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Weight at conception and gestational gains in the efficiency of beef cows and progeny performance

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Abstract: The aim of this study was to evaluate the effects of conception weight and gestational weight gain on performance and productive efficiency in beef cows and their calves. Eighty-eight primiparous, three-year old Braford females were used, divided according to weight at conception and gestational performance (High and Low): cows with a low conception weight and low gestational weight gain (LL), cows with low conception weight and high gestational weight gain (LH), cows with high conception weight and low gestational weight gain (HL), and cows with high conception weight and high gestational weight gain (HH). At calving, HH cows were heavier than LH and HL and these were heavier than LL cows. Male calves born to HH cows were superior in body weight to those born to LL cows at 150, 210 and 365 days. Female calves born to HH, HL or LH cows were superior to those born to LL cows in pregnancy at 14 months of age. The LL and HL cows were more efficient in calf production. Actual fertility was influenced by the nutritional level of the herd, where HH cows were superior than LL cows. Better cow herd nutrition increases the development and performance of the progeny.

Key words: foetal programming, reproduction, feed restriction, productivity.

INTRODUCTION

Due to their lower efficiency, breeding herds are largely kept in natural pastures. Generally, natural pastures do not have the necessary nutritional quantity or quality for the increased demands for breeding, or later during pregnancy or during lactation after calving (Vaz & Lobato 2010).

In certain situations, this restriction can cause a loss in weight and in the body condition of the cows (Colazo et al. 2009). These factors are determinants of longer birth-to-conception intervals and, consequently, a delay in the production system, which together determine animal early culling (Bohnert et al. 2013, Marques et al. 2016).

Nutrient intake during pregnancy may determine the performance of breeding cows in relation to the development of their offsprings. After conception, alterations occur in the cow's organism so that nutrient partitioning prioritises pregnancy maintenance and foetus formation (Duarte et al. 2013). A surplus or deficit of nutrients consumed by the cow can influence prenatal foetal development (Tsuneda et al. 2017), since maternal nutrition can modify the uterine environment during gestation or during the growth phase (Du et al. 2010), which, in the event of malnutrition, may impair development in the offspring. Such inadequate nutrition delays development of the reproductive tract, retarding puberty in the young heifers and resulting in lower reproductive performance and reduced longevity in heifers born to undernourished cows (Funston et al. 2010), in addition to less development of muscle and fat, and less marbling of the meat (Wang et al. 2018).

Not only the nutrition, but also the body weight of cows at conception and calving are important for their performance and that of their calves (Torres et al. 2015, Cooper-Prado et al. 2018). As such, the aim of the present study was to evaluate conception weight in primiparous cows together with gains in body weight during the second gestation, as well as the performance and efficiency of beef cows and their offsprings, up to mating the new heifers or slaughtering the male calves.

MATERIALS AND METHODS

Compliance with ethical standards

The study was approved by the Ethics Committee of Animal Use of Federal University of Pelotas (Approval number CEEA nº. 8250-2015) and was developed considering the national guidelines for care and use of animals.

Definition of experiment groups, production system and investigated characteristics

The experiment was carried out at the Granja Itú Farm in Itaqui, Rio Grande do Sul, at 29°12 ‘ S and 55°36’ W. The terrain in the region has small hills of deep soil, naturally acidic, with a medium surface texture. The soil is classified as a dystrophic Red Latosol (Embrapa 1999), and the climate is subtropical, as per the Köppen classification (Moreno 1961).

Eighty-eight primiparous Braford cows, 36 months of age and weaned at 90 days postpartum, were divided by body weight at the second conception and by daily weight gain during the second gestation, into high and low, based on the mean values of the individuals under evaluation, thereby forming four groups of cows: LL - cows which were light at conception (mean weight 326.01 ± 4.15 kg) with low gestational weight gains (mean daily gain <0.170 ± 0.038 kg); LH - cows which were light at conception (mean weight 317.3 ± 4.73 kg) with high gestational weight gains (mean daily gain >0.260 ± 0.043 kg); HL - cows which were heavy at conception (mean weight 358.32 ± 4.32 kg) with low gestational weight gains (mean daily gain <0.106 ± 0.038 kg) and HH - cows heavy at conception (mean weight 363.56 ± 4.26 kg) with high gestational weight gains (mean daily gain >0.226 ± 0.040 kg).

