

Unveiling The Evolving Dynamics Of Mountain Pastoralism At Various Altitudinal Zones Of Upper Swat Valley, Pakistan

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Abstract

The confluence of environmental, climatic, and socioeconomic transformations is intensifying the vulnerability of pastoral social-ecological systems worldwide, with mountainous regions being excessively affected. This research paper explores the adaptive strategies employed by mountain pastoralists in Upper Swat, Pakistan, to navigate the complexities of rangeland management amidst dynamic climatic, social, and environmental contexts. Through a comprehensive mixed-methods approach, involving observations, focus groups, and an extensive survey (2022-2023), this study reveals that mountain pastoralists have developed a multifaceted, adaptive strategy that integrates stall feeding with six distinct grazing mechanisms to optimize the use of spatially and seasonally heterogeneous rangeland resources. This strategy involves a coordinated sequence of winter stall-feeding near villages, spring rotational grazing in adjacent pastures, summer migration to high-elevation settlements, and intense autumn browsing of stubble fields prior to winter crop planting. The findings of this research contribute nuanced insights into the resilience and adaptability of mountain pastoralists and their rangeland management systems, informing the development of effective policies and programs to enhance the sustainability and reduce the vulnerability of mountain social-ecological systems.

Keyword: Mountain pastoralism, Grazing mechanism, Rangeland management, Adaptive strategies.

Introduction

Mountains cover a vast portion of Asia, comprising over one-third of the world's mountains (Perrigo et al., 2020). Globally, mountains are recognized as the foundation of ecosystem resources, biodiversity, and niche products, providing 80% of the world's food (Molden & Sharma, 2013; Chakraborty, 2020). Mountains can be divided into three belts: an upper snow-covered belt, a middle belt of pastures and forests, and a lower belt dominated by agriculture (Bernues et al., 2016). Mountain Agriculture and Land Use have undergone significant changes in recent decades. Scientific research has highlighted that mountains around the world are diverse and undergoing continuous transition (Dittmann, 2000; Nüsser, 2001; Dear et al.,

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2012). In the last two decades, agrarian patterns in mountainous regions have undergone dramatic changes. Bio-physical and socioeconomic factors, such as slope, elevation, farmland spatial pattern, and land-tenure systems, affect high mountain farming at various scales (Mottet et al., 2006; Wang et al., 2019). Additionally, Land Use and Land Cover (LULC) changes have transformed mountains worldwide (Quintero et al., 2018).

Farming Systems in the Hindu-Kush Himalayan Region are integrated into five types of farming systems: pastoralism, agro-pastoralism, middle-hill farming, shifting cultivation, and cash-crop based farming (Bhatta et al., 2019; Hussain et al., 2021). Livestock production, based on sheep and goats, is common at high altitudes (Rodríguez et al., 2018). Agro-pastoralism combines agriculture and livestock production with a heavy reliance on rangelands (Motuzaite et al., 2020). Middle-hill farming involves agriculture with integrated forestry, agroforestry, and animal production (Chidi et al., 2021). Shifting cultivation is a traditional slash-and-burn agroforestry approach (Heinimann et al., 2017). Agroforestry and horticulture are also practiced in the region (Singh et al., 2017). Rangelands, covering over half of the Earth's land surface (Briske, 2017), are vital components of natural ecosystems and biodiversity hotspots (Holechek et al., 2020). They provide numerous ecosystem services and benefits to human societies; supporting the livelihoods of mountain communities (Tabassum & Rahman, 2010) and meeting a significant portion of livestock feed requirements (Holechek, 2013). Sustainable use and productivity of mountain pastoral resources are critical for ensuring livelihood security and poverty alleviation among mountain communities (Moktan et al., 2008). Effective management of rangelands is essential for maintaining ecosystem health, biodiversity, and human well-being (Ericksen, 2020).

The worldwide issue of rangeland degradation (Nusser, 2002; Singh et al., 2003; Teague et al., 2009; Li et al., 2013; Lesoli et al., 2013; Mattalia et al., 2018; Tenzing et al., 2021) is further complicated by the impacts of climate change (Boone et al., 2018; Godde et al., 2020). In Pakistan, this problem is particularly acute due to various obstacles that hinder effective action on climate change and environmental degradation, as well as the undervaluation of rangelands in the Hindu Kush-Himalayan (HKH) region. Additional challenges include the lack of robust legislation protecting rangelands and a general disregard for scientific research on sustainable rangeland management. The degradation of rangelands in the Hindu Kush--Himalayan (HKH) region not only imperils the livelihoods and food security of local herding communities but also diminishes ecosystem functionality and essential services (Xu et al., 2021).

