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Weaning Age of Lambs Creep-Fed While Grazing on Marandu Pasture

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Abstract

This study aimed to examine the weaning age (60 and 90 days) of lambs supplemented while grazing on *Urochloa brizantha* cv. Marandu pasture. Production performance, incidence of worm infections, intoxication, and production cost of lambs, beside that body condition and occurrence of single or twin births in the ewes were evaluated, by two consecutive years. There was no effect of year. Lambs weaned at 90 days consumed more supplement (281.0 g/day) than those weaned at 60 days (210.2 g/day) and showed a higher total weight gain (20.76 kg vs. 14.97 kg). Weaning age did not influence the occurrence of worm infections and intoxication by *Urochloa spp*. in the lambs, dam weight or body condition score (BCS). Ewes with single-born showed a better BCS (1.8 points) than those ewes had twin-born (1.4 points). The costs of supplementing the lambs and the effective operating cost were higher when the lambs were weaned at 90 days of age. There was no difference for intake, lamb performance between the weaning age groups. We recommend to wean lambs at 90 days in a creep feeding system.

Keywords: suckling, sheep, supplementation, *Urochloa brizantha*

1. Introduction

The practice of supplementing the diet of lambs during the nursing phase in separate troughs (‘creep feeding’) emerged as an alternative to ensure higher weight gains in less time and to reduce the age at which these lambs are weaned and slaughtered. The supplement should be given soon after the first week of birth so the animal can progressively adapt to solid feed

consumption and thus have its nutritional requirements met. As a result, its growth rate can be increased and feed efficiency improved (Urbano et al. 217).

Creep feeding can contribute to heightening resistance to some diseases and gastrointestinal parasitic infections in lambs, which can affect them as early as in the first months of life (Torres-Acosta et al. 2012; Melo et al. 2017). Animals grazing on *Urochloa spp.* pasture may be intoxicated by protodioscin, a secondary compound of the grass whose function is to protect the plant against microorganisms. The main symptoms of this intoxication, known as photosensitization, are photophobia, photodermatitis, weight loss, and even cirrhosis (Faccin et al. 2014; Melo et al. 2018).

The age and weight of lambs at weaning are very important factors for sheep raising activity. The literature classifies early weaning at 45 days; semi-early or normal around 60 days; and late at 120 days old (Oliveira et al. 1996; Freitas et al. 2005; Müller et al., 2006) In aiming to increase the efficiency of sheep husbandry by shortening the rearing cycle (reducing the finishing period for slaughter), researchers have investigated strategies to advance weaning age. Oliveira et al. (1996) examined lambs weaned at 70 to 84 days of age; and Freitas et al. (2005) recommended weaning lambs at 72 days of age, as they obtained good feed conversion in feedlots and increased daily weight gains.

Our research group (Melo et al. 2018; Monteiro, 2016; Silva, 2016) worked with lambs on *Urochloa spp*. pasture in the cerrado biome and found superior performance in supplemented (creep-feeding) animals compared to those that did not receive this type of supplementation. Their weaning criterion was the average body weight of 20 kg, which resulted in the weaning age of 60 days. On these bases, with a view to improving the production system, the present study proposes to investigate the effects of increasing weaning age (90 day) as an alternative to improve the performance and increasing slaughter age of creep-fed lambs grazing on Urochloa brizantha cv. Marandu pasture.

2. Material and methods

2.1 Ethics Committee

The experimental protocol was approved by the Ethics Committee on Animal Use at the Federal University of Mato Grosso do Sul (UFMS) (approval no. 481/2012).

2.2 Location and Experimental Period

The experiment was carried out at the Sheep Farming Unit at Farm School (20º26’34.31’’S 54º50’27.86’’W; 530.7 m altitude), belonging to the Faculty of Veterinary Medicine and Animal Science (FAMEZ) at the Federal University of Mato Grosso do Sul (UFMS), located in Terenos - MS, Brazil. The animals were investigated in two years, from birth to weaning, which took place at 60 or 90 days of age. The first evaluation period started on April 26 and ended on August 20, 2015, and the second started on March 15 and ended on June 30, 2016. This period is characterized as the transition between the rainy season and start of the dry season in the region (fall/winter).

