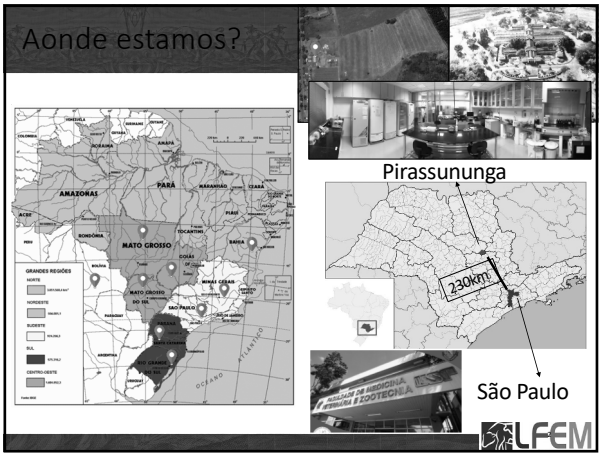
“Impacto da nutrição fetal na reprodução de vacas de corte”

Guilherme Pugliesi
Professor Doutor
Departamento de Reprodução Animal
Faculdade de Medicina Veterinária e Zootecnia
Universidade de São Paulo

Pirassununga - SP
Nov - 2021

1

Aonde estamos?



2

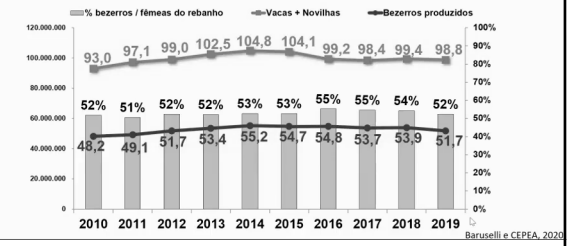
Tópicos

- Relação da Nutrição durante a gestação e Reprodução
- Estratégias para alterar a nutrição fetal
- Impactos na Reprodução da Vaca (mãe)
- Impactos na Reprodução da Progênie (programação fetal)
- Considerações Finais

3

Eficiência de produção de bezerros do rebanho brasileiro

(bezerros produzidos por fêmea do rebanho)



Baruselli e CEPEA, 2020

4

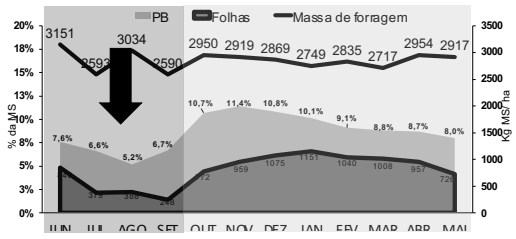
Relação da Nutrição durante a gestação e a reprodução

5

INTRODUÇÃO

Disponibilidade de MS, folha e proteína bruta

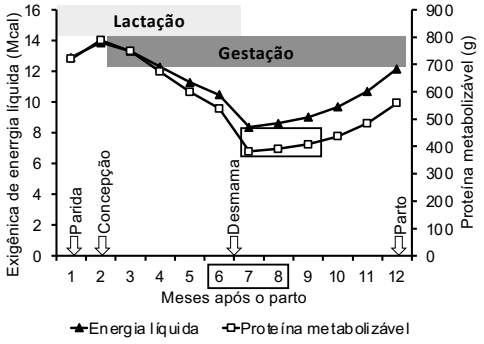
(Pastagem *Brachiaria brizantha*)



Fonte: Embrapa, 2003

6

▪ Dados de exigências de energia líquida e proteína metabolizável, no decorrer do ciclo de 12 meses, de uma vaca Nelore madura de 450 kg



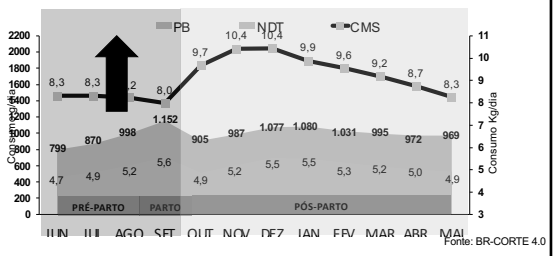
Adaptado: NRC (1996) apud: Rocha et al. (Impactos da nutrição sobre a reprodução de vacas de corte)

