GOAT BREEDING STRUCTURE AND REPEATABILITY OF LITTER SIZE IN SMALLHOLDER GOAT HERDS IN KANO, NIGERIA

[1]AKPA, G. N., [1]ALPHONSUS, C. [2]DALHA, S. Y. and [2]GARBA, Y.
[1]Animal Science Department, Ahmadu Bello University, Zaria, Nigeria
[2]Animal Science Department, Bayaro University, Kano, Nigeria

Corresponding Author: Alphonsus, C. Animal Science Department, Ahmadu Bello University, Zaria, Nigeria. **Email:** mcdyems@gmail.com; mcdyems32@yahoo.com **Phone:**

ABSTRACT

One hundred and sixteen (116) does from 22 randomly selected smallholder herds in Kano and environs were surveyed to evaluate the goat breeding herd structure and to estimate the repeatability of litter size. The study revealed that the average herd size of smallholder goats in the study area is 15.5 goats. The average breeding male and female per herd buck to doe ratio and litter size per doe was 1.8, 6.5, 4.9 and 1.7 kids, respectively. These characteristics were highly variable (CV = 42 – 70%). The breeding does constituted the majority (78%) of the breeding herd, which increases with herd size. The average buck to doe ratio for the goat herd was 1:5. However, a buck to doe ratio of 1:10 was observed for herd size 21-30 goats, while for herd size ≤ 10 and 11- 20 goats it was 1:3. The litter size of 1 and 2 was in the majority across the herd sizes. Litter size 4 was rare in the herds (0.3%). Herd size was significantly and positively correlated with the number of breeding males and females in the herd (P<0.01; r =0.40-0.80). The number of breeding males in the herd was significantly and positively correlated with breeding females (P<0.05; r = 0.25) but negatively correlated with mating ratio (P<0.01; r = -0.75). However, mating ratio was significantly and positively correlated with the number of breeding females (P<0.01; r=0.50). Litter size of the doe was not significantly correlated with the measured breeding herd characteristics (P>0.05; r= -0.05 to 0.04). The average repeatability in the herd was 0.41. However, repeatability of litter size decreases with increase in herd size; 0.71, 0.60 and 0.32 for ≤ 10 goats, 11-20 goats and 21-30goats herd size, respectively. The high estimates for litter size obtained in this study suggests that Kano brown goat which is the predominant breed of goats reared in the study area is a highly prolific breed and the moderate repeatability estimate is an evidence that the prolificacy is probably influenced by a single major gene suggesting that an appreciable rate of genetic response in litter size could be achieved through selection.

Keywords: Breeding structure, Litter size, Repeatability, Smallholder goats, Herds

INTRODUCTION

In Nigeria, goats are kept as an important component of farming activities, particularly by smallholder farmers. Goats had become an important aspect of animal production in Nigeria. A large number of rural households raise goats with a herd size varying from 3 to 10 heads. These herds represent more than 90% of total goat population in Nigeria (Akpa *et al*., 2000). Therefore increasing productivity of goats will contribute significantly to the improvement of the living standard of the rural people. Considering the possible improvement in productivity that has been reported due to changes in management practices (Adu *et al.,* 1988; Odubote *et al.,* 1992), genetic improvement of goats in Nigeria is imperative.

To optimize gain from environmental influences, the genetic parameters like heritability and repeatability of litter size and other attributes of the animals for economic traits should be appraised regularly to enable breeders determine the breeding tools of their choice. Understanding the concept and knowing the repeatability of these economically important traits would help considerably in deciding which animal to select or cull.

The existing husbandry management systems in tropical countries such as Nigeria are normally the result of hundreds of years of tradition (Chaniago, 1993). Goats are kept primarily for meat,

Thus production traits of interest are litter size per doe per year or the number of young weaned per breeding female per year and their growth rate (Bradford, 1993).

The knowledge of the smallholder breeding herd structure and the system of management is essential for identifying opportunities to shape the future of small ruminant production in Nigeria.

Therefore, the aim of this study was to evaluate goat breeding herd structure and repeatability of litter size in smallholder goat herd.

