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Agricultural Practices, Livelihood Dependency and Snow Leopard Conservation in Northern Pakistan: An Evidence-Based Synthesis

Areeba Saleha[*]

ABSTRACT

Pakistan has one of the largest populations of snow leopards in the world, but they are listed as vulnerable by the International Union for Conservation of Nature (IUCN) and their numbers continue to decline. The most frequently cited drivers are poaching, climate change and human-snow leopard conflict (HSC). While these pressures are known from the literature, the particular role of conventional agricultural methods as a root cause of this decline, is rarely studied. This is important for a country like Pakistan where agriculture accounts for a large share of rural livelihoods. Closer inspection of conventional agricultural methods reveals habitat degradation, prey depletion and intensifying human-wildlife conflict as direct consequences. This is most apparent in Gilgit-Baltistan where large-scale agricultural and livestock activity has resulted in increased predation incidents on livestock and, in turn, led to a rise in retaliatory killings. These pressures have been acknowledged in previous research, but agricultural methods are seldom viewed as a key driver, rather than a contextual detail. This paper investigates the effects of agricultural activity on snow leopard habitat and conservation in the region. It draws on secondary literature and a small-scale exploratory Environmental Value System (EVS) survey (n = 48). The survey results are indicative, not representative. A majority of the respondents (62.5%) tend towards technocentrism, favouring technological interventions to balance agricultural productivity and conservation goals. The study contributes to a more holistic understanding of the indirect pathways through which agricultural systems shape snow leopard conservation outcomes in Pakistan and highlights the need for integrated, locally grounded conservation strategies.

Keywords: Agricultural Practices, Snow Leopard, Human-Wildlife Conflict, Pakistan

JEL Classification Codes: Q13, Q15, Q18, Q54

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1. INTRODUCTION

The snow leopard (Panthera uncia) is a much sought-after species found in the high-altitude ecosystems of Central and Southeast Asia including Pakistan. Pakistan is home to one of the largest populations of snow leopards in the world. Snow leopards exist in the remote areas of Gilgit-Baltistan, Khyber Pakhtunkhwa, Azad Jammu and Kashmir in Pakistan. They were listed as vulnerable by the International Union for Conservation of Nature (IUCN) in 2017 (McCarthy et al., 2017). Some factors, such as human-snow leopard conflicts (HSCs), have been reducing the population. Previous studies estimated the number of snow leopards in Pakistan to be 300-400 (Nagri 2023; Nawaz et al., 2025), but recent camera-trapping census estimates suggest that there are around 127-167 snow leopards left in Pakistan (Nawaz et al., 2025; Nagri 2025).

Previous research on snow leopard conservation in Pakistan has identified diverse threats to the species. These include poaching, retaliatory killings, habitat fragmentation and wider environmental change (Ahmad et al., 2022; Jaffar Ud Din et al., 2022). Some of these studies also point to the role of livestock grazing and land use pressures, particularly in mountain communities where agriculture and wildlife habitats intersect (Suryawanshi 2013). This study discusses the impact of conventional agricultural methods directly on the snow leopard population based on existing literature. It explores how reliance on subsistence farming and livestock results in conflict between humans and snow leopards because of shared habitat.

Agriculture has expanded in Pakistan's mountainous regions due to economic progress and urban expansion, especially after the completion of the Karakoram Highway in the 1970s. It is crucial for sustaining human life in harsh environments. Predominantly subsistence farming is conducted, where crops and livestock are primarily used for the farmer's family. Agricultural practices have led to habitat encroachment. This forces snow leopards closer to human settlements, maximising negative interactions such as retaliatory killings (Ministry of Climate Change 2019). This study explores the extent to which agricultural practices impact snow leopards in Pakistan, by examining factors such as habitat loss, prey depletion and human-wildlife conflict. Primary prey species of snow leopards include Himalayan ibex, blue sheep, and markhor but their numbers have reduced due to overgrazing by livestock. Livestock is targeted by snow leopards, thereby initiating the conflict.

Snow leopards, apex predators, regulate prey populations and maintain trophic balance in high-altitude ecosystems. Their conservation therefore holds broader ecological significance beyond species preservation alone (Baig and Al-Subaiee 2009). Accordingly, this study aims to:

- Examine how agricultural expansion and livestock-based livelihoods influence snow leopard habitats in Pakistan;

- Analyse the role of livestock grazing and prey depletion in intensifying human–snow leopard conflict; and
- Explore public perceptions regarding agriculture conservation trade-offs using an Environmental Value System (EVS) framework in order to contextualise ecological findings within broader socio-economic attitudes.

2. LITERATURE REVIEW

2.1 Agricultural Landscapes and Snow Leopard Habitat in Northern Pakistan

Snow leopards in Pakistan are primarily distributed across the high-altitude mountain systems of Gilgit-Baltistan, including the Karakoram and Hindu Kush ranges. These landscapes are also used for agriculture by local communities. Snow leopard habitat largely overlaps with areas dominated by human settlements and intensified agricultural activity. This co-existence indicates an inherent relationship between the two.

