Bhutan Journal of Animal Science (BJAS)
Volume 6, Issue 1, Page 76-80, March 2022

ASSESSMENT OF DRY MATTER YIELD, NUTRIENT CONTENT AND CARRYING CAPACITY OF THE ALPINE RANGELAND PASTURE

JIGME TENZIN[1*], PENJOR[2] AND AITA KUMAR BHUJEL[3]

[1]District Livestock Sector, Dzongkhag Administration, Tsirang, Bhutan
[2]Department of Animal Science, College of Natural Resources, Lobesa, Punakha, Bhutan
[3]Regional Livestock Development Center, Department of Livestock, Wangduephodrang, Bhutan

*Author for correspondence: jtenzin72@gmail.com

Abstract: The study assessed the carrying capacity and nutrient content of available rangeland pasture at Phobjikha gewog, Wangduephodrang district. Stratified random sampling was used to collect sample for the study. The strata were divided into five strata of 100m altitudinal gradient interval based on elevations ranging from 2800 to 3200 masl. A total of 46 samples were collected using a quadrant from different strata by simple random method. The biomass of the samples was recorded in the field and the proximate analysis was conducted in laboratory. The study recorded mean dry matter (DM) yield of about 0.75 t/ha, 1% crude fiber (CF), 13.35% crude protein (CP), 13% ash and 2.36% ether extract (EE). The average annual carrying capacity (CC) estimated for the rangeland pasture was 0.34 LU/ha. Among the strata, the highest CC of 0.53 LU/ha was recorded at 2800 masl and the lowest CC of 0.15 LU/ha was recorded at 3200 masl. The carrying capacity and chemical composition with exception to % CP showed inverse correlation with elevation range (r =.227, p =.052).

Keywords: Ash; carrying capacity; crude fiber; crude protein; dry matter; ether extract; livestock unit; rangeland

1. INTRODUCTION

Rangeland pasture is the cheapest and most available grazing resource (Roder et al. 2001; Dorji and Thinley 2016) for the livestock in Bhutan. Rangeland in Bhutan comprise of 3.9% of the total area (Wangchuk and Dorji 2008; Roder et al. 2001). Feed cost accounts for about 70% of the total expenditure in dairy production resulting to increase in price of dairy products. As an alternative, option to maximize dairy production in cool temperate zone is by utilizing the available rangeland pasture through efficient management. It will provide adequate amount of essential nutrients to the dairy cattle. Further, proper rangeland management and grazing system will minimize the cost of production of dairy products and impact on environment.

Hence, there is a need to conduct rangeland pasture assessment to understand the carrying capacity (CC) of rangeland pasture and fodder requirement of the animals. Such study will contribute to generate information for precise supplementary feeding and planning on the quantity of concentrate feed required by the dairy farmers. As such, this study attempts to explore a better understanding amongst resource managers and livestock owners on the ruminant CC and nutrient content of native pasture. It will also contribute to sustainable management of rangelands pasture without compromising the productivity of the animals.

2. MATERIALS AND METHOD

2.1 Study area and sampling design

The study was conducted at Phobjikha gewog, Wangduephodrang district. The gewog has an area of 138.20 km^2 with an elevation ranging from 2800 to 4000 masl. The farmers of this gewog depend mostly on agriculture and livestock farming as a source of livelihood. The smallholder dairy

farming contributes 8.45% of the annual household income in the cool temperate region (Bhujel and Sonam, 2014). The dairy cattle depend on rangeland pasture for grazing. Therefore, realizing that the rangeland pasture is an important component of farming system in Phobjikha, the study area and the rangeland pasture utilized by the dairy farmers were identified using google map, the site was divided into five strata of 100 m altitudinal gradient interval (Auerbach & Shmida 1993) between 2800 and 3200 masl.

The fodder samples were collected through simple random method using a quadrant of one square meter (Tarawali 1995). The palatable grass falling within the quadrant were collected using hand clipping method (Catchpole and Wheeler 1992; Mannetje and Jones 2000). The unpalatable grasses were subtracted from total herbage to calculate forage available for ruminants. The weight of the samples was measured in the field using digital weighing balance and recorded in work sheet to calculate the total biomass per hectare.