MATERIALS AND METHODS

Study Location: The study was conducted in Kano and environs, located within the Sudan Savannah Zone of Nigeria. The area is situated between longitude 9°30'and 12°30'North, and latitude 9°30' and 8°42' East. The climate is characterized by dry and wet seasons. The dry season stretches from October to April, while the wet season from May to September. The annual rainfall and temperature is between 787 and 969mm and 21-39°C, respectively (IAR, 2005)

Animal Management and Data Collection: Three hundred and ten (310) litter size records from 116 does randomly selected from 22 goats herds were used for this study. The animals were managed under the traditional smallholder system. They were released for grazing in the morning at 8.00am and kraaled at night. The goat houses were made using corn stalk for fencing and thatched roof for protection against heat and rainfall. The houses were open sided for adequate ventilation. There was no organized health care provision in terms of vaccination and deworming. However, veterinary officers were called to treat the animals when cases of ill-health occur. Supplementary feeding of the animals was done in the morning before turning them out for grazing and in the evening before they were kraaled. They were supplemented with groundnut hulks, beans pods, maize, millets and sorghum offals. Mineral supplements and water were also provided. The kids were allowed to run with their dams throughout the study period, and weaning was by natural means.

The study commenced with primary visits to identify individual herds. The herds were monitored regularly. Data were generated on does, herd size, number of breeding males and females per herd, mating ratio, litter size and number of litters per doe. All information obtained was used to evaluate the breeding herd structure of smallholder goat herd in Kano and its environs.

Data Analysis: The data generated were analyzed using descriptive statistics, analysis of variance and correlation analysis procedure of SAS (1999). The following categorizations were made for herd size (≤ 10, 11 – 20, 21 – 30); breeding males (1, 2, 3, 5) and breeding females (2, 3, 4, 5, 6, 7, 8, 9, 10); General linear model procedure of SAS (1999) was use to determine their effect on litter size. The model used was: $Y_{ijkln} = \mu + F_i + H_j + M_k + R_l + e_{ijkln,}$ where Y_{ijkln} observed litter size of the does, μ = overall mean, F_i = effect of i^{th} number of breeding does per herd, H_j = effect of j^{th} herd size, M_k = effect of k^{th} number of breeding bucks per herd, R_l = effect of l^{th} mating ratio and e_{ijkln} = random error.

Repeatability of litter size was determined using the variance component method as follows:

$$r = \frac{\delta_A^2}{\delta_A^2 + \delta_E^2}$$

Where: r = repeatability estimates, δ_A^2 = animal variance and δ_E^2 = Environmental variance

RESULTS

The descriptive statistics of smallholder breeding goats herd indicated that the average herd size for breeding goats was 15.5 goats. The average breeding male and female per herd, buck to doe ratio and litter size per doe was 1.8, 6.5, 4.9 and 1.7, respectively; these characteristics were highly variable (CV = 42 – 70%) (Table 1).

The breeding does constituted the majority of the breeding herd (78%) which increased with herd size; 75%, 76% and 90%, respectively for herd size ≤ 10, 11 – 20 and 21 – 30 goats, respectively. The overall average buck to doe ratio for the goat herds was 1:5. However, a buck to doe ratio of 1:10 was observed for herd size 21 – 30 goats, while for herd size ≤ 10 and 11 – 20 goats the ratio was 1:3. The litter size of 1 and 2 was in the majority across the herd sizes. Litter size 4 was rare in the herds (0.3%) (Table 2).

Herd size, breeding males, breeding females and mating ratio significantly ($P < 0.05$) influenced litter size of does. Litter size was better for herd size ≤ 10 and 11 – 20 than 21 – 30 goats. Although the number of breeding males and females significantly ($P < 0.05$) influenced litter size of the does in the herds, there was no definite trend observed. However, the best mating ratio for the smallholder goat breeding herds was 1:6 and 1:7 which produced 1.8 litters per doe. These were followed by mating ratio of 1:2 and 1:5 that produced 1.7 litters per doe. The least mating ratio was 1:9 which gave 1.4 litters per doe (Table 3).

The correlated relationship between herd size, breeding males, breeding females, mating ratio and litter size of goats indicated that herd size was significantly and positively correlated with the number of breeding males and females per herd ($P < 0.01$; r = 0.40 – 0.80) (Table 3). The number of breeding males in the herd was significantly and positively correlated with breeding females ($P<0.05$; r = 0.25) but negatively correlated with mating ratio ($P<0.01$; r = -0.75). However, mating ratio was significantly and positively correlated with the number of breeding females in the herd ($P<0.01$; r=0.50). Litter size of doe was not significantly correlated with the measured breeding herd characteristics ($P > 0.05$; r= -0.05 to 0.04).

