Original Research

Influence of Season of Lambing on Postpartum Interval to Ovarian Activity in Djallonke Ewes

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Abstract

This study was conducted to estimate the influence of season of lambing on the postpartum interval to return of ovarian activity, conception and subsequent lambing (lambing interval) among 78 Djallonke ewes reared on-station in the Guinea Savannah zone of Ghana. Serum progesterone measurements were used to determine the postpartum return to ovarian activity for ewes lambing in two major seasons; the rainy and dry seasons. The results showed that Djallonke ewes resumed ovarian activity 63.7±2.7 days postpartum and conceived by 97.4±4.2 days postpartum, achieving a mean lambing interval of 249 days. Ewes lambing in the rainy season resumed postpartum ovarian activity significantly earlier than their counterparts lambing in the dry season (55.1±4.1d vs 71.5±3.2d, respectively) (P<0.001). The mean time to conception for ewes lambing in the rainy season was shorter (85.0±6.7d) compared to ewes lambing in the dry season (109.1±4.6d) (P<0.001). The ewes lambing in the rainy season also had shorter lambing intervals compared to ewes lambing in the dry season (237.2±6.8d vs 261.5±4.7d, respectively) (P<0.001). While ewes lambing in the dry season tended to lose weight over the lactation period (-1.1±0.3kg), ewes that lambed in the rainy season experienced a significant net weight gain (0.8±0.2kg) (P<0.001). It is concluded that season of lambing significantly affects the length of time to return of oestrus among postpartum Djallonke sheep, with rainy season lambing being more favourable to achieving early resumption of ovarian activity, conception and shorter lambing intervals.

Key words: ELISA, Ghana, Guinea Savannah, Progesterone, Season, West Africa Dwarf Sheep

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Introduction

The West African dwarf sheep or Djallonke sheep is the predominant sheep breed in Ghana (Annor, 2002; Koney, 1992). The breed is widely reared in the northern Guinea Savannah zone of Ghana where they serve as a source of income for farmers, insurance against crop failure and as an animal protein source (Amankwah *et al.*, 2012; Quaye, 2008). Djallonke sheep, like most sheep breeds found in tropical and equatorial regions, are known to be non-seasonal polyoestrous animals; they are not susceptible to the periods of seasonal reproductive quiescence readily observed in Temperate breeds of sheep, and are therefore capable of cycling year-round (Jainudeen *et al.*, 2000; Tuah and Baah, 1985). Even though this advantage could be exploited for year-round lambing, factors such as feed availability and quality must be assured given the importance of optimal nutrition to the success of the reproductive process (McDonald *et al.,* 2010). In tropical climes such as what pertains in northern Ghana, rainfall patterns are seasonal, with a long dry season spanning 7 to 8 months (Lacombe *et al.,* 2012). This affects quality and quantity of pasture available for ruminant livestock. The severe decline in pasture quality and availability in turn influences nutritional status where sheep depend primarily on grazing pastures to obtain their nutritional needs (Mbayahaga *et al.,*1998), leading to severe body weight losses during this period of the year (Cardoso and Alameida, 2013), with consequent losses in productive and reproductive performance (Almeida *et al.*,2006).

One of the most important indices of sheep productivity is the length of time to the resumption of postpartum ovarium activity following lambing, since this factor ultimately influences the number of lambs the ewe can produce over the course of its reproductive life (Ascari *et al.*, 2016; Santiago-Moreno, *et al.*, 2000). Data showing how season, with its attendant changes in nutritional environment, influences postpartum ovarian activity of Djallonke ewes in northern Ghana is not currently in the literature even though such data will be of value to farmers making decision about the best time to breed their sheep. Progesterone determination in various bodily fluids, which has been employed as means of assessing ovarian function and diagnosing reproductive dysfunction in animals (Blaszczyk and Stankiewicz, 2009; Khanum *et al.*, 2007; Mukasa-Mugerwa and Viviani, 1992) was therefore used in this study to determine the length of time to the resumption of ovarian activity. Time to conception following parturition, and lambing intervals were also assessed.

