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Full Length Research Paper

Influence of flushing and season of kidding on reproductive characteristics of Small East African goats (does) and growth performance of their kids in a semi arid area of Tanzania

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A study was carried out to assess the effects of nutritional supplementation (flushing) and season of kidding on reproductive performance of Small East African (SEA) does and growth performance of their crossbred (Norwegian x SEA). Seasons of kidding were defined as season 1 (June- August) and 2 (September to November) which represented the early and late dry months of the year, respectively. A total of 90 grazing does were divided into three groups of 30 does each and monitored for two years. In each observational year, one group (control goats) received no concentrate supplementation while the remaining groups were subjected to 200 or 400 g of concentrate diet/doe/day for a period of 60 days (November to January) before mating. Does were then exposed to sexually active bucks from January through June in 2008 and 2009. Nutritional flushing and season of kidding had no effects (P>0.05) on fertility, prolificacy and fecundity. Nonetheless, the relative weight increase during gestation was 35.8 % in season 1 being higher (P<0.01) than 12.6% recorded in season 2. The proportion of weight loss of does kidding in season 1(6.1%) was, however, lower (P<0.05) than 8.9% in season 2. Kids born in season 1 grew at a faster rate than their counterparts born in season 2 (80 vs. 57 g/day, P<0.05). Consequently, the average weight of kids weaned per doe kidding was 2 kg in favour of season 1. It is concluded that nutritional flushing during peak-dry season may not be necessary for goats to conceive especially when raised on lightly grazed rangeland and that breeding activities of goats should preferably be restricted to January to March for kidding to take place during early dry season (June to August).

Key words: Goats, nutritional flushing, seasonality, reproductive performance, growth rate.

INTRODUCTION

The seasonality in feed availability and quality is an important constraint to biological productivity of small ruminants in the tropics (Berhane and Eik, 2006; Ben Salem and Smith, 2008). In Tanzania, as in most tropical countries, small ruminants breed throughout the year and this can result in overall poor survival of dams and kids, reduced reproductive and productive performances especially when late pregnancy and resulting kidding fall into periods with insufficient forage availability (Karikari and Blasu, 2009). However, tropical breeds of goats are known to be a seasonally polyoestrus and therefore it is possible to manipulate their breeding activity to coincide with periods of adequate feed supply and low disease

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challenges (Amoah et al., 1996).Such a breeding strategy is potentially advantageous both in terms of improved reproductive activity of the does and the growth performance of kids.

Since nutritional requirements vary throughout the reproductive cycle, strategic feed supplementation can also be an important tool to improve reproductive efficiency. Nutrition is generally recognized as a significant regulator of reproduction (Smith and Akinbamijo, 2000) and that improvement in the nutritional status of the does particularly preceding mating (flushing),is known to increase fertility in small ruminants due to dynamic effects of nutrition on ovulation rate (Kusina et al., 2001).

Flushing has also been reported to increase the body condition and weights of does not only at mating (static effects) but also during their post-partum period (Titi et al., 2008). Responses to flushing, however, are often variable and inconsistent depending on factors such as genotypes (Sormunen-Cristian and Jauhiainen, 2002; Chemineau et al., 2004), body conditions of the animals (O'Callaghan et al., 2000), timing and duration of flushing (Sabra and Hassan, 2008; Karikari and Blasu, 2009), the amount and quality of dietary supplements for example, energy and protein levels (Acero-Camelo et al., 2008) and the grazing background (Molle et al., 1995). There is, however, scanty information on effects of nutrition and seasonal influences on productivity and reproduction of goats under grazing conditions of semi arid areas in Tanzania.

The objective of this study was to test the hypothesis that supplementary feeding during peak-dry season is needed if goats are to attain high conception rate and that kidding towards the end of the long-rains will improve performance of small east African (SEA) goats and their crossbred.

