. To reduce their risk of livestock predation, disease, and other impacts, improved cattle breeds can be introduced to the communities on cost sharing basis to reduce the unproductive livestock numbers and reduce the impact of human-wildlife conflict.

4.1.3 Initiating off-farm income activities

The annual income of the communities is contributed largely by agriculture and livestock and very less from forest resources. The area holds large verities of potential natural resources and it is recommended to initiate off-farm activities such as bamboo craft, ecotourism initiatives (farmhouse/local guide), and enhancement of vocational skills for the youths.

4.1.4 Awareness program to the local communities

The majority of the communities were not aware that they are living inside the corridor. Enhancing the knowledge of the local communities on environmental conservation, human-wildlife conflict, and climate change can make them a better guardian of the wildWildlife make them better prepared for the adverse impact of these events. A conservation awareness outreach program is recommended to diversify the knowledge of the local communities.

4.2 Community adaptation program

4.2.1 Instituting a crop guarding mechanism

The agricultural crop damage by the herbivores is a major problem for agriculture farming. This impact can be reduced through crop guarding mechanisms such as solar or electric fencing.

4.2.2 Initiate and reinstate livestock and crop insurance scheme

Crop damage and livestock depredation by wild animals are major challenges faced by the entire community. These incidences have largely impacted the substantial loss of major income of the communities. The losses from wild animals can be compensated through instituting crop and livestock compensation schemes. Therefore, forming a crop and livestock insurance scheme with proper by-laws and supporting seed money is recommended.

4.2.3 Improvement and intensification of pasture and fodder

Communities reported insufficient fodder and low milk yield as the major challenges to livestock farming. Initiating the pasture improvement program and supply of high-yielding fodder seeds in collaboration with the livestock sector can improve milk production.

4.2.4 Supplement community cattle herder livelihood by providing livelihood alternative

There are around 20 itinerant cattle herders inside the corridor and they are in direct contact with nature and wildWildlife is very pivotal in liaising with them and improving their attitude towards conservation and wildWildlifehancing the livelihood of the herders with livelihood alternatives like a mobile phone for efficient communication, biodiversity reporting, and solar lighting to reduce dependency on fuel wood.

4.3 Building community stewardship

4.3.1 Institute community citizen science program

The citizen science program is becoming a popular community stewardship initiative worldwide. Involving the communities in conservation is paramount in achieving the conservation goals in balance with improving community livelihood. Therefore, the formation of citizen scientist groups, training them, and involving them in biodiversity monitoring and data collection is recommended.

4.3.2 NWFP management and marketing group formation

Communities are utilizing the natural resources in 19 different forms and there are potential NWFPs available for sustainable management and utilization. The formation of species-specific or product-specific NWFP management groups with proper management plans and marketing plans is encouraged to improve the livelihood of the communities.

4.3.3 Implementation of community-based ecotourism initiatives

The corridor is known for rich biodiversity and it is the Tiger breeding and dispersal habitat, which has the highest ecotourism initiatives to be developed. Homestays can be enhanced and developed, and school dropped outs can be trained in nature guiding. The area has the best birding trails and wildlife safari trails and roads. Therefore, is encouraged to develop an ecotourism package for the community and the corridor.

4.4 Research and development

Most of their crop is damaged by Wild Pig and Barking Dear and they are considered a pest to the farmers. Researching the abundance and distribution of pest wild animal species for better population management of these species is encouraged. The majority of the livestock were lost to Royal Bengal Tiger, a study on the prey base abundance of the Tiger should be initiated and management intervention put in place.

Bibliography

DoFPS. (2020). Forest and Nature Conservation Code of Best Management Practives of Bhutan*: Department of Forests and Park Services: Vol. IV*.

Dorji, P. (2021). Pattern of human dhole interaction in buffer area of Jigme Khesar Strict Nature Reserve. *International Journal of Scientific Research and Management*, *9*(03), 182–190. https://doi.org/10.18535/ijsrm/v9i03.fe01

Katel, O. N., Pradhan, S., & Schmidt-Vogt, D. (2014). A survey of livestock losses caused by Asiatic wild dogs, leopards and tigers, and of the impact of predation on the livelihood of farmers in Bhutan. *Wildlife Research*, *41*(4), 300–310. https://doi.org/10.1071/WR14013

National Biodiversity Strategies and Aaction Plan. (2014). *National Biodiversity Strategies and Action Plan (NBSAP) Bhutan 2014.* 173pp.

Tshering, K., & Thinley, P. (2017). Assessing livestock herding practices of agro-pastoralists in western Bhutan: Livestock vulnerability to predation and implications for livestock management policy. *Pastoralism*, *7*(1), 5. https://doi.org/10.1186/s13570-017-0077-1

Annexures

Annexure 1: SES data collection format

Dzongkhag:	Name of respondent:
Gewog and Chiwog:	House number:
Village:	Age/sex: M ☐ F ☐
Date:	Interviewer & Phone #:
BC No:	

Section I: Household information and source of income.