Materials and Methods

Location of Study

The study was carried out at the Pong Tamale Livestock Breeding Station and the Pong Tamale Central Veterinary Laboratory in Savelugu/Nanton district of Ghana, located on Longitude 0^0 49” N and Latitude 9^0 40” W, about 32 km from the Northern Region capital of Tamale. The area falls within the Guinea Savannah vegetative zone of Ghana and experiences a unimodal rainfall pattern throughout the year; with mean annual rainfall of 1043mm. Peak rainfall is confined to the months of August and September. Rainfall for the peak period represents 40% of rain for the entire rainy season. The rainy season covers the months of May to September, while the dry season begins in October and ends in May.

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Experimental Animals and Management

Seventy-eight ewes of the Djallonke breed in their 1st to 5th parities were selected within 7 days of their last parturition for this study. Data was taken over a three-year period (2012 to 2014) from ewes lambing in the rainy and dry seasons. Thirty-seven of the ewes lambed in the rainy season between n June and July while 41 ewes lambed in the dry season, between November and December. The experimental animals were grazed on pastures of *Stylosanthes hamata*, *Panicum minimum* and *Cajanus cajan* from 9am to 5pm daily in the rainy period, but in the dry season, when the vegetation had dried up, the animals were fed crop residues from locally cultivated crops such *Cajanus cajan* waste, groundnut tops and cassava peels. Water was offered ad libitum. Routine deworming against helminths was done once every month in the rainy season and once in every two months in the dry season using Albendazole dewormer 2.5% (manufactured by KELA N.V., Belgium). The animals were also vaccinated against Peste de petit ruminants (PPR) once a year using PPR-VAC (manufactured in Botswana).

Progesterone Measurements/Assay

Blood samples were taken from the animals every third day by jugular venipuncture and the samples were stored on ice in an ice chest until they were centrifuged an hour later in the laboratory, and the serum harvested and stored at -20°C, pending analysis for progesterone. Bleeding of the ewes commenced on the 7th day after parturition, and continued until the ewes were diagnosed as pregnant, following testing for progesterone 45 days after their last mating.

A Solid Phase Enzyme Linked Immunosorbent Assay (ELISA) kit supplied by DRG International, New Jersey, USA was used to test the samples for progesterone. The assay was performed in duplicate. Inter and intra assay coefficients of variation were 7.04% and 3.81% respectively. Assay sensitivity was 0.045ng/ml. The ELISA test plates were read with a BioTek® Instruments ELISA plate reader (ELx800 model) through a 450nm filter. The absorbance/optical density (OD) values obtained from the reader were used to compute the concentration of progesterone in the samples. This was done by plotting a standard curve for each assay using 7 standards (in duplicate) with known concentrations. The concentrations of the samples collected were then interpolated from the standard curve using the OD values generated. Progesterone concentration above a threshold of 1ng/ml was taken to indicate the presence of a corpus luteum (Mukasa-Mugerwa and Ezaz, 1991; Pineda and Dooley, 2008).

Monitoring of Oestrus

Two intact rams were fitted with harnesses (raddles) containing crayons and allowed to run with the females for oestrus detection. The rams which mated with the females left streaks of crayon marks on the rumps of the females. The crayon marks were taken to mean that the ewe had been mated. To test for pregnancy,

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serum samples of mated gimmers were tested up to the 45th day after mating. Animals that continued to show elevated levels of progesterone were assumed to be pregnant.