MATERIALS AND METHODS

Site

The study was conducted at Mulbadaw farm (35º 12' E, 04º 25' S), in Hanang district of Manyara region in Tanzania. The area receives 408 to 802 mm of rainfall most of which falls between December and May.Mean annual minimum and maximum temperatures at the site are 10 and 29°C, respectively.The vegetation type is mainly wooded grassland. The area is inhabited by the Barabaig people whose main occupation is pastoralism with cattle and goats as the most predominant livestock species. The experimental site was only lightly grazed as no livestock species other than the experimental goats were allowed to graze in the area. More details of feed resources in the study area are given in Safari et al. (2011)

Animals, treatments and management

Ninety SEA does of 2 to 6 years of age and of parity 2 to 5 with mean weight of 27.9±0.7 kg were used in a two-year study commencing in November, 2007 and ending in October, 2009. All does were injected with ivermectin (Kelamectin 1%) subcutaneously at a dose of 0.2 mg/kg body weight for treatment and control of gastrointestinal and ecto-parasites.Thereafter,animals were regularly screened for gastrointestinal parasites and only those that harbored 1000 or more eggs per gram of faeces were given anthelmintics. The does were randomly assigned to three dietary treatment groups which were balanced according to weight, parity and age and were fed in groups. The dietary treatment groups were control goats (T0) where goats received no dietary supplementation and represent the traditional management system while T200 (goats supplemented with 200 g of concentrate per day) and T400 (goats supplemented with 400 g of concentrate per day) groups were supplemented with 200 g and 400 g of concentrate diet per doe per day, respectively.

The concentrate diet was composed of maize bran (70%), sunflower seedcake (28%) and mineral mix (2%). The mineral mix (TANFEED Co. Ltd) consisted of Ca (in percentage, manufacturer's specifications) (25.8), S (0.3), Mg (0.5), Fe (0.1), Na (29.05), P (12.9), Cl (31.08), Zn (0.02), B-cr (0.02) and K (0.05). The flushing period was 60 days after which does were exposed to sexually active Norwegian bucks (buck to doe ratio of 1:15) for the period between January and June in 2008 and in 2009. All goats grazed for five hours (9:00 to 12:00 and 14.00 to 16.00 h) during the day. The animals grazed in wooded grassland with *Cynodon nlemfuensis, Chloris pycnohrix, Cenchrus centgrus, Sorghum spp, Cynoglossum lanceolutum, Lactuca capensis, Sesbania sp, Bidens stepia, Solanum arundo, Acacia seyal, Acacia xanthophloea* and *Ormocarpum kirkii* as the most preferred forage species. Between 12:00 and 14:00 h, goats rested in their house where water and mineral licks were available. In the evenings, dietary treatments were provided to the animals confined in separate pens.

Measurements

Body weights (BW) and body condition scores (BCS) of does were recorded monthly for the period between flushing and three months post-kidding. A five point-scale 1 = very thin, 5 = very fat (Russel et al., 1969) was used for the assessment of BCS. Birth type (single or twins), birth weight and sex of kids were recorded. Kids were weighed within 24 h after birth and thereafter weekly for 12 weeks. Weight gains (g/day) of both does and kids were derived as (final BW (g) - initial BW (g))/number of days involved.

Statistical analyses

Data from doe live-weight, BCS and birth weight and weight gain of kids were analysed using the General Linear Model procedures of SAS (2001). For does, fixed effects included in the model were season of birth of kids (season 1 defined as June- August and season 2 as September-November), flushing (0, 200 or 400 g of concentrate/doe/day), type of birth (single or twin), parity of the doe (<3, 3 to 5 and >5) and the birth type x doe parity interactions. Least squares means were generated for body weights of does for example, pre-mating live weight changes and relative weight increase during gestation.

The independent variables used to assess response variables in does were also used to study their effects on birth weights of kids, growth rate of kids from kidding to weaning and the average weight of kids weaned per kg doe kidding. Where means were generated for variables studied in does and kids, the PDIFF option was used to separate them and when means were significant by ANOVA at $P<0.05$, they were separated by least significance difference test. If $0.05<P<0.10$, then differences were considered to suggest a trend, or tendency, to significance.

