Breeding season and aspects of reproduction of female goats

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Breeding Season and Aspects of Reproduction of Female Goats[1]

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ABSTRACT: Reproductive data were collected on 608 female goats and their 1,147 offspring, involving 20 herds, from different geographical locations in Georgia for 3 yr. Results for seven breeds and a dairy crossbred revealed that most goats bred seasonally, commencing approximately in late June and reaching a peak in September to November. However, the Pygmy had an unusual peak of mating activity during summer (July). Gestation period (± SE) was 150.6 ± 2.64 d. Pygmies had the shortest gestation period, whereas Toggenburgs had the longest. Gestation period decreased as the litter of size of the doe increased (b = –.92 d/kid, $P < .001$) and increased slightly with increasing parity (b = .22 d/parity). December and January matings had the shortest gestation period. Litter size was 1.85 ± .67, with twins being the most prevalent litter size. Litter size varied among breeds. The litter size increased with mating weight of the doe for most breeds (litter size increased approximately .02 kids/kg of mating weight). Birth weight was 3.24 ± .64 kg and varied among breeds; Pygmy kids were lightest (1.7 kg) and Toggenburgs were heaviest (3.9 kg). Males were heavier than female kids. Birth weight decreased with the size of litter (approximately .45 kg/kid, $P < .001$).

Key Words: Goats, Georgia, Breeding Season, Gestation Period, Litter Size, Birth Weight

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Introduction

Goat production has become an attractive alternative livestock enterprise for limited resource farmers in the southern United States (Adutwum et al., 1990). The goat is being recognized as a significant food source, because does can convert feed DM into milk as efficiently as other ruminants; 185 kg milk/100 kg of dry OM for does compared with 162 kg for cows in temperate environment (Spedding, 1969). Also, goats provide a remarkable diversity of products. Apart from milk and meat, morocco and suede skins are products made from goats, and their fiber is used in making mohair and cashmere garments (French, 1970). Goat gourmet cheese valued at 2 to 4 million dollars is imported from Europe annually. Georgia has over 400 dairy goat farms, with herd sizes ranging from six to 250 does (averaging 14 per herd), but there is a shortage of goat meat to satisfy the increasing demand in the southern United States (Blair, 1990). There is a paucity of scientific information on goat reproduction to help improve goat herd management. This paper provides basic statistics on the breeding season, gestation period, litter size, and birth weight of goats, based on a study conducted with herds located in different geographical regions of Georgia.

Materials and Methods

Goats. A total of 608 adult female goats (>8 mo of age) derived from seven various breeds and dairy crossbreeds (Table 1) and located at different geographical regions of Georgia were used for the 3-yr study (1987 to 1990). During the 1st year, 262 does from 16 herds were studied, in the 2nd year, 202 does from 13 herds, and in the 3rd year, 144 does from 13 herds. Seven herds provided results for all 3 yr.

Data Collection Procedures. The study commenced with primary visits to identify individual female goats involved in the study, with their names or tags. Herd details were then recorded: number of females, kids and bucks maintained in the herd, the breeds kept, the reasons for raising goats, and management practices (e.g., feeding regimen, kid and adult goat breeding protocols). Detailed information was also recorded for participating individual female goats,

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Table 1. Number of goats on study by breed and year

Breed	Year 1	2	3	Total
American Alpine	12	13	13	38
Dairy Crossbred	65	35	30	130
French Alpine	50	45	37	132
Nubian	89	49	30	168
Pygmy	—	20	12	32
Saanen	23	18	22	63
Toggenburg	23	22	—	45
Total	262	202	144	608

including breed, age and date of birth, parity (number of previous lactations), age at first kidding, and date or season of last breeding.

The herd owners were each issued a kid weigh-scale for recording birth weight and breeding/kidding cards. The cards requested information such as: date of mating, date of kidding, litter size, birth weight, sex of kids, and remarks on health of dam and kids, especially during parturition. Each herd was visited every 2 mo when the does were individually weighed with a mobile weigh-crate and data on cards were transcribed. Data collection was facilitated by the fact that most of the herds had registered pedigree does. Owners volunteered to participate in response to questionnaires at the start of the study. Other criteria used for selecting the herds were the type of breeds and size maintained in the herd.

