URBANIZATION EFFECT ON PLANT DIVERSITY AND AGRICULTURAL LAND, CASE STUDY OF SAKAR VALLEY DISTRICT GILGIT, PAKISTAN

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ABSTRACT: Urbanization has had a significant impact on the unique floral diversity and agricultural land of Gilgit district, which once boasted a rich variety of herbs, shrubs, and trees. Unfortunately, the expansion of construction, roads, and other infrastructure has led to the transformation of more and more land, resulting in noticeable consequences in the study area. To address this issue, the present study proposes mitigation strategies that focus on urban planning, prioritizing green spaces, and conserving native plant species. One evident effect of urbanization is the alarming loss of wild vegetation and green spaces, which has caused a decline in the abundance and diversity of plant species. Notably, cultivated species such as Populus Alba (with an IVI value of 4.52), Juglans Regia (with an IVI value of 5.94), and wild species like Artemisia Brevifolia (with an IVI value of (1.49001) and Artemisia Seversiania (with an IVI value of (3.15674) have experienced a significant reduction in their populations over the last few years. These declining IVI values serve as indicators of the adverse effects of urbanization on the once-thriving plant life in the area. The study also examined the soil in the area, dividing it into two zones and testing its texture and mineral percentage. Zone one exhibited sandy loam texture with a pH of 7.63, and nutrient percentages were as follows: P 5.05%, K 46.84%, Cu2 2.18%, Fe2 5.38%, Mn2 1.24, and Zn2 1.65. On the other hand, zone two showed silt loamy texture with a pH of 7.82, and nutrient percentages were as follows: P 9.33%, K 86.01%, Cu2 4.28%, Fe2 3.62%, Mn2 2.44%, Zn2 1.49%. The study reveals that soil factors, altitude, and organic matter influence vegetation variation. Urbanization negatively affects native plants and agriculture in Gilgit. Urgent preservation measures are needed. Urban planning should prioritize green spaces and native plant conservation to mitigate urbanization's impact, protect floral diversity, and preserve the region's agricultural heritage.

Key words Urbanization biodiversity climate change Gilgit Baltistan.

(Received 21.07.2023 Accepted 14.09.2023)

INTRODUCTION

Rapid urbanization poses a significant threat to environmental sustainability, as highlighted by Linger *et al*. in 2013. Pakistan, in particular, has experienced the fastest urbanization rate of 3% in South Asia, as reported by (Noor and Khatoon in 2013). This trend is primarily driven by rural-to-urban migration, with people seeking better living conditions in cities, as stated by (Hamawandy in 2023). The United Nations predicts that by 2025, approximately half of Pakistan's population will have moved to urban areas, leading to unplanned urbanization and the consequent reduction of green spaces, alteration of vegetation cover, and changes in surface water content, as mentioned by (Qutoshi *et al.* in 2022).This global issue has been acknowledged as a powerful and visible threat, as emphasized by (Abid Hussain *et al*. in 2022). Developing countries, in particular, have experienced rapid urbanization since the mid-twentieth century, as (Shahzad, Abubakr, and Fischer noted in 2021). Consequently, there is a pressing need to assess and understand the effects of urbanization, as stressed by (Azfar Hussain, Hussain, and Saif-Ud-Din in 2022). In recent times, numerous studies have been conducted to comprehensively explore the issues, impacts, and drivers of modern urbanization, as mentioned by (Rashid *et al*. in 2023). According to official statistics, Gilgit-Baltistan constitutes 0.48% of Pakistan's total land area, with a total of 6.687 million hectares (Tuladhar *et al*., 2023), which makes up about 8.4% of Pakistan's geographical area (Joshi *et al*., 2013). Out of this, the agricultural land covers 0.062 million hectares (0.71%), while the forest area spans 0.688 million hectares (7.79%) (Linger *et al*., 2013).The region is home to a population of approximately 1.49 million people, experiencing a growth rate of 2.47% (Anwar, Khan, and Atta-ur-Rahman, 2019). The poverty rate is 16.95% in urban areas and 83.55% in rural areas (Neelum Nigar, 2018). The economy of Gilgit-Baltistan heavily relies on agriculture, but the tourism industry has shown great potential for growth.Despite the positive economic impact of tourism, the increase in the number of tourists

has created a tragedy of common pool environmental problems in Gilgit-Baltistan (Bhagwat, Dudley, and Harrop, 2011). The conversion of cultivated land into commercial spaces like hotels, restaurants, and buildings has disrupted the plant community, leading to a reduction in native dominant plant species. Soil erosion, caused by various human activities, has further reduced the productivity of agriculture land, forests, and pastures (Apriliani *et al*., 2021).

