Reproduction rate in goats raised under Agro-silvo-pastoral systems in the Sudan savannah zone of Nigeria

W.A. Hassan, J. Steinbach[1] and I.Hoffmann[2]

Department of Animal Science, Usmanu Danfodiyo University, Sokoto, Nigeria.

[1]Institute of Animal Breeding and Genetics, Justus Liebig University, 35390 Giessen, Germany

Abstract

Breeding histories of 521 does covering 1,644 births over 7 years (1990 – 1996) in four village-enclaves of the Zamfara reserve in north-western Nigeria were collected, interpreted and analysed to estimate two indices for the reproduction rate of the animals. Effects of genetic and non-genetic factors on the indices were analysed using the least square procedures. The ARR I, expressed as the number of kids born per doe per year, was 1.48 ± 0.05. The parameter was influenced significantly ($P < 0.01$) by the breed of doe, parity of doe type of flock and year of birth ($P < 0.05$) of doe. The apparent pure Sokoto Red does recorded a significantly higher value ($P < 0.05$) for ARR I than their cross bred counterparts (1.57±0.07 kids versus 1.39±0.04 kids). The ARR I increased progressively from 1.13±0.05 kids in the primiparous (maiden) does to 1.79±0.10 kids in the oldest does at parity seven. Annual reproduction rate was significantly highest ($P < 0.01$) in the does kept in the village flocks, whereas the does in the transhumant agro-pastoral flocks recorded the lowest value (1.57±0.04 kids versus 1.41±0.10kids). The number of kids weaned per doe per year (ARR II) was 1.24±0.05. Similar to the trend observed for the ARR I, this was also influenced significantly by the breed of doe ($P<0.01$), parity of doe (P0.01) and type of flock ($P < 0.01$). The results of these analyses indicated that large litter size at birth, low pre-weaning mortality and shorter kidding interval are desirable to increase doe reproductive rate.

Keywords: Reproduction, goats, agro-pastoral systems, Nigeria.

Introduction

Over 90% of the 33.86 million goats in Nigeria are kept under village and pastoral systems (FDLPCS, 1992). However, most of the performance evaluation and breed improvement studies reported for goats in the country, were carried out on research farms (Molokwu and Igono, 1978; Adu et al., (1979, Ngere et al., (1979). Experimental results from such flocks hardly represent the situation in the animals' village rearing environment. It is very important to study the performance of specific economically – important production traits in different indigenous breeds of goats in their traditional production environment, particularly in the semi-arid ecological zone of Nigeria, where about 41% of the country's goats are found.

Basic information on the reproductive performance of goats raised under the traditional agro-pastoral systems is necessary for designing measures for sustainable stock management for ecological stability. The present paper therefore reports on the reproduction performance of the goat diversity in the Zamfara reserve of north-western Nigeria, as a step toward establishing a scientific basis for improved and sustainable goat production in the study area.

Materials and methods

Source of data

The data for the present study were collected from randomly selected 283 flocks with 521 does in four villages in the Zamfara Reserve, viz. Dumburum, Shamushalle, Tsabre, and Aja from July 1996 to May 1997. Located in Zamfara State in north-western Nigeria, the reserve lies between latitudes 12°10' and 13° 05' and longitudes 6° 30' and 7°15' with an altitude of about 450m above sea level. It covers an area of approximately 2,355km² and extends about 120km from north to south and about 30km from west to east.

[2]Present address: Food Production Service (AGAP), Food and Agriculture Organization of the United Nations, Rome, Italy.

The climate of Zamfara is semi-arid with a long dry and hot season. Details about the seasons, temperature, humidity, solar radiation, vegetation and soil of the reserve are reported elsewhere (Hassan, 2000). The villages on the Zamfara reserve and the surrounding settlements are inhabited by villagers and pastoralists. These groups of people keep various species of domestic animals – cattle, sheep, goats, poultry and donkeys – in that order of importance, using different but related husbandry systems (Abubakar et al. 1993). The natural vegetation of the reserve provides the basic resources for livestock keeping by its residents and pastoral ruminant production in the semi-arid zone of north-western Nigeria.