The cows were managed as a single group and kept at a mean stocking rate of 360 kg/ha (0.8 AU/ha - Animal Unit) in natural pastures until calving. After calving until the end of the breeding season, they were kept in a pasture of Brachiaria Brizanta (*Brachiaria brizantha* ‘Marandu’), at a stocking rate of 450 kg/ha (1 AU/ha), with an average of 2,305 kg DM/ha offered during the period. These pastures had mean values of 8.89 and 6.50% for crude protein, 69.6 and 71.2% for neutral detergent fibre, for the natural pastures and Brachiaria Brizanta.

Early weaning was carried out during January, when the calves reached 90 days of age. After weaning the calves were kept during the summer and autumn period in a pasture of millet (*Pennisetum americanum*) at a stocking rate of eight calves/ha (920 kg/ha), and in April they grazed on *Braquiária Brizanta* at a stocking rate of four calves/ha (430 kg/ha). During the post-weaning period, from the first 10 days in the corral and throughout the summer-autumn period, each calf received a balanced supplement of 18% crude protein and 75% TDN (1.0% of body weight). During the winter and spring, the calves grazed on oats (*Avena strigosa* Schreb) and ryegrass (*Lolium multiflorum* Lam) at a stocking rate of five calves/ha (990 kg body weight) until the end of the pasture cycle in

November, which coincided with a mean calf age of twelve months.

The cows were weighed at the beginning and end of the reproductive period, as well as every 21 days to control pasture occupancy. The date of the second conception was determined by subtracting 292 days from the date of the second birth (considered the mean gestation period in days for Braford animals). If this date was not the same as the weighing date, due to a difference between the two weighings and including the weight gain, the weight was adjusted fora date closer to one of the weighings.

The cows and their calves were weighed during the first 24 hours after calving and at weaning, with the cows also weighed at the beginning and end of the reproductive period. The calves continued to be weighed periodically, every 28 days. Weight variations were determined by the difference in weight between each weighing.

During the experimental period, the cows had free access to a mineral mixture including 80 ppm phosphorus. Vaccinations to control foot-and-mouth disease and clostridia, endoparasites (*Cooperia* spp., *Haemonchus* spp., *Ostertagia* spp. *Trichostrongylus* spp.) and ectoparasites (*Rhipicephalus (Boophilus) microplus, Haematobia irritans* and *Dermatobia hominis*) were given following health regulations and whenever necessary.

Natural mating was used, with bulls previously approved through a libido evaluation and andrological examination, at a bull/cow ratio of 1:25. The effect of the bulls was not considered, as the cows were mated as a single group regardless of gain in conception weight, with all the cows exposed to all the bulls and mating not being driven but at random. As a measure of reproductive efficiency, the rate of pregnancy was evaluated, diagnosed by rectal ultrasonography carried out 60 days after the end of the reproductive period, relating the number of females diagnosed as pregnant to the total number of females placed for servicing at the beginning of the mating season.

Calf production efficiency was determined using the calf production index, which was adjusted based on the rate of pregnancy in kg of weaned calf per maintained cow (weight of the calves at conventional weaning * Pregnancy rate/100). For the productive efficiency of the cows at conception, calving and weaning, the relationship between the body weight of the calves at weaning and the body weight of the cows at conception, calving and weaning respectively was calculated and multiplied by 100. Actual fertility was determined by calf weight at weaning x 365/calving interval.