Reproductive characteristics data were derived as follows: fertility rate as the number of does kidding (live or dead offspring) /number

Table 1. Effect of flushing on body weight and condition of small east African does (least squares means ± S.E.M).

Variable	Supplementation			S.E.M	Sign.
	T0	T200	T400		
Body weight					
Start of flushing (kg)	28.2	27.85	27.8	0.67	NS
End of flushing (kg)	26.6^{c}	28.1^{b}	29.4^{a}	0.39	*
ADG, flushing to mating	-27.8^{c}	3.3^{b}	26.2^{a}	6.61	***
At kidding (kg)	33.5^{b}	33.3^{b}	34.1^{a}	0.48	*
One month post-kidding (kg)	31.2^{b}	30.8^{b}	32.2^{a}	0.47	*
Three months post-kidding (kg)	28.5	27.9	28.6	0.47	NS
ADG, kidding to weaning	-53.9	-57.0	-53.2	6.40	NS
Body condition scores	2.81^{b}	2.87^{b}	3.07^{a}	0.03	***
Start of flushing	2.69	2.69	2.71	0.09	NS
End of flushing	2.96^{c}	3.19^{b}	3.38^{a}	0.07	*
At kidding	2.87^{c}	3.18^{b}	3.34^{a}	0.07	*
One month post-kidding	3.03	3.21	3.30	0.11	****
Three months post-kidding	2.75	2.62	2.78	0.07	NS

[abc] Means in the same row with different superscripts are significantly different (P<0.05). *P<0.05; ***P<0.001 ****0.05<P<0.1; NS not significant.

of does exposed for breeding x100; prolificacy as number of offspring born (alive or dead)/number of does kidding (live or dead offspring) x100 and fecundity as number of offspring born (alive or dead)/number of does exposed for breedingx100. Values obtained were then subjected to Chi-square test to assess the association between the reproductive characteristics and nutritional treatments. Yearly,difference was not significant for any of the traits studied. Thus, data for the two years were pooled to increase precision. Kiddings were separated into season 1 (June-August) vs. season 2 (September to November) as this categorization showed the largest variations for most of the traits studied.

RESULTS

Effects of concentrate supplementation on body weight and condition of does

Concentrate supplementation affected (P<0.05) body weight gains of does. At the end of the supplementation period, T400 does performed better than the other groups (Table 1).On average T400 does were heavier (2.8 kg) and in better condition (0.42 points) than the control does. Changes in body weight among supplemented goats relative to the control group corresponded to 5.8 and 1% increase for T400 and T200 does, respectively. During the same period, control goats lost 5.7% of their body weight. Live weights of T400 does at the time of kidding and at one month post-kidding were still higher (P<0.05) than the weights for T200 and control does. Twelve weeks post-kidding, however, the corresponding weights for these groups did not differ substantially. The average reduction in live weight of does from kidding to weaning was similar in the three groups. Generally, body condition scores followed the same trend as body weight changes. There were no significant (P>0.05) effects of concentrate supplementation on fertility, fecundity, prolificacy and twinning rates as were for the litter size, birth weight, growth rate from birth to weaning or weight loss of does from kidding to weaning. Litter size averaged 1.34, 1.28 and 1.23 in T400, T200 and control does, respectively. Differences in these means, however, were small and insignificant.

Effects of season on live weight changes of kids and does and reproductive traits of does

Period of mating as reflected by the season of kidding affected gestational weight increase of does and growth rates of kids (Table 2). Increase in relative weight during gestation period for does carrying singles for season 2 kidding was lower (P<0.01) by 21.2% compared to the weight increase of their counterparts in season 1. Corresponding value for does carrying twins was 18% higher (P<0.05) in season 1 compared to that in season 2. The average birth weights of kids born in season 1 and 2 were similar (2.5 vs. 2.4 kg, respectively; P>0.05) and a steady increase in body weights was observed for kids born in the two kidding seasons. However, the rate of growth was different between seasons. Kids born in season 1 grew at faster rates compared to their

Table 2. Least squares means ± S.E.M for the body weight changes of SEA does and their kids (N x SEA) in two seasons of kidding in two years of study.