The average repeatability in the herd was 0.41. However, the repeatability of the litter size decreased with increase in herd size; 0.71, 0.60 and 0.32, for herd size ≤ 10 goats, 11 – 20 goats and 21 – 30 goats, respectively (Table 4).

DISCUSSION

One of the most favorable attributes of goats as meat producing animals is their high rate of reproduction (Wildeus, 1996) as determined by the number of progeny delivered in a given period of time (Greyling, 2000). In this study the overall mean litter size was 1.7 kids. This value was close to those reported by Iyiola-Tunji (2008) in Red Sokoto goats, Akpa *et al.* (2004) in Red Sokoto and WAD, Sodiq *et al.* (2003) in Peranakan Etawah goat of Indonesia. However, a lower value was obtained by Alexandre *et al.* (1999) in Creole goats of Guadeloupe. The high variability of the litter size could be attributed to differences in parity of dam (Awemu *et al.,* 1994; Akpa *et al.,* 2000; Sodiq *et al.,* 2003), age of dam (Amoah and Gelaye, 1990), nutrition and management of goats (Amoah and Gelaye, 1996). Good nutrition thus enhanced good body weight had been reported to improve litter size in mature Indian goats (Sachdeva *et al.,* 1973).

In the traditional setting of Kano area in northern Nigeria where the study was conducted, majority of families own goats. The goat herd distribution showed that the average herd size was 15.5, within the range of 4 to 29 goats. This is lower than the average herd size of 19.2 in the range of 2 to 70 reported in Zaria (FAO, 2009). The herd structure in this study was 78 % females and 22 % males with average buck to doe ratio of 1:5; this was comparable to the smallholder goats herd structure in Zaria which comprised of 79.3 % females and 20.6 % males with average buck to doe ratio of 1:19.7.

Table 1: Descriptive statistics of breeding goats

Characteristics	Mean ±(se)	CV(%)	Min	Max
Herd size	15.5±0.38	43	4	29
Breeding males per herd	1.8±0.07	70	1	5
Breeding females per herd	6.5±0.13	35	2	10
Buck to doe ratio	4.9±0.15	53	2	10
Litter size per doe	1.7±0.04	42	1	4

Table 2: The distribution of breeding does according to herd size

Attributes	≤ 10 goats	11 – 20 goats	21 – 30 goats	Overall
Breeding head	48(30)	89(57)	21(13)	158
Breeding males	12(25)	21(24)	2(10)	35(22)
Breeding females	36(75)	68(76)	19(90)	123(78)
Buck to doe ratio	1:3	1:3	1:10	1:5
Litter size (LS)	83(28)	164(54)	54(18)	301
LS1	37(45)	71(43)	29(54)	137(46)
LS2	33(40)	72(44)	24(44)	129(43)
LS3	13(15)	20(12)	1(2)	34(10.7)
LS4	-	1(1)	-	1(0.3)

Figures in parenthesis are percentages

Table 3: correlated relationship between herd size, breeding male and female, mating ratio and litter size in goats

Characteristics	BM	BF	MR	Litter size
Herd size (HS)	0.07	0.80**	0.40**	-0.05
Breeding male (BM)	-	0.25*	0.75**	0.04
Breeding female (BF)		-	0.50**	-0.01
Mating ratio (MR)			-	-0.05

**= P<0.05; ** =P<0.01*

Table 4: Repeatability of litter size in smallholder goat herd

Herd size	Litter size	Repeatability
≤10 goats	1.7	0.71
11 – 20 goats	1.7	0.60
21 – 30 goats	1.5	0.32
Over all	1.6	0.41

This disparity in the mating ratio could be attributed to management differences. The number of breeding females to breeding males in this study varied from 3 to 10. This ratio is lower than the 10 to 36 ratio reported by Das and Sendalo (1990). The high preponderance of the females in the herd implied that farmers were conscious of keeping only those animals which are productive for the sake of increasing their herds.

