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Smallholder goat production in the Namaacha and Moamba districts of southern Mozambique

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Abstract

Goat rearing is one of the most common livestock farming activities in Mozambique and has the potential to play a powerful role in improving the livelihoods of resource-poor farmers. This study was conducted to investigate the status of goat husbandry practices in rural areas of southern Mozambique. Data were collected from a total of 45 smallholder goat keepers in three different villages through questionnaires complemented by interviews. Most households were dependent on crop production and livestock as their main source of income. Goats were reared under extensive systems where free grazing and tethering were the common feeding management practices with limited supplementation during the dry season. The flock sizes per household were predominantly small (13 ± 2.4) with uncontrolled breeding of goats. The goats were reared mainly as a source of meat for home consumption and a means of reserve cash income. All household members were involved in goat production but women and children had a minor role in terms of decision making. The main constrains limiting goat production were diseases, lack of veterinary services, limited size of grazing land and scarcity of feed resources. Intervention programs focused on improving the husbandry practices and veterinary assistance should be initiated to improve goat production and thereby improve the income and livelihood of the resource-poor farmers in Mozambique. This paper presents a summary of the results of a baseline study in the Namaacha and Moamba districts of Mozambique.

Keywords: communal, extensive, goat, husbandry, small-scale

1 Introduction

Goats are kept in a wide range of agro-ecological zones and management systems, and are mainly owned by smallholder farmers in developing countries (Casey & Webb, 2010), where they contribute to improved livelihoods for many resource-poor communities (De Vries, 2008; FAO, 2012; Hossain *et al.*, 2015; Ouchene-Khelifi *et al.*, 2015). Their role and relative importance varies noticeably across regions and cultural groups. In addition to providing meat and milk for household consumption, goats are one of the easiest and most readily accessible sources of income available to meet the immediate social and financial needs of rural farmers (Boogaard *et al.*, 2012; Boogaard & Moyo, 2015). Furthermore, they are used for cultural purposes such as traditional ceremonies and birthday festivities (Kosgey *et al.*, 2008; Rumosa Gwaze *et al.*, 2009; Oluwatayo & Oluwatayo 2012; Boogaard *et al.*, 2012). Goats are mostly owned by smallholder farmers and have comparative advantages over other livestock species in the traditional farming systems due to their rapid turnover, adaptability to harsh environmental conditions and the efficient use of available feeding resources (Braker *et al.*, 2002). Goat production worldwide grew steadily in the last decade, particularly in the developing world, with Africa contributing approximately 36.2 % to the global goat population (FAOSTAT, 2014).

In Mozambique, goat population is estimated at about 5 million head, of which almost 95 % are kept by rural smallholder farmers and less than 1 % is farmed commercially (INE, 2014). Mozambique has two indigenous goat breeds,

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namely the Landim breed which is spread across the country, and the Pafuri breed which is mostly located in the semi-arid area of Pafuri in South-West Mozambique (Garrine *et al.*, 2010). Goats are commonly raised under a mixed crop-livestock management system, where they subsist on grazing on natural veld and shrubs or marginal lands, and sometimes on crop residues (Devendra & McLeroy 1982). However, the prevalence of a long dry season and droughts in the country poses major challenges to most goat keepers as it leads to shortages of forage and water. In addition, the reduction of grazing land for ruminants associated with increasing human population size and its subsequent degradation, uncontrolled fires and an absence of pasture management exacerbate the shortage of fodder for goats (Timberlake & Jordão, 1985). This problem leads to underfeeding of goats and consequently loss of body condition, reduced productivity, increased susceptibility to diseases, and high mortality rates (Kanani *et al.*, 2006).

In Mozambique past efforts aimed at improving goat production are limited. The development of goat improvement programs would be more effective if information regarding the prevailing goat farming systems in the country were available. In order to design appropriate strategies aimed to improve goat production and to explore the potential contribution of goats to food security in resource-poor areas, there is a need to evaluate the existing goat production system and its role in these rural communities. This study was therefore conducted with the objective of generating baseline information with regard to the current goat husbandry practices in the rural areas of southern Mozambique (Maputo province). It aims to characterize the existing rural goat production system with regards to socio-economic factors, general management and limits encountered.