Collection of breeding histories

The Progeny History Technique was applied for the collection of breeding histories of the study does. Also called "Animal Biographies" (Swift, 1981) and "Interviewing Cows" (Armbruster and Bayer, 1992, Kassaye et al. ·1992), the technique involves recording the life history of female breeding animals and their progeny in a semi-structured dialogue between livestock owner, preferably the person who has the closest and longest contact with the animals. The purpose is to gain quickly a basic idea about herd/flock productivity. It is also possible to obtain information about ownership of the animals (e.g. contract herding for farmers, keeping of animals belonging to relatives living elsewhere, etc) and sources of purchased animals. The data provide a basis for calculating productivity parameters (fertility, mortality, age at first partiy, parturition intervals) and potential offlake, and differences in these parameters over time. This gives a dynamic picture of herd or flock development. Exploring progeny history in different herds or flocks permits a comparison of herding efficiency, management strategies and animal losses between households. It is a very useful method for collecting accurate information in a culturally – sensitive way (Iles, 1994).

The technique is cheap, relatively straight-forward, easy, to carry out and provides recall data over an extended period of time, ranging from 5 to 10 years. Progeny histories are essentially livestock genealogies which describe the fate of all the offspring of a given female animal. They provide quantitative data on the fate of all animals that have left the herd or flock. This includes information on voluntary offtake, such as number of animals sold, exchanged, given away as gifts and slaughtered for food, as well as animals that have died as a result of disease, drought, predators or other causes such as theft (Young et al., 1994). However, this method is applicable only if the livestock keepers have detailed knowledge about their animals (Waters-Bayer and Bayer, 1994).

In applying the technique, each of the study flocks was visited once, during which the histories of randomly sampled breeding does in the flock were taken in a data collection format, one fo. each doe. Basically, only the odes with breeding histories were sampled. On entering a flock, the approach was to first ask the stockowner for the oldest breeding doe in the flock for interview. In cases where the female offspring of the oldest doe were retained for breeding, some of them were also sampled. Records were taken on 3-6n does per flock. The age of each sampled doe was recorded (in months) in addition to the number and stage of teeth.

Questions asked about each doe included the age at first birth and dates of subsequent births (in months and years), size, sex and fate of the litter (that is, whether present, sold, given as gift, transferred, slaughtered, lost or dead). In cases of mortality, the cause and age of the animal were also recorded. Interviews commenced in the flocks as early as 07.00h (much earlier in the flocks of the agro-pastoralists because the goats normally follow the cattle for grazing at sunrise) and ended at a.ound 10.00h, when the does were collected for grazing by shepherds. In each village, guides were recruited locally through the village head. The guides facilitated the identification and location of stock keepers, especially in the case of the agro-pastoral flocks, which were scattered in the reserve. As an incentive, each flock was supplied with a block of salt lick at a subsidized rate of ₦120.

Interpretation of breeding histories

The month of each interview served as the reference point for translating the histories of the does into numerical data. The months of births by the does were assigned to different seasons according to the rainfall pattern in the study region (Hassan, 2000). The four seasons of birth are early dry (October-November), mid-dry (December – February), late dry (March – April) and rainy (May – September). Litter size at birth/weaning was defined as the number of kids born per doe per birth/the number of kids that survived till weaning.

Survival of litter to weaning was derived from the information given on the fate of the kids. It was considered as a discrete variable with values of 1 for singles that survived and 0 for those that died. Twin litters with only one surviving kid at weaning were scored 0.5. Quadruplet litters were grouped along with triplet litters and litter survival to weaning was scored proportionately.

The mean birth interval was calculated for each does as the difference between the age of does at first birth and its age at the last birth (as supplied in years and months by the stock owners), divided by its total number of births less one. The calculated mean birth intervals rather than intervals between subsequent births were estimated because the ages of the does at all births were not known (in most cases, only the ages of the doe at the first and last births were known). The classification of the study animals into breeds was based on the phenotypic characteristics of the animals, particular the coast colour patterns and facial profiles (Mason, 1981; Ngere *et al.* 1984).