Recent evidence suggests that this coexistence is a natural part of the socioeconomic system of Gilgit-Baltistan. Although only 1% of the total region is cultivable and nearly 52% consists of mountainous rangelands, 73% of the population in Gilgit-Baltistan is engaged in crop and livestock farming, as reported by Hameed et al. (2022). This highlights the dependence on grazing lands and how pastoralism is essential to local household survival in a marginal environment.

It is documented in the Gilgit-Baltistan Forest Carbon Inventory that about 381,000 hectares are covered by scrub forests only. There are also large alpine pastures and rangelands present that overlap with confirmed snow leopard habitat. These landscapes are important for raising livestock. However, they also serve as ecological corridors and foraging grounds for wild ungulates, which are the primary prey of snow leopards. Human interventions have increased across these ecosystems, such as grazing, fuelwood extraction and land conversion, which intensely contributes to habitat degradation and fragmentation (Ali et al., 2017). Analyses of land use changes reveal growing human activity within snow leopard range. In regions of Northern Pakistan, geospatial assessments reveal a substantial decline in forest cover and alpine ecosystems, followed by conversion to agricultural land and expansion of settlements. These trends over the years show that agricultural activity is a significant ecological driver that alters snow leopard habitat and cannot merely be seen as a contributing factor.

Khan et al. (2021) report that both the quality and quantity of snow leopard habitats have drastically changed over the last two decades. GIS-based analysis of land use and land cover reveals changes in snow-dominated landscapes between 2002 and 2021; agricultural land has expanded by 153%, and infrastructural growth increased by 163%. Gilgit-Baltistan, which supports over 60% of Pakistan's snow leopard population, clearly shows these spatial changes and is also dominated by agricultural activity and livestock grazing. Human-snow leopard conflict and retaliatory killings are triggered and intensified by high

livestock density. Degraded habitats increase the likelihood of livestock depredation. Infrastructural development causes another threat, as outlined by WWF Pakistan's BEAST project. Road developments are disrupting movement corridors and traffic-related mortality is continuously increasing among prey species, such as Himalayan ibex (WWF-Pakistan 2024a).

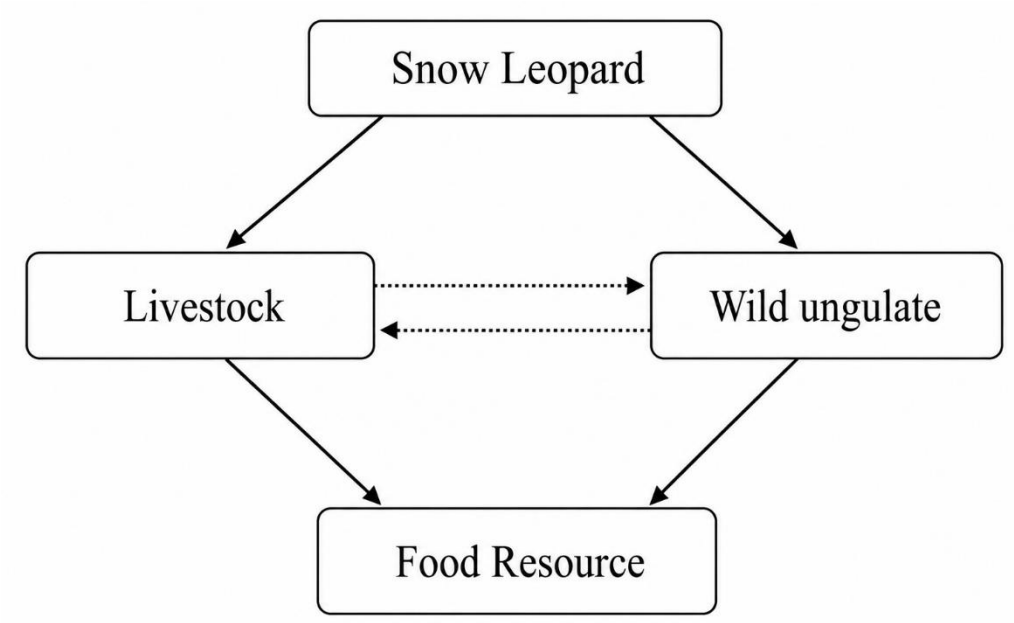
Other regions such as Khyber Pakhtunkhwa (KPK) show limited agricultural expansion due to constraints like climate and terrain, which leads to comparatively lower pressure on snow leopard populations. This regional difference is evident in Pakistani snow leopard research; the majority of the literature focuses on Gilgit-Baltistan. Interpretation differs across sources as well. Government reports emphasise climate change as the dominant driver of habitat loss (Climate Change Division 2013). Other studies examine agricultural expansion and fragmentation as vital factors (Khan et al., 2021). These variations most likely occur due to methodological differences but have important policy implications: underestimating agriculture's role results in ineffective conservation planning.

