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Variation in cow body condition score during the final third of gestation and its effects on progeny performance

Variação do escore de condição corporal da vaca durante o terço final de gestação e seus efeitos no desempenho da progênie

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Highlights

The variation in maternal body score affects the development of the progeny.
Fetal programming response is dependent on the productive system.
Intensive systems enhance the production of programmed animals.

Abstract

Maternal nutrition during gestation has recently been associated with fetal formation and the productive potential of progeny in adult life. One efficient way to evaluate the nutritional status of the pregnant cow is by considering its body condition score (BCS). Thus, the objective of this study was to evaluate the effects of the BCS variation of the cow during gestation on the performance and post-slaughter characteristics of the progeny. Progenies were divided according to the performance of the cows: LOST, cows that lost 0.20

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BCS points; KEPT, cows that maintained BCS; WON, cows that gained 0.23 BCS points in the final third of pregnancy. The experimental design used was completely randomized with three treatments. WON cows had higher weight and BCS at calving compared to LOST cows. The performance of the progeny was not influenced by the variation in the ECC of the cow during gestation (P>0.05). During feedlot finishing, LOST steers tended (P = 0.1013) to have higher dry matter intake than KEPT and WON (10.10 vs 9.75 and 9.24 kg day^{-1}, respectively). WON steers were more efficient for RFI (Residual Feed Intake) and more productive for RWG (Residual Weight Gain) compared to LOST animals. Likewise, WON progeny tended to have greater subcutaneous fat deposition (P = 0.0826) and marbling (P = 0.0961) than LOST and KEPT steers. In this way, the accumulation of maternal body score during pregnancy demonstrates fulfilling the requirements for fetal growth, which favors the development and formation of superior animals.
Key words: Feedlot. Fetal programming. Marbling. Meat quality. Residual food intake.

Resumo

A nutrição materna na gestação tem sido recentemente associada à formação fetal e ao potencial produtivo da progênie na vida adulta. Uma das maneiras eficientes de avaliar o status nutricional da vaca gestante é através do escore de condição corporal (ECC). Desta forma, o objetivo do trabalho foi avaliar os efeitos da variação do ECC da vaca na gestação sobre o desempenho e características pós-abate da progênie. As progênies foram divididas conforme o desempenho das vacas: LOST, vacas que perderam 0,20 pontos de BCS; KEPT, vacas que mantiveram BCS; WON, vacas que ganharam 0,23 pontos de BCS no terço final de gestação. Foi avaliado o desempenho da progênie do nascimento até o abate, bem como as características da carcaça e carne dos animais. O delineamento experimental utilizado foi inteiramente casualizado com três tratamentos. Vacas WON apresentaram maior peso e ECC ao parto em relação às vacas LOST. O desempenho da progênie não foi influenciado pela variação do ECC da vaca na gestação (P>0.05), porém, apresentam comportamentos distintos entre as fases de crescimento. Durante a terminação em confinamento, novilhos LOST tenderam (P = 0.1013) a apresentar maior consumo de matéria seca em relação às progênies KEPT e WON (10.10 vs 9.75 e 9.24 kg dia^{-1}, repectivamente). Novilhos WON foram mais eficientes para RFI (Residual Feed Intake) e mais produtivos para RWG (Residual Weight Gain) em relação aos animais LOST. Do mesmo modo, a progênie WON tendeu a apresentar maior deposição de gordura subcutânea (P = 0.0826) e de marmoreio (P = 0.0961) em relação aos novilhos LOST e KEPT. Desta forma, o acúmulo de escore corporal materno durante a gestação demonstra o atendimento das exigências para o crescimento fetal, aspecto que favorece o desenvolvimento e a formação de animais superiores.
Palavras-chave: Confinamento. Consumo alimentar residual. Marmoreio. Programação fetal. Qualidade de carne.

Introduction

Improving the productive indexes of the herd and the qualitative characteristics of the meat are among the main objectives of beef cattle producers. Recent studies have shown that maternal nutrition affects fetal formation and production potential of the progeny in a concept known as fetal programming. Generally, beef cows are kept exclusively in pastoral systems, which can provide periods of feed restriction and consequently limit calf production (Gutiérrez et al., 2014). Du et al. (2010) state that there may be damage to the formation of skeletal muscle tissue when a nutritional restriction occurs at the end of gestation, with a reduction in muscle mass and marbling fat content in the carcass at the slaughter of the animals.

