Goat feeds and feeding practices in a semi-arid smallholder farming system in Zimbabwe

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This study was conducted to identify the available goat feed resources for smallholder farmers in the semi-arid region of Zimbabwe. An ecological rangeland assessment was combined with participatory research methods to determine the diversity of feed resources in two wards of the Beitbridge District, namely Chamunangana and Joko. One hundred and twenty households were surveyed. All farmers depended on rangeland as the main feed resource. Some 87% of the respondents indicated that rangeland was not adequate, yet only 54% practiced supplementation. Participants predominantly used crop residues (40%), browse tree foliage (28%) and commercial feeds (22%) as supplements. Of the 46% who did not apply supplements, 53% attributed this to unavailability of feeding material and 29% were not aware of the importance, whereas the rest thought it unnecessary. Farmers in Chamunangana and those who milked their goats were more likely to supplement feed (p < 0.05). Respondents who supplemented had received training in goat husbandry (p < 0.05). The Shannon–Wiener diversity index (H’) was higher in Chamunangana (1.29), compared with Joko (1.19). There was no difference in biomass production between the study sites (p > 0.05). Improved goat nutrition could be achieved through farmer trainings in goat husbandry and incorporating available feeds into balanced rations.

Keywords: diversity, feed, goats, rangeland, supplementation

Goat production in extensive areas of most parts of Africa is characterised by problems of feed availability (Mdladla et al. 2017) during the dry season when the feed is of poor nutritional quality (high in fibre and low in protein) resulting in low voluntary intake and digestibility (Gwiriri et al. 2016; Manyawu et al. 2016). Poor nutrition contributes to low growth rates (Mayberry et al. 2018), susceptibility to diseases and parasites (Zvinorova et al. 2016), reduced reproductive performance (Díaz-Sánchez et al. 2017) and higher mortalities (Katsande et al. 2016). Farmers rarely invest in improving goat nutrition (Chakoma et al. 2016). Improved nutrition through planned supplementation of feed resources with locally grown feeds, sown pastures and better crop residue management could substantially improve goat production (Byaruhanga et al. 2015). The current scarcity of information on the available feed resources makes it difficult to come up with effective goat feeding interventions. This results in poor capacity to address the complexity of challenges faced by smallholder farmers, thereby missing opportunities for success. This study therefore aimed at demonstrating the importance of a participatory holistic assessment of available feed resources in space and time in the semi-arid region of Zimbabwe. This is important in identifying opportunities for improving feed resources, thereby providing the basis for designing effective interventions.

The study was done in in the Joko and Chamunangana wards of the Beitbridge District, located in Matabeleland South; 22°13′00″ S, 30°00′00″ E. Beitbridge receives an annual precipitation of less than 450 mm y⁻¹. The rainy season usually begins in November and lasts until April, whereas the rest of the year is dry. Minimum temperatures range between 14 °C and 18 °C, with maximum temperatures ranging between 26 °C and 32 °C. Soils are generally brown to reddish brown, moderately shallow, sillicic with a high base status, clay-clay loam (Nyamapfene 1991). Vegetation is mainly savannah woodland dominated by Colophospermum mopane and Vachellia spp. Rainfall is too erratic and unreliable for the cultivation of fodder and grain crops (Gambiza and Nyama 2000).

Key informant interviews, focus group discussions and questionnaires were used to generate information on the available goat feed resources. Village herdsman and extension officers assisted in identifying and listing farmers who owned at least one goat. One hundred and twenty households were chosen at random for individual farmer interviews. Focus group discussions to capture information on the feed resource systems comprised of men and women from different villages, extension workers and local leadership. Discussions were guided by the following thematic areas: (i) existing goat management and nutrition practices, (ii) major nutritional shortfalls in goat
nutrition, and (iii) potential solutions for nutritional shortfalls. Semi-structured questionnaires were administered to farmers to verify information obtained from discussions. Questionnaires were used to collect information, including household socio-economic characteristics, livestock production, feed resources and feeding systems.

