

Research Article



Impacts of Agriculture Land use Changes on Mobile Pastoral System in Naran Valley of Western Himalayan Northern Pakistan

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Abstract | The upland pastures in western Himalayan of Northern Pakistan are traditionally used by mobile pastoralists for livestock grazing during summer. Since the late 1980's, these pastures have been used for off season vegetables cultivation which leads to change the traditional mobile pastoral system. This study was carried out in Naran valley in 2015, to understand the agriculture land use changes during the past three decades and its impacts on traditional mobile pastoral system. For this purpose, participatory discussions, Global Positioning System (GPS) and Geographic Information System (GIS) were used to identify and record land use changes during past three decades. Detail interviews were also conducted with nomadic and semi-nomadic pastoralists to identify and evaluate the impacts of agriculture land use changes on their pastoral activities. The result shows that since the late 1980's cash crops cultivation extended from 2880 m asl (above sea level) to 3500 m asl over 1887 ha of pastureland in Buhrawai. This rapid growth of cash crops cultivation has reduced the available grazing land by 23% in Buhrawai. The over expansion of cultivation in herding venues affected the livestock grazing pattern in term of rotational grazing and open mobility within the pastures. This led to decrease herding venues 43.7% mobility routes 37.5% and herd size by 60.4% for both groups respectively. Analysis of gender-based family labor distribution during past 30 years shows that herding labor (male and female) of age 14 to 60 significantly ($P < 0.01$) reduced during past 30 years and partly shifted to cropping. The male herding labour reduced 40.2% in semi-nomadic pastoralists and 8% in nomadic pastoralists. Similarly the female herding labour reduced 54.3% in semi-nomadic and 32.2 in nomadic pastoralists. This reduction is highly observed in herding labour of semi-nomadic pastoralists followed by nomadic pastoralists. It is concluded that due to this irrational agriculture land use changes, the present nomadic pastoral system is in transition from pure nomadism to commercial vegetable farming in upland areas and this has exposed the traditional nomadic life to socio-economic and environmentally vulnerability in upland areas.

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Introduction

Hindu Kush-Himalayan (HKH) is the largest and ecologically diverse mountains that extends 3500 km across eight Asian countries including Northern Pakistan (Shikui et al., 2010). High mountain pas-

tures of Hindu Kush and Himalaya (HKH) are the major parts of pastoral land use, which are traditionally used by mobile pastoral and agro-pastoral communities during summer season (Ning et al., 2014). These pastoralists are exploiting high mountain pastures in summer and lowland pastures in winter over the an-

nual seasonal cycle (Kreutzmann, 2004). During the past three decades, these highland pastoral areas are extensively used for cash crops (potatoes and peas) cultivation. The key grazing niches (valley's bottom) formerly used for livestock grazing are occupied by this agriculture encroachment and has put great pressure on traditional nomadic pastoral system (Galvin, 2009). This continuous expansion of agriculture over pastureland in the mountains may produce significant ecological problems and is limiting assets for sustainable livelihoods, as observed in different mountainous area of the world (Nori and Gemini, 2011).

The cultivation of off season cash crops expands over high mountain pastures of western Himalayan, as these pastures are used by pastoral communities for livestock grazing (Bhasin, 2011; Tiwari, 2000). This off season crops cultivation is driven by a socio-economic change from subsistence livestock husbandry to more market based economy generated by cash cropping. The cash cropping are further encroaching pastoral niches in the uplands of Himalayan due to improved accessibility *i.e.* road and transport networks between high and lowland consumption centers (Tulachan, 2001). The prevalence of cash cropping over pasture land significantly reduced the available grazing land and altered traditional pastoral practices. As a result, pastoral communities are either pushed in to more high remote niches or they adapted agriculture as an alternative livelihood option (Campbell et al., 2003). As observed in other parts of the world studied by various researchers, due to agriculture encroachment in pastoral areas, the traditional mobile pastoral system is in transition from pure nomadic pastoralism to crops farming as commercial agriculture and the livelihood dependency of nomadic pastoralists is often decreasing on livestock (Galvin, 2008). However, the issue of using the grazing land for commercial agriculture and its impacts on the traditional pastoral system in western Himalayan have not been fully explored. In this paper we studied agriculture-land use changes during past 30 years (1985-2015) and its impacts on the traditional mobile-pastoral system in Buhrawai pasture of Naran valley in Northern Pakistan.