Mountain pastoralism in the Hindu Kush -Himalayan (HKH) region involves intricate patterns of seasonal migration to optimize grazing resources across different elevational belts throughout the year (Schmidt, 2000; Postigo et al., 2008; Kreutzmann & Schütte, 2011; Kreutzmann, 2012a; Turner & Schlecht, 2019). This migratory pattern is closely tied to temperature fluctuations, with pastoralists typically reaching the highest elevations in June and July before descending to lower areas for winter. This vertical control strategy (Kreutzmann, 2012b) enables mountain dwellers to establish settlements at three elevational levels - winter, summer field, and summer pastures (Ehlers, 2000; Clemens & Nusser, 2008; Ahmad et al., 2020). By adopting this approach, mountain farmers can ensure subsistence, mitigate various agrarian shocks, and effectively manage risk (Kreutzmann & Schutte, 2011; Zinsstag et al., 2016; Ahearn, 2018).

The agro-pastoral management systems developed by herders are shaped by their specific environmental and sociocultural contexts, operating within the general principle of seasonal mobility (Schmidt, 2000; Kreutzmann, 2004, 2009, 2017). Pastoralism and rangeland management in Eastern Hindu Kush face numerous challenges, including global climatic and

environmental perturbations, modernization (Kreutzmann, 2012a, 2013b), socioeconomic transformations (Kreutzmann, 2006; Holdschlag, 2011), shifting pastoral strategies (Kreutzmann, 2009, 2013a; Kreutzmann & Schütte, 2011; Nusser et al., 2012), diverse environmental perceptions, and the religious and socioeconomic significance of livestock (Parkes, 1987; Cacopardo & Cacopardo, 2001). This study examines how mountain pastoralists in Upper Swat, Pakistan adapt their rangeland use in response to changing social, environmental, and climatic contexts. Through this case study, we explore the complex interactions between socio-environmental processes and their outcomes. Specifically, we investigate how grazing mechanisms have evolved and changed as a result of interactions between mountain pastoralists and shifting livelihood strategies in the remote mountainous regions.

Study Area

Upper Swat is located in the northern part of Swat District in the EHK region. This region encompasses an area of 2899 km² and is divided into three altitudinal zones i.e. Madyan, Bahrain and Kalam. Topographically, the Upper Swat is an offshoot of the Hindu Kush Mountains surrounded by snow-capped peaks. The elevation of these high-altitude mountains ranges from 673 meters to 4500 meters from north to south. The region is characterized by a diverse array of agriculture that is practised on terraced slopes and fertile alluvial fans. Due to rugged topography, only (21.05%) of the land area is suitable for agriculture and the inhabitants have substantially smaller landholdings required at subsistence level. Rangeland constitutes about (6.30%) of the geographical area. The climate of Upper Swat is a function of altitude resulting in a diverse range of humid temperate, sub-humid temperate and sub-alpine climates. The mean annual temperature is 8.3°C (1991-2023) and the mean annual precipitation is 183 mm. The region is inaccessible and underdeveloped, environmentally susceptible to flash floods. Physio-Chemically, the soil is organically fertile, non-saline and the pH is slightly acidic to alkaline. The texture is medium to coarse with a loamy sand texture class of soil that decreases downstream.

The population of Upper Swat has almost doubled between the inter-censal periods from 125247 persons in 1998 to 248422 in 2017. Upper Swat is characterized by its cultural and ethnic diversity. Seven different languages i.e. Pashto, Gujri, Torwali, Gawri, Qashqari, Badeshi and Kohistani are spoken in various parts of Upper Swat. However, Pashto used to be the lingua franca of Upper Swat.

The people participate in a variety of livelihoods in order to survive on a subsistence level. Three decades ago, integrated mountain agriculture constituted the main economic activity of Upper Swat. Since 1993, mountain agriculture system has undergone significant transformation and been replaced by a cash-crop economy. The prevalent crops grown in the study area are Maize, wheat, potato, peas and maize. Moreover, vegetables as cash crops have also been introduced by the locals. Today, the residents of Upper Swat have more varied and active livelihood methods than they had thirty years ago. New means of subsistence and economic activities are expanding in the area that include government services in forest, fisheries and education departments, tourism, seasonal and international migration. However, farming continues to be the primary source of income for most of the population in Upper Swat.

