



Influence of weaning age on the reproductive efficiency of primiparous cows

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ABSTRACT - The effects of weaning age (90 days or 156 days) of female beef calves were evaluated on their subsequent performance from the beginning of the first pregnancy and the end of the second breeding season, at 22/24 months of age. During pregnancy, heifers were managed as a single group on *Brachiaria brizantha* cv. Marandu pasture; after calving, on bristle oats (*Avena strigosa* Schreb) and ryegrass (*Lolium multiflorum* Lam.); and on *Brachiaria humidicula* pasture during the second reproductive period. The characteristics studied were not influenced by calf weaning age. Heifers submitted to early or conventional weaning weighed 354.5 and 351.9 kg in the post-calving, and 363.4 and 359.2 kg when they weaned their calves. Average daily gain during the breeding season was 0.562 kg, and body condition score was 3.10 and 3.93 at the beginning and end of the experiment, respectively. Average calf birth and weaning weights were not influenced by dam weaning age, and were 28.7 ± 0.74 ; 86.5 ± 3.26 and 27.4 ± 0.92 ; 90.3 ± 4.04 kg, respectively, for dams submitted to early or conventional weaning. Dystocia, calving, birth, and weaning rates were not different between weaning ages, with mean values of 29.5; 95.3; 77.3 e 73.4%. Conception rates were 47.9% in the initial third and 40.8% in the second third versus 11.3% in the final third of the breeding season. Heifer average age at conception was 438 and 434 days for early weaning and conventional weaning. Pregnancy rates and production efficiency estimates at calving and calf weaning were not affected by heifer weaning age. Heifer early weaning did not affect their subsequent performance until the end of the second breeding season, at 22/24 months of age.

Key Words: body condition, early weaning, heifers, pregnancy rate, weaning age, weight gain

Influência da idade de desmame na eficiência reprodutiva de vacas primíparas

RESUMO - Avaliaram-se os efeitos da idade de desmame (aos 90 dias e aos 156 dias) de bezerras de corte sobre o seu desempenho subsequente entre o início da primeira gestação e o final do segundo período reprodutivo, aos 22/24 meses de idade. Durante a gestação, as novilhas foram manejadas em grupo único em pastagem de *Brachiaria brizantha* cv. Marandu; após o parto, em pastagem de aveia (*Avena strigosa* Schreb) e azevém (*Lolium multiflorum* Lam.); e, no segundo período reprodutivo, em pastagem de *Brachiaria humidicula*. As características estudadas não foram influenciadas pela idade de desmame das bezerras. Os pesos vivos pós-parto foram de 354,5 e 351,9 kg e, ao desmame de seus bezerros, 363,4 e 359,2 kg para as bezerras submetidas aos desmames precoce e convencional. O ganho de peso médio diário no período reprodutivo foi 0,562 kg e o escore de condição corporal, de 3,10 no início e 3,93 no final do experimento. Os pesos médios dos bezerros no nascimento e no desmame não foram influenciados pela idade de desmame das mães, com valores de $28,7 \pm 0,74$; $86,5 \pm 3,26$ e $27,4 \pm 0,92$; $90,3 \pm 4,04$ kg, respectivamente, para as mães submetidas aos desmames precoce e convencional. As taxas de distocia, partição, natalidade e desmame não diferiram entre as idades de desmame, com valores médios de 29,5; 95,3; 77,3 e 73,4%. As taxas de concepção foram de 47,9% no terço inicial e 40,8% no terço intermediário e 11,3% no terço final do período reprodutivo. A idade média à concepção foi de 438 e 434 dias para as novilhas do desmame precoce e do desmame convencional. A taxa de prenhez e as estimativas de eficiência produtiva ao parto e ao desmame dos bezerros não foram alteradas pela idade de desmame das vacas quando bezerras. O desmame precoce de bezerras não afeta seu desempenho subsequente até o final do segundo período reprodutivo, aos 22/24 meses de idade.