Most of the herds were managed intensively to provide milk, cheese, and yogurt on a small scale for sale to neighbors or for sale of weaned buck-kids and culls to agents who ship them out to specialty markets. The Goat Research and Extension Center's herd at Fort Valley State College was also included in the study. Breeding was mostly done by hand-mating using mature bucks (>3 yr old) as soon as initial estrus was observed in each individual doe during the breeding season. Only one herd was freely mated because the buck was left with the does throughout the year, and as a result no mating records were obtained.

Statistical Analysis. Information obtained was used to examine the annual pattern of breeding and kidding, gestation period, litter size, and birth weight of does. Data were analyzed using Proc Mixed of SAS (1994). Various models were developed for these variables, but all models included herd within year as a random effect. Within project year, the frequency of mating and kidding by months, herds, and breeds was obtained. For gestation period, the following effects were assessed: breed, month of mating, mating weight, parity, kidding interval, and the sex of the kids. Sex was treated as a continuous variable and was calculated as the percentage of female kids. For litter size, the variables of breed, month of mating, mating weight, parity of the doe, date of last kidding, age at first kidding, kidding interval, and the sex of the kids were evaluated. For birth weight, the variables of breed, parity, month of mating, mating weight, litter size, kidding interval, and sex were evaluated. For each model, the least squares means for significant fixed effects are presented in tabular form and the maximum likelihood solutions for continuous variables are presented.

Results

Breeding Season. The pattern of breeding was not significantly different among the 3 yr within the various breeds of goat examined. Therefore, results were pooled across years. Mating, though variable among breeds, especially for the peak of mating activity, commenced around June, with the majority of breeds reaching a peak in September, October, and November (Figure 1). Kidding peaked between February and April. Figure 2 shows the months and peaks of mating activities of the various breeds monitored. The Nubian and Pygmy breeds had an extended breeding period. Pygmies also displayed a pronounced peak of activity during July.

Gestation Period. Gestation period was significantly affected by breed, litter size, parity, and month of mating (Table 2). Pygmy goats had the shortest gestation period (149.4 d); Toggenburgs had the longest (152.1 d). In spite of significant differences among breeds, their 95% confidence intervals overlapped, which suggests that the differences are minor. The gestation period also varied significantly depending on the month of mating (or a related factor such as month of parturition), with shortest gestations from December and January matings. The gestation period decreased as the number of offspring increased ($b = -.9243$ d/kid, $P < .001$) and increased slightly ($b = .2158$ d/parity) with increasing parity.

Litter Size. Litter size over the 3 yr ranged between 1 and 4 (Table 3), with a mean (± SE) of 1.847 ± .670. The most frequent litter size was twins (48.1%), with the next highest frequency being singles (34.6%), together accounting for 82.8% of births. Litter size varied significantly among breeds, but significance disappeared from the statistical model if litter size was regressed on mating weight within breeds (chi-square = 41.0, 7 df, $P < .05$ comparing the two maximum likelihood models). The regression of litter size on deviations of mating weight from breed average was significant (Table 4) over all breeds and with an increase in litter size of about .03 kids/kg of mating weight.

Birth Weight. A total of 1,147 kids born during the three seasons were used for the analyses of variations in birth weights. The weight of kids at birth was 3.24 ± .643 kg. Male kids weighed more at birth than female kids (Table 5), and birth weight decreased as

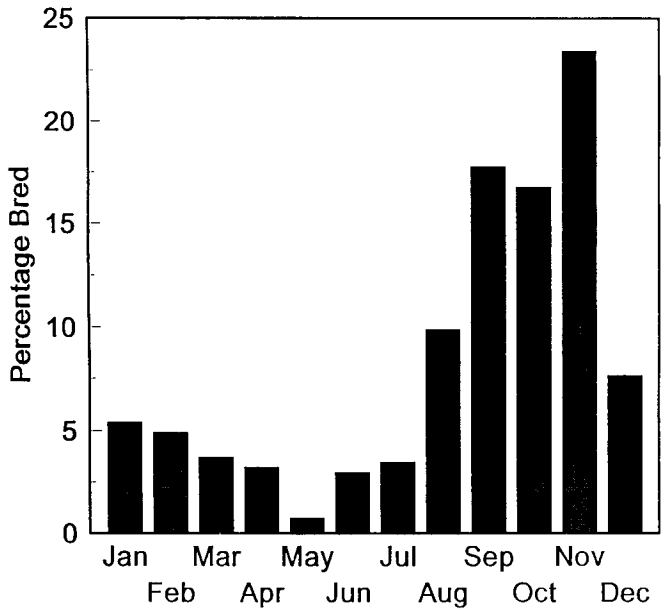

Figure 1. Frequency of goat mating in Georgia by month.