Alongside the economic benefits, tourism has brought about various environmental issues such as noise pollution, garbage accumulation at tourist spots, and increased air pollution due to the use of private vehicles by tourists (Baig, Khan, and Khan, 2021). The recent flood in 2020 stands as an example of environmental degradation in the region.One study area, Sakar, serves as an example of rapid urbanization and is considered a junction point of Gilgit along the Karakorum highway (N 35) (Abbas *et al*., 2023). The local communities in Sakar valley have been observed constructing accommodation facilities, such as hotels, guest houses, camping sites, as well as other facilities like restaurants and shops, on their agricultural land. This has had a significant impact on the native plants of the study area (Jehan *et al*., 2022).Additionally, the settlement of non-native people has increased due to locals selling barren land at affordable prices, leading to further construction and tree cutting, affecting the vegetation of barren lands (Spies, 2017).If not tackled timely, this unplanned and rapid development poses a severe threat to the natural landscape of Gilgit-Baltistan (Zeits chriftenartikel, 2014). It is crucial to address these issues promptly to prevent a significant decline in native plant species in the coming years (Rahman, Tahir, and Ali, 2023).

METHOD AND MATERIAL

Study area: Sakar, the nearest town to Gilgit city, boasts remarkable floristic diversity and serves as the gateway to Gilgit. Its unique topography, climate, and natural forest patches sustain the livelihoods of the inhabitants, who rely heavily on the area's natural resources. The residents speak Sheena as their language, and the valley features stunning mountain scenery, pastures, and waterfalls. However, the region faces water scarcity, and irrigation depends on melting snow from the mountains. The indigenous people cultivate various crops and fruits like wheat, maize, potatoes, tomatoes, and apricots to meet their domestic needs. Despite its abundant plant diversity, this area remains untouched by research efforts.