2 Materials and methods

2.1 Study setting

The study was conducted in two districts (Namaacha and Moamba) of the Maputo province in southern Mozambique. These districts were selected because of their importance in goat production and their proximity to the Extension Centre of the Eduardo Mondlane University. The Namaacha district covers an area of 2,196 km^2 and is characterised by a tropical humid climate with an average annual rainfall of 751 mm. However, the district has experienced a substantial decrease in rainfall over the last years, having received an annual rainfall of 260 mm in 2015 and 471 mm in 2016. Most parts of the district are classified as semi-arid, with visible land degradation due to poor management caused by overgrazing (MAE, 2005). The Moamba district, covering an area of 4,598 km^2, is characterised by a subtropical dry climate, with an annual rainfall ranging between 580 and 590 mm. In both districts, the average annual temperature varies between 23 °C and 24 °C, with maximum highs of 36 °C. The rainy season is from October to April and the dry season is from May to September. According to Timberlake & Jordão (1985) and Morgado (2007), the vegetation consists mainly of grasses (*Andropogon gayanus*, *Cynodon dactylon*, *Eragrostis superba*, *Panicum maximum*, *Setaria holstii*, *Themeda triandra*, *Urochloa mosambicensis*), and shrubs and trees (*Acacia nigrescens*, *Acacia nilotica*, *Dichrostachys cinerea*, *Sclerocarya birrea*).

2.2 Sampling and data collection

Prior to the study, goat keepers from both districts were approached to evaluate their willingness to participate in the study. Three villages (Michangulene and Mahelane from Namaacha district, and Moamba-sede from Moamba) were chosen and fifteen goat keepers were randomly selected from each village to participate in the study, resulting in a total of 45 goat keepers. Information regarding household demographics and goat management practices (e.g. feeding, health, reproduction and constraints) was collected through questionnaires. Participants ranked certain parameters such as major sources of income and reason for keeping goat on a scale of 1 to 3, with 1 being the most important and 3 the least important. The questionnaires were complemented by directed observations to collect additional qualitative data. The interviews were performed by the principal investigator and a trained enumerator. In order to ensure that all questions were clear to the interviewees, the questionnaire was pre-tested before the survey and was translated into the local language where necessary. Before the commencement of the study, consent was obtained from the villages' leaders and from each individual respondent.

2.3 Data analysis

Data were captured in EpiData Entry Client version 4.0 (Lauritsen & Bruus, 2005) and exported to SPSS version 20.0 (IBM Corp, 2011) for analysis. Data were analysed using descriptive statistics, wherein means and standard deviations were obtained for quantitative data and frequency and percentages were obtained for categorical data. The source of income, purpose of rearing goats, reasons for choice of buck, and marketing/culling of goats were subjected to a rank analysis according to the perceived grade provided by the goat keepers. Indices were calculated using the following formula: Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for an individual use divided by the sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] summed over all uses.

Table 1: *Socio-economic characteristics of goat keeping households in the three study villages.*

Parameters	*Villages*			*Total*
	Michangulene	*Mahelane*	*Moamba*	
Land holding (%)				
Own	86.7	100	100	95.6
Lease	6.7	0.0	0.0	2.2
Other	6.7	0.0	0.0	2.2
Sex of household head (%)				
Male	66.7	53.3	93.3	71.1
Female	33.3	46.7	6.7	28.9
Age group of household head (%)				
≤ 30	0.0	13.3	6.7	6.7
31–45	26.7	0.0	33.3	20.0
46–60	33.3	73.3	20.0	42.2
> 60	40.0	13.3	40.0	31.1
Marital status of household head (%)				
Married	73.3	80.0	66.7	73.3
Single	20.0	13.3	13.3	15.6
Widower / Widow	6.7	6.7	20.0	11.1
Level of education of the household head (%)				
Primary	60.0	40.0	33.3	44.4
Secondary	6.7	6.7	20.0	11.1
Tertiary	0.0	13.3	13.3	8.9
None	33.3	40.0	33.3	35.6
Household size (mean ± sd)				
Male	1.5 ± 1.1	1.6 ± 0.8	2.2 ± 1.6	1.8 ± 1.2
Female	1.8 ± 0.9	1.9 ± 0.9	1.9 ± 1.8	1.8 ± 1.3
Children (< 15 years)	2.1 ± 1.5	4.1 ± 3.0	4.7 ± 12.9	3.6 ± 7.7
Total	5.3 ± 2.6	7.6 ± 3.6	8.8 ± 13.5	7.2 ± 8.2