2.3 Animals and Treatments

The experiment involved mixed-breed ewes (mean age ± 3-4 years) that were mated to Texel sires. During the entire experimental period, the lambs and their mothers were kept on a pasture of Urochloa (syn. Brachiaria) brizantha cv. Marandu, in a 3.43-ha area that was divided into six paddocks. Three paddocks were used per treatment (i.e., weaning ages: 60 or 90 days). A continuous grazing system was adopted, with variable stocking rate and an herbage allowance of 10% body weight (BW). Put-and-take ewe lambs were employed to adjust the allowance whenever necessary. Twenty-eight ewes and 36 lambs (14 ewes with 18 lambs weaned at 60 days of age; and 14 ewes with 18 lambs weaned at 90 days of age) were used in year 1 (2015). In year 2 (2016), 32 ewes and 39 lambs (16 ewes with 19 lambs weaned at 60 days of age; and 16 ewes with 20 lambs weaned at 90 days) were used, totaling 60 dam records and 75 lamb records. Of these 70 lambs, 45 were born from single births and 30 from twin births.

The lambs were assigned to the treatments immediately after birth according to birth type (single or twin) and were given concentrate ad libitum in a separate trough. The supplement was provided since the first week of life. In both treatments, water and supplement were provided ad libitum.

Lamb age was the criterion for weaning (60 and 90 days), which was based on the average age of all lambs in the treatment groups. Upon attaining weaning age, the lambs were separated from their mothers and moved to the management center, where they received supplement and Tifton 85 (*Cynodon spp.*) hay for three days. Subsequently, they were distributed into the finishing paddocks.

2.4 Diets

The supplied feed and orts were harvested and weighed daily to calculate supplement consumed. The lamb supplement was formulated to provide an average daily weight gain of 250 g, following the NRC (2007) requirements for animals with a BW of 20 kg. The supplement contained 21% crude protein and 3.1 Mcal of metabolizable energy/kg of dry matter (DM) and was supplied ad libitum in a creep feeding system (Table 1). Metabolizable energy was calculated as the total digestible nutrient value multiplied by 3.615. The supplement was provided in separate troughs (creep feeding) with an internal area of 2.6 m^2 (2.0 × 1.30 m). These troughs were located within wooden enclosures equipped with opening systems (dimensions: 30 cm high × 20 cm wide). Each lactating dam received concentrate supplementation at the rate of 350 g/day, which was formulated to meet 30% of the requirements of lactating ewes with a BW of 50 kg, consuming 1.26 kg of DM/day, in accordance with NRC (2007). Water and mineral supplement were provided ad libitum to all animals.

Table 1. Chemical composition of the supplement given to lambs and ewes

	Supplement	
	Lambs[1]	Ewes[2]
Dry matter (g/kg)	909.0	908.3
Mineral matter (g/kg)	68.8	51.6
Organic matter (g/kg)	931.2	948.4
Crude protein (g/kg)	209.7	200.3
Ether extract (g/kg)	26.9	30.0
Neutral detergent fiber (g/kg)	10.7	21.5
Acid detergent fiber (g/kg)	3.7	5.52
Total digestible nutrients (g/kg)	842.7	774.6
Metabolizable energy (Mcal/kg DM)	3.1	2.8

[1]Ingredients (per kg): 517.0 g corn; 473.0 g soybean meal; 10 g mineral premix (artificial milk flavor, sodium bicarbonate, calcium carbonate, choline chloride, sodium chloride, sulfur, soybean meal, dicalcium phosphate, cornmeal, potassium iodate, dry sugarcane yeast, powder molasses, Rovimix©, sodium selenite, aluminum silicate, cobalt sulfate, copper sulfate, manganese sulfate, zinc sulfate and urea).

[2]Ingredients (g/kg): 761.1 corn; 198.9 soybean meal; 40 calcium carbonate.

