Research Article

ASSESSMENT OF MAJOR FEED RESOURCES AND ITS UTILIZATION IN MANASLU CONSERVATION AREA (MCA), NEPAL

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ABSTRACT

An assessment was made about the available feed resources, its utilization pattern, specifically, roughage and concentrate, produced from Manaslu Conservation Area (MCA) of Nepal to formulate the appropriate strategies in satisfying the annual dietary requirements of the livestock covering its present production and management scenarios. A Comparative study was done by employing purposively conducted survey to deduct distribution of forage sources in the area. Findings revealed that natural vegetation, seasonally available crop residues, and dried grasses were major feed resources whereas their contribution to the total supply varied significantly ($p<0.01$). The amount of feed obtained from various sources was calculated by standard conversion and by using primary household data. Finding revealed that farmers allow significantly higher ($p<0.01$) number of grazing days and hours per day for large ruminants, such as Yak and Chauries compared with small ruminants, such as goats and sheep. The findings also indicated seasonal variation of feed supply whereas January to March is the period of short supply ($p<0.01$). It was relatively in good supply during June to September though average roughage and crude protein supplement for the animals was far below than optimum requirements. These scenarios suggest the need of immediate attention to improve the range productivity in the MCA as the deteriorating situations of the rangelands may raise questions on sustainability of livestock herders.

Keywords: Altitude; Dietary Requirement; Carrying Capacity; Rangeland

INTRODUCTION

Livestock is the major component of livelihoods within the mountain people of Nepal (Joshi & Pande, 1991; Pariyar, 1993). Moving farther from hills to mountain, the geographic conditions become harsher, therefore less crop productivity may be achieved, whereas as altitude progressed, it is compensated by higher livestock population (Upadhyaya et al., 2011). The animal type also differs within two altitude range. In the hilly region, there is predominantly indigenous type of cattle, with the less potentiality of milk production, whereas in the lower region, buffaloes and cattle are predominant livestock species. The area is characterized by food insecurity, land degradation, soil loss and extremely vulnerable to climate change (Tiwari & Shrestha, 2004; Devkota & Kolachhapati, 2008; 2009; Joshi & Pande, 1991; Pariyar, 1993). As a result, animals are not able to get their optimum nutrient requirements and often lose their productivity.

Crop residues and dried forage products are the major feed resources, and the concentrate supplement is poor to the animals in these regions. Therefore, appropriate management and utilization of crop residues and dried forages is of paramount importance to identify best intervention practices for efficient utilization and assessments of available feeds resources. It is difficult to arrive at realistic estimations in this region in terms of exact quantity produced and utilization, and also to identify constraints related to feeding management that often limits improved utilization (Hailu & Fekede, 2007) mainly due to the harsh geographic situation and highly remoteness.

So far, information on the feed availability, utilization pattern and conservation strategies are scanty. This study was therefore designed to assess the available feed resources, estimate the amount of feed that can be produced per-annum, and relate with the annual requirements for the existing livestock population to help improve livestock feed supply in Manaslu Conservation Area, Nepal.

MATERIAL AND METHODS

Study area

Manaslu Conservation Area (MCA) includes seven former Village Development Committees (VDCs) such as, Sirdibas, Chumchet, Chekampar, Bihi, Prok, Lho and Samagaun. A comprehensive survey was conducted mainly into two VDCs of Manaslu Conservations Area i.e. Lho and Prok VDC of the Gorkha district. There were 1952 households and 4465 males and 4465 females reside. It is joined to Tibet in North, Manang in West and Dhading in the East (Figure 1, 2).

