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Reproductive performance of Santa Inês ewes during dry and rainy seasons in eastern Amazon

A.C.B. Moura[1], P.P.M. Teixeira[1,4,5], L.N. Coutinho[2], C.C. Paz[1], V.J.C. Santos[2], F.N. Soares[1], M.E.F. Oliveira[2], W.R.R. Vicente[2], A.A. Araújo[1], L.F.S. Rodrigues[1]

[1]Universidade Federal Rural da Amazônia (UFRA), Centro de Pesquisa em Caprinos e Ovinos do Estado do Pará (CPCOP), Belém, PA, Brazil.
[2]Faculdade de Ciências Agrárias e Veterinária, Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP), Jaboticabal, SP, Brazil.
[3]Universidade Estadual do Ceará (UECE), Fortaleza, CE, Brazil.
[4]Universidade Estadual do Centro-oeste (UNICENTRO), Guarapuava, PR, Brazil.

Abstract

The aim of this study was to evaluate the reproductive performance of ewes during the dry and wet months in northern Brazil. The females were divided into two groups: reproduced during the dry season and lambing in the rainy season (Group A, n = 38), and the opposite with the other group (Group B, n = 55). There was no difference (P > 0.05) for expression of estrus (86.8 and 98.3%), pregnancy rate (86.8 and 90.9%), lambing (76.3 and 83.6%), abortion (9 and 7.4%), fecundity (86.8 and 96.3%), birth (103.4 and 110.8%) and prolificacy (113.7 and 115.2%) observed in groups A and B, respectively. However, there was a difference (P < 0.05) in lamb mortality (26.6% for group A and 49% for group B). Ewes from group A presented a higher average live weight at the end of the reproductive season and during the final third of pregnancy (P < 0.05).

Keywords: Amazonian climate, lambing season, reproductive performances, seasonality.

Introduction

Sheep farming is a growing agricultural activity with great investment potential in Brazil. However, there is little information on the behavior of these animals in a hot and humid climate such as that found in Amazonia. Knowledge about the relationship of the animal with its environment, as well as its response to each bioclimatic situation are fundamental for the success of agricultural exploration (Neiva *et al*., 2004; Steinheim *et al*., 2008).

The Amazon region is crossed by the Equator, and, therefore, there are no seasonal changes and no influence of the photoperiod in the animals. However, inappropriate climatic conditions reduce the productive and reproductive performance of animals, causing alterations in the estrus behavior, embryo death and birth of weak lambs and several disorders (Wilson, 1989; Ozawa *et al*., 2005). Rainfall may affect hormonal secretions and has an important modulating effect on reproductive periods in tropical regions, as noticed in ewes in the highlands of Ethiopia (Mukasa-Mugerwa *et al*. 2002; Vieira *et al*., 2008).

Amazonia, especially the state of Pará, has emerged as a pole for sheep and goat farming. However, the high temperature and humidity of this region, in addition to high rainfall indices, require studies for understanding and to limit the obstacles imposed by environmental factors, searching for adequate management in order to allow the rationalization of sheep farming in this region. Moreover, there is no specific management application for local conditions; the programed breeding season is partly adopted, but without the observance of possible environment influences according to the season of the year (Martins, 2007).

Thus, the present study aimed to evaluate the reproductive performances of Santa Inês ewes under the hot and humid climate of eastern Amazon, determining breeding seasons in periods of dry and wet weather in order to understand the most suitable time of year to apply reproductive techniques in sheep in the Bragantina microregion, in the northeastern of the state of Pará.

Materials and Methods

The study was conducted between August 2007 and September 2008 on a private farm located in the municipality of Igarapé-açu, northeastern of Pará, northern region of Brazil. The property is located at 1º 12' S latitude and 47º 36' W longitude at an altitude of 93 m above sea level. The climate of the municipality is of the megathermal humid type Am according to the Köppen classification.

