

Research Article



Understanding the Role of Agriculture Encroachment in Pastoral Resources Degradation in Western Himalaya of Northern Pakistan

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Abstract | Pastoral production system remained a central component of mountain subsistence economy in the Hindu Kush- Himalayan (HKH) region of Northern Pakistan. However, the growing trends of crops cultivation in the high mountains of HKH region have largely transformed this subsistence livestock production in to commercial agricultural system and shaped an uncertain environment that is not suitable for both landless nomadic pastoralism and ecological sustainability. This study reflects that how this agriculture encroachment may have contributed to the pastoral resources degradation and subsequent landless pastoralist's marginalization in uplands of Naran. Extensive field surveys carried out during last three years (2013-2016) to understand crops encroachment process and its implications for pastoral resources. Land use-classes such as forest, agriculture, pastures and snow cover were recorded by means of Global Positioning System (GPS) and further processed to develop maps by using Geographic Information System (GIS). The impacts of agriculture encroachment were determined by means of group discussions, household's interviews and personal observations. The results showed that crops cultivation occupied 18 % of the bottomlands in Naran valley, where this cultivation is gradually extending towards steeper slopes without any soil conservation measures. The alpine open pastures (45%) is available in deep inside and upper niches of sub-valleys for livestock grazing while 4% of pasture land is degraded due to heavy grazing and is dominantly encroached by non-palatable or poisonous weeds species. Furthermore, this crops encroachment effected the capabilities of pastoral communities to keep large herds containing more livestock for their livelihood dependency. It is concluded that unsustainable crops expansion has triggered pastures resource degradation and is threatening the traditional pastoral system in HKH region. Integrated and collaborative approaches are needed for pasture resources management with efficient and sustainable livestock production in Northern Pakistan.

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Introduction

In Hindu Kush-Himalayan (HKH) region, the mountain communities are greatly relying on mixed crops-livestock farming system for their livelihoods. The production of cereal, horticultural and cash crops combined with livestock rearing are the important

integral components of their livelihoods (Tulachan, 2001). However agriculture has been increasingly diversified from cereal and horticultural crops production in to high value cash crops particularly off season vegetables (potatoes, peas and cabbage) production from past few decades, indicating the importance of cash cropping in their subsistence economy and

traditional farming systems (Tulachan, 2001; Partap et al., 2000). The area under cash crops cultivation is rapidly increasing due to higher economic return, accessibility through improved roads and market networks, increasing demand for off season vegetables and strong institutional support (Tulachan, 2001). The uplands above tree limits and perpetually below snowline are comprising alpine pastures that are extensively encroached for these cash crops cultivation (Duncan et al., 2006; Bagchi et al., 2002). However, this form of income generation through crops cultivation is posing new challenges for pastoral resources management and sustainable livelihoods in ecologically fragile environment. (Rao et al., 2001).

The increasing trends towards growing off season vegetables as cash crops is exacerbating the marginalization of centuries-old pastoral practices due to reducing grazing space and limited fodder production (Mishra, 2001; Magchi et al., 2002). This massive crops expansion in many pastoral regions in turn led to lose the carrying capacity of ecological niches to sustain long-standing ecosystem services and pastoral livelihood (Brown, 2002). In this context, the leading role of crops cultivation in pasture resources degradation and subsequent pastoralist's marginalization is not understood in Hindu Kush-Himalayan region of Pakistan. Thus as an example, the alpine pastures of Naran valley in Western Himalayan studied to understand this debatable role of off season crops encroachment in pastures resource degradation in connection with traditional pastoral system.

Materials and Methods

Study area

Naran valley is situated in western Himalayan of Northern Pakistan and is bounded by Azad Kashmir in East, Gilgit Baltistan in North and Kohistan in West (Figure 1). Local communities (*Gujjars*) of Kaghan, Balakote and Gharee Habibullah are using the alpine pastures of Naran valley for potato and pea production from late May to mid-June and harvested in September. They are often planting potatoes at relatively lower elevations while peas are cultivated further up because of their shorter growing period requirement. This cultivation over alpine pastures occupied the bottomland in Naran valley which formerly used for livestock grazing. These crops producing households have renounced livestock herding in favour of growing cash crops and predominantly used

the bottomland of Naran-sub valleys for crops cultivation. Furthermore, landless pastoral communities have maintained the traditional pastoral system which is based on seasonally mobility between upland-lowland pastures and using the grazing niches deep inside these mountain valleys during summer.

