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Transhumant migration of Baruwal sheep (*Ovis aries*): A case study from the Kanchenjunga conservation Area of Nepal

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The transhumant sheep production is traditional farming system adopted by the herders of the Kanchenjunga Conservation Area (KCA) of Nepal. A rapid field survey by was organized in the KCA of Nepal in order to know the basic of transhumant sheep production in the focus group discussion (FGD), it was learned that the current number of herders and sheep population were sharply declined since the last two decades in KCA. Among the problems identified, conflict of sheep herders due to grazing overlap with the yaks and chauries at high altitude summer pastures, farming systems overlap at low altitude in winter, and the legal conflict between the conservation area management and the sheep herders were prominent. The rapidly growing commercial cultivation of cardamom in suburb of villages at low altitude areas (<2000 m) restricted the sheep migration during winter and, the net benefit gained through transhumant sheep herding was often lower than that of cardamom cultivation. This study would provide the base for future experiments on transhumant sheep production. In general, the scope of transhumant sheep production in view of livelihood of the shepherds were discussed briefly in this case study.

Key words: Transhumance system, grazing route, alpine pasture, Baruwal sheep, conservation area.

INTRODUCTION

The transhumance system is characterized by the seasonal movement of livestock to high altitude alpine pastures for grazing in summer and progressive downward movement and lying at mixed forest areas in winter (Dong et al., 2009a). Among 17 different livestock species reared in Nepal, sheep are one of the important ruminant species for livelihood (Wilson, 1997). Transhumant sheep farming is a traditional practice in the northern high altitudinal regions of Nepal (Joshi et al., 2004). Among the total sheep population available in the country, 60% of them are reared under the transhumance system (LMP, 1993) and Baruwal sheep is one of the important native sheep breeds of Nepal kept in transhumance as a multipurpose small ruminant (Wilson, 1997; Joshi et al., 2004). In KCA, Baruwal sheep are raised in mid hills (2000 to 3000 m) and their crossbreds

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with Kagi, can migrate from 1500 to 4500 m a.s.l, is reared on extensive numbers in transhumance, mostly by the Gurungs and Kirats ethnic groups (KCA, 2004). The sheep herders move their flocks upward in early summer for utilizing the alpine pasture and downward in late autumn/early winter to protect their herds from winter cold weather at high altitude. However, transhumant sheep production is declining in terms of practices, size of flocks reared and overall keeping due to lack of advanced management, and socio-economic factors (Joshi et al., 2004). A study was thus conducted in the KCA in order to get basic information with regard to the transhumant Baruwal sheep production so that the migration system, constraints faced by herders and future scope of transhumance sheep farming in the Kanchenjunga conservation area of Nepal would be possible to learn for research and development.

METHODOLOGY

The following three step procedures were followed with the common principles of rapid rural appraisal (Chambers, 1994) to collect the information on basic of transhumant sheep production in KCA.

Identification of shepherding villages in KCA

The sheep herding communities around the KCA were first identified from the KCA office in Taplejung district of Nepal. The transhumances sheep herding communities of Lelep/Lungthung area which were close to the KCA headquarter at Lelep were selected for this case study. Four flocks were chosen from the herders each two from the Gurung and Kirat ethnicities moving the herds together to high altitude in summer months.

Focus group discussion (FGD)

A checklist was prepared in consultation with the KCA staffs and 3 local key informants with covering history, current practices, challenges and interrelationship of sheep rearing with other farming components from the holistic perspectives. Later, a pre-planned and organized discussion was organized with villagers following the steps of rapid rural appraisal in Lungthung of KCA and five key informants (consultation with the ages and old shepherds) interview was taken focusing transhumance migration, animal management, productivity and current situation of transhumant sheep farming by the local villagers. The participants were the local farmers and former transhumant sheep herders. The FGD was organized intensively with 30 local peoples of Lungthung of KCA and the discussion was set according to the checklist. The discussion with participants was completed in two consecutive days. Information collected during FGD were verified further with key informants' so that reliability of the information would be better established to discuss with the shepherds during field visit (shepherds on pastures).