7

INTRODUÇÃO

Exigências nutricionais
(Primípara Nelore no pré e pós-parto)

Peso: 400 kg
Crescimento: 0,3 kg/dia
Leite: 5L/dia



Fonte: BR-CORTE 4.0

8

Relação da Nutrição durante a gestação e a Reprodução

Nutrição Pré-parto

1. Período de maior ingestão de alimentos
2. Gestação como prioridade metabólica
3. Maior facilidade de aumento da condição corporal e acúmulo de gordura
4. Nutrição fetal

9

Relação da Nutrição durante a gestação e a Reprodução

Vaca

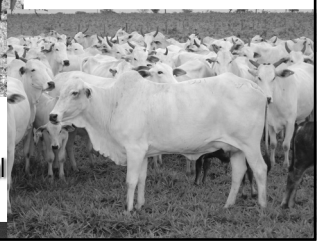
Feto – próxima progênie

Cria ao pé

10

Nutrição X Reprodução

Baixa condição corporal



Satisfatória condição corporal

11

Animal Reproduction Science 198 (2018) 27–36

Importance of body condition score and ovarian activity on determining the fertility in beef cows supplemented with long-acting progesterone after timed-AI

Thiago K. Nishimura[a], Thiago Martins[b], Maria Isabel da Silva[b], Bruna S. Lafuente[b], José Ricardo de Garla Maio[c], Mario Binelli[c], Guilherme Pugliesi[b,c], Arlindo Saran Netto[a]

Table 2
Mean ± SEM of body condition score (BCS), ovarian characteristics, and pregnancy and conception rates according to BCS (Low [2–2.5], Moderate [2.75–3.25] or High [3.5–5]; scale 1–5) in suckling beef cows submitted to a timed-AI (TAI) protocol, and supplemented or not supplemented with 150 mg of long-acting progesterone.

End points	BCS			P value
	Low	Moderate	High	
BCS	2.47 ± 0.005[c]	2.82 ± 0.004[b]	3.84 ± 0.04[a]	< 0.0001
Follicle diameter, mm	11.46 ± 0.15[b]	11.26 ± 0.10[b]	12.23 ± 0.24[a]	0.0001
Estrous rate, %[W]	25.0 (20/80)	54.3 (140/258)	. .	< 0.0001
Corpus luteum area, cm[2]	1.21 ± 0.02[b]	1.19 ± 0.02[b]	1.34 ± 0.04[a]	0.007
Ovulation rate, % (ovulated/n)	82.9[b] (353/426)	90.5[a] (903/998)	94.8[a] (110/116)	< 0.0001
Conception rate, % (P/ovulated cows)[Z]	50.1 (177/353)	54.3 (490/903)	60.9 (67/110)	0.27
Pregnancy rate, % (P/TAI)[Y]	41.5[b] (177/426)	49.1[a] (490/998)	57.8[a] (67/116)	0.04

[ab]Different superscript letters in the same row indicate differences ($P < 0.05$) between groups by analysis of variance.
[W] For the category of BCS between 3.5–5, only one cow was detected in estrus, therefore, the data were excluded for this group.
[Y] P/AI: number of pregnant cows divided by the total number of cows that had TAI.
[Z] Conception rate: number of pregnant cows divided by the number of cows detected with a corpus luteum 4 days after TAI.

