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Review Articles

Research Articles

Research Article

DETERMINING CHEMICAL CONSTITUENTS OF THE SELECTED RANGELAND TO HELP IMPROVE FEED QUALITY UNDER THE CONTEXT OF CLIMATE CHANGE IN THE DISTRICTS OF GANDAKI RIVER BASIN

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ABSTRACTS

This study was conducted in the selected rangelands of Gandaki River Basins (GRB) to determine the major chemical constituents of the rangelands under the context of possible adverse impact of change in climatic variability to provide guidelines for best possible feeding to the graziers. Five rangelands were selected whereas five quadrat samples were taken twice during post monsoon and before start of the winter season in each rangeland. Significant difference ($p<0.05$) in Dry Matter, Crude Protein, Crude Fibre and Total Ash in post monsoon period were observed. But, there was no significant difference in any chemical constituent before the start of winter season in all five rangelands. The crude protein content varied from 7.04±0.96% to 11.71±3.26% in post monsoon and 8.40±0.93% to 11.16±3.33% before the start of winter season. The status of CP was quite good for ruminants' maintenance, and was with the standard of grade 4 and 5 in terms of protein availability. Similarly, the range of DM was 25.9±8.26% to 50.14±7.36% in post monsoon sampling whereas it was 26.04±2.00 to 49.16±7.04 % before the start of winter. They fall in the range of high category with respect to the dry matter content. Grasses were pre-dominant in the rangelands whereas proportion of legume was minimum. More than 80% farmers had knowledge about climate change and they have felt the impacts of climate change in livestock production including feeds and feeding management. The availability of grasses and legumes in the rangelands are decreasing and it needs proper improvement to meet the nutritive requirements of animals also in line with improving such rangelands to develop more productive to tackle with possible adverse impact of change in climatic variabilities in the days to come.

Key words: rangelands, chemical constituents, climate change, feeding management, monsoon

INTRODUCTION

Livestock is an integral part of the mixed farming system and socio-economical life in Nepal which contributes nearly 26 % to the total Agricultural Gross Domestic Product (MoAD, 2012). Livestock and livestock products are an important source of cash income, especially in the hills and mountain (Sharma, 2012). Livestock are still a critical support to the livelihoods of rural people in Nepal who live in or near poverty. There is acute shortage of animal feed during winter and the dry season (Tulachan, 1985) and livestock are generally underfed to the extent of one third of the required amount. Nepal as a whole has a feed shortage of 20-36% (Sherchand & Pradhan, 1997), the problem being more acute in hills and mountains. The climate of Nepal varies greatly from South to North due to the various types of topography and vast altitudinal variation. Temperature observations in Nepal show a great warming trend. According to available data, average annual mean temperatures have been increasing in Nepal by 0.06°C and these increases are more pronounced at higher altitudes and in winter.

Nepal hosts different types of feedstuff in different agro-ecological zones which are used to feed large number of animals and birds. But the animal industry is suffering from many problems which are responsible to hinder the productivity and production level in Nepalese farming system. Among these, feed related problems are: shortage of feedstuff mainly fodder leaves and green forage during winter (October to May) (Devkota & Kolachhapati, 2008).

The Gandaki River Basin lies in the central part of Nepal which is also the major river basin of Nepal. The Gandaki River flows on to India, where it drains into the Ganges River. The spatial area covered by the basin in Nepal is about 35000 sq kilometers. The rangelands comprise about 11.5 percent of the total land resources on Nepal and over 98 percent of rangelands are located in high mountains & Himalayan regions (Pande, 2009). These rangelands contribute 12.6% of supply on TDN basis (Singh, 2002). The annual feed

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deficit in Nepal is estimated at 34.7% on TDN basis. The feed deficit is severe in hills region (-56%) followed by Terai (-42%) and surplus in mountain region (26%) (Sherchand & Pradhan, 1997; Singh, 2002).

Rangelands are important resource for feed for domestic as well as wild animals, especially in Hills and Mountain regions of Nepal. Rangelands are rich sources of herbaceous vegetation. There is lack of concrete and comprehensive scientific study of Nepalese rangelands due to several pertinent reasons, such as remoteness, low level of priority, and due to no or poor estimates of mountain livelihood systems (Miller 1997, Devkota & Kolachhapati 2008, 2009). Determination of major chemical constituents in the herbage of rangelands under the context of climate change helps to manage such rangelands in a better way. This study was carried out in the selected rangelands of Gandaki River Basin Districts viz. Lamjung and Chitwan during post monsoon period and before the start of winter season in 2014with the objective to analyses the quality and quantity feed, or feeding materials produced in the transect of Gandaki River Basin (GRB) and to develop strategy to provide guidelines of best possible feeding strategy in the context of climate change and change in climatic variability. The other objective was to determine the botanical composition of selected herbage sample after monsoon and before the start of winter period to make its link to productive performance in the selected rangelands of GRB transect.

