



## Variation in quantity and quality of native forages and grazing behavior of cattle and goats in Tanzania



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### ABSTRACT

The study was conducted to assess the effects of seasonal variation in the quality and quantity of pasture and management of livestock enclosures (*ngitili*) on the grazing behavior of cattle and goats. The study was  $2 \times 2 \times 2$  factorial design with three independent variables: season (Dry or Rainy), *ngitili* management (Private or Communal) and animal species (Cattle or Goats). Focal and scan observation methods were used to record different behavioral activities. Vegetation attributes from the study areas were measured in two consecutive seasons. Most key forage species had significant higher crude protein (CP) content and *in vitro* organic matter digestibility (INVOMD) in rainy than in dry season ( $P < 0.05$ ), but Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) did not vary significantly with season ( $P > 0.05$ ). ADF and NDF were significantly higher in species from communal *ngitili* than those from private *ngitili* ( $P < 0.05$ ). Above-ground herbaceous biomass and bulk density (BD) were significantly higher in the rainy season and in the private *ngitili* than in the dry season and in the communal *ngitili* respectively. Cattle and goats spent considerably more time grazing and browsing respectively in the rainy season than in the dry season ( $P < 0.05$ ). Cattle foraging activities did not vary significantly ( $P > 0.05$ ) with *ngitili* management, but goats found to spend considerably more time browsing in the communal *ngitili* and more time grazing in the private *ngitili* ( $P < 0.05$ ). Despite the merits of stocking cattle and goats together in the heterogeneous pasture, seasonal variation in forage resources requires investigation of other strategies such as use of multipurpose trees and treatment of crop residues to improve livestock production.

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### 1. Introduction

Ruminant production in Tanzania depends mainly on communal semi-arid rangelands (Rubanza et al., 2003). More than 70% of the ruminant livestock population of Tanzania kept in north-western and central parts of the country:

Shinyanga, Simiyu, and Mwanza Manyara (Mwilawa et al., 2008; URT, 2006). In particular, the Shinyanga and Simiyu regions have the largest livestock population in the country with a total of 3.6 million cattle, 1.9 million goats and 0.7 million sheep (URT, 2012). According to Rubanza et al. (2007) these regions are characterized by scarcity of feed, especially during the dry season. Despite the scarcity of forage, the livestock production in these regions has sustained the livelihoods of pastoralists and agropastoralists for decades. Livestock owners in these areas have different coping strategies, including traditional conservation of forage to supplement livestock during acute shortage of feeds, and

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seasonal mobility in search of forage and water. However, climate variability (Rowhani et al., 2011), along with an increase in human (Meertens et al., 1999) and livestock (Wiskerke et al., 2010) populations in these regions, have increased pressure on grazing lands, and therefore traditional grazing practices need to be modified accordingly.

Grazing management can significantly affect the quality and quantity of pasture and subsequently grazing behavior of free ranging livestock (Cozzi and Gottardo, 2005). In the study area, the most common tradition grazing management is deferred grazing system, in which a piece of land is reserved during rainy season to be used in dry season when feed is scarce. These traditional enclosures are known as *ngitili* and two types are common in the study area: private and communal *ngitili*. Managements of these two enclosures vary in the extent that can contribute to variation in the quality and quantity of available forage resources. While private *ngitili* are managed by individual pastoralists, communal *ngitili* are managed under collective responsibilities of community members. The communal *ngitili* in the Shinyanga and Simiyu regions have been reported to be in poor conditions compared to private *ngitili* (Selemani et al., 2012). Generally, over-exploitation of communal rangelands resources in Tanzania has been associated with lack of community responsibilities and absence of clear boundaries (Quinn et al., 2007).