Statistical analysis of data

Annual reproduction rate (ARR I< the total number of kids born per breeding doe per year) was calculated according to Wilson et al. (1984), while the total number of kids weaned per does of reproductive age per year (ARRII) was determined according to Gatenby (1986), that is.

Index I:

$$\text{ARR I (days)} = \frac{\text{Litter size at birth} \times 365}{\text{Subsequent birth interval}}$$

Index II

$$\text{ARR I} = \frac{\text{Litter size at birth} \times \text{litter survival to}}{\text{Subsequent birth interval (year)}}$$

Breeding histories of 521 does covering 1,644 births over 7 years (1990-1996) in four village-enclaves of the reserve were analysed. The least square procedures for data with unequal sub-class numbers (Harvey, 1987) were used for estimating the extent of systematic effects on the indices. These reproduction data. The analyses involved a series of step-down procedures before arriving at the optimal models employed. In these procedures, factors that were found not to be statistically significant and which did non-interact signi-ficantly with any other factors were dropped from the initial models. Both indices were analysed using the following fixed model that included the fixed effects of breed of doe, parity of doe, type of flock and year of birth:

$$Y_{ijklm} = \mu + B_i + C_j + G_k + T_l + \epsilon_{ijklm}$$

Where

Y_{ijklm} = estimated value,

μ = population meant

B_i = fixed effect of breed of doe (i = 1, 2);

C_j = fixed effect of parity of doe (j = 1,7)

T_l = fixed effect of type of flock (l = 1,3);

G_k = fixed effect of year of birth (k = 1,7);

ϵ_{ijklm} = the random residual effect associated with the variable Yijklm (Y_{nop}), assumed to be identically, independently and normally distributed with zero mean and constant unit variance, i.e. $\in_{ijk} \ell m\ (\in nop) \sim \text{IInd}\ (0, \delta^2)$.

Significantly different sub-class means were ranked using the results of the comparisons of their linear functions by contrast statements of the least squares procedures.

Results and discussion

Number of kids born per doe per year (ARR I)

The ARR I, expressed as the number kids born per doe per year, was 1.48 ± 0.05 (Table 1). The parameter was influenced significantly by the breed of doe ($P < 0.01$), parity of doe ($P < 0.001$), parity of doe ($P < 0.01$) type of flock ($P < 0.01$) and year of birth ($P < 0.05$) of doe (Table 2). The apparent pure Sokoto Red does recorded a significantly higher value for ARR I than their crossbred counterparts (1.57 ± 0.07 kids versus 1.39 ± 0.04 kids). The significantly shorter mean subsequent birth interval recorded for the former (378 ± 14 days) compared with the interval of 403 ± 6 days for the latter (Table 3) partly explains this result.

Table 1: Least squares means (±S.E.) for number of kids born per doe per year (ARRI) and number of kids weaned per doe per year (ARRII)

Classification	ARRI No.	ARRI LSM	ARRI S.E.	ARRII No.	ARRII LSM	ARRII S.E.
Overall	1249	1.48	0.05	1249	1.24	0.05
Breed of doe						
Sokoto Red (SR)	96	1.57	0.07^{b}	96	1.34	0.08^{b}
Sokoto Red x Sahel	1153	1.39	0.04^{a}	1153	1.15	0.04^{a}
Parity of doe						
1	448	1.13	0.05^{a}	448	0.91	0.06^{a}
2	329	1.29	0.05^{b}	329	1.10	0.06^{b}
3	209	1.36	0.06^{b}	209	1.14	0.07^{b}
4	121	1.45	0.07^{c}	121	1.18	0.08^{b}
5	62	1.64	0.09^{d}	62	1.34	0.10^{c}
6	36	1.70	0.11^{de}	36	1.35	0.12^{c}
7	44	1.79	0.10^{e}	44	1.68	0.11^{d}
Type of flock						
Village	724	1.57	0.04	724	1.44	0.05^{c}
Sedentary agro-pastoral	481	1.46	0.04	481	1.32	0.05^{b}
Transhumant agro-pastoral	44	1.41	0.10	44	0.98	0.11^{a}
Year of birth						
1990	49	1.46	0.10^{a}	49	1.30	0.11
1991	98	1.46	0.07^{a}	98	1.25	0.08
1992	163	1.41	0.06^{a}	163	1.17	0.07
1993	235	1.47	0.06^{a}	235	1.23	0.06
1994	340	1.40	0.05^{a}	340	1.17	0.06
1995	318	1.52	0.06^{b}	318	1.25	0.06
1996	46	1.65	0.10^{b}	46	1.34	0.11