3 Results

3.1 Socio economic characteristics of households

Socio economic characteristics of the households included in the study are presented in Table 1. The majority of the respondents (95.6 %) surveyed in all three villages owned their land. Of the households surveyed, most (71.1 %) were headed by males. However, there was a substantial number of female-headed households in Michangulene (33.3 %) and Mahelane (46.7 %). Most household heads (73.3 %) were over 45 years old, and had attained some level of formal education (64.4 %). Results on additional household characteristics (marital status and household size) are also presented in Table 1.

Generally, the household members shared roles and responsibilities regarding goat husbandry activities. Overall, Table 2 shows that in Moamba and Mahelane villages mainly men are responsible for goat husbandry, while in Michangulene village, activities are more evenly spread over men and women. However, in latter village women are largely responsible for some activities, such as breading, purchasing and selling, although this percentage is clear lower in the other two villages. Table 2 also shows that children are to a high extent responsible for the herding/feeding of the goats in Michangulene and Mahelane villages.

The majority of surveyed households in the study villages were dependent on mixed crop and livestock production as their main source of income. Crop production such as maize, beans and cassava was ranked as the primary source of income in Michangulene and Mahelane, while in Moamba, livestock was ranked highest (Table 3). In addition to crops, other sources of income regarded as important in Mahelane and Michangulene were earning a salary as farm workers and livestock, while informal business related activities also played an important role as source of income in Moamba village.

Table 2: *Extent of household members' participation (%) in various goat husbandry activities in the three study villages.*

Activity	Michangulene			Mahelane			Moamba		
	Men	Women	Children	Men	Women	Children	Men	Women	Children
Herding/Feeding	14.3	42.9	42.9	6.2	18.8	75.0	83.3	16.7	0.0
Breeding decisions	35.7	64.3	0.0	66.7	33.3	0.0	93.3	6.7	0.0
Slaughtering	57.1	42.9	0.0	71.4	28.6	0.0	93.3	6.7	0.0
Selling	47.1	52.9	0.0	70.0	30.0	0.0	93.3	6.7	0.0
Purchasing	38.5	61.5	0.0	71.4	28.6	0.0	92.9	7.1	0.0
Animal health care	54.5	45.5	0.0	66.7	33.3	0.0	90.0	10.0	0.0

Table 3: *Ranking of source of income in households in the three study villages.*

Source of income	Rank (Index)		
	Michangulene	Mahelane	Moamba
Salary	2nd (0.12)	2nd (0.33)	4th (0.05)
Crops	1st (0.56)	1st (0.40)	2nd (0.38)
Livestock	3rd (0.32)	3rd (0.24)	1st (0.44)
Business	4th (0.00)	4th (0.03)	3rd (0.14)

The average livestock holding per household was higher in Moamba village (14.0 ± 3.55 TLU) than the other two villages (Table 4). Among livestock type, average cattle holding was also higher in Moamba (11.1 ± 3.03 TLU). In terms of number of heads, goats were the major livestock species kept by the households in Michangulene followed by chickens and pigs, while in Mahelane and Moamba chickens were kept in higher numbers, followed by goats and cattle. Irrespective of village, goats were kept in larger numbers (13.04 ± 2.41 head) when compared to cattle (6.76 ± 1.88 head) and pigs (1.20 ± 0.44 head). With regard to the number of goats kept by village, Moamba had larger flock sizes (23.0 ± 6.39 head) compared to Michangulene (8.0 ± 1.2 head) and Mahelane (8.13 ± 1.48 head).

3.2 Reason for keeping goats

The reason for rearing goats was evaluated based on the rank attributed to each specific purpose by the goat keepers. Generally, most goat keepers primarily used goats as a source of meat for home consumption and cash income from sales (Table 5). In Mahelane and Michangulene villages, the use of goats for social ceremonies and for investments/insurance, respectively, were indicated as other important reasons for rearing goats.

3.3 Important traits for goat keepers

Goat keepers indicated their preferences in terms of phenotypic traits and the ranking thereof is presented in Table 6. In general, all traits were considered important, however, body size, growth rate, disease and drought tolerance were considered the most important traits for male goats, while prolificacy and fertility traits were ranked very high for female goats. Irrespective of the sex of the goat, the traits that were considered as being the foremost important were body size in Michangule, while growth rate and quality of meat were ranked at the top in Mahelane, and grow rate and body size in Moamba.

