Indian Journal of Animal Sciences **82** (9): 1046–1050, September 2012

Nutritional status of herbage and goats under different grazing management practices on semi-arid rangeland vegetation

S K MAHANTA[1], G H PAILAN[2] and N C VERMA[3]

Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh 284 003 India

Received: 26 May 2011; Accepted: 28 January 2012

ABSTRACT

A grazing trial of 120 days duration was conducted in goats on rangeland vegetation to record herbage mass and its quality, and nutritional status of animals. Yearling female Barbari goats divided into groups G_1, G_2 and G_3 of 9 animals each, were allowed to graze on 3 ha of vegetation (@ 9 animals/ha) during winter for 6.5 to 8 h daily following 3 different grazing management practices viz. continuous, rotational and deferred rotational, respectively. They were also supplemented with barley grain (@ 1.0% of body weight) as energy source. Availability of herbage mass (kg DM/ha) of grass dominated vegetation was comparatively higher (2910) under deferred rotational than rotational (2677) and continuous (2365) system of grazing management However, quality of herbage mass in terms of CP (4.57 to 4.70%), NDF (77.8 to 79.7%) and ADF (46.6 to 50.3%) was comparable among the different grazing management practices. Similarly average CP of mouth grab forage samples was comparable amongst the treatment groups and ranged from 10.7 to 11.9%. Daily feed (DM) intake was 506, 512 and 546 g in goats under G_1, G_2 and G_3 groups, respectively, and the differences were nonsignificant among the groups. The digestibility of nutrients was statistically similar among the groups. Goats were also on similar plane of nutrition consuming comparable quantities of CP and TDN. Concentration of glucose, plasma protein and urea-nitrogen was similar in G_1, G_2 and G_3 groups. It was concluded that at similar stocking rates, grazing management practices did not have any influence on herbage mass and its quality as well as nutrient utilization and blood metabolites in goats allowed to graze on rangeland vegetation of Bundelkhand with supplementation of barley.

Key words: Goats, Grazing practices, Herbage mass, Nutritional status, Rangeland vegetation

Small ruminant production is an important component of livelihood of farmers in semi-arid Bundelkhand region of India, contributing about 17% of total incomes (Dwivedi *et al.* 2004). In this region, sheep and goats are generally allowed to graze on degraded grasslands and wastelands of poor nutritional quality, which has deteriorated with the maturity and cannot support livestock productivity during the lean period (Pailan *et al.* 2001, Rai and Rai 2010). Goats grazing on such natural herbage, suffer from energy deficiency instead of protein (Verma *et al.* 2001). Studies revealed that the performances of animals or sustenance of systems were better in planned grazing management practices viz. rotational and deferred rotational than continuous and cut-and-fed in terms of biomass yield, nutrient intake and utilization, productivity and economic gain (Verma *et al.* 2001). Since India is characterized by tropical monsoon climate and active growth in grazing land occurs only during monsoon months, there is surplus forage during rainy season and deficit of various levels in other months (Sharma 2006, Bakare and Chimonyo 2011). Keeping this in view, in the present study 3 different grazing management practices viz. continuous, rotational and deferred rotational were compared in terms of herbage mass and quality as well as nutrient utilization and blood metabolites in goats allowed to graze on natural vegetation of Bundelkhand with supplementation of barley grain as energy source during winter.

MATERIALS AND METHODS

Experimental site and design: The study was carried out in a typical semi-arid rangeland (3 ha) at Central Research Farm, Indian Grassland and Fodder Research Institute, Jhansi. The farm is located at 25º 27´ N latitude 78º37´ E longitude and 275 m above mean sea level. Mean maximum and minimum temperature are 32.5 and 17.7º C with temperature reaching as high as 48º C and as low as 1.5º C during May and January, respectively. The region receives an annual rainfall of 906 mm with 781 mm during rainy

Present address: [1]Senior Scientist (mahantask@rediffmail.com), [3]Principal Scientist (retired), (ncv@igfri.up.nic.in), Plant Animal Relationship Division.[2]Senior Scientist(ghp_par@rediffmail.com), CIFE, Kolkata Centre, 32 G N Block, Salt Lake, Kolkata 91..