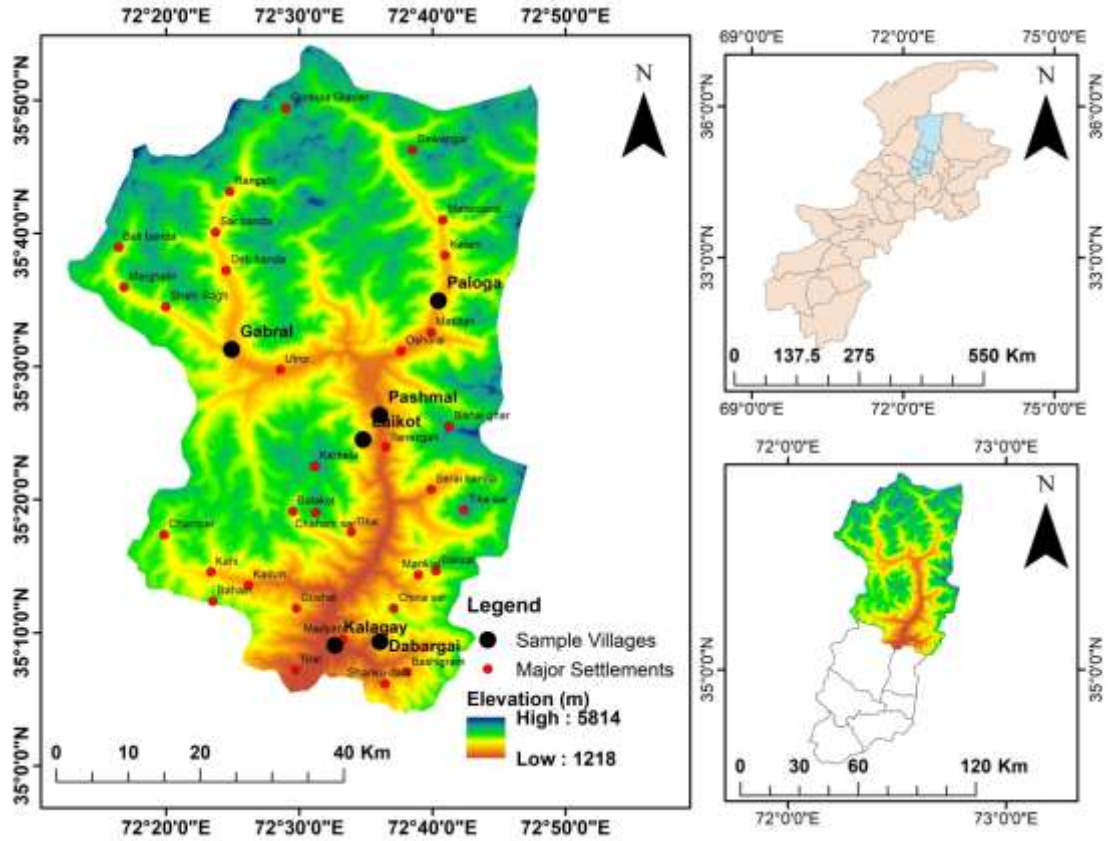


Fig 1. Location of the Study Area

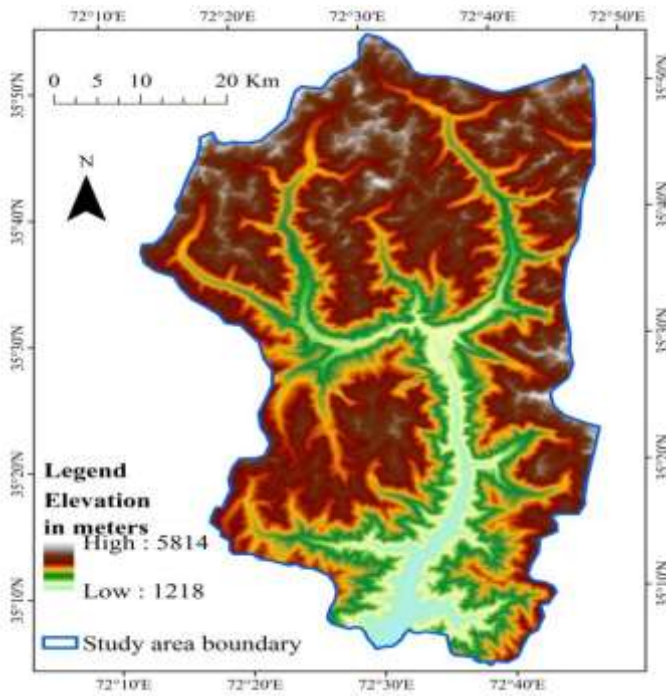


Fig. 2: Physiographic Map of Upper Swat

Materials and Methods

Data were collected in 2023 through self-administered questionnaire surveys (n = 338), focus groups, and participant observation. Initially, two villages from each altitudinal zone of Madyan, Bahrain and Kalam were chosen. The sample size for each stratum has been selected by proportional allocation. Focus groups in each of the six selected sample villages provided data on pasture ownership and utilization, grazing mechanisms and the provision of fodder. Secondary data were collected for cross-checking and verifying the field data, sourced from the the 1988 district census of rural settlements (GoNWFP, 1990), and the Swat district census report of 2017 (GoP, 2018). Land use and land cover changes were mapped using Landsat-5 Image of 1993 and Landsat-8/9 Images of 2023.

Table 1. Sampling Frame

Altitudinal Zone	Altitude (meters)	Climatic Zone	Name of Sample Villages	Total Number of Households (2017)	Sample Household to be Surveyed
Madyan	(1500-1900)	Cool Temperate Zone	Dabargai	376	59
			Kalagai	389	61
Bahrain	(1900-2300)	Cold Temperate Zone	Laikot	400	63
			Pishmal	354	55
Kalam	(2300-3600)	Sub Alpine zone	Gabral	442	69
			Paloga	201	31
Total				2162	338

Source: GOP, 2018

Data Analysis

Changes in Household Size