Statistical analysis

The experimental design was completely randomised in a 2 x 2 factorial scheme (two weight classes at conception and two weight-gain classes during pregnancy) with repeated measurements over time, and the results submitted to analysis of variance and the F-test. The mathematical model used in the analysis was:

$$Y_{ijkl} = \mu + Period_i + Treatment_j + Period*Treatment_{ij} + Ob_k + EBc_l + S_m + \Sigma_{ijklm,}$$

where:Y_{ijkl}= dependent variables; μ - mean value of all the observations; $Period_i$ = effect of the i-th period of animal evaluation, where i=1 (conception data), 2 (calving data),and 3 (weaning data).....; effect of the j-th treatment: 1 = low conception weight and low gestational gain; 2 = low conception weight and high gestational gain; 3 = high conception weight and low gestational gain and 4 = high conception weight and high gestational gain; $Period*Treatment_{ij}$ = interaction of the i-th evaluation period and j-th treatment associating weight and weight gain;

Ob_k = k-th effect of the covariable calving order; EBc_l = effect of the covariable body condition score; S_j = m-th effect of the covariable sex of the calf, where m = 1 (male); 2 = (female); Σijkl = residual error.

The analysis was carried out using the PROCMIXED procedure. The data were analysed by the SAS v6.08 statistical software, adopting 0.05 as the maximum significance level. The mean values were compared by Tukey's test. Percentage pregnancy for the different groups of cows was analysed by the chi-square test at a significance level of 0.05.

RESULTS

The weights of the groups differed at calving (P<0.05), white HH cows being heavier, followed by LH cows, then the HL cows, and finally, with the lowest weight, LL cows (Table I).

Weight gain during pregnancy was a determinant factor in the inversion of group

Table I. Adjusted mean values and standard errors for the developmental variables of cows and their calves based on primiparous cow weight at conception and weight gain during the second gestation.

Gestational gain	LL	LH	HL	HH
Cow weight, kg				
At conception	326.01±4.15[b]	317.30±4.73[b]	358.32±4.21[a]	363.56±4.26[a]
At calving	375.05±4.15[c]	390.09±4.73[b]	389.53±4.21[b]	424.29±4.26[a]
At weaning	333.09±4.15[b]	324.41±4.73[c]	357.53±4.21[a]	365.43±4.26[a]
Variations in daily cow body weight, kg				
Gestation	0.159±0.038[bc]	0.261±0.043[a]	0.106±0.038[c]	0.226±0.040[ab]
Early lactation	-0.644±0.031[c]	-0.711±0.034[a]	-0.376±0.030[d]	-0.655±0.036[b]
Calf weight, kg				
At birth	29.4±3.68[a]	30.6±4.13[a]	27.43±3.67[a]	30.5±3.77[a]
Weaning (90days)	75.62±3.68[a]	79.6±4.13[a]	76.8±3.67[a]	80.1±3.77[a]
At 150 days	103.1±3.68[b]	106.4±4.13[ab]	108.3±3.67[ab]	112.7±3.77[a]
At 210 days	127.3±3.68[b]	127.6±4.13[b]	131.0±3.67[ab]	138.5±3.77[a]
At 12 months	261.9±3.68[c]	271.5±4.13[bc]	277.3±3.67[ab]	281.0±3.77[a]
Variations in daily calf body weight, kg				
Birth to weaning	0.678±0.025[b]	0.737±0.028[a]	0.724±0.025[ab]	0.744±0.026[a]
Weaning to 150 days	0.326±0.025[a]	0.321±0.028[a]	0.359±0.025[a]	0.387±0.026[a]
From 150 to 210 days	0.677±0.025[a]	0.725±0.028[a]	0.719±0.025[a]	0.717±0.026[a]
Pregnancy rate in heifers mated at 14 months, %	43.8B	58.3A	69.3A	68.5A

[a,b,c,d] on the same line differ by Tukey's test (P<0.05); A, B on the same line differ by the chi-square test. LL - cows which were light at conception with low gestational weight gains; LH - cows which were light at conception with high gestational weight gains; HL - cows which were heavy at conception with low gestational weight gains; HH - cows heavy at conception with high gestational weight gains.

calving weights, where the greatest mean daily weight gain during gestation made these groups heavier at calving. Although lighter at conception, LH cows were heavier at parturition than HL cows.