Data collection

Preliminary consultative sessions held with landless and crops producing communities in Naran valley during early summer 2015. The purpose of these initial consultative sessions was to identify main pastures, settlements/villages and land use pattern. Five main pastures namely Battakundi, Buhrawai, Jahlkad, and Basel were identified for survey. For questionnaire survey 1/3 of households was sampled in each pasture. The questionnaire mainly pertained to the decadal changes in livestock population, herd's management, income diversification and assessment of pastoralist's perceptions towards pastures degradation.

Global Positioning System (GPS) was used to record land use boundaries i.e. agriculture, forest, snowline, pasture and settlement's locations in Naran valley. Arc GIS (9.3 version) used to develop Digital Elevation Model (DEM) of Naran valley to understand the topography and land use classes.

Results and Discussion

The decline in pasture land resource

Off season cash crops cultivation encroached 30271 (ha) of the total pastureland (128279 ha) in Naran uplands (Figure 2), where this cultivation is gradually extended from 2100 to 3500 m a.s.l and mainly occupied the bottomland (Table 1; Figure 2). The results show that present available grazing land is about 74569 (ha), which shows 33% reduction in the total pastureland due to this irrational crops cultivation during past three decades. Due to limited grazing space about 7122 (ha) of pastureland is heavily grazed by livestock in the lower meadows of valley which is predominantly encroached by non-palatable species or poisonous weeds. The disappearance of nutritious plants species and dominance of such poisonous weeds are indicating pasture degradation status (Yan et al., 2011). The surface analysis in Figure 2 further shows that high elevation area above 4400 m is permanently occupied by snow and glaciers which is inaccessible for livelihood activities.

Before 1980s, Naran uplands accounted for about

128279 (ha) of productive pastureland used by local transhumant and landless pastoralists for their livestock grazing. Due to sufficient pastureland availability, pastoral livelihoods were greatly based on sustainable livestock production and pasture resource use. However since the beginning of 1980s cash crops cultivation resulted in a land-use system that was not conducive for both pastoral livelihood and pasture resource sustainability.

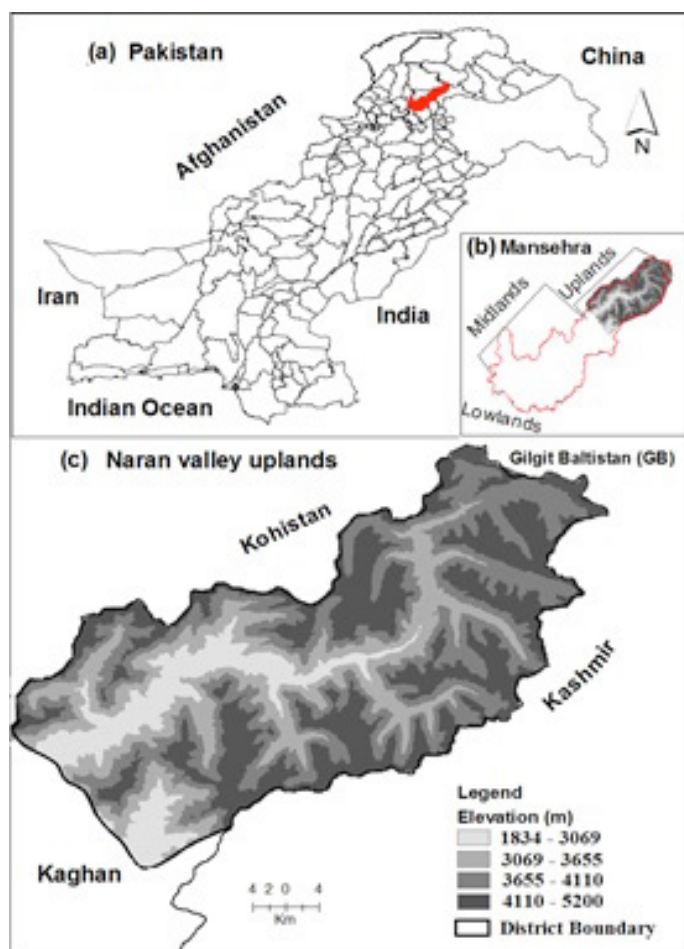


Figure 1: Elevation map of Naran valley

Local transhumant households who had been occupied bottomland of the valleys (Figure 2) from past several decades on the base of their annual tenancy, where they converted productive pastureland in to potatoes and peas crops cultivation. The decreasing

trends of cropland productivity compelled the crop producers to abandon the old cultivated land and cultivate new fields even at gentle and steep slopes.