Palavras-chave: condição corporal, desmame precoce, desmame à idade convencional, ganho de peso, novilhas, taxa de prenhez

Introduction

Reproductive efficiency is essential in breeding-to-fattening systems or cow-calf systems, where cows are

maintained for the production and sale of weaned calves. Under native pasture conditions, excessive stocking rates, beyond pasture capacity, result in low pregnancy rates (Simeone & Lobato, 1996; Quadros & Lobato, 1996;

Fagundes et al., 2003). In addition, the presence of the suckling calf inhibits the release of reproductive hormones (Short et al., 1990), particularly in cows with low body condition score.

Under these conditions, the use of management practices, such as early weaning, is required to improve reproductive efficiency (Simeone & Lobato, 1996; Restle et al., 2001; Almeida et al., 2002). In his literature review, Simeone (1995) quoted by Lobato (1997), obtained 71.3% average pregnancy rates in cows submitted to early weaning, and 28.3% in cows whose calves were weaned at 7 months of age.

However, early weaning is an alternative to improve body condition and pregnancy rates of cows in beef systems with high stocking rates or to attenuate annual weather effects, which are frequent in pasture systems, as it eliminates the nutritional cost of lactation, decreasing beef cow nutritional requirements (Lobato et al., 2000; Restle et al., 2001). On the other hand, early weaning may impair calf development (Simeone & Lobato, 1998), reducing the possibility of finishing steers at 14-15 or 24 months of age (Restle et al., 1999; Pötter & Lobato, 2003).

In breeding-to-fattening systems, the reproductive performance of primiparous females with a suckling calf is low, regardless of the age at first calving (Costa et al., 1981; Restle et al., 2001), as these females are still growing (Freetly, 1999) and their live weight and body condition at calving and at the beginning of their second reproductive cycle are inadequate (Gottschall & Lobato, 1996; Rovira, 1996; Fagundes et al., 2003).

Considering the need to intensify production systems and to obtain higher productivity in kg of weaned calf per female bred, this study was carried out to evaluate the reproductive and productive performance of primiparous cows weaned, on average, at 90 days or 156 days of age.

Material and Methods

The experiment was carried out on Itú Farm, Itaqui, on the western border of Rio Grande do Sul, Brazil, latitude 29° 12' south and longitude 55° 36' west. The terrain consists of hills and valleys, with deep, naturally-acid soils with intermediate surface texture. According to the mapping units Júlio de Castilhos and Tupanciretã, the soil is classified as red podzolic latosol (EMBRAPA, 1999). The climate is subtropical, according to Köppen's classification (Moreno, 1961).

Pregnancy was diagnosed using ultrasound on March 3rd, 2006, i.e., 31 days after the end of the heifers first

breeding season, and on March 15th, 2007, when these females had their first calves.

The primiparous females analyzed in the experiment belonged to an extensive study on the effect of early weaning (at an average age of 90 days) in a breeding-to-fattening system. The Braford heifers used in the experiment were born in the spring of 2004, between September 7th and October 15th, and were daughters of 3-year-old primiparous cows. These heifers had been submitted as calves either to early weaning (23 female calves weaned at an average age of 90 days) or to conventional weaning (21 female calves weaned at an average age of 156 days).

These heifers were reared from birth to breeding as described by Vaz & Lobato (2010a), and the first breeding season, from 13-15 months of age to pregnancy diagnosis, was described by Vaz & Lobato (2010b). After March 3rd, 2006, these 44 heifers grazed on native pasture, and were managed for approximately 60 days before calving on *Brachiaria* (*Brachiaria brizantha* cv Marandu) pasture. After calving, they were managed on winter-spring pasture, consisting of bristle oat (*Avena strigosa*) and ryegrass (*Lolium multiflorum*), at an average stocking density of 1.050 kg live weight/hectare. After being removed from this pasture (on Nov 10th, 2006), they grazed on *Brachiaria humidicola* until the end of the second breeding season.

Continuous grazing was used, and forage availability was periodically estimated by a comparative method (Haydock & Shaw, 1975) on the days the females were evaluated. The collected samples were identified, weighed, and stored according to collection day. Samples were analyzed at Animal Nutritional Lab of the School of Agronomy, UFRGS, and Table 1 shows the results for crude protein (CP) and neutral detergent fiber (NDF) contents according to the techniques described by the AOAC (1984).