The average household size, as shown in Table 2, for the years 1993 and 2023, reveals a consistent decrease across all three areas over the 30-year period. Madyan experienced the largest decline, from 8.2 to 6.3, followed by Bahrain, which saw a reduction from 9.6 to 5.7, and Kalam, which decreased from 10.4 to 7.2. This trend signifies a significant demographic shift.

Table 2. Changes in Household Size

Average Household Size	1993			2023		
	Madyan	Bahrain	Kalam	Madyan	Bahrain	Kalam
Household Size	8.2	9.6	10.4	6.3	5.7	7.2

Source: Field Survey, 2023

Source: GoNWFP (1993)

Changes in House Ownership

The Bahrain and Kalam Zones encompass a significant range in altitude, extending from 1900 meters to 3600 meters above sea level. Inhabitants of these regions have established three distinct types of settlements: spring, summer field, and summer pasture settlements. These settlements serve the purpose of optimizing the utilization of spatially separated and seasonally

productive resources. Three decades ago, all households in Kalam and Bahrain were equipped with three houses. However, the current data indicates that merely 9.3% of respondents in Kalam and 11.2% respondents in Bahrain zone possess triple houses situated at various altitudinal levels. In contrast, no households in Madyan Zone own three houses. Instead, they typically maintain two houses, one for winter settlement and the other for summer pasture settlement. Furthermore, the distribution of double house-owners also varies within the study area. Thirty years ago, nearly all households in the region had double houses at different altitudinal levels. However, more recently, approximately 32% of people in Kalam, 39% in Bahrain, and 69.4% in Madyan now maintain double houses (Figure 3).