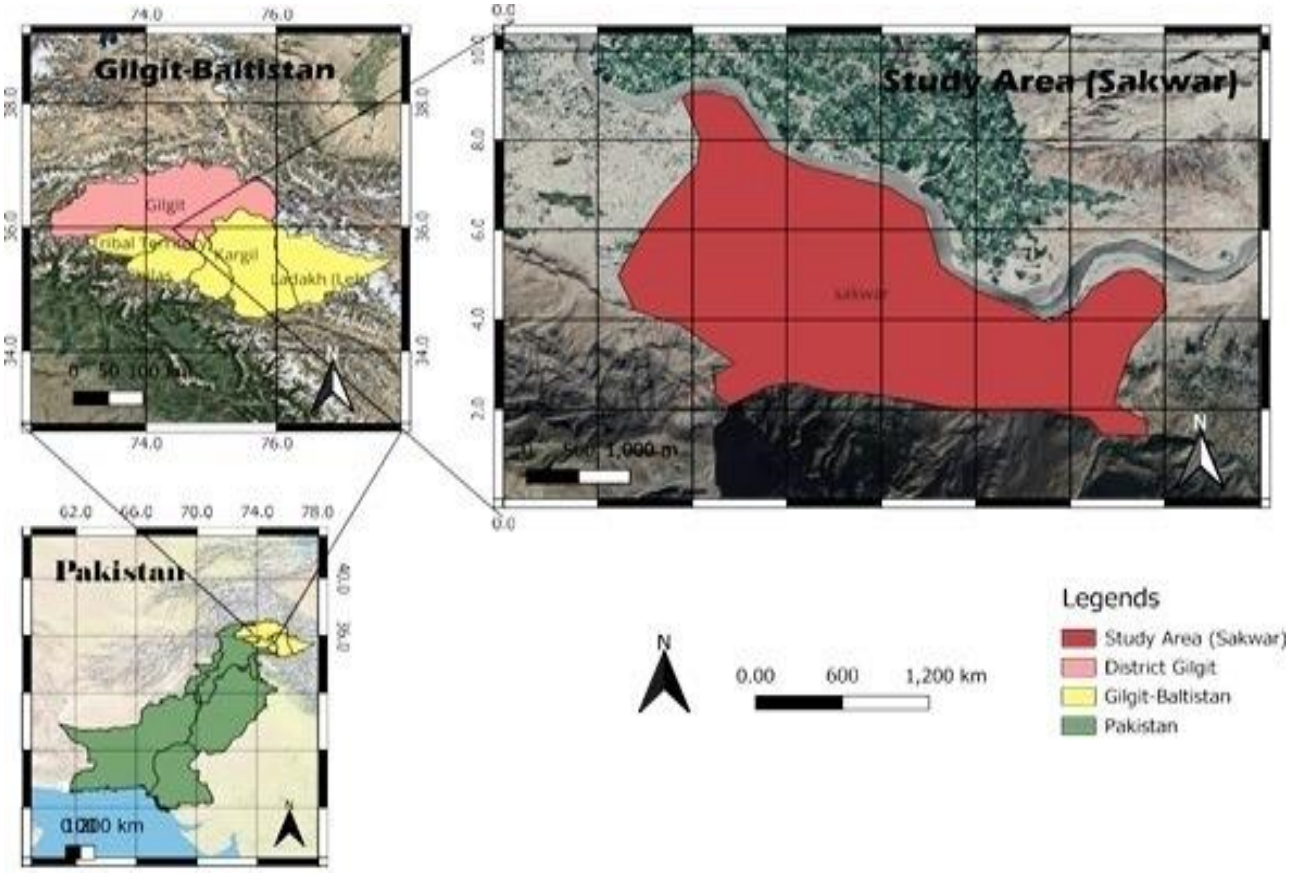

Fig.1 Map of study area

Mythology: In the study of accurately assessing the vegetation of a specific area, two sides were chosen based on their physiognomy characteristics. The survey was conducted during the spring of 2022, and standard locality procedures were followed at both sites (Maryo and Wendawek, 2014). Sampling was carried out using the quadrate method, with a fixed quadrate size of 4×4 placed at regular intervals of 100 meters from the initial margin of each study site. Data were collected on various parameters, including relative frequency, relative density, relative cover, and Importance Value Index (IVI), from both sites (Hakizimana, Huynen, and Hambuckers, 2016). The collected plant specimens were dried and mounted on standard herbarium sheets. Their identification was aided by references from the Flora of Pakistan (Ali, 2008) and existing specimens in the KIU Herbarium. All specimens were then deposited at the Herbarium of Plant Sciences, Karakorum International University, Gilgit main campus (Wali Khan *et al*., 2015).Additionally, composite soil samples were taken from all the quadrates at each study site, and various physicochemical analyses were conducted at the laboratories of Karakorum International University. The analyzed soil parameters included organic matter, pH, texture, phosphorus (ppm), and potassium (ppm).

Data analysis: The data collected in this study were analyzed using SPSS (Statistical Package for the Social Sciences) version 2021 and Excel version 2013. To calculate certain parameters, the following formulas were used:

$$\text{Relative frequency} = \frac{\text{individual species frequency}}{\text{Frequency of all species}} \times 100$$

$$\text{Relative density} = \frac{\text{number of individual of species}}{\text{Number of individual of all species}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Coverage of species}}{\text{Cover of all species}} \times 100$$

IVI Relative frequency+ Relative density + relative dominance

Soil analysis: Two soil samples, each weighing 1 kg of dry soil, were gathered from two distinct sites in Sakar Valley. These soil samples underwent physiochemical analysis at the Water Quality Lab of Karakoram International University. The obtained results were then compared with previous studies conducted in the area.

RESULT AND DISCUSSION

This survey was conducted to analyze the characteristics and process of urbanization in Sakar Valley, District Gilgit, with a focus on vegetation disruption, land use changes, and construction activities. Urbanization, a significant anthropogenic factor, has been affecting natural resources in the area. The study examined a total of 37 plant species belonging to 32 genera and 15 families at two different sites. The roadside site revealed 16 species from 9 families, while the mountain site recorded 21 species from 6 families. During interviews and field surveys, it was observed that the plant species *Populus Alba* .L and *Ficus carica* L are facing extinction in the roadside area due to deforestation. Additionally, the wild species *Artimesia brevifolia* and *Artimesia seversiana* are under immense pressure from unregulated collection for medicinal purposes and overgrazing by local livestock. Soil erosion is another concerning issue in the study area. This survey highlights the impact of urbanization on vegetation and agricultural land in Sakar Valley, District Gilgit. It sheds light on the potential threats to various plant species and the need for sustainable practices to conserve the region's natural resources.

