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The Reproductive Performance of Sheep Carrying Natural Infections of Gastro-Intestinal Nematodes

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Abstract: Reproductive performance of a flock of 63 ewes carrying natural infections of gastrointestinal worm burdens was studied. Parameters monitored included: ovarian activity through progesterone profiles, parturition intervals, birth weights, mortality rates of offspring and worm burdens through faecal egg counts. Mean lamb birth weight was 2.6±0.48, litter size was 1.1 lambs and up to 50% of the ewes lambed two or more times within the 18 month period. Twining rate was 6%, with 4.5% abortions and a mortality rate of 37% up to three months of age. There were significantly less lambs born in the late wet season, than any other season, lambing percentages being 9.9, 23.3, 25.9 and 38% for the late wet, late dry, early wet and early dry seasons, respectively. Mean lambing intervals was 192±7.5 days in 17% of ewes and 220±10.4 days in another 34.8% of the animals. The remaining 47.8% had mean LI of between 250-349 days. EPG was significantly lower ($p<0.05$) in ewes with mean LI of 192 days (5025EPG) but was not significantly different in ewes with longer LI. EPG ranged from 13011 to 16317 in these groups. Progesterone profiles showed that long lambing intervals was due to delayed resumption of ovarian activity post partum. In addition to seasonal variation in availability of quantity and quality of feed, helminthosis may have an effect on reproductive efficiency in sheep, mediated mainly through effects on body condition which ultimately affects re-breeding intervals.

Key words: Gastrointestinal nematodes, reproductive efficiency, sheep

INTRODUCTION

Tropical breeds of sheep are not seasonal breeders, like temperate breeds although breeding can be controlled so that lambing takes place at the most suitable time of the year by timed introduction of the rams (Osinowo, 1982) Any seasonal lambing peaks have been attributed primarily to nutrition linked to local variation in rainfall, vegetation, growth and availability of forage (Regassa *at el*., 2006). However the humid and sub-humid environments also enhance the reproductive life cycle of parasites and gastrointestinal (GIT) nematodes are among the commonest causes of poor productivity and profitability in tropical climates (Chiejina, 2001; Behnke *et al*., 2006). In most of the agro-ecological zones of Nigeria, *Haemonchus contortus* and *Trichostrongylus colubriformis* are the dominant nematode species and are invariably implicated in field outbreaks of parasitic gastroenteritis (PGE) in sheep and goats (Chiejina, 1987; Ajanusi and Ogunsusi, 2002). Under the traditional system of production, PGE in general and haemonchosis in particular, manifest as chronic and mostly subclinical syndromes, which often go unrecognised and untreated by the farmers (Fakae, 1990). Breeding is also not controlled and rams are run with ewes such that breeding takes place at any time of the year. The high susceptibility of the breeding ewe to GIT parasitism due to a breakdown of immunity is well

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documented (Waller and Thamsborg, 2004). For tropical breeds this means that the ewe spends at least a third of each year in this immunocompromised state since breeding occurs throughout the year. Reduced fertility of ewes, does and cows, low milk production, high rates of stillbirths and abortions, as well as reduced birth weight of the progeny born to infected animals as a result of GIT helminth infections have been reported for many tropical breeds (Mckay, 1980; Khallayoune and Stromberg, 1992; Berrag *et al*., 1994; Waruiru *et al*., 2005; Githigia *et al*., 2005) Although emphasis has been placed in these studies on the positive effect of anthelmintic treatment on productivity of sheep, no data are available with regard to the reproductive performance of untreated breeding animals. The aim of this study is to access the impact of natural gastrointestinal nematode infections on reproductive parameters in breeding Yankasa sheep.