Table 1. Plants encountered in vegetations grazed by experimental goats

Latin name	Common/ local name
Grasses	
Cenchrus ciliaris	*Anjan* grass
Chrysopogon fulvus	*Dhwalu* grass
Dicanthium annulated	*Kail* grass
Heteropogon contortus	*Lampa* grass
Sehima nervosum	*Sain* grass
Themeda quadrivalis	*Machhauri* grass
Legumes	
Atylosia scarabaeoides	*Bankulthi*
Stylosanthes hamata	*Caribbean stylo*
Forbs and others	
Borreria stricta	*Ganthia*
Euphorbia hirta	*Ghamra*
Triumfetta rhomboidea	*Burbush*
Carrisa spinosum	*Karondi*
Dichrostachy cineria	*Nutan*
Zizyphus numularia	*Jharberi*
Zizyphus xylopyrus	*Ghont*

(*kharif*) and 52 mm winter (*rabi*) season and experiences annual potential evaporation of 1512 mm (Singh *et al.* 2005). The study was conducted on 27 yearling Barbari female goats and allowed to graze on 3 ha of rangeland (@ 9 goats/ha), divided into 4 equal size paddocks during winter (November-February). These paddocks were surrounded by fencing wires with removal of unwanted plants for proper establishment and management of vegetation (Table 1). Goats divided into 3 treatment groups (G_1, G_2 and G_3) of 9 animals in each were allowed to graze for 6.5 to 8 h daily following 3 different grazing management practices viz. continuous, rotational and deferred rotational, respectively. Under continuous system of grazing management, animals were allowed to graze in all the 4 paddocks every day and in rotational grazing animals were also allowed to graze in all the 4 paddocks but one after another with rotation of 14 days. While in deferred rotational grazing, animals were initially rotated for grazing in 3 paddocks with rotation period of 14 days and later the remaining one paddock was taken in rotation for grazing once the growth period of herbages was over. All the experimental goats were also supplemented with barley grain (@ 1.0% of live weight) as energy source.

Experimental sampling and analysis: Herbaceous biomass yield was estimated at monthly intervals by clipping all the herbs to a 2.5 cm stubble height in four 0.5 m × 0.5 m random quadrates (Tadmor *et al.* 1975). Herbaceous samples collected from 4 quadrates were physically separated and dried to determine herbage mass components. Separation of dead biomass from green materials (growing) was also performed for each sampling.

After 35 days of experimental grazing, a digestion trial of 7-day duration was conducted on goats using lignin as internal marker. Total faeces voided for 24 h in a day were collected using the faeces collection bags. The representative samples of barley grain and mouth grab forage samples from each animal during the trial period were collected and processed for laboratory analysis. Blood samples were also collected from each animal in the morning (8:00AM) before feeding and watering towards the end (115th day) of experimental feeding and immediately processed for glucose, plasma protein and urea-N levels (Gupta *et al.* 1992). The representative samples of digestion trial and herbage mass collected were analyzed for proximate constituents (AOAC 1990) and cell wall fractions (Goering and Van Soest 1970).

Statistical analysis: The data were subjected to analysis of variance (Snedecor and Cochran 1989) procedure of SPSS Base 10 (SPSS 1999) and the difference between the means was compared by Duncan's multiple range test (Duncan 1955).

RESULTS AND DISCUSSION

Herbage mass and quality: Availability of herbage mass from grass dominated pasture was 3631 kg DM /ha in November, which declined significantly ($P<0.01$) to 1890 kg DM /ha in February (Table 2). This decline (~ 48%) in herbage mass from November to February was attributed to its utilization by the experimental goats and seasonal growth pattern of herbage (Hu *et al.* 2007). The estimated botanical composition of experimental vegetation during the grazing period suggested that graminaceous plants dominated (65.4 to 83.3%) the grazing land compared to legumes (3.67 to 8.37%) and other miscellaneous plant species. This observation can be explained by the greater resilience of graminaceous plants to variable temperatures in the region of study. These plants have also greater adaptive ability, especially under grazing and have high potential for regrowth compared to legumes. Further, animals showed a greater preference for the legumes (Papanikolau *et al.* 1993, Pavlu *et al.* 2006). Forbs and other plant species also constituted a good portion of biomass and gradually increased from November (5.50%) to February (21.07%), which were highly palatable to goats and well adapted to Indian semi-arid grazing lands. The percentages of litters in herbage mass were fluctuated from 2.77 to 9.83% during the different grazing months. Average crude protein (CP) content of herbage mass was 6.36% in November, which also reduced gradually to 3.54% in February. Shinde *et al.* (1997) also observed wide monthly variation in CP content of grass pasture. On the contrary, there was increase in fibre contents of herbage mass from Nov to Feb indicating progressive deterioration of its nutritive values.