30

12

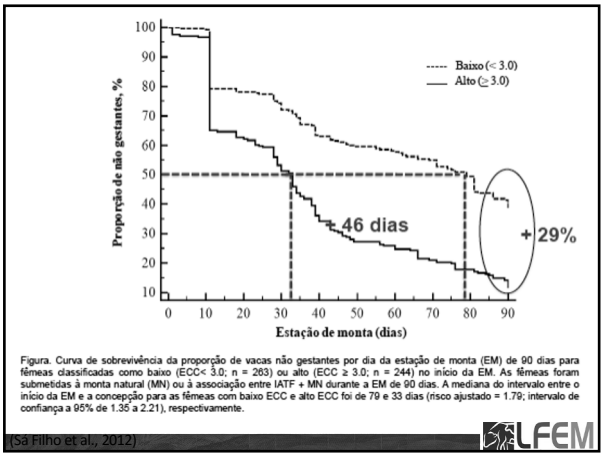
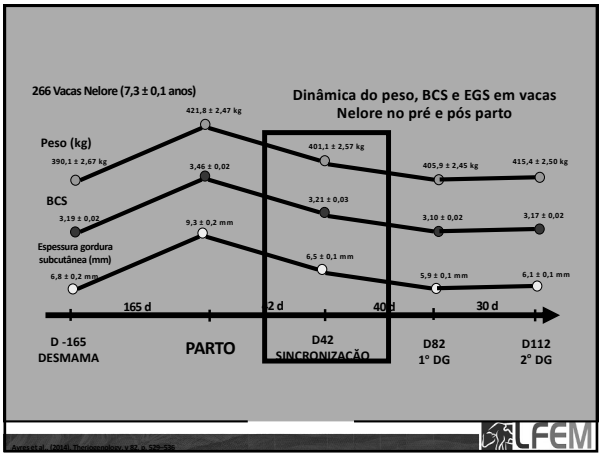


Figura. Curva de sobrevivência da proporção de vacas não gestantes por dia da estação de monta (EM) de 90 dias para fêmeas classificadas como baixo (ECC< 3.0; n = 263) ou alto (ECC ≥ 3.0; n = 244) no início da EM. As fêmeas foram submetidas à monta natural (MN) ou à associação entre IATF + MN durante a EM de 90 dias. A mediana do intervalo entre o início da EM e a concepção para as fêmeas com baixo ECC e alto ECC foi de 79 e 33 dias (risco ajustado = 1.79; intervalo de confiança a 95% de 1.35 a 2.21), respectivamente.

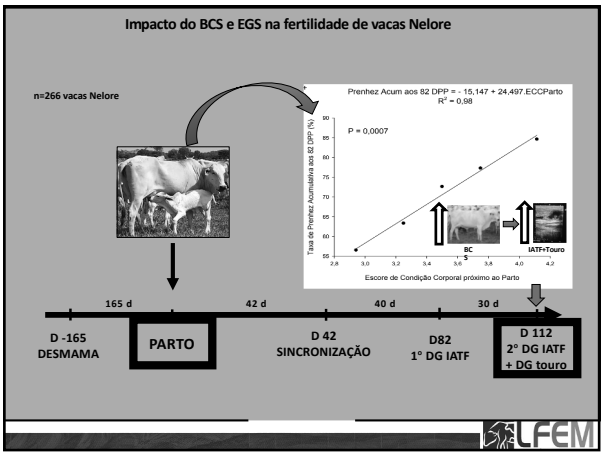
(Sá Filho et al., 2012)