The groups of cows LL and HH differed in calving weight and at early weaning at 90 days postpartum.

The calves did not differ (P>0.05) in relation to their weight at birth or early weaning at 90 days, between cows grouped by conception weight and gestational gain. From 150 to 365 days of age, animals born to cows that were heavy at conception and with high gestational weight gains were superior to those born to cows that were light at conception and with small gains in body weight during gestation.

Female calves born to cows with a low conception weight and low gestational weight gain showed inferior pregnancy rate, measured at fourteen months of age compared to female calves born to cows with either a high conception weight or high gestational weight gain, or both.

Pregnancy rates and post-parturn oestrus intervals were similar (P>0.05) irrespective of conception weight or gestational weight gain (Table II).

Greater weight gain of cows during gestation was a determinant of lower values for calf production per cow exposed for breeding, with values of 65.2 and 65.6 kg in cows with low gains, and 58.0 and 57.8 kg in cows with high gestational gains, for cows with low and high conception weights respectively.

When relating calf weight at weaning to cow weight at conception, cows of low weight, but with higher weight gains during gestation, were more productive compared to the other groups. However, when efficiency is expressed relative to cow weight at calving, cows with a high conception weight but with low weight gains during gestation were more productive than those that were heavy at conception but had high gestational weight gains, with values of 20.3 and 18.8 kg respectively for every 100 kilograms of cow in the herd. The groups made up of light cows at conception had an intermediate production of 20.0 and 19.4 kg, not differing (P>0.05) from each other, nor from the groups of cows with high conception weights, irrespective of weight gain during gestation.

Table II. Mean values and standard errors for efficiency variables in cow herds according to primiparous cow weight at conception and weight gain during the second gestation.

Gestational gain	LL	LH	HL	HH
Post-partum Pregnancy, %	84.1	74.5	83.3	74.7
Post-partum oestrus interval, days	83.3±1.59[a]	78.3±1.91[a]	81.6±1.58[a]	78.2±1.85[a]
Cow efficiency, kg				
Calf production	65.2±0.55[a]	58.0±0.60[b]	65.6±0.54[a]	57.8±0.56[b]
Productive efficiency at conception	23.0±0.21[b]	24.8±0.23[a]	22.1±0.20[b]	21.8±0.21[b]
Productive efficiency at calving	20.0±0.18[ab]	19.4±0.20[ab]	20.3±0.18[a]	18.8±0.19[b]
Productive efficiency at weaning	23.5±0.21[ab]	24.8±0.24[a]	22.7±0.22[b]	22.7±0.22[b]
Actual fertility, kg	74.5±0.79[b]	78.8±0.95[a]	79.9±0.79[a]	80.7±0.91[a]

[a,b] on the same line differ by Tukey's test (P <0.05). LL - cows which were light at conception with low gestational weight gains; LH - cows which were light at conception with high gestational weight gains; HL - cows which were heavy at conception with low gestational weight gains; HH - cows heavy at conception with high gestational weight gains.

At weaning, cows with low conception weights and high gestational gains produced more calf kilograms (P<0.05) compared to cows that were heavy at conception, regardless of their development during gestation; cows with low conception weights and low gestational gains had intermediate values, but did not differ from the other weight groups (P>0.05).

The actual efficiency of the cow herds showed that cows which were light at conception with low weight gains during gestation were inferior (P <0.05) to cows light at conception but with high gains during gestation, and to the groups formed of heavy cows at conception, irrespective of their gestational development.

Daily gestational weight gain (MWDG) correlated negatively with conception weight (r = -0.39124; 0.0002) and positively with calving weight (r = 0.56135; 0.0001), showing a negative correlation (r = 0.322475; 0.0020) with the weight at weaning (Table III).

Calf weight correlated positively between each weight-control evaluation carried out up to 365 days of age. Cow weight at calving correlated positively with the birth weight of the calves (r = 0.44095, 0.0001). Cow weight at weaning at 90 days correlated positively with calf weight at weaning, as well as with the other evaluations up to 365 days of age.

