

Effect of natural browse fodder availability on feeding behaviour of goats

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Abstract

Feeding behavior of goats on natural pasture was studied during three consecutive seasons of the year: dry, rainy and post-rainy. Concurrently, observations were made on the availability of five browse forages by following their phenological phases.

Availability of browse forages components (green leaves, litter, flowers and fruits/pods) varied with the species phenological stage. *Acacia raddiana*, *Balanites aegyptiaca* and *Ziziphus mauritiana* showed a long cycle compared to *A. laeta* and *A. seyal*, which lost their leaves early. In general, browse forage in terms of green leaves, litter and fruits/pods was available from July to March. This forage was particularly beneficial from December to March when herbaceous biomass decreases in quantity and quality. The feeding behavior of goats varied according to forage availability. The main activity of goats was browsing, 40% of their grazing time in rainy season and 60% in dry season. Grazing was the second activity with a maximum (22 to 38%) in the rainy season, from July to September. Resting time was high in dry season, with a maximum in March, probably due to high temperatures.

Key words: browsing, grazing, herbaceous biomass dynamic, phenology, Sahelian zone

Introduction

In tropical dry countries, livestock production is important for the farmers and for the country economy. Burkina Faso has a significant livestock population: 7.3 million heads of cattle, 6.7 of sheep and 10 of goats, according to the national livestock census (MRA 2004). The Sahelian zone has the largest numbers, 20.6 % of cattle, 14% of sheep and 17% of goats (MRA 2004). The animals are kept mainly in extensive production system on natural pastures.

Burkina Faso and other Sahelian countries face the crucial problem of feed shortage in the arid and semi-arid areas. Degradation of natural resources, competition between humans and livestock and the rainfall variability inherent to the arid and semi-arid areas, are the main constraints affecting animal productivity.

Animal numbers are increasing, especially in the Sahelian zone where the carrying capacity is largely exceeded (MRA, 1997). A study on herbaceous cover dynamics showed important decrease in production as early as January, from 76 to 83 % according to pasture type (Ouattara 2004). The diversity of browse species with the length of their production cycle, the variety of feed components (fresh and dry leaves, flowers and fruits/pods) and the high content of protein and some minerals, constitutes a key resource for grazing animals especially in the dry season, insofar they are less dependent on rainfall compared to herbaceous plants.

However, the contribution of browse depends on the animal species and their feeding behavior. Cattle and sheep, as grazers, prefer herbaceous plants, while goats, as browsers, prefer browse species. The study of Sanon et al (2007) showed that goats spent 43, 44.6 to 52 % of time browsing in rainy, post rainy and dry seasons, respectively, versus 4.8, 6.4 and 28% for sheep and 4.5, 3.9 and 6.6% for cattle. As stated by Silanikove (2000), this ability allows goats to

survive and to produce in hard situations with low feed availability and quality, lack of water and excessive heat.

This study aimed to assess the relation between goat feeding behavior and the availability of natural browse fodders in a Sahelian area, through a monitoring of feeding behavior and the species phenology.

Material and methods

The study was undertaken in the Regional Centre of Environmental and Agricultural Research (CRREA) at Katchari, in the Sahelian area, North of Burkina Faso. The station is located between 13°55' and 14°05' N and 0° and 0°10'W within the north Sahelian agro-climatic zone (Fontes and Guinko 1995), characterized by a short rainy season from June to September (300 mm to 600 mm of rain), followed by a long dry season characterized by Harmattan dry wind, which blows NE to SW, with a cool and dry period from November to February and a hot period from March to May with maximum temperatures reaching 45° C in April.

The vegetation is of the steppe type, with shrubs and trees. Forest galleries are found along riversides and in some parts ligneous species may form more or less penetrable bush (e.g. tiger bush). The most common ligneous species found in the area are: *Acacia nilotica*, *A. senegal*, *A. laeta*, *A. seyal*, *Balanites aegyptiaca*, *Boscia senegalensis*, *Commiphora africana*, *Pterocarpus lucens* and *Grewia flavescens*. The grass cover is sparse and dominated by annual grasses such as *Aristida mutabilis*, *Cenchrus biflorus* and *Schoenefeldia gracilis*.