The 74-d breeding season using natural mating lasted from Nov 24th, 2006 to Feb 6th, 2007. Two-year-old Braford sires, with negative expected progeny difference (EDP) for birth weight, were used. The bulls had been previously submitted to breeding soundness and libido tests. A 1:25 bull to cow ratio was applied.

The heifers were weighed every 28 days from pregnancy diagnosis until 24 hours after calving (CLW), when their calves were weaned (WLW), and at the start and end of the breeding season, at 28 months of age. Average weight gain was determined as the weight difference between weighings divided by the number of days between weighings.

At weighing, the females were scored for body condition (Lowman et al., 1973), on a scale of 1 to 5, with

Table 1 - Forage mass (MF), crude protein (CP) and neutral detergent fiber (NDF) percentages of the pastures used during the experimental period

Item	Period	Forage mass (kg/ha MS)		Crude protein (%)		Neutral detergent fiber (%)	
		Mean	Variation	Mean	Variation	Mean	Variation
				2006			
Native pasture	Mar-Jul	1670	1530-1890	5.64	5.16-6.22	72.9	69.3-75.2
<i>Brachiaria brizantha</i>	Aug-Oct	1280	1130-1410	5.10	5.00-5.15	73.2	72.8-73.4
Oat + ryegrass	Sep-Nov	1890	1820-1960	12.2	12.0-12.4	55.4	55.0-55.8
<i>Brachiaria humidicola</i>	Oct-Dec	2705	2540-2870	7.32	7.26-7.38	73.9	73.4-74.4
				2007			
<i>Brachiaria humidicola</i>	Jan-Mar	3050	3080-3730	5.94	5.91-5.97	72.2	72.0-72.3

1 as very thin and 5 as very fat. Calves were identified and weighed at birth, and were weaned on Nov. 20th, 2006, before the start of the breeding season, when the youngest calf was 60 days old.

At weaning (on average, 78 days post-calving), milk production was estimated using the indirect method by Melton et al. (1967). Calves were separated from their dams from 12:00 pm to 06:00 pm, when they were reunited to the dams and allowed to suckle, aiming at emptying the udder. After that, the calves were again separated from their dams until next morning, or 12 hours of fasting, and were weighed, allowed to suckle until they stopped, and weighed again. Milk production in the period and in 24 hours was estimated by the weight difference between weighings, considering the time interval between suckling.

From the beginning of the experimental period, animals had free access to a mineral mixture containing common salt and dicalcium orthophosphate, with 60 ppm phosphorus (P). During the breeding season, the mixture contained 80 ppm phosphorus. The experimental animals were submitted to the same health management as the other animals on the farm, and according to the legislation.

The percentage of heifers that calved was expressed as calving rate; birth rate corresponded to the percentage of live calves after the first 24 hours post-calving; weaning rate corresponded to the percentage of weaned calves. These percentages were relative to the number of pregnant heifers at the beginning of the experiment. The dystocia rate included all primiparous cows that required any assistance during calving due to causes ranging from calf malposition to small pelvic area, and was relative to the number of cows that calved.

After calving, all the females that lost their calves were removed from the experiment, and only cows with calves were kept as experimental units. Pregnancy rate represented the percentage of pregnant cows with suckling calves.

The reproductive efficiency of the cows was estimated at calving and weaning, according to the methodology

described by Ribeiro et al. (2001). The estimates were determined relative to weaned calf weight, in kg, for each 100 kg of cows that calved: $PEC = (W100/CLW) * 100$; for each 100 kg of cow with weaned calf: $PEW = (W100/WLW) * 100$, where W100 is calf weight adjusted to 100 days of age.

A randomized complete design was applied and the results were submitted to analysis of variance and the F test, using the following mathematic model:

$$Y_{ijkl} = \mu + A_i + S_j + (T*S)_{ij} + IN_k + CD_l + \Sigma_{ijkl}$$

where: Y_{ijkl} = dependent variables; μ = mean of all observations; A_i = effect of the i-th age at weaning, with $i=1$ (early weaning) and 2 (conventional weaning); S_j = effect of the j-th calf sex, with $j = 1$ (male) and 2 (female); $(T*S)_{ij}$ = effect of the interaction between the effect of the i-th age at weaning and the effect of the j-th calf sex; IN_k = covariate calf age of the k order; CD_l = effect of calving date of heifers of the l order; Σ_{ijkl} = residual error.

