Egyptian Journal of Sheep & Goat Sciences, Vol. 5 (2), p:35-55, (2010)

FACTORS AFFECTING REPRODUCTIVE PERFORMANCE OF ZARAIBI GOATS

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ABSTRACT

A total 4601 records collected from El-Serw experimental station, Animal Production Research Institute, were used to investigate the effect of early growth rate, season of mating and age of doe at kidding on reproductive performance of Zaraibi goats. Data were analyzed using stepwise forward, univariate logistic regression analyses. Goats with birth weight lower than 1.6 kg were likely 1.2 times less to become pregnant (P<0.05) than goats with heavier birth weights. Mid-age does (2 to 6 years) were likely 1.6 times more to become pregnant (P<0.05), compared with either younger does (<2 years) or does aged more than six years. Season of mating can be considered as a significant risk factor for pregnancy rate; goats mated in fall had greater chances of getting pregnant than goats mated in summer. Mid-age does were likely half to abort (P<0.05) when compared with younger or older goats. Goats with the lowest daily gains (<86 g/d^{-1}) were at increased risk of abortion (P < 0.05). The oldest does were likely 70% more having stillbirths than younger and older does (P<0.05). The risk of stillbirth was lower (P < 0.05) in goats less than six years. The risk of stillbirth was also lower in does bred in the fall, as compared with does mated in summer. Goats with the highest body weights at 30d of age had higher odds of multiple births than goats with moderate or low weights at 30d of age. Goats bred in the fall had lower (P<0.05) odds of multiple births than goats mated in summer. The present findings indicate that reproductive success in Zaraibi goats increased with birth weight of doe >1.6 kg, body weight at 30d of age >6 kg, growth rate from birth to 30d of age higher than 150g /d^{-1}, age of doe at kidding not more than six years and breeding in fall.

Keywords: *Abortion; Stillbirth; Pregnancy rate; Litter size; Birth weight*

INTRODUCTION

Reproductive performance of goats is a major determinant of productivity and economic viability of commercial goat farms. The reproductive process is regulated by genetic and environmental factors and the net effect of all these influences determine the level and efficiency of reproduction. Fertility in healthy goat herds is influenced by prepuberal and postpartum nutrition (Bocquier *et al*., 1996), body condition (Absy *et al*., 2001) and age of dam at kidding (Erasmus and Fourie, 1985). Although goats can tolerate moderate weight losses at mating and still get pregnant (Goonewardene *et al*., 1997), more severe changes in energy intake during pregnancy markedly affect fetal survival, thus abortions and stillbirths are major causes of economic loss for the goat industry under intensive (Engeland *et al*., 1998) and extensive (Mellado *et al*., 2001) production systems. The objective of this study was to investigate the effect of some non-genetic factors associated with the likelihood of pregnancy, gestation failure, stillbirths and litter size for Zaraibi goats.

MATERIALS AND METHODS

Animal and management

Data were obtained from El-Serw Experimental Station located in North Delta, and belonging to the Animal Production Research Institute. Milk production for this breed was 253 kg per lactation of 251 day (Hamed, 2010). Goats were kept in a large semi-open barn, with a cement sheets roof. The barn was partitioned into small pens. Each

ISSN : 2090-0368 - Online ISSN : 2090-0376 (Website : www.easg.eg.net)

pen was provided with feeder designed for forage and concentrate. Goats were fed twice a day (morning and evening) on Egyptian clover from December to May. For the rest of the year they were fed on rice straw and green fodder in addition to concentrate mixture. These diets were formulated to achieve consistency of supply of energy and protein according to the physiological state of the animals (NRC Allowances). Trace-mineral mixture, common salt and clean water were always available.

Kids were reared natural. Does were allowed to breed for the first time at approximately 14 months of age. Breeding was mostly done by natural mating, exposing goats to fertile mature bucks during June and during October. Kids were identified and weighed within 24h of birth.