Data Collected and Statistical Analysis

Data collected from the postpartum ewes were length of time to first progesterone rise, time to conception, lambing intervals. Monthly weights of all animals were taken and growth rates in the postpartum period were computed from them. The main variable of interest or the fixed effect was season of lambing. The GLM procedure of SAS Institute Inc, (2014) was used to analyse the effect of season on the weight and reproductive parameters of the ewes. The Student-Newman-Keuls test was used to separate means for significant differences. Year of lambing, parity of ewe and type of birth were included in the model for analysis of interval to first progesterone rise, interval to conception and lambing intervals.

$$Y_{ijkl} = \mu + S_i + P_j + T_k + yl_l + Sx_{m} + \varepsilon_{ijkl}$$

Where

Yijk = Dependent variable: Average daily gain, Length of time to first progesterone rise, time to conception, lambing interval

Si=fixed effect of season

Pj=fixed effect of parity

T_k=fixed effect of type of birth

yl_l= fixed effect of year of lambing

Sx_m=fixed effect of sex of lamb

ε_{ijkl}=error term

Results and Discussion

Weight Dynamics of Postpartum Ewes

Weight parameters for the experimental ewes are presented in Table 1 and Table 2. Ewes that lambed in the dry season lost about 4% of body weight during the postpartum lactation period (lambs were weaned at 120 days old) while ewes lambing in the rainy season gained weight over the same period (P<0.05) (Table 1). Parity, type of birth and year of birth had no significant effect on the average daily gain of the ewes during the postpartum period up to weaning (P<0.05) (Table 2).

The superior weight performance of the rainy season ewes could be attributed to the comparatively better supply of fresh pasture during the lactation period, compared to their counterparts lambing in the dry season that had to nurse lambs under conditions of relatively depleted pasture. Mbayahaga *et al.* (1998) and McDonald *et al.* (2010), have noted that lactation generally increases metabolic and nutritional requirements, which have to be met by commensurate intake of the right amounts of nutritious feed. When feed supply is inadequate, such as occurs in the dry season period, dams sacrifice their own body nutrient

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stores to cater for the lambs, which leads to a loss of weight around that time (Cardoso and Alameida, 2013; Mbayahaga *et al.*, 1998).

Table 1: Weight parameters of postpartum ewes

Parameter	Rainy Season (N=37)	Dry Season (N=41)	P value
Weight of ewe at lambing (kg)	26.6±0.8[a]	26.3±0.6[a]	0.379
Weight of ewe at weaning (kg)	27.4±0.8[a]	25.2±0.7[b]	0.001
Weight change at weaning (120d) (kg)	0.8±0.2[a]	-1.1±0.3[b]	0.001

Means in the same row for each factor with different alphabet superscripts are significantly different at the 95% level of probability. Numbers in parenthesis (N) = number of animals involved in experiment per season.

Table 2: Postpartum growth rate of ewe

Source of Variation	Number	Average Daily Gain (g/day)	P value
Overall	78	-1.6±1.9	
Season			
Rainy season	37	6.9±1.9[a]	0.001
Dry season	41	-9.4±2.7[b]	
Parity			
1	15	-7.5±5.9	0.202
2	22	-1.2±2.6	
3	14	-4.8±4.1	
4	14	6.9±4.3	
5	13	-1.2±4.4	
Type of birth			
Singleton	67	-0.5±2.0	0.211
Twin	11	-8.8±4.8	
Year			
2012	20	-5.0±4.1	0.06
2013	32	-1.7±2.5	
2014	26	1.1±3.7	

Means in the same column for each factor with different alphabet superscripts are significantly different at the 95% level of probability

Effect of Season on Return to Ovarian Activity, Conception and Lambing Intervals

The mean interval from parturition to the resumption of ovarian activity, as evidenced by progesterone rise above 1ng/ml, was 63.7 ± 2.7 days (range: 19 to 130 days) (Table 3). Ewes lambing in the rainy season resumed ovarian activity earlier than ewes that lambed in the dry season by 16 days (P<0.001). They also conceived earlier and had shorter lambing intervals compared to animals that had their last parturition in the dry season (P<0.001). Mbayahaga *et al.* (1998) reported a postpartum return to ovarian activity of 81 days while (Mukasa-Mugerwa and Ezaz, 1991) reported it as 76 days postpartum for Burundian local ewes and Ethiopian Menz breed respectively. Postpartum to conception of 90 days was reported by Mukasa-Mugerwa *et al.* (1990). The period of time to return of oestrus following parturition is known to be highly variable and is influenced by factors such as uterine involution (Hayder and Ali, 2008), the suckling