To determine herbage biomass, four pasture samples were harvested per paddock, in representative areas, at every 28 days. For herbage collection, metal frames (0.5 × 0.5 m) were cast over random areas in the paddock and the grass within them was then cut near the soil level (Euclides et al. 2019). Areas near roads, spots of fecal accumulation, areas near troughs and drinkers, and areas with sparse herbage were avoided. After weighing, composite samples were formed per paddock and taken to the Laboratory of Applied Nutrition at FAMEZ at UFMS, where part of the total sample was separated into the following morphological components: leaf blade, stem (stem + sheath), and senescent material. These parts were subsequently weighed.

Stocking rate was adjusted by calculating the amount of herbage available in each paddock (which had different sizes) and the percentage of green leaf. Based on this calculation, we determined how many kilograms each paddock could carry, under a fixed allowance of 10% BW.

2.5 Laboratory Analyses

Samples of concentrate supplement (supplied and orts) and pasture were dried in a forced-air oven at 55 ℃ for 96 h and ground through a mill to 1-mm particles. The concentrations of dry matter (DM), organic matter (OM; 100 – ash), crude protein (CP), and ether extract (EE) were measured as proposed by AOAC (2000), via methods 930.15, 932.05, 976.05, and 920.39, respectively. The neutral detergent fiber (NDF) content was determined following Mertens (2002), using heat-stable amylase but not sodium sulfide, and expressed inclusive of residual ash (Table 2).

Table 2. Chemical composition of stem and leaf of *Urochloa brizantha* cv. Marandu in each treatment (lamb weaning ages)

	Weaning age				
	60 days		90 days		
	Month 1	Month 2	Month 1	Month 2	Month 3
	Stem				
DM g/kg DM	350.0	268.1	339.4	307.15	354.6
OM g/kg DM	935.6	950.0	920.2	921.25	921.9
CP g/kg DM	56.0	46.0	39.2	57.15	62.5
EE g/kg DM	9.0	5.4	8.8	6.35	5.1
NDF g/kg DM	675.5	579.95	682.0	643.2	674.9
ADF g/kg DM	634.2	569.2	590.5	565.2	550.8
	Leaf				
DM g/kg DM	347.2	373.9	347.1	358.6	357.9
OM g/kg DM	913.9	918.5	921.5	905.7	919.6
CP g/kg DM	108.1	101.2	105.8	116.1	495.8
EE g/kg DM	16.1	18.1	16.0	16.3	10.9
NDF g/kg DM	604.9	515.5	545.8	509.0	498.6
ADF g/kg DM	393.0	373.9	388.9	340.5	358.7
		60 days		90 days	
% Leaf		24.74		26.48	
% Stem		42.79		39.18	
% Dead material		39.72		31.91	

DM: dry matter; OM: organic matter; CP: crude protein; EE: ether extract; NDF: modified amylase-treated neutral detergent fiber; ADF: acid detergent fiber.

2.6 Performance

To determine production performance, average daily gain (ADG) was calculated as the difference between weaning weight and birth weight divided by weaning age. Ewes had their body condition score (BCS) assessed by palpation to determine the amount of muscle and fat in the transverse and dorsal processes of the lumbar vertebra by assigning scores of 1 to 5 (1 = too lean; 5 = too fat), following the methodology described by Russel et al. (1969).

2.7 Parasitic Control and Sanitary Management

After lambing, all ewes received 1 mL of an avermectin-based active principle subcutaneously to prevent myiasis infections and infestations. Additionally, they were managed at lambing and at every thirty days by weighing, determination of BCS, determination of degree of anemia (Famacha method), and fecal collection for the count of eggs per gram of feces (EPG).

Feces were harvested for the EPG count and Famacha testing in the lambs from the first month of life until weaning. Sanitary management measures were performed, including cutting and disinfecting the umbilical cord with tincture of iodine in the newborns.

For parasitological monitoring, individual samples were harvested directly from the rectal ampulla, aiming to quantify the number of eggs per gram of feces (Gordon & Whitlock, 1939 - modified). Analyses were performed at the Laboratory of Pathology at FAMEZ, and the animals were dewormed with nitroxynil- (ewes) and monepantel (lambs)-based active principles whenever their EPG was equal to or above 1000. If signs of apathy, weight loss, skin alterations, edema, jaundice, and photophobia—possibly caused by hepatogenic intoxication due to Urochloa spp. consumption—were observed, the animals were separated from the group and taken to a sun-shaded shelter, where they started to be fed alfalfa (Medicago sativa) or Tifton grass (*Cynodon dactylon*) as roughage, having ad libitum access to water and mineral salt. After complete clinical recovery, the lamb/ewe pair was reintroduced into the herd, in their respective treatments.