Data analysis

Reproductive data were obtained from records routinely kept in the farm. The records covered a period of 21 years (1987–2008). The reproductive traits of young and old goats recorded consisted of: (1) kidding rate (kidding goats divided by the number of services performed, regardless of whether or not pregnancy was established; 4601 records); (2) abortion rate (number of aborting does divided by total pregnant goats); (3) percentage of stillbirths (birth of a dead kid or a kid dead within 24 h after parturition); (4) birth litter size (including still-born kids). Additional variables measured were doe type of birth (single or multiple), average daily gain of doe from birth to 30d of age, body weight of does at birth and at 30d of age, season of mating and age of doe at kidding. Mating months were categorized into two seasons: summer (June) and fall (October). Birth weight of goats was grouped into classes of <1.6, 1.6–2.0 and >2.0 kg. Body weight of doe at 30d of age was grouped into classes of <6, 6–7 and >7 kg. Growth rate of does from birth to 30d of age was classified as <86, 86–150 and >150 g/d^{-1}. Age of doe at kidding was grouped into three classes of (young=does less than two years, mid-age = 2–6 years and old=does more than six years). Stepwise, forward univariate logistic regression analyses (SAS, 1999) was used to evaluate the likelihood of pregnancy, abortion, stillbirth, and litter size as dependent variables, given age of doe at kidding, season of mating, type of birth of doe, weight of doe at birth and at 30d of age, weight increment of doe from birth to 30d of age. Factors affecting reproductive performance were included in the statistical model. In order to discard confounding effects the variable "year" was included into the models to check for potential confounding effect associated with the year in the study. The regression coefficients between pairs of variables were used to calculate odds ratio (odds ratio = anti-natural logarithm of the regression coefficient of a dichotomous independent variable in the exponential function of the logistic regression) and its 95% confidence interval (Proc Logistic procedure of SAS, 1999).

RESULTS

Table (1) lists the factors which significantly affected the likelihood of pregnancy. Goats whose birth weight was less than 1.6 kg were likely 1.2 times less to become pregnant (P<0.05) than goats with heavier birth weights. Compared with all other animals, kids with the heaviest weights at 30d of age were 1.2 more likely to become pregnant. Goats less than 2 years old were 0.6 likely to become pregnant compared to mid-age and old does. In contrast, mid-age does (2–6 years) were 1.6 times more likely to become pregnant (P<0.05), compared to other goats. Mid-age does were half likely to abort (P<0.05) compared to younger or older goats (Table 2). The oldest goats had 50% higher odds of abortion (P<0.05) compared with the youngest does. Another factor affecting the likelihood of abortion was the daily gain from birth to 30d of age. Goats with the lowest daily gains (<86g d^{-1}) were at increased risk of abortion. In contrast, daily gains higher than

150g decreased risk of this reproductive disorder.

Goats mated in fall had lower odds (P<0.05) of abortion, compared with goats bred in summer. The oldest (>6 years) goats were 70% more likely (P<0.05) to have stillbirths than the younger does (Table 3), and the risk of stillbirth was lowest in goats aged less than six years. The risk of stillbirth was also lower in goats bred in the fall as compared with goats mated in summer. Goats with heavier body weight at 30d of age and the highest daily gain from birth to 30d of age were at increased risk of stillbirth. Goats with the heaviest body weight at 30d of age had a greater likelihood of multiple births (P<0.05) than goats with moderate or low weight at 30d of age (Table 4). Young does had (P<0.05) half likely multiple births compared to old goats. Goats bred in the fall had lower odds (P<0.05) of multiple births than goats mated in the summer.

DISCUSSION

Pregnancy

The present study showed that birth weight and weight at 30d of age play an important role on pregnancy rate of adult doe. Lighter kids at birth and at 30d of age had 20% lower odds of conceiving as adults, compared with heavier does at early life. The increased productivity of goats born as singles (heavier) over twin and multiple births has been documented by Marai *et al*. (2002). The early body weight in animal life influences on breeding circle have also been documented in red deer, where the higher the growth rate of yearlings the higher the odds of conception (Audige *et al*., 1999). In female sheep, under nutrition during late pregnancy or in early postnatal life can permanently and irreversibly reduce the lambing rates of ewes throughout adult life (Gunn *et al*., 1995). Another possible explanation of the lower fertility of goats with reduced growth early in life is the impact of low birth weight and postnatal nutrition on different body functions. For instance, low-birth-weight lambs are less mature than high-birth weight lambs in aspects of metabolic and endocrine development (Greenwood *et al*., 2002).

In agreement with other studies on dairy breeds of goats (Majid *et al*., 1993), pregnancy rate was markedly affected by season. Goats exposed to bucks during the hottest period of the year (summer) had lower odds of becoming pregnant.