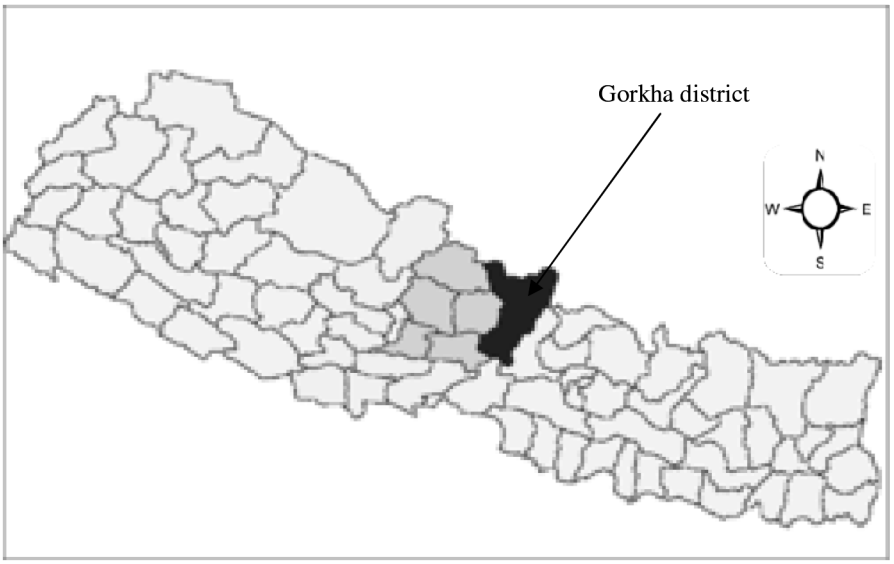


Figure 1. Map of Nepal showing Gorkha district

Figure 2. Map of MCA

Selection of the respondents

Two hundred households were randomly selected for the purpose of this study mainly to conduct household survey. A semi-structured questionnaire which focused on current livestock number, available feed stuffs, and amount of feed stuffs provided daily and available land was employed to obtain the precise information from each selected household. For the subjected study, a questionnaire was developed through a consultative process keeping in view the objectives of the study. Developed questionnaire was pre-tested to avoid the chances of duplication and biasness. Moreover, secondary information was also obtained from local organizations.

Estimation of the quantity of available feed resource

The quantity of feed resources used per household was estimated on the basis of available information about the cultivated croplands area and daily use of the feed resources to feed livestock. Similarly, secondary information on cultivated area, total livestock population was taken from the respective district. The amount of crops residues and by-products and total volume of grass collection was assessed by calculating the core value available from the primary and secondary sources. For the purpose of crop by product measurement, total amount of crop production was identified. Different crop by products useful for animal feeding was calculated based on amount of major crop harvested by using standard conversion factor suggested by FAO (1987).

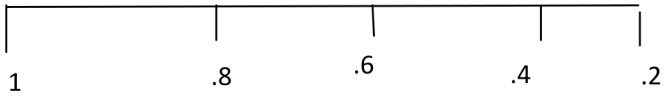
The amount of feed resources utilized by the animal was estimated by using standard conversion factors, called multipliers. The multiplier for maize was 2.0 where as 1.5 for wheat and barley. The output of the grazing pasture was measured based on FAO (1987) multiplier factor which was 2.0 t/ha, and crop aftermath grazing potential was estimated using a mean of 0.5 t per hectare.

Estimation of available dry roughages and animal requirements

The total available dry matter of the feed was estimated by using a standardized formula (Yitaye et al., 1999a) as modified and cited from MAFF (1975). The number of animals available in each household was converted to the livestock unit. It was considered that the average dry matter requirements per livestock unit (250 kg body weight in dry condition) would be 5 kg dry matter per day for maintenance ration (FAO, 1996). The digestible protein requirements for maintenance and growth were considered as 100g and 160g digestible protein (DP)/day/livestock unit, respectively. In the case of the average ME calculation, the average value of the major feed resources was used, while the other less available feed resources were not considered in the estimation, due to their insignificant contribution (Pande, 1994). Furthermore, average feed required for maintenance was considered as 2% of the body weight (Kear Lc, 1982). Scarnecchia & Kothmann (1985) defined the LSU as a unit of animal demand equivalent to approximately 11.8 kg dry matter (DM)/day. The Livestock unit coefficients used according to the reference provided by FAO, (2011) stands- cattle 0.65 LSU, buffalo 0.7, goat or sheep 0.1, swine 0.25, horse 0.65, and poultry 0.01 LSU, respectively.

Indexing and ranking tool

Scaling technique, which provides the direction and extremity attitude of the respondent towards any proposition was used to construct indexes. The formula given below was used to find the index for intensity of various problem/reasons (Wigboldus et al., 2016).



$$I_{prob} = \Sigma S_i f_i / N$$

Where, I_{prob} = Index value for intensity of problem, Σ = Summation, S_i =Scale value of i^{th} intensity, f_i = Frequency of i^{th} response N = Total number of respondents

Statistical analysis

All the available data were entered into Microsoft Excel sheet, edited for clarity, and were subjected to the appropriate statistical analysis by using Statistical Packages of Social Science (SPSS) Version (16). Descriptive as well as analytical statistics were used for the analysis of the data.