Field visit

The information collected during FGD and key informants interview were further confirmed with the four shepherds in the field who were migrating the flocks and were available at Mauma pasture at 4000 m a.s.l in KCA. The questions concerning the livelihood and traditional migratory sheep herding were further elaborated together with the shepherds.

Calculation of net benefit from sheep herding

First the revenue resources and the items of cost of shepherding were collected from FGD and further revised in consultation with the shepherds. The net benefit of sheep farming was further calculated from 120 sheep that were jointly herded and from which the total benefit were shared by four herders. The monetary values both for items of revenue and costs were first recorded in local currency altogether for four herders and further expressed to the US dollar. Information was further summarized from four herders having a total of 180 sheep. The net benefit of shepherding was calculated as:

Net benefit = Gross revenue - Gross expenses

RESULTS

The results and explanations in this study were based on the above mentioned criteria described in methodology.

Herd structure

The herd studied was mixed of pure *Baruwal* sheep and their crossbreds with Kagi sheep. It was learned that the number of ewes dominated the flock (83.3%) followed by rams (9.5%) and the least by the lambs (7.2%). However, the number of Baruwal × Kagi crossbreds were in small proportions than the purebred Baruwal sheep (Table 1). Most of the lambs were sold out for daily subsistence of the herder's family.

The crossbreds were produced at the lower altitudes when the Baruwal herd migrated down in the winter according to the respondents. The rams were all intact used for breeding purposes, although they were in small proportions (Table 1). Among the females; around 80% were parturient annually according to the herders. Few lambs (less than 10%) were raised to replace the male and females within the flock, whilst rests of the lambs were sold out for family needs.

Transhumant movement

The general pathway of flock movement has been sketched in Table 2. Usually the upward migration starts at April and the flocks were allowed to graze on 3 to 5 pastures of varying altitudes ranging from 2000 to 4500 m.Then at around mid- August, the flocks used to move to the high elevation alpine vegetation zones in between 4500 to 4700 m. Again at the start of September, flocks move down to the rangeland/pastures of lower altitudes (3500 to 4000 m) of mixed forest vegetation. In the winter

Table 1. Structure of the flock selected for study purpose in Mauma, Taplejung.

Breed type	Rams	Ewes	Lambs	Total
Baruwal	15	140	10	165 (91.7%)
Baruwal × Kagi	2	10	3	15 (8.3%)
Total	17 (9.5%)	150 (83.3%)	13 (7.2%)	180 (100%)

Table 2. Transhumance migration of selected sheep herds in the study site of the KCA as given by the herders (observation for four sheep herds at 4000 m in 2011).

Variables	Transhumance movement pattern			Ecology	
	Altitude	Months	Direction	Pasture type	Competitive species
Lungthung	1700-2000	April-May	Upward	Subtropical	Buffalo, hill cattle, and goats
Se Lele	2600	May-June	Upward	Subtropical-temperate	-
Bakang/Mauma	3600-4100	June-July	Upward	Subalpine-alpine	Yaks and chauries
Langyong	4100-4500	July-August	Upward	Alpine	Yaks and chauries
Thangje	4200-4700	July-August	Top lying	Alpine	Yaks and chauries
Lumbasamba	4500-4700	August-September	Top lying	Alpine	Yaks and chauries
Lamidanda	4000	September	Downward	Alpine	Yaks and chauries
Hile	3500	September-October	Downward	Subalpine-alpine	Yaks and chauries
Lungthung	1700	October-March	Winter stay	Subtropical	Buffalo, hill cattle, and goats

period, the flocks are confined to the summer crop residues, fodder trees and straws. The duration of stay at pastures depends upon the weather; pasture condition and availability and the herd size. At high altitude pastures, the grazing competition basically occurs with yaks and their hybrids with cattle called chauries (*Bos indicus* × *Bos grunnniens* or *Bos grunniens* × *Bos taurus*) (detail in Table 2).

The vegetation remained different according to the altitude and slope and aspect (authors own observation during field visit). In the lower mountains, the mixed meadow is available for sheep grazing. The main palatable pasture species in the altitudes (3500 to 4000 m) were the *Poa* sp*., Kobresia* sp. and *Bistorta* sp. and *Potentilla* sp*.* In the upper zones (>4000 m) mixed meadow of *Kobresia, Festuca,* and *Agrostis* with other plant species were available rather than *Poa*.