3.4 Production system

Goats were raised under extensive conditions where they were allowed to graze either freely on communal grazing areas, herded or tethered. In Michangulene and Mahelane villages, children were at large responsible for herding the goats to grazing areas during the day, while in Moamba village goats mostly grazed unsupervised during the day and confined at night. Tethering was also a common practice in the Michangulene and Mahelane villages (50–93.3 %). Although supplementary feeding was not common, some goat keepers (7.1–53.3 %) in the Michangulene and Mahelane villages provided crop residues and leaves from fodder trees, such as *Leucaena leucocephala* and *Moringa oleifera* mainly during the dry season.

The major sources of water for goats were boreholes in the Michangulene and Mahelane villages, and a river in the Moamba village. These water sources provided water for the goats throughout the year and were usually located near to the households in the case of boreholes, while the river was distant from the households.

Most goat keepers (60–98 %) housed their goats in own kraals throughout the year. The kraals were used to keep the goats safe during the nights, while they were either left to browse or tethered during the day. The kraals were mostly traditional, made of untreated wood and with earth floors. Approximately half of the kraals in the Namaacha villages (Michangulene and Mahelane) had an iron sheet roof to protect the animals from the rain, while in Moamba the kraals were mostly open.

Table 4: *Herd size (Mean ± SE) per household in the three study villages.*

Livestock type	*Number of heads*			*TLU*		
	Michangulene	*Mahelane*	*Moamba*	*Michangulene*	*Mahelane*	*Moamba*
Cattle	0.3 ± 0.21	4.2 ± 2.33	15.8 ± 4.32	0.2 ± 0.14	2.9 ± 1.64	11.1 ± 3.03
Goats	8.0 ± 1.20	8.1 ± 1.48	23.0 ± 6.39	0.8 ± 0.12	0.8 ± 0.15	2.3 ± 0.64
Sheep	0.0 ± 0.00	0.3 ± 0.26	3.7 ± 2.80	0.0 ± 0.00	0.0 ± 0.03	0.4 ± 0.28
Chicken	5.3 ± 0.82	12.2 ± 3.17	24.9 ± 7.40	0.1 ± 0.01	0.1 ± 0.03	0.2 ± 0.07
Pigs	1.5 ± 0.82	1.9 ± 1.01	0.2 ± 0.20	0.3 ± 0.16	0.4 ± 0.20	0.0 ± 0.04
Other †	1.67 ± 0.62	7.93 ± 6.54	1.20 ± 0.52	–	–	–
Total herd size				1.3 ± 0.25	4.3 ± 1.93	14.0 ± 3.55

† Includes ducks, rabbits and donkeys
TLU=Tropical Livestock Unit

Table 5: *Purpose of keeping goats as ranked by goat keepers in the three study villages.*

Purpose	*Rank (Index)*		
	Michangulene	*Mahelane*	*Moamba*
Meat	2nd (0.20)	1st (0.29)	1st (0.26)
Skin	6th (0.01)	7th (0.00)	6th (0.00)
Cash from Sales	1st (0.21)	3rd (0.13)	1st (0.26)
Ceremonies	5th (0.08)	2nd (0.21)	2nd (0.17)
Breeding	3rd (0.17)	4th (0.11)	3rd (0.16)
Insurance/emergency	2nd (0.20)	6th (0.06)	5th (0.04)
Cultural rites	6th (0.01)	5th (0.10)	4th (0.07)
Investment	4th (0.12)	5th (0.10)	5th (0.04)

Table 6: *Preferred traits as ranked by goat keepers in the three study villages.*