The weight and body condition score were analyzed statistically using the GLM procedure of the SAS software package, version 6.08 (SAS, 1997), adopting 5% as maximum significance level in the F test. The pregnancy rate, calving rate, birth rate, weaning rate, and dystocia rate were analyzed by the Chi-Square test at 5% significance level.

Results and Discussion

There was no effect of the interaction ($P > 0.05$) between weaning age of primiparous cows as calves and the sex of their calves on any of the evaluated reproductive performance parameters. Average cow weights after calving and at weaning were similar ($P > 0.05$) between cows' weaning ages as calves and their calves' sex (Table 2). Cows of both weaning ages presented virtually the same average weights at calving, at weaning, and the same weight gain between these periods.

Average post-calving weight, 353.2 kg, was below the target for the studied animal class, because the heifers were still growing at the beginning of the lactation

period (Freetly, 1999). Despite having finished their first breeding season as heifers with the minimum average weight of 296.5 kg for their class (NRC, 1996), weight gain during pregnancy was only 56.7 kg. According to Lobato (1997) and Pötter et al. (2004), the development of pregnant heifers to achieve proper mature weight and high pregnancy rate as first-calf cows, requires weight gains higher than 100 kg from the end of the first breeding season to the first calving, when they should reach approximately 400 kg.

The low weight gain between the end of the conception period and calving may be explained by the nutritional restriction during the pre-calving period, as demonstrated by forage availability (1,475 kg), and by NDF (73.1%) and crude protein (5.37%) contents. Forage limitations during the pre-calving period result in low weight and poor body condition at calving, causing low reproduction indexes (Gottschall & Lobato, 1996).

Pre-calving nutritional level influences reproductive response and the duration of the anestrus period (Wiltbank et al., 1964), with more pronounced effects on first- and second-calving cows (Short et al., 1994). Adequate feeding during the last months of pregnancy may increase the percentage of cows cycling at 60-80 days post-calving (Osoro, 1986).

Despite grazing on bristle oat and ryegrass pasture from calving until the beginning of the breeding season, the mean daily gain of the cows was only 0.100 kg. Several studies have reported low weight gains in primiparous cows, between 0.100 and 0.300 kg/d, during the post-calving period, regardless of age (Restle et al., 2001; Pilau & Lobato, 2008). The results demonstrated the energy cost of milk production (NRC 1996), and that feed intake is directed to milk production (Restle et al., 2001).

In the present study, due to administrative restrictions and area limitations, one paddock was previously deferred to receive the heifers after calving, possibly reducing its quality due to changes in the structure of its leaf blades (Aguinaga et al., 2006). Later, a high stocking rate, of 1,050 kg live weight/ha (three cows/ha), associated to the

class of growing primiparous cows and the energy cost of milk production, contributed to the low average daily weight gain of the cows. High stocking rates do not allow selectivity, and result in intakes below the required for optimal individual performance (Pilau & Lobato, 2006).

Lobato & Magalhães (2001), in a study with 24 to 26-month-old Hereford and crossbred Hereford cows managed during the post-calving period on native pasture improved with the introduction of ryegrass, white clover, and bird's foot trefoil at a stocking rate of 1.5 cow/ha, observed higher weight gains, of 0.510 kg/d, from calving until the beginning of the next breeding season, as compared to the present study. These authors attributed this performance to pasture availability and quality (1,816 kg DM, 8.28% CP, and 62.1% DM *in vitro* digestibility).

In order to achieve good reproductive performance during the breeding season, which begins 60 to 90 after calving, cows must be fed to have adequate weight gain rates. Ribeiro et al. (1990) observed low pregnancy rates (5.8%) in primiparous cows that lost weight between calving and the end of the breeding season. According to Lobato et al. (1998), the reproductive performance of Devon cows was not affected by slight weight loss during the post-calving period, provided that weight at calving was adequate (409.2 kg). Short et al. (1994) and Lobato et al. (1998) stressed that, in addition to weight at calving, body condition also influences cows reproductive performance.