15

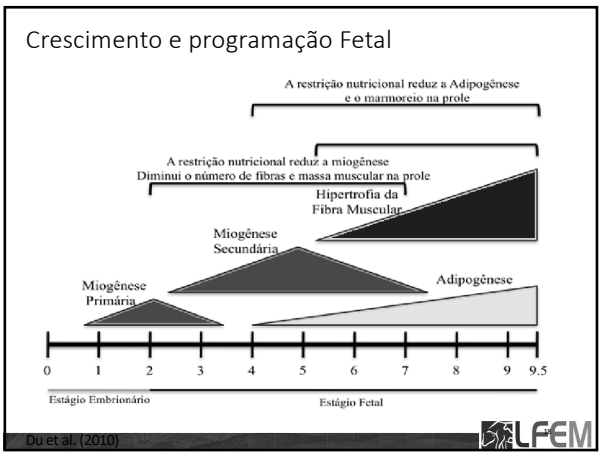


Aves et al., (2016). Theriogenology, v.82, p. 529–536

16

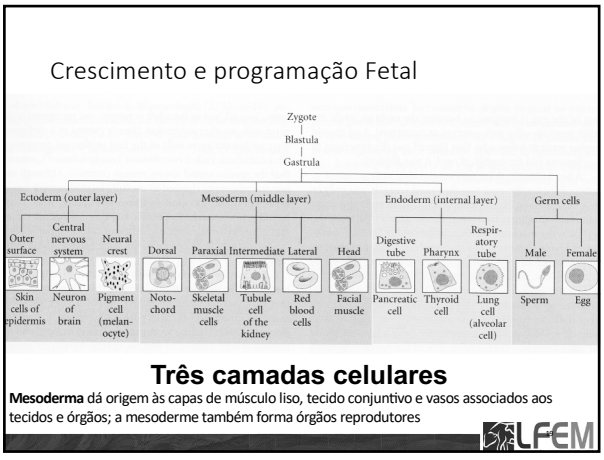


17



Du et al. (2010)

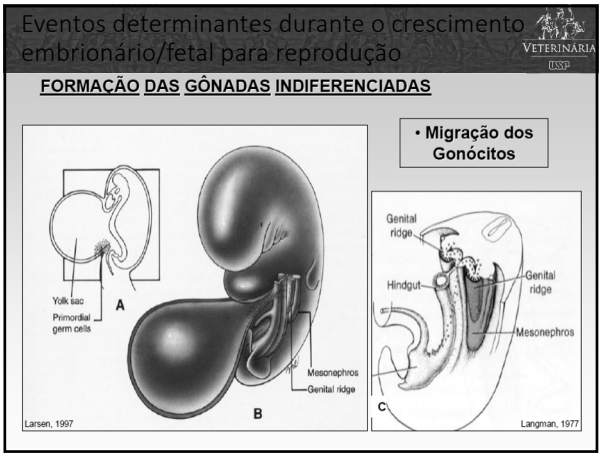
18



Três camadas celulares

Mesoderma dá origem às capas de músculo liso, tecido conjuntivo e vasos associados aos tecidos e órgãos; a mesoderme também forma órgãos reprodutores

19



20

Eventos determinantes durante o crescimento embrionário/fetal para reprodução

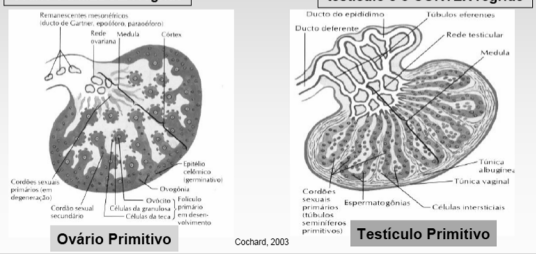
Dependente do sexo cromossômico do embrião

Embriões

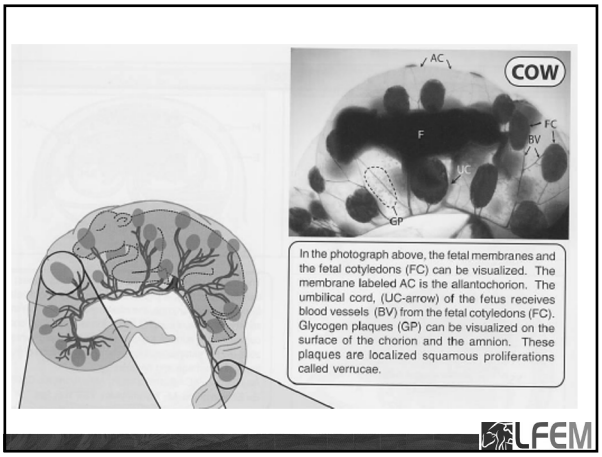
XX XY

CÓRTEX se diferencia no ovário e a MEDULA regride

MEDULA se diferencia no testículo e o CÓRTEX regride



21



22

Tópicos

Relação da Nutrição durante a gestação e Reprodução

Estratégias para alterar a nutrição fetal

Impactos na Reprodução da Vaca (mãe)