Evaluating the nutritional status of the herd using the body condition score (BCS) has been an efficient tool to predict the nutritional status of pregnant cows, as this variable is closely associated with fetal formation and the future quality of the progeny. Evaluating the BCS of cows at calving, Bohnert et al. (2013) observed higher birth weight of calves from cows with a higher score at calving, and this superiority was maintained until the animals were slaughtered. Likewise, Marques et al. (2016) evaluated the effects of BCS variation during gestation on progeny performance. The authors obtained a higher weaning weight of calves born from cows that gained BCS in the second or third trimester of gestation than calves from cows that maintained high or low scores during gestation.

From these results, we can infer that the nutritional stimuli that lead the pregnant cow to lose or gain body reserves strongly affect fetal formation. According to Reynolds et al. (2019), the changes caused by maternal nutrition during gestation allow the rapid adaptation of the developing fetus to the pressure of uterine environmental selection. This aspect leads to the formation of more adapted phenotypes to the system in which they were formed.

Evaluating progeny performance in different breeding systems is a challenge for research since the effects of fetal programming can be reduced by adapting the animals to the breeding environment. Thus, this study aims to evaluate the effects of variation in the body condition score of cows in the final third of gestation on the performance and post-slaughter characteristics of the progeny.

Material and Methods

All procedures performed in the present study were approved by the Ethics Committee on the Use of Animals of the Universidade Federal de Santa Maria under protocol 2531070319.

The experiment was carried out at the Beef Cattle Laboratory of the Federal University of Santa Maria, in the municipality of Santa Maria, located in the Central Depression of the State of Rio Grande do Sul, at an average altitude of 95 m, with 29° 43’ South latitude and 53° 42’ West longitude. The climate in the region is “Cfa” (humid subtropical), according to the Köppen classification, with annual rainfall between 1600 and 1900 mm, an average annual temperature of 18.8°C, with a minimum mean of 9.3°C and a maximum mean of 24.7ºC (Alvares et al., 2013).

Study factors and management

The finishing period of feedlot steers occurred between April and June 2019, starting with the adaptation of the animals to the diet and facilities (14 days) and subsequently divided into three periods of 28 days. Forty-one (41) non-castrated steers originating from the same bull were used from continuous alternating rotational crosses between Charolais (CH) and Nellore (NE) breeds, with crossbred animals belonging to the fifth and sixth generations. The animals had an average age and initial weight of 17 months and 407 kg of body weight, being distributed in the treatments according to the variation in the body condition score (BCS) in the final third of gestation, following the scale of 1 to 5 points described by Lowman et al. (1973): LOST, cows that lost 0.20 points of BCS during gestation (13 animals); KEPT, cows that maintained BCS during gestation (15 animals); WON, cows that gained 0.23 BCS points in the final third of gestation (13 animals). The variation in body score consisted of the difference between assessments at 180 days of pregnancy and birth. Additionally, cows were weighed at calving, reproduction beginning, and calves weaning. Cows were maintained under continuous grazing on natural pasture with free access to mineral supplementation, with a stocking rate of 400 kg of body weight per hectare.

After calving (October and November of the same year), all calves were kept under similar conditions until slaughter, undergoing different management and rearing systems. The breeding phase of the animals occurred in a continuous grazing system on oat + ryegrass pasture, while rearing occurred on sudangrass pasture, receiving only mineral supplementation.

Before the finishing period, steers underwent a tick prevention control (Boophilus microplus) through an immersion bath in a syrup composed of the commercial product Colosso FC30® (Fenthion + Cypermethrin + 30% Chlorpyrifos), followed by the application of Fluatac DUO® Pour-on type product, with Fluazuron + Abamectin as active ingredient, using a dosage of 1 mL/10 kg of body weight. In addition, strategic verminosis was controlled by applying Ivermectin + Albendazole Sulfoxide in a dosage of 1 ml/20 kg of body weight.

The steers were finished in a feedlot system, in individual boxes with approximately 10 m² in area, paved with reinforced concrete and a slope of 3%. The boxes had automatic feeders and drinkers regulated by a float tap. The terminal diet was calculated following the nutritional recommendations of the National Research Council [NRC] (2000), as shown in Table 1, using as parameters the nutritional requirements for steers to obtain a daily weight gain of around 1.50 kg/day from an estimated dry matter (DM) intake of 2.5% of animal live weight.