As the breeding season started on Nov 24th, 2006, immediately after the calves were weaned (Nov 11th, 2006), and the cows were still under the stress of weaning, they presented the same weight at weaning and at the beginning of the breeding season (Table 3).

Average weight and body condition score at the beginning and end of the second breeding season were not different between cows weaned at different ages as calves. It is recommended that beef cows achieve at least 85% of their mature weight at the beginning of the second breeding season (NRC, 1996). As the average mature weight of the cows in the herd studied was 450 kg, the minimum average

Table 2 - Mean post-calving and weaning weights and mean weight gain between calving and weaning of 22/24-month-old primiparous cows submitted to early or conventional weaning as calves

Item	Number of cows	Weight, kg			
		Calving	Weaning	Daily weight gain	
Age at weaning	Early weaning	23	354.5 ± 7.10	363.4 ± 7.97	0.105 ± 0.050
	Conventional weaning	21	351.9 ± 8.81	359.2 ± 8.89	0.097 ± 0.062
Calf sex	Male	20	353.3 ± 9.00	361.4 ± 10.1	0.092 ± 0.063
	Female	24	353.1 ± 6.47	361.3 ± 7.27	0.110 ± 0.045
	Mean		353.2	361.3	0.101
	CV (%)		8.11	8.90	19.7

Means were not different ($P > 0.05$) by t-test.

weight required to obtain adequate reproductive levels should be 383 kg, which is higher than the observed 361.3 kg.

Body weight at the beginning of the breeding season was not optimal for primiparous cows; however, it was similar to the 367.6 kg observed by Lobato & Magalhães (2001) under feeding conditions that were slightly better than those of the present study. The body weight observed at the beginning of the breeding season was higher than the 311 kg determined by Gottschall & Lobato (1996), working with inferior nutritional conditions – native pasture with 1,100 kg DM/ha of forage availability – as compared to the present study, and obtained an average pregnancy rate of 7.9%. Those authors concluded that, under those circumstances, native pasture was not sufficient to promote greater weight gain and faster recovery of the body condition of primiparous cows.

Presenting body weights lower than those recommended by the NRC (1996) and by Rovira (1996), the cows' body condition allowed the early weaning of calves at the beginning of the second breeding season (Rovira, 1996), i.e., 3.1 score points. After the early weaning of their calves, the cows started to direct pasture nutrients, which were previously used for milk production, to body development and fat deposition, resulting in greater body weight and better body condition.

Daily weight gain during the breeding season was not different as a function of the cows weaning age as calves, and was 0.562 kg, on average. The increase in body condition score was 0.83 in this period, being 3.10 at the beginning of the breeding season and 3.93 at the end. High pregnancy rates and shorter intervals between calvings, as well as conception at the beginning of the breeding season, are obtained when body condition scores are higher than 3.5 at the beginning of the breeding season (Lobato et al., 2000; Restle et al., 2001; Pötter et al., 2004).

Primiparous cows and mature cows with poor body condition scores at calving usually do not have time to recover and to conceive in the next breeding season, or have delayed conception, even with the use of early weaning

(Moojen et al., 1994; Almeida et al., 2002; Fagundes et al., 2003). Rovira (1996) recommended early weaning at earlier ages, at approximately 60 days post-calving, when cows present poor body condition, to improve their physiological condition, and consequently, their pregnancy rates.

Simeone & Lobato (1996), used early weaning after the first half of the breeding season and observed considerable weight gain in cows grazing on native pasture. Cows submitted to early weaning went from 0.245 kg/d weight loss to 0.410 kg/d weight gain, and finished the breeding season with 0.67 higher body condition score as compared to those submitted to conventional weaning.

The heifers weaning age did not affect their conception period at 13-15 months of age, nor their pregnancy rate after the first calving (Table 4). The highest concentration of conception occurred in the initial and intermediate periods of their first breeding season, and this was also observed in their second breeding season. This result is consistent with the findings of Osoro (1986) that heifers that conceive at the beginning of the breeding season and calve at the beginning of the calving season are those that present the highest pregnancy rate as primiparous cows. A higher calving concentration at the beginning of the calving season allows a greater calving interval at the end of the second breeding season.