Seasonal variations in the quality and quantity of forages are considered to be among the most important constraints to livestock production (Ngwa et al., 2000). Despite the clear evidence that physical structure and chemical composition of forages vary greatly from season to season (Bennett et al., 2007; Kennedy et al., 2007; Safari et al., 2011; Yaynesht et al., 2009) yet, the interaction effects of seasonal variation and *ngitili* management on animal behavior have not been explored in the study area. This study investigated how seasonal fluctuation, in terms of physical and chemical composition of forages and *ngitili* management affect the behavioral activities of mixed herds of cattle and goats grazing on native pasture. Knowledge on this interaction can be harnessed for improving the management of grazing animals. In particular, this knowledge could be used to optimize forage allocation to different grazing ruminants and enable herders to identify vegetation attributes on which to base the rangeland restoration practices.

## 2. Material and methods

### 2.1. Study area

The study was conducted in northwestern Tanzania, Simiyu region, formerly part of Shinyanga region. This new region was administratively established in March 2012 and forms part of the Sukumaland. Simiyu region encompasses five districts: Meatu, Maswa, Bariadi, Busenga, and Itilima, and the present study was carried out in Meatu district. The region is characterized by semi-arid climate (Dercon, 1998). The rainfall in this area is bimodal with mean annual rainfall ranging from 600 to 800 mm (Rubanza et al., 2005). Data from the Tanzania Meteorological Station (TMS) indicated that the mean ambient temperature in the study area during the period of behavioral observation ranged from

18.3 °C (minimum) to 29.8 °C (maximum) for both seasons. The landscape is mostly flat and largely covered with wooded grassland (Wiskerke, 2008). The dominant woody species in the study area were *Acacia tortilis* (umbrella thorn acacia), *Acacia nilotica* (scented-pod acacia), *Dichrostachys cinerea* (sickle bush) and *Anisotes dumosus* while herbaceous cover was dominated by *Bothriochloa insculpta* (sweet pitted grass), *Urochloa mosambicensis* (sabi grass), *Cynodon nlemfuensis* (Africa star grass) and *Eragrostis tenuifolia* (elastic grass).

### 2.2. Sampling procedures

#### 2.2.1. Study design and enclosures description

The present study was a 2 × 2 × 2 factorial design with three independent variables, each with two levels: Season (dry or rainy), *Ngitili* management (private or communal) and Animal species (cattle or goats). Two mixed herds of cattle and goats belonging to two villagers of Mwambegwa and Buganza villages of Meatu district were selected for observation. The herds from Buganza and Mwambegwa were stocked under private *ngitili* and communal *ngitili* respectively. Herds selection was based on requirements for the proposed grazing management regime that one herd should be stocked under private *ngitili* and another under communal *ngitili*. Selected grazing sites were familiar to the study animals. The livestock owners were fully involved in the study, especially during pilot phases, in which observers were able to familiarize themselves with the study animals and the grazing areas. The pilot phases were done 1 week prior to the observation phases for each season.

The two enclosures used in this study differed in terms of ownership and grazing management. However, they had similar ecological and climatic characteristics. Both areas have semi-arid climate with similar vegetation type. The common vegetation types were Acacia open woodland. The herbaceous vegetation covers in both *ngitili* were dominated by *B. insculpta*, *U. mosambicensis*, *C. nlemfuensis* and *E. tenuifolia*. A previous work (Selemani et al., in press) indicated that the two enclosures did not vary significantly in terms of herbaceous vegetation composition and density of woody species. The distance between the two studied *ngitili* was approximately 20 km. These areas were inhabited by Sukuma agro-pastoralists practicing typical subsistence mixed crop-livestock farming. Cattle and goats were the common livestock species and the dominant crops were maize (*Zea mays*), sorghum (*Sorghum bicolor*) and Rice (*Oryza glaberrima*). The two selected enclosures were close to villagers' farms and therefore in dry season livestock had free access to crop residues after farmers harvesting their crops.

The communal *ngitili* was demarcated with mutual consent of community members and was managed by Mwambegwa village government. It was initiated since 1980s and has been seasonally rested for more than 30 years. The size of this enclosure was approximately 80 ha. This *ngitili* was used as income generating asset for the village government and was seasonally hired to pastoralists for livestock grazing especially in dry season when forage is scarce. During the time of data collection, it was engaged by one village member with herd size of 75 animals; 50 cattle and 25

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