Cow weight at conception correlated positively with calf weight at weaning at 90 days of age, as well as with calf weight at 210 and 365 days. On the other hand, gestational gain in the cows showed no correlation with calf development for any of the phases under evaluation up to 365 days of age.

Table III. Pearson correlations for the developmental variables of cows and their calves for different primiparous conception weights and different weight gains during the second gestation.

	MWDG	CWC	CWW	WCB	WCW	WC210	WC365
WCC	-0.39124 0.0002***	0.54199 0.8665	0.92060 0.0001***	0.07580 0.4827	0.19527 0.0683*	0.40352 0.0001***	0.29634 0.0051***
MWDG		0.56135 0.0001***	-0.32475 0.0020***	0.08608 0.4252	0.01063 0.9217	-0.18105 0.0914*	-0.12803 0.2345
CWC			0.51130 0.0001***	0.44095 0.0001***	0.18530 0.0839*	0.19754 0.0651*	0.14958 0.1642
CWW				0.10205 0.3441	0.25906 0.0148**	0.32446 0.0020***	0.34132 0.0011***
WCB					0.38787 0.0002***	0.25456 0.0167***	0.52615 0.0001***
WCW						0.59000 0.0001***	0.59990 0.0001***
WC210							0.69487 0.0001***

***P<0.10; **P<0.05; ***P<0.01;**
MWDG - variation in the body weight of cows during gestation; CWC - Cow weight at calving; CWW - Cow weight at weaning; WCB –Calf weight at birth; WCW - Calf weight at weaning at 90 days; WC210 - Calf weight at 210 days of age; WC365 - Calf weight at 365 days of age; WCC - Cow weight at conception.

DISCUSSION

Differences in cow body weight at calving in the different groups, explained by the association of conception weights and gestational weight gains, were fundamental for the efficiency of herd production. Cows with better nutritional condition at conception, or more efficient in feed conversion during gestation, calved in better conditions (Bohnert et al. 2013, Gutiérrez et al. 2014). As result, cows produce more milk (Rodrigues et al. 2014), weaning heavier calves (Vaz et al. 2014); furthermore, greater body weight at calving is a determinant of better reproductive performance (Torres et al. 2015).

Greater cow weight at calving, or better nutritional levels during gestation, determined in calves a greater number and hypertrophy of muscle fibres, determining greater foetal skeletal-muscle development (Du et al. 2010, Wilson et al. 2016). Gestational weight gain was negatively correlated with the weight of the cow at weaning (r = -0.322475). Weight loss during lactation was seen in all groups, where virtually all the positive variations in cow body weight during gestation were lost during lactation, despite this having been interrupted by early weaning of the calves at 90 days postpartum. This shows how stressful lactation is for the bovine female, where all the weight gained over approximately 290 days is lost in just 90 days. This loss is due to milk production, which is costly for the female organism, which is higher than the pregnancy requirement (Marques et al. 2016).

The greatest weight loss was seen in the heaviest cows at calving, due to the negative energy balance which cows experience postpartum (Marques et al. 2016) due to not meeting their own maintenance and milk production requirements through feeding, especially with milk production, and which are greater in relation to cows of lesser weight. The amount of energy required for lactating cows to lose body weight is approximately ten times less than the amount of energy required to gain the same unit of weight (NRC 2016).

The similarity in calf weight up to early weaning, irrespective of the conception weight and gestational gains of their mothers, can be explained by the above comments concerning the compensation of greater weight loss during lactation in previously better-nourished cows, which during gestation accumulated greater reserves.

The similarity in calf weight at birth contradicts the literature. In general, cows that are better nourished during gestation give birth to heavier calves (Schoonmaker & Eastridge 2013, Wilson et al. 2016). Greenwood & Cafe (2007), comparing severe feeding restrictions during gestation to proper feeding, found a loss of 35.3% in calf weight at birth. The same was seen by Schoonmaker & Eastridge (2013), who studied the last 100 days of gestation in correctly nourished cows and those receiving only 70% of the recommended energy requirement, and found greater weight at birth and weaning in the calves born to the correctly nourished cows.