MATERIALS AND METHODS

Study Area

The study was conducted in 1997, at the National Animal Production Research Institute (NAPRI) Shika, Zaria. The area is located on altitude 11° 12'N and longitude 7° 37'N with al altitude 610 and annual rainfall of 1107. The climate of the area is sub humid while the vegetative zone is Northern Guinea savannah. Rainfall is distributed in such a way that the year can be divided into four seasons namely late dry (Jan-March), early wet (April-June; late wet (July-Sept) and early dry (Oct-Dec).

Animals and Management

A flock of 63 Yankasa ewes aged between $1^1/_2$ to 3 years old, carrying natural gastrointestinal infections, were used for the experiment. They were continuously run with rams of same breed equipped with marking harnesses. The animals were housed in concrete floor pens which were cleaned daily and were grazed on improved pastures and supplemented daily with a 15% crude protein concentrate mixture fed at the rate of 0.3-0.5 kg day^{-1} depending on physiological status. Water, hay and mineral salt licks were provided *ad lib*.

The ewes received adequate veterinary care, which included vaccination against pest de petit ruminants, treatment against common haemoparasites with long acting Terramycin and dipping against ectoparasites at the appropriate times. They did not receive any anthelmintic treatment during pregnancy and parturition.

Experimental Design

The study was conducted for a period of 18 months. The animals were run and maintained as one flock grazing the same pastures. Data were also collected from another flock of 300 Yankasa ewes from the NAPRI Sheep Breeding Project which received regular anthelmintic treatments. The data from these animals were meant to serve as comparable data on reproductive characteristics of Yankasa sheep. The Sheep Breeding Project of the Institute covers 50 ha of grazing land divided into paddocks with improved pasture. All sheep were managed under a semi-intensive system similar in all ways to the way in which the experimental animals were managed with the exception that the Sheep Project animals received regular anthelmintic treatments. The occasional salvage treatment, with albendazole (5 mg kg^{-1}), was given to individual animals in the experimental flock to prevent death. Animals given a salvage treatment were included in analyses.

Progesterone Radioimmunoassay

After parturition blood was collected once a week by jugular venupunture uptill the animal became pregnant again or for up to 6 months post partum if it did not conceive during the interval. Ethylenediamine tetra-acetic acid was used as anticoagulant. Radioimmunoassay (RIA) technique for Progesterone (P_4) level determination (Oyedipe *et al*., 1986) and non-return to estrus by 21 days after natural breeding by the rams were used to diagnose pregnancy in the ewes.

Reproductive Indices

- Normal ovarian function was assumed in sheep which showed progesterone concentrations above 0.2 ng mL^{-1} in two consecutive samples with concentrations at or near the baseline in the following sample. The occurrence of acyclicity was assumed when progesterone concentrations were below 0.2 ng mL^{-1} in at least two or more consecutive samples. Pregnancy was assumed in the ewes with the finding of progesterone concentrations in excess of 1.0 ng mL^{-1} for 4 consecutive weeks and confirmed by eventual lambing of the animals.
- Interval between lambing: was calculated from the day of one lambing to the day prior to the day of the next lambing. Data from 46 ewes with complete birth records and progesterone profiles were selected for analysis to determine the mean and distribution of lambing intervals. From consecutive lambing dates and progesterone profiles, the parturition to conception intervals were calculated for ewes that parturited two or more times.

Faecal Egg Counts

Faecal helminth egg count was done by the modified Macmaster technique (MAFF, 1986) EPG was taken bi-weekly throughout pregnancy and weekly at parturition till six months post parturition.

RESULTS

Reproductive Indices

Mean lamb birth weight for animals in this study was 2.6±0.15, fecundity of the ewes was 1.0 lambs and abortion/stilbirth rate was 4.5% Ewes from the NAPRI Sheep project that received regular anthelmintic treatments had better reproductive characteristics than the experimental untreated ewes (Table 1). Lambing was fairly evenly distributed between the seasons but with significantly ($p<0.05$) lower lambings in the late wet season, values being 9.5, 23.3, 25.9 and 38%, respectively for the late wet, late dry, early wet and early dry seasons. In 46 ewes in which complete lambing records could be collected, over 50% of the ewes conceived again within 60 days after the last parturition (Table 2). Over 87% of conceptions occurred during the months June-February and only 12.8% occurred during the hot dry months of March-May.