After recording the fresh bio-mass in the field, the samples were brought to laboratory for proximate analysis to determine the nutrient contents of the samples. The dry matter (DM) yield was calculated through oven drying of samples at 100^{o}C for 24 hours. The crude protein (CP) was determined by combustion and crude fiber (CF) by acid detergent fiber methods. The data recorded from the field and the laboratory analysis were analyzed using the Statistical Package for Social Science (SPSS), version 23 (George and Mallery, 2017) for correlation and significance between the mean of variances. The CC of the rangeland was estimated using standard Bhutanese LU reported by Samdup et al. (2010).

3. RESULTS AND DISCUSSION

3.1 Species composition

A total of 13 genera of grasses were observed at the study site that includes *Yushania microphylla* (16.12%), *Cyperus* spp. (16.12%), *Festuca* spp. (12.9%), *Arundinella* spp. (9.67%), *Eragrostis* spp. (9.67%), *Schizachyrium* spp. (9.67%), *Agropyron* spp. (6.45%), *Eleocharis atropurpurea* (3.22%), *Carex* spp. (3.22%), *Poa* spp. (3.22%), *Trigonella* spp. (3.22%), *Gnaphalium* spp. (3.22%) and *Parochitus communis* (3.22%) as presented in Figure 1 below. The majority (61.53%) of the genera was observed at the elevation of 2800 to 2900 masl and there was decline in number of genera as the elevation increased with 30.77% at an elevation of 3200 masl. The genera of grasses found in the rangeland pasture supports the finding of Wangchuk (1995). It was also reported that native grasses like *Agropyron* spp., *Agrostis* spp., *Eragrostis* spp., *Festuca* spp., *Poa* spp., *Carex* spp. and *Gnaphalium* spp. were found in alpine pasture of Laya (Dunbar, 1979).

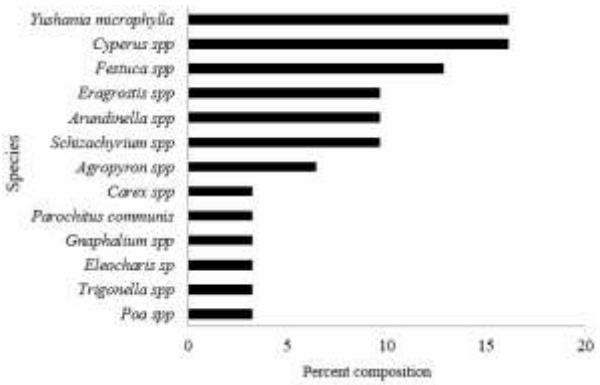

Figure 1: Composition of local grass species found in the rangeland pasture in percentage

3.2 Dry matter yield

The mean/average DM yield recorded for the rangeland pasture from the study areas was 0.76 t/ha, ranging from 0.18 to 2.58 t/ha. There was significant difference on DM yield between five different elevations; F (4, 40) = 6.08, p= .001. The result was similar to the findings of Gyamtsho (1996), Wangchuk and Dorji (2008), Roder (2013) and Wangchuk et al. (2014). However, the study showed inverse relationship between DMY and altitudinal belts (r = -.514, p =.000).

Among the different elevation strata, the maximum mean DM yield of 1.18±0.54 t/ha was recorded at an elevation of 2800 masl, followed by 2900 masl, 3000 masl, 3100 masl and 3200 masl with mean DM yield of 1.11±0.70 t/ha, 0.56±0.37 t/ha, 0.47±0.30 t/ha and 0.34±0.09 t/ha respectively (Table 1). This clearly indicate that the DM yield will be higher in the lower elevation than in the higher elevation as with increase in elevation there

is a fall in environmental temperatures causing negative influences on the pasture growth. This could also be due to low concentration of soil nutrients especially Phosphorus content of the soil with increase in altitude.

3.3 Crude protein content

The crude protein content of the palatable fodder was analyzed. The result showed an overall mean % CP content of 13.35 ± 2.59%. Among the five altitudinal belts, the highest % CP of 14.4 ± 2.41 was recorded at 2900 masl, followed by 3000 masl, 3100 masl, 3200 masl and 2800 masl with 14.21 ± 3.39%, 14.12 ± 2.03%, 13.25 ± 1.83% and 10.99 ± 1.49% respectively (Table 1).

