

Influences of fallow age and season on the foraging behavior and diet selection pattern of goats (*Capra hircus* L.)

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Abstract

A study was undertaken to determine the foraging behavior and diet selection pattern of goats maintained on communal enclosures in relation to the influence of fallow age (years since effective protection initiated; <8 years vs. >12 years) and season (long rainy, dry, and short rainy seasons). The frequency of browsing was higher ($P < 0.05$) in the enclosures fallowed for >12 years compared to those fallowed for <8 years and this frequency was also highest during the short rainy season. More ($P < 0.05$) herbaceous bites were recorded in the <8 years fallow enclosures, compared to the >12 years fallow enclosures. Herbaceous species bites were maximized during the long rainy season whereas woody species bites were maximized during the dry season. The goats foraged upon 48 plant species of which 69% were woody species, 19% grasses, and the rest comprised of various forb species. The top species that significantly ($P < 0.05$) contributed to the diet of goats were *Acacia etbaica*, *Balanites aegyptica*, *Cadaba farinosa*, *Capparis tomentosa*, *Dichrostachys cinerea*, and *Ocimum forskolei*. The goats targeted taller woody species than the average of the enclosures. *Maurea angolensis*, *Jasminium abyssinicum*, *C. farinosa*, and *Ormocarpum pubescence* were among the preferred species that appeared to be on the verge of disappearance in most of the enclosures investigated in this study and require immediate attention. Using goats to reduce the threat of potential bush infestation appears to be a viable option for managing and sustaining production from enclosures since the goats showed preference for *D. cinerea*, the species considered a prolific invader plant. There is, however, a need to conduct further research on the impacts of direct browsing by the goats and this should also entail the determination of optimum number of goats/unit area.

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1. Introduction

Ruminants continuously discriminate between vegetation types and plant parts in a horizontal and vertical

plane, respectively (Hodgson, 1986). This discrimination is usually greater under open range conditions and maximal when animals are browsing (Van Soest, 1994). Diet selectivity by herbivores shapes the diversity, structure, and dynamics of plant populations (McNaughton, 1985; Smith and Rushton, 1994; Hodgson and Illius, 1996; Duncan et al., 2006). The selectivity of diet by herbivores is explained by a multitude of factors such as differences in botanical composition, variations in phenological stages, and season (Illius and Gordon, 1993;

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Newman et al., 1994; Illius et al., 1999). Identification of diet preferences of herbivores can lead to better understanding of the successional development of native rangeland vegetation and help to improve management strategies.

The native rangeland vegetation in the semi-arid region of Tigray in northern Ethiopia has been severely degraded (Hurni et al., 2005; Tewolde-Berhan, 2006). In response to this problem, local people have constructed a network of exclosures since the early 1990s (Aerts et al., 2006). Such efforts appear to be successful in many technical and social standards (Berhanu et al., 2002; Mengistu et al., 2005) but the vegetation recovery eventually lead to an increased demand for products and services from the exclosures (Betru et al., 2005). This pressure coupled with increasing emphasis on the livestock sub-sector as a means of contributing to regional food security (Berhanu et al., 2002) need to effectively use the diverse vegetation resources of the exclosures. Due to their efficient feeding behavior (Lu, 1988; Silanikove, 2000; Morand-Fehr et al., 2004), goats are suitable species for exploiting feed resources from exclosures and the fact that the region harbors one of the largest concentration of goats (BoANRD, 1997) further strengthens their candidacy for using these exclosures. However, there is paucity of information on the pattern of diet selection by goats as influenced by fallow age (years since effective protection initiated) of these exclosures, which essentially reflects variation in different vegetation attributes such as density, cover, and biomass, on the diet preference of these free ranging goats. Moreover, the pattern of diet preference of free ranging goats under contrasting wet and dry seasons is not covered to the same level as that of a more stable environment such as in the temperate region.

Therefore, this study was designed to determine the influence of fallow age and identify seasonal changes in diet selection of goats maintained on communal exclosures.

2. Materials and methods

2.1. Description of study site

The study site was located in Tembien (13°41'–13°43'N and 38°57'–39°00'E) in northern Ethiopia. Average annual rainfall and temperature for 1973–1979 and 1995–2005 were 519 mm and 21.6 °C, respectively. More than 90% of the rainfall occurs during the long summer rainy season from late June to early September. The dry season usually extends from October to February, although when the short rains fail the dry season can extend to May or June. The short rain season in March and April is not observed as frequently as the long rain and

is characterized by a coefficient of variation as high as 55% among years (Meze-Hauske, 2004). Altitude ranges between 1780 and 2250 m and slope ranges between 5 and 30%.

Cambisols, Leptosols, and Regosols are among the dominant soil types (FAO, 1998). The vegetation is typical of the East African montane area that is part of the Sudano-Sahelian transition subzone (Le Houérou, 1989) and common plant formations include mesophyllic deciduous woodland, mixed evergreen and deciduous open woodland (Le Houérou and Corra, 1980). Smallholder farmers practice a typical subsistence mixed crop-livestock farming with goats and cattle being the most common livestock species. Dominant crops are finger millet (*Eleusine coracana*), maize (*Zea mays*), sorghum (*Sorghum bicolor*), and *teff* (*Eragrostis tef*).

2.2. Exclosure description and sampling

The exclosures used for this study were communal grazing lands that have been protected from grazing by domestic livestock since the early and late 1990s (Betru et al., 2005). They are similar to the system of land abandonment or fallow reported for the Mediterranean (Ruecker et al., 1998), although both systems differ in the reasons for being fallow. They can thus conveniently be defined as communal areas that have been degraded by different causes and subsequently allowed to rest for defined period of time from anthropogenic disturbances such as humans and livestock grazing until the natural vegetation is regenerated. Prior to their protection, these exclosures were severely degraded supporting sparse unpalatable vegetation with little grazing value for the local herds. The priority areas were identified by local experts and user groups who agreed to strictly protect them from any form of grazing, manual harvesting of grass, and tree cutting. As the exclosures lacked fence, guards were subsequently hired by the local administration on food-for-work basis to protect them from illegal grazing livestock and people (Gebremedhin et al., 2004). Some predators (mostly hyena and foxes), rabbits, and birds were present in the exclosures, but large wild ungulates are generally missing due to the severe land degradation and long civil war history of this region.

The diet preferences of 24 randomly selected mature free ranging Abergelle male goats with an average body weight of 20.4 (± 0.8 S.E.) kg was observed between 8:00 and 12:00 and 14:00–16:00 h for 10 min at 10 min intervals for 5 consecutive days during three seasons (long rainy, dry season, and short rainy seasons) over 2 years. The long rain season sampling took place in mid-September, the dry season sampling at the end of January, and the short rainy season sampling in mid-April. This was done on 6 exclosures that differed in age of fallow (years since effective protection initiated) from less than 8 years to more than 12 years. For each fallow age 3 exclosures of 50–120 ha in size and 3–10 km apart from each other were selected and in each exclosure 4 goats were randomly assigned to record species selected, number of bites, total time spent, number of times visited, and other activities. For each goat two trained observers were assigned. The first observer recorded species foraged upon by the goats and counted total bites while

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