2.2 Livestock Grazing, Rangeland Degradation, and Wild Prey Dynamics

The most common land use in the high-mountain ecosystems of northern Pakistan is livestock grazing. In Gilgit-Baltistan, livestock numbers increased from 1.92 million to 2.62 million between 2006 and 2019, and nearly 80% of the animals graze on mountain pastures. Pressure on rangelands has increased due to an annual livestock growth rate of 2.8%; pastoralists themselves identify rangeland degradation as a major concern (Hameed et al., 2022). Increased grazing directly affects vegetation structure and forage availability, which results in reduced habitat quality for wild ungulates such as Himalayan ibex, blue sheep, and markhor. Carrying capacity for wild species is lowered as overgrazing depletes plant biomass and accelerates soil erosion. This ecological mechanism is established across mountain ecosystems. It is supported by empirical studies, which demonstrate that increased livestock density suppresses wild ungulate abundance, indirectly affecting predator populations (Bagchi et al., 2020).

These dynamics are conceptually illustrated in Figure 1, which presents a three-trophic-level food web model. In this framework, livestock and wild ungulates compete for forage resources (dotted lines), while snow leopards prey on both wild prey and domestic animals (solid lines). The model illustrates the ecological process where grazing pressure reduces wild prey availability, leading to a change in snow leopard behaviour.

Figure 1: Conceptual Diagram of Trophic Interactions between Snow Leopards, Livestock and Wild Ungulates



Source: Author's own.

2.3 Snow Leopard Diet and Livestock Depredation Patterns

Decline in natural prey has significant implications for snow leopard diet composition and behaviour. Through the use of camera trapping and scat analysis, recent dietary research from Khunjerab National Park (Akber et al., 2025) reveals that snow leopards obtain 72% of their diet from wild prey and 28% from domestic livestock. Himalayan ibex and yak were identified as key prey. This finding provides context-specific evidence of livestock dependence within Pakistan. Seasonal patterns further intensify conflict. Predation peaks in winter, when snow leopards break into poorly fortified corrals. It peaks again, in early summer, when livestock are moved to high-altitude pastures and females with cubs have elevated dietary requirements (Rosen et al., 2012). In northern Pakistan, livestock management practices also appear to influence predation risk. Unattended yaks were observed to display irregular activity patterns that increased their susceptibility to snow leopard attacks (Khan et al., 2025a).

Snow leopards are consistently identified as the dominant cause of livestock losses in high-altitude valleys, as indicated by predator-wise assessments. In parts of Gilgit-Baltistan, snow leopards account for 50–70% of livestock depredation, goats and sheep (Jaffar Ud Din et al., 2019). A study conducted in Baltistan further found that poorly constructed corrals and extensive free-range grazing increased the likelihood of snow leopard attacks

on livestock. In contrast, predator-proof corrals and awareness programmes have helped reduce conflict levels (Zaman et al., 2024).

Livestock depredation patterns align with broader regional findings. While snow leopards primarily prey on wild ungulates, livestock predation in Pakistan is reportedly around twice the global average of approximately 25% of diet (Lyngdoh et al., 2014). This reveals a pattern attributed to prey depletion and high livestock densities within core habitats of snow leopards.

2.4 Economic Impacts of Livestock Losses and Household Vulnerability

Households in Gilgit-Baltistan are heavily dependent on subsistence agriculture and livestock rearing. They are important for both food security and income generation. Although only 1% of the land is cultivated, recent data indicate that 73% of households are engaged in crop and livestock farming. Around 52% of the region consists of mountainous rangelands that overlap extensively with snow leopard habitats (Hameed et al., 2022). Pastoral households maintain sizable herds: on average four cattle, 15 small ruminants, and ten yaks. Their grazing extends into core wildlife areas. This highlights the dual importance of rangelands for human livelihoods and snow leopard prey availability. The dependence of households on agriculture-based activities is summarised in Table 1.

Table 1: Livelihood Sources and Income Composition of Households in Northern Pakistan

Livelihood Category		Households Reporting Yes
Agriculture-Based	Crop	262
	Livestock	137
	Forest	201
	Rented out land	78
	Agriculture wages	66
	Farm machinery	32
	Fruit Sale	125
	Vegetable Sale	11
	Fodder Sale	64
Total		976 (55%)
Non-Agriculture Based	Small-scale business	122
	Public/private sector	157
	Foreign remittances	49
	Home remittances	149
	Non agri. wages	122
	Pension	9
	Other sources	190
Total		798 (45%)

Source: Israr and Khan (2010).