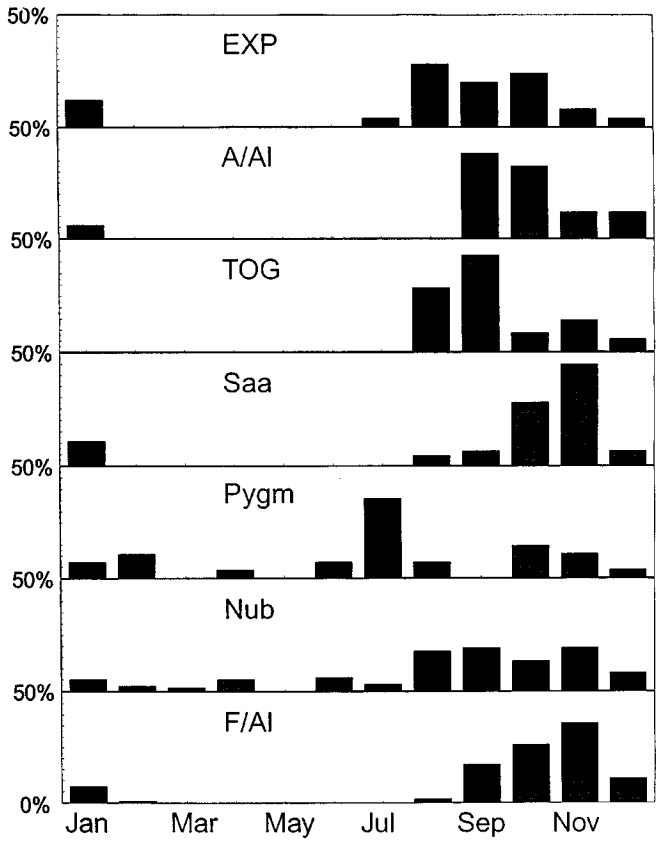

Figure 2. Percentage of goats mated in Georgia by month and breed.

Table 2. Least squares means for gestation period by breed and by mating-month and regression coefficients for gestation period on litter size and parity in Georgia goats

Effect	Class	Gestation period, d	SE	Range, d
Breed[a]	American Alpine	149.7	.7	148–151
	Dairy Crossbred	150.1	.7	148–152
	French Alpine	151.3	.5	150–152
	Nubian	151.1	.4	150–152
	Pygmy	149.4	.9	148–151
	Saanen	150.5	.6	150–152
	Toggenburg	152.1	.7	151–154
Month[b]	January	148.1	.6	147–149
	February	152.3	1.1	150–155
	March	151.1	1.9	148–155
	April	151.5	1.0	150–154
	May	—	—	—
	June	150.3	1.2	148–153
	July	151.8	.8	151–153
	August	150.7	.5	150–152
	September	151.0	.4	150–152
	October	150.6	.4	150–151
	November	150.1	.4	149–151
	December	148.4	.6	148–151
Litter size[b]	—	–.92	.19	—
Parity[a]	—	–.22	.10	—

[a]Denotes significant difference at $P < .035$.
[b]Denotes significant difference at $P < .002$.

litter size increased, by approximately .45 kg/kid ($P < .001$). Weights of kids varied among breeds, with Pygmy producing the smallest (1.7 kg) and Toggenburg producing the largest kids (3.9 kg, Table 5). Mating weights influenced weights independently of breed, with the within-breed regressions of birth weight on mating weight being significant and positive for most breeds, although varying in magnitude.

Discussion

Breeding Season. The general pattern of breeding of most goats in Georgia is similar to that of goats located in other temperate regions of the world. Goats display an endogenous circannual rhythm of biological activity that responds to day length changes (BonDurant et al., 1981, Amoah, 1982). The majority of goats in this region commenced to breed after June or July, reaching a peak from September to November when day lengths are relatively short. As day lengths increased after December, breeding of goats started to decline. Between February and June, there was negligible ovarian cycling and reproductive activity (Amoah, 1982).

