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Reproductive performance of local goats in extensive production systems of arid Northern Kenya

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Abstract

Goats in the arid and semi arid lowlands of northern Kenya are kept in a harsh and resource poor environment. The goats' reproductive performance is an indicator of their adaptation to the adverse conditions. A six months field study was carried out to assess reproductive performance of Gabra and Rendille goat populations in Marsabit district of northern Kenya. Reproduction data of 444 Gabra and 432 Rendille female goats (does) with 1267 and 1602 parturitions during period 1997 to 2006, was gathered using progeny history survey technique. Reproduction parameters were calculated both at the doe level (age at first birth and average kidding interval) and population level (abortion, mortality and annual reproductive rates). Main and interaction effects of goat population, goat adaptation types and number of parturitions, with the number of abortions as the covariate, were assessed in an ANCOVA model. A saturated loglinear model was fitted for the number of first births for does at different combinations of age by goat population, type of year of birth and goat adaptation type. Logit models were used in the analysis of abortions and occurrence of kid mortality by goat population, goat adaptation type, doe's parity and sex of kid (only for mortality data). Rendille goats had better reproductive performance than the Gabra goats. Most important was the higher mortality rate of 25% for kids at the age of 3 to 8 months in Gabra goats as compared to 13% in Rendille goat kids. Nevertheless the reproduction parameter values in both goat populations were similar to those observed in other pastoral systems. Management measures to reduce reproduction loss are recommended, and most importantly in health management amongst the Gabra kids where majority of the death incidences were due to diseases.

Keywords: Arid areas, goats, livestock keepers' knowledge, local breeds, reproductive performance, resource poor systems

Introduction

Goats in the arid and semi arid lowlands of Northern Kenya are kept under production conditions that are characterized by prolonged periods of annual drought, and inadequate feed and water resources. Reproductive performance has been identified as an indicator of goats' compatibility with such adverse environments (Casey and van Niekerk, 1988). A study was carried out to assess reproductive performance of two local goat populations in northern Kenya using long-term data (9 year period) and a high number of animals in order to determine parameter values that include inherent variations on production conditions. Understanding of reproductive performance is necessary especially in local goat populations under pastoral management where fast rebuilding of flocks in post-drought periods is of high importance for maintenance of the production system.

Materials and methods

The study was carried out in northeast and southwest parts of Marsabit district of Northern Kenya, occupied by the Gabra and Rendille pastoral communities, respectively. The district lies between latitude 01° 15' North and 04° 27' North and longitude 36° 03' East and 38° 59' East. During the period 1992 to 2006 Gabra and Rendille areas received a mean average annual rainfall of 215.7mm (Stdev=77.2) and 344.8mm (Stdev=177.4), and seemingly experienced similar types of years in the order of 8 and 7 good years (wet and normal years) and 7 and 8 bad years (dry years) respectively[1].

Reproduction data was collected in an eight months field survey that entailed interviewing livestock keepers on the progeny histories of 444 and 432 does, with 1267 and 1602 parturitions being realised in Gabra and Rendille goat populations, respectively. The overall reproduction period refers to the time from year 1997 to 2006. Formal group meetings with livestock keepers were also held to deliberate on the management practices that had influence on reproduction performance.

Reproduction parameters that were calculated on the doe level were age at first birth and average kidding interval, which was calculated as the doe's reproduction period in months divided by the number of its parturitions. Abortion and mortality rates were calculated at the population level. The overall kid mortality (0 to 8 months) and mortality rates for kids at 0 to 3 and 3 to 8 months old were calculated as the deaths that occurred over the number of kids alive at the beginning of each period. Annual reproductive rate for each of the goat populations was calculated as the product of the size of the litter and number of days in the year divided by the average parturition interval.

Data analysis was performed using SAS 9.1 (SAS Institute Inc., Cary, NC, USA). PROC GLM was used in the analysis of covariance (ANCOVA) for the continuous dependent variable average kidding interval per doe. Main and interactions effects of goat population, goat adaptation type[2] and number of parturitions, with covariate number of abortions per doe during its reproduction period, were assessed. Discrete response variable age at first kidding, and count variables abortions and mortality were analysed in

[1] Type of years are based on Rainfall Indexes (RI) 0.25 to 2 (wet year), -0.25 to 0.25 (normal year) and -1.5 to -0.25 (dry year), calculated for each calendar year using a procedure given by Hote et al. (2002) from partial indices of three and two locations in the Gabra and Rendille areas.

[2] Gabra and Rendille livestock keepers identify goat adaptation types (strong, moderately strong and weak) in their flocks according to goat's response to drought and dry season when lactating.