Table 1
Chemical composition in dry matter and participation of ingredients in the diet of feedlot finished steers

Diet ingredient	Bromatological composition. %					Participation. %
	DM	MM	CP	TDN[A]	NDF	
Corn silage	30.40	4.60	5.65	65.70	60.10	42.00
Corn grain	86.70	1.70	9.00	89.80	12.00	33.30
White oat grain	87.20	2.55	14.69	71.00	19.60	20.50
Soybean meal	86.35	7.10	54.20	88.70	12.30	3.60
Calcitic limestone	96.00	99.00	-	-	-	0.40
Common salt	96.00	99.00	-	-	-	0.20
Total diet[B]	48.70	3.90	10.40	75.30	33.80	100.00

[A] Total digestible nutrients determined by the digestible organic matter method.
[B] Final composition calculated from the ingredients and their participation in the diet.
DM, dry matter; MM, mineral matter; CP, crude protein; TDN, total digestible nutrients; NDF, neutral detergent fiber.

Measurements and laboratory analyses

Animals were fed twice daily, at 8:00 am and 2:00 pm. Voluntary food intake was calculated by recording the amount of food offered daily and food leftovers from the previous day, which ranged from 5 to 8% of the total diet provided. Therefore, dry matter intake (DMI) was calculated by the difference between the food offered and the amount of leftovers taken the next day. Additionally, the daily fluctuation of animal consumption was calculated using the following equation: fluctuation % = *((DMIday - DMIprevious)/DMIprevious)*100.*

Each week, samples of diet and leftover food not ingested by the animals were collected. These samples were taken to an oven at 55ºC for 72 hours until they reached constant weight, being subsequently ground in a "Willey" type mill with a porosity sieve of 1 or 2 mm and sent to the Laboratory of Bromatology and Ruminant Nutrition at UFSM to determine the bromatological composition of the diet. After chemical analyses, the consumption of crude protein (CP), total digestible nutrients (TDN), and neutral detergent fiber (NDF) were determined.

Animals were weighed at the beginning and the end of the 28-day experimental period to evaluate their performance, and the body condition score of the steers was jointly assigned. The average daily gain (ADG) of the animals for the rearing phases was calculated by the quotient of the total weight gain by the number of days between two weighings, expressed in kg/day. Biological production efficiency measures were obtained by calculating feed conversion (*CA=DMI/ADG*), Kleiber ratio ($RK = ADG/BW^{0.75}$), residual feed intake (*RFI=DMIreal-DMIpredicted*), and residual weight gain (*RMG=ADGreal -GMDpredicted*).

The animals were slaughtered after 98 days in a feedlot, in a commercial slaughterhouse located about 20 km from the farm. After fasting solids and liquids for 14 hours, the animals were weighed to obtain the slaughter weight. Slaughter followed the normal flow of the commercial slaughterhouse, which has a state inspection service (SIE) for sanitary inspection, with the animals submitted to a spray bath and desensitization before bleeding. Before the carcasses entered the cooling chamber, the two half-carcasses were identified and weighed to obtain the hot carcass weight. After cooling for 24 hours, with a temperature oscillating between 0 and 1ºC, they were weighed again to obtain the cold carcass weight. Through these parameters, the hot and cold carcass yields and the breakdown on cooling were determined.

After leaving the carcasses in the cold chamber, the left half-carcass was separated into primary commercial cuts: forequarter, rib, and hindquarter. Each piece was weighed to determine its participation in the cold carcass. Subsequently, in the right half-carcass, between the 12^{th} and 13^{th} ribs, a horizontal cut was made to expose the *Longissimus dorsi* muscle to measure the loin eye area (cm^2). In this section, subcutaneous fat thickness (mm) was also determined, as well as the degree of marbling of the meat by subjective evaluation, according to Müller (1987). After removing the section between the 10^{th} and 12^{th} ribs (HH section), dissection was performed to predict the proportions of muscle, fat, and bone tissue in the carcass, following the methodology described by Hankins and Howe (1946).

During the dissection of the "HH" section, the extracted portion of the *Longissimus dorsi* muscle was identified and frozen for later analysis of the sensory characteristics of the meat. After 30 days of freezing, two 2.5 cm thick slices were extracted from the frozen samples. Both slices underwent thawing processes for 24 hours and subsequent cooking at an internal temperature of 70 °C to assess the loss of liquid during cooking. After these processes, in slice "A," six cylindrical samples with 1 cm^3 were cut perpendicular to the muscle fibers and used to evaluate the shear force through a Warner-Bratzler Shear device. Slice "B" was evaluated by six evaluators for tenderness, palatability, and juiciness (Müller, 1987).