Some breeds of goats have extended breeding seasons. In this study, Nubian and Pygmy breeds were

Table 3. Frequency of litter sizes in Georgia goats

Litter size	Frequency	Percentage
1	211	34.6
2	292	48.1
3	97	15.9
4	8	1.3

found to have extended (8 to 11 mo) breeding seasons. This could be due to the lack of sensitivity of these two breeds (with tropical ancestry) to photoperiod changes during the year. Chemineau et al. (1992) also showed that seasonality of estrus and ovulatory activities of the temperate Alpine goat were not modified when females were exposed to a simulated tropical photoperiod, thus indicating an insensitivity in endogenous rhythm to stimuli different from the goat's usual indigenous pattern. Goats from the tropics have been reported to be polyestrous year-round (Devendra and Burns, 1983, and Amoah and Gelaye, 1990), and it is believed that environmental factors other than the photoperiod (e.g., feed availability, rainfall, temperature and humidity variations) may affect the breeding season of tropical breeds of goat (Prasad and Bhattacharyya, 1979). There were active matings of the Nubian and Pygmy breeds during the summer in this study: matings for the Pygmy breed actually peaked in July, at a time of long day lengths when other temperate breeds show a behavior pattern ranging from a very limited to a complete absence of estrous cycling and ovulation. The behavior of the Nubian and Pygmy breeds seem to contradict the retarding effect of long day length upon breeding in temperate goats located in Georgia, a physiological behavior that is naturally possible only in goats with tropical/subtropical ancestry.

Gestation Period. Various physiological as well as environmental factors have been reported to affect the gestation period in goats and sheep (Shelton, 1960; Peaker, 1978; Amoah and Bryant, 1983; Trimnell et al., 1988; Amoah and Gelaye, 1990). In this study, the gestation period of Pygmy goats (which carried the lightest offspring) was shorter than that of Toggenburg goats (which carried the heaviest kids) (149.4 vs 152.1 d). A possible explanation is that the larger breed needed more physiological and nutritional requirements to carry kids to term. Thrift and Dutt (1969) established a relationship in blackface sheep that indicated that for each additional pound of birth weight, gestation period increased approximately .05 d. However, the irony is that gestation period declined by approximately 1 d as litter size increased from singles to twins, and further decreased as the number of offspring continued to increase. This demonstrated that as birth weight increased due to fetal numbers, gestation period declined. Both Shelton (1960) and Peaker (1978) observed similar drops in gestation period as litter size increased in goats. There is a smaller decline in days of pregnancy of .1 as twins are born instead of singles, and also a decline of .5 d for triplets instead of twins in sheep (Thrift and Dutt, 1969, Trimnell et al., 1988). The species difference could be due to the fact that the drop in litter weight as litter size increased seems to be less significant in goats than in sheep. Mishra et al. (1979) established a significant correlation (.33) between gestation period and birth weight.

December and January matings resulted in the shortest gestation period in this study. Trimnell et al. (1988) reported a similar significant effect of season of mating on gestation period in sheep; however, their finding was in the dry vs wet months. Again, as in sheep, the period of pregnancy in goats was expected to be affected by the age or parity of the doe. Trimnell et al. (1988) observed that <1.5-yr-old ewes had shorter gestation periods than older ewes (151.0 vs 151.9 d). Very early goat studies by Asdell (1929) also reported that older dairy does had a shorter period of pregnancy than younger ones. This study also demonstrated a slight increase in gestation period as parity increased.

Litter Size. The litter size for most prolific breeds of goat in the temperate region, including Anglo-Nubian, Alpine, and Saanen, has been reported to be >1.6 (Devendra, 1984). Results of this study therefore indicate that most goats in Georgia are prolific, with twins being most frequent litter size (48.1%, Table 3). Breed differences in prolificacy exist; the lightest breed, the Pygmy, had the highest litter size (2.79, Table 4), an observation also made by Devendra and Burns (1983) among the breeds they studied in the tropics.

