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Crop encroachment over alpine pastures in the Himalayan mountains of northern Pakistan: Socio-economic implications for pastoral communities

Inam-ur-Rahim[1], Muhammad Khurshid[2*], Henri Rueff[3], Muhammad Nafees[2] and Daniel Maselli[4]

[1]Foundation for Research and Socio-Ecological Harmony, Islamabad, Pakistan
[2]Department of Environmental Sciences, University of Peshawar, Pakistan
[3]School of Geography and Environment, University of Oxford, UK
[4]Climate Change and Environment Network, Swiss Agency for Development and Cooperation (SDC), Switzerland
*Corresponding author e-mail: khurshed75@live.com
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Abstract

This paper analyses the socio-economic impacts of crop encroachment on pastoral communities. The data was collected through semi-structured interviews and participatory rural appraisal (PRA) with stakeholder communities. Paired *t* test was applied to compare past and current herd size, composition and herding labour. The results show that crop encroachment significantly reduced herd size and changed the herd composition. Furthermore significant proportion of family labour shifted from herding to cropping. The previous cattle herders occupying the key pastoral niches have shifted to cash crop, while the sheep and goat herders are still following the pastoral occupation. It is concluded that in high Himalayan pastures income diversification through the introduction of cash crop have positive economic impacts for the crop producers but have negative economic consequences for the herding communities. The results of this study can contribute to the development of pastoral land policy and high mountain ecosystem conservation in developing countries in general and in mountain valleys of northern Pakistan in particular.

Keywords: Agriculture, Herding, Labour allocation, Livelihood, Pastoral system

Introduction

The cultivation as cash cropping is a common form of livelihood activity in high mountains, which restricts the access of pastoral communities to all grazing niches (Nautiyal *et al.,* 2003). This cultivation shifts pastoralists to crops farming and decreases their dependency on livestock. (Desta and Coppock, 2004; Galvin, 2008). The ease of supply of agricultural inputs and outputs (harvest) with the development of road infrastructure further accelerates the encroachment of cash crops onto marginal lands (Tulachan, 2011; Dong *et al.,* 2011). Due to crop encroachment pastoralists access to grazing niches has squeezed (Dong *et al.,* 2011) and their herd size has been reduced (Ekaya, 2005). The push of the pastoral communities to increase the livestock concentration on the remaining grazing area (Harris, 2010) results in over-grazing that has direct negative impacts on natural vegetation, soil erosion, and hydrology (Koulouri and Giourga, 2007) and it contributes to accelerated pasture land degradation (Tschopp *et al.,* 2010). Singh *et al.* (2011) revealed that better soil quality and sustainable use of grazing niches enhance pasture land productivity. Those who favour crop encroachment over native pastures argue that this process leads to increase integration of crop and livestock and accommodates surplus labour available from herding communities (Berhanu *et al.,* 2007; Okoruwaa *et al.,* 1996). However, such labour shift has also contributed to eroding the traditional pastoral practices (Farah *et al.,* 2001) and have negatively impacted the livelihoods of communities that opt to continue herding as a primary occupation (Dong *et al.*, 2011; Bhasin, 2011; Ekaya, 2005).

Off-season cash crops cultivation is gradually occupying the key pastoral niches in western Himalayan of northern Pakistan. This irrational cultivation is leading to alteration in traditional pastoral system and has different consequences for different pastoral groups. Despite the on-going debate of advantages and disservices of crop encroachment over marginal lands, the socio-economic impacts of crop encroachment at high elevation pastures, in the context of upland-lowland mobile pastoral systems, remains undocumented. We posit that by shrinking the available grazing area, crop encroachment leads to reduced herd size, changes in herd composition, and alter ater family labour division. Therefore this paper intends to investigate the impacts of cash cropping on

herd size, herd composition and herding labour allocation for different household groups.

Materials and Methods

***Study area*:** The current study was conducted in Buhrawai of the Naran upland pastures, situated on the left bank of the Kunhar river in the Khyber Pakhtunkhuwa Province, Pakistan. The elevation of Burhawai valley ranges from 2980m to 4860 m a.s.l., and the average annual precipitation is 1600 mm with a cumulative snow depth of up to 6m (Sardar, 2003). The total area of Buhrawai is 16300 ha, with 2% occupied by cropping, 48.2% used for grazing and the remaing 49.4% is permanently occupied by glaciers and snow.

Geographically, the study area is located on the extreme western boundary of the Himalayan range (Khan *et al.,* 2012). The mean minimum temperature of the area reaches -8.9°C in January, while the mean maximum temperature reaches 24.6°C for both July and August. The relative humidity varies from 42 to 84% (Sardar, 2003). The valley is used as summer pasture by transhumant livestock that arrive after a three to four month grazing period in the Potohar foothill scrub plateau. The valley pastures are owned by absent landlords (Syed) living in the town of Naran and are rented out annualy to herders. Crops are sown from late May to mid June and harvested in September.