Table 1: Land- use in Naran valley, Northern Pakistan

Land use	Area (ha)	%age	Altitude range (m a.s.l)
1 Forest land	16317	9.9	1834-2100
2 Agriculture land	30271	18.4	2100-3500
3 Grazing land/alpine pastures	74569	45.4	3500-4400
Degraded pasture	7122	4.3	
4 Glaciers and steep rocks	35685	21.7	4400-5200
Total area	163964	100	

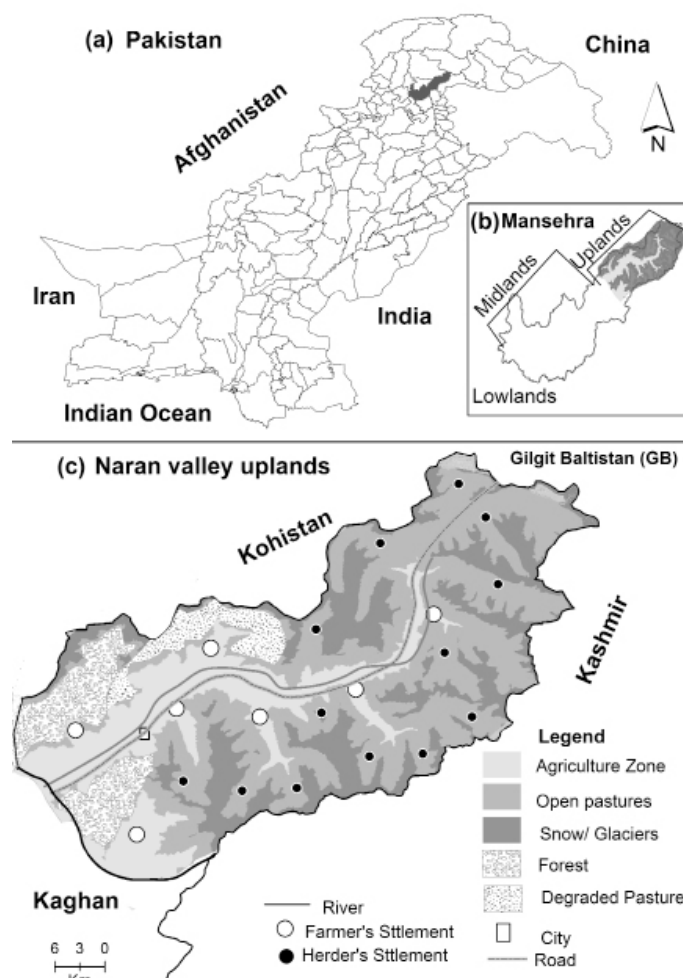


Figure 2: Land use map of Naran valley

Table 2: Grazing intensity on approximate available grazing land during summer season in Naran valley.

Pastoral Settlements	Livestock population (Animal Unit)	Approximate Grazing land (ha)	AU/ha	Grazing duration	Days spent
¹ Basel	20503	14063	1.45	Late-June to Mid Oct	105
¹ Jahlkad	11778	10920	1.07	Late-June to Mid Oct	105
² Buhrawai	10730	7495	1.43	Early-June to late Oct	120
² Battakunid	2299	5326	0.46	Early-June to late Oct	120

1: High elevation pastures (3800 –4200 m); 2: Lower elevation pastures (2100–3800 m)

Table 3: *Perceptions of the herders about perceived indicators of pasture degradation (respondents, n= 70)*