Statistical analyses

The experimental design used was completely randomized, with 3 treatments and a varied number of repetitions. All statistical analyses were performed using the SAS® Studio University Edition (Statistical Analysis Systems Institute [SAS Institute], 2016) statistical package, initially using the Shapiro-Wilk test to analyze the normality of the residuals. Subsequently, the performance variables were subjected to analysis of variance by the F test through the PROC GLM procedure. When significance was found, the means were compared by Tukey's test at a 5% probability level using the following mathematical model:

$$Y_{ijk} = \mu + S_i + Z_j + \varepsilon_{ij}$$

where: Y_{ijk}: dependent variables; μ: mean of all observations; S_i: effect of the *i*-th variation of the body condition score of the cow at the end of gestation; Z_j: effect of the *j*-th com-variable percentage of Nellore breed in cows; ε_{ij}: residual random error effect.

The behavioral and blood variables were submitted to analysis of variance by the F test through the PROC MIXED procedure with repeated measures over time, using the covariance structure of the lowest AIC value (Akaike's information criterion), with the following mathematical model:

$$Y_{ijk} = \mu + S_i + Per_j + Z_k + (S * Per)_{ij} + \varepsilon_{ijk}$$

where: Per_j: effect of trial evaluation period; $(S*Per)_{ij}$: interaction of the i-th variation of the body condition score of the cow and the j-th evaluation period.

Results and Discussion

Production variables of cows during the final third of gestation are shown in Table 2. Cows that gained body score at the end of gestation (WON) had a higher body weight at calving (P = 0.0488) due to greater weight gain in this period (P = 0.0491), with values of -15.35, 6.20, and 20.40 kg respectively for LOST, KEPT and WON cows. Likewise, the variation in the body score of the cows led to a difference in the accumulation of reserves during late gestation and, consequently, higher body scores at calving of WON cows compared to LOST cows (2.97 *vs* 2.85 points).

As all cows had similar body weight at the beginning of the final third of pregnancy (P = 0.8652), a possible explanation for the accumulation of body reserves of WON cows may be related to pregnancy metabolism and better use of pasture nutrients in order to meet maintenance and fetal requirements, as well as compensatory gain for these initially thinner cows.

The most applicable way to assess the nutritional status of pregnant cows is based on the body condition score. According to Tanner et al. (2020), the increase in body reserves by the pregnant cow represents a better nutritional status, while the loss of body score indicates that it has mobilized its reserves to meet the requirements of fetal maintenance and growth. Evaluating maternal nutrition during pregnancy is an important indicator of fetal formation since the nutritional status of the pregnant female has been related to fetal formation in the uterine period and its productive potential in adult life, in concepts known as fetal programming (Broadhead et al., 2019).

Thus, our hypothesis points to a better intrauterine nutritional condition in WON cows that gained body score during gestation. A similar study was carried out by Bohnert et al. (2013), who observed a higher birth weight of calves born from cows with a higher body score at calving (38.8 vs. 41.4 kg), and this superiority was maintained until the animals were finished. In our study, the birth weight of LOST calves was approximately 4.8% lower than those born from KEPT and WON cows, a result that may be related to the reduction in muscle mass and muscle hypertrophy of the progeny as a result of maternal malnutrition at the end of gestation (Du et al., 2010).

Table 2

Productive variables of the cows according to the variation in the body condition score in the final third of gestation

Cow performance	Body score variation			SEM	P - value
	LOST (13)	KEPT (15)	WON (13)		
Initial weight, kg	456.00	471.47	478.23	9.27	0.8652
Birth weight, kg	440.54[b]	477.67[ab]	499.63[a]	10.14	0.0488
Weight gain, kg	- 15.46[b]	6.20[ab]	20.40[a]	2.10	0.0491
Initial score[1], points	3.05[a]	2.82[b]	2.73[b]	0.02	<0.0001
Score at birth, points	2.85[b]	2.87[ab]	2.97[a]	0.02	0.0348
Calf weight at calving, kg	36.50	38.03	38.57	0.93	0.8689

Means followed by distinct letters on the row differ by Tukey's test at 5% probability ($P < 0.05$).
SEM: Standard error mean
[1] measured at 180 days of gestation
LOST, cows that lost 0.20 body score points; KEPT, cows that maintained body score; WON, cows that gained 0.23 body score points during gestation.