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stimulus and negative energy balance (Senger, 2005). The relative abundance of plentiful grazing in the rainy season may account for the better performance of ewes that lambed and suckled their young in the rainy season as they had better nutrition. This assessment is supported by work done on Mexican Pelibuey ewes and Burundian ewes, where ewes lambing in rainy season showed higher oestrus activity, conception rates and shorter lambing intervals compared to ewes lambing in the dry season (Arroyo *et al.*, 2016; Canché *et al.*, 2016; Mbayahaga *et al.*, 1998). Parity of ewe had a significant influence on the interval to first rise, conception and lambing intervals as well (P>0.05), with animals in their first parities returning to ovarian activity and conceiving much later than animals in their second parity onwards (Table 3).

Table 3: Effect of season, parity and year of lambing on resumption of ovarian activity, conception and lambing intervals

Source of Variation	N	First P4 Rise (days)	Lambing to Conception (days)	Lambing Intervals (days)
Overall mean	(78)	63.7±2.7	97.4±4.2	249.8±4.3
Season of Lambing				
Rainy season	(37)	55.1±4.1[a]	85.0±6.7[a]	237.2±6.8[a]
Dry season	(41)	71.5±3.2[b]	109.1±4.6[b]	261.5±4.7[b]
Parity of Ewe				
1	(15)	83.9±7.2[a]	123.5±11.2[a]	276.6±11.3[a]
2	(22)	62.1±5.5[b]	102.6±9.3[ab]	254.5±9.7[b]
3	(14)	57.6±5.7[b]	88.8±6.2[b]	241.4±6.2[b]
4	(13)	57.7±3.8[b]	85.3±8.3[b]	237.4±3.6[b]
5	(14)	56.2±5.0[b]	82.4±3.6[b]	233.7±8.4[b]
Type of Birth				
Singleton	(67)	62.5±3.1	93.1±3.7	244.0±3.7
Twin	(11)	71.0±1.7	102.1±5.2	251.0±5.1
Sex of Lamb				
Female	(45)	64.0±3.6	94.2±4.3	246.3±4.4
Male	(44)	65.2±3.3	96.5±4.1	248.7±4.2
Year of Lambing				
2012	(20)	70.8±5.2	104.4±6.1	257.0±6.2
2013	(32)	60.1±4.6	97.3±7.3	250.0±7.5
2014	(26)	62.7±4.2	93.7±7.6	245.3±7.5

Means in the same column for each factor with different alphabet superscripts are significantly different at the 95% level of probability

The effect of parity on return to ovarian activity and the related lambing intervals has been documented in the literature (Berhanu and Aynalem, 2009; Magaña-Monforte *et al.*, 2013). Ibrahim (1998) has suggested that older ewes require less time to regain condition after parturition compared to younger ewes, which may account for their earlier return to cycling and shorter lambing intervals. The type of birth and sex of lamb has no significant effect on the postpartum performance traits (P>0.05).