On the contrary, grazing management practices i.e. continuous, rotational and deferred rotational under similar stocking rate did not have any influence on herbage mass yield, botanical as well as chemical composition of herbage mass except lower ($P<0.05$) percentage of legumes in G_3

Table 2. Yield (DM) and composition (mean±SE) of herbage mass during different grazing months

Attributes	Months				Cumulative Mean±SE
	Nov	Dec	Jan	Feb	
Herbage mass (kg/ha)**	3631^{a}±201	2756^{b}±178	2326^{bc}±150	1890^{c}±113	2651±206
Botanical composition (%)					
Grasses**	83.37^{a}±1.41	78.73^{ab}±0.86	73.13^{b}±0.95	65.43^{c}±2.96	75.17±2.15
Legumes	8.37±2.00	6.53±1.16	6.47±1.67	3.67±0.56	6.26±0.80
Litter**	2.77^{c}±0.27	3.70^{c}±0.58	6.77^{b}±0.22	9.83^{a}±0.63	5.77±0.86
Forbs and others**	5.50^{c}±1.78	11.03^{bc}±1.26	13.63^{ab}±2.28	21.07^{a}±3.70	12.81±1.98
Chemical composition (%)					
DM**	42.18$^{c±}$2.04	57.23^{b}±1.15	60.44^{b}±0.95	70.73^{a}±1.18	57.64±3.14
OM**	92.63^{a}±0.24	91.71^{ab}±0.07	90.32^{c}±0.52	91.48^{b}±0.09	91.53±0.28
CP**	6.36^{a}±0.09	4.42^{b}±0.11	4.27^{b}±0.06	3.54^{c}±0.19	4.65±0.32
NDF*	77.19^{b}±0.50	77.94^{b}±1.57	78.34^{b}±0.45	82.57^{a}±0.06	79.01±0.73
ADF*	44.28^{b}±0.17	51.27^{a}±1.94	52.09^{a}±0.50	50.26^{a}±0.15	49.61±0.96
Cellulose*	35.42^{b}±0.28	40.45^{a}±2.07	41.56^{a}±0.58	40.08^{a}±0.29	39.38±0.85
ADL	7.54±0.41	8.62±0.18	8.66±0.23	8.32±0.35	8.29±0.19
Total ash**	7.37^{c}±0.24	8.29^{bc}±0.07	9.68^{a}±0.52	8.52^{b}±0.09	8.47±0.28

Means bearing different superscripts differ significantly (*P< 0.05, P<0.01).

group (Table 3). The reason for lower percentage of legumes was not clear. Average CP and NDF contents of herbage mass were also comparable among the treatment groups, ranging from 4.57 to 4.70% and 77.89 to 79.79%, respectively. However, all the values on nutrient contents were within the similar range as reported in pasture dominated by *Sehima nervosum* and *Heteropogon contortus* grasses (Pailan *et al.* 2001).

Table 3. Yield (DM) and composition (mean±SE) of herbage mass (n = 12) under different grazing practices

Attributes	Grazing practices/treatment groups		
	Continuous (G_1)	Rotational (G_2)	Deferred rotational (G_3)
Herbage mass (kg/ha)	2365±342	2677±364	2910±410
Botanical composition (%)			
Grasses	74.00±3.07	77.00±3.09	74.50±5.49
Legumes*	6.40^{ab}±1.14	8.48^{a}±1.43	3.90^{b}±0.46
Litter	6.58±1.71	5.48±1.50	5.25±1.62
Forbs and others	13.03±2.50	9.05±2.96	16.35±4.39
Chemical composition (%)			
DM	58.61±5.33	57.57±6.38	56.76±6.23
OM	91.14±0.65	91.72±0.44	91.74±0.40
CP	4.57±0.61	4.68±0.56	4.70±0.65
NDF	79.35±1.09	79.79±1.04	77.89±1.71
ADF	50.35±1.89	50.11±1.97	48.38±1.37
Cellulose	39.90±1.83	40.03±1.46	38.22±1.33
ADL	8.53±0.19	8.21±0.52	8.12±0.22
Total ash	8.86±0.65	8.29±0.44	8.26±0.40

Means bearing different superscripts differ significantly (*P< 0.05).

Herbage utilization and nutritional status of goats: Average CP content of mouth grab forage samples (Table 4) was comparable amongst the treatment groups and ranged from 10.7 to 11.9%. The higher CP content in ingested forages than available herbages in the paddocks under different grazing management practices was due to predominant presence of leafy parts in mouth grab herbages due to selective browsing behavior of goats in natural vegetations (Sun and Zhou 2009). Similarly OM, EE, NDF, ADF and cellulose contents were also comparable in mouth grab forage samples among the different treatment groups. All the values were within the similar range as reported earlier by Pailan *et al.* (2001) in small ruminants.

