THE EFFECT OF INBREEDING ON PREWEANING GROWTH OF YANKASA SHEEP

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ABSTRACT

The accumulated and annual levels of inbreeding and their effects on growth traits of lambs were investigated using data collected over 11 years at the National Animal Production Research Institute, Zaria. Inbreeding level averaged 1.314% per year, cumulating to 14.45% over the years. Average individual inbreeding coefficients of offspring from sires used for more than one breeding period was 0.103% across the inbred individuals and 0.004% over all lambs. Regression coefficients of growth traits (average values per year) on inbreeding levels by year were - 0.185kg + 1.820 g and - 0.391 kg for birth weight, preweaning average daily gain and weaning weight, respectively. All regressions were not significant (P>0.005). The regression coefficients indicated that birth weight and weaning weight declined by 0.185 kg and 0.391 kg, respectively while preweaning average daily gain increased by 1.820 g. Conscious efforts to reduce inbreeding level and its effects on growth traits will greatly lead to improved productivity.

Key words: Inbreeding, effects, growth traits, Yankasa sheep.

INTRODUCTION

Inbreeding (mating of closely related animals) has been applied to some animal species (Wright, 1922; Mcphee and Spencer, 1936; Gavora *et al.* 1979) in the development of breeding stock with high prepotency, to reveal and thus make possible the elimination of hidden genetic defects, and to increase the frequency of desirable genes in the population. This process unfortunately increases homozygosity for whatever genes that are present, including the less desirable ones, with the result that merit typically declines in some traits. In such a case selection will be provided with an opportunity to act upon rare recessives.

Many researchers have examinaed the effects of inbreeding on the productivity of sheep (Hazel and Terril, 1945; Ragab and Asker, 1954; Morley, 1954; Brown et al., 1961; Doney, 1966; Ghoneim and McCarty, 1967; Lax and Brown, 1968; Lamberson *et al.* 1982; Lamberson and Thomas, 1984; Ercanbrack and Knight, 1991, Wiener *et al.*, 1992). The general consensus from the results of these works is that inbreeding leads to progressive deterioration especially with respect to important reproductive characters, lowered vigor, decreased survival rates and slower growth rates. The general effect therefore of raising the level of inbreeding may be a lowering of productivity, a phenomenon known as inbreeding depression.

Sheep production in Nigeria is largely in traditional hands with no controlled breeding and selection practices and hardly any routine introduction of new genetic stock into flocks. In any such closed flock or herd there will be a build-up of inbreeding with the consequent inbreeding depression in performance traits, unless deliberate attempts are made specifically to avoid mating close relatives (Dalton, 1981). When the mating plan is devised to give the maximum avoidance of inbreeding the rate of increase in homoxzygosity is drastically reduced. Consequently, the closing of a flock or herd does not automatically mean that a high level of inbreeding will develop (Legates and Warwick, 1990). With several sires and relatively few new sires each year, a flock or herd can be closed for a good number of generations before the average inbreeding reaches a high level.

The sheep is an important source of meat and liquid cash to the rural farmer and its productivity needs to be increased through improved husbandry and breeding strategies. The objective of this study was to determine the level, rate and effects of inbreeding on preweaning growth traits of Yankasa sheep, the most numerous and widely distributed sheep in Nigeria.

MATERIALS AND METHODS

Flock Management:

Data collected from 1983 through 1993 from the Yankasa sheep breeding project of the National

Animal Production Research Institute (NAPRI), Shika, Zaria were used for the investigation. Shika is located within the subhumid zone with mean annual precipitation and temperature of 1107 mm and 24.4°C, respectively. Forage availability follows the distribution of rainfall with abundant and good quality forage in the early and late wet seasons.

Animals were managed semi-intensively. An accelerated lambing programme is practised on the flock aimed at increasing the number of lambings during the lifetime of an ewe. Breeding males and females were selected based on growth rate and litter size. Less productive dams were culled at the end of each breeding season based on a fertility index which considers the dam's present and previous records in relation to those of its contemporaries. Yearling lambs were used for breeding and were replaced after each mating season, to reduce generation interval and inbreeding. However, the best 2 or 3 rams may be retained for a second breeding season. Of the 110 sires used throughout the period under study, only 10% were used for more than one breeding season. Also to minimize inbreeding, not more than 3 ram lambs per sire were selected as future sires. Mating ratio was about 1 male: 7 females. All animals in the flock were properly identified by means of ear tags for record keeping. Following parturition, lambs were allowed to run with their dams until about 90 days of age when they were weaned.