The ARR I increased progressively from 1.13 ± 0.05 kids in the primiparous does to 1. 79 ± 0.10 kids in the oldest does at parity seven (Table 2, Figure 1). Progressive reduction in the mean interval between subsequent births and steady increase in the litter size at birth as the does aged as observed in the study flocks (Hassan *et al.*, 1998) reasonably account for this trend. The observed rise in the annual reproduction rate with the age of does probably advises the practice of keeping many old does in the flocks by the stock keepers.

Table 2: Least square analysis of variance for number of kids born per doe per year (ARR I) and number of kids weaned per doe per year (ARR II)

Source of variation	ARR I			ARR II		
	DF	MS	F	DF	MS	F
Breed of doe	1	3.005	8.56**	1	3.263	7.42**
Parity of doe	6	6.398	18.23***	6	6.111	13.89***
Type of flock	2	1.856	5.29**	2	5.647	12.84***
Year of birth	6	0.765	2.18*	6	0.473	1.08
Residual	1,233	0.351	-	1,233	0.440	
R^2			0.109***			0.094***

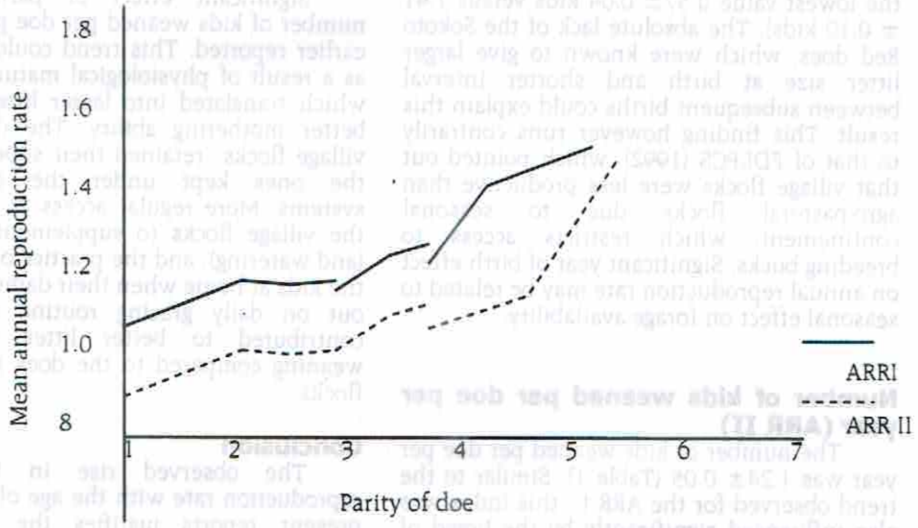

Figure 1: Mean annual reproduction rates according to parity of doe

Table 3: Least square means (±_S.E.) for components of annual reproduction rate

Trait	Overall			Sokoto Red (SR)			SR x Sahel		
	No.	LSM	S.E.	No.	LSM	S.E.	No.	LSM	S.E.
Litter size at birth	1644	1.50	0.02	132	1.59	0.05	1512	1.50	0.02
Litter size at weaning	1644	1.33	0.04	132	1.40	0.07[b]	1512	1.26	0.03[a]
Mean birth interval (days)	1249	391	8.00	96	378	14.0[a]	1153	403	6.00[b]
Litter survival to weaning (%)*	1249	88.7	0.90	96	92.2	2.7	1153	88.4	0.90

*Arithmetic mean

Annual reproduction rate was significantly highest (P < 0.01) in the does kept in the village flocks, whereas the does in the transhumant agro-pastoral flocks recorded the lowest value (1.57± 0.04 kids versus 1.41 ± 0.10 kids). The absolute lack of the Sokoto Red does, which were known to give larger litter size at birth and shorter interval between subsequent births could explain this result. This finding however runs contrarily to that of FDLPCS (1992), which pointed out that village flocks were less productive than agro-pastoral flocks due to seasonal confinement, which restricts access to breeding bucks. Significant year of birth effect on annual reproduction rate may be related to seasonal effect on forage availability.