RESULTS

Basic information about the MCA

Manaslu Conservation Area (MCA) lies in Northern region of Gorkha district. This district is mainly characterized by the highly steep and rocky area with poor infrastructure development, such as roads, electricity and communication. Though, this area is recognized as one of the highly remote areas, but equally well known for its richness in natural flora and fauna along with high variation in altitude and the latitude. Geopolitically, it is one of the most sensitive areas of Nepal. The Manaslu Conservation Area (MCA) is a protected area of Nepal established on 31st Dec, 1998. It covers 1663 km^2 (46.06%) in the Mansiri Himalayan range, out of total 3610 km^2 area of the Gorkha district. This region occupies hilly region as well as mountainous region with 46.07% of the total area of Gorkha district (NTNC, 2016)

The study was conducted in the MCA which lies in the protected region of Nepal. It is geographically important place in terms of wildlife and is also known for one of the Peak Mountains of the world with the total height of 8,000 meters above sea level (masl). MCA is one of the richest areas of natural flora and fauna, wild animals with huge biodiversity. The area is considered one of the highly vulnerable areas to the climate change (Yan et al., 2003). The precipitations fall more in summer while it is significantly lower during winter season. Yan et al., (2003) also suggested that Nepalese rangeland is extremely affected by the land degradation, soil loss, and overgrazing and degradation of the pastureland, which is typically similar case of MCA.

Existing biodiversity

The conservation area starts at 600 m and reaches up to 8th highest peak in the world, Mt. Manaslu at 8,613 masl. There were about 9,000 inhabitants living in the MCA and 2,000 species of plants, 33 mammals, 110 birds, 3 reptiles, and 11 butterflies within 11 types of forest, recognized from this area. There were approximately 2000 species of plants, 11 types of forests and over 50 species of high value plants. The vegetation of the area

can be divided into three main categories, mainly based on the altitude, such as low hills, high hills, and high mountain types. Each category has its own types of climate, dominant forests and other associated species (Pokhrel & Thakuri, 2016).

Socio economic conditions

The area was neglected in terms of infrastructure development, which had directly affected the livelihood of the farmers. The local people had been deprived of the benefits of proper bridges and trails. Most of the 56 villages did not have safe drinking water supply and electricity. Education and health services were almost non-existent. Since no other economic opportunities were available, they had to depend on marginal agriculture, animal husbandry and exploitation of natural resources for survival. As agriculture cannot sustain their livelihood, a high dependency on natural resources was constantly straining the capacity of the fragile mountain ecosystem (Pokhrel & Thakuri, 2016).

Lho, VDC covers 212 km^2, having four settlements with 229 households, counting total population of 1,031 (525 males and 506 females). All were Lamas ethnicity, speaking Tibetan language. Their main source of livelihood support is livestock and agriculture. The main livestock species were Yaks, Naks, Chauries (yak hybrid), horses, and some hill cattle at lower altitude. Himangtal, Nyad, and Himchuli snow range were the attractive ecotourism range.

This area has been mainly occupied with Bhote, Gurung and Mongolian ethnicity. These farmers were considered as resource poor and marginalized with respect to availabilities of modern facilities and technologies for their basic needs. (Pokhrel & Thakuri, 2016) (NTNC, 2016).

The number of the animals and socioeconomic characteristics of the households

The average own land and available grazing land per household was 0.1 and 3.7 ha, respectively. The majority (87%) of the household adopt mixed type of farming system mostly agricultural crops integrated with livestock production. The average numbers of livestock per household include 4.75±.85 (Chauries), 2.02±.46 (Yaks) and, 0.57±14 (mules) (Figure 3). Wheat, naked barley/ uwa, potato and Cole vegetables are the major agricultural products. About 70% of the land is owned by women while remaining 30% is owned by male, respectively. Mean household size is 6.5. Besides agriculture crops, livestock is the major source of livelihood. Majority of the farmers (60%) in the study area are uneducated. Meanwhile, among the educated group, only 10% have joined the University for Higher Study.