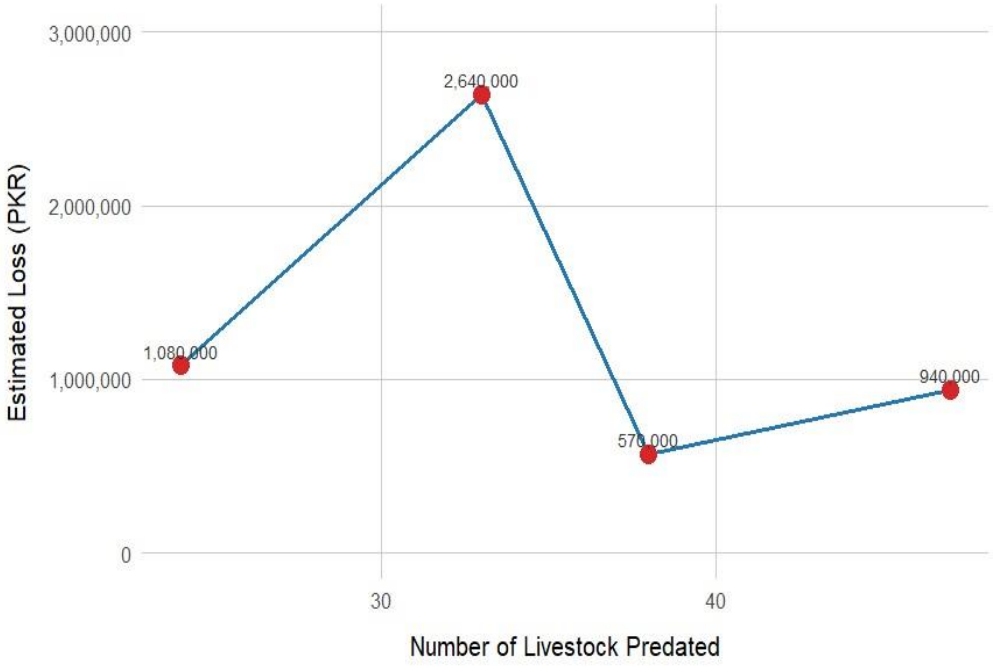
Hence, snow leopard predation on livestock puts a substantial economic burden on local households. In the Misgar Valley, Hunza District, Bano et al. (2021) reported that snow leopards were responsible for over 60% of large livestock losses. It resulted in an average annual household loss of PKR 87,000–120,000, which is equivalent to 18–30% of household income (Table 2; Figure 2). Similarly, households in Shimshal and Khunjerab landscapes lost USD 900–1,000 annually, representing 25–35% of cash income (Rashid et al., 2021).

Table 2: Financial Impact of Livestock Predation by Snow Leopards in Misgar Valley, Hunza District (2014-2019)

Livestock Type	Predation by SL	Unit Price (PKR)	Estimated Loss (PKR)
Cattle	24	45,000	1,080,000
Goats	47	20,000	940,000
Sheep	38	15,000	570,000
Yaks	33	80,000	2,640,000
Total	142	160,000	5,230,000

Source: Bano et al. (2021).

Figure 2: Financial Impact of Livestock Predation by Snow Leopards in Misgar Valley, Hunza District (2014–2019)



Source: Author's own; visual representation of Table 2, created using R.

Small ruminants and yaks are commonly preyed on, as confirmed in both Jaffar Ud Din et al. (2019) and the Misgar Valley dataset. This highlights the role of species-specific vulnerability in an ecological system. These financial losses are intense in a region where household incomes are low, and poverty remains widespread (Climate Change Division 2013). This can be explained by a lack of protective measures. The combination of high dependence on livestock and significant predation pressure causes retaliatory killings. It is now recognised as a leading cause of snow leopard mortality in northern Pakistan.

2.5 Human–Wildlife Conflict and Retaliatory Killing

Rashid et al. (2023) found that 69% of the locals wanted a reduction in snow leopards due to predation on their livestock. Bano et al. (2021) link repeated losses to increased tolerance thresholds and heightened risk of retaliatory killing. In Misgar Valley, 63% of respondents identified snow leopards as the most dangerous predator. It reflects both perceived and experienced threats. Historical records indicate that retaliatory killing has long posed a threat to snow leopard populations in Pakistan. During the late 1990s, Hussain (2003) documented multiple killings in the Northern Areas. Schaller (1976) reported at least seven snow leopards shot near Chitral Gol National Park between 1971 and 1973. Recent interventions, such as government-facilitated releases following capture incidents (Nagri 2023), show growing institutional engagement. However, retaliatory killing remains a persistent conservation challenge. The Climate Change Division (2013) explicitly identifies livestock depredation and rural poverty as the leading drivers of snow leopard mortality nationwide. This reinforces the conclusion that conservation outcomes cannot be separated from agricultural practices and livelihood security in snow leopard landscapes. Livestock losses impose substantial financial strain on rural households. It fosters negative attitudes toward snow leopards and increases the likelihood of retaliation. This pattern is also reflected in other mountain regions. In Bhutan, snow leopards were identified as the main source of conflict for highland pastoral communities, with conflict severity increasing alongside dependence on livestock-based livelihoods (Sherub et al., 2025). Similar attitudes have also been observed elsewhere in Pakistan. In Lakki Marwat, households experiencing repeated livestock losses reported increasingly negative perceptions of wildlife species involved in depredation incidents (Khan et al., 2025b). That suggests that the social impacts of livestock loss extend beyond snow leopard landscapes alone.

Nevertheless, community-based interventions have shown results. Where mitigation measures exist, attitudes can shift. In Gilgit-Baltistan, snow leopards trapped in corrals have increasingly been released alive with farmer cooperation. Farmer cooperation and tolerance appear to be increasing. When compensation schemes fail, local resentment escalates. This was observed in the case in Misgar, Hunza when authorities refused compensation (Rosen et al., 2012). This pattern points to the need for responsive, community-centred policies. A comparable pattern from Nepal suggests that compensation schemes can face major implementation challenges. This includes delays and weak administrative processes, which reduces local willingness to coexist with wildlife (Dahal et al., 2025). The same risk applies

to Pakistan; poorly administered compensation mechanisms have similarly contributed to resentment following livestock losses.