Minor influences of body score variation were observed on the performance variables of the progeny until slaughter (Figure 1). However, it seems that WON animals are programmed for better fetal nutrition and consequent gain in maternal body score during pregnancy, especially during the phases of a better supply of nutrients. According to Mohrhauser et al. (2015), the real effects of fetal programming may have been suppressed by the greater capacity for environmental adaptation and possibly the compensatory gains of LOST animals, as they performed better in nutritionally unfavorable moments. Testing 50, 75 and 100% of maintenance energy at the end of gestation, Ramírez et al. (2020) observed a capacity for recovery and compensatory gain of progeny subjected to severe restriction (50% of energy) during late gestation in relation to calves from cows kept under 75 and 100% of requirements in the fetal period.

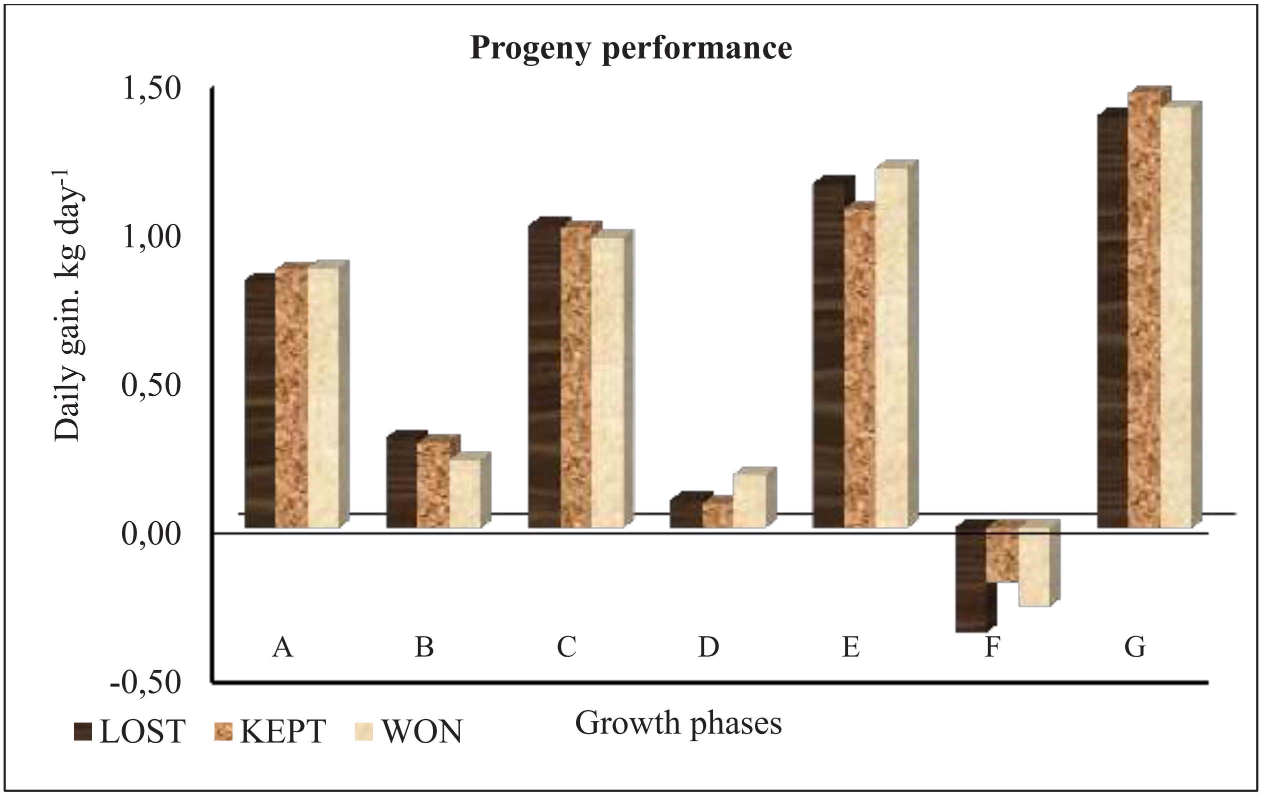

Figure 1. Weight performance of the progeny of cows with different body condition variations in the final third of gestation.
LOST, cows that lost 0.20 body score points; KEPT, cows that maintained body score; WON, cows that gained 0.23 body score points during gestation.A suckling period (165 days); B post-weaning period (105 days); C period in oat + ryegrass pasture (65 days); D spring transition (50 days); E period in Sudan Grass pasture (110 days); F adaptation period (15 days); G termination period in feedlot (88 days);

Compensatory gains contribute to understanding the adaptation of the organism to the uterine environment as a way of predicting the rearing scenario that the progeny will face in adult life. This theory was used by Reynolds et al. (2019), who claim that physiological and functional changes in organs and tissues allow rapid environmental adaptation of individuals in formation, similar to the process of natural selection, although in this case in an immediate way. Thus, organs related to the metabolism of the animal have been the subject of numerous studies related to fetal programming, especially the liver (Symonds et al., 2010) and pancreas (Duarte et al., 2013; Washburn et al., 2016; McCarty et al., 2020), which are organs significantly influenced by nutrition during gestation.