Abortion

The overall incidence of abortions was 9.5% which is much lower than figures recorded for dairy goats (Engeland *et al*., 1998, Mourad, 1993 and Chawla and Bhatnagar, 1984). Age of doe at kidding was a significant risk factor for abortion. Both the youngest (<2 years) and oldest does (>6 years) group were at increased risk of reproductive disorder. Prior results on the effect of age of doe on the incidence of abortion in goats are conflicting. Under intensive conditions, some authors have found higher incidences of abortion in mid-age than in younger does (Engeland *et al*., 1998; Marai *et al*., 2002). Under range conditions, there have been more abortions among younger does than among older ones (Mellado *et al*., 2001). In the present study, the higher odds of younger does to abort suggest that drive young does to achieve mature body size has a higher physiological priority than improving reproduction performance. Moreover, the propensity of the youngest does to abort could be due to the social stress exerted by the dominant multiparous does in the mating group. In contrast, the higher occurrence of abortion in old goats, as compared with mid-age goats, is likely to result from an age-dependent decline in uterine environment and fetus quality. Low growth rate of doe from birth to 30d of age was a significant risk factor for the occurrence of abortion at adult. Metcalfe and Monaghan (2001) have documented in wild mammals, that low weight gains in early postnatal life can have pronounced consequences for subsequent

ISSN : 2090-0368 - Online ISSN : 2090-0376 (Website : www.easg.eg.net)

breeding success. The higher proportions of abortions in does with slow growth rate in early life could be the result of suboptimal growth rate during pregnancy. This would be expected because insulin tolerance is greater in light compared to heavy lambs at birth (comparison between female twin), which results in lower growth rates in animals with low birth weight (Clarke *et al*., 2000). The adverse effects of retarded development early in life on the insulin-dependent signaling pathway, which acts at the levels of cells and genes to mediate the ecological, physiological and evolutionary effects of early growth into adulthood, have been also reported by Godfrey (1998). In Addition, the inadequate rate of weight gain during pregnancy could result in the local production of prostaglandin, which triggers the events leading to a pre-term birth (Fowden and Silver, 1983). Season of mating was another important risk factor for abortion. Mellado and Meza-Herrera (2002) showed that, in a hot arid environment, high temperatures favors reproductive success of goats, their results indicated that the hottest the temperature during gestation of goats, the higher the risk of abortion.

Stillbirth

The overall incidence of stillbirth was 14.7%, which is higher than figure reported by Chawla and Bhatnagar (1984) for Alpine and Saanen goats, and Koratkar *et al*. (1998) for Osmanabadi goats. The present data have shown that stillbirth was twice as frequent in goats with more than six years as in younger does. These results are in agreement with other studies where stillbirths increased exponentially with increasing age of doe (Osuagwuh, 1991). In cattle, stillbirths are about twice more frequent in heifers than in cows (Markusfeld, 1987), and this reproductive disorder is strongly associated with dystocia (Markusfeld, 1987; Chassagne *et al*., 1999). Thus, data of the present study implies that stillbirth in goats is not a dystocia-related problem, rather the observed higher odds of stillbirth late in life is likely to result from an age-dependent decline in offspring quality. These data support the senescence hypothesis, which predicts a progressive loss of function accompanied by decreased performance with age. Goats with higher growth rates in early life and high body weight at 30d of age were at increased risk of stillbirth, compared with lighter does. These results are intriguing, because it was expected that does with a higher growth rate would provide a better uterine environment to fetuses than thinner does. Since heavier does in early life had higher odds of multiple births, the significant effect of high body weight early in life on the likelihood of stillbirth might be due to lighter fetus weights, because as number of fetuses, increases, the birth size of individual offspring decreases, and survival has been found to be size dependent. Moreover, with multiple fetuses a nutrient deficit is likely which could alter lactogenesis, parturition and maternal behavior, through changes in hormonal concentrations (Mellor, 1988).

Litter size

Goats mated in the fall were almost half as likely to present multiple births as were does mated in the hottest part of the year (summer). Other studies in hot environments also reported significant larger litters in goats mated in spring or summer, compared to the cooler seasons of the year (Lopez *et al*., 1992; Silva *et al*., 1997). In cooler environments, however, no direct relationship between season of breeding and litter size of goats has been found (Amoah *et al*., 1996). In agreement with studies on dairy breeds in temperate (Crepaldi *et al*., 1999) and arid (Erasmus and Fourie, 1985) environments, multiparous goats were more likely to have higher number of kids per birth. There is a growing body of literature in different environments which indicates that Zaraibi goats give higher odds of multiple births than some dairy goats of European origin (Majid *et al*., 1993; Amoah *et al*., 1996; Dickson-Urdaneta *et al*., 2000). High body weight at 30d of age was an important determinant of larger litter size.

1Does with a higher growth rate might consume more feed during growth, be healthier and have a better nutrient status for better reproductive performance than the goats with lower growth rates. Thus, the significant effect of high body weight early in life on the likelihood of multiple births might be due to a higher ovulation rates in heavier does. The lower ovulation rates of does with low body weight at 30d of age could be reflected under nutrition in utero, because ovulation rate is reduced in underfed compared to well-fed in utero, in adult female (Rae *et al*., 2002).