Daily feed dry matter (DM) intake was 506, 512 and 546 g in goats under G_1, G_2 and G_3 groups, respectively, and the differences were nonsignificant among the groups (Table 5). DMI expressed as kg/100 kg live weight was also comparable

Table 4. Chemical composition (%DM basis) of mouth grab herbage samples (n = 16) and barley grain

Attributes	Mouth grab herbage samples			Barley grain
	G_1	G_2	G_3	
DM	50.10±0.37	49.53±0.97	53.21±1.12	93.27
OM	92.37±0.80	90.77±0.55	90.57±1.65	94.17
CP	11.04±0.28	10.72±0.68	11.91±0.38	9.18
EE	2.79±0.12	3.03±0.33	2.20±0.27	2.01
NDF	59.39±0.33	60.05±0.87	57.22±0.67	34.23
ADF	40.26±0.44	43.67±0.83	42.11±0.78	16.18
Cellulose	19.10±0.41	19.42 0.88	19.09±0.77	14.21
ADL	16.54±0.63	17.57±0.86	17.82±0.48	1.74
Total ash	7.62±0.80	9.22±0.55	9.42±1.65	5.83

Table 5. Nutrient utilization and blood metabolites (mean±SE) in experimental grazing goats

Attributes	Treatment groups		
	G_1	G_2	G_3
Feed/ nutrient intake			
Feed (DM) intake (g/d)	506±38.76	512±33.56	546±38.37
DMI (kg/ 100 kg b.wt)	2.90±0.33	2.82±0.19	3.20±0.18
DMI (g/ kg $W^{\circ.75}$)	59.37±3.15	58.27±4.07	65.12±3.92
CPI (g/d)	53.32±3.89	52.45±4.66	61.53±3.48
DCPI (g/ d)	26.03±2.71	24.76±1.84	30.22±2.41
TDNI (g/d)	249±23.97	252±27.65	256±20.47
Nutrient digestibility (%)			
DM	44.23±0.74	46.30±2.53	44.92±0.68
OM	50.05±0.97	50.61±2.42	48.99±0.62
CP	48.85±2.41	47.17±0.87	49.19±1.84
EE	33.66±1.93	32.94±3.75	34.22±3.39
NDF	24.49±3.52	26.75±2.52	24.04±1.26
ADF	21.50±2.39	21.87±2.08	20.21±1.00
Cellulose	27.35±2.95	30.34±2.55	26.83±0.79
Blood metabolites (*units/dl*)			
Glucose (mg)	50.13±1.16	52.63±1.66	51.63±1.33
Plasma protein (g)	7.08±0.27	7.35±0.35	7.38±0.42
Plasma urea-N (mg)	14.40±0.83	14.33±0.76	14.13±0.47

(P> 0.05) Means of treatment groups did not differ significantly.

in experimental grazing goats and ranged from 2.82 to 3.20. The digestibility of DM, OM, CP, EE, NDF, ADF and cellulose were statistically similar among the groups. This indicated that grazing management practices did not have any influence on forage intakes as well as their utilization in goats during winter. Forage intakes and their utilization were also similar in goats allowed to graze following continuous, rotational and deferred rotational systems in natural vegetations during summer (Mahanta *et al*. 2007). Goats were also on similar plane of nutrition consuming comparable quantities of CP (52.4–61.5 g) and TDN (249–256 g). Performances were also similar for sheep on continuous and rotational grazing practices at comparable stocking rates during the year round grazing in South Western Queensland of Australia (Skerman and Riveros 1990). On the contrary, cattle had better performances under continuous system of grazing than deferred rotational from the arid *Lasiurus-Eleusine-Aristida* grassland in Rajasthan (Prajapita 1970). Variation in grazing management practices did not influence the concentration of blood metabolites in experimental goats. Concentration (units per dl) of glucose, plasma protein and urea-nitrogen ranged from 50.1 to 52.6 mg, 7.08 to 7.38 g and 14.1 to 14.4 mg, respectively and were within the normal range as reported earlier (Patel *et al.* 2004).

Thus it was concluded that different grazing management practices viz. continuous, rotational and deferred rotational at comparable stocking rates did not have any influence on herbage mass and quality, nutrient utilization and blood metabolites in goats allowed to graze on natural vegetation of Bundelkhand with supplementation (@ 1.0% of live weight) of barley grains as energy source during winter.

ACKNOWLEDGEMENTS

The facilities provided by the Incharge, Network Collaborative Programme on 'Crop based animal production system', IGFRI, Jhansi for conducting this work is thankfully acknowledged.