Despite these fetal adaptations, there was no influence of the variation in the body score of the cow at the end of pregnancy on the performance of the progeny in the termination period (P>0.05), with initial and final weights of 408.33 and 526.55 kg, respectively (Table 3). The average daily weight gain of the steers was 1,180 kg during the finishing phase, including the initial period of diet adaptation.

No difference (P = 0.101310) was observed for dry matter intake (DMI) between LOST, KEPT, and WON steers, with values respectively of 10.10, 9.75, and 9.24 kg of dry matter (DM) per day. As the animals presented similar performances in the feedlot, no differences were observed in the food conversion of the progeny, with a value of 8.20 kg of DM per kg of body weight.

Table 3
Effect of varying the body condition score of the cow during the final third of gestation on the performance of the progeny in the feedlot finishing phase

Progeny performance	Body score variation			SEM	P - value
	LOST (13)	KEPT (15)	WON (13)		
Initial body weight, kg	418.33	406.47	400.77	6.88	0.5743
Final body weight, kg	528.69	528.60	522.38	7.27	0.6919
Average daily gain, kg day^{-1}	1.140	1.227	1.182	3.34	0.9525
Initial body score, points	3.23	3.24	3.31	0.02	0.9168
Final body score, points	3.97	4.02	4.01	0.06	0.4860
Dry matter intake, kg/day	10.10	9.75	9.24	0.18	0.1013
Feed conversion, kg DM kg BW^{-1}	8.46	8.12	8.02	0.20	0.6115
Kleiber's relation, g BW MSU-1	3.38	3.52	3.40	0.09	0.7876
Residual food intake, RFI	0.22	0.06	-0.26	0.10	-
Residual weight gain, RWG	-0.03	0.02	0.05	0.03	-

Means followed by distinct letters in the row differ by Tukey's test at 5% probability (P < 0.05).
SEM: Standard error mean
LOST, cows that lost 0.20 body score points; KEPT, cows that maintained body score; WON, cows that gained 0.23 body score points during gestation.
DM, dry matter; BW, body weight; MSU, metabolic size unit;

The measures of productive efficiency given by the residual feed intake (RFI) and residual weight gain (RWG) demonstrated that WON animals were more efficient and productive than the LOST progeny, as they presented negative RFI and positive RWG. To better visualize the effects of fetal programming on the productive efficiency of the progeny, Figure 2 demonstrates the distribution of animals according to RFI and RWG measurements. The highest concentration of WON animals is found in quadrant 1 (46.2%), which are the most efficient and productive animals. In comparison, the LOST and KEPT progenies present only 16.6 and 26.7% of the animals in this quadrant. Inefficient and low-productive animals are located in quadrant 3, where 33.4% of LOST and KEPT animals are concentrated. It is clear that the measure that improved the nutritional status of the pregnant cow, i.e., when they maintained (KEPT) or gained (WON) body score during gestation, the presence of efficient and more productive animals doubled.

Given these results, we can infer that animals programmed via better maternal nutrition during gestation have greater production potential in intensive production systems, such as feedlots. Zago et al. (2020), when evaluating different nutritional levels of cows during the final third of pregnancy, observed that animals born from cows with favorable nutritional status were slaughtered with around five fewer days of feedlot than those born from cows with worse nutritional status. On the other hand, we observed a tendency for animals that went through restrictions or challenges during gestation to produce more in extensive breeding systems (Figure 1). This aspect is strongly correlated with forming an "economical phenotype," as described by Webb et al. (2019).