Number of kids born per doe indicated multiple births. The goats in this study showed higher incidence of multiple births (54 %) with twinning rate of 43 %; this is slightly higher than the 40.9 % reported in blended does (Das and Sendalo, 1990). Although litter size ranged from 1 to 4, but majority (89 %) of the goats had litter size of 1 and 2, with rare cases of litter size of 4 (0.3 %). The number of breeding males increased with increase in herd size; however the number decreased as the herd size exceeded 20 goats. This is probably so because majority of the herd size > 20 goats are mostly managed semi-intensively in which some level of mating control is practiced, hence few bucks are required, unlike the traditional system of management where mating is not control and many bucks are

allowed to run with the herd. Although the determination of the buck to doe ratio depends on the type of mating practiced, Gebrelul (2003) suggested that a young, active buck can breed up to 30 does during the breeding season; he equally suggested that in pen mating, a ratio of 1:30 could be safely used. On pasture mating, depending on the area of the pasture, a 1:15 – 20 ratio can be used. As a rule of thumb a 1: 20 ratio is sufficient to ensure more than 95 percent herd fertility (Gebrelul, 2003).

The significant effect of breeding males and females on litter size is an indication of the genetic contribution of both the sire and dam to the performance of their offsprings, hence parents with high potential for twining or triplets may likely give birth to off-springs with high litter size potential, thus this trait can be improve through selection. In his study, Turner (1978) concluded that litter size seemed to be the most useful selection criterion for genetic improvement of meat production. Although selection for litter size has been successful (Clarke, 1972; Turner, 1978), the rate of improvement has not been large, partly because the trait is only observable in females of reproductive age that do conceive and maintain their pregnancy.

Herd size was less correlated with breeding males but highly correlated with breeding females. This implies that increase in herd size is more dependent on the quality rather than number of breeding males in the herd. Therefore, to ensure increase in herd size, proven sires with high potential for litter size should be used in the herd. However, herd size is highly dependent on the number of breeding females in the herds, because the higher the number of breeding females in the herd, the higher the number of the kids turned into the herd; hence the larger the herd size.

The correlated relationship amongst the herd size, breeding males, breeding females and mating ratio indicates that increase in herd size will increase the mating ratio; hence increase in breeding females will require an increase in the breeding males to meet the appropriate mating ratio.

The overall repeatability estimates obtained for litter size, in this study, was 0.41. Repeatability in this study was much higher than estimates of 0.06 for crossbred of common African goat with Alpine goat in Rwanda (Mourad, 1996), and estimates of 0.01 for Alpine goats (Mourad, 2001). The results of this study suggest that culling of unproductive animals might be the most important management practice to increase the litter size at birth.

Conclusion: The high estimates for litter size obtained in this study suggests that Kano brown which is the predominant breed of goats reared in the study area is a highly prolific breed and the moderate repeatability estimate is an evidence that its prolificacy is probably influenced by a single major gene suggesting that an appreciable rate of genetic response in litter size could be achieved through selection and or culling of unproductive animals as management practice to increase the litter size at birth.

REFERENCES

ADU, I. F., ODENIYI, A. O. and TAIWO, B. B. A. (1988). Production characteristics of a herd of West African Dwarf goats at Ubiaja, Bendel State of Nigeria. Pages 140 – 144. *In:* SMITH, O. B. and BOSMAN, H. G. (Editors), *Goat Production in the Humid Tropics.* Proceedings of a Workshop at the University of Ife, Ile-Ife, July 1987.

AKPA, G. N., DURU, S. and BAWA, G. S. (2000). The herd structure of breeding does of smallholder red Sokoto goat. *Nigerian Journal of Animal Production,* 28(2): 119 – 122.

AKPA, G. N., JOKTHAN, G. E., OGUNLEYE, K. O. and LAKPINI, C. A. M. (2004). Genetic and non-genetic sources of variation for litter size, gestation length and sex ratio in Nigerian goats. *Journal of Sustainable Tropical Agricultural Research,* 12: 66 – 70.

ALEXANDRE, G., AUMONT, G., MAINAUD, J. C., FLEURY, J. and NAVES, M. (1999). Productive performance of guadalupean Creole goats during the suckling period.

Small Ruminant Research, 34: 155 – 160.

AMOAH, E. A. and GELAYE, S. (1990). Reproductive performance of female goats in South Pacific countries. *Small Ruminant Research,* 3: 257 – 267.

AMOAH, E. A., GELAYE, S. GUTHRIE, P. and REXROAD, C. E. (1996). Breeding season and aspects of reproduction of female goats. *Journal of Animal Science,* 74: 723 – 728.