The distribution of lambing intervals is shown in Table 2. The overall man lambing interval was 241±45.5 days. About 17% of ewes had Lambing Intervals (LI) of less than 200 days with a mean of 192±7.5 days, (short LI ewes) while 35% had an average lambing interval of less than 240 days (mean 220.4 ±10.4 days), these were regarded as (intermediate LI ewes). A further 39% had average lambing intervals of 259.3 ±17.3 days (long LI ewes) and 8.7% had mean lambing intervals of 349 ±46.9 days (abberant LI ewes).

Table 1: Reproductive characteristics of Yankasa Sheep carrying untreated worm burdens compared with treated flock

Characteristics	Experimental flock	Control flock
Birth weight	2.6	3.20
Litter size	1.0	1.25
Twinning rate	6.0%	12.00%
Mean Lambing interval	241.9±46	-*
Abortion/Still birthrate	4.5%	1.14%
Mortality rate(within 90 days of birth)	37.4%	14.00%

*: Not done

Table 2: Lambing, parturition to conception intervals and helminth egg counts of sheep carrying natural infections

% of Animals	Mean lambing intervals (days)	Mean parturition to conception intervals (days)	Mean eggs per gram (EPG)
17.4	192.0±7.50	42	5025±4441
34.8	220.0±10.4	75	13011±6959
39.1	250.0±17.3	108	16317±2315
8.7	349.0±46.9	178	12555±3914

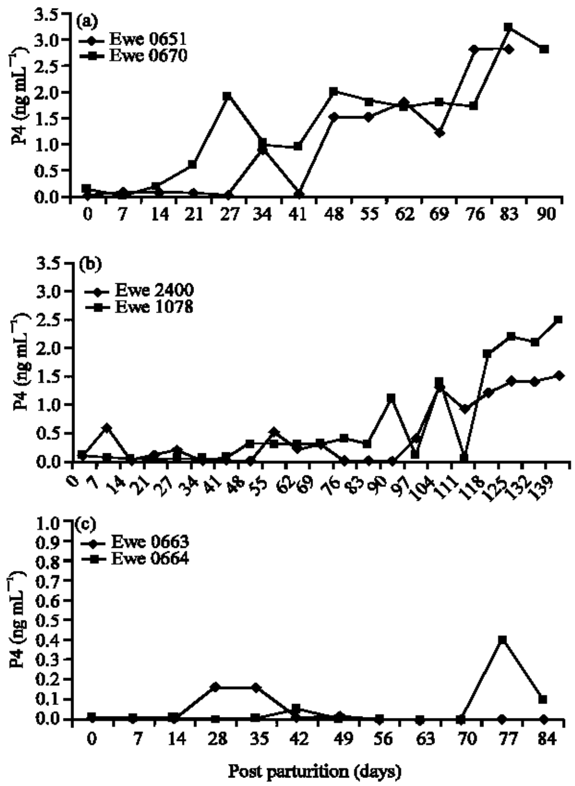

Fig. 1: Parturition to conception interval as shown by Progesterone profiles. Each figure is a prototype of two animals in that category. (a): short LI ewes with ovarian activity 3-4 weeks post partum, (b) intermediate LI ewes with ovarian activity 5-9 weeks post partum and (c) anoestrus ewes with basal P_4 levels all through the study

Analysis revealed that there was no significant changes in egg count until a few weeks before parturition (periparturint period). Therefore to reduce the bulk of the EPG data only the data for egg counts in the six weeks before and six weeks after parturition were used as the mean egg count for each animal. Mean egg counts were significantly lower ($p<0.05$) (5.025 epg) for the ewes with short parturition intervals while mean egg counts for ewes with intermediate and long intervals were 13,011 and 16,317 epg, respectively; did not show significant difference with 12,555 epg in the abberant LI ewes. There were wide individual variations but generally the ewes with longer parturition intervals had higher mean egg counts.