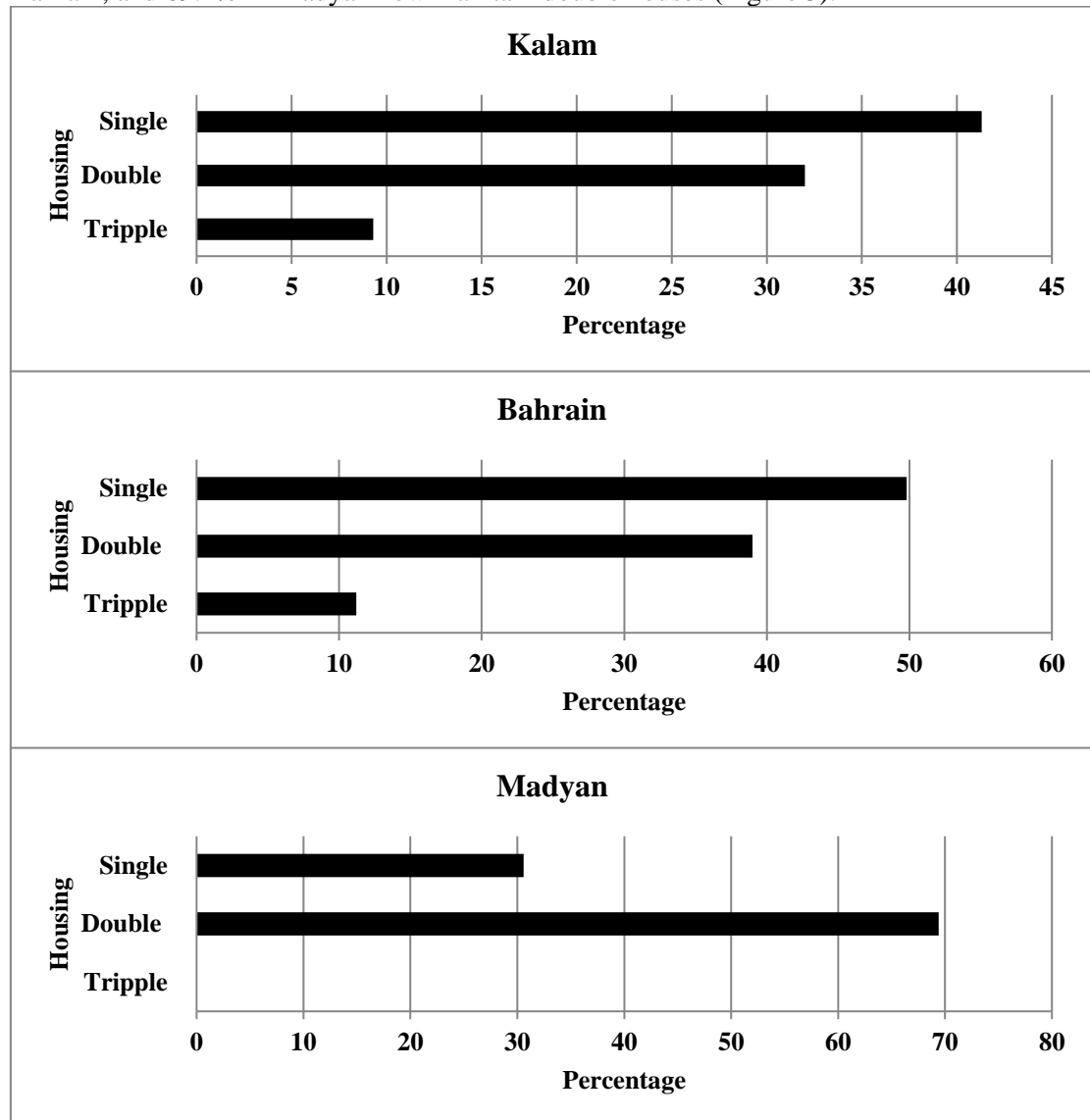


Fig. 3: House Ownership
Source: Field Survey 2023

Change in Herd Size and Composition

The predominant feature of animal husbandry in the study area is its diversity. Three decades ago, households typically maintained a herd comprising six species, including goats, sheep, cows, bullocks, donkeys and horses. This varied herd composition serves as a primary strategy for managing risk and seasonal shocks, as highlighted by researchers in the Karakorum and

Madyan	Small	<0.5	46	38.3	69	57.5	50
	Medium	0.5-1	64	53.4	45	37.5	29.6
	Large	> 1	10	8.3	6	5	-40
Bahrain	Small	<0.5	59	50	85	72.1	44.1
	Medium	0.5-1	48	40.6	28	23.7	-41.7
	Large	> 1	11	9.3	5	4.2	-54.5
Kalam	Small	<0.5	52	52	74	74	42.3
	Medium	0.5-1	41	41	22	22	-46.3
	Large	> 1	7	7	4	4	-42.8
Source: Filed Survey, 2023							

Change in Economic Activities

Before 1993, the study area had limited off-farm livelihood opportunities. However, agricultural innovation has introduced new cash income streams, diversifying local livelihood strategies.

According to Faseeh et al., (2023), Upper Swat produces 250,000 bags of potatoes annually, which are transported to Peshawar, Gujranwala and other markets. This complex marketing process creates various job opportunities, including commission agents, contractors, labourers, shopkeepers, and driver/mechanics. Analysis reveals that 4.5% of sampled households in the study area work as commission agents (fig. 4), facilitating product collection and marketing. They purchase potatoes from farmers, charging commissions from both contractors and farmers. Additionally, 1.2 % of respondents are contractors, mostly local, and 5.5% work as labourers (fig. 4).