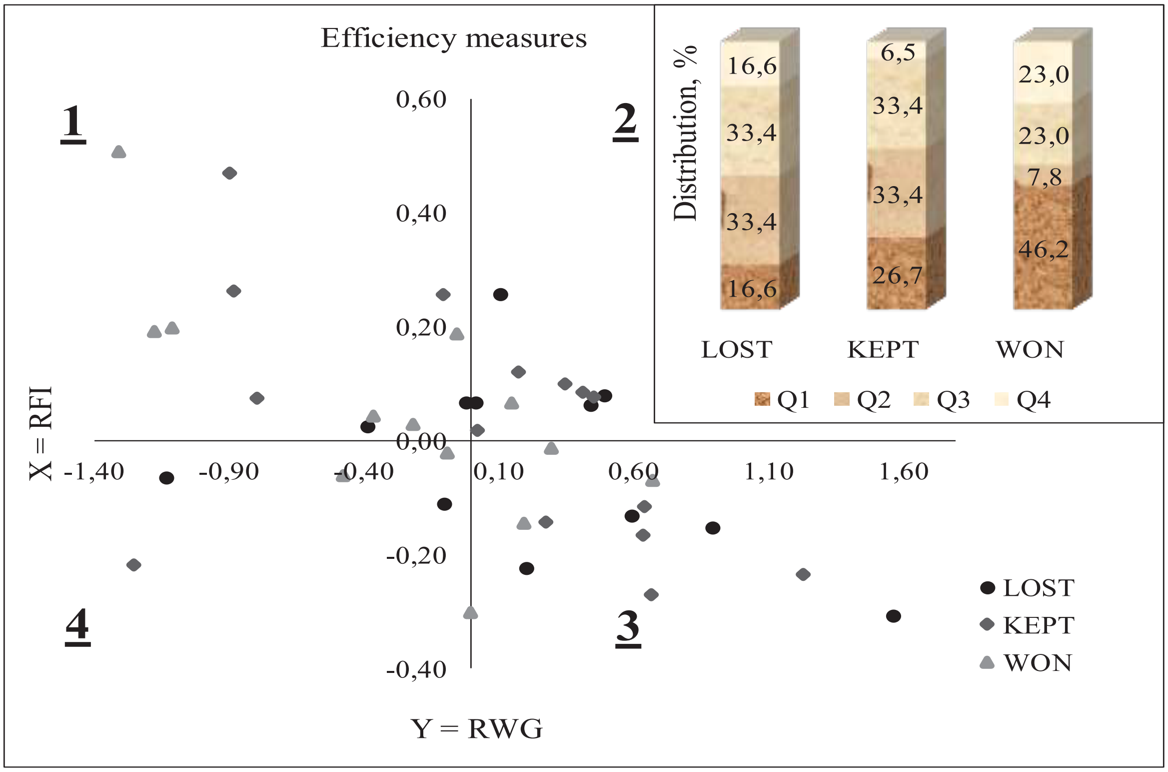

Figure 2. Residual feed intake and residual weight gain of the progeny of cows with different body condition variations in the final third of gestation.
LOST, cows that lost 0.20 body score points; KEPT, cows that maintained body score; WON, cows that gained 0.23 body score points during gestation.
Quadrant 1: efficient and productive animals; Quadrant 2: inefficient but productive animals; Quadrant 3: inefficient and unproductive animals; Quadrant 4: efficient but not very productive animals.

This ability of animals to adapt to the environment may have suppressed the effects of fetal programming on the quantitative measures of the carcass of progeny (Table 4). The hot carcass yield was equivalent to 57.83%, and participation of the forequarter, ribs, and hindquarters of 34.29, 10.63 and 50.65%, respectively. Our results corroborate the statements by Klein et al. (2021), who claim that the effects of maternal nutrition on the progeny are less evident in the adult life of the animals.

Likewise, a few effects of the variation in the body score of the pregnant cow were observed on the qualitative and sensory characteristics of the meat (Table 5). Only superficial changes and trends were observed in subcutaneous fat thickness (4.03 vs 3.03 and 3.13 mm and P = 0.0826) and marbled fat deposition (7.02 vs 5.53 and 6.73 points and P = 0.0961) in the carcass of WON, LOST and KEPT progenies, respectively. These results further reinforce the hypothesis that an intensive production system, or even more concentrated diets during the breeding phases, could further highlight the effects of the better metabolic status of cows during pregnancy on the performance of the progeny.

Table 4

Effect of the variation in the body condition score of the cow in the final third of gestation on the carcass characteristics of the progeny

Progeny performance	Body score variation			SEM	P - value
	LOST (13)	KEPT (15)	WON (13)		
Slaughter weight, kg	528.69	528.60	522.35	7.27	0.6919
Hot carcass weight, kg	302.88	308.85	302.44	4.91	0.8556
Cold carcass weight, kg	294.80	300.61	294.10	4.80	0.8516
Chilling loss, %	2.66	2.67	2.66	0.02	0.9669
Hot carcass yield, %	57.25	58.37	57.89	0.23	0.1544
Cold carcass yield, %	55.72	56.81	56.28	0.22	0.1340
Forequarter, %	39.16	39.36	39.21	0.20	0.8928
Rib, %	10.64	10.50	10.76	0.10	0.6391
Hindquarter, %	50.74	50.53	50.68	0.18	0.8309

Means followed by distinct letters in the row differ by Tukey's test at 5% probability (P < 0.05).
SEM: Standard error mean
LOST, cows that lost 0.20 body score points; KEPT, cows that maintained body score; WON, cows that gained 0.23 body score points during gestation.