Table 1: Mean ±SD/SE CP and DMY

Altitude	% CP*	DMY* in t/ha
2800	$10.99^{a} \pm 1.49$	$1.18^{a} \pm 0.54$
2900	$14.40^{b} \pm 2.41$	$1.11^{ab} \pm 0.70$
3000	$14.21^{b} \pm 3.39$	$0.56^{abc} \pm 0.37$
3100	$14.12^{ab} \pm 2.03$	$0.47^{bc} \pm 0.30$
3200	$13.25^{ab} \pm 1.83$	$0.34^{c} \pm 0.09$

** Same letter in the column is not significant*

The altitudinal belt 2900 masl has higher % CP than other elevation indicates that the grass species like *Parochitus communis* and *Poa* spp. has higher CP content than other grass species in the rangeland. The mean % CP was lowest in the altitudinal belt 2800 masl attributes to available of grass species like *Eleocharis atropurpurea* and *Gnaphalium* spp. That has low CP content than other grass species. The result disagrees with findings of Chaturvedi et al. (2003) and Kamstra (1973), where CP% in the present study area was determined by the presence of different species composition in belts rather than stage of maturity.

3.4 Crude fiber content

The mean CF% content of the fodder from the rangeland was 1.01±0.82%. The % CF was found to be highest at the elevation of 2800 masl followed by 2900 masl, 3100 masl, 3000 masl and 3200 masl with mean value of 1.81±1.06%, 1.17 ± 0.82%, 0.79 ± 0.21%, 0.57 ± 0.32% and 0.50 ± 0.30% respectively. The study showed inverse co-relation between CF content of the native fodder grass and the elevation range (r= -.383, p = .001) which is similar to the findings of Brown (1939); Deinum (1966); Crouse (1973) and Wilson and Ford (1971) who reported that there is inverse relationship between CF% and temperature. The result is supported by the findings of Todd (1956) and French (1957) where the variation in CF% are affected by botanical composition. The result also indicated that CF% of native pasture was lower compared to Napier (26.5-33.6%) as reported by Kidder (1945). This indicated that the natural pasture species available in the rangeland are highly digestible than those fodder species at lower elevations.

3.5 Ash

The mean % ash content recorded for rangeland pasture was 13.60 ± 4.31%. The highest% ash content of 17.74 ± 3.89% was recorded at 2800 masl, followed by 2900 masl (15.95 ± 2.95%), 3000 masl (11.97 ± 3.04%), 3200 masl (11.14 ± 3.29%) and 3100 masl (9.56 ± 1.60%). There was significant difference in % ash among the elevation; F (4, 40) =11.174, p = .000.

The mean % ash of the different elevations decreases as the altitude increases (r=- .555, p< .05). This was due to variation in the species diversity of the pasture that affects the % ash content (Deak et al. 2004 and Tilman et al. 2006). The pasture species composition was found highest at an elevation of 2800 and 2900 masl followed by gradual decline in species composition at 3000 masl, 3100 masl and 3200 masl which determined the % ash content of the elevation. The % ash content is also affected by the stages of grass maturity, there is positive relation between the DM content and % ash of native grass indicating positive relationship between grass maturity and % ash content.

3.6 Ether extract (EE)

There was significant difference (F [4, 40] =5.415, p=.001) in the EE% among the samples from different elevation ranges. Highest mean % EE was recorded at elevation of 2900 masl (3.12 ± 1.00%) followed by 2800 masl (2.29 ± 0.57%), 3000 masl (2.08 ± 1.02%), 3100 masl (1.75 ± 0.70%) and 3200 masl (1.62 ± 0.74%). The variation of the % EE among elevations could be due to presence of

different species in different elevations as reported by Wallace et al. (1972). However, the mean % EE of native grasses was found at par with EE% of improved Napier grass (Kidder 1945; Tan 1970). The study suggests that grass species like *Parochitus communis* and *Poa* spp. has greater % EE than other grass species. Tan (1970) observed higher percent of EE in native grass as compared to Guinea grass**.**

3.7 Carrying capacity

Considering the available nutrient contents of the rangeland pasture at the different strata as shown in Figure 2, the species composition of palatable forages and the live weight of standard Bhutanese livestock of 300 kg (Samdup et al. 2010 in Wangchuk, 2013), the annual carrying capacity of the study area was found to be 0.34 LU/ha.