Furthermore, the study area boasts a comparative advantage and reputation for excellence in horticulture, apiculture, and pisciculture (Rasul & Hussain, 2015). Consequently, the transformation in agriculture has led to the emergence of three new on-farm activities - horticulture, pisciculture, and apiculture - which have been introduced as novel sources of livelihood (fig. 4).

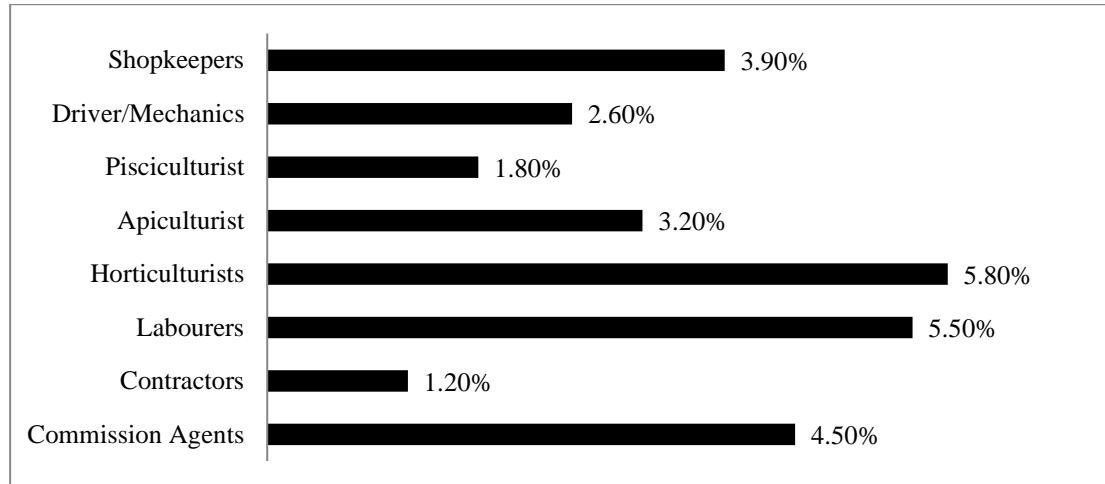


Fig. 4: Upper Swat, Novel Sources of Off-Farm and On-Farm Income, 2023

Gender-Based Division of Labour

Men's Role in Mountain Agriculture

In Upper Swat, men are integral to many aspects of mountain agriculture. They are mostly involved in the preliminary work that goes into farming; they are responsible for preparing the ground via ploughs and terracing. For example, men have a crucial part in agricultural production since they plant and tend to crops. This includes doing necessary chores like planting seeds, fertilizing, and keeping an eye on the general health of crops. Men also oversee the management of water resources for agriculture, including the building and upkeep of irrigation systems, which is a crucial component of irrigation. The management of livestock, which involves individuals taking care of and controlling bigger animals like cattle, is another important duty. This entails a variety of duties, including the provision of fodder to the animals, promoting reproduction, and making sure that correct feeding procedures are followed.

Women's Role in Mountain Agriculture

On the other hand, women in Upper Swat confront particular difficulties but also show incredible resilience and adaptability in their situations. Women are responsible for a wide range of duties in Upper Swat regions outside of Lower Swat or Swat proper. They take care of household chores, raise and graze cattle, gather firewood, dried fruits, and non-timber forest products (NTFPs). They also actively take part in vegetable cultivation, chicken raising, and collecting water from springs. Women benefit economically from these occupations, especially when it comes to raising animals and raising poultry. Many women raise livestock for their families as well as animals whose milk and progeny generate income. In addition, raising poultry is. The detail of gender based division of labour is given below.

Table 5: Upper Swat, Gender-Based Division of Labour

Task	Men's Role	Women's Role
Land Preparation	Ploughing, terracing, land preparation	
Crop Cultivation	Planting, tending to crops, applying fertilizers	
Irrigation	Managing water resources, irrigation systems	

Livestock Management	Larger livestock care, e.g., cattle	Smaller livestock care, e.g., poultry, goats
Heavy Labour	Tasks requiring physical strength and endurance	
Crop Harvesting	Harvesting crops	
Food Processing		Cleaning, sorting, preserving agricultural products
Seed Saving		Preservation and storage of seeds
Source: Field Survey, 2023		