A rangeland assessment was done in the study sites. These assessments were based on vegetation parameters (Mureithi et al. 2016). Range sites were stratified based on the plant community. A total of 80 quadrats (20 m²) and 10 (100 m) line transects were used to collect information on species diversity and biomass production. The plot size in each study site was 3,200 m². All browse species in the area were identified and listed. The total number of plants and plants per species were recorded in each quadrat. Species diversity was calculated after physical counting of plants in each quadrat. Biomass production was obtained using the double sampling technique as illustrated by May (2015).

Data obtained from the questionnaire was exported to SPSS IBM version 20 application for analyses (IBM Corp 2011). Frequency, means, percentages and standard deviation were generated for demographic and count data. Chi-square tests for association were used to determine the effect of geographic location, whether the farmer had received some form of training in goat husbandry and whether the farmer milked goats on the decision to supplement goat feed. A binary logistic regression was also carried out to determine the effect of gender, marital status, age, level of education and experience in goat keeping on the decision to supplement goat feed. Ranked data were assigned relative importance indices and descriptive statistics employed thereafter. A non-parametric test (Kruskall–Wallis) was employed to determine whether biomass production for the two study sites varied significantly. The Shannon–Wiener diversity index (H′) was then calculated to analyse plant species diversity.

The diversity of feed resources included browse tree species, crop residues, Vachellia and other tree pods, Manula fruits, forages and commercial feeds. All farmers depended on rangeland as the main feed resource, with a peak contribution in February followed by a decline in May up to November, as illustrated in Figure 1. Farmers also indicated rangeland degradation based on shift in species composition, less plant cover and low goat productivity. The majority (95.5%) of participants practiced free range feeding management, whereas 3.3% herded goats and the rest practiced both, depending on the season. Approximately 87% of the respondents indicated shortage of rangeland, yet only 54% practice supplementation. Participants predominantly used crop residues (40%), browse tree foliage (28%) and commercial feeds (22%) as supplements. Farmers harvested foliage from tree branches beyond the browsing heights of animals on species like Colophospermum mopane, Grewia spp. and Vachellia spp. to supplement feed. The harvested foliage was for immediate animal feeding and accordingly no special storage was involved.

Crop residues play an important role during the dry season from May until October, with a peak contribution in June. Farmers tend to prioritised cattle in supplementing feed than goats. Farmers mainly utilised Zea mays (maize), Sorghum bicolor (sorghum), Arachis hypogaea (groundnuts) and Vigna subterranea (round nuts) residues to supplement goat feeding. The storage of residues employed varied, from storing bales under the shade to storing uncovered bales outside on raised wooden platforms. Some stacked crop residues were also left uncovered in the fields. Cut and carry, which in this study included cut fodder, pods and forages are utilised mainly during the driest period of the season with peak practice normally in October. Pods were mostly collected by farmers for feeding goats during drought periods. The commonly grown pastures were Pennisetum purpureum and Mucuna pruriens, whereas Medicago sativa was rare. Commercial feed usage as supplement was minimal in comparison with other resources.

Farmers who did not supplement feed, attributed this to unavailability of feeding material (53%) and 29% were not aware of the importance, whereas the rest thought it was not necessary to supplement. Farmers in Chamunangana and those who milked their goats (p < 0.05) were more likely to supplement feeding than farmers in Joko and those who did not milk their goats. Gender, marital status, age, level of education and experience in goat keeping had no influence on supplementing (p > 0.05). Respondents who supplemented had received some form of training in goat husbandry (p < 0.05). Most farmers had received training from Agritex (41.7%) and the rest from other Non-Governmental Organisations (NGOs). There were no differences in biomass production (p > 0.05) between the study sites; Chamunangana had a mean production of 0.05 kg m², whereas Joko had a value of 0.089 kg m². Species diversity and richness varied between study sites, as shown in Table 1.

Homann-Kee Tui et al. (2007) and Mlambo et al. (2008) agree that smallholder farmers rely mostly on browse tree foliage, crop residues, forages and commercial feeds for animal feeding. Rangeland resources contribute immensely to ruminant nutrition (Moyo et al. 2013). Its contribution is influenced by stocking densities with high stocking densities aggravating degradation (Homann-Kee Tui et al. 2015) and season with the least contribution during the driest period. The findings on feeding management are contrasting to those by Rumosa Gwaze et al. (2009) that herding is the
most commonly practiced goat management system in Southern Africa. The free-range management system also contributes to the noticeable rangeland degradation, due to selection pressure on certain browse species by animals based on the plant physical and chemical defence mechanisms (Samuels et al. 2016).