The greater post-weaning development of calves born to better-nourished cows, whether or not associated with greater conception weight, compared to calves born to lighter-weight cows associated with poorer performance during gestation, is due to nutrient deficiency during formation of the foetus. In nutrient partitioning, muscle formation is less of a priority than are the vital organs. As such, muscle development depends on the amount of nutrients ingested or metabolised by the mother from her reserves during gestation (Zhu et al. 2006), reducing or increasing the number of muscle fibres in the calf and, consequently, reducing body development when adult (Du et al. 2010). Lemaster et al. (2017), testing three supplementary feeding systems for cows during gestation, found greater calf weight at birth, but with a gap between the higher nutritional levels, compared to the present experiment. Higher nutritional levels during gestation favour the processes of myogenesis and muscle hypertrophy (Du et al. 2010).

The better reproductive performance of heifers born to cows of greater weight and/or better gestational gain can be explained by the probably greater nutritional support they received during the foetal phase. Malnutrition at this stage of life can determine endocrine changes in the foetus, promoting its adaptation to malnutrition, and causing changes in its physiology and metabolism, and consequently, in its postnatal development (Wu et al. 2006). Limitations on energy or protein in the uterine environment may be a determinant of lower reproductive performance during early mating, or of the manifestation of female puberty (Schoonmaker & Eastridge 2013, Funston et al. 2010).

The lack of any difference in the rates of post-parturn pregnancy and in the post-parturn oestrus interval of cows in the different groups of weight and gestational gain, contradicts the literature. Usually, these factors, related to reproduction, are positively associated with better nutritional levels (Torres et al. 2015), greater gains in body weight during gestation and higher weights at birth (Batista et al. 2012). In addition, other factors such as age (Rodrigues et al. 2014), calving season (Carneiro et al. 2012), breed and crossbreeding (Leal et al. 2018) may also determine better reproductive performance in beef cows.

In the present study, even with the differences in weights between groups, cows with higher body weight that correlate with a higher pregnancy rate did not differ from lighter cows. The similarity in rates of pregnancy is probably due to the larger body size of the cows at calving; this is associated with a higher maintenance requirement (Farias et al. 2018a), which is not properly met by the natural pastures during gestation or by the Brizanta Brachiaria during lactation. The qualitative values, together with the quantity offered in the pastures, did not provide the cows the conditions to correctly supply their demand for nutrients during the various stages of the production cycle. Castilho et al. (2018), working with primiparous cows at 24 months of age that were gaining weight during lactation, found that the body weight of the cows at calving determined better rates of reproduction for the same system of adequate nutrition, due to the cows still being at the growth stage, as in the present study.

Another factor that may in part explain the lack of any difference in subsequent cow reproduction, is the small difference in weight gain found in the present study during gestation, which was always positive. Differences in calf birth weight are found in studies where there are feed restrictions on the cows, however in cow reproduction, when they are subjected to the minimum amount of nutrients necessary for their maintenance, compared to cows fed more than required, this does not occur (Wilson et al. 2016). Wilson et al. (2016), when comparing cow diets that supplied 100 and 125% of the total digestible nutrient demand, found a higher weight for calves born to better-nourished cows, with no effect from the better nutrition on the reproductive performance of the cows.

The weight loss observed during lactation, which is more pronounced in cows with a higher body weight at calving, is the result of the strain of milk production. Weight loss does not positively correlate with better reproductive performance. Vieira et al. (2005), studying a Nellore herd in the Cerrado of the State of the Mato Grosso – Brazil showing oscillations in positive weight gain during lactation of up to 30 kilograms, with losses of up to 120 kilograms, found that the curves of reproductive performance followed this variation. The greater the weight loss in cows during lactation therefore, the worse their reproductive performance, being more marked in females that are still growing (Vieira et al. 2005).