Reason	*Rank (Index)*					
	Michangulene		*Mahelane*		*Moamba*	
	Bucks	*Does*	*Bucks*	*Does*	*Bucks*	*Does*
Growth rate	2nd (0.10)	2nd (0.10)	1st (0.10)	1st (0.10)	1st (0.10)	1st (0.10)
Body size	1st (0.11)	1st (0.11)	2nd (0.09)	2nd (0.09)	1st (0.10)	1st (0.10)
Meat quality	4th (0.07)	3rd (0.09)	1st (0.10)	1st (0.10)	1st (0.10)	2nd (0.09)
Prolificacy	3rd (0.09)	1st (0.11)	2nd (0.09)	1st (0.10)	2nd (0.09)	2nd (0.09)
Disease tolerance	1st (0.11)	2nd (0.10)	3rd (0.08)	3rd (0.08)	2nd (0.09)	2nd (0.09)
Drought tolerance	2nd (0.10)	3rd (0.09)	3rd (0.08)	3rd (0.08)	2nd (0.09)	2nd (0.09)
Heat tolerance	2nd (0.10)	4th (0.08)	2nd (0.09)	2nd (0.09)	2nd (0.09)	2nd (0.09)
Temperament	2nd (0.10)	2nd (0.10)	1st (0.10)	1st (0.10)	2nd (0.09)	2nd (0.09)
Body shape	2nd (0.10)	2nd (0.10)	2nd (0.09)	3rd (0.08)	4th (0.07)	3rd (0.08)
Colour	5th (0.03)	5th (0.02)	2nd (0.09)	3rd (0.08)	3rd (0.08)	3rd (0.08)
Fertility	1st (0.11)	2nd (0.10)	1st (0.10)	1st (0.10)	1st (0.10)	2nd (0.09)

Goat flocks consisted of local breeds where kids and weaners formed the major part of the flock structure. The main source of goats for the majority of goat keepers (46.7–93.3 %) was purchasing from other goat keepers across the study villages. Within their own flocks, most goat keepers (53.3–63.6 %) used their own breeding bucks for natural breeding. However, in Mahelane village, goat keepers were largely dependent on the use of communal breeding bucks (60 %).

Although breeding was uncontrolled, the choice of bucks for mating was based mainly on their body size (39.0–100 %), while other selection criteria such as body shape and performance (11.0–33.0 %) were also important. Buck performance and body shape were ranked second in Mahelane (11.0 and 29 %, respectively) and Moamba (33.0 and 19.0 %, respectively). Other traits, such as colour and availability, were generally perceived as being less important.

Bucks were used for breeding from as young as 6 months (46.7–86.7 %) and their breeding life lasted typically between 2 to 4 years. The majority of goat keepers (46.7–64.3 %) reported ages at first kidding to be between 12 and 18 months. However, a substantial portion of respondents (28.6–50.0 %) also reported early kidding ages of between 6 and 12 months. The kidding interval was commonly between 6 and 8 months, but sometimes it lasted as long as 12 months. Natural weaning was the sole practice of weaning and many goat keepers did not allow kids to wean before 4 months of age.

In general, culling was a common practice among goat keepers (20–73.3 %) in the villages. Old age and temperament were the main reasons for removing male goats from the flocks, while poor fertility and old age were the main reason for culling of females. All culled animals were marketed either to consumers or to other goat keepers. Apart from culling, selling of goats was also a common practice (50.0–68.8 %). Male goats constituted the major proportion of goats sold (20–73.3 %) as compared to females (0–13.3 %). Goats were sold mainly to cover household needs, such as food, school fees, medicines and traditional ceremonies.

3.5 Constraints to goat production

The households generally considered health issues as the most important constraint for goat production, where diarrhoea was stated as a main concern, followed by respiratory problems and ectoparasites. Theft of goats, limited grazing areas particularly in Michangulene and Mahelane, as well as shortage in quantity and good quality pastures in the dry season, and insufficient veterinary/extension assistance were the other constraints reported (Fig. 1).