Farmer and Herder (the two distinct groups) are using Buhrawai pasture for their livelihood activities in summer season. Farmer group is consisting of the dominant tenants that have occupied the bottomland from the past several decades and are involved in potato and pea cultivation as cash cropping. They are

previous herders and have renounced livestock herding at the expense of cash cropping. The herders are nomadic or semi-nomadic pastoralists; utilizing the upper niches of these pastoral units as summer pastures for livestock grazing from early June to mid-October. The main pastoral settlements in the study area are Pecho Bella, Wijtar, Karra, Gattia, Riverhy, Johrian, Boot Konali, Maidan, Daschali and Rati Gali. The average annual precipitation is 1600 mm with a cumulative depth of snow reaching up to 6 m. The mean minimum temperature of the area recorded as -8.9°C in January while the mean maximum temperature 24.6°C for both July and August. The relative humidity varies from 42% to 84% (Sardar, 2003).

Material 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). Geographically, the valley is located on the extreme western boundary of the Himalayan range on the margin of the Indian Plate (Khan et al., 2012). Naran valley is drained by Kunhar River and its tributaries produce various valleys including Batakundi, Dabuka, Burawai, Jalkhad and Lake Saif ul Malook (Sardar, 2003).

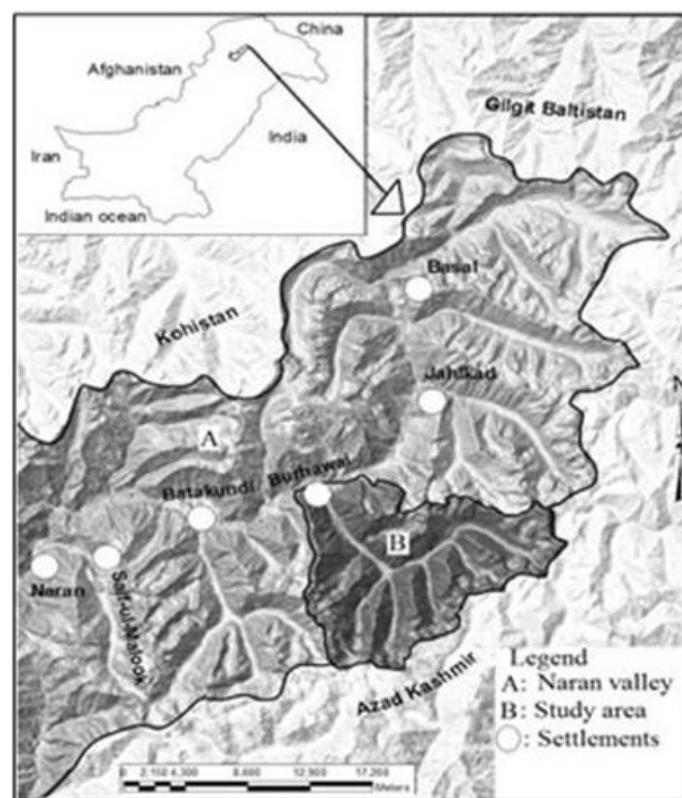


Figure 1: Study area (Buhrawai) in Naran valley

The study area (Buhrawai) located between 34.48 to 34.55 degree north and 73.51 to 74.02 degree east in the Naran valley and the elevation ranges from 2980 m to 4600 m above sea level (ASL). Topographically, the area is formed by rugged and steep slope mountains. Ecologically, the valley has been recognized as an important part of the Western Himalayan (Ali and Qaiser, 1986).

Data collection and interpretation

Focus Group Discussions: Preliminary, 10 participatory group discussions were conducted during early July 2015 in pastoral settlements *i.e.* Pecho Bella, Wijtar, Karra, Gattia, Riverhy, Johrian, Boot Konali, Maidan, Daschali and Rati Gali. These discussions were held with elderly family members of farmers, nomadic and semi-nomadic pastoralists. The purpose of the group discussions was to identify total households in each settlement and land use changes during past three decades.