Variable	Season 1	Season 2	Sign.
Relative weight increase during gestation (%)			
Does carrying singles	33.9±2.35	12.6±7.57	**
Does carrying twins	35.8±5.57	17.8±5.50	*
Live weight of kids (kg)			
Week1	2.5±0.23	2.4±0.07	NS
Week4	5.5±0.14	4.4±0.25	***
Week8	7.5±0.24	6.4±0.47	*
Week12	9.8±0.26	7.6±0.55	**
Growth rate of kids (g/day)			
Week 1- 4	102.2±6.22	68.0±5.62	*
Week 4-8	68.1±5.96	65.3±6.05	NS
Week 8-12	76.6±7.57	41.2±8.97	*
Weight of kid weaned, kg/kg doe kidding	2.6±0.24	1.80±0.30	*
Weight of kid weaned, kg/doe kidding	9.5 ±0.20	7.5 ±0.33	***
Pre-weaning mortality (%)	13	17	NS
Weight change of does (%), kidding to weaning	-6.1±0.47	-8.9±0.45	*

*P<0.05; **P<0.01; ***P<0.001; NS, not significant.

counterparts in season 2 with a difference of 2.2 kg (29%) being reached at 12 weeks post-kidding (P<0.01). The average weight of kids weaned per kg doe kidding was higher (P<0.05) in season 1 than in season 2 (2.6 vs. 1.8 kg) and the weight of kids weaned per doe kidding was about 27% lower (7.5 vs. 9.5 kg; P<0.001) in season 2 than that in season 1.

Pre-weaning mortality was similar for seasons 1 and 2. However, percentage weight loss of does from kidding to 12 weeks post-kidding was lower (P<0.01) for season 1 compared to that in season 2 (6.1vs. 8.9). Of 180 observations made during the two years of study, a total of 128 does kidded in season 1 whereas only 34 does kidded in season 2.Comparison of reproductive performance between season 1 and 2 showed no significant differences in terms of fertility (71.0 vs 65.4%, x^2 = 0.23, P>0.05), prolificacy (1.07 vs 1.05 x^2 = 0.00, P>0.05), and fecundity (0.76 vs 0.69, x^2 = 0.00, P>0.05).

Effects of sex, type of birth and parity of dam on growth rates of kids

Male and female kids had similar (P>0.05) weights at birth but male kids were consistently heavier (P<0.05) than female kids thereafter (Table 3). Differences of 0.55, 0.94 and 0.48 kg in favour of male kids were recorded at the fourth, eighth and twelfth week, respectively. Type of birth also affected weight gain in kids. Between week of birth and week 12, kids born as singles gained weight at a faster rate than twins. As a result, the weights of singletons were higher (P<0.01) by 1.1 kg at 12 weeks of age. In contrast, parity of does had no effect (P>0.05) on birth weight and pre-weaning growth rate of kids. Sex of kids, type of birth and parity of dams did not influence (P>0.05) the survival rates of kids significantly. Birth type x parity interaction affected (P<0.05) birth weight of kids where single kids from all parity classes were similar (P>0.05) in birth weights but heavier (P<0.05) than twins from parity five and below. However, the difference narrowed at the fourth week and disappeared at the eighth week of age. Differences between weights of kids born singles and those born twins also narrowed with increasing parity stage. These differences were 0.8, 0.3 and 0.2 kg for kids born of does in <3, 3 to 5 and >5 parity categories, respectively.