Data collection and analytical procedures:

Information for the study were extracted from breeding and pedigree records of individual animals. Traits of the lamb considered were; birth weight, preweaning average daily gain and weaning weight. The accumulated inbreeding of the flock was calculated based on the number of breeders used each year. Pedigree information was incomplete for the year 1991 so only dam information was used in calculating inbreeding level for that year. Wright (1931) has shown that approximately 1/8 Nm + 1/8 Nf of the heterozygosity present in a closed population would be lost each generation i.e. the proportion of the loci that are heterozygous that would be expected to have become homozygous each generation. Thus the formula of Wright as presented by Turner and Young (1969) and Gavora et al. (1979) was used in calculating accumulated inbreeding:

$$F'x = \sum_{i=1}^{t} \Delta Fi$$

$$= \frac{1}{8}\left[\sum_{i=1}^{t} \frac{1}{N_{mi}} + \sum_{i=1}^{t} \frac{1}{N_{fi}}\right]$$

where

$F'x$ = accumulated inbreeding

Fi = change in inbreeding estimated in year i

N_{mi} = numbers of male breeders used in year i

N_{fi} = number of female breeders used in year i

t = generation or year

Individual inbreeding coefficients were estimated for progenies of the 11 sires that were used for more than one breeding period in the flock. The method used was Wright's method of path coefficients as presented by Lush (1945):

$$Fx = \sum\left[\left(\frac{1}{2}\right)^{n+n'+1}(1 + Fa)\right]$$

where

Fx = coefficient of inbreeding of individual X

n = number of generations from the sires of X back to some ancestor common to both sire and dam

n' = Number of generations from the dam of X to the same common ancestor

Fa = Coefficient of inbreeding of the common ancestor

Effects of inbreeding on traits were evaluated by the regression technique.

RESULTS AND DISCUSSION

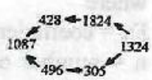
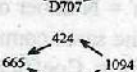
The level of inbreeding per year, accumulated inbreeding over years and means of growth traits over years are presented in Table 1. Inbreeding levels did not follow any consistent pattern and were determined by the number of breeders used each year. The more the number of breeders, the lower the inbreeding level. Thus, the coefficient of breeding ranged from 0.56% (25 sires vs 227 dams) to 2.52% (7 sires vs 17 dams), with an accumulated inbreeding coefficient over all years of 14.45%. Average individual inbreeding coefficient of offsprings from sires used for more than one breeding period was 0.103% over inbred

TABLE 1: INBREEDING AND MEANS OF GROWTH TRAITS IN 11 YEARS OF BREEDING YANKASA SHEEP

Year	No. of sires	No. of dams	No. of offspring	Fx(%)	F'x(%)	*Birth weight (kg)	*Preweaning average daily gain(g)	*Weaning weight(kg)
1983	7	72	97	2.00	2.00	2.71	98.52	11.58
1984	11	96	129	1.27	3.27	2.58	99.32	11.52
1985	17	108	145	0.85	4.12	2.57	93.40	10.97
1986	18	91	122	0.83	4.95	2.66	86.33	10.43
1987	24	102	141	0.64	5.59	2.54	102.66	11.79
1988	25	227	397	0.56	6.15	2.54	82.70	9.98
1989	18	79	100	0.85	7.00	2.83	96.73	11.54
1990	8.	37	50	2.00	9.00	2.36	84.97	10.00
1991	—	90	121	1.11**	10.11	2.09	85/60	9.96
1992	8	49	66	1.82	11.93	2.47	78.43	9.53
1993	7	17	23	2.52	14.45	2.00	103.85	10.05

Fx = Level of inbreeding per year; F'x = Accumulated inbreeding.
*Average values per year; ** Based on dam information only.