The human population is mainly composed by the autochthonous Fulani people who have livestock keeping as their main activity followed by cropping. The main species kept are cattle, sheep, goats, camel, donkey and poultry. Goats are numerically more important and kept mainly by poor farmers as first step toward the forming a sheep herd and a cattle herd later.

Data collection

Two consecutive studies were undertaken. The first was the monitoring of goat feeding behavior on pasture during different seasons marked by fluctuation of feed availability. The second study concerned the phenology of five main browse species, followed by repeated measurements of the herbaceous biomass.

Feeding behavior study

A farmer's herd of Sahel type goats with animals of different ages was observed in the natural pastures during the successive seasons: rainy (July to September), post rainy (October to December) and dry (January to March-April). The herd behavior was recorded during three consecutive days per month. From 6 am to 6 pm, with help of stop watch, the activities of one selected animal for the day were recorded every 15 minutes. The activities registered were grazing, browsing fresh leaves or litter, watering, ruminating, resting and walking. A Global Positioning System (GPS) was used to determine the coordinates of the feeding paths.

Study of species phenology

Five woody species, prevalent in the pastures studied, were considered: *Acacia raddiana*, *A. laeta*, *A. seyal*, *Balanites aegyptiaca* and *Ziziphus mauritiana*. According to a previous study in the same area (Sanon 2002), *A. raddiana* constituted 94% of woody species on the glaciais pasture; and *A. laeta* and *Balanites aegyptiaca* were more abundant on sandy soil pastures representing 6% and 14% of the woody flora, respectively; *A. seyal* and *Ziziphus mauritiana* constituted on average 18% and 12% of woody flora in lowland pasture respectively.

Individual plants of each species were chosen taking into account their height: [$<1\text{m}$], [$1 - 3\text{m}$], [$3 - 5\text{m}$], [$5 - 7\text{m}$], [$>7\text{m}$] and they were protected against browsing with wire fence.

Three plants were chosen per height class, resulting in 12 individuals of *A. laeta* and *Z. mauritiana* (since no trees were found in the highest rank) and 15 individuals for the other species. Records were taken of the phenology, June 2001 to May 2002, by scoring the development of leaves, flowers and fruits every second week. The leaf phases were divided into four stages: leafless, the beginning (leaf buds to open buds <50%), fully leafed or optimum foliation (50-100% leaves) and foliation end (leaves drying and falling). The three stages recorded in the flowering phase were: the beginning (floral buds to <25% of open flowers), full flowering (>50% of open flowers) and flowering end (dry flowers and shedding of floral elements). For fructification the three stages were: the beginning (25 to 50% of fruits); full fructification (>50% fruits mature); and fructification end (fruits dried and falling). A stage was only recorded if at least 2 of the 3 individuals in the height class were in this stage. The results were presented in a phenogram.

Seasonal dynamics of herbaceous biomass

The herbaceous biomass on pasture types, where browse plants were selected, was evaluated during 5 months from November to March. Each month, 20 random locations of 1 m² were chosen in each pasture type and the herbaceous biomass cut at about 5 cm above the soil.

Statistical analysis

The data were analyzed using the General Linear Model (GLM) procedures of Minitab Program Version 14 (Minitab 2002). Means, which showed significant differences at the probability level of $P < 0.05$, were compared using Tukey's pairwise comparison procedures. The data from the behaviour study and the herbaceous biomass production were submitted to one way analysis of variance according to the model: $Y_i = \mu + \alpha_i + e_i$ with Y_i the dependant variable, μ the general mean, α_i the effect of season (behavior study) / pasture type (biomass) and e_i the residual.

Results

Phenology of browse species

The species phenograms studied are presented in Figure 1. All the species started the foliation after the first rain in June. The time between the onset of flushing and full foliation was approximately 1 to 1.5 months. *A. laeta* and *A. seyal* were the first to lose the leaves by the end of the rains in October, and the shedding of leaves was such that by the end of December, all trees were leafless. The leaves of *A. raddiana* started falling in November and finished until February, depending on the individuals. *B. aegyptiaca* and *Z. Mauritiana* kept their leaves longer. Their leaves started falling in February, and by March the defoliation was total for *Z. Mauritiana*, while for *B. aegyptiaca* it continued until April – May, with some individuals starting immediately a new foliation. On average, the foliation phase lasted 5 to 6 months for *A. laeta* and *A. seyal*, 6 to 7 months for *A. raddiana*, 8 to 9 months for *Z. mauritiana*, and 9 to 10-11 months for *B. aegyptiaca*. *A. laeta* and *B. aegyptiaca* flowered before *A. raddiana* and *Z. mauritiana*; for this last species, flowers appeared in full phase by August. *A. seyal* did not bear flowers or fruits during study period.