Spatiotemporal Management of Livestock

In Upper Swat, animal husbandry faces numerous challenges, including harsh winter conditions, limited fodder resources, and challenging topography. As observed in previous studies (Clemens & Nüsser, 2000; Stöber & Herbers, 2000; Ahmad, 2014), the residents of this region have devised a sophisticated agro-pastoral system and grazing strategy to make the most of various ecological niches in this unforgiving environment. The management of animal husbandry in Upper Swat is intricately linked to both the timing and spatial aspects of agricultural activities primarily influenced by various factors, including weather conditions and the seasonal availability of livestock fodder, as discussed in previous studies (Ehlers, 1997, 2000). To make the most of spatially distinct and seasonally abundant resources sustainably, grazing methods and stall-feeding mechanisms are implemented. These methods include:

i) Winter Grazing System

As winter sets in, livestock in Upper Swat are moved down from their summer pastures, a practice similar to that in other mountainous regions (Schmidt, 2004; Stöber & Herbers, 2000; Nüsser et al., 2012; Ning et al., 2016). In December, stall feeding becomes the norm for nearly all types of livestock. Due to the limited availability of feed during winter, livestock must be carefully managed in terms of their rations, often resulting in insufficient nutrition. This scarcity can sometimes lead to weakened animals.

Throughout the valley, livestock feeding practices are generally consistent. Cattle are typically provided with straw along with dried maize or potato leaves. However, lactating animals, such as cows and goats, receive supplementary nutrition, including kitchen scraps.

ii) Spring Grazing System

Spring is a critical period due to the severe shortage of fodder at the end of winter. In mid-April, the agricultural season commences in the study area, aligning precisely with the crop's growing season. During this time, two main considerations arise. Firstly, it becomes imperative to prevent livestock from entering the fields to safeguard crops from damage by animals. Simultaneously, owing to the insufficient forage in alpine pastures, livestock are generally kept within the villages from March to May. Additionally, March stands out as the most critical month in terms of fodder scarcity throughout the year. Consequently, various grazing strategies are implemented during this season. During this period, nearly all types of grazing are employed, except for grazing in summer pasture settlements, which is hindered by snowfall.

a. Community-Based Rotational Grazing

In mid-April, as the snow begins to melt in the spring pasture and the surrounding spurs, the practice of community-based rotational grazing commences in the Gabral and Paloga villages. This method is employed to alleviate the strain on fodder resources. Similar to practices

observed in other mountainous villages (Mulk, 1991; Nüsser & Clemens, 1996; Clemens & Nüsser, 2000; Fazlur-Rahman, 2009; Nüsser et al., 2012), the community-based rotational grazing (CBRG) mechanism is adopted for goats and sheep grazing in the study area. Under this system, goats and sheep are typically led to nearby pastures early in the morning and returned to the enclosures late in the afternoon, following a pattern outlined by Ahmad (2014). To facilitate this process, households residing in a village form a single grazing group. This mixed herd is rotated through the pastures on a scheduled basis. This season coincides with the cultivation of spring crops, offering a dual advantage: it prevents crop damage caused by livestock and alleviates the pressure on available fodder resources.

The residents of Upper Swat have established specific regulations governing this grazing practice, which delineate the duration of grazing shifts and outline the responsibilities of group members. Generally, community-based rotational grazing serves to alleviate the workload on households. It is typically carried out by a team of two or three individuals, consisting of one adult and two children aged over ten years. The appointed herders guide the livestock to an appropriate pasture and oversee their well-being throughout the day. To retrieve the animals from the grazing areas, each household designates one person to the location where the livestock pathway enters the cultivated land. This individual takes a count of their livestock and guides them back to their respective enclosures.

The CBRG mechanism is practiced in the study area from April to June and is generally consistent throughout the region. The responsibility of taking sheep and goats to the pasture is traditionally assigned to males. In instances where there is a shortage of male household members, a female member may go to the pasture with a relative in Pishmal and Laikot. However, it's important to note that in Madyan Zone, females are not permitted to go to the high pastures.

b. Individual Grazing

In contrast to the Community-Based Rotational Grazing (CBRG) system, the individual grazing mechanism is primarily employed for lactating animals, horses, and calves. Under this grazing approach, each household assumes the responsibility of tending to their animals. Typically, households utilize privately owned land, which includes meadows, irrigated grasslands, and field margins. However, some households transport their animals daily to the spring pastures for grazing and return them to the village before the afternoon. These observations align with Ahmad's findings in 2014, the lactating animals, particularly cows, are kept at home year-round in the Gabral and Paloga valleys. Females usually graze these animals alongside their young on private land. In contrast, in the Pishmal Valley, lactating animals are sent to alpine pastures, and the responsibility for grazing falls solely on male household members.