2.8 Economic Analysis

An economic analysis was carried out to identify the most economically viable weaning system considering the following equations:

• Cost of supplements for lams and ewes: Total intake × US$/supplement

• Cost of tenant farming: 20% of the @ of fattened cattle × Quantity (AU) of ewes (@ = price charged per 15 kg of livestock; 1 AU = 450 kg/50 kg)

• Cost of mineral supplement: Total intake × US$/kg of salt

• Effective operating cost (EOC): sum of operating costs (supplement for lambs, tenant farming, and mineral supplement)

The supplement provided to the lambs and the ingredients that made up the supplement given to the ewes were purchased in the local market. These ingredients were mixed in a mixer at

the feed factory at School-farm of FAMEZ/UFMS. The costs of purchase of lamb supplement and dam supplement ingredients and the @ of fattened cattle were the average prices charged by the market in the years 2015 and 2016, based on quotations obtained from livestock product companies in Campo Grande - MS, Brazil, and the Esalq/BMF Index, respectively (Table 3). The average currency exchange rate during the experimental period was US$1 = R$3.34 (Brazilian currency).

Table 3. Mean values of the purchase of lamb supplement, ingredients constituting the dam supplement, and price of the @ of fattened cattle used in the calculation of the cost of tenant farming

Supplement	US$	US$/kg
Lamb supplement (40-kg bag)	21.03	0.53
Mineral supplement (25-kg bag)	17.18	0.69
Ingredient		
Corn (60-kg bag)	5.99	0.10
Soybean meal (60-kg bag)	20.96	0.35
Calcium carbonate (t)	21.04	0.03
Sale price		
@ of fattened cattle (year 1)	43.54	
@ of fattened cattle (year 2)	45.78	

Values obtained at the purchase of inputs and using the Esalq/BMF Index quotations.

1 @ = 15 kg of carcass (‘arroba’, livestock weight unit adopted in Brazil).

US$ 1.00 = R$3.34.

2.9 Statistical Analysis

The experiment was set up as a randomized-block design as a function of birth type (single and twin), treatments (weaning age: 60 and 90 days), sex, and year. The factors were analyzed according to the following statistical model: Y = m + WA +BT + WA*BT + S + A + e, where Y is the observed value for the evaluated variable; m is the overall constant; WA is the effect of weaning age (60, 90 days); BT is the effect of birth type (1,2); WA*BT is the weaning age × birth type interaction effect; S is the sex effect (1,2); A is the year effect (1,2); and e is the random error associated with each observation. The data were analyzed by analysis of variance and means were compared by Tukey’s test at the 0.05 significance level.

3. Results

Year and lamb sex did not influence the intake or production performance of lambs and ewes or the economic variables (P>0.05). Likewise, there was no interaction effect between the tested factors on those variables.

The herbage chemical analysis showed no significant difference between the years 2015 and 2016 (P>0.05). For this reason, they have been presented together.

3.1 Supplement Intake and Lamb Performance

Weaning age influenced average supplement intake, which was 25% higher in the group weaned at 90 days (281.0 vs. 210.2 g/day). Total supplement intake was also higher in the group weaned at 90 days, compared with the group weaned at 60 days of age (25.3 vs. 12.7 kg/animal) (P=0.0001) (Table 4).

Table 4. Supplement intake of lambs reared on *Urochloa brizantha* cv. Marandu pasture according to weaning age (60 or 90 days)

	Weaning age		SEM	P
	60 days	90 days		
Average supplement consumed (g/day)	210.2[b]	281.0[a]	192.76	0.0001
Total supplement consumed (kg/animal)	12.7[b]	25.0[a]	14.72	0.0001

Different lowercase letters in the row differ statistically according to Tukey's test (P<0.05).