Rocha & Lobato (2002) concluded that female calf weight at weaning is a good indicator to design nutritional strategies to obtain a higher number of conceptions at the beginning of breeding and in the next breeding season, and, despite lactation, to favor higher pregnancy rates. Average age in days to conception was not different between heifers weaned at different ages, making feasible – biologically at least – pregnancy at 13/15 months of age in intensive production systems. This allows the farmer to specifically and strategically feed leaner female calves, aiding their development and possible pregnancy (Pereira Neto & Lobato, 1998), or at least to identify individuals with better response and development. This practice promotes selection for precocity and higher herd fertility (Fries, 2003).

Table 3 - Live weight and body condition score (BCS) at the beginning and end of the breeding season, and daily average weight gain of 22- to 24-month-old primiparous cows submitted to early weaning or conventional weaning as calves

Variables	N	Initial weight, kg	Final weight, kg	Daily weight gain, kg	Initial BCS	Final BCS
Early weaning	23	363.4 ± 7.97	410.6 ± 9.2	0.638 ± 0.156	3.15 ± 0.06	3.93 ± 0.07
Conventional weaning	21	359.2 ± 8.89	395.3 ± 11.4	0.489 ± 0.143	3.04 ± 0.08	3.91 ± 0.06
Male	20	361.4 ± 10.1	404.5 ± 11.7	0.582 ± 0.153	3.17 ± 0.08	3.89 ± 0.06
Female	24	361.3 ± 7.27	401.3 ± 8.4	0.540 ± 0.151	3.03 ± 0.06	3.95 ± 0.07
Mean		361.3	402.9	0.562	3.10	3.93
CV (%)		8.90	9.25	19.8	8.50	7.79

Means were not different ($P>0.05$) by t-test.

Table 4 - Conception period, age at conception, and pregnancy rates in the first and second breeding seasons of 22- to 24-month-old primiparous cows submitted to early weaning or conventional weaning as calves

Age at weaning	Conception period (%)			Age at conception, days	Pregnancy, %
	Initial	Intermediate	Final		
Early weaning	43.5	43.5	13.0	438 ± 1.51A	69.6a
Conventional weaning	52.4	38.1	9.5	434 ± 1.88B	57.1a
Mean	47.9a	40.8a	11.3b	436	63.4
Second pregnancy, %	38.7a	38.7a	22.6b		

a,b in the same row are different ($P < 0.05$) by Chi-Square test.
A,B in the same column are different by the t-test.

The use of early weaning at the beginning of the breeding season promoted 63.4% average pregnancy rate, which was lower than that obtained by Lobato (1997), of 71.3%. Pregnancy rates lower than 80% damage the production performance of breeding-to-fattening beef cattle production systems (Beretta et al., 2001).

The 3.93 body condition score and the 402.9 kg average body weight at the end of the breeding season should have been sufficient to result in better performance (Table 3). However, the poor reproductive performance observed may be explained by the average weight gain of only 8.1 kg during the average 78-day period between calving and weaning (Table 2). The calves were weaned on Nov 20th, and the breeding season started on Nov 24th, 2006. Despite the average daily gain of 0.562 kg/d during the breeding season, its 74-day duration was not sufficient to allow a higher number of first-calf cows to gain enough weight to begin cycling. Pötter & Lobato (2004) stressed that the period between early weaning and the end of the breeding season is an important source of variation in the success of the application of early weaning. Fagundes et al. (2003) did not observe any significant difference ($P > 0.05$) in pregnancy rates between weaned or non-weaned animals, and attributed this fact to the short period of 37 days between early weaning and the end of the breeding season.

The average pregnancy repetition rate of 63.4% is between the 67 and 87% rates reported by Pilau & Lobato (2008), using the same animal class and different feeding

sequences during the pregnancy of heifers. Pilau & Lobato (2008), using better feeding conditions near the pre-calving period of primiparous heifers, obtained 85% pregnancy repetition rate, demonstrating the care needed with this animal class.