Perceived indicators of pasture degradation	%age of herder response (Yes)	%age of herder response (No)	%age No response (Unsure)
Decline in palatable/brows plants species or grasses	73	21	6
Non-palatable species/piousness weeds encroachment	51	37	12
Disappearance of medicinal and food plants	66	29	5
Decrease in grazing capacity of the pastures	94	3	3
Overgrazing and browsing	86	10	4
Increase in surface runoff	91	8	1

This steep slope cultivation and land abandonment in the uplands of Himalayan is increasingly considered the main factors causing pasture resource degradation and other environmental problems (Sen et al., 1997). The prevalence of crops cultivation in these mountain valleys resulted a competition between crop producers and existing traditional nomadic pastoralists for pasture resource use. However nomadic landless pastoralists pushed to higher niches above 3500 m (Figure 2) due to dominant land tenancy of the crops producers over bottomland. Consequently the traditional grazing system of nomadic landless pastoralists disturbed in term of livestock mobility, access to diverse herding niches, grazing time and rotational grazing (Khushid et al., 2016), though the heterogeneous use of pastoral niches enhance pasture productivity and yield higher livestock production (Muller et al., 2007). This upland cultivation in the traditional pastoral zone that is suited only for livestock herding is generally accepted a factor behind pasture resources degradation both because of its direct impacts on soil, vegetation, hydrology and indirect impacts of overstocking on remaining pastures.

Estimation of pasture carrying capacity and grazing intensity

Grazing land, duration, days spent for grazing and livestock population reared by pastoral communities in main pastoral settlements (pastures) of Naran valley are depicted in Table 2. At present, Basel is the biggest pasture in Naran valley with maximum grazing land 14063 ha, closely followed by Jahlkad, Buhrawai and Battakundi pastures (Table 2). The upper pastures (Basal and Jahlkad) are exclusively used for grazing and limited cultivation occurred in these pastures due to shorter growing period. The bottom land of lower elevation pastures i.e. Battakundi, Buhrawai are extensively used for cultivation due to climatic suitability, better soil quality and irrigation facilities. As the high elevation niches in Himalayan region including

these pastures are not suitable for cultivation due to limited accessibility and early autumn frost that are the main topographic and climatic constraints for agriculture in uplands (Mishra et al., 2003).

The pastoralists with few number of livestock or having small herds are mainly utilizing lower pastures, while those having larger herds including Afghani sheep herders are favouring the higher remote niches for their livestock grazing. Furthermore, according to the pastoralist's perceptions, pastoralists with small livestock herds are mainly moving through main Kaghan-Naran road and arrive to these pastures before crops sowing and starts their downward mobility after crops harvesting. This pattern has compelled pastoralists on early arrival to and late departure from Buhrawai and Battakundi pastures (Table 2). It is further revealed from pastoralist's perceptions that pastoral households with larger herds containing more livestock are moving through mountains routs and are taking more time during their mobility. Therefore, pastoralists in Basel and Jahlkad are following these mountain routs and arrive during late June when snow melts and start their downward mobility during mid-October (Table 2) when permafrost or snowfall starts.

The estimation of pasture carrying capacity shows that there is on average 1 animal unit per hectare in these pastoral niches except in Battakundi, whereas ecologically permissible level of pasture carrying capacity is considered to be 3.5 hectare per animal unit in Himalayan region (Singh et al., 1984). This grazing pressure is very acute in Naran valley but seems to be increased in the coming decades due massive crops expansion over available grazing land in Buhrawai and Battakundi. As a consequence of this crops encroachment the current pastoral households in these pastures are shifting to Jahlkad and Basel pastures, where the increasing grazing pressure may exposed them to ecological degradation. As the major risk to the upland pastures in Him-

alayan is the dearth of vegetation and fodder resulting from heavy grazing far beyond the carrying capacity of the area (Shaheen and Shinwari, 2012).

Pastoralist's perceptions towards pasture degradation

The key indicators of pasture degradation broadly classified in to five categories (Table 3): i.e. declining trends in livestock preferred grazing plants/grasses in the upper niches; removal of vegetation cover as a consequence of crops cultivation; appearance of livestock less-preferred grazing species or weeds encroachment; disappearance of valuable medicinal and food plants particularly herbaceous species; and excessive surface runoff in the watershed during monsoon season.