***Data collection and analysis*:** Participatory rural appraisal (PRA) was used to identify the households to be surveyed and to categorize them. The four categories distinguished are: i) herding sheep and goats as the sole occupation (Group A); ii) herding sheep and goats with occasionnal labor service in cropping (Group B); iii) engaged both in cropping and herding (Group C); iv) engaged mainly in cropping with only a few cattle for homestead milk (Group D). One-third households of each of the four groups (126 out of 378) occupying the study area since before 1985 were interviewed (Table 1) regarding their past and present family labour allocation, herd size, herd composition. Field activities were conducted in 2009 and 2010 summer seasons. The data collected was analysed using paired *t*-tests to compare past and current herd size, herd composition and herding labour allocation.

Table 1. Category wise distribution of interviewed households in Burhawai

Household groups	A	B	C	D
Interviewed	20	24	26	56
Total	60	72	78	168

Results and Discussion

***Impact of crop encroachment on herd size*:** The impact of crop encroachment on the herd size of different herding groups in Burhawai by comparing the 1985 and 2010 situations is shown in table 2. The encroachment of crops over key previous grazing niches contributed to the reduction in herd size of all groups. The total livestock in animal unit with all the herd type groups was reduced from 9568 to 3488 animal units, indicating a reduction in stocking pressure on the remaining pastures. This reduction is, however, more pronounced for group D, followed by C, B and A, respectively. The increase in population among all the herd type groups further reduced the availability of animal units per person. During the 1985-2010 period, the total number of household members in all herd type groups in the study area increased from 988 to 1745, thus reducing the number of animal units per person. Group A still continues herding, as their relatively larger herds make them reluctant to shift their dependency from herding to cropping (Desta and Coppock, 2004). Group D on the other hand now only has less than 20% of their 1985 herd size and have shifted their dependency from herding to cropping. Groups B and C appear between groups A and D because they occupy the slopes near the crop land. Hence, they are more motivated to initially shift part of their labour force to cropping, and with the availability of alternate income from cropping, they consequently reduce their herd size. The partial shifting to cropping (group C) or partial shifting to cropping labour (group B) may depend on their livestock wealth status, *i.e.* the herd size. This also shows that the increased stocking pressure on the remaining pastures is not because of animal numbers, but because of the duration of their stay beyond the permissible limits.

***Impact of crop encroachment on herd composition*:** The data presented in table 3 shows the impact on herd composition of different groups as a result of crop encroachment in Burhawai. The least reduction was noticed for cattle (36.7-43.1%) with comparatively less variation among the groups. The reduction in sheep and goat was highest for group D and lowest for group A. There was only a fractional reduction in the number of equines for group A, but for other groups, partially or fully involved in cropping, the reduction was highly significant and more than 58%.

Herd composition determines the occupation of pastoral niches (Prins and Fritz, 2008) and its balance grazing is essential to fully exploit the available grazing lands (Manoj

Table 2. Comparison of average herd size for different herd type groups (1985-2010)

Time-wise pairs (1985 and 2010)	Paired difference (animal unit / person)						Reduction in animal unit [%]	
	N	Mean	95% confidence interval		t	df		
			Lower	Upper			Absolute	Per person
Group A	20	10.12	7.56	12.67	8.29**	19	47.6	66.9
Group B	24	10.64	7.61	13.66	7.28**	23	63.4	79.6
Group C	26	9.89	7.39	12.40	8.14**	25	68.8	83.8
Group D	56	4.173	3.26	5.079	9.23**	55	80.4	88.9

Source: Survey data. *(Significance level ** P<0.01)*

Table 3. Comparison of average herd composition for different herding groups

Time-wise pairs (1985 and 2010)	Paired difference						Reduction in herd size [%]
	N	Mean	95% confidence interval		t	df	
			Lower	Upper			
Group A							
Goats	20	117.8	63.39	172.1	4.53**	19	54.3
Sheep	20	184.6	83.96	285.5	3.93**	19	43.6
Cattle	20	0.7	-0.22	1.62	NS	19	36.8
Equine	20	1.4	-3.17	5.97	NS	19	10.0
Group B							
Goats	24	181.5	115.9	247.1	5.72**	23	69.6
Sheep	24	140.6	61.72	219.4	3.68**	23	60.7
Cattle	24	0.79	-0.19	1.78	NS	23	42.1
Equine	24	7.62	3.96	11.29	4.30**	23	67.0
Group C							
Goats	26	118.8	82.11	155.6	6.66**	25	66.4
Sheep	26	101.5	75.80	127.2	8.13**	25	70.3
Cattle	26	1.92	0.71	3.13	3.27**	25	36.5
Equine	26	4.0	2.4	5.6	5.15**	25	67.8
Group D							
Goats	56	54.71	42.79	66.64	9.20**	55	91.3
Sheep	56	39.95	27.0	52.89	6.19**	55	98.3
Cattle	56	3.44	2.32	4.56	6.18**	55	43.0
Equine	56	1.17	0.79	1.56	6.12**	55	60.0