Birth weight differed significantly (P=0.0007) according to birth type. The average birth weights in the single- and twin-birth groups were 4.3 and 3.7 kg, respectively.

The animals weaned at 90 days showed a 22% higher average weaning weight (25.3 kg) than the animals weaned 60 days (19.6 kg). Total weight gain (TWG) in the lambs differed significantly between the treatments (P=0.00001), with mean values of 20.8 and 15.0 kg/animal (a 28% difference) for the groups weaned at 90 and 60 days of age, respectively (Table 5).

Table 5. Productive performance of lambs reared on *Urochloa brizantha* cv. Marandu pasture according to weaning age (60 or 90 days) and birth type (single or twin)

	Weaning age				SEM	P_1	P_2	P_3
	60 days		90 days					
	Single birth	Twin birth	Single birth	Twin birth				
Birth weight (kg)	4.3 [a]	3.7[b]	4.3 [a]	3.6[b]	0.76	0.9997	0.0007	0.8795
Weaning weight (kg)	20.3	18.9	27.2	23.6	4.94	0.0001	0.0497	0.3984
TWG (kg/ha)(ewes+lambs)	118.38	119.81	186.22	194.41	11.118	0.0010	0.8169	0.8699
ADG (kg/day/ha)(ewes+lambs)	1.97	1.65	2.06	2.16	0.174	0.3899	0.7435	0.5572
TWG lambs (kg/animal)	15.94	14.00	21.67	19.86	0.666	0.0001	0.0966	0.9498
ADG lambs (g/day)	266.67	233.33	240.78	220.67	0.666	0.0001	0.0966	0.9498
TWG lambs (kg/ha)	147.54	176.91	242.56	247.51	11.474	0.0001	0.4054	0.5533
ADG lambs (kg/day/ha)	2.46	2.95	2.69	2.75	0.138	0.9438	0.3263	0.4327
Lamb weight-to-dam weight ratio (%)	39.99	34.60	49.66	47.49	1.609	0.0002	0.1971	0.5814

P_1 = effect of weaning age (60 vs. 90 days); P_2 = effect of birth type (single vs. twin); P_3 = interaction between weaning age and birth type. Age = dam age, in months; TWG = total weight gain, ADG = average daily gain.

Different lowercase letters in the row differ statistically according to Tukey's test ($P<0.05$).

The average TWG of ewes + lambs in the 90-day weaning age treatment was higher (190.3 kg/ha) than that shown by the group in which the lambs were weaned at 60 days of age (119.1 kg/ha). The same was true for TWG of lambs per area (245.0 vs. 162.2 kg/ha for 90 and 60 days, respectively), with a difference of approximately 34%. By contrast, the ADG of ewes + lambs and the ADG of lambs did not differ significantly ($P>0.05$). The lamb-to-dam weight at weaning ratio (%) showed significant differences ($P=0.0002$), averaging 48.6% (90-day weaning age) and 37.3% (60-day weaning age) (Table 5).

3.2 Dam Performance

Dam age, weight at lambing, and weight at weaning were not significantly influenced ($P>0.05$) by birth type (single and twin) or lamb weaning age (60 and 90 days). There was an interaction effect between treatment and birth type ($P=0.01582$) for BCS at birth and a birth-type effect ($P=0.01984$) for BCS at weaning. Single-bearing ewes had a better BCS than those which lambed more than one offspring at a time (Table 6).

Table 6. Production performance of supplemented ewes grazing on *Urochloa brizantha* cv. Marandu pastures according to lamb weaning age (60 or 90 days) and birth type (single or twin)

	Weaning age				SEM	P_1	P_2	P_3
	60 days		90 days					
	Single birth	Twin birth	Single birth	Twin birth				
Age (months)	46.36	48.80	45.27	60.00	2.964	0.38480	0.14201	0,29120
Weight at lambing (kg)	54.15	55.15	54.95	55.94	0.963	0.68139	0.60499	0,92063
Weight at weaning (kg)	49.09	48.43	50.46	52.54	1.111	0.21809	0.74923	0,53593
BCS at lambing	2.18	2.47	2.36	1.71	0.094	0.13532	0.33772	0,01582
BCS at weaning	1.86[a]	1.53[b]	1.68[a]	1.29[b]	0.075	0.16307	0.01984	0,83318

P_1 = effect of weaning age (60 vs. 90 days); P_2 = effect of birth type (single vs. twin); P_3 = interaction between weaning age and birth type; BCS = body condition score.