2.6 Conservation Measures and Community Interventions

With funding from the Department for International Development (DFID-UK), the Pakistan government has mainly revised Gilgit-Baltistan curriculum to include environmental education such as snow leopard conservation, under the Northern Areas Education Project (NAEP) (Abbas 2003). Leading NGOs in snow leopard conservation are the Aga Khan Education Service (AKES), WWF Pakistan, and IUCN. A successful collaboration within the organisation is Pakistan Snow Leopard and Ecosystem Protection Program (PSLEP). This is a Global Environment Facility (GEF)-funded project, with implementation by the Snow Leopard Foundation, Ministry of Climate Change and Environmental Coordination, and United Nations Development Programme (UNDP) Pakistan. It combines livestock insurance schemes with predator-proof coral construction at a national level (Ministry of Climate Change and Environmental Coordination n.d.).

Non-formal sectors have contributed through activity-based initiatives. However, a significant issue remains; the lack of coordination among these organisations and government departments, which hinders the effectiveness (Climate Change Division 2013). However, initiatives like PSLEP are a step forward for the future. Furthermore, the government has designated national parks in regions with significant snow leopard populations, these areas were originally established to protect other species, such as the Marco Polo sheep. Today, these parks also serve as protected areas (PAs) for snow leopards.

The Baltistan Wildlife Conservation and Development Organization, under the anthropologist Shafqat Hussain, was launched in Skoyo, Rondu Valley. The programme, known as PSL, operates on the principle of setting aside a collective pool of money equal to the annual livestock loss rate. Beyond functioning as an insurance scheme, it deploys prevention measures such as predator-proof corrals and community empowerment initiatives. Thirteen years after its launch, the project had expanded into ten villages across three valleys. PSL surveys suggest a reduction in conflict, although this evidence remains unpublished and is treated here as supplementary rather than substantive. A notable technological development in the field is an AI-Based Snow Leopard Early detection system, developed by students at the Lahore University of Management Sciences (LUMS). It sends immediate warnings to farmers through SMS, before a snow leopard enters the vicinity. Through collaboration with WWF Pakistan, the system is installed in a few strategic locations in Gilgit-Baltistan (WWF-Pakistan 2024b).

2.7 Conceptual Framework: Linking Agriculture, Ecology and Conflict

The framework used in this study to link conventional agricultural methods and snow leopard conservation. The literature reviewed indicates that extensive grazing and land use

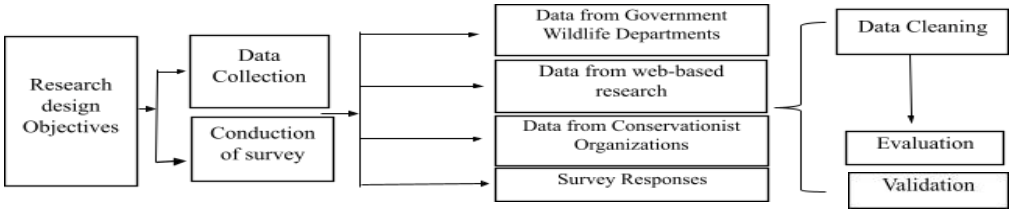
change has led to the degradation of habitat quality over the years. This has affected the availability of wild prey. This has resulted in an increase in snow leopard diet predation of livestock. Livestock is the main source of income for many households. Thus, predation on livestock causes substantial economic losses. Their negative attitude stems from this economic burden. There is resentment from repeated losses, which leads to retaliatory killings. The link makes agriculture not an outside or contextual factor, but a core cause for the decline of snow leopard populations. Research has shown clearly that snow leopard conservation is not effective when all contributing factors are not integrated. These include rangeland management; measures to recover prey and protect livestock. Overall, the reviewed evidence helps to understand the impact of conventional agricultural methods on snow leopard population in Pakistan.

3. METHODOLOGY

3.1 Research Design

Figure 3 illustrates the methodological workflow followed in this research. The study adopts a mixed-methods approach, combining secondary data analysis with primary survey data. This approach was selected to capture both ecological patterns related to snow leopard conservation and broader public perspectives on agriculture and human–wildlife conflict. The research process begins with the formulation of research objectives, followed by data collection through secondary sources and a survey, and concludes with data analysis and synthesis. The use of secondary data is common in snow leopard research due to the remoteness of habitats and the logistical challenges of conducting direct fieldwork in high-altitude regions. Mixed-methods approaches have been applied in snow leopard conservation research to integrate socio-economic and ecological dimensions of human–wildlife interactions. For example, Maheshwari and Sathyakumar (2020) combined structured questionnaires with ecological analysis to assess livestock depredation patterns. Dorji and Powri (2022) used interviews with herders to link livestock losses with local perceptions. These studies support the use of a mixed-methods design in this research to assess agricultural practices, human perceptions, and conservation outcomes in shared landscapes.

Figure 3: Methodological Workflow



Source: Author's own.