Peak contribution of crop residues in June coincide with the period during which the rangeland feed resources supply begin to shrink and farmers rely more on alternative feed resources, which is similar to findings by Musara et al. (2013) and Homann-Kee Tui et al. (2015). Crop residues are highly used as feed supplement, since they are fairly cheap and easily accessible. Cereal crop residues, however, are less nutritious, since they are high in fibre and low in crude protein making them less digestible (Haile et al. 2017). Protein supplementation with locally available sources, such as chicken litter, and additional treatment with mineral supplements or molasses could improve digestibility.

Lablab and Velvet bean, which has a high crude protein ranging from 16% to 19%, could also be included in diets to improve goat nutrition. These legume forages have been proven to thrive under semi-arid conditions (Gwiriri et al. 2016). The major drawback to their usage by smallholder farmers is lack of access to seeds (Chakoma et al. 2016). In this study, only a few farmers were growing these under donor-funded projects. Legume residues contribution to goat feeding was low mainly as a result of competition with other livestock species, such as cattle. These results are contrasting to findings by Homann-Kee Tui et al. (2007) that smallholder farmers in Matabeleland South of Zimbabwe supplement rangeland grazing mainly with legume crop residues and to a lesser extend with cereal crops. Storage methods employed, such as leaving residues in the fields for goat feeding are also likely to depreciate the nutritional quality. According to Heuzé et. al (2019), storing crop residue bales under cover increase their shelf life to 120 days, whereas outdoor bales are prone to dry matter losses during the warm season.

Browse tree species provide nutrients, such as minerals, proteins and vitamins, which are usually in short supply in grasslands during the dry seasons (Mkhize et al. 2016). Mopane shrubs maintain leaves until very late in the dry season. Grewia spp. are highly palatable, whereas Vachellia spp. are an excellent fodder for goats, as their leaves, fruits and pods are highly palatable, with a crude protein content of 12%–23% (Brown et al. 2016). Secondary plant metabolites endowed in most shrub species found in Southern Africa limit intake by goats regardless of them being physiologically and anatomically suited to thrive in shrub-dominated ecosystems (Estell 2010). Ensiling browse species (Gusha et al. 2015) and forages with drought tolerant shrubs, such as Opuntia spp. (Truter et al. 2015) could potentially improve goat nutrition. There are also beneficial effects of carbon based secondary metabolites, because studies by both Chikwanda et al. (2013) and Zvinorova et al. (2016) agreed that access to trees with high levels of tannins, such as Vachellia can reduce levels of internal parasite infection.

The discontinuation in use of cut and carry is mainly because collection is time specific, mostly common during the drought periods. This presents an opportunity for habitual collection of tree pods and branches for supplementing during the driest periods. In some areas local environment related legislation remains a major drawback to this practise. The low usage of commercial feed supplements is mainly as a result of procurement challenges, such as high cost and availability (Gwiriri et al. 2016).

In conclusion, information on the available diverse feed resources, such as legume forages, crop residues, legume tree pods and pastures, provide the basis for any meaningful intervention. More emphasis should be put on training farmers on better feed storage and feeding technologies, such as bailing, shade storage, hay making and silage making. It is important to educate farmers about the importance of supplementing feeding. A holistic participatory approach could be useful in additional studies on how locally available feed resources can be incorporated into balanced feeds. Variation in availability of feed resources in time and space also presents an opportunity to develop feed calendars, feed banks and feed markets, to ensure that the available feed resources are properly utilised.

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Table 1: Species richness and diversity per study site

| Study site | Common species | Species richness | Shannon–Wiener diversity index (H') | Equitability index |
|------------|----------------|-----------------|-------------------------------------|-------------------|
| Chamunangana | *Vachellia tortilis*, *Grewia bicolor*, *Colophospermum mopane*, *Eragrostis superba* and *Anisida spp.* | Eight species were identified | 1.29 | 0.80 |
| Joko | *Colophospermum mopane*, *Grewia bicolor*, *Grewia flavescens*, *Anisida spp.* and *Digitaria milinjiana* | Nine species were identified | 1.19 | 0.74 |
