

Effect of Agro-ecological Zones, Farm Category and Season on Feeds and Feeding of Large Ruminants in Rural Bangladesh

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ABSTRACT : Availability of feeds and fodder and amount of their intake by large ruminants in eight different agro-ecological zones (AEZ) of Bangladesh were recorded over a year. Roughages such as straw, naturally grown green grass, water hyacinth, tree leaves, legumes and sugarcane tops were the major feedstuffs fed to the large ruminants. Amount of intake of these ingredients differed ($p < 0.01$) across AEZ studied, but did not differ across seasons or farmers' categories ($p > 0.05$) except for green grasses ($p < 0.01$). Byproduct concentrates offered to animals in the studied areas were rice bran, wheat bran and different oil cakes. The amount of intake of concentrates by the animals also differed ($p < 0.01$) across AEZs, but did not differ across seasons or farmers' categories ($p > 0.05$), except for rice bran and wheat bran which differed between season and farm category, and season respectively ($p < 0.01$). The large standard errors of mean indicate that there are wide variations in intake of roughages and concentrates across AEZ's, seasons and farmers' categories and even across days. This further indicates that the feeding practices of large ruminants are largely heterogeneous. In addition to feeding roughage and concentrates, the animals were allowed to graze for six hours a day. Grazing hours also differed ($p < 0.01$) across AEZ, but not by farmers' categories or seasons. (*Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 5 : 643-649*)

Key Words : Ruminants, Feeds, Roughage, Concentrate, Grazing

INTRODUCTION

The livestock industry in Bangladesh (and South Asia in general) is mostly rural based and production systems of livestock are small scale in operation. Fibrous crop residues, seasonal weeds, natural grasses, and a meager amount of byproduct concentrates are being fed to the large ruminants. Consequently, animals remain in a state of under-nutrition, which cannot sustain animal's production performances, that is of milk and meat etc. This situation of under-nutrition is aggravated by the unsystematic feeding practices exercised by the farmers, which in fact depend on the seasonal availability and consistent natural hazards in the country. However, data on the feeding practices, availability of feeds and fodder, and their consumption by the large ruminants is scarce (Lumanta et al., 1990). To improve animal production as a whole, it is important to know the actual status of feed availability and consumption of different available ingredients for large ruminants in Bangladesh.

Unlike chemical composition and digestibility, which give only a qualitative estimation of nutritive value (Van Soest, 1982), intake is the single most significant quantitative entity of nutritive value to be considered in establishing a feeding system. The intake is the interaction between animal's requirement or consumption and the amount offered (van Soest, 1982). In a small farm system,

the latter is largely determined by the availability of feed in the system, which in turn depends to a large extent on natural environment conditions. To formulate a feeding system for the rural large ruminants in Bangladesh and in South Asia, where small farm system is a predominant livestock production system, it is important to know the availability or amount offered and intake of feed ingredients by ruminants.

The present study was therefore undertaken to understand the status of feed availability and consumption which would serve as a guideline to develop a feeding system for large ruminants in the country.

MATERIALS AND METHODS

In order to get a detailed insight in the traditional feeds and feeding of large ruminants, e.g. cattle and buffaloes existing in the country, a year-round study was carried out in eight different agro-ecological zones (AEZ). There are however, 30 AEZs in Bangladesh, which were classified according to soil type, temperature regimes, annual rainfall, natural vegetation types and cropping practices (Karim, 1988). This study covered eight of the 30 zones and those selected were :

1. The old flat alluvial basin (e.g. Kaunia)
2. Milk shed area with pasture land (e.g. Sirajgonj)
3. Intensive milk pocket area (e.g. Manikgonj)
4. Riverine area (e.g. Faridpur)
5. The tea plantation area (e.g. Srimangal)
6. The high terrace barind tract (e.g. Naogaon)
7. The elevated dry Madhupur tract (e.g. Savar)

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8. The hilly area (e.g. Naikhongchari).

The characteristics of the selected sites are given in table 1 and the locations of AEZ's are given in figure 1.