Impactos na Reprodução da Progênie (programação fetal)

Considerações Finais

23

Tópicos

Relação da Nutrição durante a gestação e Reprodução

Estratégias para alterar a nutrição fetal

Impactos na Reprodução da Vaca (mãe)

Impactos na Reprodução da Progênie (programação fetal)

Considerações Finais

24

Estratégias para alterar a nutrição fetal

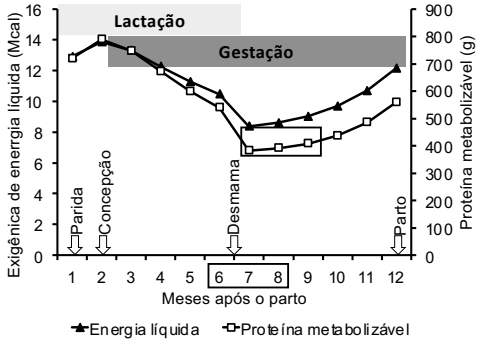
Nutrição do Feto

1 Nutrição da mãe

2 Reduzir demanda da mãe → Cria ao pé

25

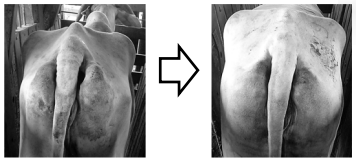
▪ Dados de exigências de energia líquida e proteína metabolizável, no decorrer do ciclo de 12 meses, de uma vaca Nelore madura de 450 kg



Adaptado: NRC (1996) apud: Rocha et al. (Impactos da nutrição sobre a reprodução de vacas de corte)

26

▪ Qual seria um boa estratégia de suplementação visando recuperar ECC



ECC:2,50 ECC:3,00

27

Importância da suplementação nutricional

- Suplementação proteica (animais em pastejo de baixa qualidade)
- Corrigi deficiências nutricionais:
  - Melhora utilização da forragem (DelCurto et al., 2000)
  - ↑ Digestibilidade (Meteer et al., 2015)
  - ↑ Ingestão de matéria seca, proteína bruta e nutrientes (Kunkle et al., 2000)
  - ↑ Peso, ECC, metabolitos sanguíneos e performance reprodutiva (da Silva et al., 2017; Quintans et al., 2016; Wilson et al., 2016)

28

Nutrição

Suplemente as vacas de cria no momento certo

Adotar a prática após a desmama é ideal para a vaca recuperar a condição corporal e melhorar os índices de prenhez na estação seguinte

- Condição razoável da pastagem

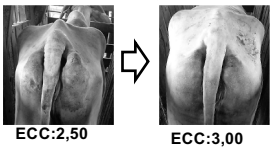
- Suplementos minerais proteicos para estimular a ingestão de MS, e consequentemente o ganho de peso

- GPD: 600 g/d x 75d = 45kg

- Vaca Nelore 400 kg

-522 g de PM e 9,1 Mcal/dia

45 kg



ECC:2,50 ECC:3,00

29

AMAMENTAÇÃO
X
REPRODUÇÃO

30

Tópicos

Relação da Nutrição durante a gestação e Reprodução

Estratégias para alterar a nutrição fetal

Impactos na Reprodução da Vaca (mãe)

Impactos na Reprodução da Progênie (programação fetal)

Considerações Finais

31

Tópicos

Relação da Nutrição durante a gestação e Reprodução

Estratégias para alterar a nutrição fetal

Impactos na Reprodução da Vaca (mãe)

Impactos na Reprodução da Progênie (programação fetal)

Considerações Finais

32

Efeitos da nutrição pré-parto na reprodução da vaca

Winter grazing system and supplementation during late gestation influence performance of beef cows and steer progeny
D. M. Larson, J. L. Martin, D. C. Adams and R. N. Funston

J ANIM SCI 2009, 87:1147-1155.
doi: 10.2527/jas.2008-1323 originally published online November 7, 2008

Suplementação no terço final

- 109 Vacas Angus x Simental, 495kg
- Suplementação Pré e/ou Pós-parto (fatorial 2x2) – 1 kg/vaca/dia