On the other hand, Lobato & Magalhães (2001), also working with 24- to 26-month-old primiparous heifers, observed a 93.1% pregnancy repetition rate. In another study with first-calf heifers, but in this case with 36 months of age and improved pastures in the post-calving period, Lobato et al. (2000) obtained 100 and 89.5% pregnancy rates in cows submitted to early or conventional weaning, respectively.

There was no difference ($P > 0.05$) between weaning ages as to birth weight, weaning weight, average daily weight gain, or dam milk production (Table 5). Calf development from birth to weaning was reasonable, considering growth requirements in intensive production systems breeding heifers at 14 months of age, and finishing steers at 14-16 months of age. Calves presented 0.730 kg/d average daily gain, which was similar to that reported by Restle et al. (2004a), of 0.717 kg/d from birth to 98 days of age for calves of multiparous cows grazing cultivated winter pastures (oat+ryegrass), whereas those maintained on native pasture presented 0.517 kg/d.

Calf weight gain is highly dependent on the dam's milk production in the initial phase (Ribeiro et al., 1991; Quadros & Lobato, 1997). The literature reports diverse results on

Table 5 - Average birth weight, weaning weight (78 days), and average daily gain from birth to weaning of calves of 22- to 24-month-old primiparous cows, and milk production

		Number of animals	Weights, kg			
			Birth,kg	Weaning,kg	Daily weight gain, kg	Milk production, L
Weaning age	Early weaning	23	28.7 ± 0.74	86.5 ± 3.26	0.702 ± 0.037	4.4 ± 0.6
	Conventional weaning	21	27.4 ± 0.92	90.6 ± 4.04	0.758 ± 0.046	5.4 ± 0.8
Calf sex	Male	20	28.8 ± 0.94	87.9 ± 4.13	0.716 ± 0.047	4.7 ± 0.8
	Female	24	27.2 ± 0.68	89.2 ± 2.97	0.744 ± 0.044	5.1 ± 0.6
	Mean		28.0	88.6	0.730	4.9
	CV (%)		9.72	14.9	20.4	57.8

Means were not different ($P > 0.05$) by the t-test.

beef cow milk production, as it depends on several factors, including environment and nutritional level (Moojen et al., 1994; Quadros & Lobato, 1997; Freetly & Cundiff, 1998; Restle et al., 2007), genetic line (Fagundes et al., 2004, Cerdótes et al., 2004; Vieira et al., 2005), age or parity (Cerdótes et al., 2004), and sex and calf genetic line (Restle et al., 2004a, b).

The average milk production of 4.9 L obtained on weaning date is capable of promoting proper calf development, particularly those born from 22- to 24-month-old primiparous cows. Quadros & Lobato (1997) obtained higher milk production as compared to the present study, with an average of 5.96 L/d during six months of evaluation of 2- and 3-year-old cows, and average calf daily gain of 0.722 kg/d. Fagundes et al. (2004) obtained 6.21 L/d milk production in ½ Hereford ½ Nellore, and 5.83 L/d in ¼ Nellore ¾ Hereford primiparous cows.

Calf sex did not influence milk production, as reported by other authors (Kress et al., 1990; Ribeiro et al., 1991; Fagundes et al., 2004). Dystocia, calving, birth, or weaning rates were not affected by the weaning age of the studied females (Table 6). The 29.5% dystocia rate was consistent with the findings of Reynolds et al. (1991) in Angus and Hereford cows (27 to 30%). Rocha & Lobato (2002) observed 20.58% dystocia in Hereford and Braford primiparous cows, a lower rate compared to the previously mentioned study. Angus heifers also bred at 13/15 months of age presented 19.7% dystocia in the study of Pilau & Lobato (2008).

The difference between calving rate and birth rate was 18%, which was higher than the 12.5% determined by Pilau & Lobato (2008), who observed a considerable increase in dystocia in heifers kept on low-quality native pastures at the beginning of pregnancy, as compared to those grazing on a cultivated millet pasture, with better quality (26.7 and 12.7%, respectively).