MATERIALS AND METHODS

Study area and period

The study area of this research consisted of selected rangelands across the two districts of Gandaki River Basin viz. Chitwan and Lamjung. Gandaki River Basin lies in the central part of Nepal which originates from the southern edge of the Tibetan Plateau, flows through Nepal to India, and drains into the Ganges River. The livestock population distribution of the two districts is as follows:

Table 1. Distribution of livestock population in the Lamjung and Chitwan

	Cattle/Ox	Buffalo/Bull	Goat	Sheep	Pig	Horse/Mule	Total
Chitwan	21.63	28.10	47.06	0.66	2.55	0.00	100.00
Lamjung	15.16	27.27	46.98	7.34	3.07	0.18	100.00

Source: MOAD 2014

The rangelands in Lamjung were of *Khudi, Ghanapokhara* and *Bhulbhule* VDCs, and rangelands in Chitwan were of *Chandibhanjyang* and *Jutpan*i VDCs. The rangelands were selected based on the transects, by following the natural grazing.

Social survey

The survey was done covering 126 households randomly to those farmers who took their livestock for grazing in those selected rangelands. The respondents of the survey were both male and female and were of age above 20 years.

Collection of samples for proximate analysis

The samples were taken in every 50 m in the transect of animal movement during grazing. From each rangeland, 5 quadrant samples were taken in each period for the proximate analysis. Proximate Analysis was done following the AOAC official method of analysis.

Botanical composition

To determine the botanical composition of rangelands, herbages were separated as legume, non-legume, weeds and dead matter. Botanical composition was calculated following the method described by Tothil et al (1978):

$$T_{fw} \text{ of herbage} = \frac{T_{fw} \text{ of herbage}}{S_{fw} \text{ of herbage}} \times S_{dw}$$

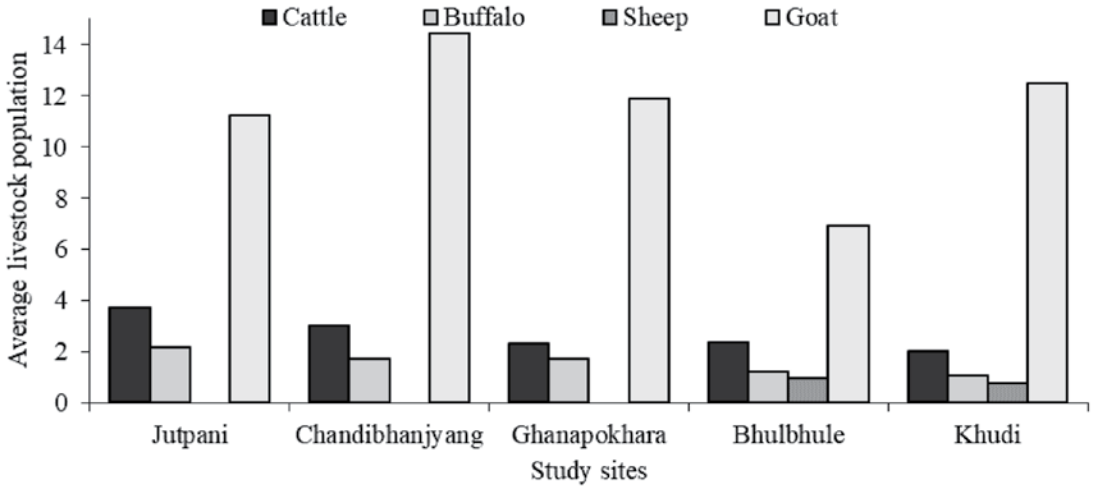
$$\text{Percent composition of herbage} = \frac{T_{dw} \text{ of herbage}}{G_{tdw} \text{ of all species}} \times 100$$

Where:

T_{fw} = total fresh weight
S_{fw} = sub- sample fresh weight
S_{dw} = sub- sample dry weight
T_{dw} = total dry weight
G_{tdw} = grand total dry weigh