Give details per household member

Permanent household members living with the household *(> 6 months/year at home)*				**Absent household members:** *registered with the household, but not living here (more than 6 months/year absent):*				
Sl.no.	Sex *M/F*	Age	Main Occupation	Sl.no.	Sex *M/F*	Age	Occupation	Reason for being absent
1				1				
2				2				
3				3				
4				4				
5				5				
6				6				
7				7				
8				8				
9				9				
10				10				
11				11				

1. What are the main sources of income to the family?

- ☐ Agriculture
- ☐ Livestock
- ☐ Horticulture crop
- ☐ Medicinal plants
- ☐ Tourism/Pottering
- ☐ Labour
- ☐ Employment
- ☐ Bussness
- ☐ Others (Specify)

Section II: Livestock

2. Livestock holding and importance

Livestock type	Total
Yak	
Buffalo	
Cattle	
Horse	
Goat	
Sheep	
Poultry	
Pigs	
Others	

3. What is the importance of livestock to the household?

- ☐ Source of income
- ☐ Source of food
- ☐ Draught power
- ☐ Manure
- ☐ Means of transportation
- ☐ Others (Specify)

4. What is the annual income from livestock

Livestock type	Item	Quantity	Unit	Rate/unit in Nu.	Total	Remarks If any….
Yak	Milk					
	Cheese					
	Butter					
	Meat					
	Manure					
	Sale of live animal					
	Others…..					
Buaffalo	Milk					
	Cheese					
	Butter					
	Meat					
	Manure					
	Sale of live animal					
	Others…..					
Cattle	Milk					
	Cheese					
	Butter					
	Meat					
	Manure					
	Sale of live animal					
	Others…..					
Horse	Transportation charges					
	Sale of live animal					
	Others					
Poultry	Egg					
	meat					
	Sale of live animal					
	Others					
Pig	Meat					
	Manure					
	Sale of live animal					
	Others					

Goat	Meat					
	Sale of live animals					
	Other					
Others						

5. Where does the household graze their livestock? *Please Tick*

- ☐ Improved pasture
- ☐ Forest
- ☐ Abandon agriculture field
- ☐ Tethered and Stall feeding

Is there enough area for grazing? ☐ Yes ☐ No

(a) Do you use pastureland in the village for grazing?	☐ Yes ☐ No
If Yes, Do you own it/ use other's pasture?	☐ Own ☐ Others
If No, do you intend to develop it?	☐ Yes ☐ No

6. What are the main Problems/constraints for the livestock of the HH?

Problem/Constrain	Rank
☐ Losses due to predators ☐ Insufficient fodder ☐ Insufficient grazing land ☐ Poor quality grazing ☐ Low milk yields ☐ Poor quality local breeds ☐ Poor veterinary & extension visits ☐ Diseases ☐ Parasites ☐ Other	

Section III: Agriculture

Landholding *(specify size. eg. langdo, acre, deci, etc)*

Type:	cultivated/used by HH	fallow/unused	sharecropped / rented in	sharecropped / rented out
Chhuzhing, wetland				
Kamzhing, dryland				
Tsesha, kitchen garden/ Khemsa				
Orchard				
Tsamdrog				
Other: _ _ _ _ _ _ _ _ _ _ _ _				

7. What crops has the household grown this year? List in order of importance

1.	2.
3.	4.
4.	5.
6.	7.
8.	9

Does the household have any special agriculture/ livestock production (e.g. Mushroom, bees, etc.) not included above?

8. What is the annual income from the Agriculture crops?

Sl.#	Type of crops	Quantity (Unit)	Unit cost	Total amount	Remarks
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

9. Any other source of income, e.g. Honey from bee, fishery, tourism, business etc.

Sl.#	Income source	Quantity	Unit cost	Total amount	Remarks
1	Bee farming				
2	Tourism				
3	Fishery				
4	Business				
5	Employment				
6	Labour				
7	Handicraft				
8	Others (Specify…)				

10. What are the main problems/Constrains for Agriculture of the HH *(Rank 1, 2,3….base on severity of the problem)*

Problem/Constrain	Rank
☐ Poor accessibility to market ☐ Pest and diseases ☐ Poor soil fertility ☐ Soil erosion ☐ Shortage of labour ☐ Unavailability of good quality seeds ☐ Insufficient land	

☐ Damage by wild animals ☐ Insufficient irrigation water ☐ Insufficient funds to invest ☐ Erratic climatic condition ☐ Others (Specify)…….	

11. Have you changed your cropping practice in the last five to ten years? Yes ☐ No ☐

If yes:

New crop grown	Reason	Crop not grown any more	Reason
1.		1.	
2.		2.	
3.		3.	

Section IV: Wildlife Conservation

What animals and at what frequency do you sight wild animals in your areas and what is your feeling towards them? Also your views on the population trend

Sl.no	Species	Frequency of sighting	Your feeling to WildWildlife	ulation trend	Reasons for increase or decrease (use additional sheet if space is not enough to write)

Frequency: *A= Always, O=Occasionally.* ***Feelings:*** *L=Like, N=Neutral, D=Dislike*

Population Trend: *I=Increasing, S=Stable/Same, D=Decreasing*

12. Do some wild animals have any significance other than ecological importance? Or kind of belief or some interesting tales?