Overall, the fruiting phase started in August – September and lasted on average 6 to 7 months for *A. raddiana*, *Z. mauritiana* and *B. aegyptiaca*, and 5 months for *A. laeta*. For all species, the small individuals <1m did not bear flowers or fruits, nor did the class 2 of *A. laeta*, *A. raddiana* and *B. aegyptiaca*.

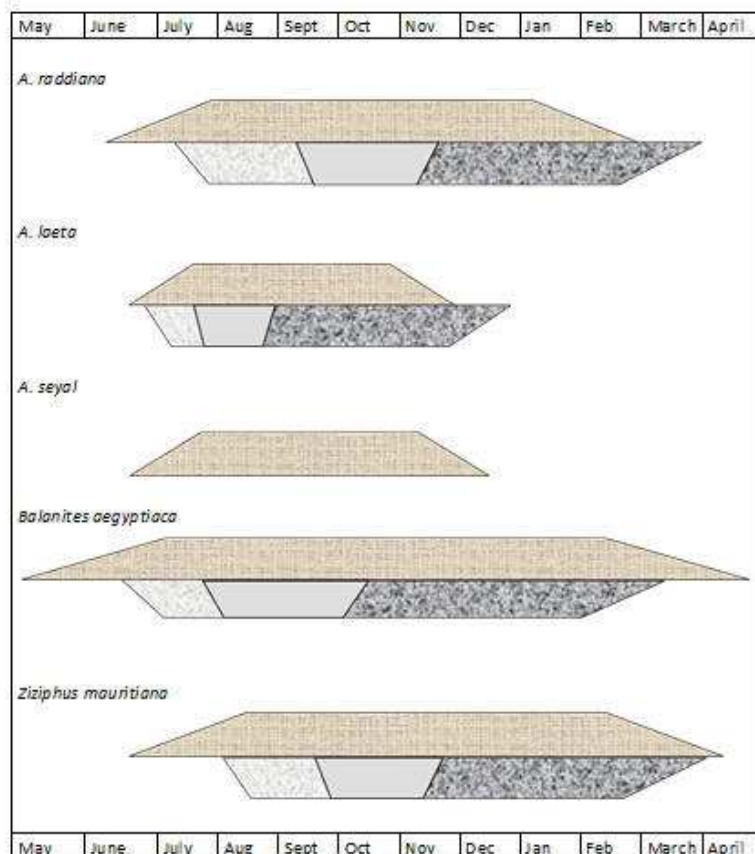


Figure 1. Phenogram of the species studied

Herbaceous biomass dynamics

The figure 2 shows the evolution of biomass production from November to March on the studied pasture types.

The biomass production in November was significantly higher in lowland pasture (1718 kg/ha DM) compared to the other pasture types and the glacis pasture had the lowest value (289 kg/ha DM). This tendency remained as the season advanced to post-rainy and dry. Overall, there was a decrease in biomass availability with the seasons, varying with pasture types. From November to March, the rate of biomass disappearance was 54% in the glacis pasture, 84% in sandy soil pasture and 79% in hollow pasture. The respective speeds of disappearance were 1.05 kg/day, 2.88 kg/day and 9.1 kg/day.



Figure 2. Variation of herbaceous biomass in different pasture types

Feeding behaviour of goats on natural pasture

During the study period, 1136 observations were made: 349 in the rainy season, 377 in the post rainy season and 410 during the dry season. The goat herd was enclosed at night for security reasons. The time spent on pasture varied from 7 to 10 hours in rainy season to 11 hours in the post rainy and dry seasons.

Description of the grazing paths

The grazing path varied according to the fodder availability. During the rainy season, the herder directed the animals towards the glacis and lowland pastures, far from croplands areas, which were protected with thorny branches. During the post rainy season, the forage availability diversified and they were important quantities of crop residues available, especially cereals straws. During this period goats consumed different forage resources with a marked preference for browse forages. During the dry season, the goats were first directed towards the glacis pasture, seeking dry leaves and pods of *Acacia* species, especially *A. raddiana*. After watering them at the village borehole, they were taken to the depression and sandy soil pastures, where residual biomasses still existed, spending most of the time there. At last, harvested cropland areas were used.