PROC GENMOD. A saturated loglinear Poisson model was fitted for the number of first births for does at different combinations of age by goat population, type of year of birth and goat adaptation type. Logit models assuming a binomial distribution were used in the analysis of abortions and kid mortality by goat population, goat adaptation type and doe's parity. Sex of kid was additionally included as explanatory variable in the analysis of mortality. Treating of pregnancies and parturitions for each doe as repeated measures made it possible to use generalised estimation equation (GEE) approach to include the doe effect on abortions and kid mortalities respectively, in the GENMOD procedure. The likelihood χ^2 (chi square) statistic for type 3 analysis was used. Odd ratios and confidence intervals were used in the evaluation of associations between the variables.

Results

Age at first birth ranged from 12 to 36 months and was similar in both populations. The proportion of first births for does at ages younger than 18 months in the Gabra goats (n=425) was 49% and in Rendille goats it was 47% (n=402). Age differences at first birth were significant in the dry years (χ^2 =25, p<0.001, saturated loglinear model) and in the wet years (χ^2 =6.39, p<0.05, saturated loglinear model). During the dry years, many of the does had their first birth at an age older than 18 months, whereas in wet years at younger age than 18 months (Table 1).

Table 1: Percent of goats giving birth for the first time during different types of years by age

Age at first birth (months)	<18	+18
Goats (n)	395	430
Dry (% goats)	3 [a]	11 [b]
Normal (% goats)	21 [a]	22 [a]
Wet (% goats)	24 [a]	19 [b]

Frequencies in rows followed by the same superscripts do not differ significantly at p<0.05; decision is based on analysis of odds ratios over age at first birth and type of years.

An overall average kidding interval for the two goat populations ranged from 6.8 to 21 months, with an overall mean average kidding interval of 10.7 months and a coefficient of variation of 20.8% (n=610). The mean average kidding interval of 11.1 ± 0.1 months (LSMeans $\pm$ S.E.; n=300) for Gabra goats differed marginally from that recorded in Rendille goats of 10.7 ± 0.1 months (n=314) (P<0.05). A significant effect was also found in does' number of parturitions (d.f =3, F value= 86.6, p<0.001). Does that had two parturitions were found having the longest average kidding interval (13.6 ± 0.2), and the shortest kidding interval among does that had two parturitions (9.5 ± 0.2). Similar parturition intervals were found in does that had three (10.4 ± 0.2) and four (10.1 ± 0.2) parturitions.

Does in both goat populations had a similar litter size of 1.02 per doe. Annual reproductive rate for Gabra goats was 1.12 and for Rendille goats 1.16.

Both Gabra and Rendille goat populations had similar abortion rates of 7% and 6%, which were recorded from 1342 and 1724 pregnancies, respectively. The abortion rates

could have been under-estimated due to some early abortions occurring unnoticed by livestock keepers.

Rates of overall mortality from birth to 8 months of age were 27.8% in Gabra goat kids (n=1257) and 16.7% in Rendille goat kids (n=1574). Especially mortality of kids at age 3 to 8 months for the Gabra goats was higher (24.5%, n=1201) than for the Rendille goats (12.8%, n=1504). Kids at the age of 0 to 3 months in both goat populations had similar but low mortality rates of 3.8% in Gabra goats (n=1249) and 3.7% in Rendille goats (n=1561). Difference in goat populations was significant for overall kid mortality (d.f. = 1, χ^2 =27.28, p<.001), and age at 3 to 8 months (d.f. = 2, χ^2 =145.8, p<0.001).

Number of deaths in kids between the age of 3 and 8 months differed significantly by sex (d.f. = 1, χ^2 =5.49, p<0.05), with mortality in males (20%, n=258) being higher than in female kids (17%, n=222). Deaths in kids dying at the age of 3 to 8 months also deferred significantly by parturitions (d.f. 4, χ^2 =26.09, p<0.001). Higher proportions were recorded for the does in their first parturition than in other parturitions.

Whereas drought was a major factor that caused deaths in both Gabra and Rendille goats, majority of the deaths that resulted from diseases were recorded in Gabra goat population (Figure, 1).