☐ Yes ☐ No

If yes, which species & what are they?

1) 2) 3)

13. Have you heard about the biological corridor/PA and its importance before?

☐ Yes ☐ No

14. Is there any poaching in your areas?

☐ Yes ☐ No ☐ Don't know

If yes, which wildlife species and why do people poach?

1) 2) 3) 4) 5)	1) 2) 3) 4) 5)

15. What kind of weapons /methods used for poaching?

Gun ☐ Bow and arrow ☐ Traps ☐ Snares ☐ Poison water source ☐ Aided by Dogs ☐

Don't know ☐ Other please specify ☐

16. Who are responsible for poaching?

☐ Local people ☐ Outsiders

If outsiders, mostly from which community or Dzongkhag?

1) 2) 3)

Section V: Human-wildlife conflict

17. Do you get any of the following problems due to wildWildlifeease tick in the appropriate cell (Trick in the cell)

Problem	Yes	No	Degree of problem			Rank
			Minor	Moderate	Severe	
1. Crop Damages						
2. Livestock predation						
3. Property damages						
4. Attack on Human						
5. Disease transmission						
6. Harassment						
7. Others						

18. Has household lost livestock to wild predators in the year 2018? □Yes / □No

Type of livestock killed	Breed	Date of kill (DD/MM)	Time(day or night)	Age	Sex	Dist. from village	Cost	Predator	Evidence

**Indicate* code for the identification evidence of the predator for each case: s=animal seen, h=animal heard, p=pugmarks, t=type of killing, etc.

*Indicate code for time as: D=Daytime N=Night

19. What are the root causes for livestock depredation?

20. What are the prevailing traditional measures adopted and other possible solution? (*Also, rank the efficiency as 1,2,3 and 4 with 1 being the most effective and 4 being the least)*

1) 2) 3) 4) 5)

21. What do you think about the trend of livestock depredation in your area?

- ☐ Increasing
- ☐ Same
- ☐ Decreasing

22. Has household lost crop to wild herbivores in the year 2018? ☐Yes / ☐No

If yes

Animal species	Crops	Month	Stage of the crop	Frequency (once, occasionally, frequently)	Since when? *(year such incidences occurred)*	Quantity (reflect the unit such as kg, sang, drey, etc)	Local rate per unit

A=planting, B=flowering, C=yield formation (ears, cobs, tubers, roots, seeds) D=matured stage (just before harvesting)

23. What are the possible reasons for wild animals coming to field and damaging the crops and properties?

1) 2) 3) 4) 5)

24. What are the prevailing traditional measures adopted and other possible solution? (*Also, rank the efficiency as 1,2,3 and 4 with 1 being the most effective and 4 being the least)*

1) 2) 3) 4) 5)

25. Do you guard your crops?

Yes ☐ No ☐

If yes, what are the expenditure incurred on guarding the crops

Expenditure head		Unit cost	Number	Total amount	Remarks
Guarding	Hire of labour				
	Purchase of torch				
	Batteries				
	Firewood				
	Kerosene				
Fencing	Labour cost				
	Materials				
	Food				

Conduct of rituals	As individual				
	Contribution in groups				
Others (specify)					

26. What do you think about the trend of crop damage in your area?

- ☐ Increasing
- ☐ Same
- ☐ Decreasing

Section VI: Resources use & People's outlook

27. What is your consumption and income from forest products? Rank 1, 2, 3…….

Resources	Collection month	Qty. With scale/unit		Rate	Distance from village	Trend	Remarks
		Consumption	Sale				
Firewood							
Fodder							
Medicinal plants							
Mushrooms							
Incense							
Fern tops							
Thatch grass							
Canes							
Bamboo							
leaves for bedding							
Top soil							
Stone							
Sand/soil							
Others (specify)							

I = Increasing, D = Decreasing, S = Stable/Same

28. Do you have plan to renovate or construct house in next 25 years. Yes ☐ No ☐

If Yes, Renovation ☐ Construction of 1 storeyed house ☐ Two storeyed House ☐

29. What are the main threats to their environment? Please rank as per importance, 1 being most important.

1)

2)

3)

4)

5)

30. What are the important actions that need to be taken to improve the conservation in your area? Prioritize them in order of 1, 2, 3…..

1)

2)

3)

4)

5)

31. Do you see any possibility that local community can benefit by participating in the conservation? □Yes / □No, How?

1)

2)

3)

4)

5)

32. Do you agree that wildWildlifeds to be conserved?

Agree ☐ Do not agree ☐ No idea ☐

Reason: Conservation value ☐ Social value ☐ Ecotourism value ☐

33. What are the actions taken by local forest offices towards conservation of wildWildlifeyour area?

Patrolling ☐ Awareness & education ☐ Incentives (ICDP) Nothing ☐

34. Will you support conservation program in your area?

Yes ☐ No ☐

Please state your opinion

1)

2)

3)

35. What do you think are the various ecotourism opportunities in your area?

*****Kadenchey!!!*****

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