Table 3. Effects of grazing winter range or corn residue and CP supplementation during the last trimester of gestation on cow performance and reproduction

	Treatment[1]							
	WR		CR			Treatment *P*-value[2]		
Trait	PS	NS	PS	NS	SEM	Sys.	Supp.	S × S
n	6	6	6	6				
Precalving BW, kg	518[a]	480[b]	546[c]	537[c]	16	<0.001	<0.001	0.02
Precalving BCS	5.15	4.77	5.39	5.24	0.07	<0.001	0.001	0.10
Calf birth date, Julian d	83[a]	89[b]	84[a]	84[a]	2	0.18	0.02	0.01
Calved in the first 21 d, %	83[a]	62[b]	78[a]	80[a]	5	0.20	0.07	0.03
Prebreeding BW, kg	468	453	494	488	22	<0.001	0.006	0.16
Prebreeding BCS	5.28	5.02	5.41	5.27	0.06	0.004	0.003	0.32
May 24-h milk, kg	5.5	5.4	6.1	5.7	0.9	0.08	0.39	0.48
Nov. 24-hr milk, kg	2.3	2.5	3.5	3.5	0.3	0.002	0.85	0.67
Cow weaning BW, kg	490[a]	482[b]	508[c]	516[c]	14	<0.001	0.32	0.006
Cow weaning BCS	5.17	5.09	5.12	5.18	0.06	0.74	0.88	0.22
Pregnancy rate, %	96	94	98	95	3	0.65	0.39	0.97

[a–c]Within a row, means without a common superscript differ at $P < 0.05$.
[1]WR-PS = dams supplemented 3 times per week with the equivalent of 0.45 kg/d of 28% CP cake (DM basis) during gestation and grazed dormant winter range; WR-NS = dams not supplemented with CP during gestation, grazed dormant winter range; CR-PS = dams supplemented with the equivalent of 0.45 kg/d 28% CP cake (DM basis) during gestation and grazed corn residue between weaning and the subsequent calving

33

Effects of pre- and postpartum nutrition on reproduction in spring calving cows and calf feedlot performance[1]

L. A. Stalker,[*2] D. C. Adams,† T. J. Klopfenstein,[*3] D. M. Feuz,‡ and R. N. Funston†

Table 4. Body weight, BCS, and reproductive performance of cows fed 0 (No Supp) or 0.45 kg (Supp) supplement prepartum and allowed to graze subirrigated meadow or fed grass hay postpartum

	Supp		No Supp			*P*-value[2]		
Item	Meadow	Hay	Meadow	Hay	SEM[1]	Pre	Post	Pre × Post
Cow BW, kg								
December 1	490	487	493	496	4	0.16	0.95	0.52
February 28	489	491	457	475	6	0.001	0.13	0.20
May 1	447	449	433	447	5	0.14	0.13	0.22
May 30	466	453	457	451	5	0.24	0.06	0.52
October 8	486	476	478	481	5	0.81	0.55	0.23
BW change, kg								
Prepartum	−1	3	−37	−21	5	<0.001	0.06	0.25
Postpartum	19	4	24	3	3	0.52	<0.001	0.32
Cow BCS								
December 1	5.2	5.2	5.3	5.3	0.05	0.11	0.67	0.91
February 28	5.1	5.2	4.5	4.8	0.10	<0.001	0.16	0.35
May 1	4.8	4.9	4.5	4.7	0.05	<0.001	0.06	0.80
May 30	5.2	4.9	5.1	4.8	0.06	0.01	<0.001	0.97
October 8	5.2	5.1	5.1	5.1	0.05	0.21	0.39	0.96
BCS change								
Prepartum	−0.1	−0.1	−0.8	−0.5	0.1	<0.001	0.22	0.29
Postpartum	0.4	0.1	0.5	0.1	0.1	0.05	<0.001	0.62
Pregnancy rate, %	94.8	91.5	89.2	91.3	3.9	0.46	0.88	0.49
Calving d of yr	87	88	84	85	1	0.01	0.16	0.80
Calving to conception,[3] d	82	79	84	82	2	0.26	0.12	0.91
Conception first 21 d,[3] %	68.7	71.3	76.2	66.3	5.4	0.97	0.36	0.17

[1]Pooled standard error of treatment means, n = 12 pastures per treatment.
[2]Pre = prepartum treatment main effect; Post = postpartum treatment main effect; Pre × Post = prepartum × postpartum treatment interaction.
[3]Determined from subsequent calving date minus 285 d.