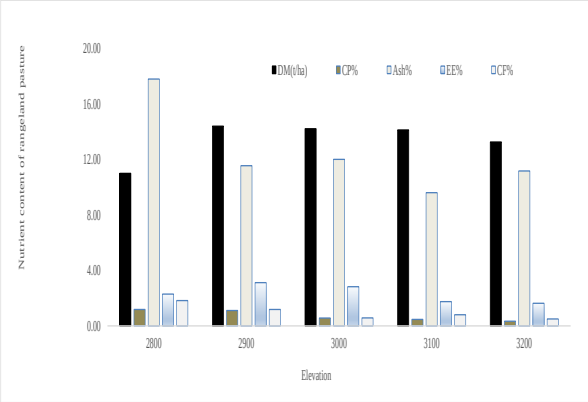

Figure 2: Mean nutrient contents

Among the elevations, 2800 masl has highest carrying capacity of 0.53 LU/ha followed by 2900 masl, 3000 masl, 3100 masl and 3200 masl of 0.50 LU/ha, 0.25 LU/ha, 0.21LU/ha and 0.15 LU/ha respectively. The result supports the findings of Wangchuk et al. (2013) where the annual CC in prescribed burned rangeland meadows was 0.23 LU/ha compared to 0.05 LU for the control and cut plots. Therefore, the intervention by the resource managers on this rangeland through scientific management regimes such as prescribed burning will increase the CC of the rangeland. And if such management practices induced growth of some palatable species in the rangelands that will lead to increased bio-mass and hence CC. Such intervention will enhance production capacity of the rangeland and improve livestock production.

4. CONCLUSIONS & RECOMMENDATION

The findings from the study showed that forage yield and quality of the rangeland pasture differed at different elevation ranges. The nutrient content of native grasses in the rangeland also showed significant variation among the elevation with higher nutrient content in lower elevation as compared to higher elevations. The stage of plant maturity and climate variability in general were critical in determining the quality of grass species in the study area. Proper management of rangeland pasture using scientific management practices such as prescribed burning will enhance rangeland pasture productivity, growth of palatable forage species and quality. Therefore, the study concluded that rangeland pasture provides adequate amount of nutrient to the dairy cattle particularly in the highland although the stocking density and carrying capacity of the rangeland pasture was quite low.

REFERENCES

Auerbach M and Shmida A. (1993). Vegetation Change Along an Altitudinal Gradient on Mt-Hermon, Israel - No Evidence for Discrete Communities, Journal of. 81(1): 25-33 Ecology

Bhujel AK and Sonam T. (2014). Smallholder Dairy Farming as a Source of Livelihood: A Case Study from Three Agro-Ecological Zones of Bhutan. Bhutan Journal of Natural Resources & Development. 1(1): 11-17, doi:10.17102/cnr.2014.02.

Brown EM. (1939). Some effect of temperature on the growth and chemical composition of certain pasture grasses, Research Bulletin Missouri Agriculture Experiment Station. 299

Catchpole WR and Wheeler CJ. (1992). Estimating the biomass: A review of the techniques, Journal of Austral Ecology.17(2):121-131. http//doi: 10.1111/j.1442-9993.1992.tb00790

Chaturvedi OH, Bhatta R, Santra A, Mishra AS and Mann JS. (2003). Effect of Supplementary Feeding of Concentrate on Nutrient Utilization and Production Performance of Ewes Grazing on Community Rangeland during Late Gestation and Early Lactation, Asian Australian Journal of Animal Science.7:983-987

Crouse BW. (1973). Effect of temperature on the chemical –physical properties of Kenal fibers, Journal of Crop science .13: 52-55

Deak A, Hall MH and Sanderson MA. (2004). Forage production and forage mixture complexity, Proc Am Forage Grass Council.13:220–224

Deinum B. (1966). Influence of some climatological factors on the chemical composition and feeding value of herbage. Proceeding 10th International grassland Congress, Helsinki: 145

Dorji N and Thinley J. (2016). Impact of the climate change on the cattle farming and the welfare in Bhutan. Lobesa, Punakha: CNR.