From each of the zones, a village was selected as a study area. A complete survey of total households in each of the village was carried out using a standard questionnaire regarding size and tenurial status of farms, number and distribution of cattle and buffaloes, cropping pattern and management of livestock. After compilation of questionnaires, farmers were grouped into four (large, medium, small and marginal farmers) depending on the cultivable lands and number of ruminants they had. Afterwards from each group of farmers, three households (replications) were selected at random. Therefore 12 households, three from each category of farmers, were selected from each site. The stratification of selected farmers was as follows:

1. Large farmers: more than 2.02 ha of cultivable land owned and more than 10 heads of cattle and/or buffaloes.

2. Medium farmers: from 1.01 to 2.02 ha and more than 5 heads of cattle and/or buffaloes.
3. Small farmers: from 0.61 to 1.01 ha of land and 4 to 5 heads of cattle.
4. Marginal farmers: less than 0.61 ha of land and 1 to 3 heads of cattle.

The large ruminants studied in this experiment included indigenous non-descript ruminants of all classes over one years of age present in a farm. These were bullock, milking cows, pregnant cows, barren cows, heifers, yearling bull and adult bulls. In small farm systems in Bangladesh animals are reared for multipurpose objectives such as meat, draft power/and or milk. Average body weight (kg) of these animals in different sites was: 162.8 (Faridpur), 174.2 (Savar), 166.2 (Naogaon), 107.3 (Naikhongchari), 176.5 (Sirajgonj), 120.3 (Srimangal), 112.5 (Mankgonj) and 164.6 (Kaunia). The average body weight of animals from all sites was 147.9 kg. Body weight was estimated by the following (Payne and Wilson, 1999) formula:

$$\text{Body weight (kg)} = \{(\text{Length} * (\text{Heart girth})^2) / 300\} / 2.205$$

In order to draw a complete schema about the availability and amount offered of roughages and concentrate, feeds were weighed and recorded every month from each household throughout the study period, whatever farmers offered to their large ruminants. Ruminants of four farmers from each category were monitored during the first 3 days of the month; four other farmers during the mid-three days, and the remaining four farmers were monitored during the last 3 days of the month. The whole year was divided into three seasons to get seasonal availability of feeds and fodder and their amount offered. These seasons were January to April (dry and hot, called *Aus*), May to August (hot and wet, called *Aman*), and September to December (cool and dry, called *Rabi*). Data on amount offered and feed refusals were measured using a top loading balance to estimate the intake of each ingredient offered on fresh matter (FM) basis. The farmers usually offered feed ingredients to their ruminants as group-fed system in one or more mangers. As the number of ruminants differed across farm categories, daily feed intake was determined as the total amount of feed intake (offered minus refusals) dividing by the total number of animals for each farm category. Refusals were weighed on the next day after offering feeds to determine intake. Types of ingredients and their sources were also recorded. Moreover, daily grazing hours were also recorded.

The design of the experiment was an 8x4x3 factorial design with 3 replicates (i.e. 12 household; see above in this section) where there were 8 AEZs, 4 farmer's category and 3 seasons which was analyzed by a 4 way ANOVA, and