Effects of season of kidding, type of birth and parity stage on live weight changes of does from birth to weaning

Results summarizing live weight changes of does from kidding to weaning are presented in Table 4. Kidding season influenced live body weight of does up to weaning period. Higher (P<0.05) live weights of does were recorded in season 1 than in season 2 at kidding (29.6 vs 28.5 kg) and at weaning (27.9 vs 26.1 kg). Type of birth had a significant (P<0.05) influence on weight of dams up to eight weeks post-kidding with does nursing singles

Table 3. Effect of birth type, parity of dam, and sex on growth performance (1 to 12 weeks) and survival rates of N x SEA kids in two years of study.

Fixed effect	Time (weeks)				Survival rate Chi square
	1	4	8	12	
Sex of kid					
Male	2.38±0.06	5.23±0.14	7.37±0.22	9.25±0.18	72/82 (87.8 %)
Female	2.37±0.07	4.68±0.14	6.43±0.23	8.77±0.17	78/92 (84.7 %)
Significance	NS	*	**	*	NS
Type of birth					
Single	2.4±0.06	5.3 ±0.11	7.31 ±0.20	9.4±0.24	124/142 (87.3%)
Twin	2.2±0.07	4.3 ±0.15	6.18 ±0.27	8.3±0.31	26/32 (81.3 %)
Significance	*	***	***	**	NS
Parity					
<3	2.3±0.26	4.96±0.58	7.08±0.93	9.1 ±1.06	44/50 (88.0 %)
3-5	2.4±0.07	5.19±0.16	7.19±0.93	9.3 ±0.34	58/64 (90.6 %)
>5	2.4±0.12	5.10±0.22	7.27±0.93	9.3 ±0.46	48/60 (80.0 %)
Significance	NS	NS	NS	NS	NS
Birth type-parity interaction					
Single x parity <3	2.4^{a}±0.19	4.96±0.55	7.08±0.91	9.3±1.03	
Single x parity 3-5	2.4^{a}±0.06	5.49±0.19	7.49±0.32	9.8±0.42	
Single x parity >5	2.5^{a}±0.08	5.19±0.23	7.42±0.39	9.9±0.46	
Twin x parity <3	1.6^{b}±0.03	-	-	-	
Twin x parity 3-5	2.1^{b}±0.09	4.52±0.28	6.52±0.48	8.4±0.58	
Twin x parity >5	2.3^{ab}±0.21	4.58±0.55	6.12±1.12	8.6±1.03	
Significance	*	****	NS	NS	

[ab] Least squares means with a common superscript in the same column are not significantly different (P>0.05), *P<0.05; **P<0.01; ***P<0.001; ****0.05<P<0.1; NS, not significant.

exhibiting heavier weights compared with those nursing twins. However, at twelve weeks post-kidding, weights of these two groups of does were similar (P>0.05). Between week 1 and week 8, does in parity 3 and those in >5 parity category had similar (P>0.05) body weights but were heavier (P<0.05) than those with < 3 parity stage. However, no differences of live weights of does due to parity were found 12 weeks post-kidding. Interaction between parity and litter size indicated lowest live weights for does with <3 parity nursing singles whilst the heaviest does were those with <5 parity nursing twins.

DISCUSSION

The effect of the nutritional flushing on reproductive performance was not significant and the results are in agreement with previous investigations (Sormunen-Cristian and Jauhiainen, 2002; Zarazaga et al., 2005) but disagrees with observations made by Blache et al. (2008), and this indicates that flushing has variable effects on such performance. Failure to detect flushing effects in the present study could be explained by the fact that does used were already in good body condition at the time of flushing. In a similar study, Hart (2008) concluded that flushing practice in Spanish goats is unlikely to show clear effects on kidding or conception rates when the goats are in reasonable body condition score (2.5 to 3.5, in a five point-scale). Thus, there appears no justification for flushing does except when they are in poor body condition.

A sufficiently high live weight of does is essential in maintaining good reproductive performance as well as growth performance and survival rates of kids. In the present study, the gestational live weight increase of does that kidded in season 1 were well above the range of 20 and 22% required during pregnancy in order to prevent mobilisation of fat reserves by the dam (Teacher, 1970). However, the corresponding gestational weight increase of does kidding in season 2 were below this range. Weight changes of does during pregnancy often indicate pre-natal development of the fetus as evidenced by significant correlations between birth weight of the offspring and the body weight of the dam (Bosso et al.,

Table 4. Least-squares means ± SE of live weight of fertile SEA does (kg) from birth to weaning (week 1 to 12) as affected by season, litter size and parity at kidding in two years of study.