This experiment was approved by the Ethics and Animal Experimentation of the Federal Rural University of Amazonia, following all the precepts of ethics and animal welfare. Ninety-three Santa Inês sheep, aging 24.7 ± 6.9 months, with 2.52 ± 0.34 body condition score and mean live weight of 38.5 ± 0.89 kg were used as the baseline of this study. The body condition was measured as described by Jefferies (1961). The females were ready and healthy to reproduce, according to clinical (general clinical

[5]Corresponding author: p_paulomt@yahoo.com.br
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examination, assessment of physiological parameters - frequency heart rate, respiratory rate, rectal temperature, dehydration degree, visible mucosal assessment and evaluation Famacha method) and parasitological exams. Throughout the experiment, following the routine handling of the property, all animals were in a semi-intensive system with full access and rotation system to paddocks with *Bhrachiaria humidicola* and *Bhrachiaria brizantha*. Returning to the sheepfold, the ewes were daily provided with *Penninsetum purpureum*, a variety of napier and Cameron grass and *Pueraria phaseoloides* as a source of non-protein nitrogen, and suplemented with 200 g of feed (maize grain, wheat bran, coconut bran, limestone, salt and phosphate) with 17% of crude protein and 73% total nutrient digestive (TND). The mineral salt and water were provided *ad libitum*.

The females were randomly selected into group A (n = 38) and group B (n = 55). Group A was submitted to breeding season in the dry period (September and October) with lambing in the rainy season, the opposite happened with group B (with the mating occurring in March and April).

The meteorological data from the region were collected monthly and provided by the climatology lab of Embrapa Eastern Amazon, characterizing each period studied in respectively dry and rainy. The climatic indices used were maximum temperature, minimum temperature, medium temperature (^{o}C), relative humidity (%), wind speed (km/h), pluviometric precipitation (rainfall) (ml), evaporation (mm de H_2O), solar radiation (E/m^2) and temperature and humidity index -THI.

Three months before the breeding season, females stayed with two teasers to prevent the male effect. The breeding season lasted 45 days. The rams were released to pasture daily in the morning with the females and separated in the late afternoon returning to the sheepfold, and at this time the estrus behavior was observed.

The belly of rams was marked with a mixture of grease and paint and females that accepted males had their back marked for the indication of estrus. The color of the paint was changed with a 15 day interval to facilitate the understanding of the distribution of estrus and its possible repetitions. Fertile estrus was defined as estrus followed by a diagnosis of pregnancy.

Thirty days after the breeding season, transrectal ultrasonography exams were carried out fortnightly for pregnancy diagnosis and to observe possible abortions until the final third of gestation. The estrus distribution and the lambing (lambing number by number of females exposed to the ram, in percentage), lambing fertility (number of ewes that lambed by number of females exposed to the ram, in percentage), pregnancy (number of females positive for the pregnancy diagnosis 45 days after the breeding season by number of females exposed to the ram, in percentage), abortion (number of ewes that start pregnancy, but not lambed/number of ewes that start pregnancy), prolificacy (number of lambs born, dead or alive, by the number of females exposed to the ram, in percentage), natality (number of lambs born, alive, by the number of females exposed to the ram, in percentage) and lamb mortality (number of deaths by the number of lambs born, in percentage) up to 10 days old were evaluated. The females were weighed at the beginning and at the end of the reproductive season, during the final third of pregnancy, and immediately after lambing. The lambs were also weighed at birth and confined and observed until 10 days old. All live weight data, except for the post-partum and birth data, were performed in the morning before the animals were left loose in pasture.

The *t* Student's test was applied to compare the average live weight between groups A and B. The nonparametric chi-square test was used to compare the reproductive parameters. In cases where the contingency of the expected frequency was less than five, making the chi-square test ineffective, the Fisher exact test or G (Williams) test was used. The significance level of 5% was used for all the tests.

Results

During the experimental period the meteorological data, temperature, relative humidity and wind speed were similar in the two periods evaluated, dry and wet. However, average rainfall and evaporation were higher in the rainy season. The solar intensity, in turn, expressed higher values through the dry season. The average monthly climatic data are presented on Table 1.

There was also no significant difference between groups ($P > 0.05$) for the lambing fertility rate. In the end of the breeding season, 86.8% (33/38) of females which mated in the dry season and 98.3% (54/55) which mated during the rainy season had a diagnosis of pregnancy. It is noteworthy that these sheep, 45.4% (15/33) and 64.8% (35/54) for groups A and B respectively, presented estrus at the first fortnight of the breeding season.

Pregnancy rates, lambing, lambing fertility, natality and prolificacy did not differ significantly ($P > 0.05$) between animals exposed to reproduction during dry and rainy seasons (Table 2) and the abortion rate was also similar in both groups ($P > 0.05$). The mortality rate of lambs up 10 days old differed between groups ($P < 0.05$), with a higher death incidence among those born during the dry season. We could not establish a specific cause of death for these cases, but lambs died by inanition/hypothermia.

Table 1. Mean meteorological data observed during the reproductive and lambing seasons of group A (GA) and group B (GB).