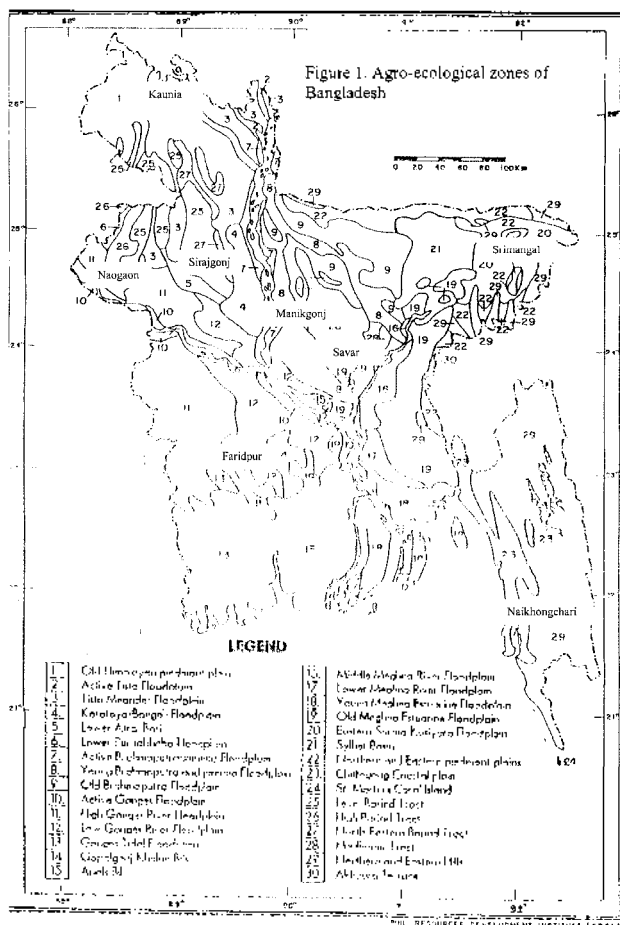


Figure 1. Agro-ecological zones of Bangladesh

Table 1. Characteristics of selected sites according to agro-climatic criteria

Zones	Bovine population (nos.)	Soil type	Temp (°C)		Annual rainfall (mm)	AEZ ¹	Location and extents
			Max	Min			
Kaunia	33,848	Noncalcareous brown and grey floodplain soil	38	12	2,032	3	Tista meander floodplain (Most of greater Rangpur, eastern part of Panchagarh and Dinajpur, northern Bogra and part of Jaipurhat, Noagaon & Rajshahi districts) (9,468 km ²)
Sirajgong	84,549	Noncalcareous grey and dark grey floodplain soil	38	7	1,179	4	Karatoya-Bangali floodplain (Eastern half of Bogra district and most of Sirajgong district) (2,572 km ²)
Manikgongj	46,936	Calcareous dark grey and brown floodplain soil	38	10	NA	8	Young Brahmaputra and Jamuna floodplain (Western parts of Sherpur, Jamalpur and Tangail districts, parts of Manikgongj, Dhaka, Munshigonj, Narayangonj and Gazipur districts, & adjoining to old Brahmaputra e.g. Mymensingh, Kishoregonj and Narsingdi districts) (5,924,310 km ²)
Faridpur	39,560	Calcareous dark grey and brown floodplain soil	38	8	1,489	12	Low Ganges floodplain (Natore, Pabna, Goalanda, Faridpur, Madaripur, Gopalgongj and Shariatpur, parts of Kushtia, Magura and Narail, Khulna, Bagerhat, Barisal, Manikgongj, Dhaka and Munshigonj district)
Srimangal	44,514	Noncalcareous grey floodplain soil and acid basin clays	37	9	4,017	20	Eastern Surma-Kushyara floodplain (Sylhet, Moulavibazar, Sunamgonj & Habigonj districts) (4,622 km ²)
Naogaon	72,026	Deep grey terrace soil and grey valley soil	38	12	2,032	26	High barind tract (Rajshahi, Nawabgonj and Naogaon districts) (1,600 km ²)
Savar	59,567	Deep to shallow red brown terrace soil	38	10	2,053	28	Madhupur tract (Dhaka, Gazipur, Narsingdi, Narayangonj, Tangail, Mymensingh and Kishoregonj district) (4,244 km ²)
Naikhongchari	12,032	Brown hill soil	37	10	2,794	29	Northern and eastern hills (Khagrachai, Chittagong hill tracts, Bandarban, Chittagong, Cox Bazar, Habigonj & Moulavibazar districts; parts of Sherpur, Mymensingh, Sunamgonj, Brahmanbaria, Comilla and Feni districts) (18,171 km ²)

Sources: BBS (1986); The Bangladesh Census of Agriculture and Livestock (1983-84); Statistical Yearbook (1986); NA=Not available; ¹AEZ=Agroecological zone.

where only main effects were considered for discussion for simplicity. The degrees of freedom were 1152. A computer using SPSS package analyzed the collected data (Snedecor and Cochran, 1989). The statistical model was as follows:

$$Y_{ijkl} = \mu + A_i + F_j + S_k + R_l + E_{ijkl}$$

where Y_{ijkl} is the dependent variable, μ the overall mean, A_i the average effect of AEZ i ($i=8$), F_j the average effect of farmers category j ($j=4$), S_k the average effect of seasons ($k=3$), R_l the average effect of individual household ($l=12$) and E_{ijkl} the residual error, assumed to be normally, identically and independently distributed.