Perceptions of the traditional herding communities towards pasture degradation analysed in Table 3 against pre-determined indicators. Among total 70 herder's interviews, 73% of the pastoral households claimed that we observed decadal decline trends in livestock preferred grazing plants/grasses in the pastures. As pastoralists have indigenous ecological knowledge of plants diversity and palatability that livestock prefer for grazing (Mapinduzi et al., 2003). However non-palatable or piousness weeds encroachment predominantly replaced these nutritious plants in some pastoral niches (51% respondents), that was perceived to be next significant indicator of pasture degradation. As a consequence of overgrazing in some niches, the disappearance of palatable plants species and the dominance of such poisonous weeds are indicating pasture degradation status (Peer et al., 2007; Yan et al., 2011). Furthermore crops cultivation in pastoral niches of Naran uplands greatly hindered rotational grazing system and traditional herding pattern. As this traditional grazing practices are minimizing grazing pressure and provides opportunities for sprouting forbs and grasses to regenerate (Singh et al., 2015). The current irrational grazing system adopted by pastoralists in the remote pastoral niches increased the grazing pressure on some pasture units that subsequently contribute to diminish palatable forbs and grass species. Degradation of plants biodiversity particularly medicinal and food plants is also occurred in the uplands of Naran (reported by 66% of the respondents) which is an attribute of pastures degradation. Though medicinal and food plants significantly contribute to pastoral livelihoods and provide key supplements to their diet (Aryal et al., 2009). According to local's perceptions, this disappearance

of medicinal and food plants in pastoral zone is primarily influenced by over staking, irrational grazing and irregular harvesting pattern. Reduction in grazing capacity of the pastures as a consequence of crops encroachment considered a significant indicator of pasture degradation as reported by 94% of the respondents. Of the total, 86 % of the respondents believed that this decreasing trends in carrying capacity of the pastures in lower pastures (Battakundi and Buhrawai) is leading to overgrazing, extensive browsing practice and subsequent soil compaction. The removal of vegetation cover has increasingly triggered surface runoff or overland flow (91% respondents) which has subsequently contributed to devastating floods and land sliding. The rich vegetation cover is a key indicator of pasture health which sustain soil integrity and enhance ecological sustainability in the mountains (Panastasis et al., 2003).

Impacts on nomadic pastoralists

Recent trends of pasture land allocation to crops cultivation is one of the main driving forces behind the abandonment of traditional pastoral practices and subsequent pastoralist's marginalization. The local occupants (crops producers) completely or partially renounced herding in favour of crops cultivation and they are solely dependent on such cash crops for their livelihoods. But this situation is worsened for landless pastoralists due to difficulty in getting other non-pastoral employment opportunities or income sources in such a competitive environment. Furthermore, this irrational crops cultivation over pastureland restricted landless pastoralists affected them to freely move with their livestock in search of grazing land. The results in Table 4 is showing the changes in pastoral households locations and decadal declining trends in livestock population per herd or household across four main pastoral settlements (pastures) in Naran valley. Since 1980s, the allocation of pastoral niches to crops cultivation is curtailing traditional pastoral practices in Naran uplands and reducing the capability of landless pastoralists to keep large herds containing more livestock.

Though livestock rearing is an integral component of pastoral economy and is the only viable livelihood strategy for pastoralists (Nautiyal and Kaechele, 2007; Galvin, 2008). A significant proportion of the pastureland has been brought under crops cultivation mainly in the lower valleys of Battakundi and Buhrawai due to easy accessibility climate suitability

ity and irrigation potential. Consequently pastoral households either renounced herding and adopted cultivation or moved to Jahlkad and Basel pastures for livestock grazing. This situation led to displace pastoral households from lower pastures (Buhrawai and Battakundi) to higher pastures i.e. Jahlkad and Basel (Table 4). Furthermore, highest reduction in livestock population per household is observed in Battakundi followed by Buhrawai, Jahlkad and Basel pastures (Table 4). The prevalence of cropping, insufficient grazing space, less rotational grazing, curtailed livestock mobility and limited accessibility of livestock to water points are the main driving factors contributed to changes in pastoral household localities and reduction in livestock population. It is revealed from the respondent interviews that pastoralists with small herds are mainly utilizing Buhrawai and Battakundi pastures while those having larger herds are moving to Jahlkad and Basel pastures (Table 4).