Maintaining birth and weaning rates is essential for production systems, showing the importance of post-calving management on calf survival (Pilau & Lobato, 2008). The use of semen from Red Angus sires, which produce calves with lower birth weight, was one of the variables used by Vaz (1998) in Charolais, Nellore, and crossbred 22/24-month-old primiparous cows to obtain low dystocia rates

(5.3%), as well as pre-calving nutritional management to prevent excessive fetal growth at the end of gestation. Short et al. (1994) cautioned that reducing age at first weaning may determine an increase in dystocia, and may result in lower production efficiency.

Dystocia may be caused by factors such as calf weight and malposition (Rovira, 1996). According to Bellows & Short (1978), small pelvic areas and poor body condition are the main dam characteristics associated to dystocia. Dystocia incidence may be reduced by selecting heifers with larger pelvic areas and the use of sires with expected progeny differences negative for birth weight. Heifers and cows must have the genetics for low birth weight and calving ease. The correct feeding management in the final third of gestation, using feed restriction, is essential for reducing excessive fetal growth (Rovira, 1996).

A 3.9% decrease (5.31%) was observed between calf birth rate and weaning rate, differently from the study by Pilau & Lobato (2008), in which birth and weaning rates were similar (84.4%) and higher than those in the present study.

Calf weight at weaning was adjusted to 100 days of age (AW100) and the means were adjusted to calculate production efficiency (kg weaned calf/100 kg cow) at calving (PEC) and at weaning (PEW), which was not affected by the weaning age of the dams as calves (Table 7).

Average production efficiency at calving was 25.6 and average production efficiency at weaning was 29.1 kg weaned calf/100 kg cow. Using cows lighter than those in the present study, Pilau & Lobato (2008) observed higher production efficiency values at calving (30.3 kg) and at weaning (28.1 kg). Ribeiro et al. (2001), worked with 4-year-old primiparous Aberdeen Angus and Charolais cows and found higher values: 42.9 and 33.8 kg weaned calf/100 kg cow at calving, and 40.1 and 34.2 kg weaned calf/100 kg cow at weaning, respectively. The authors concluded that, despite producing more milk and weaning heavier calves, Charolais cows were less productive compared to the Aberdeen Angus cows, as shown by the high efficiency measurements.

Breeding at 13/15 months of age becomes feasible and efficient when it increases the productive efficiency of the breeding herd (Pötter et al., 1998; Beretta et al., 2001). Cows calving for the first time at 22/24 months of age were biologically more efficient than those that calved at older ages (Morris, 1984). Herds with a higher number of breeding heifers have a higher number of young cows, with lower average body weight, increasing the biological efficiency, provided the same reproductive rates are maintained (Beretta et al., 2001).

Table 6 - Dystocia, calving, birth, and weaning rates (%) of 22- to 24-month-old primiparous cows submitted to early weaning or conventional weaning as calves

Age at weaning	Dystocia	Calving	Birth	Weaning
Early weaning	30.4	100.0	78.3	78.3
Conventional weaning	28.6	90.5	76.2	68.4
Mean	29.5	95.3	77.3	73.4

P>0.05 (Chi-Square test).

Table 7 - Calf weight adjusted to 100 days of age and production efficiency averages at calving and weaning of 22- to 24-month-old primiparous cows weaned at different ages

Age at weaning	Weight 100 days	Production efficiency at calving	Production efficiency at weaning
Early weaning	102.0+3.75	24.8+1.16	28.3+1.28
Conventional weaning	106.2+4.65	26.5+1.44	29.9+1.58
Mean	104.1	25.6	29.1
CV (%)	14.6	15.9	17.8

Means were not different ($P>0.05$) by t-test.

Production efficiency at calving = (Weight adjusted to 100 days / Dam live weight at calving)*100.

Production efficiency at weaning = (Weight adjusted to 100 days / Dam live weight at weaning)*100.

Production efficiencies = kg weaned calf / 100 kg cow.

Conclusions

The use of the technique of early weaning did not influence the development and the performance of 22/24-month-old primiparous cows. The milk production of 22/24-month-old primiparous cows, at 78 days of lactation on average, was not influenced by their ages at weaning as calves. Heifers that conceive and calf at the beginning of the breeding season presented higher pregnancy rates in the next breeding season.

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