RESULTS AND DISCUSSION

The availability and mean roughages consumed by the large ruminants are given in table 2. Roughages like straw, naturally grown green grass, water hyacinth, leguminous fodder, and sugarcane leaves and tops are the major feedstuffs fed by most of the farmers in the study areas. However, the magnitude of intakes of each ingredient differed across AEZ ($p < 0.01$) in all cases of roughages, but did not differ across farmers' categories and seasons ($p > 0.05$) except for the intake of green grasses ($p < 0.01$). Ruminants in Sirajgonj consumed the highest (4 kg FM/head/day) amount of straw, while the lowest (1 kg FM/head/day) amount was consumed at Savar and Naikhongchari sites. On the other hand, animals at Savar consumed the highest amount of green grass (15 kg FM/head/day) but had lowest straw consumption; ruminants of Naikhongchari also consumed the lowest amount of green grass. The fact that farmers of Savar have easy access to cut and carry exotic fodder from plots adjacent to the farms to feed their animals explains the large amount of green forages consumed by the animals of Savar. It is, however, not the true aspect of what can be seen in the whole Madhupur tract areas where green forages are scarce.

Interestingly, ruminants of Naikhongchari were fed neither straw nor green grasses in good amount due to the

fact that the management and raising of ruminants in the hilly areas are different to those from the rest of the country. Farmers in hilly areas, as in Naikhongchari, rely completely on grazing on hillocks and hence straw or green grasses were not generally offered to the animals in stall, and this was the main reason for the lowest intake of straw and grasses by ruminants in Naikhongchari. Although Naikhongchari is a hilly area where tree leaves are in abundance, farmers did not collect them to feed their animals at stalls. Leaves, mainly water hyacinth were fed to the animals of Faridpur areas, while feeding leaves in other areas was not so common. Faridpur is a low floodplain area where water hyacinth grows abundantly and, unlike Naikhongchari there is no grazing land. Legumes, mainly khesari (*Lathyrus spp.*) and matikalai (*Vigna spp.*) were mostly fed to the ruminants in Naogaon, Sirajgonj, Faridpur and Kaunia.

Seasonal legume pulses are extensively grown in these areas during *Rabi* (winter) season, and farmers feed their animals by cut and carry method or by pasturing. Sirajgonj is a special grazing area, locally known as 'bathan' where farmers grow khesari and matikalai after the receding of floodwater for pasturing their animals. Flood receded later than usual during the 'bathan' season in the year when the data were taken. Therefore, availability of these legumes was lower for animals than was expected. Such situations

Table 2. Intakes of roughages (mean, kg FM/head/day) as fed as affected by agro-ecological zones (AEZ), season and farm category

Factors	Sub-factors	kg/head/day					F-values and level of significance (Total df=1,152)				
		Straw	Green grass	Leaves	Legumes	Sugarcane tops	Straw	Green grass	Leaves	Legumes	Sugarcane tops
Zones	Kaunia	2.9 ^{ab}	2.5 ^{bc}	0.6 ^b	0.5 ^c	0.1 ^d	94.6**	5.8**	13.5**	13.4**	21.0**
	Sirajgonj	4.2 ^a	6.1 ^b	0.03 ^{bc}	1.5 ^b	0.1 ^d					
	Manikgonj	2.1 ^{ab}	5.6 ^b	0.2 ^b	0.01 ^d	0.0 ^b					
	Faridpur	2.7 ^{ab}	6.2 ^b	1.2 ^a	0.6 ^c	0.0 ^b					
	Srimangal	1.1 ^{ab}	5.9 ^b	0.6 ^b	0.1 ^d	0.0 ^b					
	Naogaon	2.8 ^{ab}	0.4 ^c	0.2 ^b	2.1 ^a	0.0 ^b					
	Savar	0.9 ^b	15.2 ^a	0.3 ^b	0.0 ^d	0.0 ^b					
	Naikhongchari	0.9 ^b	0.2 ^c	0.0 ^{bc}	0.0 ^d	0.0 ^b					
Season	Aus	2.1	0.6 ^b	0.5	0.0	0.03	2.9NS	7.3**	2.5NS	2.4NS	3.0NS
	Aman	2.0	7.5 ^a	0.5	0.05	0.01					
	Rabi	1.4	5.5 ^a	0.5	0.2	0.0					
Farm category	Large	2.7	2.1 ^b	0.3	0.08	0.02	3.4NS	30.6**	1.6NS	2.7NS	4.0NS
	Medium	1.7	11.5 ^a	0.1	0.05	0.01					
	Small	1.3	3.3 ^b	0.5	0.25	0.01					
	Marginal	1.4	3.5 ^b	0.2	0.01	0.02					
	Mean	2.0	5.0	0.3	0.1	0.01					
	SE	1.5	2.8	1.1	0.6	0.04					