Studies involving changes in maternal nutritional status during pregnancy have gained prominence in the production of beef cattle in an attempt to improve the deposition of subcutaneous fat and marbling, aspects related to the sensorial characteristics of the meat, with positive effects on the tenderness, palatability and juiciness of the final product. According to Reynolds et al. (2019), overnutrition of pregnant cows is associated with increased expression of intramuscular adipogenesis genes due to epigenetic mechanisms that, through signals and gene transcription mechanisms, stimulate or inhibit the expression of specific genes exclusively during fetal development (Du et al., 2013, 2015).

Table 5

Effect of the variation in the body condition score of the cow in the final third of gestation on the meat quality of the progeny

Progeny performance	Body score variation			SEM	P - value
	LOST (13)	KEPT (15)	WON (13)		
Qualitative characteristics of the meat					
Subcutaneous fat thickness, mm	3.03	3.13	4.03	0.18	0.0826
Marbling, points	5.53	6.73	7.02	0.35	0.0961
Longissimus dorsi area, cm²	78.18	79.27	75.85	1.53	0.8192
Bone, %	15.24	15.24	14.78	0.15	0.4978
Fat, %	20.65	20.71	22.95	0.53	0.5139
Muscle, %	64.64	64.58	62.98	0.53	0.8177
Meat sensory characteristics					
Tenderness, points[A]	6.56	6.60	6.87	0.17	0.6992
Palatability, points[A]	6.53	6.41	6.68	0.10	0.6548
Succulence, points[A]	6.71	6.86	7.23	0.12	0.6545
Shear force, kgf per cm³	6.31	6.20	6.22	0.25	0.8512

Means followed by distinct letters in the row differ by Tukey's test at 5% probability ($P < 0.05$).
SEM: Standard error mean
LOST, cows that lost 0.20 body score points; KEPT, cows that maintained body score; WON, cows that gained 0.23 body score points during gestation.
Marbling: 1-3: traces; 4-6: light; 7-9: small; 10-12: medium; 13-15: moderate; 16-18: abundant.
[A] 1: extremely tough, tasteless, and lacking in juiciness; 2: too tough, lacking in flavor and juiciness; 3: hard, not very tasty, and not very juicy; 4: slightly below average; 5: average; 6: slightly above average; 7: soft, tasty and juicy; 8: very tender, tasty and juicy; 9: extremely tender, tasty and juicy.

Despite the small increase in fat deposition in the carcass, the sensory characteristics of the meat measured by the panel of evaluators were not influenced by the variation in the body score of cows at the end of gestation (P>0.05), with meat being classified as slightly above average for the parameters of tenderness, palatability, and juiciness (Table 5). However, the qualitative score characterizes the meat of WON steers as juicier than that of LOST and KEPT progeny. This aspect is generally associated with greater deposition of marbling fat in the meat.

In general, our results indicate an influence of the nutritional status of the pregnant cow on fetal formation and, consequently, on the phenotype of the progeny. However, in a certain way, these effects may be more expressed in favorable and more intensive breeding conditions. According to Greenwood and Bell (2019), many effects of fetal programming are reduced when progenies are kept in pasture-based breeding systems, followed by finishing in the feedlot, as our animals were kept. Thus, the current major objective is to set up adequate productive strategies (intensive or extensive) to receive animals as they were programmed in the fetal period, i.e., under a nutritional restriction regime or programmed to be superior.

Conclusions

Considering that the gain in the body condition score of cows in the final third of pregnancy represents a better metabolic status for the pregnant female and consequently for better fetal formation, we conclude that cows that maintain or gain body condition (WON) at the end of pregnancy gestation can produce more efficient and productive progeny, being more adapted to more intensive production systems.

Superficial results in our study suggest that the effects of variation in body score on fetal formation and consequent performance of the progeny may have been suppressed by the semi-intensive system in the early stages of the life of calves. This aspect may have favored animals with worse fetal training.

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