Number of kids weaned per doe per year (ARR II)

The number of kids weaned per doe per year was 1.24± 0.05 (Table 1). Similar to the trend observed for the ARR I, this index was also influenced significantly by the breed of doe (P < 0.01), parity of doe (p <0.01) and type of flock (P <0.01) (Table 2). The survival rate of litter to weaning was very instructional in determining this index. Undoubtedly, higher survival rate in the kids born by the Sokoto Red does, coupled with bigger litter size at birth contributed positively to the higher number of kids weaned by them compared to the crossbred does. This finding necessitates on-station evaluation studies to unravel the underlying causes of better productivity of the apparently purebred does for possible ma.ximisation of returns from the animals.

Significant effect of parity on the number of kids weaned per doe per year was earlier reported. This trend could have been as a result of physiological maturity of does, which translated into larger litter sizes and better mothering ability. The does in the village flocks retained their superiority over the ones kept under the agro-pastoral systems More regular access of the does in the village flocks to supplementary feeding (and watering), and the practice of restraining the kids at home when their dams were taken out on daily grazing routine might have contributed to better litter survival to weaning compared to the does in the other flocks.

Conclusion

The observed rise in the annual reproduction rate with the age of does in the present reports justifies the practice of retaining old does in the flocks by the stock keepers. The results of these analyses indicated that large litter size at birth, low pre-weaning mortality and shorter kidding interval are desirable to increase reproductive rate. Flock management measures that will ensure these should be adopted to take maximum advantage of the prolificacy of the does under the prevailing management systems.

References

Abubakar, M.M. Hassan, W.A. and Mohammed, I. 1993. Animal husbandry systems: a survey. *In: Range Development in the Endangered Sudan Savannah in Sokoto State, Nigeria.* Research Report 1992 - 1994. pp 53 - 56.

Adu, I.F., Buvanendran, V. and Lakpini, C.A.M. 1979. The reproductive performance of Red Sokoto goats in Nigeria. *Journal of Agricultural Science (Cambridge)* 93: 563 - 566.

Armbruster, T. and Bayer, W. 1982. Quick ways to assess animal productivity: Interviewing cows. *ILEIA Newsletter* 8 (3): 25.21. 1280 (Abstract).

FDLPCS. 1992. Federal Department of Livestock and Pest Control Services. *Nigerian Livestock Resources. Vol. II National Synthesis.* Federal Government of Nigeria. 287 pp.

Ferguson, W. 1964. *The development of sheep and goat production in the northern region of Nigeria.* First FAO Africa regional meeting on Animal Production and Health. Addis Ababa, Ethiopia.

Harvey, R.W. 1987. *User's Guide for LSMIMW PC-1 Version. Mixed Model Least Squares and Maximum Likelihood Computer Program.* 59 pp.

Hassan, W.A. 2000. *Biological productivity of sheep and goats under agro-silvo-pastoral systems in the Zamfara Reserve in north-western Nigeria.* Ph.D. Thesis, Justus Liebig University, Giessen, Germany (Published. ISBN 3- 89712 - 804 -7).

Hassan, W.A., Hoffmann, I., Tukur, HM., Maigandi, S.A., Malami, B.S. and Steinbach, J. 1998. Some performance characteristics of sheep and goats in Zamfara reserve, using the progeny history technique. *In: Prospects of pastoralism in West Africa.* (ed. Hoffmann, I.) Giessener Beitrage zur Entwicklungs-forschung. Schriftenreihe des Wissens-chaftlichen Zentrums. Tropeninstitut der Justus-Liebig-Universitat Giessen, Reihe I (Symposien) Bd. 25.203 – 210.