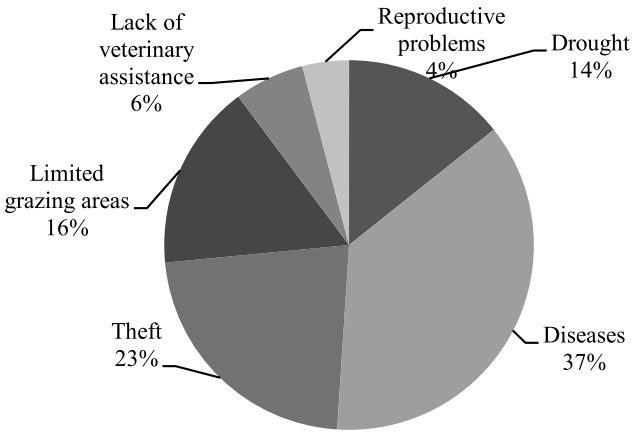

Fig. 1: *Constraints for goat production in the three study villages.*

4 Discussion

Communal, indigenous goats are mostly kept by rural communities and play a crucial role in food security and improving of livelihoods (Hossain *et al.*, 2015; Ouchene-Khelifi *et al.*, 2015). Most research on goats has been performed in controlled research conditions, and is usually not applicable to the rural conditions in which animals are kept. Rumosa Gwaze *et al.* (2009) stressed that surveys to collect baseline data using questionnaires, discussions and direct observations from goat keepers, are essential for goat development in Southern Africa.

Demographic characteristics of this study indicated that while males are still dominating as heads of households, women do have reasonably good participation in the goat production systems. However, goat husbandry is largely a male activity in Moamba village, probably due to traditional habits prevailing in that area whereby men own and are responsible for livestock, while women are relegated to crop production and domestic duties. In contrast, in Michangulene and Mahelane villages the involvement of women in goat activities is more pronounced, likely because men are engaged in other activities, either as farm workers, or other occupations locally or at nearby industrial plants in Maputo province. Furthermore, the university centre located at Michangulene village has been developing gender-based livestock programs which might have contributed to involvement of more women in goat production. According to Guèye (2009), development programmes aimed to enhance the role of rural female farmers in agro-production systems have a potential to empower women over time. On the other hand, the absence of children in goat activities observed in Moamba village might reflect the husbandry system used in that area, whereby cattle and goats are not herded to the grazing and watering points, whereas the increasing human population in Michangulene and Mahelane may

have contributed to an increased level of goat's thefts, resulting on the need of a supervised grazing or tethering.

Although most households owned some land in the study areas, it has mainly been used for crop farming. While in Moamba village, grazing land is not yet a problem, the increasing need of land for habitation in Michangulene and Mahelane villages, has been reducing the areas formerly used for grazing. Previous studies have pointed that the land available for agriculture activities has been negatively affected by the increasing human population (Berihu *et al.*, 2015; Kalema *et al.*, 2015). Goats are only allowed to graze in fallow lands or shared grazing areas within the communities. These findings are in line with those reported in other studies targeting small ruminants (Simela & Merkel, 2008; Kosgey *et al.*, 2008; Oluwatayo & Oluwatayo 2012). Limited grazing land pose an important challenge to smallholder goat farming since it negatively affects the quantity as well as the quality of available fodder and consequently the reproduction efficiency and health of goats, and therefore the role these animals play in the livelihoods of the rural poor.

The larger TLU and goat flock size observed in Moamba village may probably reflect the availability of grazing areas and other conditions when compared to Michangulene and Mahelane villages. However, overall average flock size (13.04 ± 2.41 head) found in the present study corresponds to the large range previously reported for rural goat herd sizes. Average goat flock sizes in Southern Africa varies from 9.7 in Mozambique (van Niekerk & Pimentel, 2004) and 12.0 in Zimbabwe (Assan & Sibanda, 2014) to 16.0 and 25.3 in South Africa as reported by Mahanjana & Cronjé (2000) and Mdladla *et al.* (2017), respectively. Flock sizes in communal areas are generally limited by little available grazing land available, low reproduction efficiency and high prevalence of parasites and diseases (Rumosa Gwaze *et al.*, 2009).