^{a,b,c} Means with different superscripts in each column of sub-factors differ significantly ($p < 0.01$). ** $p < 0.01$; NS, $p > 0.05$.

occur often since it depends mainly on nature (Hossain, 1987). The availability and consumption of sugarcane leaves and tops were observed only in Kaunia and Naogaon. These are sugarcane-growing areas where farmers grow sugarcane to sell to the adjacent sugar mills.

Neither seasons nor farmers' category differed ($p>0.05$) on any of the ingredients consumed except that of the green grass intake ($p<0.01$) although apparently there was a big difference in intake of each ingredient due to these two factors. The reasons for not differing across the treatments lay on the fact that the standard error of the treatments was too large. The reason for large difference in error was due to the contrasting sites chosen. The other feature could be that the amount offered and consequently intake of each ingredients also varied abruptly even across days. Indeed, abruptly changing feeding system is a common feature on small farm systems reported elsewhere (Ralman et al., 1991; Osafo, 1993; Osafo et al., 1997); feed availability at the time of offer is likely to be responsible for intake not differing between farmers category and season. Intake of green grass was higher during *Aman* season since grasses grow abundantly everywhere due to hot and wet climate, whilst the lowest intake during *Aus* season was due to the unavailability grasses in hot and dry spells. The mean intake of straw, green grass, leaves, legumes and sugarcane tops

per day per animal was 2.0, 5.0, 0.3, 0.1 and 0.01 kg FM, respectively.

Intake of byproduct concentrates by the ruminants in the study areas is shown in table 3. The amount of intake of concentrates by the animals also differed ($p<0.01$) across AEZs, but did not differ across seasons or farmers' categories ($p>0.05$), except for rice bran and wheat bran which differed between season and farm category, and season respectively ($p<0.01$). Mostly rice bran, wheat bran and different types of oil cakes, e.g. mustard, linseed etc. were offered to the animals. Crushed grain, pulses and their brans and molasses were also offered to the animals, but the amount was too small to record. Intake of rice bran differed due to AEZ, farmers' category or season ($p<0.01$). Intake of rice bran was higher in Faridpur, Sirajgonj, Savar and Manikgonj than other areas. These areas are not only intensive rice producing areas but are also considered as animal or more particularly intensively milk producing areas, and farmers are able to allow more rice bran to their animals than in other areas. Intake of wheat bran was also higher in Faridpur and Manikgonj area. Farmers in these areas grow wheat alongside rice. Oil cakes were mainly fed to the animals in Naogaon area. In Naikhongchari, farmers did not allow any byproduct concentrates to their animals. As stated earlier, that the farmers rely on grazing their

Table 3. Intakes of concentrates (mean, g FM/head/day) as fed as affected by agro-ecological zones (AEZ), season and farm category

Factors	Sub-factors	g/head/day			F-values and level of significance (Total df=1,152)		
		Rice bran	Wheat bran	Oilcakes	Rice bran	Wheat bran	Oilcakes
Zones	Kaunia	500 ^{ab}	30 ^{bc}	30 ^a	83.7**	25.5**	10.0**
	Sirajgonj	800 ^a	50 ^{bc}	30 ^a			
	Manikgonj	700 ^a	200 ^a	30 ^a			
	Faridpur	800 ^a	200 ^a	0 ^b			
	Srimangal	400 ^b	30 ^{bc}	0 ^b			
	Naogaon	400 ^b	0 ^c	50 ^a			
	Savar	700 ^a	100 ^{ab}	0 ^b			
	Naikhongchari	0 ^c	0 ^c	0 ^b			
Season	Aus	300 ^b	20 ^b	10	13.7**	46.5**	1.0NS
	Aman	400 ^b	10 ^b	10			
	Rabi	600 ^a	70 ^a	20			
Farm category	Large	600 ^a	20	10	4.1**	3.1NS	1.0NS
	Medium	400 ^b	30	10			
	Small	500 ^{ab}	50	10			
	Marginal	40 ^c	10	10			
	Mean	500	30	10			
	SE	400	92	17			