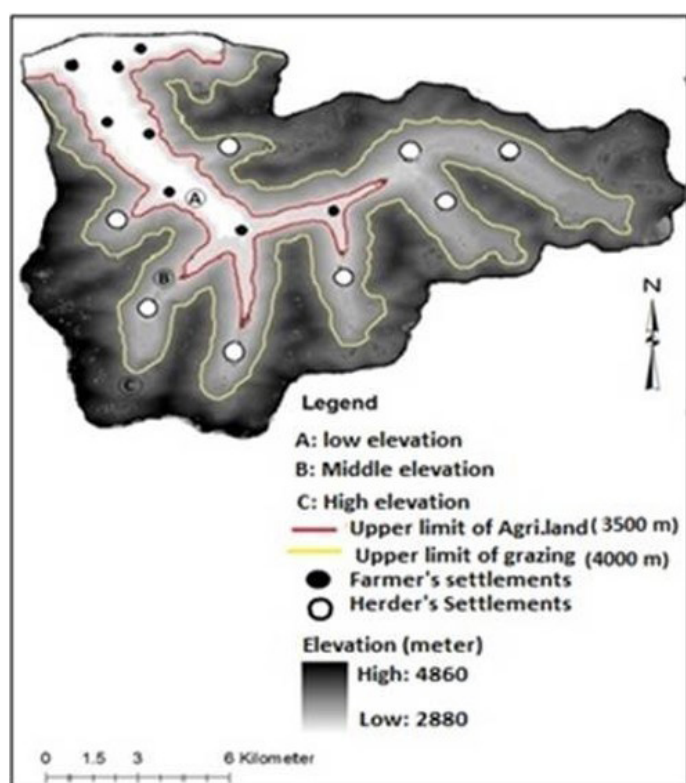


Figure 2: Land use map of Buhrawai

Land-use mapping: To understand land use changes in Buhrawai, on the basis of digital elevation model (DEM) it can be divided into three zones (Figure 2). Zone A was termed as low elevation-Agriculture zone extends from 2880-3500 m ASL, Zone B is the mid elevation-transhumant Zone extends from 3500-4000 m ASL and Zone C, high elevation-inaccessible area extends from 4000-4860 m ASL, respectively.

Land use changes were identified in focus group discussions in each settlement and recorded by means of Global Positioning System (GPS). Thirty GPS points were recorded in Buhrawai to show grazing, cropping and inaccessible area and additionally one point was also recorded to show pastoral settlement on the map. The Terrain image of the study area was downloaded from google maps and was used as a base map. Geographical Information System (GIS) software ArcGIS 9.3 version was used to geo-reference the Terrain image through WGS-84 coordinate system. For the developed elevation attribute table, the contour lines were digitized manually. This digitized map was converted into digital elevation model (DEM) for detail surface analysis.

Interviews: On the basis of their occupation, mobile pastoralists were categorized into two groups *i.e.* nomadic and semi-nomadic pastoralists. The nomads are the ones whose prime occupation is livestock herding. Semi-nomadic pastoralists are those who are partly involved in agriculture labouring with livestock rearing. They are taking pasture tenancy either on annual basis for livestock grazing or provide agriculture labouring in reward to grazing pastures.

During focus group discussion, it was found that there are 132 households of both nomadic and semi-nomadic pastoralists. One third (33%) (Nomadic $n = 20$, semi Nomadic $n = 24$) households of each group were randomly selected for detail interviews. The purpose of detail interviews was to collect information about the impacts of cash cropping livestock herding pattern and pastoral livelihoods (labour distribution pattern) during past three decades. The collected data was analysed at level of significance ($P < 0.01$) through GraphPad Prism version (5) software. Paired t-Test applied to compare past and current gender-based herding activities to see significant reduction in herding labour during past thirty years.

Results and Discussion

Agriculture Land use Changes

On the basis of land use, the Buhrawai pasture is divided into three zones *i.e.* A, B and C. It is evident from Table 1 that the total area of zone (A) is 1887 ha, where 337 ha has already been converted into cropland and 1550 ha remained as cropping candidate land. This land is cropping candidate due to better soil quality and water availability for irrigation. The allo-