Season	Breeding (GA)	Breeding (GB)	Lambing (GA)	Lambing (GB)
Season	Dry	Rainy	Rainy	Dry
Tx	32.2	30.2	30.4	32.8
Tn	21.6	22.3	22.3	21.6
Tm	26.9	26.3	26.6	27.2
Rh	78	89	89	78
Ws	1.2	0.8	0.8	1.1
Rf	50.8	454.3	278.8	63.3
Ev	85	114.1	116.5	85.3
Is	247.9	30.2	30.4	249.5
THI	85e	84e	84e	87e

Tx: maximum temperature; Tn: minimum temperature; Tm: medium temperature; Rh: relative humidity; Ws: wind speed; Rf: pluviometric precipitation (rainfall); Ev: evaporation; Is: solar radiation; THI: temperature and humidity index.

Table 2. Reproductive rates and lamb mortality up to 10 days of age in group A (reproductive season during the dry period) and group B (reproductive season during the rainy period).

Group	A	B
Pregnancy[2]	86.8% (33/38)	90.9% (50/55)
Lambing fertility[3]	86.8% (33/38)	98.3% (54/55)
Abortion[2]	9.0% (3/33)	7.4% (4/54)
Lambing[1]	76.3% (29/38)	83.6% (46/55)
Prolificacy[2]	113.7% (33/29)	115.2% (53/29)
Natality[3]	103.4% (30/29)	110.8% (51/46)
lambs' mortality*[1]	26.6 % (8/33)	49.0% (25/53)

*P < 0.05; ns: not significant; [1]chi-square test; [2]Fisher' test; [3]G (Williams) test.

The type of pregnancy was not influenced by climate (Table 2; P > 0.05). The live weight at the beginning and in the end of the breeding season, average daily gain during breeding season, live weight during the final third of pregnancy, postpartum live weight, and lamb birth live weight are shown in Table 3. Birth live weight was not influenced by season or sex of lamb (P > 0.05) but differed between the types of gestation (P < 0.01). The average live weights at birth, in groups A and B respectively, were 3.3 and 3.1 kg for males from singletons and 3.5 and 3.3 kg for females from singletons, however, for the twins, males showed live weights of 2.9 and 2.4 kg and females 2.2 and 2.6 kg respectively.

Table 3. Mean (± standard error) live weight (kg) and average daily gain (g) of Santa Ines sheep mated during the dry and rainy seasons in Northeastern Pará.

Season	Dry	Rainy
Group	A	B
LWBRS (kg)	37.7 ± 0.99^{a}	41.4 ± 0.80^{a}
LWERS (kg)	43.6 ± 0.93^{a}	38.5 ± 0.75^{b}
ADG (g)	98.3 ± 0.009^{a}	8.3 ± 0.008^{b}
LWFTP (kg)	49.0 ± 1.07^{a}	41.4 ± 0.84^{b}
PPLW (kg)	39.7 ± 0.98^{a}	36.0 ± 0.78^{a}
BLW (Kg)	3.2 ± 0.12^{a}	3.0 ± 0.09^{a}
MSBLW (kg)	3.3 ± 0.13^{a}	3.1 ± 1.0^{a}
FSBLW (kg)	3.5 ± 0.13^{a}	3.3 ± 0.09^{a}
MDBLW (kg)	2.9 ± 0.08^{a}	2.4 ± 1.0^{a}
FDBLW (kg)	2.2 ± 0.092^{a}	2.6 ± 0.091^{a}

LWBRS: Live weight at the beginning of the reproductive season; LWERS: Live weight at the end of the reproductive season; ADG: average daily gain during the reproductive season; LWFTP: Live weight during the final third of pregnancy; PPLW: post-partum live weight; BLW: lamb live weight at birth; MSBLW: males lamb live weight from singletons; FSBLW: females from singletons live weight; MDBLW: males lamb weight from twins live weight; FDBLW: females lamb weight from twins live weight. Means in the same column followed by different superscript letters differed from one another (P < 0.01; Student *t*-test).

Discussion

According to Ribeiro *et al*. (1999), the Hampshire Down breed of sheep in southern Brazil mates during both seasons. However, when this region is under the influence of photoperiod, these authors observed an increase in cyclic activity during the summer and fall. On the other hand, Sasa *et al*. (2002) observed no reproductive seasonality of Santa Inês sheep in São Paulo. In this study, the satisfactory performance of these cyclic females reflected the good adaptation of Santa Inês the region, allowing for reproduction regardless of season and thereby demonstrating that when near the Equator, this breed does not have pronounced reproductive seasonality.