Source: Survey data. *(Significance level ** P<0.01; NS, P>0.05)*

Table 4. Change in labour allocation for herding with crop encroachments

Time-wise pairs (1985 and 2010)	Paired difference						Reduction in herding labour allocation [%]
	N	Mean	95% confidence interval		t	df	
			Lower	Upper			
Group A	20	6.52	-1.79	14.84	NS	19	9.5
Group B	24	28.23	17.37	39.09	5.37**	23	42.1
Group C	26	32.33	24.69	39.97	8.72**	25	51.0
Group D	56	53.98	48.27	59.69	18.96**	55	81.4

Source: Survey data. *(Significance level ** P<0.01*; NS, *P>0.05)*

et al., 2015). Hence, cattle based herds occupy the valley bottoms with gentler slopes, as cattle generally avoid grazing on slopes steeper than 5.7° (Bailey *et al.,* 1996). Sheep and goat herds can graze and browse on much steeper slopes. In the past, group D with cattle dominant herds were the occupants of valley bottoms where the available land turned out to be most suitable for cash crop cultivation. They are now the main cropping tenants, but still keep a few cattle for their homestead milk cons-umption. They also regularly buy and use crop residues and concentrates to feed their animals intensively. The herders with smaller sheep and goat herds (*i.e.* group B and C) used to occupy the slopes near the valley bottom with a vertical seasonal movement. The herders with larger sheep and goat herds on the other hand had to shift horizontally to remote and relatively wild grazing niches for three months.

This occupation pattern, as a result of herd size and composition, has played a key role in triggering the cropping activities and their encroachment throughout the area. Cattle mainly serve the homestead milk needs of all the herd type groups. They, therefore, cannot be reduced beyond certain limits (1.2-4.5) depending on the number of family members in a household. The sheep and goats are primarily reared for sale; hence, the reduction in their number is related to the shift in household dependency from herding to cropping. The higher reduction of sheep and goats with group D is due to the limited availability of grazing niches for animals grazing around their settlements and of the fear of possible damage to cash crops. Group A still occupies the remote niches and have to come through the mountain or road side routes by foot. As such, they still require equine for load carriage. On the other hand, groups B, C and D enjoy better road access, making equine load carriage obsolete.

***Impact of crop encroachment on herding labour allocation*:** The changes in family labour allocation for herding between 1985 and 2010 for different herding groups in Burhawai were presented in table 4. The data depicts reduction in herding labour from Group A to D. Group D has diverted most of its family labour from herding to cropping, while in group A, the change in family labour allocation for herding is non-significant.

Apart from Group D which shifted from herding to cropping, higher economic returns from cash crops attract family labour from herders with smaller sheep and goat herds *viz*., group B (Shaoling *et al.,* 2007). Group C, while occupying the slopes near the valley bottom, also converted part of the grazing slopes under their occupation to cropping. According to Berhanu *et al.* (2007) the low marginal return to labour in traditional pastoralism suggests the existence of surplus labour that can gainfully be transferred to non-pastoral activities. This sets the stage for a gradual labour shift from herding to cash cropping. The cash crop encroachment also attracted special cropping labour most of them belong to the Kohistani communities coming from further north in the Indus valley. Twenty five households in Burhawai (*i.e*. 6.6% of the total households) are now pure cropping labours without any livestock. They are new comers to the area after initiation of crop encroachment in the valley. Group A on the other hand, still retains its original occupation due to the larger herd size. Apparently herders of that group have little intention of changing (Desta and Coppock, 2004).

Conclusion

The cash crops extension to Himalayan uplands forced the herders to reduce their herd size leading to reduced economic returns from livestock production. This situation also created competition on land use for crops and grazing. Thus off season cash crops cultivation provides high cash income to the crop producers on one hand and negatively affects mobile herders on the other hand. To fulfil their subsistence needs with reduced herd size the part of herding family labour is forced to work as cropping labour and the children and aged family members are left to look after the livestock herd. The reduced availability of herding labour leads to over use the accessible niches and remote pasture areas are left under used leading to unsustainable pasture use.

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