RESULTS

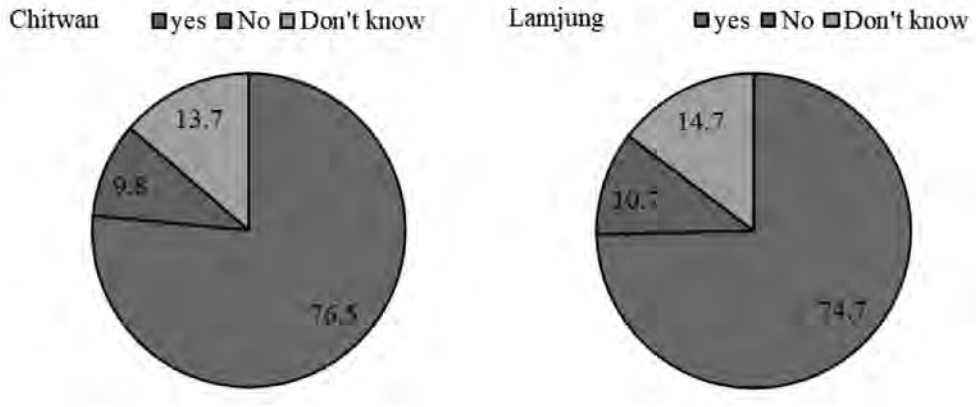
Livestock population per household in study sites



Source: Field Survey, 2014
Figure 1. Average livestock population per household in study sites

The findings revealed that goat is most preferred livestock species in all the study sites of GRB followed by cattle (Figure 1). In the study sites of *Jutpani, Chandibhanjyang*, and *Ghanapokhara* there was no sheep reared during study period which indicates that farmers have left rearing sheep.

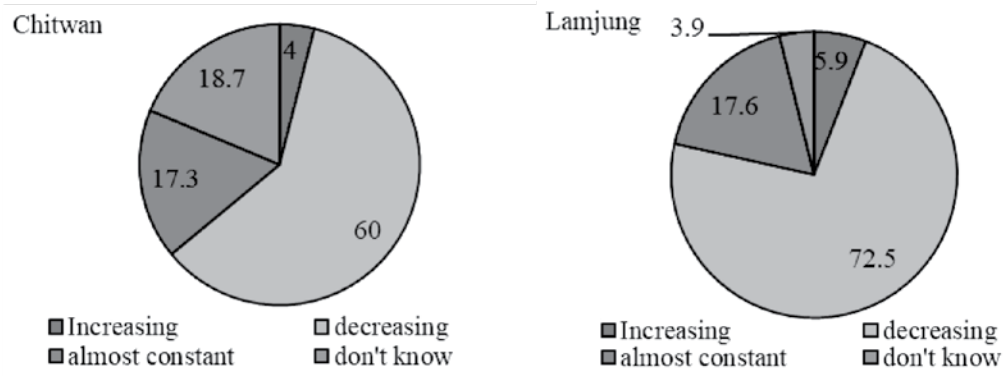
Knowledge on change in rangelands due to climate change



Source: Field Survey, 2014
Figure 2. Change in rangeland due to climate change

It was revealed from the survey that nearly $4/5^{th}$ of the respondents in both the districts(76.5%) felt about change in rangeland due to the factors related to climate change, or climatic variability, especially in the past 5 years. On the other hand slightly more than $1/10^{th}$ of the respondents on both the districts had not such feelings and perception about climate change (Figure 2).

Knowledge on availability of herbages in rangelands in past 5 years



Source: Field Survey, 2014
Figure 3. Availability of herbages in rangelands in past 5 years

Findings revealed that about 3/4th of the respondents in Lamjung felt decrease in availability of herbage in rangelands in past 5 years compared to 3/5th of the respondents who had such feelings in Chitwan. Whereas about 1/5th of the respondents in both the districts felt that there is almost constant level of grasses/ herbages in their rangelands in past 5 years (Figure 3).

Major chemical constituents in the selected rangelands during post monsoon period

Table 2. Mean major chemical composition of herbage mass during post monsoon period

Rangeland Sites	DM%	EE%	CF%	CP%	TA%
Jutpani	41.36±6.6^{ab}	3.48±0.2	24.72±3.0^{b}	10.82±2.6^{a}	7.98±0.3^{b}
Chandibhanjyang	38.08±5.3^{b}	3.24±0.4	27.94±3.1^{b}	8.35±2.2^{ab}	8.04±0.6^{ab}
Ghanpokhara	25.9±8.2^{c}	3.34±0.2	23.84±1.8^{b}	11.71±3.2^{a}	6.60±0.2^{c}
Bhulbhule	39.20±14.^{ab}	3.38±0.2	27.66±4.8^{b}	8.57±3.4^{ab}	7.76±0.5^{b}
Khudi	50.14±7.3^{a}	3.12±0.3	34.22±4.3^{a}	7.04±0.9^{b}	8.64±0.3^{a}
Probability	<0.01	NS	<0.01	<0.05	<0.05
F- Value	4.695	0.961	6.753	2.62	12.93
CV%	23.03	9.47	13.05	28.37	5.96
LSD (p<0.05)	11.83	0.41	4.75	3.48	0.61

Note: Means in column with different superscripts differ significantly by LSD (p<0.05) ; NS denotes non-significant at (p<0.05).