c. Open Range Grazing

The study area predominantly employs the practice of free grazing for animal husbandry. Under this approach, animals are allowed to graze unattended in pastures, and it comes in two variations: a) daily free grazing and b) long-term free grazing. Both of these methods are commonly utilized in the study area. In the case of daily free grazing, which is practiced in Gabral and Paloga for sheep and goats, households living near the pasture release these animals early in the morning for unrestricted grazing. The animals are then brought back to their shelter in the evening. On the other hand, in Bahrain Valley, the long-term free grazing method is applied to cattle and lactating animals due to the proximity of lush pastures. Free grazing is an ecologically sustainable practice because it entails animals' not remaining stationary in one location for extended periods. Instead, they move to different grazing areas based on the pasture's productivity and the availability of forage. This mobility is beneficial for the

environment as it helps prevent overgrazing in a specific area, promoting the health and sustainability of the pastures.

The exclusive utilization of long-term free grazing is observed for non-lactating cattle across the entire study area. Typically, these cattle are taken to the alpine pastures in May and are left to graze unattended for a period ranging from 3 to 5 months. They are checked approximately once every two weeks to ensure their well-being and to prevent them from straying into the cultivated areas of neighbouring settlements.

In the evenings, the cattle naturally find a sheltered location for the night, forming a circular grouping, with the younger animals positioned at the centre and the older, more robust ones situated around the periphery. The decision on when to bring the cattle down from the alpine pastures is contingent on weather conditions and the availability of forage in the alpine rangeland. Generally, this decision is made collectively by all households involved. Members of the concerned households then move to the alpine pastures to guide the cattle back to their winter settlements. It's worth noting that long-term free grazing is the least labour-intensive grazing method.

iii) Summer Grazing System

During the summer season, households in the Gabral and Paloga valleys often decide to relocate, either entirely or partially, to their designated summer settlements along with their livestock. This move is undertaken to facilitate the grazing of their animals in the alpine pastures. Nevertheless, some households are unable to partake in this practice due to the absence of their summer settlements. Instead, they opt to entrust their livestock to neighbours or relatives for seasonal grazing in the alpine pastures, with an agreed-upon payment. The nature of these payments may differ from village to village. Notably, the compensation provided to herders remains consistent in both the Gabral and Paloga valleys. In addition to these grains, herders also receive minor fringe benefits from the livestock owners, which can include items like tea, sugar, rice, and fruit as a form of gratitude for their services.

iv) Fall Grazing System

This is the last outdoor grazing season leading to a prolonged duration of stall-feeding. Thus, to maximize the use of available fodder resources before the beginning of snowfall, an intensive grazing mechanism is utilized during this time, following the tactics utilized in prior grazing seasons.

Typically, at the start of October, livestock are relocated from alpine pastures to the villages. In this transitional period, field stubble emerges as a significant source of forage. Before the cultivation of winter crops, livestock are individually grazed in these stubble fields. Subsequently, as winter crops are sown, herds of goats and sheep in Gabral and Paloga are shifted to community-based rotational grazing pastures. In the Laikot Village, goats and sheep are allowed to graze unattended until the first snowfall of winter. Furthermore, with the commencement of snowfall, all outdoor grazing activities are suspended, and stall feeding becomes the primary method of sustenance for all types of livestock.

Conclusion

In conclusion, this research demonstrates that the traditional pastoralist community in Upper Swat has developed a sophisticated and resilient rangeland management system, characterized by a combination of six grazing mechanisms and winter stall feeding, which enables the spatiotemporal allocation of livestock on segregated and seasonally productive rangeland resources, ensuring the sustainability of this mountain social-ecological system. However, recent transformations, including the introduction of hired shepherds and the expansion of agriculture, have led to increased rangeland degradation and livelihood vulnerability, highlighting the need for policymakers and development practitioners to recognize and support

the locally established institutions and practices that underpin the resilience of mountain communities. This research contributes to the existing body of knowledge on sustainable rangeland management and mountain livelihoods, emphasizing the importance of contextualized and community-led approaches that prioritize the empowerment of local communities and the conservation of natural resources, and underscores the need for a nuanced understanding of the complex relationships between human and environmental systems in mountain regions, and highlights the importance of collaborative and inclusive approaches to sustainable development that prioritize the well-being of both people and the planet.

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