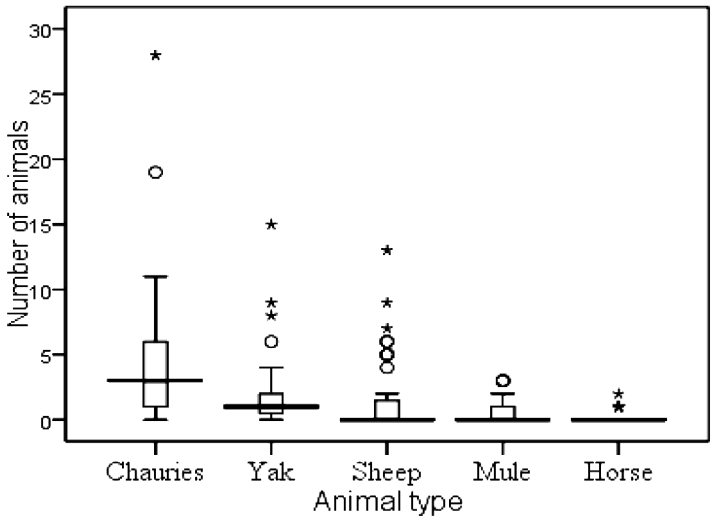


Figure 3. The average number of animals per household in Lho and Prok VDC of MCA

Contribution in livestock sector

Yak and Chauries combined covered majority (70%) of the income sources of the farmer. Meanwhile, sheep and other small ruminants covered non significant amount (less than 1%). The livestock production system in the watershed area was almost conventional type. Yak and Chauries are preferably used for carrying loads, fuel woods and transportation. (Figure 4).

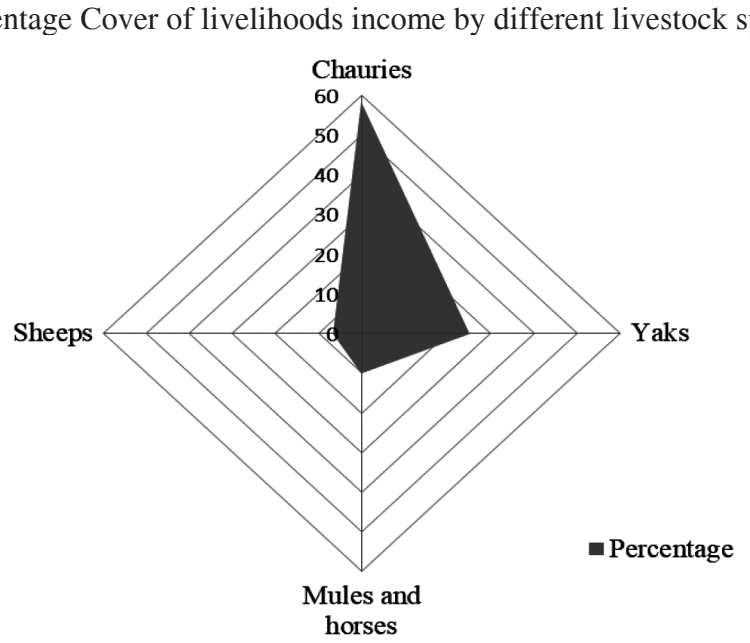


Figure 4. Likelihood of risk minimization of different animal species in winter feed scarcity period

Available feed resources and utilization

Farmer preferably used to graze their animal round the year with minimum dependencies in the external inputs such as medicine, concentrate feeds, and other veterinary services. However, it was revealed from the findings that there were acute problems in health of these animals mainly due to parasitic and other diseases outbreak. The disabilities of the animals such as breaking of the legs were also major issues. The survey findings revealed that grazing natural pasture was the major feed sources for livestock, which was estimated as 85.4% of the total feed supply (dry matter basis) followed by natural grass hay (10%), and the remaining 4.5 % is fulfilled by the collection from nearby land and vegetation. Agricultural crops and its by-products such as crop and beans Stover had negligible (2.1%) contribution to the dry matter supply to these mountain animals. Those cultivated pasture and grass had almost null (less than 0.5%) contribution (Figure 5).

Barley and seed beans Stover feeding

Farmers usually harvest barley and beans during summer season when the feed availability is comparatively higher, ultimately possible to conserve and used during feed shortage period; more concisely, during winter period. The survey results showed that about 95.5% of the residues is used as feed, while the remaining is used for sale (5%). The price of the stover is very high and fetches about NRs. 20 rupees per kg dry matter. They utilize these feed stuffs without processing and fortification of the nutrients.