The study on major chemical constituents in the herbages of selected rangelands during post monsoon period revealed significant differences (p<0.05) in dry matter (DM), crude fibre (CF), crude protein (CP) and total ash (TA), except ether extracts (EE) at different sites. The range of DM at different sites varied from 25.9±8.2-50.14±7.3%. The DM in the herbages of *Khudi* site was significantly different (p<0.05) from *Chandibhanjyang* and *Ghanapokhara* site. Similarly, CP in the herbages of *Jutpani* site was significantly different (p<0.05) from *Khudi* site. Also, CF in the herbages of *Khudi* sites was significantly different (p<0.05) from all other sites. TA in the herbage of *Khudi* sites was significantly different (p<0.05) from *Ghanapokhara* and *Bhulbhule* sites.

Major chemical constituents in the selected rangelands before start of winter

Table 3. Major chemical constituents of herbage mass before start of winter period

Rangelands Site	DM%	EE%	CF%	CP%	TA%
Jutpani	26.04 ±2.0[b]	2.88±0.6	27.56±5.4	11.16±3.3	8.32±0.5
Chandibhjyang	47.32±13.2[a]	3.32±0.5	28.84±4.9	9.46±3.6	8.38±0.6
Ghanpokhara	37.66±9.7[ab]	3.38±0.1	28.10±2.9	10.50±3.4	7.82±0.6
Bhulbhule	42.70±9.3[a]	3.20±0.2	31.04±2.9	9.35±2.7	8.74±0.3
Khudi	49.16±7.0[a]	3.08±0.4	28.84±3.0	8.40±0.9	8.10±0.3
Probability	<0.01	NS	NS	NS	NS
F- Value	5.195	0.943	0.549	0.65	2.03
CV%	22.41	14.5	13.84	30.44	6.47
LSD (p<0.05)	11.99	0.61	5.44	3.93	0.80

Note: Means in column with different superscripts differ significantly by LSD (p<0.05); NS denotes non-significant at (p<0.05).

The study findings on major chemical constituents in the herbages of selected rangelands before the start of winter period revealed significant differences (p<0.05) in DM only. There was no significant difference (p>0.05) in EE, CF, CP and TA during this period. The range of DM in the herbages at different sites varied from 26.04 ±2.0-49.16±7.0%. The DM in the herbage of *Jutpani* site was significantly different (p<0.05) from *Chandibhanjyang, Bhulbhule* and *Khudi* site. The range of CP varied from 8.40±0.9-11.16±3.3 % (Table 3).

Botanical composition of rangelands during post monsoon

Table 4. **Botanical composition of different rangelands during post monsoon**

Rangeland Sites	Legume	Non-Legume	Weeds	Dead matter	Total weight (g)
Jutpani	1.75 (5.40)	22.1(68.17)	5.59 (17.24)	2.98(9.19)	32.42(100)
Chandinhjyang	1.67(4.09)	27.53(67.44)	7.42(18.18)	4.2(10.29)	40.82(100)
Ghanapokhara	2.23(4.67)	32.02(67.09)	10.52(22.04)	2.96(6.20)	47.73(100)
Bhulbhule	3.04(6.00)	31.39(61.99)	11.43(22.57)	4.78(9.44)	50.64(100)
Khudi	3.2(5.91)	36.87(68.08)	9.53(17.60)	4.56(8.42)	54.16(100)

Figures in Parenthesis indicate percentage distribution of each component

The study on botanical compositions revealed that in all the rangeland sites non-legume is predominant which is more than 60% followed by weeds, dead matter and legume herbages (Table 4). The legume proportion in all the rangeland sites was 4-6 % during this period. Similarly the range of weeds was 17-22%. The composition of weeds and dead matter was higher than legume grasses (Table 4).