Fixed effect	Time (weeks)			
	1	4	8	12
Kidding season				
Season 1	29.6 ±0.43	29.3±0.41	28.8±0.44	27.9±0.5
Season 2	28.5 ±0.40	28.0±0.40	27.5±0.50	26.1±0.3
Significance	*	*	*	*
Type of birth				
Does nursing singles	31.8±0.35	30.3±0.7	30.3±1.1	29.0±1.2
Does nursing twins	29.7±0.47	28.3±0.5	28.2±0.4	27.9±0.5
Significance	*	*	*	NS
Parity				
<3	25.8^{b} ±2.24	24.0^{b}±1.93	24.7^{b}±1.82	25.0±1.86
3-5	30.6^{a} ±0.69	28.5^{a}±0.60	28.7^{a}±0.57	28.0±0.58
>5	31.9^{a} ±0.89	29.5^{a}±0.78	29.3^{a}±0.76	28.9±0.80
Significance	*	*	*	NS
Birth type-parity interaction				
Single x parity <3	25.8^{c}±2.21	24.0^{c}±1.90	24.7^{c}±1.78	25.0±1.18
Single x parity 3-5	30.6^{b}±0.76	28.4^{b}±0.65	28.3^{b}±0.63	27.7±0.66
Single x parity >5	31.5^{ab}±0.93	29.1^{ab}±0.82	28.9^{ab}±0.79	28.9±0.84
Twin x parity <3				
Twin x parity 3-5	31.9^{ab}±1.56	29.3^{ab}±1.34	30.2^{ab}±1.26	29.1±1.33
Twin x parity >5	35.7^{a}±2.71	33.4^{a}±2.33	32.5^{a}±2.18	28.5±3.26
Significance	*	*	*	NS

[abc] Least squares means with a common superscript in the same column are not significantly different (P>0.05), *P<0.05; NS, not significant.

2007).

Overall, reproduction is energetically demanding especially for gestational development and production of milk and therefore the growth performance of kids (Blache et al., 2008). The observed differences in weight changes between the two seasons in the present study are most likely a result of the fluctuating nature of nutrient supply in semi-arid areas. Nutrient availability during late dry season was probably insufficient to cover the requirement of dams as both herbage availability and quality are usually low. Results of the assessment of important forages relished by goats in the same area (Safari et al., 2011) showed a drastic decline in energy and protein levels in this period.

The low growth performance of kids born in season 2 was presumably a result of reduced ability of dams to produce sufficient milk for the kids in this season. It is likely that weaning stress of such kids would be severe as pointed out by Hary (2002) and Berhane and Eik (2006) following observations made during long dry seasons. The present study also shows that it is potentially advantageous if goats are bred in January-March so that late pregnancy and lactation stages with high nutritional demands will coincide with the season of adequate supply of feeds (season 1). Goats kidding in this season are also likely to have a short post-partum anoestrus and hence shorter kidding intervals (Hary and Schwartz, 2002). The growth rates of crossbred kids in the present study were higher than those reported elsewhere with pure SEA kids under the same environment (Ntakwendela et al., 2002) and could be attributed to the genetic differences of goats involved. Increased growth performance of SEA x Norwegian goats compared to SEA goats has also been reported in earlier studies (Kiango, 1996; Safari et al., 2005).

Kidding in the wet season is normally discouraged because this period is associated typically with adverse weather condition which is also exacerbated by high intestinal parasitism (Hary, 2002; Hoste et al., 2005). Thus, kidding taking place soon after rains as illustrated in the present study will confer the best results in terms of weight gain of the dams and the production efficiency. Higher production efficiency in season 1 implies low investments in self-maintenance among animals and this is an important aspect in animal production as drastic losses of weight and condition during lactation may influence negatively the resumption of oestrous and ovarian activity (Butler, 2000).