Increase in the mating weight significantly improved the litter size of does. Sachdeva et al. (1973) concluded that a high energy diet seems to be associated with a greater proportion of multiple births, but they provided no information on doe live weight, a factor that this study found to have direct

Table 4. Least squares means for litter size by breed and adjusted for within-breed mating weight deviation in Georgia goats

Breed	Class	Litter size[a]	SE	Range
Breed[b]	American Alpine	1.9	.12	1–4
	Dairy Crossbred	1.9	.08	1–3
	French Alpine	1.7	.07	1–3
	Nubian	2.0	.07	1–4
	Pygmy	1.9	.13	1–3
	Saanen	1.7	.11	1–3
	Toggenburg	1.6	.20	1–3

[a]Regression of litter size on mating weight deviation from breed means =.033, SE = .015, P = .025. There was no evidence for heterogeneity of regression, P = .44.
[b]Significant difference, P < .028.

Table 5. Least squares means for birth weights of kids by breed adjusted for mating weight deviation from breed mean and litter size

Effect	Class		Birth weight, kg	SE	Range, kg
Breed[a]	American Alpine		3.4	.12	3.2–3.7
	Dairy Crossbred		3.3	.09	3.1–3.4
	French Alpine		3.4	.09	3.3–3.6
	Nubian		3.3	.07	3.2–3.5
	Pygmy		1.7	.14	1.4–2.6
	Saanen		3.6	.10	3.4–3.8
	Toggenburg		3.9	.22	3.4–4.3
Sex[b]	Female		3.1	.07	
	Male		3.4	.07	
Litter size[c]	Litter size	–.451	.034		
Mating weight deviation[d] within breed				[d]	
	American Alpine		.014	.006	
	Dairy Crossbred	.016	.004		
	French Alpine	.020	.003		
	Nubian	.008	.003		
	Pygmy	.013	.011		
	Saanen	.003	.005		
	Toggenburg	.024	.010		

[a]Breed, $P < .001$.
[b]Sex, $P < .001$.
[c]Regression of birth weight on litter size, $P < .001$.
[d]Regression of birth weight on deviations of mating weight from breed mean were heterogenous ($P = .05$). The pooled within breed regression was significant ($P < .001$).

significant influence on litter size. It seems that the ability to improve the condition or live weight of the doe at mating could improve ovulation rate and therefore litter size of goats, a situation that makes "flushing" a realistic part of proper management practice. Moulick et al. (1966) and Adu et al. (1979) also found positive correlations (r = .40 and .27, respectively) between the litter size and body weight of the doe. Age or parity was not found to have a significant influence on litter size of does in this study as was reported by Kim and Chung (1979) and Devendra and Burns (1983).

Depressed fertility and limited cycling were concluded to be the cause of reduced kidding rate in goats bred in February compared with those bred in April in Australia (Gherardi and Johnson, 1990). However, these authors, in agreement with our observations, did not find a direct positive relationship between season of breeding and litter size in goats as has been reported for sheep (Hendy and Bowman, 1974).

Birth Weight. The usual weight changes in the doe during pregnancy are often assumed to be indicative of prenatal development of the fetus. Significant correlations have been established between the birth weight of the offspring and the body weight of the dam in sheep (Roberts, 1970) and goats (Epstein and Hertz, 1964). In this study, mating weight, irrespective of the breed, improved the birth weight of the offspring. There was also a significant decrease in birth weight as litter size increased (.45 kg/kid). Dickinson et al. (1962) and Donald and Russell (1970) developed models that indicated that twin and triplet birth weights decline more in sheep (.78 and .62). It seems that does should be brought up to a reasonable good mating weight or condition to improve litter size and also provide good-sized offspring.

Implications

Statistics on the breeding season, gestation period, litter size, and birth weight of goats were determined. Models demonstrating how these important reproductive variables are affected by factors such as breed, month of mating, and parity and mating weight were established. The goats used in this study in Georgia seem to be quite prolific and are significant producers of milk and meat. The results presented seem to indicate that a reasonable size in litter could be achieved, with a possible two kiddings per annum (approximately 150.6 d period of pregnancy), using photoperiod or hormonal controls without compromising the ability of offspring to survive, because birth weights of goats are not severely reduced. This may be achieved with a reasonably improved maintenance program.

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