Botanical composition of rangelands before start of winter

Table 5. Botanical composition of different rangelands before start of winter

Rangeland Sites	Legume	Non-Legume	Weeds	Dead matter	Total weight (g)
Jutpani	3.43 (9.03)	23.39(61.58)	7.41 (19.51)	3.755(9.89)	37.985(100)
Chandibhjyang	2.82 (7.88)	23.7(66.23)	5.32(14.87)	3.945(11.02)	35.785(100)
Ghanapokhara	2.63(10.24)	17.09(66.54)	3.585(13.96)	2.38(9.27)	25.685(100)
Bhulbhule	1.79(4.87)	25.69(69.87)	5.43(14.77)	3.86(10.50)	36.77(100)
Khudi	2.24(5.63)	27.43(69.00)	6.26(15.75)	3.825(9.62)	39.755(100)

Figures in Parenthesis indicate percentage distribution of each component.

Findings revealed that botanical composition of the herbage before the start of winter was slightly different than that in post monsoon period. In this period also, proportion of non-legumes was predominant which was more than 60% in composition, followed by weeds, dead matter and legume herbages (Table 5). The proportion of legume in all the rangeland sites was 4-10 % during this period. The proportion of weeds and dead matter was higher than legume in all the rangeland sites during this period also (Table 5).

DISCUSSION

Farmers' perspective on climate change and its impact on rangeland's productivity

The findings of this study revealed that about 85% of the farmers have some knowledge about the climate change and its impact on livestock production and herbage availability in their rangelands. More than 75 % respondents experienced climate change with increasing temperature in all ecological regions in the transect of Gandaki River Basin. These findings also reflect the similarity with the finding of Dahal (2010) as the author had reported that 86.67 % farmers had felt change in rainfall pattern, and 82.54 % felt increase in temperature every year in Nepal. Farmers, in all study sites, during the interview also revealed the fact that changes in climatic variability could impact in the rangeland productivity, mainly due to unpredictable pattern of precipitation that easily affects to the growth and availability of herbage in short-run and sustainability of rangelands in the long-run.

Major chemical constituents in rangelands at different period of the year

This study finding revealed the significant differences in the DM, CP, CF and TA among the sites during post monsoon period (Table 2), but, significant difference was only in DM in case of winter period (Table 3). There was no significant difference ($p>0.05$) in all the major chemical constituents when compared between districts in both periods (data not presented). This suggests that DM, CP, CF, TA changes significantly during post monsoon period but does not changes significantly before the start of winter. The mean CP % ranged from 7.04-11.1% during post monsoon period and 8.4-11.4 % during the start of winter. This CP % is within the range as reported by Marten et al. (1987) which is 7.2 and 28.6% depending on locations, years and species. Since the mean CP % in the range was 7.04-11.4% in both the period of the study and in all the selected rangelands, it is within the quality standard of grade 4 and grade 5 as standard assigned by Hay Market Task Force of American Forage and Grassland Council with respect to protein content. This CP% is somehow adequate for ruminants' maintenance requirement only if they are based on grazing.

Variation in botanical composition of selected rangelands

In botanical composition, non-legume grass was highest in all the selected rangelands in GRB region in both the periods (Table 4, 5). Non-legume grasses during both periods were > 60% in all the rangelands. Legume proportion was lowest in both the period in all the rangelands. Even the proportion of weeds and dead matter was higher than that of the legumes in both periods. The proportion of weeds was higher during post monsoon period as compared to before the start of winter period. These findings clearly warn about the consequence of lowest proportion of legumes that could directly affect quality of herbage. Attention is required to increase the proportion of legumes in the days to come.

CONCLUSION

The farmers of Lamjung and Chitwan districts are well aware about the climate change and its impact in their livelihood that could also impact to their livestock and feeding management. They have felt change, especially in the rainfall pattern that is also related to agriculture system and feeding management. In all the study sites, we found change in vegetation and available herbage mass that are deteriorating in quantity and quality. This warrants the need to introduce rangeland improvement scientific practices to safeguard the herbage mass producing potentials of both the districts in GRB, also considering probable consequence of climate change in rangeland management.

The major chemical constituents in all the selected rangelands of GRB seems to be not much superior quality during both the periods of winter onset and post monsoon, but is of grade 4 and grade 5 with respect to CP % which is adequate for ruminants' maintenance requirement only. This also suggests the need to introduce rangeland improvement scientific practices to safeguard herbage mass production and make available nutritious feed to livestock, through improvement in herbage quality in the rangelands.

The botanical composition of the selected rangelands also reflects deteriorating quality due to low percentage of the legume and high percentage of weeds and dead matter during both study periods. This suggests the need to introduce legume forage species along with appropriate improvement practices in enhancing the overall nutritive quality of rangelands, especially, during dry periods.

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