Feeding behaviour

Table 1 shows the proportion of time spent by goats walking, watering, resting and ruminating during different seasons. The time spent grazing and browsing leaves and litter is shown in figure 3.

	Rainy season	Post rainy season	Dry season	SE	Prob.
Walking	13,93 ^a	20,76 ^b	10,45 ^a	1,21	0.000
Watering	1,58 ^a	3,19 ^b	2,20 ^{ab}	0,42	0.04
Resting	1,989 ^a	5,52 ^{ab}	7,07 ^b	1,08	0.01
Ruminating	8,40 ^{ab}	13,57 ^a	3,65 ^b	1,78	0.005

^{abc} Means in the same row with different superscripts are different at $p < 0.05$

Walking

This activity includes going to and returning from pastures and searching for feed. It varied

from 10% to 21% of the time spent and was at maximum in the post rainy season. At this period, crop residues were abundant and most of the trees had mature fruits/pods (especially Acacia species) which fell down regularly, encouraging goats to move more in search for this supplemental feed.

Watering

The time devoted to watering was small compared to other activities and varied significantly from the rainy season (1.6%) to the post rainy season (3.2%). This activity was more or less under the control of the herder. During the rainy season goats drank in small water points in the pastures themselves. At the end of the rainy season, these water sources quickly dried and the animals were watered either from the village borehole or from shallow wells dug mainly in the bed of the natural water point. Animals were watered twice a day, at about 8.00 and at about 3.00 pm.

Ruminating and resting

Resting and ruminating occurred alternatively. The time spent by goat in ruminating was maximum in the post rainy season and differed significantly from the dry season. Controversially, goats rested more during the dry season and less during rainy season. In the dry season the feed availability was low and temperatures were high, thus, goats spent most of their time resting.

Grazing

It also included feeding on crop residues. This activity presented a pick during the rainy season with 32.6% of time spent on pasture. At this time, herbaceous cover was abundant and of high nutritive value. Grazing time decreased significantly in post rainy (5%) and dry seasons (16%).

Browsing

Browsing was the first activity during all seasons. It varied from 40% in rainy season to 60% in dry season. Browsing leaves was the most important activity during the rainy season as all trees were in full foliage. With the falling of dry leaves and fruit/pods in post rainy and dry seasons, consuming litter become quite important. The time devoted to this activity varied much between seasons: 3%, 22% and 40% in rainy, post rainy and dry seasons, respectively. The overall feeding time was low in post rainy season (57%) compared to rainy (74%) and dry season (77%).