Kids born in season 1 were heavier at different stages of growth and this has implications on future reproductive performance of animals. Greyling (2000) and Papachristoforou et al. (2000) found that such kids achieve better reproductive performance when they attain sexual maturity and thus increase efficiency of goat enterprises. Overall, results from the present study also concur with the conclusion from a study in Kenya that showed seasonal breeding could reduce the impact of fluctuations in nutrient supply necessary for growth and survival of young stock through improvements in birth weights and maternal lactation ability(Hary and Schwartz, 2002). A major observation in this study is that BW of does and growth rates of kids are significantly higher when kidding takes place during early dry season (June to August).Thus, under semi-arid areas of Tanzania mating activity of goats should preferably be restricted to the months of January-March. Lack of flushing and seasonal effects on reproductive performance of goats in the present study is contrary to findings from other studies and warrants further investigations to elucidate the many factors explaining such variations.

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Abbreviation

ADG, Average daily gain; **BCS,** body condition scores; **BW,** body weight; **N x SEA,** Norwegian x Small East African goats; **T0,** control goats; **T200,** goats supplemented with 200 g of concentrate per day; **T400,** goats supplemented with 400 g of concentrate per day.

REFERENCES

Acero-Camelo A, Valencia E, Rodríguez A, Randel PF (2008). Effects of flushing with two energy levels on goat reproductive performance. Livest. Res. Rural Dev. http://www.lrrd.org/lrrd20/9/acer20136.htm.

Amoah EA, Gelaye S, Guthrie P, Rexroad Jr. CE (1996). Breeding season and aspects of reproduction of female goats. J. Anim. Sci. 74:723-728.

Ben Salem H, Smith T (2008). Feeding strategies to increase small ruminant production in dry environments. Small Rumin. Res. 77:174-194.

Berhane G, Eik LO (2006). Effect of vetch (*Vicia sativa*) hay supplementation to Begait and Abergelle goats in northern Ethiopia: II. Reproduction and growth rate. Small Rumin. Res. 64:233-240.

Blache D, Maloney SK, Revell DK (2008). Use and limitations of alternative feed resources to sustain and improve reproductive performance in sheep and goats. Anim. Feed Sci. Technol. 147:140-157.

Bosso NA, Cissé MF, van der Waaij EH, Fall A, van Arendonk JAM (2007). Genetic and phenotypic parameters of body weight in West African Dwarf goat and Djallonké sheep. Small Rumin. Res. 67(2-3):271-278.

Butler WR (2000). Nutritional interactions with reproductive performance in dairy cattle Anim. Reprod. Sci. 60-61:449-457.

Chemineau P, Daveau A, Cognié Y, Aumont G, Chesneau D (2004). Seasonal ovulatory activity exists in tropical Creole female goats and Black Belly ewes subjected to a temperate photoperiod, BMC Physiol. 4:12. doi: 10.1186/1472-6793-4-12.

Greyling JPC (2000). Reproduction traits in the Boer goat doe. Small Rumin. Res. 36:171-177.

Hart S (2008). Meat goat nutrition. In Proc. 23rd Ann. Goat Field Day, Langston Univ. pp.58-83.

Hary I (2002). Analysis of survival curves in seasonally mated pastoral goat herds in northern Kenya using logistic regression techniques. J. Arid Environ. 50:621-640.

Hary I, Schwartz HJ (2002). Effects of seasonal breeding on productive performance of pastoral goat herds in northern Kenya: a longitudinal analysis of growth in kids and body weight development of does. J. Arid Environ. 50:641-664.

Hoste H, Torres-Acosta JF, Paolini V, Aguilar-Caballero A, Etter E, Lefrileux Y, Chartier C, Broqua C (2005). Interactions between nutrition and gastrointestinal infections with parasitic nematodes in goats. Small Rumin. Res. 60:141-151.