Table 4: Shift in localities of pastoralists and declining trends in their livestock

Name of major pastures	No. of pastoralists households		Average livestock population per Households	
	1980	2015	1980	2015
Battakundi	22	12	200	80
Buhrawai	35	19	320	150
Jahlkad	22	35	370	280
Basal	28	41	450	300

Pastoral income diversification pattern

Pastoral communities in Naran uplands are increasingly abandoning livestock production systems and are increasingly diversifying their livelihood activities in to other non-pastoral economic activities. Different studies in the Hindu Kush-Himalayan (HKH) region revealed that pastoralists diversified their livelihood activities due to downward spiral of resources depletions, institutional failure and ambiguity in land tenure to clearly define property rights, and loss of grazing land due to the encroachment of cultivation and conservation policies (Nautiyal et al., 2003; Eneyew, 2012; Wu et al., 2014). However, this income diversification process among smallholders in Naran (valley) is mainly driven by the penetration of market-economy generated from cash crops cultivation and other high cash earning opportunities i.e. wage labouring, petty trading or out-migration. Livelihood dependency of the locals is often decreasing on livestock herding which is highly observed in crops

farming communities. Though, these crops producers remained previous herding communities and were predominantly dependent on livestock herding for their livelihood. At present income distribution pattern of smallholders in Figure (3) shows that smallholders are primarily dependent on crops cultivation and animal husbandry for their livelihoods.

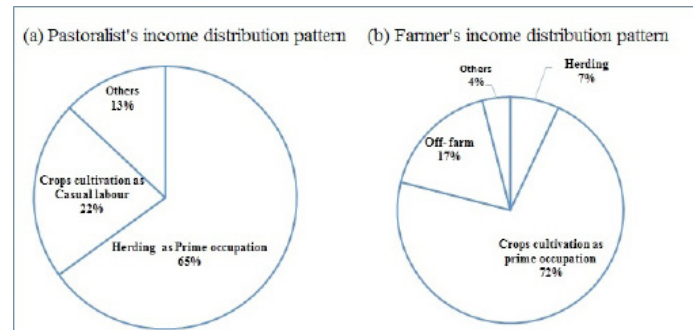


Figure 3: Income distribution pattern of pastoralists and farmers

Landless pastoralists are greatly deriving their household income from livestock (65%) while crops farming households are deriving 72% cash income from crops cultivation. The landless pastoralists with smaller livestock herds are additionally involved in crops farming as casual labour where crops producers are compensating them either in cash or in kind which contributes about 22% to their household income. Similarly crops producers with small landholding are alternatively involved in daily wage labouring and herding which is contributing to their household income as 17% and 7% respectively. Furthermore remittances, petty trading and government service are tertiary contributors which account about 12 % in pastoral household's income and 4% in crops farming household's income. This pattern of income diversification shows a decadal shift in pastoral livelihood from animal husbandry to cash crops cultivation due to competing cash earning opportunities in summer pastures. As these communities have increasingly given priority to cash income activities, though livestock is the backbone of subsistence economy particularly in Hindu Kush-Himalayan region of northern Pakistan (Wu et al., 2014).

Conclusion

Livestock production system is a cornerstone of pastoral livelihoods and is greatly contributing to subsistence and regional economy in Hindu Kush-Himalayan (HKH) region including Northern Pakistan. However this indigenous livelihood system combined

with pastures resources are declining due to increasing trends of off season commercial crops from the last few decades. The cultivation of off season crops is one of the main driving forces behind pastures degradation in ecologically fragile mountain's ecosystems that is further threatening the sustainability of pastoral livelihoods. A significant reduction in pastoral resources including grazing land and livestock population reflects that pastoral livelihood dependency on livestock production system is often decreasing. Consequently pastoralists are pushed towards income diversification through agriculture labouring or wage labouring and remittances earning. Collaborative and integrated approaches are needed for pastoral resources conservation and management with efficient livestock production to sustain long-standing ecosystem services and pastoral livelihood.

Authors' Contributions

Muhammad Khurshid carried out field work, collected data and designed the manuscript. Prof. Dr. Muhammad Nafees and Prof. Dr. Mehmet Somuncu provided their valuable inputs on the manuscript designing and final drafting.

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