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Progesterone Profiles of Postpartum Ewes

The general patterns of progesterone elevations observed in this study are presented in Figs. 1 to 4. Progesterone concentration of postpartum ewes 7 days after parturition was below the threshold of 1ng/ml from the start of blood sampling until 63.7 ± 2.7 days postpartum when ewes experienced their first postpartum progesterone rise. The difference in time to first progesterone rise between rainy season ewes (55.1 d) and dry season ewes (71.5 d) was statistically significant ($P<0.001$). The patterns in individual ewes were varied but in all ewes, there was an initial elevation of progesterone, which was usually of short duration (less than 10 days). Sixty-four percent of animals came into oestrus and conceived after this first elevation. The rest of the animals showed between 1 and 3 more transient elevations of progesterone after the first rise and before conception, which were either accompanied by mating and failure to conceive (Fig. 3), or were not accompanied by any overt oestrus or mating. Some of these progesterone elevations were not associated with any overt display of oestrus or mating (Fig. 2) while some were preceded by mating and failure to conceive (Fig. 3).

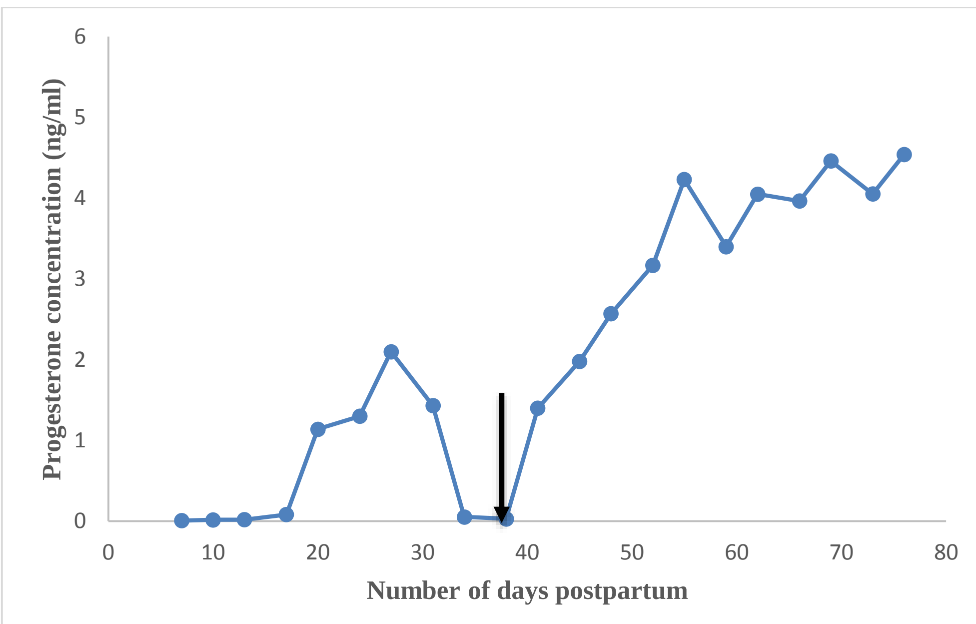

Fig. 1: Rainy season postpartum ewe displaying initial progesterone elevation at day 19 before conception at day 41. Black arrow indicates mating.

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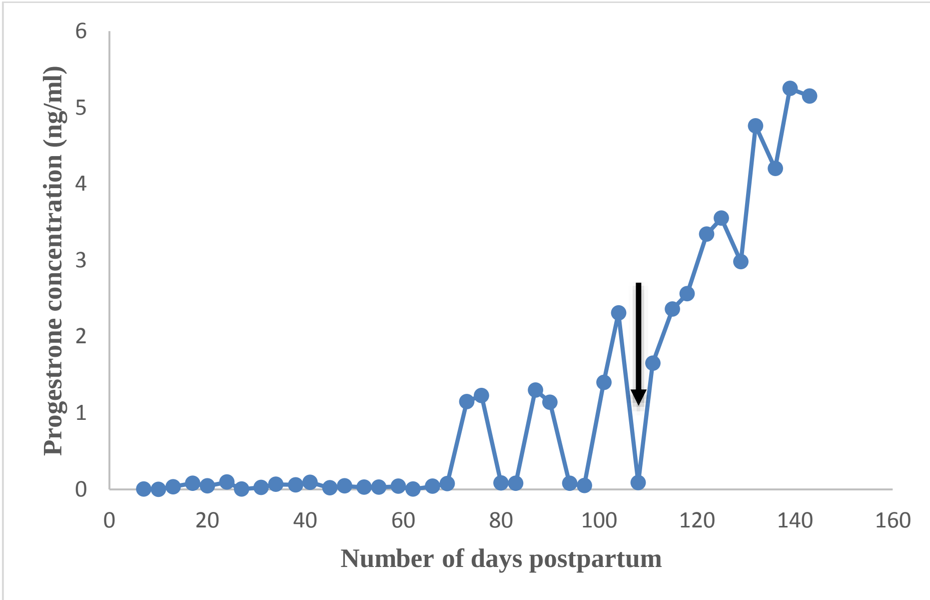