REFERENCES

AOAC. 1990. *Official Methods of Analysis*. 15th edn. Association of Official Analytical Chemists, Arlington, VA.

Bakare A G and Chimonyo M. 2011. Seasonal variation in time spent foraging by indigenous goat genotypes in a semi-arid rangeland in South Africa. *Livestock Science* **135**: 251–56.

Duncan D B.1955. Multiple range and multiple 'F' test. *Biometrics* **11**: 1–42.

Dwivedi R N, Singh M, Sharma P, Pandey S, Meena B S, Tamankar M B, Sharma R K and Upadhyay J P. 2004. *Nutritive-Cereal Based Rainfed Agro-ecosystem for Bundelkhand Region: Technology Assessment and Refinement through Institution Village Linkage Programme*. Pp.20. Indian Grassland and Fodder Research Institute, Jhansi.

Goering H K and Van Soest P J. 1970. Forage Fibre Analysis (apparatus, reagents, procedures and some applications). *Agricultural Hand Book* No. 379, ARS, USDA, Washington, DC.

Gupta P C, Khatta V K and Mondal A B. 1992. *Analytical Techniques in Animal Nutrition*. Pp. 64–78. Directorate of Publications, Chaudhary Charan Singh Haryana Agricultural University, Hisar.

Hu H L, Lu D Y and Liu Y Z. 2007. Effect of supplementary feeding on growth performance and ruminal fermentation in winter season grazing sheep. *Journal of Animal Feed Science* **16**: 460–64.

Mahanta S K, Singh B B, Pailan G H, Verma N C and Kumar S. 2007. Effect of grazing management practices on nutritional status of grazing goats supplemented with barley grain during summer in Bundelkhand. *Range Management and Agroforestry* **28**: 239–41.

Pailan G H, Verma N C and Pachauri V C. 2001. Impact of different systems of grazing management on growth performance in kids and lambs. *Indian Journal of Animal Production* **33**: 33–35.

Papanikolau K, Karalazos A, Dotas D and Nitas D. 1993. Grazing capacity and herbage mass quality fluctuation and goats and sheep grazing behavior on grassland that came from burned shrubland. *Animal Science Review* **12**: 63–64.

Patel M S, Singh N P, Gehlaut B S and Singh H S. 2004. Performance of Babari goats under different systems. *Indian Journal of Animal Sciences* **74**: 299–302.

Pavlu V, Hejcman M, Pavlu L, Gaisler J, Hejcmanova-NezerKova P and Meneses L. 2006. Changes in plant densities in a mesic species-rich grassland after imposing different grazing management treatments. *Grass and Forage Science* **61**: 42–51.

Prajapita M C. 1970. Effect of different system of grazing by cattle on Lasiurus-Eleusine-Aristida grassland in the arid regions of Rajasthan. *Annals of Arid Zone* **9**: 114–24.

Rai A K and Rai P. 2010. Role of silvipastoral system in increasing

productivity of small ruminants. *Range Management and Agroforestry* **31**: 102–08.

Sharma N. 2006. *Forage Production and Utilization- Challenges Ahead*. Indian Grassland and Fodder Research Institute, Jhansi, India. pp. 4.

Shinde A K, Karim S A, Patnayak B C and Mann J S. 1997. Dietary preference and grazing behavior of sheep on Cenchrus ciliaris pasture in a semi-arid region of India. *Small Ruminant Research* **26**: 119–22.

Singh J B, Pradeep Behari and Rai S K. 2005. Annual and seasonal climate variability in a semi-arid region. *Range Management and Agroforestry* **26**: 108–12.

Skerman P J and Riveros F. 1990. *Tropical Grasses*. Food and Agricultural Organization of the United Nations, Rome.

Snedecor G W and Cochran W G. 1989. *Statistical Methods*. 8th edn. Iowa State University Press, Ames, Iwoa.

SPSS Inc. 1999. SPSS Base 10 *Statistical Package for Windows*. Chicago, IL, USA.

Sun H X and Zhou D W. 2009. Prediction of diet composition and intake of sheep grazing soyabean and maize residues. *Journal of Applied Animal Research* **35**: 125–29.

Tadmor N H, Beighet A, Noy Meiv R W and Eyal E. 1975. An evaluation of calibrated weight estimated method for measuring production in annual vegetation. *Journal of Range Management* **28**: 65–69.

Verma N C, Pailan G H and Pachauri V C. 2001. Effect of different grazing management systems on pasture quality and livestock production. *Indian Journal of Animal Production* **33**: 26–28.