TABLE 2: INDIVIDUAL INBREEDING COEFFICIENTS FROM OFFSPRING OF SIRES USED FOR MORE THAN ONE BREEDING PERIOD

Sire tag	No. Of offsprings	No. Inbred	Path diagram	Fx	F'x	F''x
202	12	1		0.125		
428	19	1		0.031		
424	52	3		0.125		
				0.125		
				0.063		
1095	37	1		0.125		
1630	9	1		0.125		
226	5					
248	8					
305	13					
D952	15					
1620	14					
961	9				0.103	0.004

Fx = Individual inbreeding coefficients
F'x = Average inbreeding coefficient over inbred individuals
F''x = Average inbreeding coefficient over all lambs

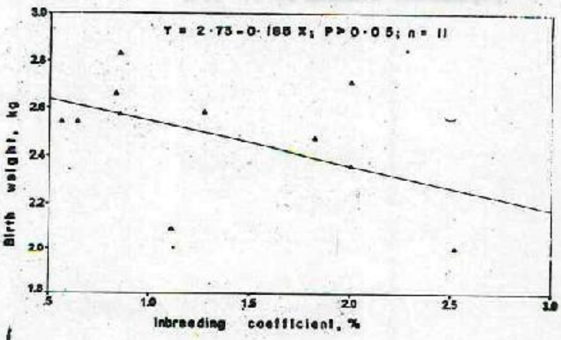


Fig. 1. Relationship between birth weight and inbreeding coefficient

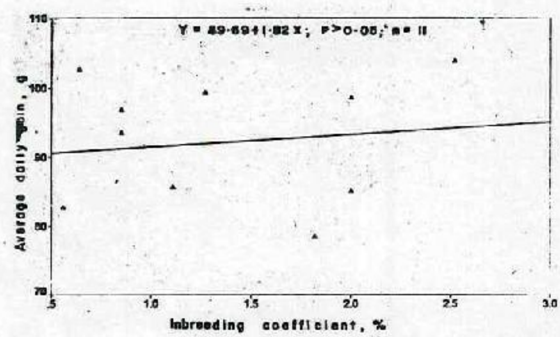


Fig 2. Relationship between preweaning average daily gain and inbreeding coefficient

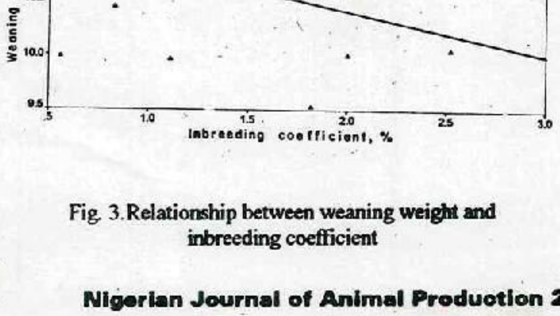


Fig. 3. Relationship between weaning weight and inbreeding coefficient

ividuals and 0.004% across all lambs (Table 2). Regression coefficients of growth traits (average values per year) on inbreeding levels by year were -0.185 kg, +1.820 g and -0.391 kg for birth weight, preweaning average daily gain and weaning weight, respectively (Figures 1,2 and 3). The regression coefficients indicate that, for every 1% increase in flock inbreeding, birth weight and weaning weight declined by 0.185 kg and 0.391 kg, respectively and preweaning average daily gain increased by 1.820 g. The positive coefficient for preweaning average daily gain is rather surprising because it was expected to follow a similar trend as birth weight and weaning weight since it determines the gain from birth to weaning. However, all regressions were not significant ($P > 0.05$).

The above results indicate that the inbreeding level in the Yankasa flock was obviously low and affected growth traits very little, owing to the strict measures taken to avoid matings of closely related animals. In the few cases of inbred individuals, the parents were most commonly related as halfsibs, a situation which did not continue to the next generation due to replacement of all male breeders after each generation.

The absence of significant detrimental effects of inbreeding on growth traits found in this study may be due to the low level of inbreeding in the flock. Also, positive response to selection combined with an excellent nutritional environment could have masked any negative effects of inbreeding on these traits, Ragab and Asker (1954), Brown et al., (1961) and Lamberson et al., (1982) also reported a non significant effect of individual inbreeding on birth weight and weaning weight of lambs. Lax and Brown (1968) however observed a significant decrease (0.015 kg) in birth weight of lambs with every 1% increase in inbreeding lamb. Reductions in weaning weight of up to 0.170 kg and 0.116 kg with every 1 % increase in individual inbreeding have been respectively reported by Hazel and Terril (1945) and Ghoneim and McCarty (1967). It is concluded from this study that the harmful effects of inbreeding on livestock productivity can be consciously avoided by breeding and management practices.

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