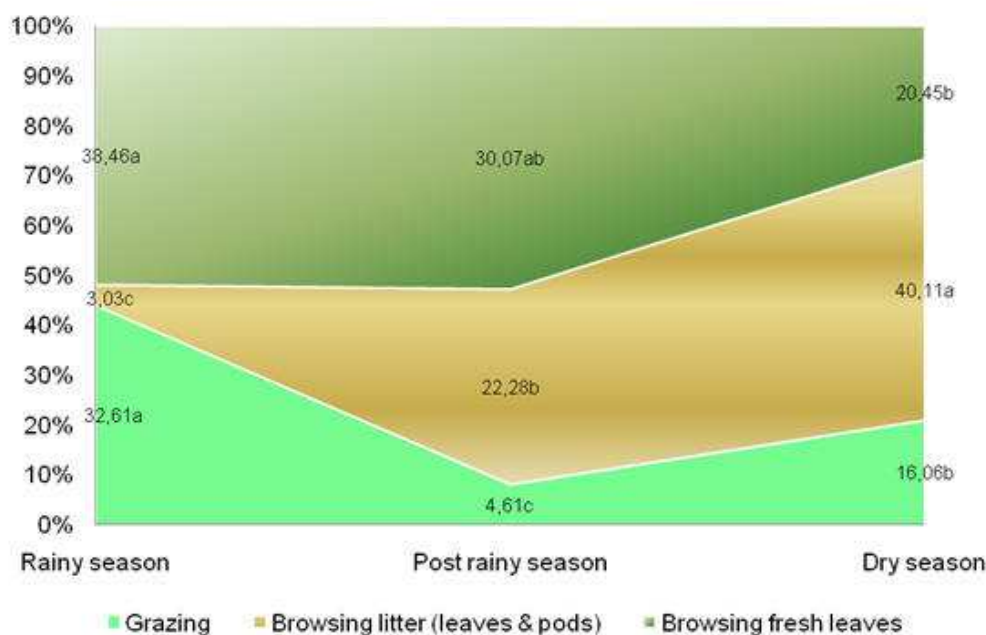


Figure 3. Feeding activities of goats on pasture during different seasons
(Means of activities between seasons with different letters are significantly different)

Discussion

Phenological phases varied between and within species, according to the height classes. Hiernaux et al (1994) distinguished five phenological types of Sahelian trees and shrubs, varying in foliation length and the leaf renewal period. The species in the present study can be divided into two groups depending on the foliation length: *A. leata* and *A. seyal* as deciduous since they lost their leaves early and *B. aegyptiaca* and *Z. mauritiana* as semi-deciduous since they kept leaves longer. Semi-deciduous species shed leaves in short periods, having the ability to use water sources in deep layers or close to a river system; they reduce water loss during the dry season thanks to their scleromorphic leaves (De Bie et al 1998). Many factors influence the phenological pattern of woody species, but the most important is water availability (Borchert 1994; Pavon and Briones 2001). Relative air humidity, soil type, plant water storage capacity and temperature are also involved.

A. seyal did not produce flowers during the study. Piot et al (1980) also reported blooming irregularities in this species, reporting only two individual plants from five with fruits in 1978 and 1979. The same authors stated that the foliation phase of *B. aegyptiaca* lasted over a year with a reduction of leaf density during the dry months.

In general, all species bore leaves from the beginning of the rainy season, and from June-July until September-October, all were in full foliation and fruiting. The foliation, flowering and fruiting overlapped between September and February. In the middle of the dry season (February-March) almost all the trees entered a period of vegetative rest, hence there was a considerable decrease in browse fodder availability.

Although limited to one year observations, this study gives a fair idea on browse availability, lasting almost 10 months per year. The variability of phenological phases coupled with the diversity of browse species clearly indicated the fundamental role of this component for animal feeding in the arid zones.

Browse fodder provides animals feed rich in protein and vitamins at a period where herbaceous forage is in the form of straw, with low nutritive value. The chemical composition of the leaves and fruits/pods of *A. raddiana*, studies by Sanon (2002) showed crude protein content of 19.6%.

With regard to herbaceous biomass production, the values obtained in the different pasture types were low compared to the results by Sanou (1996). This difference could be explained by late period of measurement (November), but also by the heavy utilization of forages during the rainy season. The decrease in production with time can be explained by animal presence, but also by the senescence of mostly annual plants, in addition to losses due to wind and insects (termites). Facing this decrease in herbaceous availability, all the animals fall back on browse fodders, especially on pods, to meet their maintenance requirements.

The results on goat feeding behavior were in accordance with many studies. Nianogo (1997) noted that goats spent 38–67% of their time browsing in the Sahel of Burkina Faso. Cissé et al (2002), noted the variation of goat diet composition between seasons, with the contribution of ligneous species increasing after the rainy season, from 16% in October, to a peak in January (95%) and in July (96%) then decreasing to 5% in September, corresponding to maximum herbaceous intake. Sanon et al (2007) showed that goats preferred browse species when herbaceous species were limited, spending 43%, 44.6% and 52% of the time browsing during the rainy, post rainy and dry seasons, respectively.

These results confirm the preference of goats for browse fodders which allows them to get enough nutritive elements from the pastures. In addition, Haenlein and Caccese (1992) stated that the ability of goats to select various fodder types make them less subject to bloat compared to other ruminants species.

Conclusion

- The phenology study of the five main browse species in the area indicated the period of availability of browse fodder (leaves, fruits/pods) during the year, influenced by species and the height of the shrubs and trees. In addition, the monitoring underlined the critical period for animal feeding (March-April to May-June) in the Sahelian zone where pasture resources herbaceous as well as ligneous are lacking. With the beginning of the foliation in June-July for most species and the fall of browse component by March, one can conclude that browse fodders are more regularly available than herbaceous forages in the Sahel. The knowledge of the browse fodder variability allows better integration into the animal production systems.
- Goat feeding behaviour on pastures follows this variation in browse availability, indicating that this feed resource constitutes their preferred feed, allowing them to balance the nutritive components of pastures in any season.
- This study also highlights the limits of natural pastures in the Sahel, and the need to associate other feed resources in order to maintain animals in sustainable production. Collection and storage of pods for their utilization during the period of scarcity could be an alternative.