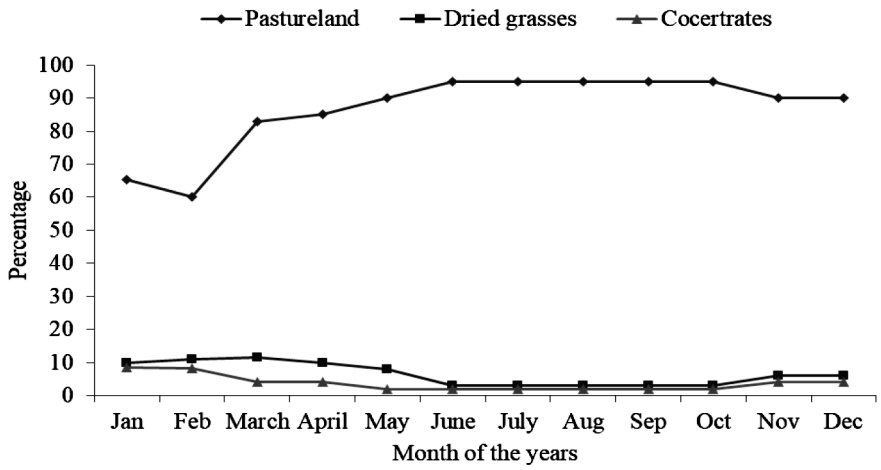


Figure 5. Percentage feeds contribution of different feed resources in Manaslu Conservation Area, Nepal

Month of feed availability and feeding calendar

Seasonal feed availability and feeding calendar is shown in Table (1). Feed was in short supply during December to May. During this period, all preserved crops residues and dried grasses become exhausted and consequently the grazing grasses also become extremely poor in terms of nutrients supply. The strategy used to cope within the feed shortage months was supplementing dry crop residues and dried grasses. Those lactating animal would be dried up during this period and therefore milk production reduced.

Moreover, due to cool period, they follow the transhumant system of grazing to minimize the risk of climate hazards. This has resulted in huge conflicts on the utilization of the grazing land between the communities of upper and lower regions. This leads to decreasing the number of livestock mainly due to acute shortage of grazing land.

Table1. Relative feed availabilities in the pasturelands/ranges and scenario of overall available roughages

Feed type	Months of the years											
	J	F	M	A	M	J	J	A	S	O	N	D
High altitude Pasture	-		+	+	+	X	X	X	X	-	-	-
Crop resides and stover	-	-	-	-	-	X	-	+	+	+	-	-
Low altitude pasture	+	+	-	-	-	X	-	-	-	-	+	+

Note: (+) indicate Months of fairly availabilities of feeds/ roughages, (X) indicates Months of good availabilities of feeds/roughages and (-) indicates Months with extreme shortage of feeds/roughages

Farmer preserve crop residues for the dry seasons; however, the way of conservation was not generally appropriate. Relatively feed was in good supply during the months of June to September. During this period, there is better growth of pasture so they collect grasses and use them to make hay for feeding during critical periods when animal cannot go outside for grazing.

Grazing practices

Table 2. Scenario of grazing practice in the study area

Species	Time spent by animal in upper region (hours/day)	Time spent by animal in lower region (hours/day)	P value
Average time large ruminant (Yak and cattle)	10±0.30	4±0.20	<0.01
Small ruminant (goat and sheep)	6±0.20	4±0.05	<0.01
P value	<0.01	NS	

The total time spent by each animal in the upper region is significantly higher. Livestock herder of both small and large ruminants of the upper region used to allow more time to the animals to graze on their rangeland. Moreover time spent by large ruminant was higher than that of small ruminants in both regions (Table 2).

Concentrates supply

Concentrates were supplemented occasionally by only few households (10.7%) in the watershed, which is normally purchased from the neighbors and local traders. These feeds were carried by the mules from the nearer market. The price of transport is equivalent to the original price of the concentrates. Concentrates feed used is below optimum level of requirements and the supplied amount differed according to the period of production of the animals. Required quantity of concentrate feed was not supplied to either dry as well as productive animals. The commonly used concentrates composed of maize, rice polish, and wheat bran, either in the form of mixture or fed alone.

Feed quantification

Estimation of major feed resources

Grazing in rangelands of natural vegetation was mostly common (98%). Other concentrates feed-stuffs such as maize and barley covered about 1.64% dry matter requirements per year per household. Farmers used to

graze their animal in the stubble land during barren periods, but its contribution in non-significant. The type of grasslands and amount of major feed stuffs available has been presented in Table (3).