Lambing and herd management

Usually the lambing starts during October when the herds arrive from a long march after utilizing the alpine pasture. Around 50% of the sheep lambs. Amongst them 10% lose their respective lambs due to abortion, whilst next 10% had the kid mortality (unknown causes). The high rate of abortion might be due to the long transhumant route in the grass based natural pasture or due to the diet energy constraints. Feeding of high plane of nutrition (concentrates) to the sheep at pregnancy was almost nil at the same time when the vegetation is tended to be lignified in the lower altitudes at the start of winter in the study site.

Shearing of wool

In the traditional practice, wool was sheared for two times in a year that is, first at spring (April) before being at high altitude (>4000 m a.s.l) and second at autumn (<3000 m a.s.l) in September to October at the start of the downward movement (Table 2). The average annual wool production was about one kg and costs nearly NRs.100/kg (1 USD/kg) for raw wool (according to the herders).

Economics of transhumance sheep farming

Instead of decline of transhumant sheep population, the system is depended on the natural vegetation and costs very little to the unit sheep production. Herders usually give only salt occasionally to the sheep besides grazing. The rate of feeding salt is about 70 kg in winter compared to 60 kg during summer for 120 sheep. Concentrate feeding is not established in the traditional transhumant sheep farming. Sheep herding is depended merely on natural seasonal pasture and has been recognized to be the low input system of rearing. The inputs used to rear the sheep in transhumance is very low as compared to the output gained. One mature sheep (20 to 25 kg) in this area costs around NRs 5000 (USD 75), although the

Table 3. Annual expenses for herding of 180 Baruwal sheep at KCA.

[1]Particulars	Total costs	
	[2]NRs.	[3]USD
Expenses for salt (130 kg) and others for sheep	6500	87.00
Food support for 2 herders during grazing period	25000	333.33
Expenses of shelter to the herders (tents, plastic thatch etc.)	4000	53.30
Food for 2 dogs annually	3000	40.00
Annual payment to KCA community forest users groups	500	6.67
Gross expenses	39,000	520

[1]information based on the combined flock of 4 herders having common share of benefits and moving the herds together, [2]information based on the herder's record during the time of interview in 2011, [3] based on exchange rate of 1USD= 75 Nepalese Rupees (NRs.).

Table 4. Annual net income from transhumant herding of 180 Baruwal sheep at KCA.

[1]Particulars	Total income	
	[2]NRs.	[3]USD
Selling of wool 160 kg @NRs100	16000	213.33
Selling of lambs 60 @NRs2000	120000	1600.00
Selling of mature rams @ NRs 5000 (5 rams)	25000	333.33
Occasional selling of ghee and butter and cheese 30 kg @NRS 350	10500	140
Gross income	171500	2286.66

[1]information is based on the combined flock of 4 herders having common share of benefits and moving the herds together, [2]information based on the herder's record during the time of interview in 2011, [3]based on exchange rate of 1USD= 75 Nepalese Rupees (NRs.)

price might vary depending upon male and female and live weight. The net expenses and net return of the herd has been highlighted in Tables 3 and 4.

From Tables 3 and 4, the net benefit was calculated. Accordingly Net benefit= Gross income- Gross expenses= 2286.66-520 = 1766.67 (USD) value. This value gained from sheep farming is 50% net benefit gained from one ropani (500 m^2) land from cardamom in Lungthung area of KCA (general estimation of production of cardamom as of 200 kg from one ropani and current price of the one kg fresh harvested cardamom is 75 USD) according to the respondents.

Constraints of transhumant sheep farming in KCA

A number of constraints/problems have been identified in the FGD. The major constraints of transhumance herding of sheep have been discussed as follows:

Transhumant livestock species overlap

Domestic species overlapped both yak/chauri grazing at high alpine pastures. However, the intensity of grazing competition and its impact on vegetation and productive performance has not yet been available. According to the shepherds, sheep had blamed for spoiling the yak pasture due to frequent urination and gutter, and hoof damage of yaks (*Bos grunniens*) and yak × cattle hybrids called chauries had been reported by the yak herders when yaks travelled closely at the night camps sites of sheep and or during daytime grazing. The exact scientific reason for hoof damage of yaks and chauries due to sheep dung was not known but however it could be due to the bacterial infections.