Species composition (Site 1 road area): A study conducted by (Qutoshi *et al*. in 2022) revealed interesting findings about the plant diversity in the Gilgit Valley region. In their research, they recorded a total of 16 species from 9 different families. Among these families, Rosaceae stood out as the dominant one, with a total of 5 species, while Moraceae followed closely with 3 species. The remaining families had only 1 species each. Interestingly, the study noticed that trees were the dominant plant habit in the road areas of the Sakar Valley. However, despite this dominance, the area was found to lack overall plant diversity. The plant habit categories observed were 11 in number, consisting of herbs, shrubs, and trees.The concept of Importance Value Index (IVI) was used in the study to determine the dominant species. The IVI values of certain species were notably high, indicating their dominance in the region. For instance, *Rubus idaeus* displayed an IVI value of 68.24, making it one of the most dominant species. *Eriobotrya japonica* followed with an IVI value of 55.98. These species were found to be preferred by people for fruit cultivation purposes. On the other end of the spectrum, species like *Populus Alba* L. and *Juglans regia* L. showed the lowest IVI values of 4.52 and 5.94, respectively, suggesting their lower dominance in the area. The study by(Print *et al.* 2015). also identified a significant issue affecting the vegetation cover and agricultural land in the Sakar Valley. They attributed this problem to the extensive construction activities taking place in the region, which were adversely impacting the plant diversity. This study's findings were consistent with previous literature(Ali *et al*. 2015 and Khan *et al*. 2015) as the researchers found similar results in nearby areas such as Parri and Munawar. The overall decrease in vegetation cover and

agricultural land was an evident concern in those regions as well.

Table 1: Relative density, Relative frequency, Relative cover and IVI of selected plant species (site 1)

Families	species	Relative cover	Relative density	Relative frequency	Important value index
Rosaceae	*Eriobotrya japonica*	11.41	11.27	22.99	55.98
Rosaceae	*Prunus persica*	12.45	6.67	11.28	20.56
Rosaceae	*Rubus idaeus* Linn.	10.96	41.76	15.7	68.42
Rosaceae	*Prunus arminica* L.	1.22	9.16	8.26	18.64
Rosaceae	*Malus pumila* Mill.	16.37	0.18	0.83	17.38
Rosaceae	*Prunus avium* L.	0.96	7.33	7.44	15.72
Rosaceae	*Prunus dulcis*(Miller)Webb	11.78	2.81	1.1	15.69
Urticaceae	*Urtica dioica* Linn	7.27	1.95	3.03	12.25
Vitaceae	*Vitis vinifera* Linn Linn	1.22	4.33	6.61	12.17
Moraceae	*Morus nigra* Linnaeus,	7.95	0.85	2.75	11.56
Moraceae	*Morus alb*a L	8.66	2.08	0.83	11.56
Moraceae	*Ficus carica* L.	1.22	3	7.16	11.37
Simaroubaceae	*Ailanthus altissimus*(Miller) Swingle	2.54	1.95	4.96	9.45
Saxifragaceae	*Saxifraga flagellaris* Willd	2.95	2.81	3.03	8.79
Juglandaceae	*Juglens regia* L.	1.82	2.75	1.38	5.94
Salicaceae	*Populus alba* L.	1.22	1.1	2.2	4.52

Loss of agricultural land: A significant influx of people migrating from various villages to Gilgit and its neighboring areas is observed, driven by the promise of better educational, healthcare, and economic opportunities (Hussain, Hussain, and Saif-Ud-Din 2022). One of these areas, Sakar, has become a shelter for non-local residents, resulting in a rapid increase in construction activities. However, the region is facing challenges like low water availability, which is negatively impacting agricultural land and natural vegetation. Iconic species such as Populus Alba and Ficus carica are particularly threatened by the extensive construction (Sosilawaty 2020).The urbanization process in the research area is posing a significant threat to the native vegetation and agricultural land. This finding is consistent with previous studies conducted by Hassan *et al*. (2017), Amjad *et al*. (2020), Da Costa Ferreira *et al*. (2021), and Shahzad, Abubakr, and Fischer (2021).Moreover, the high population density in the area is not adequately supported by the necessary infrastructure, leading to issues like a lack of proper sewage systems. As a result, toxic water and elevated chemical levels are posing severe harm to the local plant life (Gilgit Baltistan 2023).