cation of bottomland to crops cultivation is increasing livestock vulnerability in dry season; as the bottomland areas are in great demand for grazing (Angassa and Oba, 2008). The agriculture encroachment on the cropping candidate land will likely take place even at gentle and steep slope; which has a great risk of soil erosion and land degradation as observed in Indian Himalayan (Sen et al., 1997). This prevalence of cash cropping in Zone (A) significantly reduced grazing land by 23% (Table 1). As a result, pastoral communities either directly pushed to higher grazing niches in zone (B) for livestock grazing or reduced their herd size and taking up agriculture as an alternative livelihood option. The over expansion of cultivation in bottomland (zone A) affected the livestock herding pattern in term of accessibility to herding venues, rotational grazing and livestock mobility. Moreover, the early arrival (mid-June) to and late departure (mid-October) from zone (B); extend the grazing time, thus putting plants under stress and reducing the overall productivity of the pastures and also exacerbating over grazing that contributes to desertification, land degradation and soil erosion (Sardar, 2003; Khan et al., 2012). The high elevation area (zone C) above 4000 m to 4880 m (8063 ha) in Burahwai is permanently occupied by snow and glaciers which is inaccessible for both livestock and other livelihood activities.

Table 1: Elevation classes and land use changes during past three decades

Land use (2014)	Elevation class	Area (ha)
Low elevation: Agriculture zone	2880 – 3500 m	1887
Cropped land	2880 – 3200 m	337.3
Cropping candidate	3200 – 3500 m	1550
Middle-elevation: Transhumant zone	3500 – 4000 m	6350
High-elevation: Permanent snow/inaccessible area	4000 – 4880 m	8063
Land use (1985)	Elevation class	Area (ha)
Transhumant zone	2880– 4000 m	8237
Permanent snow/glaciers zone	4000 – 4880 m	8063

Table 1 further shows the grazing pattern in zone (A) and (B) during 1985. The total grazing area of both zones was 8237 ha which extends from 2880-4000 m ASL. According to the perceptions of the respondents in group discussions and interviews, both these zones were openly available for livestock grazing during summer season *i.e.* livestock grazed zone (A) in

early summer (mid-June to mid-July) and zone (B) till late summer (mid-July to mid-September). After use of these zones in different time periods, pastoralists moved downward mobility to lowland areas. This old pattern of livestock grazing was appreciated by pastoral communities to sustain sufficient livestock for their livelihoods. Moreover, from environment point of view this practice was a sustainable way to utilize mountains pastures in different time periods.

Table 2: Pastoralist's perceptions towards historical changes in herding pattern

Herding attributes	1985 (n)	2015 (n)	% Reduction
Accessibility to herding venues	16	9	43.7%
Mobility routs to water points	16	10	37.5
Herd size (livestock population)	23359	9245	60.4%
Herd composition	88	44	50%
Herding labour per herd	6	3	50%

Impacts on Livestock Herding Pattern

It is apparent from the perceptions of pastoralists in Table 2 that the pattern of livestock herding changed during past three decades. The accessibility of the livestock herds to rich forage-venues has been reduced by 43.7 %. Rich forage species are available in lower elevation pastures (zone A) where livestock access has been restricted due to cultivation. The heterogeneous use of herding venues yields higher livestock productivity and quality of pasture land than the pressure of homogeneous continuous grazing (Muller et al., 2007). Furthermore, these high forage value species, rotational grazing and water availability are important factors structuring a sustainable herding system which is a key for the productivity of livestock and pastures (Coppolillo, 2000). According to the perceptions of the respondents, the livestock mobility routs to water points also reduced by 37.5%. This situation affected the rotational grazing pattern and open livestock mobility within the pastures. Limited herding venues and less possibility of rotation grazing triggered the continuous grazing system with mixed-species (sheep and goats) resulting the disappearance of palatable species (livestock preferred species) and increase in species less desired by livestock that degrade the pastureland (Oba and Kaitira, 2006). Compellingly, pastoralists reduced their livestock population and number of herds by 60.4% and 50% respectively. This alteration in herding system is coupled by cultivation over the land that is suited only for grazing (Harris, 2010).

Table 3: *Shift in gender based family labour allocation with changing dependency from herding to cropping*

Pastoral groups	% Family labour involved in herding (Age 14-60 years)				% Family labour involved in cropping (Age 14-60 years)			
	Male		Female		Male		Female	
	1985	2015	1985	2015	1985	2015	1985	2015
Nomadic Pastoralists	100±0	92.0±2.73	35.4±5.16	24.0±4.86	Nil	Nil	Nil	Nil
Semi-Nomadic Pastoralists	92.5±3.58	55.3±4.30	36.5±5.63	16.6±4.73	Nil	19.5±4.24	Nil	11.0±3.57

Furthermore, according to the perceptions of the respondents the average number of persons per herd reduced by 50%, which shows that part of the herding labour shifted to cropping. The cultivation in the mountains provides high cash earning opportunities which attract herding labor by reducing the time allocated to herding (Coppolillo, 2000; Shaoliang et al., 2007).