Rural smallholder farmers in Mozambique depend on mixed crop-livestock farming for their subsistence. Goats are raised primarily as a source of meat for home consumption and to use as cash reserve, and the finding of this study is in agreement with observations from previous studies conducted in other African countries (Collins-Lusweti, 2000; Kosgey *et al.*, 2008; Rumosa Gwaze *et al.*, 2009; Semakula *et al.*, 2010; Oluwatayo & Oluwatayo 2012; Hassan & Tesfaye, 2014). Variation in the importance of livestock as a source of income is normal, as it depends on the production environment as well as the proximity to markets (Monau *et al.*, 2017). In villages closer to urban areas, goat keepers are more prone to have other means of income such as informal employment. The use of goats in social ceremonies was ranked second in some areas (Moamba and Mahelane), which emphasizes the socio-cultural importance of goats in rural areas of Mozambique. The importance of selection criteria is vital in goat breeding and has been reported to vary according to production systems in the tropics (Kosgey & Okeyo, 2007). In this study, body size and growth rate as well as disease and drought tolerance were considered the most important traits for male goats. In addition to these traits, prolificacy was considered as a major trait in female goats. Body size and growth rate are valued since they are linked to improved weight gains and hence to increased income and meat. Similarly, disease and drought tolerance were emphasised by farmers due to their influence on flock production. This corresponds to the traits used for selection in West African goats (Dossa *et al.*, 2015), which also ranged from health status and body conformation to tolerance and drought and disease resistance. In Botswana, Monau *et al.* (2017) also reported that body conformation and body size were the two most important characteristics for selection of Tswana goats. Lack of tolerance to droughts and diseases predisposes animals to loss of body condition, and therefore results in reduced productivity (Kanani *et al.* 2006). When selecting male breeding animals, farmers put most emphasis on body size, being an indicator of meat production. These findings are consistent with previous reports from Ethiopia (Tadesse *et al.*, 2014), Uganda (Byaruhanga *et al.*, 2015) and West Africa (Dossa *et al.*, 2015).

This study shows that farmers value animals that have shown an ability to survive and thrive under stressful environmental conditions. Prolificacy and fertility are also valued traits for female goats since they influence the growth and productivity of the flock. It is clear from this study that goat farmers rely on multiple selection criteria to ensure adaptability to the local environment and increase goat production.

This study showed that most of the animals grazed on poor-quality natural veld in communal land. This practice is common in extensive smallholder systems and is used in many resource-poor areas of the developing countries where cattle, goats and sheep depend on natural vegetation as their primary source of feed (Kusiluka & Kambarage, 1996; Salem & Smith, 2008; Kumar *et al.*, 2010; Byaruhanga *et al.*, 2015). Tethering was a common management practice and was used throughout the year, particularly in Michangulene and Mahelane. This practice was used to prevent stock theft and destruction of crops during the cropping season, while it also limit the animals to a specific area with sufficient vegetation. While tethering is a common practice in goat keeping in many parts of Africa (Banda *et al.*, 1993; Lovelace *et al.*, 1993; Webb & Mambabolo, 2004; Boogaard *et al.*, 2012), it can have an adverse effect on goat production. It generally leads to restricted

feeding and therefore results in inadequate nutrition (Salem & Smith, 2008; Byaruhanga *et al.*, 2015), particularly if supplementary feeding is not provided or the alternative available is of low quality.

Supplements were provided for goats mainly during the dry season when feeding resources were scarce. Supplementation consisted mainly of crop residues and leaves from fodder tree species such as *Leucaena leucocephala* and *Moringa oleifera*. This practice was largely observed in villages where tethering was common, suggesting that the practice of tethering forced farmers to provide supplementary fodder to meet feeding and nutritional needs of the animals. However, supplementation was not practiced at all in the Moamba village, where farmers indicated that they were not aware of the nutritional qualities of the fodder trees such as *Leucaena leucocephala* and *Moringa oleifera*. This indicates the importance of extension and knowledge transfer regarding such alternative fodder resources. The fodder trees can easily be grown in this study area, and will relieve grazing pressure during the prolonged droughts. The use of supplementary feed sources, such as maize grain and flours has been reported as a common practice in other studies conducted in resource poor areas of Asia and Africa (Collins-Lusweti, 2000; Kumar *et al.*, 2010; Boogaard *et al.*, 2012; Tadesse *et al.*, 2014; Byaruhanga *et al.*, 2015) as a way of meeting maintenance requirements and sustaining body condition and flock productivity during the dry seasons.

Goats usually graze communal fields that are unfenced, and this makes them vulnerable to predators and thieves. Protection from stock theft during the night is the main reason for providing housing. The housing was basic and did not allow systematic separation of animals based on their physiological status. This preventative measure seems to work, as theft accounted for 23 % of stock losses, which is lower than the 52 % reported by Collins-Lusweti (2000) in South African village goats and 40 % reported by Monau *et al.* (2017) for Tswana goats in Botswana.