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References

- Borcherf R 1994** Soil and water storage determine phenology and distribution of tropical dry forest trees. *Ecology* 75, 1437-1447.
- Cissé M, Ly I, Nianogo A J, Sané I, Sawadogo J G, N'Diaye M, Awad C, and Fall Y 2002** Grazing behaviour and milk yield of Senegalese Sahel goat. *Small Ruminant Research* 43, 85-95.
- De Bie S, Ketner P, Paasse M and Geerling C 1998** Woody plant phenology in the West Africa savanna. *Journal of Biogeography* 25, 883-900.
- Fontes J and Guinko S 1995** Carte de la végétation et de l'occupation du sol du Burkina Faso. *Note explicative*. Ministère de la Coopération Française, Toulouse, France, 67 p.
- Haenlein G F W, Caccese R and Sammelwitz P H 1992** Behaviour. *Goat Extension Handbook*. University of Delaware, Newark, 7 p.
- Hiernaux P, Cissé M I, Diarra L and de Leeuw P N 1994** Fluctuations saisonnières de la feuillaison des arbres et buissons sahéliens. Conséquences pour la quantification des ressources fourragères. *Revue d'Élevage et de Médecine Vétérinaire des Pays Tropicaux* 47, 117-125.
- Minitab 2002** Minitab User's guide 2. Data analysis and quality tools. Release 14 for Window, Window 98 and Window NT. Minitab Inc., Pennsylvania, USA.
- MRA (Ministère des Ressources Animales) 1997** Note d'orientation du plan d'action de la politique de développement de l'élevage au Burkina Faso. Version officielle finale, 47 p.
- MRA (Ministère des Ressources Animales) 2004** Deuxième enquête nationale sur les effectifs du cheptel. Ouagadougou, Burkina Faso, 77 p.
- Nianogo A J 1997** Impact des pratiques d'élevage des petits ruminants sur la productivité et sur l'environnement dans le bassin versant de Donsin (Influence of management methods for small ruminants on the productivity of the environment in the slopes of the pond of Donsin) Rapport final de la phase I (95-97) programme. SANREM/CRSP, 36 p.
- Ouattara F 2004** Dynamique saisonnière de la disponibilité des ressources fourragères en zone sahélienne et leur utilisation par les ruminants domestiques : cas du terroir de Tongomayel. Mémoire de fin de cycle ingénieur du développement rural, option élevage. Institut du développement rural, Université Polytechnique de Bobo-

Dioulasso, Burkina Faso, 117p.

Pavon N P and Briones O 2001 Phenological patterns of nine perennial plants in an intertropical semi-arid Mexican scrub. *Journal of Arid Environment* 49, 265–277.

Piot J, Nebout P P, Nanot P and Toutain B 1980 Utilisation des ligneux sahéliens par les herbivores domestiques. Etude quantitative dans la zone sud de la mare d'Oursi (Haute Volta). CTFT, IEMVT, Maison-Alfort, 201 p.

Sanon H O 2002 Evaluation de la production de biomasse ligneuse accessible aux animaux. Incidence sur la production ultérieure des plantes. Rapport d'activités 2001 ; INERA – DPA ; 28p.

Sanon H O, Kaboré-Zougrana C and Ledin I 2007 Behaviour of goats, sheep and cattle and their selection of browse species on natural pasture in a Sahelian area. *Small Ruminant Research* 67, 64–74.

Sanou S 1996 Etude des sols et de leurs potentialités pastorales au Sahel Burkinabè : Cas de la zone de Katchari. Mémoire de fin de cycle Ingénieur du Développement Rural, option Agronomie ; Institut du Développement Rural, Université Polytechnique de Bobo-Dioulasso, Burkina Faso, 110p.

Silanikove N 2000 The physiological basis of adaptation in goats to harsh environments. *Small Ruminant Research* 35, 181-193.

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