Mortality to 3 months of age in the experimental flock was 37.4 and 14% in the experimental and control flocks, respectively with 15% of lambs born to ewes in the Experimental flock dying within the first week of life. Lamb mortality was highest in the late wet and harmattan months.

Progesterone Profiles

The parturition to conception lambing intervals as shown by P_4 profiles exhibited by sheep in this study are shown in Fig. 1a-c and fall into three broad categories. Figure 1a-c is a prototype of 2 animals in each category.

The first category is depicted in Fig. 1a. and represent ewes which resume ovarian activity as early as 3-4 weeks post partum, these exhibited P_4 profiles, with basal values between P_4 peaks which then became consecutively elevated; coinciding with oestrus, conception and pregnancy.

The second category consisted of ewes with long parturition intervals (Fig. 1b,) characterized by 6 weeks or more of basal P_4 level following parturition. This was recognized clinically as temporary anoestrus. The third category of ewes were those which after one parturition, exhibited basal P_4 levels and were not pregnant up till the end of the study (Fig. 1c) and these were recognised as being anoestrus altogether.

A fourth category of ewes (not shown) are some ewes which had exceptionally long (>400 days) parturition intervals. Their P_4 pattern suggest that they were pregnant but since the animal was not known to have lambed, may have aborted undetected in the field.

DISCUSSION

These results suggest that the reproductive potential of Yankasa sheep does not receive full expression as a result of malnutrition and helminthosis interactions in the tropics. The benefits from controlling GIT parasites can be seen in the higher reproductive values obtained in the flock of Sheep project ewesis that received regular deworming. The lower abortion and mortality rates in treated ewes agrees with that reported by (Berrag *et al*., 1994; Pandey *et al*., 1984) and the improved birth weights and growth rates of offspring of treated ewes and does (Gatongi *et al*., 1997; Thomson *et al*., 2000). The abortion/stillbirth rates recorded in this experiment represent only foetuses seen inside the sheep pens. The possibility of foetal reabsorption or of aborted foetuses being missed cannot be ruled out. This is supported by the fact that P_4 profiles of some animals were consecutively high, reaching up to 7.3 ng mL^{-1} for several weeks only to come down abruptly without any recorded parturition or abortion. In the case of a hypophagic parasite like *Haemonchus* severe maternal anaemia can cause foetal hypoxia which may precipitate abortion or foetal death.

Only 13% of the lambings took place in the late wet season while being fairly evenly distributed in the other seasons. To lamb in the late wet season (July-Sept) animals must conceive in March-May which is the late dry season, a period associated with scarcity and low quality of forage. (Leperre *et al*., 1992). This, coupled with worm burdens may have contributed to poor body condition and hence poor conception rates at this period. Sub-optimal nutritional status exercebated by parasitism have been reported as a cause of reduced fertility rates in sheep and goats, Gatongi *et al*., 1997; Regassa *et al*., 2006) as well as in cattle (Okelly *et al*., 1988; Agyemang *et al*., 1991) in tropical environments. The observation of shorter lambing intervals in animals carrying light worm burdens is consistent with the findings of Gatongi *et al*. (1997) who reported that conception occurred as early as 33 days post parturition, with significantly shorter lambing and kidding intervals in both sheep and goats with light helminth infections. They also recorded first births as early as 11 months in ivermectin treated groups and as late as 24 months in the untreated groups.