Karikari PK, Blasu EY (2009). Influence of nutritional flushing prior to mating on the performance of West African Dwarf goats mated in the rainy season. Pak. J. Nutr. 8(7):1068-1073.

Kiango SM (1996). Studies on factors affecting performance of dairy goats and on socio-economic aspects of dairy goat production in Tchenzema and Dareda wards in Tanzania. Msc Thesis, Department of Animal Science and Production, Sokoine University of Agriculture, Morogoro, Tanzania p.184.

Kusina NT, Chinuwo T, Hamudikuwanda H, Ndlovu LR, Muzanenhamo (2001). Effect of different dietary energy level intakes on efficiency of estrus synchronization and fertility in Mashona goat does. Small Rumin. Res. 39:283-288.

Molle G, Branca A, Ligios S, Sitzia M, Casu S, Landau S, Zoref Z (1995). Effect of grazing background and flushing supplementation on reproductive performance in Sarda ewes. Small Rumin. Res. 17:245-254.

Ntakwendela L, Mtenga LA, Pereka AE, Chenyambuga SW, Laswai GH, Kimambo AE, Muhikambele VRM (2002). Effects of substituting sunflower seed cake with *Acacia tortilis* pods as protein source in supplementary diets of small east African goats Tanzania J. Agric. Sci. 5(1):39-48.

O'Callaghan D, Yaakub H, Hyttel P, Spicer L J, Boland M P (2000). Effect of nutrition and superovulation on oocyte morphology follicular fluid composition and systemic hormone concentrations in ewes J. Reprod. Fertil. 118:303-313.

Papachristoforou C, Koumas A, Photiou C (2000). Seasonal effects on puberty and reproductive characteristics of female Chios sheep and Damascus goats born in autumn or in February Small Rumin. Res. 38(1):9-15.

Russel AJF, Doney JM, Gunn RG (1969). Subjective assessment of body fat in live sheep. J. Agric. Sci. Cambridge 72:451-454.

Sabra HA, Hassan SG (2008). Effect of new regime of nutritional flushing on reproductive performances of Egyptian Barki Ewes. Global Veterinaria 2(1):28-31.

Safari J, Mushi DE, Kifaro GC, Mtenga LA, Eik LO (2011). Seasonal variation in chemical composition of native forages, grazing behaviour and some blood metabolites of small East African goats in a semi-arid area of Tanzania. Anim. Feed Sci. Technol. 164(1-2):62-70.

Safari J, Mushi DE, Mtenga LA, Eik LO, Kifaro GC, Muhikambele VRM, Ndemanisho EE, Maeda Machang'u AD, Kassuku AA, Kimbita EN, Ulvund M (2005). A note on growth rates of local goats and their crosses with Norwegian goats at village level in Tanzania. Livest. Res. Rural Dev. 17(4):47. http://www.cipav.org.co/lrrd/lrrd17/4/safa17047.htm.

SAS (2001). Statistical Analysis System. User's guide, version 8.2. SAS Institute, INC. Carry. NC. USA.

Smith OB, Akinbamijo OO (2000). Micronutrients and reproduction in farm animals. Anim. Reprod. Sci. 60-61:549-560.
Sormunen-Cristian R, Jauhiainen L (2002). Effect of nutritional flushing on the productivity of Finnish Landrace ewes. Small Rumin. Res. 43(1):75-83.
Teacher TT (1970). Effects of nutrition in late pregnancy on subsequent milk production in ewes. Anim. Prod. 12:23-36.
Titi HH, Alnimer M, Tabbaa MJ, Lubbadeh WF (2008). Reproductive performance of seasonal ewes and does fed dry fat during their post-partum period. Livest. Sci. 115(1):34-41.
Zarazaga LA, Guzmán JL, Domínguez C, Pqrez MC, Prieto R (2005). Effect of plane of nutrition on seasonality of reproduction in Spanish Payoya goats. Anim. Reprod. Sci. 87:253-267.