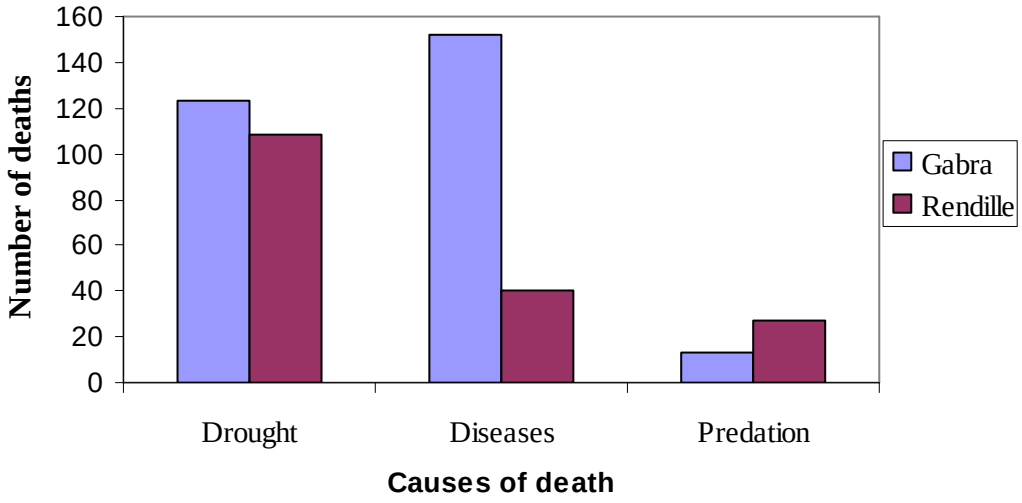

Figure 1: Causes of kid mortality at the age of 3 to 8 months

Discussion and conclusions

Using the progeny history survey technique it was possible to circumvent the common problem of lack of animal recording in pastoral systems. Pastoralists in the study area, as it has been noted in previous studies, generally possess the ability to recall dates of births and exits of goats from the flocks (Kaufmann, 2005; Mbuku, et al., 2006) This made it plausible to use a progeny history technique in the current study to collect long-term data from a relatively high number of does in a reproduction period that was characterized by good and bad years.

Delayed age at first kidding was observed in the majority of goats during the dry years, which implies that these goats had a chance to develop to full body size before first kidding. This is advantageous to the doe since dry years are characterized by feed insufficiency, long walking distances to and from water points and extended watering cycles that impact negatively on body development of does conceiving at an early age. The majority of goats kidded at an early age during the wet years, an outcome that livestock keepers were contented with. For wet seasons the livestock keepers' stipulated their aims as having high numbers of does conceiving and ensuring fast growth of kids because of the adequate supply of milk that results from the relatively high level of nutrition. Such a focus is necessary especially in building of flocks in the wet years that coincide with post drought periods.

The results show that the annual reproductive rate was only slightly higher in Rendille than in Gabra goats. This is attributed to the average kidding interval that was marginally longer in Gabra goats than in the Rendille goats. The low litter size of 1.02 kids per doe observed in the two goat populations is mainly due to low twinning rate (2.1%) caused by the overall harshness of the environment and the deliberate breeding decision of promoting single births by culling does that kid twins at first birth. Abortions in both populations led to reduction in expected parturitions. Livestock keepers experience high numbers of abortions during the short dry seasons (January and February), which is usually hotter than the long dry season. However, avoiding pregnancies in the short rainy season would increase the kidding interval, and hence livestock keepers do not avoid mating in the latter season. Mating bucks were culled during the drought periods to avoid any possible mating as pregnancies could jeopardize the life of does.

In normal years during the long rainy season occurring in March to May, Gabra livestock keepers explained that they strive at having higher mating ratio (buck: doe) of about 1:40 in order to attain high kidding rates in the following long dry season in June to October. The kids are expected to receive a sufficient amount of milk supply from does feeding on forage resulting from high biomass growth in the preceding long rains. This strategy is in agreement with the postulation of a recent study that joining of does with bucks just at the onset of long rains could produce a large number of offspring in Northern Kenya (Hary et al., 2003).

We have shown in this study that pastoralists of Northern Kenya are able to manage reproductive performance of their flocks in a harsh environment that is characterized by inter- and intra-year variations of production conditions. Average age at first kidding in pastoral systems is 17 months (Otte and Chilonda, 2002). Values of 24 months for the Afar goat in Ethiopia and Djibouti, and 30 months for the Somali/Boran goat in central Somali have been recorded (Wilson, 1991). The average kidding interval for the long legged West African goat in pastoral system was reported as 328 days (10.9 months) (Wilson, 1991). The mean kid mortality risk in pastoral areas is 27.4% (Otte and Chilonda, 2002). Therefore, the reproductive parameter values of the studied local goats are comparable to those in other pastoral systems, and this is an indication of the studied goat populations having high adaptive ability to the production conditions of Northern Kenya. Reproduction performance between the two populations, however, differed with Rendille goats having the comparative advantage of better reproductive performance.

Pastoralists of Northern Kenya have suited reproduction management of goats for the prevailing conditions, though not without some limitations that hinder realisation of optimal reproductive performance of the goats. Improvement measures should address the reproductive loss that occurs as a result of abortions during the short dry season and the high kid mortality between 3 and 8 months of age. High death incidences that result from diseases in Gabra goat kids explain the higher rate of mortality observed amongst the Gabra kids. This is an indication that improvement of goat kids' health management is of utmost importance in Gabra area. Reducing reproductive loss is especially important in the post drought years, when pastoralists need to build their decimated flocks fast.

Recent studies (e.g. Okoti et al., 2006; Ayantunde et al., 2006) have demonstrated that pastoralists have insightful knowledge of their local livestock breeds and range resource that has influence on their livestock management decisions. It would therefore be necessary to consider such knowledge while carrying out improvement measures.

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