Pastoral Livelihood Activities

Cash crops cultivation over pastureland occupied the key grazing areas in Burahwai, where mobile pastoral communities have changed their family labour distribution pattern and their livelihood dependency on livestock. Their professions transformed from pure herding to vegetable farming. This transition in their livelihoods is driving by high cash income in cropping, limited grazing space and curtailed livestock mobility. As pastoral communities diversify their livelihood activities into commercial agriculture or wage laboring, the livestock may not remain the primary income source for them, but study revealed that for those who keep livestock for their livelihood dependency need adequate access to productive pasture resources (Galvin, 2008). The nomadic pastoralists group in Burhwei have maintained sufficient livestock for their livelihood dependency and occupied high elevation grazing niches in zone B, while semi nomadic pastoralists group occupied the cropland boundaries in the bottom land where limited space is available for livestock grazing. As a result they have significantly reduced their herd size and partially involved in cultivation for their livelihood. This shift in pastoral livelihood activities is highly observed in semi nomadic pastoralists group and less observed in nomadic group. The pastoral livelihood activities for both male and female statistically analyzed to see the gender based shift in family labour distribution pattern from herding to cropping. Table 3 shows the mean percent of male and female labour distribution pattern during past 30 years. In nomadic and semi nomadic group, where significant ($P < 0.01$) reduction observed in both male and female herding labour. Male herding labour of nomadic pastoralists

reduced from 100% to 92% and female herding labour reduced from 35% to 24% in the past thirty years. Their male workforce is mainly involved in livestock herding while female are involved in livestock management at settlements. Moreover the semi nomadic pastoralists significantly ($P < 0.01$) reduced their male herding labour from 92% to 55% and female herding labour from 36% to 16% and subsequently their partial male workforce diverted to cropping by 19% and female workforce by 11%, respectively (Table 3). This shows that the total workforce in herding activities is decreasing and partly shifted to cultivation. Thus the agriculture labour are encouraged due to high cash income from cropping, which results over use of the agriculture land and contribute to more cultivation over pasture land.

Conclusions

The upland pastures of Hindu-Kush and Himalayan mountain areas are increasingly used for off season cash cropping during summer. The prevalence of this irrational cash cropping reduced the grazing land by 23% in Burhawai pasture of Naran valley during past thirty years which leads to force nomadic pastoral communities to either shift their occupation to cropping or move to high marginal areas for livestock grazing. The cultivation of off season crops encroached the bottomland in Burhawai pastures which restricts the access of livestock to suitable herding venues, water points and curtailed their mobility for rotation grazing. Consequently pastoralists reduced their livestock population and number of herds by 60.4% and 50% respectively. Due to limited availability of grazing space, the herds tend to become smaller and hence economically less rewarding. As a result, those who occupied cropland boundaries partly shifted to cropping and reduced their dependency on livestock.

Moreover, this cash crops cultivation offered high cash earning opportunities to nomadic pastoral communities and attracted available herding labour to cropping. As a result, the available herding labour

diverted to cropping and renounced the herding activities. This labour diversion to cropping is highly observed in semi-nomadic pastoralists as compared to pure nomadic pastoralists. Due to reducing availability of labour for herding, the herds over use the accessible niches and under-use the remote niches which is exacerbating the ecological sustainability in the mountains.

This research has policy recommendations towards cross-sectoral and integrated development in the mountain areas. Regional policy oriented efforts are needed to involve the multi-stakeholders in development initiatives that contribute to rehabilitation of the degraded alpine pastures and ensure secure livelihood options for marginalized pastoral communities.

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Authors' Contributions

Muhammad Khurshid designed/wrote the manuscript, carried out field work and collected data on land use changes and pastoral system. Dr. Muhammad Nafees (Internal Supervisor) and Dr. Inam-Ur-Rahim (Co-Supervisor) provided their valuable inputs on the manuscript writing and drafting. Wajid Rashid worked on data management and literature review for the manuscript.

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