In the present study purchasing was the main way of acquiring goats, corroborating findings from previous studies conducted in some African countries (Assan & Sibanda, 2014; Byaruhanga *et al.*, 2015; Dossa *et al.*, 2015). Goats were also acquired via government programs in the Michangulene village. Most farmers used their own breeding buck(s) for natural breeding although farmers in Mahelane village relied on a communal breeding buck. Regardless of the source of the male, uncontrolled breeding took place. Breeding bucks were used for mating from as young as 6 to 12 months. As soon as males reached puberty, they were free to mate as all animals graze together. The lack of structured breeding systems and appropriate infrastructure, such as paddocks, as well as limited knowledge regarding herd management facilitate does and bucks run together all year round (Rumosa Gwaze *et al.*, 2009). A lack of controlled breeding results in inbreeding and no fixed kidding seasons (Monau *et al.*, 2017) compounding the poor management as kids are born throughout the year.

A male is usually kept within a production system for between 2 to 4 years, after which they were slaughtered for meat or sold. The age at first kidding of 12 to 18 months reported by the majority of farmers, was similar to that reported for the Mashona breed (16–18 months) in Zimbabwe (Ndlovu & Royer, 1988) and the Nguni breed (16–18 months) in South Africa (Webb & Mamabolo, 2004). Earlier ages between 6 and 12 months were also reported in this study, which can be expected in traditional management systems where bucks run continuously with does (Chukwaka *et al.*, 2010). Kidding intervals of 6–8 months for goats reported across the study villages were in line with results reported by Webb & Mamabolo (2004) for Nguni goats in South Africa. The longer kidding intervals reported in the Michangulene and Mahelane villages, corresponds with that reported by McKinnon & Rocha (1985), Wilson (1989) and Rumosa Gwaze *et al.* (2009). A large variation in kidding intervals are associated with traditional management systems where random mating and continuous mating throughout the year is common (Chukwaka *et al.*, 2010).

Droughts, theft and diseases are commonly reported as major constraints to rural goat farming (Collins-Lusweti, 2000; Monau *et al.*, 2017). Health problems were frequent during the rainy season in which diarrhoea was most prevalent. The occurrence of diarrhoea can be attributed to grazing on regrowth of natural vegetation with high moisture content and nutritive value, after periods of scarcity and poor quality vegetation during the dry season (Payne, 1990). Respiratory disorders and ticks were also frequent, indicating poor or lack health management and limited or non-existent veterinary assistance in the study areas. Similar findings were described in other studies (Devendra & McLeroy, 1982; Kusiluka & Kambarage, 1986, Nsereko *et al.*, 2015; Onzima *et al.*, 2017), who reported gastrointestinal, infection diseases on extensive systems with limited veterinary assistance.

Culling of goats was a common practice among goat farmers across the study villages. Old age and temperament were the main reasons for culling male goats from the flock. This is not in agreement with previous studies conducted in Ethiopia (Demissie *et al.*, 2014; Seid *et al.*, 2015) and West Africa (Dossa *et al.*, 2015), where health problems were the main reason for farmers to cull goats, irrespective of their sex. However, in the present study, poor fertility and old age were the main causes for culling female goats, which is

in agreement to the findings reported in Kenya (Bett *et al.*, 2009).

This study has been limited by the low number of respondents inquired, due to several challenges for data collection in the rural villages. These include a lack of understanding of the benefits of a survey for goat keepers, the limited number of possible participants and their unavailability during the cropping season as they prioritize farm activities. Furthermore, smallholders do not have any phenotypic records on the productive and reproductive parameters of their animals, making it very difficult to provide data to inquirers. Similar numbers of households per village were used in surveys of goat production in South Africa by Collins-Lusweti (2000) and Mdladla *et al.* (2017). As baseline data for goat production is virtually non-existent in the rural regions of Mozambique, these findings will contribute to future research and assist in baseline knowledge.

5 Conclusions

Goat production plays an important role in the livelihoods of rural Mozambican farmers. It is comprised of indigenous goats reared under extensive system, browsing natural pasture throughout the year. Although the goats are hardy and well adapted to local conditions, their production is limited by poor nutrition, a lack of management and a high prevalence of diseases and parasites. Therefore, there is a need for appropriate intervention strategies to improve goat production, through education of farmers on good husbandry practices, such as better breeding and feeding practices as well as disease control strategies. Also, the baseline information provided in this study will contribute in the development of coordinated and comprehensive goat production improvement programs and ultimately improve goat productivity and the livelihood rural farmers.

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