3.2 Study Regions and Temporal Scope

Most of the studies cited in this research were conducted in Gilgit-Baltistan, Khyber Pakhtunkhwa and Azad Jammu and Kashmir. These are areas known to have significant populations of snow leopards. They engage in extensive agriculture based on livestock. These areas are often discussed in the literature of snow leopard conservation because of their ecological importance and high degree of human-wildlife interaction. The most recent data published in the last 10-15 years was prioritised to reflect the recent ecological conditions, socio-economic trends and conservation challenges. This period also sees advances in research methodologies and the rise of new pressures on snow leopard habitats, including increased livestock grazing and land use change. Earlier studies were cited only to give ecological context to the baseline.

3.3 Secondary Data

Empirical and statistical studies were used as secondary data sources. This study gathered quantitative data on livestock predation, prey availability and snow leopard distribution from peer-reviewed journal articles. Reports of conservation organisations and government bodies provided contextual information on conservation efforts and land use practices. Secondary data were identified using a targeted search strategy. Key search terms included 'snow leopard Pakistan,' 'human-wildlife conflict,' 'livestock predation,' 'pastoralism,' and 'agricultural expansion.' The analysis prioritised studies published within the last 10-15 years so that the analysis is reflective of recent ecological conditions, land use changes and conservation challenges. There were also methodological advances during this period, including camera trapping, satellite tracking and community-based monitoring. Studies were included if conducted in Gilgit-Baltistan, Khyber Pakhtunkhwa or Azad Jammu and Kashmir. These are the areas where snow leopard populations and agricultural activity are known. In addition, documentaries and reports prepared by local experts were viewed to provide qualitative insights into human–wildlife conflict, particularly in relation to livestock loss and retaliatory killing. The study specifically used news reports from Dawn because of its long history of editorial scrutiny and reliance on expert commentary. These sources were used to supplement rather than replace the academic literature. These sources were relevant to the research objectives as they documented lived experiences of communities living near snow leopard habitats and socio-economic drivers of conflict. Knowledge of the local context helped identify gaps and inconsistencies between sources.

3.4 Data Analysis

The quantitative data from the literature was used to generate visual representations or simplified tables, including graphs produced using R coding. This helps to easily support a comparative evaluation and to build indications of a pattern. Descriptive analysis of qualitative data from reports, documentaries and expert accounts provided context for numerical trends and interpretation of socio-economic dimensions of human-wildlife conflict. This analysis helped explain the common retaliatory response to livestock

predation and how agricultural reliance influences local attitudes toward snow leopard conservation. Social media updates from conservation organisations were also analysed to construct a broad timeline of conservation initiatives and awareness campaigns. Sources were used sparingly, only to supplement information already available in formal reports and academic literature.

3.5 Primary Data Collection

The primary data was obtained through a survey conducted on Google Forms. Questions to respondents focused on the snow leopard conservation dynamics in Pakistan. Their views were categorised into three Environmental Value Systems: anthropocentric (concentrating on the necessities of human livelihood), ecocentric (focusing on the protection of ecology) and technocentric (focusing on technological solutions to balance both). The survey consisted of eight questions (see Appendix). The survey was distributed on social media and answered by 48 people. The results are presented in a pie chart (Figure 4) to show general environmental perspectives. Response options were designed to be divided into three Environmental Value Systems: anthropocentric, ecocentric and technocentric. Questions 4–8 were directly related to the study's objective of assessing perceptions of the agriculture–conservation relationship. During the course of the study, survey results only indicate general perceptions. No formal ethical clearance was sought for the anonymous participation or non-collection of sensitive personal data. Participation implied knowing consent. Results show a majority prefer technocentric (62.5%), followed by ecocentric (27.5%) and anthropocentric (10%). Finally, the findings from secondary and primary data are combined in the analysis. The research question is answered and the extent of influence of conventional agricultural methods over snow leopard populations in Pakistan is evaluated. The study aims to contribute to the development of conservation strategies that will reconcile the needs of wildlife and the human communities by bringing together ecological evidence and socio-economic perspectives.