By associating cow pregnancy with calf weight, the greater kilogram production in cows with smaller weight gains during gestation is probably associated with the greater weight loss in better-nourished cows during lactation, which is a determinant factor for reduced reproductive performance. In addition, the greater weight loss of the better-nourished cows during pregnancy was not a determinant of greater calf development, as all the groups consisted of similar conception weights and gestational gains at weaning after 90 days of lactation. Higher calf production is observed when better nutritional levels are used pre- (59.7 kg) or postpartum (54.1 kg), compared to cows kept exclusively on natural pasture (37.7 kg) for up to 90 days of lactation (Vaz et al. 2014). However, when calf production is related to the metabolic weight of the cows, the various nutritional levels are similar; Vaz et al. (2014), concluded that the stress of maintaining lactation, and the resulting lower weight, were factors influencing this similarity in production. Vaz et al. 2016, when comparing light and heavy cows at calving, found that lighter cows are the most efficient in producing kilograms of calf per kilogram of cow, however lactation continued for up to 210 days. These results agree with those of the present study, since reproductive performance in this study was not affected by weight or nutritional level at gestation, and lactation was interrupted by the early weaning of the calves at 90 days. With early weaning, the stress of milk production is removed, and the cow's body begins to direct nutrients to recovering bodily reserves and weight gain, factors that are associated with better reproductive performance (Vaz & Lobato 2010).

Greater production of calf kilograms per kilogram of cow at conception, calving or weaning is dependent on the body weight of the cows, as this is used to calculate the ratio of calf weight to cow body weight. Cows with less body weight, irrespective of evaluation phase, are more productive compared to cows with a larger body size (Castilho et al. 2018, Farias et al. 2018a). This becomes more evident when the treatments imposed on the cows show no difference in calf development, which may be a determinant of productivity (Farias et al. 2018a). However, when weight differences occur in calves, influenced by body size (Farias et al. 2018b) or nutritional level (Ribeiro et al. 2001, Vaz & Lobato, 2010, Vaz et al. 2014), the results contradict the present study, demonstrating that the milk production is a determinant factor of higher biological efficiency (Restle et al. 2007).

The results for the actual fertility of the herds are different to those of the other characteristics under evaluation, where cows with greater conception weights and gestational weight gains, or even with one of the above characteristics showing high values, are superior to cows with a lower conception weight and less weight gains during gestation. Cows with more weight at conception or gestational weight gains, produced during lactation more kilograms of weaned calf at 90 days compared to cows of lower weight at conception and weights gains gestational. The greater production of calves per year, adjusted by calculating actual cow fertility, shows that the nutritional level of the breeding herd is fundamental for their greater productive efficiency.

Actual fertility is important in evaluating breeding herds, as it includes in one characteristic reproductive factors, the maternal capacity of the cow, and the genetics of growth of each individual calf, in addition to evaluating the annual production of the cows (Silveira et al. 2004). Actual fertility correlates positively with weaning weight and negatively with calving interval (Mcmanus et al. 2002). For the breeding system to be efficient, minimum production is considered one calf per year (Torres Junior et al. 2009). Calf weight is fundamental for the profitability of the production system, where in addition to the current production, the cow should also become pregnant during the following breeding season (Vaz & Lobato 2010).

CONCLUSIONS

The weight of calves at birth and weaning at 90 days are not influenced by conception weight or by greater weight gains during the second gestation in primiparous cows.

Primiparous cows with a greater conception weight and/or greater gestational weight gain during the second pregnancy produce progeny with better development up to one year of age and greater reproductive performance from their daughters when mated at 14 months of age.

Lighter cows at conception and/or lower weight gains in the second gestation are more efficient in producing kilograms of calf/kg per cow in the herd.

Actual fertility in primiparous cows is dependent on body weight at conception, gestational weight gain, or both.

The calves' weight at 210 and 365 days is positively correlated with the weight of the mothers at conception, at weaning, and with gestational weight gain.

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