Fig. 2: Progesterone profile of ewe showing 3 progesterone elevations (silent ovulations) without overt oestrus prior to conception. Black arrow indicates mating.

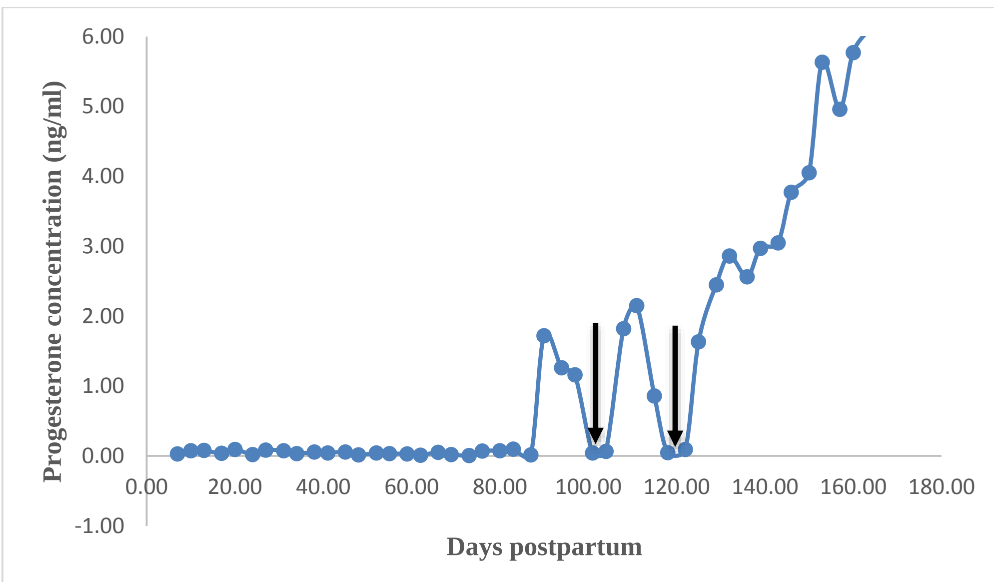

Fig. 3: Progesterone profile of ewe showing two matings before conception. Black arrows indicate mating.

In three cases (4% of ewes), progesterone stayed elevated beyond the normal luteal phase of 10 to 12 days for sheep (Fig. 4) before dropping to basal levels. All ewes in the study eventually conceived, with mean interval to conception occurring at 97.4±4.2 days postpartum (range 39 to 159 days postpartum).