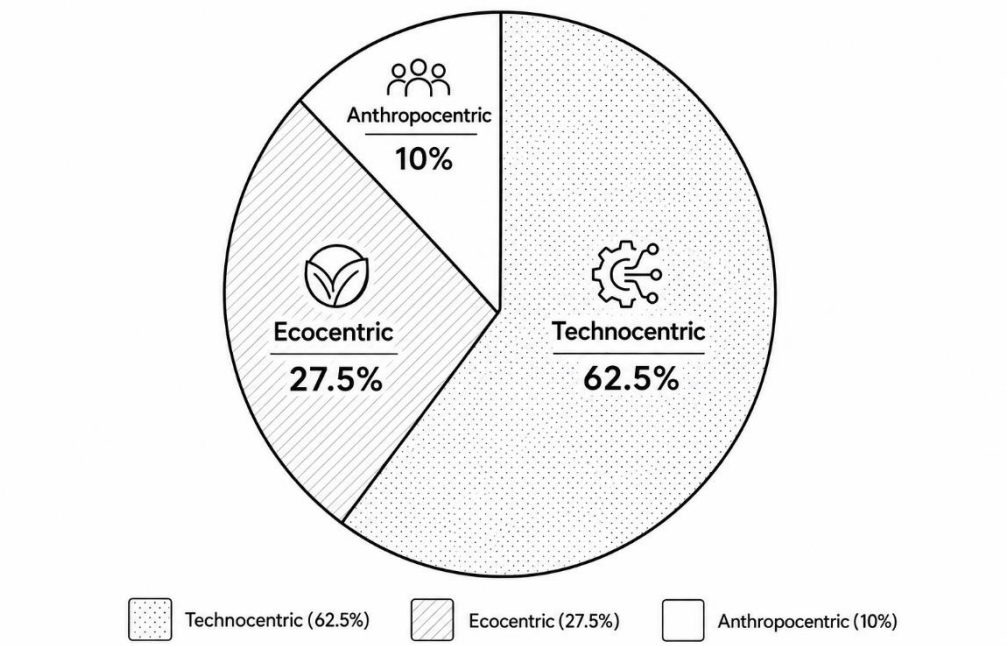
4. ANALYSIS AND DISCUSSION

The EVS survey (n = 48) grouped responses into three categories: anthropocentric, ecocentric, and technocentric. Results showed 62.5% opted for technocentric solutions, 27.5% ecocentric, and 10% anthropocentric (Figure 4). The ecocentric minority is notable; it suggests some respondents prioritise ecological conservation over economic convenience. This is important within an agriculture-dependent context. However, given that agriculture is central to Pakistan's economy and livelihoods, this is not unexpected.

The majority of respondents appear to favour solutions that allow farming practices to continue while minimising ecological damage. The findings are treated as indicative rather than representative of farming communities directly affected by conflict. The sample was small, digitally distributed, and mostly composed of educated urban respondents.

The survey results are consistent with the secondary evidence. Communities involved in human–wildlife conflict are not opposed to the idea of conservation. Their choices are defined by their livelihoods. In order to protect their economic loss, snow leopards are killed in retaliation. Technocentric solutions offer co-existence among the two, and that is reflected by responses in pilot study and choice of predator-proof corrals in the secondary studies. The main barrier is not local resistance but the absence of mechanisms that make coexistence financially practical.

Figure 4: Environmental Value System (EVS) Orientation among Survey Respondents (n = 48)



Source: Author's own; visual representation of survey results, created using R.

Realistically, conflict between humans and snow leopards can be minimised, but never eliminated. As long as humans and snow leopards co-exist within the community, livestock losses will continue. Shifts in environmental value systems can improve tolerance through awareness among the locals. However, it cannot undo the economic burden on the subsistence farmers. Retaliatory killings are a rational survival response, despite being a cause for ecological damage, and cannot be taken as a deliberate disregard for conservation. It is unrealistic to expect impoverished communities to prioritise species conservation over livelihood security. Therefore, effective conservation takes note and integrates local needs in policymaking. Evidence from Pakistan and comparable regions demonstrates that coexistence-oriented interventions, such as improved animal husbandry, predator-proof corrals, guarded grazing and habitat restoration, can significantly reduce conflict (Abbas et

al., 2026). Economic risk can be mitigated by community-based livestock insurance schemes, along with fostering cooperative attitudes (Dar et al., 2009; Rosen et al., 2012).

There is weak enforcement and limited coordination between government agencies and conservation organisations, which weakens effectiveness. Findings of the pilot survey point toward technocentric solutions. This is consistent with broader evidence of what has worked already in similar conflict landscapes. Technology can potentially address research and monitoring gaps. AI-enabled trail cameras, used in a recent initiative in Gilgit-Baltistan, allowed early detection of snow leopard presence and proactive livestock protection (WWF-Pakistan 2024b). This transforms conflict into co-existence. Nevertheless, technological solutions must be complemented by education.

5. CONCLUSION

Pakistan's ecosystems, in the provinces of Gilgit-Baltistan, KPK and Azad Jammu and Kashmir, are the habitat of a rare species, snow leopards. As apex predators, they are crucial to ecological balance. However, their numbers are declining gradually over the years. The trophic balance composed of wild ungulates and grazing livestock is slowly tipping to disruption due to factors, such as overgrazing, vegetation degradation and human settlements encroachment. Conservation efforts are not simple to operate, given the complex socioeconomic realities. Especially in agricultural dependent regions, human-snow leopard conflict arises and leads to retaliatory killings of snow leopards. This has been a growing factor associated with the decline in the population. The conflict primarily occurs due to livestock predation by snow leopards, which puts the livelihoods of the locals at risk. Livestock predation has increased over the years due to habitat encroachment and reduction in the number of wild prey. This study has examined how agricultural activities contribute to decline in snow leopard populations. The conclusion is drawn based on spatial and socio-economic, and attitudinal evidence from existing literature and an exploratory pilot survey. However, humans and snow leopards can co-exist through well-researched interventions. Community-based measures such as livestock insurance and predator-proof corrals have shown measurable success. However, their long-term effectiveness depends on institutional support, public financing, and formal integration into provincial conservation and agricultural policies. Conservation is sustainable and effective only if it balances ecological priorities and local human requirements. There is realistic hope for co-existence between the two, if a technocentric approach is explored. Human-snow leopard conflict will persist due to overlapping of the habitats. However, measures based on evidence and research can largely mitigate it. There is hope for preserving snow leopards and Pakistan's mountain ecosystems for future generations.