Guerrini (1981), Young (1988), and Armstrong (1994) referred to high temperatures associated to solar radiation, low rainfall and high humidity as causes of thermal discomfort and subsequent decline in animal production. For ovine, Baêta and Souza (1997) considered 25 to 30ºC as the optimum range temperature for thermal comfort. This affirmation corroborates to the satisfactory reproductive performance of sheep in this research and contradicts Nääs (1989) assertion, who considers the temperature and humidity, observed during the two studied periods, higher than the considered as optimal for sheep. Mukasa-Mugerwa *et al*. (2002) describes the rainfall also as having an influence in the sheep reproductive indices. Thus, considering the hardiness of Santa Inês, the climate of this Amazon micro-region supported the good reproductive rates for the species (Wilson, 1989; Martins *et al*., 2003).

Regarding temperature associated to humidity, Finocchiaro *et al*. (2005), studying Santa Inês ewes observed reduced production for each unit of THI above 23^{o}C. In this study, we found far superior THIs and these results are possibly still below those which could be obtained in areas considered less stressful to sheep, especially in lamb's mortality. But clearly the animals were able to make a tolerable homeothermy.

Rensis and Scaramuzzi (2003) observed a higher incidence of twin pregnancies during the warmer months. However, similarly to Fonseca (2006), no significant changes in prolificacy in sheep reared near the Equator were observed in this research, and the type of pregnancy was not influenced by climate.

In general, the higher availability in quantity and quality of pastures during the rainy season (Martins *et al*., 2003) favors gains on live weight. However, our ewes had less weight gain during this period in both groups (98.3 ± 0.009 *vs*. 8.3 ± 0.008; P > 0.05). Even with a supply of steady and satisfactory pasture in both evaluated seasonal periods, the constant and heavy rains that characterize the region's rainy season, grazing was voluntarily limited by the hours of sunlight. This change in feeding behavior of females reduced the frequency and duration of the meals during the rainy season. Another reason for the limitation of food intake and subsequent weight loss was the high incidence of health problems more frequently observed during the rainy season.

The live weight difference in the final third of pregnancy between groups A and B can also be explained by these reasons. Therefore, the majority of females in group B, as mentioned above, presented fertile estrus during the fortnight of the breeding season (rainy season) and the births occurred in the beginning of the lambing season. The birth live weight of lambs was similar in groups A and B. In the study of Colodo *et al*. (2004), conducted in northeastern Brazil, no diferences on lamb birth live weight were noticed between the dry and rainy periods. Carvalho *et al*. (1984), also in state of Pará , found an average lamb birth live weight of 3.2 and 3.1 kg for males and females of singletons and 2.7 and 2.7 kg for males and females, respectively. Boucinhas *et al*. (2006) report that the concentrate supplementation during the dry winter showed a considerable improvement on weight gain during late gestation in sheep in the state of São Paulo.

The complex starvation/hypothermia happens when the lamb does not have sufficient energy reserves to maintain their body temperature. Two factors are responsible for the occurrence of death: adverse weather conditions and low birth live weight, resulting in greater heat loss and lower energy reserves, a major cause of perinatal period death (Nóbrega Jr *et al*., 2005). Mortality rates of lambs up 10 days old differed between groups (P < 0.05), with a high mortality rate during the dry season (group B). Although the birth live weight did not differ between the seasons, the ewes in group B started a phase of high nutritional need (pregnancy and lactation). During pregnancy the body reserves for fetal growth can influence milk production (Haenlein, 2007) and contribute to the high rate of maternal rejection observed during lambing in the dry season and thus contribute to poor survival of offspring.

Despite the differences occurred in the climate between the seasons studied, they were not determinant to the reproductive parameters evaluated in this study, confirming the possibility of adopting to reproductive strategies in both periods, considering health, nutrition and care related to each season of the year.

In conclusion, under the climatic conditions of the northeastern state of Pará, the reproductive performance of Santa Inês ewes was not influenced by the time of year that the breeding season was held. Good reproductive rates presented by the sheep award satisfactory reproductive activity during the two periods, characterizing good adaptation to the region.

The rainy season seems to be a period that requires female greater nutritional and sanitary care during reproduction and lambing, although there was no effect of weight on reproductive responses.

The productive efficiency of the herd is affected

when lambs are born during the dry season because of the higher lamb mortality rate during this period.

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