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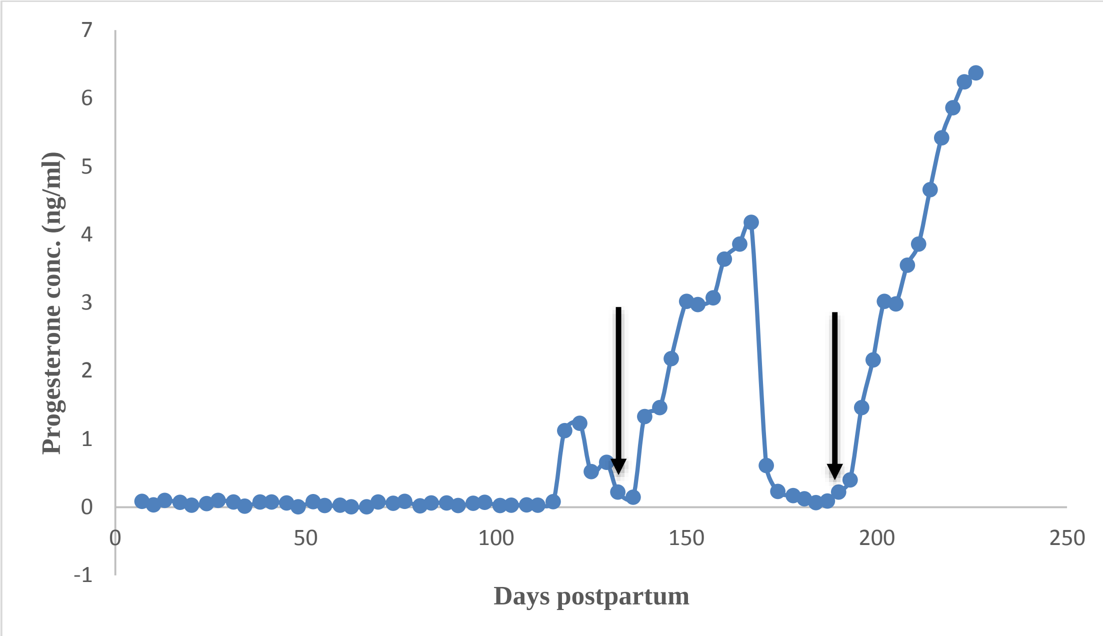

Fig. 4: Progesterone profile of ewe showing prolonged luteal phase (possible embryo death).

The profiles observed in this study depict patterns similar to progesterone profiles observed in Burundian ewes and Ethiopian Menz ewes (Mbayahaga *et al.*, 1998; Mukasa-Mugerwa *et al.*, 1990). The authors in those studies reported that resumption of full postpartum ovarian activity in ewes was preceded by silent ovulations and irregular oestrous cycle. The first oestrous cycles following parturition are generally known to be short and anovulatory and the first ovulations not usually associated with overt oestrus (Noakes *et al.*, 2001). Mukasa-Mugerwa and Ezaz (1991) observed silent ovulations in 66% of ewes returning to ovarian cyclical activity after parturition and (Mbayahaga *et al.*, 1998), working with postpartum Burundian ewes observed progesterone profiles that were indicative of silent ovulations. Bartlewski *et al.* (1999) showed that some "silent ovulations" are really immature ovarian follicles that luteinize and attain progesterone-secreting ability without actual ovulation occurring. Noakes *et al.* (2001) and Hafez *et al.* (2000) have suggested that silent ovulations, which occur in prepubertal ewes and ewes returning from seasonal anoestrus and postpartum ewes, provide the postpartum progesterone required to prime the central nervous system (CNS) to become sensitive to the effects of oestrogen, which then triggers full oestrus behaviour (Legan *et al.*, 1991). Ewes showing sustained progesterone elevations may have experienced embryo deaths during early pregnancy as reported by (Mukasa-Mugerwa *et al.*, 1990).

Conclusion

In conclusion, ewes lambing in the rainy season period returned to oestrus earlier, conceived earlier, and had shorter lambing intervals compared to ewes that lambed in the dry season period. This effect was largely

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attributed to the availability of pasture during the rainy season period. Animals in their early parities also tended to have longer periods to resumption of ovarian activity, conception and lambing intervals. Ewes tended to lose weight when they lactated through the dry season months while postpartum ewes raising lambs during the rainy season experienced a net weight gain. It is therefore recommended that for free-grazing Djallonke ewes, lambing should be set to coincide with the rainy season, since that would support early resumption of ovarian cyclicity and reduce lambing intervals.

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