Table 3. The average area coverage and estimated contribution of grazing lands, stubble grazing and communal grazing land

Feed sources	Area (ha)	Conversion factor	Dry matter production (Conversion factor) kg/m^2)	Total Contribution(tons)	Average contribution %
Natural grazing lands or rangelands (only 60% used properly)	750	2	0.5	4500	98.20
Stubble grazing land	30	0.15	0.001	0.05	0.02
Bush and shrubs	500	1.2	0.0112	67.2	0.38
Crop residues	30	0.5	0.09	13.5	1.64
Total				4580.75	100
P value				<0.001	

*conversion factor given by (FAO, 2000; Alemayhu Mengistu, 2002)

Dry matter yield of stable crops

Contribution of Stover and residues of maize and barley contributed significantly higher proportion of roughages ($p < 0.01$) to feed the animal. Leafy vegetable had the lowest contribution in total dry mater fed to the animal. Maize and barley residues had significantly higher contribution in total dry matter yield where as this value significantly lower for other leafy vegetables beans and other high altitude crops namely Sorghum and Barley (Table 4).

Table 4. Dry matter yield of cultivated crops

Major parameter	Major crops					
	Barley	Beans	Leafy vegetables	Maize	Sorghum and other	Total
Cultivated area per household (ha)	0.1	0.05	0.03	0.1	0.05	0.33
Proportion of total cultivated area (%)	30.77	15.38	7.69	30.77	15.38	100
Economic yield (t/h/year)	2.4	3.5	7	2.5	2	17.4
Conversion factor (percentage)	1	1	2	2	1	7
Dry matter yield of residues (t/household)	0.01	0.00	0.00	0.02	0.00	0.04
P value	<0.01					

DISCUSSION

Most of the households (HHs) in the study area had kept more than one species of domestic animals which helped them to minimize the risk and provided income in regular bases (Tiwari & Shrestha, 2004). It was revealed that, having more large number of animals was an indicator of wealth and was the means of risk aversion in case of natural disaster, or during difficult situation. Dong et al. (1990) also had reported the similar finding in their case in high altitude range of Nepal, Rasuwa district. Farmer used to sell their animal during emergency to fulfill their basic need. This fact was also echoed by Barsila (2008). Majority of the farmers (80%) suggested that it was easy

to manage Yak and Chauries on the feed scarcity period and extreme climatic condition than sheep and donkeys (Sherestha, 1996; Shrestha, 1998). They could thrive well in snowfall or extreme weather so that they left their animal in the rangelands during summer and winter period.

It was found that livestock in the study area were managed in an extensive management system where communal grazing was predominant. This was similarly reported also by the several other researchers (Dong et al., 2009; Miller, 1987; Miller, 1997). Accordingly, majority of the herders followed the transhumant system of grazing (Pande, 2004; Shrestha, 1998). During cold winter they grazed their animals at the lower range than their residences while during summer seasons, they used to graze in the higher altitude range. During those cold months, grazing land are generally not efficiently managed and utilized as communal grazing resource (Miller, 1987). The area occupied used to be already fixed to graze therefore new rivals possibly could not get chances. This means new owners were not allowed to graze in any of the grazing land. Therefore, there was almost absence of newly started herder which signifies the deterioration of the transhumant system in the days to come.

On the other hand, the grazing system followed by herders was not scientific to control the regular deterioration. This grazing land had a huge potentiality, if management was to be improved such as by enclosing the area of rangeland, and by following some scientific grazing practices including rangeland renovation and re-establishment program, but till date, all practices are almost non existence.

Severe dependency was found with unrestricted access of herders towards deteriorated rangeland during most of the months of the year, except January and February (Figure 4) which signifies that rangelands was ultimate sources of forage in high altitude. Blocked from different communities' forestry program to graze animal in the forest land and rangelands ownership issues had compounded the grazing frequency in the rangelands. This may lead to diminishing of palatable species and finally bolsters the emergences of exotic and less palatable species (Amiri et al., 2008). This bolster the need of rangeland improvement activities in high altitude range of Northern high hills of Nepal, but practices of renovation of rangelands by adopting improved forages species is still lagged behind. However, different perennial forages and pasture species such as Napier (*Pennisetum purpureum*), white clover (*Trifolium repens*), perennial ryegrass (*Lolium perenne*), Italian ryegrass (*Lolium multiflorum*), paspalum (*Paspalum dilatatum*), Dhumchi (*Paspalum falcatum*) were found to be successfully adopted in similar agro climatic conditions of different mountain regions of Nepal (Joshi and Pande, 1991; Pariyar 1993). Barsila (2008) also suggested that scientific forage processing technology would help them to conserve forage with optimum standard and maintain the year round nutrition. In addition to the forage species, various planting technologies, such as hedgerow, backyard production, particularly associated with the natural resource conservation seems to be advantageous in one hand and while the natural resource conservation practices such as soil and vegetation improvement in other (Devkota & Kolachhapati, 2008; 2009; Pande, 1997) could be more relevant to intervene. However, the past experiences suggests that the adoption rate of the forage technologies in the study area was found to be very low due to weak extension support, which mainly emphasized on food crops. This may be particularly due to less emphasis by research and extension agents on livestock and forage development (Joshi & Pande, 1991; Pariyar, 1993).