Disputes between the shepherds and conservation area management

After the declaration of conservation area in 1996 (Parker and Thapa, 2012), few sanctions had been imposed to the transhumant herders. Every year, the sheep herders had to pay NRs. 500 (6.7 USD / herd) to the local community forest users groups (CFUG) for alpine grazing. But there were no sufficient provisions for training of herders on herd management to promote the livelihood of the sheep herders.

Wildlife-domestic animal species overlap

Predation of sheep and their lambs had also been

Table 5. Ranking of major diseases and parasites of sheep by the respondents at KCA.

[1]Rank	[1]Major problem	[2]Altitude	[2]Months
1	Hoof infection	4000-4500 m	July
2	Eye infection and head swelling	>4500 m	August
3	Cough	4000-4500 m	July-September
4	Leach bite and bleeding, plant poisoning	2000-3000 m	April-June

[1]Information collected during the FGD,[2]Information elaborated together with the sheep herders during field visit.

reported by the local people. However, no satisfactory insurance payment system had been arranged by KCA to the shepherds whose sheep were poached by the wild predators (leopards, jackals and foxes). Annual depredation rate was unpredictable but loss of 1-2 animals was unstoppable according to the shepherds. Ikeda (2004) reported the series of depredation the domestic animals by snow leopards in the eastern part of KCA with having no economic damage on households of larger herd size (37 per households) of yaks and chauries, but this might cost to the households of smaller herd sizes of sheep and the intensity of depredation might have also been increased over time.

Farming systems overlap

The lower altitude sites (<2000 m a.s.l) of Kanchenjunga conservation area had been intensified with the commercial high value crop like cardamom and the grazing land has been reduced annually since few decades.

In discussion, the herders replied that cardamom grown at 500 m^2 could yield three times more earning than the herder having 100 sheep in transhumance. The net return of sheep herding from 180 sheep was quiet low to cardamom farming, although the transhumance sheep farming was very labor extensive but observed with less productive (Tables 3 and 4).

Diseases and parasites

Diseases and pests were also found causing significant reduction in sheep production. The herders had ranked the following diseases and pests related to the decline of sheep productivity. In FGD, it was learned that hoof and eye infection was a major disease of sheep during high altitude stay (Table 5). Likewise, the eye infection and head swelling were reported by the herders for crossbreds when above 4500 during alpine period followed by the cough. Leach bite and bleeding were of less importance for high altitude period although happened during the start of upward movement due to progressing hot and humid environment at low altitude grazing period.

Others

When the rainy season started in June, however leaching remained the main problem when starting the upward movement at low altitude sites in between 2000 to 3000 in those days when the weather is wet and humid. Likewise, trapping in stony caves was being the problem in high alpine pastures due to rough and undulated Himalyan pastures.

DISCUSSION

There were no separate indicators available on productive traits of Baruwal sheep in transhumance for KCA. To the author's knowledge, this paper is the first to report on the basic of transhumant sheep production from KCA of Nepal. The information collected in this study supposed to be helpful for future planning of the nature conservation, decentralization of development activities in KCA for improvement of the livelihood of people and also for the sheep based grazing experiments at high altitude conditions.

In Nepal, the history of mountain development has rather a very short history (Barsila, 2008); likewise, the promotion activities for mountain livestock development are still on shadow due to poor institutional infrastructures (Dong et al., 2009b). Although, the livestock system is the sort of livelihood of peoples of mountains of Nepal (Tulachan and Neupane, 1999) where there are no sudden possibilities of other economic interventions and due to very limited arable land holding (CBS, 2001/02). In KCA, the arable land holding is only 2% of the total area (2035 km^2) of KCA coverage (Parker and Thapa, 2012). Baruwal Sheep are the important native transhumant species raised by the mountain peoples of Nepal since the historic period.