Limited public money is being invested in conservation research in Pakistan. Much of the data is produced by NGOs instead of government sources. This results in uneven regional coverage; some areas remain underrepresented in the literature. Secondary data may

contain potential bias, as there is no reporting incentive. Government numbers on retaliatory killings are observed to be lower and might be downplaying the implications. NGO numbers might be inflated because conflict severity helps with funding. Variations in methodology can also account for this difference; some sources attribute habitat fragmentation to climate change, rather than agricultural expansion. Therefore, multiple studies were compared and interpreted accordingly.

The primary data from the pilot EVS survey (n = 48) was distributed online and voluntarily completed. This resulted in a sample inclined towards educated urban respondents rather than farming communities which are directly affected by human-snow leopard conflict. Therefore, survey findings are treated only as indicative of general perceptions, throughout the study. Due to anonymous participation and absence of sensitive personal data, formal ethical clearance was not sought. Informed consent was implicit in the act.

Finally, the evidence gathered is heavily concentrated in Gilgit-Baltistan. This shows where most Pakistani snow leopard research is focused. Findings may not generalise to other regions where agricultural, climatic and governance factors differ. The study is mainly correlational; the evidence reviewed is drawn on existing literature's findings. The pattern emerging is consistent, agricultural expansion contributing to habitat degradation and conflict. However, secondary data cannot rule out other factors that influence the pattern.

6. RECOMMENDATIONS

Currently, implementation of most measures is affected by weak enforcement and limited coordination between wildlife departments and NGOs (see Discussion), which is a structural barrier that must be dealt with. In high conflict regions, large-scale implementation of predator-proof corrals should be prioritised. This will allow agricultural activity to continue while minimising economic loss of farmers. Existing pilot corrals show measurable evidence of reduction in livestock losses and hence, retaliatory killings. The barrier to such large-scale effort is a lack of funding and an official policy, apart from NGO-led efforts.

Insurance or compensation schemes, similar to PSL model in Skoyo, Rondu Valley, should be officially run and co-financed by provincial government. This proposal has been effective in creation of PSLEP. It shows that a government-backed project, in collaboration with other organisations, can operate at a national scale. The programme combines livestock insurance with corral construction (Ministry of Climate Change and Environmental Coordination n.d.). This recommendation can be further expanded in future and can yield effective results. Comparable schemes show that compensation schemes reduce hostility towards snow leopards. These schemes are to be designed by giving communities ownership and decision-making power. Otherwise, schemes such as in Nepal faced resentment as local communities lost control (Dahal et al., 2025). Furthermore, the addition of GIS and remote-sensing data in provincial development planning processes can

identify encroachment zones before development approval. This is urgent, as climate projections predict a 30–40% decline in snow leopard habitat by 2070 (Ahmad et al., 2022). Agricultural expansion in snow leopard habitat must be regulated by use of spatial habitat data (as in Khan et al., 2021). This can reduce proximity of both communities, before emergence of conflict.

Building on existing pilots, such as the LUMS early-detection system, can ensure integration of advanced trail camera networks and AI-enabled monitoring tools into conservation policy. This will improve early detection of snow leopard movement and reduce unexpected livestock damage. Strategic testing has begun and must be deployed at large scale in the near future. Technological interventions were preferred in this study's exploratory EVS survey on public preferences. They offer a pragmatic pathway for co-existence. On the other hand, legislation in Gilgit-Baltistan permits killing or capture of snow leopards under certain circumstances. This law requires a formal review, given that the snow leopards rarely threaten human life. Unreported retaliatory killings might increase, so rather than removal of the law, it can be revised with compensation and other measures. Effective legal measures would not neglect farmers' economic context.

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Appendix: Survey Questionnaire

This appendix reproduces the survey instrument distributed to participants via Google Forms between 13 September–3 October 2024. The survey collected demographic information followed by questionnaire. It assessed Environmental Value System (EVS); anthropocentric, ecocentric or technocentric, regarding agriculture-conservation conflict in snow leopard habitat in Pakistan.

Part 1: Demographic Information

No.	Question	Response Options
1	Are you a resident of Pakistan?	yes /no
2	What is your profession?	Open response
3	Gender?	Male/Female

Part 2: Environmental Value System Assessment

No.	Question	Response Options
4	What is your opinion on the impact of agricultural expansion in snow leopards' habitats?	[Anthropocentric option] / [Ecocentric option]/ [Technocentric option]
5	Do you believe it is acceptable to alter snow leopard habitats, to increase agricultural yields?	[Anthropocentric option] / [Ecocentric option]/ [Technocentric option]
6	How should conflicts between farmers and snow leopards be managed?	[Anthropocentric option] / [Ecocentric option]/ [Technocentric option]
7	What is the best way to address the declining snow leopard populations in agricultural areas?	[Anthropocentric option] / [Ecocentric option]/ [Technocentric option]
8	How important is it to conserve snow leopards compared to improving agricultural productivity in Pakistan?	Open response