AWEMU, E. M., NWAKOLAR, L. N. and ABUBAKAR, B. Y. (1994). *The biological productivity of the Yankasa sheep and the Red Sokoto goat in Nigeria.* Department of Animal Science, University of Nigeria.

BRADFORD, G. E. (1993). Small ruminant breeding strategies for Indonesia. Pages 83 – 94. *Proceedings of a Workshop Held at the Research Institute for Animal Production.* Bogor, August 3 – 4, 1993.

CHANIAGO, T. D. (1993). Present management system. Pages 34 – 50. *In:* Monika *et al.,* (Editors). *Small Ruminants in the Humid Tropics,* UNS-Press.

CLARKE, J. N. (1972). Current levels of performance in the Ruakura fertility flock of Romney sheep. *Proceeding of New Zealand Society of Animal Production,* 32: 99 – 111.

DAS, S. M. and SENDALO, D. S. (1990). Comparative performance of improved meat goats in Malya, Tanzania. Pages 445 – 452. *In: Proceedings of the First Biennial Conference of the African Small Ruminant Research Network held at ILRAD, Nairobi, Kenya, 10 – 14 December 1990*. African Small Ruminant Research Network, ILCA (International Livestock Centre for Africa), Nairobi, Kenya.

FAO (2009). *Small Goat; Red Sokoto Goats.* Food and Agricultural Organization, Rome, Italy. ftp://ftp.fao.org/docrep/fao/009/t0376e/t0376e07.pdf.

GEBRELUL, S. (2003). *Goat Breeding and Reproduction.* Southern University Agricultural Research and Extension Center, Ashford O. Williams Hall, POBox 10010, Baton Rouge, LA 70813 USA. http://www.suagcenter.com/News%20Archives/Sept-Dec2005/GoatBreeding.html, Date accessed: June 12, 2010.

GREYLING, J. P. C. (2000). Reproduction traits in the Boer goat doe. *Small Ruminant Research,* 36: 171 – 177.

IAR (2005). *2005 Kano Weather Report.* Institute for Agricultural Research, Meteorological Station, Ahmadu Bello University, Zaria, Nigeria.

IYIOLA-TUNJI, O., ONI, O., AKPA, G. N., AFOLAYAN, R. A., ADEYINKA, I. A. and LAKPINI, C. A. M. (2008). Sex ratio and litter size in Red Sokoto goats. *In: Proceedings of the 13th Annual Conference of the Animal Science Association of Nigeria (ASAN).* September 15 – 19, 2008. Ahmadu Bello University, Zaria, Nigeria.

MOURAD, M. (1996). Estimation of repeatability of litter size of Common African goats and cross with Alpine in Rwanda. *Small Ruminant Research*, 19: 263 – 266.

MOURAD, M. (2001). Estimation of repeatability of milk yield and reproductive traits of Alpine goats under an intensive system of production in Egypt. *Small Ruminant Research*, 42: 1 – 4.

ODUBOTE, I. K., AKINOKUN, J. O. and ADEMOSUN, A. A. (1992). Production characteristics of West African Dwarf goats under improved management system. Pages 202 – 207. *In:* AYENI, A. A. O. and BOSMAN, H. G. (Editors), *Systems Goat Production.* Proceedings of an International Workshop held at the Obafemi Awolowo University, Ile – Ife, 6 – 9 July 1992.

SACHDEVA, K., SENGAR, O., SINGH, S. and LINDAHL, I. (1973). Studies on goats. I: Effect of plane of nutrition on the reproductive performance of does. *Journal of Agricultural Science,* 80: 375 – 379.

SAS (1999). *Guide for Personal Computers, Version 8 Edition.* SAS/STAT, SAS Institute, Cary, North Carolina, USA.

SODIQ, A., ADJISOEDARMO, S. and TAWFIK, E. S. (2003). Reproduction rate of Kacang and Peranakan Etawah goats under village production systems in Indonesia. *International Research on Food Security, Natural Resource Management and Rural Development.* Deutscher Tropentag – Göttingen, 8 – 10 October 2003.

TURNER, H. N. (1978). Selection for reproduction rate in Australian Merino Sheep: direct responses. *Australian Journal of Agricultural Research,* 29: 327 – 350.

WILDEUS, S. (1996). Reproductive management for meat goat production. *Proceedings of Southeast Regional Meat Production Symposium.* Feb 24, 1996, Tallahassee, Florida.