The transhumant cycle is associated with the increasing ambient temperature for which the sheep could not tolerate at low altitude during summer. The year round altitude movement of sheep across the altitudinal gradients in the Himalayan Mountains of KCA was longer in duration and wider in altitude comparable to the migration pattern of of yaks and their hybrids in Nepal. Approximated 6 to 8 months of high altitude sheep grazing observed in this study was higher than that of the

transhumant sheep grazing in the French Alps (Gruner et al., 2006). However, it could be hypothesized that high altitude summer grazing competitions and farming system overlap in winter at low altitude of KCA might have resulted the poor performance of sheep, as there were no provisions of winter feeding except than the common salt. Galanopoulos et al. (2011) reported that smallholder transhumant sheep had the technical efficiency low due to smaller herd size as this might also be applied in this study having only 180 sheep by four herders of different families. The annual wool production per sheep and shearing time reported by the respondents in this study were similar to that reported by Joshi et al. (2004) and Wilson (1997) for Nepalese sheep.

The grazing route in the present study site was comparatively long (more than 30 km estimated by authors) and were physically isolated. Unlike in winter crossbreeding with Kagi sheep available at low altitude the inbreeding would result significant declined sheep productivity in the transhumance. The pedigree and the time since when the inbreeding started were unknown in the traditionally raised flocks, as herders lack most of the information due to poor record keeping system. The data on rainfall variation and its relationships on parasitic infection were also not known and for which the separate indicators yet to be built in future experiments.

The diseases and parasitic infections during high altitude grazing reported by the respondents in this study were similar to the report by Joshi et al. (2004) in the western Nepal for the Baruwal sheep. The crossbred sheep would be less tolerant to move on a long grazing route as it might be tedious to them to walk in hypoxic pastures of high altitude and were usually affected by eye swelling due to high altitude sickness (Joshi et al., 2004) and hoof damage during July to August could also be due to the poor mineral content of mountain pastures (Xin et al., 2011). The high altitude pasture sites had been reported covered by more unpalatable forbs than the palatable grasses and sedges in the recent study (Barshila and Devkota, 2013). The eye infection and head swelling were prominent to the crossbreds (Baruwal × Kagi) as compared to the purebred Baruwal sheep could also be viewed as the high altitude intolerance and due to the reason that one of the parents of crossbreds was the native dwellers of low altitude (Kagi sheep), whilst Baruwal sheep are migrated to high altitude and would have better adaptability than Kagi at high altitude. The change in crossbreeding strategy would be an option to improve the high altitude tolerance of crossbreds. The detailed quantitative genetic studies of transhumant sheep performance further needs to be carried out in KCA particularly for Baruwal sheep.

The major constraints of transhumant sheep farming in KCA was learnt due to poor net return from the herding and further exacerbated by legal, biological and social problems as noted in this study. In spite of these constraints the KCA region has a greater scope of transhumant sheep farming due to the availability of different kinds of vegetation due to its wider ecology from 1200 m that is, mixed forest in lower elevation zones to open mixed meadows in high alpine Himalayan Mountains (more than 3000 m). KCA is also well known for trekking route and usually 600 tourists per year visit KCA (Parker and Thapa, 2012) to the world's third highest peak – Mt. Kanchenjunga (Parker and Thapa, 2011).

The transhumant sheep farming still has the opportunities for the valorization of products as Baruwal is raised as a multipurpose animal (Wilson, 1997). Meat and milk products from animals grazing on the high alpine areas are known to have excellent nutritive quality that is, conjugated linoleic acid is higher in milk fat of naturally grazed animals (Pajor et al., 2009). High altitude milk products are also thought useful in prevention of various human diseases including cancer and diabetes (Mcguire and McGuire, 2000; Singhfield et al., 2012). For further promotion of livelihood of the herders, a number of possible interventions could be suggested in short term example, concentrate feeding before and after lambing, fencing and lighting at night, frequent vaccination and introduction of new rams for control of inbreeding etc. Market promotion and crossbreeding as well could be the better alternatives in long term development strategies.

Conflict of Interest

The authors have not declared any conflict of interest.

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