Haumesser J.B. 1975. Some aspects of reproduction in the Red Sokoto goat. Comparison with other tropical and subtropical breeds. *Revue Elevage Medecine veterinaire Pays Tropicaux.* 28: 225 - 233.

Iles, K. 1994. The progeny history data collection technique: A case study from Samburu District, Kenya. *Rural rapid Appraisal (RRA) Notes.* 20: 71 - 77. International Institute of Environment and Development (IIED), London.

Kassaye, H. Mohammed, Y. and Girmay, T. 1992. Interviewing cows. *RRA Notes.* 15: 52-53.

Knipscheer, HC., Kusnadi, U. and De Boar, AJ. 1984. Some efficiency measures for analysis of the productive potential of Indonesian goats. *Agricultural Systems.* 15: 125-135

Mason, I.L. 1981. Goat production: Breeds. *In:* Gall, C. (ed.) *Goat Production.* Academic Press Inc. (London) Ltd. 619 pp.

Molokwu, E.C.I. and Igono, M.O. 1978. Reproductive performance and pattern in the brown goat of Nigerian Savannah zone. Proc. 4th Wld Conf Anim. Prod. Argentina [Orji, B.I., 1985].

Mtenga, L.A. Kifaro, G.C. and Belay, B. 1994. Studies on factors affecting reproductive performance and mortality rates of small East African goats and their crosses. *In:* Lebbier, S.H.B., Rey, B. and Irungu, E.K (eds.) *Small Ruminant Research and Development in Africa.* Proceedings of the second biennial conference of the African small ruminant Network, AICC, Arusha, Tanzania, pp. 69 - 74.

Ngere, L.O., Adu, I.F. and Okubanjo, I.O., 1984. The indigenous goats of Nigeria. *Animal Genetic Resource Information.* F.A.O. Rome. 3: 1 - 9.

Robinet, A.H. 1967. La Chevre Rousse de Maradi. Son exploitation et sa place dans l'economie et l'elevage de la Republique du Niger. [The Maradi goat. Its exploitation and position in the economy and livestock industry of the Republic of Nigeria]. *Revue Elevage Med. vet. Pays Tropicaux.* 20: 129 - 186.

SPSS, 1997. *SPSS for Windows Version 6. Praxisorientierte Einfuehrung in die moderne Datenanalyse* Addison-Wesley Publishing Co. Bonn. 238 pp.

Steinbach, J. 1987. Methodology of evaluating caprine ecotypes. *In:* Annual meeting of the EAAP Lisbon-Portugal. 27 Sept - 1 Oct 1987.

Swift, J. 1981. Rapid appraisal and cost-effective participatory research in dry pastoral areas of West Africa. *Agricultural Administration.* 8: 485 - 492.

Waters-Bayer, A and Bayer, W. 1994. *Planning with pastoralists: PRA and more a review of methods focused on Africa.* Deutsche Gesellschaft fuer Technische Zusam-menarbeit (GTZ). Germany. 153 pp.

Wilson, R T. and Light, D.E. 1986. Livestock production in central Mali: economic characters and productivity indices for traditionally managed goats and sheep. *Journal of Animal Science* (USA) 62 (3): 567 - 575.

Wilson, R T. and Murayi, T. 1988. Productivity of the small East African goat and its crosses with the Anglo-Nubian and the Alpine in Rwanda. *Tropical Animal Health and Production.* 20: 21 9 - 228.

Wilson, R T., Peacock, C.P. and Sayers, A.R 1984. Aspects of reproduction in goats and sheep in south-central Kenya. *Animal Production.* 38: 463 - 467.

Wilson, RT., Peacock, C.P. and Sayers, A.R 1985. Pre-weaning mortality and productivity indices for goats and sheep on a Masai group ranch in south-central Kenya. *Animal Production.* 41: 201 - 206.

Young, J., Dijkema, H-P., Stoufer, K., Ojha, N., Shrestha, G. and Thapa, L. 1994. Evaluation of an animal health improvement programme in Nepal. *RRA Notes.* 20: 58 - 65.