The overall mean parturition interval of 241 days with a range of 182-418 showed that parturition intervals were short in a small number of animals but extended in some ewes. Only 52% of conceptions had taken place 75 days after lambing, with 17.4% having PI intervals of less than 200 days. Osinowo (1992) had recommended that 80% of conceptions take place 5-8 weeks (35-56 days) after lambing in order to achieve an acelerated twice yearly lambing programme in the same breed. This means that under the twice yearly lambing programme for improved sheep production at NAPRI only the 17% of ewes with parturition intervals of 200 days or less qualify for selection. This is also the same ewes that had low worm burdens and with EPG of about 5000. P_4 profiles confirmed long anoestrus periods and conception intervals in a number of ewes that had high helminth egg counts. Although Thomson *et al*. (2000) observed no significant effect of ewe treatment on ewe fertility, we agree with the postulation of Okelly *et al*. (1988) on the influence of parasitism on fertility of heifers carrying moderate burdens of parasites. They postulated that calving rates would be lowered when the interactions between nutrition and infection prevented the attainment of a target mating weight. In the Northern region of Nigeria where most of the nation's livestock are concentrated, the long and pronounced dry season are also accompanied by rapid deterioration in the nutrient quality of available pasture hence, the basic nutritional requirements of the animals during pregnancy or lactation are not met (Malau-Aduli *et al*., 2004). Though the animals in this experiment received supplementary feeding the untreated helminth infections caused a considerable periparturient increase in egg counts coupled with anaemia and weight loss in the animals (published elsewhere). It appears that the development of immunity during the periparturient period competes with live-weight gain for limited essential resources. Late pregnancy and lactation impose a drastic increase in the nutrient requirements in mammals and the break-down in immunity in the periparturient ewes has been attributed to the scarce supply of metabolisable protein at such times of increased demands (Houdijk *et al*., 2001).

They argued that the expression of immunity to gastrointestinal parasites competes with other bodily functions when nutrient resources are scarce. Animals will invariably give priority, when the nutrients are scarce, to nutrient allocation to the maintenance of body protein, since this guarantees the individual's survival in the short term. It is proposed that growth and reproduction, which ensure the survival of the species in the long term, are given the second-highest priority. These priorities are not absolute but rather partial or graduated. This implies that functions such as the increment of maternal body weight and expression of immunity to gastrointestinal parasites have a relatively low priority for the allocation of scarce nutrients. Emaciation and the consequent hypoglycemia when they set in are thought to affect ovulation rate by affecting energy needed for the release of gonadotrophic-induced LH release (Osburn and Kennedy, 1981). Energy balance and supply is increasingly being recognized as an important factor in the immune response (Lord, 2002) as well as in reproduction.

Apart from having a low reproductive rate, heavily infected ewes are also more likely to neglect their lambs which would then die of hyponutrition. This may account for the high mortality of lambs in the first week of life, observed in this experiment. This is in agreement with the findings of Mandonneta *et al*. (2005) who highlighted a relationship between the severity of peri-parturient rise and the maternal stress on the doe. This stress they pointed out would lead to reduced intensity of milk production. Through lower milk intake (associated with high infection levels in the doe) kids may have been forced to graze earlier and thus receive greater larval challenges that impaired growth, while experiencing an inferior protein intake Thus, controlling intensity of peri-parturient rise in FEC may have direct and indirect consequences on does' and kids' health and productivity. This effect may be higher in flocks reared under tropical climatic conditions where helminth infections are more severe.

In conclusion, strategic gastrointestinal parasite control, aiming for threshold levels of less than 5000EPG, combined with supplementation in late pregnancy and lactation would have a positive effect on reproductive parameters in ewes. Improved nutrition through all seasons would not only modulate the immune response to the periparturient increase in egg counts but would also put the ewes in good body condition that would provide for a short lambing to conception interval, improved lambing rate and lamb birthweight as well as less reproductive wastage. This has clear implications for grazing animals, particularly their nutritional management in late pregnancy and lactation and provides a simple management strategy that is sustainable. However, more data is needed to confirm threshold level of infection that would affect reproduction in different breeds. This study supports the growing body of evidence that parasite control improves reproductive efficiency in sheep.

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