Species composition (Site 2 mountain area): In a study conducted in the region of Gilgit Baltistan, researchers observed the presence of 21 plant species belonging to 6 different families. Among these species, 18 were categorized as herbs, while 3 were classified as trees .The leading family was Asteraceaecis, comprising 9 species, followed by Apiceae with 4 species, Amaranthaceae with 3 species, and Alliceae and Cuperssaceae, each containing 2 species. Salicaceae had 1 species (Table 2).Based on the important value index (IVI), *Thuja orientalis* emerged as the dominant species with an IVI value of 16.031, followed by *Juniperus excelsa* with an IVI of 15.414, *Salix Alba* with an IVI of 14.985, and *Heracleum candicans* with an IVI of 13.0409 (Negi 2005).The study also revealed that soil erosion is a common issue in the area, affecting various herbal species. For instance, species like *Artimisia brevifolia*, with an IVI of 2.49, *Artimesia seversiana*, with an IVI of 4.15673, and *Cichorium tntybus*, with an IVI of 4.6953, are facing challenges such as soil erosion, overgrazing, and reduction due to human activities (Arshad, Ming, and Bibi 2014). These findings are consistent with results from other researchers studying different areas of Gilgit Baltistan (Blundo *et al*. 2021). The area is facing a significant problem of soil erosion attributed to rapid urbanization, leading to the degradation of agricultural land and reduced water availability (Khan, 2015). This phenomenon has resulted in the loss of valuable plant species, animals, and micro-organisms (Maryo and Wendawek, 2014). Additionally, the expansion of construction activities has had a profound impact on the vegetation cover, posing further challenges to the survival of important medicinal plants like Artemisia brevifolia, which are increasingly threatened due to indiscriminate collection for various purposes. Furthermore, the selective grazing of local animals such as cow, buffalos, and goats (Shahzad, Ahmed, and Fischer, 2021) has contributed to alterations in the vegetation structure, exacerbating the issues related to urbanization and causing the disappearance of indigenous flora in the area.

Physiochemical analysis of soil and urbanization effect: The soil in the studied area exhibits a sandy loam texture with a pH of 7.63 and lime content of 3.938%. The composition includes 62.4% sand, 28.6% silt, and 19.01% clay. Nutrient percentages in this soil are as follows: P 5.05%, K 46.84%, Cu 2.18%, Fe 5.38%, Mn 1.24, and Zn 1.65.

On the other hand, Zone two shows a silt loam soil with a pH of 7.82 and lime content of 7.488%. The composition includes 19.01% sand, 62.012% silt, and 19% clay. Nutrient percentages in this soil type are as follows: P 9.33%, K 86.01%, and Cu2 4.28%, Fe2 3.62%, Mn2 2.44%, and Zn2 1.49% as shown in table: 3.The variation in physicochemical characteristics is attributed to differences in parent material composition. Both areas exhibit a natural to alkaline soil reaction due to their pH levels. The high sand content (62.4%) indicates a deposition from river terraces and alluvial sources, which likely contains a diverse mixture of associated minerals (Noor and Khatoon, 2013; Ali *et al*., 2017; Print *et al*., 2015). However, the significant silt content in the road area (62.01%) suggests richness in silt particles. Urbanization and a poor sewerage water system have likely washed out nutrient particles, contrasting with previous findings (Ali *et al*., 2015).Urbanization has negatively impacted the soil by altering its structure and health. It slows down organic matter decomposition, prevents water from filtering the soil, and leads to the accumulation of pollutants, affecting plant growth and nutrient cycles. Consequently, there is a loss of biodiversity in the studied area, as observed in the species composition and reduced plant diversity, potentially caused by higher temperatures and reduced green areas due to urbanization (Qutoshi *et al*., 2022).The study suggests that over time, the diversity in the road area has mitigated the adverse effects of urbanization on soil health. Protecting and improving urban soil quality is crucial for maintaining a healthy urban ecosystem.

Table 2 Relative density, relative frequency, Relative cover and IVI of selected plant species (site 2).