3.3 Illness and Mortality

No mortality occurred throughout the experimental periods. Only four animals were hospitalized due to intoxication by *Urochloa* spp. (three from the 60-day weaning age group and one from the 90-day weaning age group) and one due to worm infection (60-day treatment) (Table 7).

Table 7. Morbidity rate (%) for worm infection and photosensitization during the experimental period according to treatment (weaning ages)

Morbidity	Weaning age	
	60 days	90 days
Morbidity [1]– Worm infection (%)	2.70 (1/37)	0.00(0/38)
Morbidity[1] – Photosensitization (%)	8.11 (3/37)	2.63 (1/38)

[1] Morbidity rate = n of diseased animals from birth to weaning/n of animals in the category.

3.4 Economic Assessment

Total cost per lamb per day was higher when lambs were weaned at 90 days of age (US$0.1568) compared to those weaned at 60 days old (US$0.1194). The same result was found for EOC per day (US$7.112 vs. US$8.654, respectively). The total EOC during the entire rearing period was higher when the animals were weaned at 90 days of age (Table 8).

Table 8. Costs (US$) of producing lambs and ewes (total/animal) according to weaning age

	Weaning age	
	60 days	90 days
Supplementation of lambs/day	0.1105	0.1477
Tenant farming of lambs/day	0.0089	0.0091
Total cost of lambs/day	0.1194	0.1568
N of lambs/treatment	37	38
Total cost of lambs (animal/day)	4.418	5.960
Supplementation of ewes/day	0.0509	0.0509
Tenant farming of ewes/day	0.0389	0.0389
Total cost of ewes/day	0.0898	0.0898
N of ewes/treatment	30.0	30.0
Total cost of ewes (animal/day)	2.694	2.694
Effective operating cost/day	7.112	8.654
Total effective operating cost	426.72	778.86

Effective operating cost: cost of supplement and tenant farming of lambs + cost of supplement and tenant farming of ewes.

4. Discussion

4.1 Supplement Intake and Lamb Performance

The increasing weaning age influenced average and total supplement intake because the animals ate more solid feed as they grew older, consuming less maternal milk. Providing supplement since birth might have favored the development of the rumen papillae, which stimulates the fermentation of solid-feed particles, resulting in more energy and higher intake to the ruminant. Consequently, weight gain was increased (237 and 290 g/day for the 60- and 90-day treatments, respectively). Probably, after the second and third weeks of life, lambs start to develop their reticulorumen according to the quantity and type of feed supplied, becoming fully functional. After that age, the lamb may be considered a full ruminant, better utilizing the solid feed ingested (Urbano et al. 2017). The average difference in total supplement intake between the lambs weaned at 60 and 90 days of age was 12.3 kg (Table 4), which was probably consumed in the last 30 days of the period in the group supplemented for 90 days. Lambs born from single births were heavier at birth weight than those from twin births (Table 5). According to Ekiz et al. (2012) birth type is a source of great variation for the weights at birth, at weaning, and at 6 and 12 months of age. In the same sense, Bathaei and Leroy (1997) observed that lambs from single births were 20% heavier at birth than twins.

The lambs in the group weaned at 90 days showed a heavier weaning weight, which was due to their greater development and longer supplementation period. The average weaning weights of the lambs in the two treatment groups were 19.6 kg (60 days) and 25.4 kg (90 days). Freitas et al. (2007) found an average TWG of 18.4 kg at weaning in Santa Inês crossbred lambs reared on *Urochloa* humidicola pasture that were weaned at 84 days old, in a creep feeding system. This value is lower than the average 25.4 kg observed at 90 days, in the present experiment (Table 5), which is likely due to the difference in the quality of herbage offered to the animals, besides genetic factors. Melo (2014) evaluated the performance of lambs grazing on *Urochloa* spp. pasture in a creep feeding system and observed a weaning weight of 19.91 kg at 58 days of age, which is similar to the 19.6 kg found in the present study in the group weaned at 60 days old. Monteiro (2016), in turn, found an average weaning weight of 16.0 kg at 64 days of age in animals grazing on *Urochloa spp.*, which is lower than the 19.6 kg mentioned above.