5. Conclusions

Results obtained in this study suggested that high weights at birth and early life of kids are linked to a better reproductive performance as adults. Our findings also support the idea that hot dry weather does not favor reproductive performance of goats. The results also revealed that, under Egyptian environmental conditions, higher fertility can be obtained with goats less than six years.

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Table 1. Logistic regression coefficient estimates of various factors significantly (P<0.05) associated with pregnancy of does.

Parameter	n[a]	β[b]	S.E.(β)	OR[c]	95% CI (OR)[d]
Doe birth weight (kg)					
>2.0	1410	0.08	.08	1.1	0.9–3.0
1.6–2.0	1974	0.17	.08	1.2	1.1–1.4
<1.6	1218	-0.29	.08	0.8	0.6–0.9
Weight of doe at 30 d of age (kg)					
>6	1387	0.15	.09	1.2	1.1–1.7
5–6	2028	0.04	.08	1.0	0.8–1.2
<5	1188	-0.17	.08	0.8	0.6–0.9
Age of doe at kidding					
>6	1016	0.14	.11	1.2	0.9–1.2
2–6	2536	0.48	.10	1.6	1.5–2.2
<2	1050	-.052	.08	0.6	0.5–0.7
Mating season (fall or summer)	4567	0.68	.08	2.0	1.7–2.3

a: Different number of observations among traits are due to missing data;
b: Regression coefficients for the association between non-genetic factors of does and pregnancy rate; c: OR: odds ratio; d: Confidence interval

Table 2. Logistic regression coefficient estimates of various factors significantly associated (P<0.05) with abortion of goats.

Parameter	n[a]	β[b]	S.E.(β)	OR[c]	95% CI (OR)[d]
Age of doe at kidding					
>6	955	0.39	.17	1.5	1.3-2.1
2–6	1982	-0.54	.18	0.52	0.4-0.6
<2	929	0.29	.21	1.3	1.2-2.0
Growth from birth to 30d of age (g d^{-1})					
>150	940	-0.20	.18	0.8	0.5-1.1
86-150	1293	0.08	.18	1.1	0.7-1.5
<86	1633	0.15	.19	1.2	0.8-1.7
Mating season (fall or summer)	3849	0.50	.17	1.7	1.2-2.4

b: Regression coefficients for the association between non-genetic factors of does and occurrence of abortions and see footnote Table 1.

Table 3. Logistic regression coefficient estimates of various factors significantly associated (P<0.05) with stillbirths of Zaraibi goats

Parameter	n[a]	β[b]	S.E.(β)	OR[c]	95% CI (OR)[d]
Age of doe at kidding					
>6	955	0.55	.18	1.7	1.2-2.4
2–6	1982	-0.27	.16	0.6	0.5-1.0
<2	929	-0.16	.18	0.7	0.6-1.2
Growth from birth to 30d of age (g d^{-1})					
>150	940	0.14	.18	1.2	0.8-1.7
86-150	1293	-0.22	.17	0.8	0.5-1.1
<86	1633	0.91	.16	1.1	0.8-1.5
Weight of doe at 30 d of age (kg)					
>6	1020	0.31	.17	1.3	0.9-1.8
5–6	1707	-0.15	.16	0.9	0.6-1.2
<5	1138	-0.13	.18	0.9	0.6-1.3
Mating season (fall or summer)	3834	-0.12	.18	0.8	0.5-1.1

b: Regression coefficients for the association between non-genetic factors of does and occurrence of stillbirths and see footnote Table 1.

Table 4. Logistic regression coefficient estimates of various factors significantly associated (P<0.05) with litter size

Parameter	n[a]	β[b]	S.E.(β)	OR[c]	95% CI (OR)[d]
Weight of doe at 30 d of age (kg)					
>6	1005	0.19	.07	1.2	1.1-1.3
5–6	1680	-0.09	.07	0.9	0.7-1.0
<5	1127	-0.07	.08	0.9	0.7-1.1
Age of doe at kidding					
>6	935	0.31	.08	1.2	1.0-1.4
2–6	1998	0.29	.07	1.3	1.1-1.4
<2	980	-0.54	.07	0.5	0.4-0.5
Mating season (fall or summer)	3821	-0.57	.06	0.6	0.5-0.7

b: Regression coefficients for the association between genetic and non-genetic factors of does and litter size and see footnote Table 1.

ISSN : 2090-0376 - Online ISSN : 2090-0376 (Website : www.easg.eg.net)