Family Name	Botanical Name	Relative density	relative frequency	Relative cover	Important value index
Cupressaceae	*Thuja orientalis L*	3.40223	6.08108	8.54817	18.0314
Cupressaceae	*Juniperus excelsa* M,Bieb.	6.21856	7.43243	2.98767	16.63866
Salicaceae	*Salix alba* Linnaeus	4.70706	4.72973	8.54817	17.98496
Alliaceae	*Allium cepa* L.	8.07804	4.05405	2.76391	14.896
Alliaceae	*Allium sativum* L.	6.09663	6.02703	5.15604	17.2797
Apiaceae	*Heracleum candicans* Wall.exDC	5.18214	9.7027	5.15604	20.04088
Apiaceae	*Carum carvi* Linn	6.34126	6.08108	5.15604	17.57838
Apiaceae	*Daucus carota* L.	6.77991	5.37838	5.15604	17.31433
Apiaceae	*Coriandum sativum* L.	3.24387	6.37838	6.54817	16.17042
Amaranthaceae	*Amaranthus caudatus* Linn	6.03567	3.37838	3.76391	13.17796
Amaranthaceae	*Amaranthus viridis* Linn.	3.47508	5.40541	8.76391	17.6444
Amaranthaceae	*Amaranthus retroflexus* Linn	6.76726	4.02703	7.40706	18.20135
Asteraceae	*Echinops echinatu*s Roxb.	3.59701	5.02703	7.76391	16.38795
Asteraceae	*Artium minus* (Hill) Bernh	4.14571	5.7027	1.13569	10.9841
Asteraceae	*Soncus oleraceu*s L.	5.68252	2.02703	8.76391	16.47346
Asteraceae	*Lactucus sativa* L.	5.5487	4.05405	6.76391	16.36666
Asteraceae	*Carathmus tinctorius* L.	5.97211	5.35135	1.76391	13.08737
Asteraceae	*Cirsium vulgare*(Savi)Ten	3.64609	3.37838	0.13569	7.16016
Asteraceae	*Cichorium tntybus* L.	4.25575	3.67568	1.76391	9.69534
Asteraceae	*Artimesia seversiana* Ehrh.ex.Willd.	0.3658	1.02703	1.76391	3.15674
Asteraceae	*Artimisia brevifolia* Wall.ex DC.	0.7316	0.35135	0.40706	1.49001

Table: 3 physiochemical properties of soil of sakar valley Gilgit.

area	ph	texture class	lime%	sand%	silt%	caly %
mountain area	7.82	silt loam	7.488	19.01	62.012	19
Road area	7.63	sandy loam	3.938	62.4	28.6	9.01
nutrient status	**P**	**K**	**Cu2**	**Fe2**	**Mn2**	**Zn2**
mountain area	9.33	86.01	4.29	3.62	2.44	1.49
road area	5.05	76.84	2.18	5.38	1.24	1.65

Conclusion and recommendation: Urbanization is a powerful human activity that significantly impacts the environment, leading to serious problems. The rapid construction and migration of people from rural to urban areas result in a substantial loss of agricultural land and damage to biodiversity, causing issues such as climate change, ecological changes, and pollution. In the region of Gilgit-Baltistan, the effects of climate change are evident in the form of floods, melting glaciers, and deforestation, which are the primary problems faced. This paper aims to document the impact of urbanization on vegetation in the study area. Three main factors contribute to the loss of forest and agriculture land: (a) the expansion of cities, (b) high flooding caused by water erosion, and (c) construction for accommodation purposes. For instance, the construction of hotels and restaurants to accommodate tourists has led to the conversion of pastures and forests into tourist points. In order to understand and address these environmental impacts, further research is necessary to measure and define the extent of the problem in advance. The study area's unplanned construction and poor practices have led to the loss of vegetation cover. It is crucial to acknowledge that human prosperity relies on access to food, water, and biodiversity. Therefore, it is imperative to implement proper management strategies at the required level to mitigate the adverse effects of urbanization on the environment and ensure sustainable development.

Statement of ethical approval: Prior approval for the study was granted by the faculty's ethical committee for scientific research and animal welfare, demonstrating due consideration of all ethical aspects.

Conflict of interest: There are no conflicts of interest reported by the authors.

Author's contribution: The initial draft was prepared by Shakeel Hussain, Anam Zahra and Sherish Hina, while the field survey was conducted by Waqar Hussain, Naveed Hussain, Saleem Khadim, Syed Shakir Hussain and Farida. The review and finalization of the first draft were undertaken by Qamar Abbas.

Acknowledgement: The Author expresses deep gratitude to the generous people of Sakar Valley for their invaluable contributions. Additionally, the Author extends heartfelt appreciation and utmost respect to the esteemed senior researchers of Karakoram5 International University for their unwavering support throughout the journey.

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