Dunbar GA. (1979). Alpine pasture ecology and improvement. Rome. Italy: Food and Agriculture Organization

French MH. (1957). Nutritional value of tropical grasses and fodders, Herbage Abstracts. 27:1-9

George D and Mallery P. (2017). IBM SPSS statistics 23 step by step: a simple guide and reference. Boston : Pearson Education. Retrieved from https://www.worldcat.org/title/ibm-spss-statistics-23-step-by-step-a-simple-guide-and-reference on 14 March, 2022

Gyamtsho P. (1996). Assessment of the Condition and Potential for Improvement of the High-Altitude Rangelands of Bhutan. Dissertation No. 11726. Zurich, Switzerland: ETH

Kamstra LD. (1973). Seasonal changes in quality of some important range grasses. Journal of Range Management, 26(4): 289-291

Kidder BRW. (1945). Composition and digestible nutrient content of Napier grass leaves, Journal of Agriculture Research, 70(3):1-8

Mannetje L and Jones R. (2000). Field and laboratory methods for grassland and animal production research. New York. USA: CABI publisher

Rancane S, Karklins A, Lazdina D and Berzins P. (2015). Biomass yield and chemical composition of perennial grasses for energy production. <http://tf.llu.lv/conference/ proceedings2015/Papers/089_Rancane.pdf>. Accessed 3rd January 2016

Roder W. (2013). Grazing Management of Temperate Grassland and Fallows. Journal of Bhutan Studies. pp. 44-60.

Roder W, Wangdi K, Gyamtsho P and Dorji K. (2001). Feeding the Herds - Improving Fodder Resources in Bhutan. Kathmandu, Nepal: International Centre for Integrated Mountain Development

Samdup T, Udo HMJ, Eilers CHAM, Ibrahim MNM and Van der Zijpp AJ. (2010). Crossbreeding and intensification of smallholder crop-cattle farming systems in Bhutan, Livestock Science, 132(1-3): 126–134. https://doi.org/10.1016/j.livsci.2010.05.01

Tan YT. (1970). Composition and nutritive value of some grasses, plants and aquatic weeds tested as diets, Journal of Fish Biology 2: 253-257. https://doi.org/10.1111/j.1095-8649.1970.tb03283

Tarawali S. (1995). Methods for the evaluation of forage legumes, grasses and fodder trees for use as livestock feed, ILRI Manual. 1: 31

Tilman D, Reich PB and Knops JMH. (2006). Biodiversity and ecosystem stability in a decade-long grassland experiment. Journal of Science. 441:629–632

Todd JR. (1956). Investigation into the chemical composition and nutritive value of certain forage plants at medium altitudes in the tropics, Journal of Agricultural Science. 47:225-231

Wangchuk K, Gyaltshan T, Yonten T, Nirola H and Tshering N. (2013). Shrubland or Pasture? Restoration of Degraded Meadows in the Mountains of Bhutan. Mountain Research and Development, 33(2) : 161-169. International Mountain Society. https://doi/10/1659/MRD-JOURNAL-D-12-00091.1.

Wangchuk K. (2013). Cattle Production Dynamics, Species Diversity and Relative Abundance of Understory Vegetation in the Mixed Conifer Forests of Bhutan. Thesis Dissertation, University of Natiral Resources and Life Science, Vienna.

Wangchuk K, Wurzinger M, Darabant A, Gratzer G and Zollitsch W. (2014). The Changing Face of Cattle Raising and Forest Grazing in the Bhutan Himalaya, Mountain Research and Development. 34(2): 131–138

Wangchuk K and Dorji T. (2008). Animal Feed Production and Management in Bhutan, Bhutan Journal of Animal Science:1-24. https://doi.org/10.13140/2.1.1572.0642

Wilson JR and Ford CW. (1971). Temperature influences on the growth, digestibility and carbohydrate composition of two tropical grasses, Australian Journal of Agricultural Research (22):563-571.