The TWG of ewes + lambs differed between the weaning ages (119.1 and 190.3 kg/ha for 60 and 90 days, respectively). Total weight gain in the lambs was also significantly higher for the group weaned at 90 days of age, although no effects were detected for ADG. This difference in TWG is related to the supplementation period (60 vs. 90 days), which was longer for the lambs weaned at 90 days, regardless of birth type. For this reason, TWG was higher. This fact suggests that weaning at 90 days may be advantageous, considering that the animal will need less time to attain slaughter weight in the finishing stage, especially in the case of farmers specialized in the production of younger animals, for which they are remunerated (Urbano et al. 2017)

The 90-day weaning age group showed superior results for lamb-to-dam weight at weaning

ratio (48.6 vs. 37.3%, respectively), suggesting that ewes which spend more time with their lambs are more productive, including those which bore only one lamb.

4.2 Dam Performance

Despite the equal weight of ewes at lambing and, subsequently, at weaning, there was a birth-type effect for BCS at weaning, which implies that the females which bore two lambs at once mobilized more of their reserves (Table 6). The worse BCS of the twin-bearing ewes might have been due to higher energy requirement for milk production. There was no significant difference for dam BCS according to the treatments ($P>0.05$), which may be related to lamb supplementation and to the similar management between the treatments. Creep feeding might have reduced the energy requirement and provided similar recovery conditions to the ewes. Oliveira et al. (2014) found that daily supplementation for lambs in a creep feeding system optimized the reproductive efficiency of woolless ewes on *Brachiaria* humidicola pasture.

Melo (2014) observed that ewes grazing on *Urochloa spp.* pasture which weaned their lambs at 58 days of age showed a BCS of 1.7 at weaning (1-5 scale), which is exactly the same average value found in the ewes that weaned their lambs at 60 days of age in the present study (Table 5).

Monteiro (2016) supplemented ewes also grazing on Urochloa spp. pasture which weaned their lambs at 64 days of age. The authors found a BCS of 2.3 at weaning, which is higher than the 1.7 obtained in the current study. It should be noted that lamb performance was inferior in their experiment, and this may be related to factors that caused energy to be redirected towards body recovery in the ewes rather than to nurturing their lambs.

4.3 Illness and Mortality

Weaning age did not influence the occurrence of diseases. There was only one case of worm infection, which was found in the 60-day treatment (Table 7). No animals died, which was likely a consequence of the good animal performance in the first two treatments (Table 5) provided by the supply of high-quality herbage (Table 2) and supplement intake (Table 4). According to Silva (2016) and Melo et al. (2017), creep-feeding lambs is an effective strategy, as it increases their ADG and reduces parasitic load as well as the number of cases of hepatogenic photosensitization.

Both treatment groups exhibited cases of intoxication by *Urochloa spp.* (Table 6)—three in the group of lambs weaned at 60 days and one in the group weaned at 90 days. Photosensitization occurred in only a few animals probably due to greater predisposition or resistance to this illness. According to Pupin et al. (2016), sheep may have genetic factors that make them resistant to intoxication by *Urochloa spp*. and thus not manifest these problems.

4.4 Economic Assessment

The total EOC of lambs was higher in the 90-day treatment (Table 8). This finding is in consistent with the higher intake and weight at weaning, which were a consequence of longer grazing time and supplementation. As regards the ewes, there was no difference for the costs

of supplementation and tenant farming or number of ewes per treatment. The ratio between cost of supplement and daily gain (R$/kg gain) was 0.000768 and 0.000707 for the groups weaned at 60 and 90 days, respectively. Therefore, the 90-day weaning age treatment was more economic.

5. Conclusion

We recommend to wean lambs at 90 days of age in a creep feeding system on *Urochloa brizantha* cv. Marandu pasture. Because this type of management allows weaning heavier lambs more economically, which can reduce finishing time and increase the profit margin of the producer.

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