The availability of feed in the study area was seasonal; feed was in short supply during December to May and very critical during the months of April to May. However; relatively feed was in good supply during June to September. The farmers preserve crop residues for dry seasons; however, the way of conservation is not generally appropriate and often products were used for other purposes such as fire fuel, and as a construction material. Silage and hay making is not practiced in a strict sense as it was rarely done without following scientific methods whenever the available grasses was abundant. Farmers were limited in terms of their experience in treating and processing forages to improve the nutritional quality of crop residues. Therefore, intervention of several scientific activities related to effective collection, conservation and proper utilization of crop residues and hay making might be useful to help increase the available feed. Those could be, for example seeking alternatives options such as use of chemical method of straw/crop residue treatments to enhance forage quality. Introduction of nutrient blocks, scientific silage making procedure, and scale-up of improved forage species with the participatory approach might help to enhance the nutritional quality of available feed for dry season (Pande, 1997).

The findings from this study also revealed that the livestock production system in the MCA was heavily dependent on grazing from rangelands and natural pastures. The entire animal feeding system was solely based on grazing and sometimes feeding of grasses/vegetation/weeds found in terraces and barren land during summer seasons. This system contributed about 1.64% (Table 3) of the roughages consumed by the animals. These feed resources are generally poor in quality and their productivity and supply is seasonal, particularly critical during the dry season. Currently, with the rapid encroachment and uncontrolled grazing, the quality of the pastureland/

rangelands is in diminishing state, not only in terms of number of palatable plant species available, but also in terms of quality of the whole grasslands. It was estimated that available protein percentage in the grazing land has been decreased at least by 40% due to decrease in the number of forbs, legumes and broadleaf grasses as about 40 % cover of palatable species was found replaced by other less palatable and exotic species. This finding matches well with the finding as reported by Pariyar (1993); Devkota & Kolachhapati; (2008; 2009); and Tiwari & Shrestha, (2004). This signifies that the carrying capacity of the rangeland was in diminishing rate. Besides these, available rangelands was steadily shrinking due to the conversion of grazing lands to barren and open land and due to imposition of restriction to the areas for grazing, particularly in the community forest.

These all findings and related facts clearly revealed about lack of enough available feed resource even to cover the maintenance requirements of the livestock population (Pande, 2019) in the study area. The available feed supported only 83.3% of the total dry matter requirements of animals though some of the dry matter requirements was compensated by supplementation of weed, tree leaves (that was not included in the estimation because poor practice of the cut and carry system of fodder twigs and forage (Acharya & Baral, 2017). Meanwhile, the CP requirement was 135.13 t/year, while the amount supplied was 67.54 t on DM basis, covering 50.03% of the digestible protein requirements of animals. Both energy and protein are the major limiting factors for livestock productivity in the MCA where protein deficit was prominent. Pariyar (1993), Tiwari & Shrestha (2004); Devkota & Kolachhapati, (2008; 2009) had also reported that livestock in high hills are under severe feed deficit condition.

CONCLUSION

Relatively low level of feed availability has intensified the dependency of high altitude herders on rangelands leading to deterioration on quality and quantity aspects of herbage mass availability. The acute shortage of grazing vegetation/pasturing has compelled the local people, especially herders, to abandon the practice of traditional agricultural systems, and forced them to engage on alternative options of livelihoods. These scenarios thus suggest the need of immediate attention to improve the pasture/range productivity in the MCA. The deteriorating situations of the rangelands have not only depleted the production potential, but also rendered the cause for loss of biodiversity. This may eventually raise the questions on sustainability of livestock herders.

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