^{a,b,c} Means with different superscripts in each column of sub-factors differ significantly ($p<0.01$). ** $p<0.01$; NS, $p>0.05$.

ruminants on the hill slopes and valleys throughout the season is likely to be the reason for not supplying any concentrates. There are at least 27 species of grasses, shrubs and tree leaves grazed by the cattle in the hill slopes and valleys of Naikhongchari. The dominant plant species in the grazing land of hill slopes and valleys were *durba* (*Cynodon dactylon*), *Dal* (*Hymenachne pseudointerrupta*), bamboo (*Bamboosa spp.*) leaves and sprouts, wild banana (*Musa spp.*), *dumur* (*Ficus spp.*) and many other unidentified plants. However, there is no information about the standing volume of these plant species found in Naikhongchari, which needs to be studied further. Since Naikhongchari is a hilly area, farmers have little space in the valley to grow crops other than rice for their own consumption. Farmers in hilly areas also practice shifting cultivation for their own consumption.

The higher intake of concentrate in *Rabi* ($p < 0.05$) was due to the fact that it is the biggest harvesting season of pulse crops and hence farmers are able to supply by-product concentrates to their animals during that season. In *Aus* season, animals get half the amount offered in *Rabi* because it is the smallest harvesting season. While large farmers can supply by-product concentrate in *Aus* season from their preserved material, small farmers cannot supply the required amount to the animals as in the *Rabi* season. This result indicates that only the large farmers presumably preserve concentrates throughout the year for feeding ruminants in times of need. The mean intake of rice bran, wheat bran and oil cakes by ruminants in the studied areas were 500, 30 and 10 g FM/head/day, respectively.

In addition to feeding roughages and concentrates to their animals, farmers usually grazed their animals during daytime in the vicinity of homestead, in the field after harvesting and in the hillocks (e.g. Naikhongchari). The mean grazing hours differed across AEZ ($p < 0.01$), but did not differ by farmers' category or season ($p > 0.05$). Farmers in Naikhongchari grazed their animals for the longest time (9 h/day), while in other parts of the study areas grazing period ranged from 4 to 6 h a day (table 4). The reason for longer grazing hours in Naikhongchari has been described earlier. However, it should be kept in mind that there is actually no land for grazing in the country other than the hilly areas and hence grazing in different AEZ's other than Naikhongchari is restricted to the homestead areas, roadside, embankments, boundary dykes of crop fields and in the field after harvesting of crops. A noticeable feature of animal nutrition is that grazing plays a significant role in ruminant production in Bangladesh, because irrespective of any of the studied factors involved, farmers in Bangladesh grazed their ruminants at least 4 h a day (4-9 h/day in all areas) which is consistent compared to the amount offered at stall.

Therefore, although the feeding system of ruminant

Table 4. Grazing (hours/day) as affected by agroecological zones (AEZ), season and farm category

Factors	Sub-factors	Grazing (hours/day)	F-values and level of significance (Total df=1,152)
Zones	Kaunia	4 ^c	10.9**
	Sirajgonj	6 ^{ab}	
	Manikgonj	5 ^{bc}	
	Faridpur	4 ^c	
	Srimangal	4 ^c	
	Naogaon	5 ^{bc}	
	Savar	6 ^{ab}	
	Naikhongchari	9 ^d	
Season	Aus	7	2.0NS
	Aman	6	
	Rabi	6	
Farm category	Large	6	2.4NS
	Medium	7	
	Small	6	
	Marginal	6	
	Mean	6	
	SE	2	

^{a,b,c} Means with different superscripts in each column of sub-factors differ significantly ($p < 0.01$), ** $p < 0.01$; NS, $p > 0.05$.

livestock in terms of the amount offered in stall is a heterogeneous, grazing plays a significant role in the animal nutrition status of ruminants of Bangladesh. Straw, naturally grown green grass and rice bran are the main feeds available and offered to the animals. However, the amount offered suggests that it is unlikely to sustain production. Notwithstanding, the result implies that a significant portion of nutrition is coming from grazing, which is usually not taken into account and therefore needs to be quantified to get an actual intake to formulate a relatively sound feeding practice for rural ruminants.

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