(Stalker et al., 2006)

34

Efeitos da nutrição pré-parto na reprodução da vaca

Late gestation supplementation of beef cows differing in body condition score: Effects on cow and calf performance
D. W. Bohnert, L. A. Stalker, R. R. Mills, A. Nyman, S. J. Falck and R. F. Cooke

J ANIM SCI 2013, 91:5485-5491.
doi: 10.2527/jas.2013-6301 originally published online August 29, 2013

Suplementação no terço final

- 228 Vacas
- *Fatorial 2x2* (ECC e Suplementação no terço final)
- 0,9 kg/dia no terço final

Table 2. Body weight, BCS and reproductive performance of cows managed to enter the last trimester of gestation in low BCS (LBCS; approximately 4) or high BCS (HBCS; approximately 6) and offered 0.0 (No) or 0.9 kg/d (Yes) of dried distillers grains plus solubles during the last trimester of gestation[1]

	BCS				Supplementation			
Item	LBCS	HBCS	SEM	*P*-value	No	Yes	SEM	*P*-value
Initial BW, kg	503	565	14.7	<0.001	535	533	14.7	0.81
Calving BW, kg	513	554	13.2	<0.001	516	550	13.2	0.002
Weaning BW, kg	518	547	27.6	<0.001	528	537	27.6	0.16
Initial BCS	4.4	5.7	0.13	<0.001	5.1	5.0	0.13	0.41
Calving BCS	4.4	5.3	0.06	<0.001	4.8	5.0	0.06	0.005
Weaning BCS	4.7	5.2	0.15	<0.001	4.9	5.0	0.15	0.08
Pregnancy rate, %	79.3	91.6	4.14	0.05	85.2	85.6	4.14	0.94

[1]Initial BCS and BW was determined at study initiation, approximately 80 d prior to calving.

(Bohnert et al., 2013)

35

Efeitos da nutrição pré-parto na reprodução da vaca

Suplementação no terço final

- 106 Vacas Angus x Simental
- Controle vs. Suplem no terço final (125%)

Influence of prepartum dietary energy on beef cow performance and calf growth and carcass characteristics

T.B. Wilson [1], D.B. Faulkner [2], D.W. Shike [*]

Table 4
Influence of prepartum dietary energy on cow BW, BCS, calving, milk production, and subsequent reproduction.

	Treatment[a]		SEM	*P*-value
Item[b]	REQ	HE		
BW, kg				
Initial	686	681	7	0.65
Post-calving	652	660	8	0.51
Breeding	655	684	10	0.03
Change initial to calving	−34	−22	5	0.07
Change initial to breeding	−31	3	6	<0.01
BCS				
Initial	6.0	5.9	0.1	0.28
Post-calving	5.7	5.6	0.1	0.33
Breeding	5.8	5.8	0.1	0.37
Change initial to calving	−0.3	−0.3	0.1	0.80
Change initial to breeding	−0.2	−0.1	0.1	0.09
Calving				
Calving date, Julian d	48	47	2	0.78
Unassisted births, %	90	86	–	0.30
Milk production, kg/d				
65 ± 9 d	5.9	5.8	0.8	0.99
120 ± 9 d	6.6	6.8	0.5	0.27
Subsequent reproduction[c]				
AI conception, %	41	52	–	0.34
Overall pregnancy, %	72	74	–	0.86

[a] REQ = limit-fed to provide 100% TDN requirement; HE = limit-fed to provide 125% TDN requirement.
[b] Cow performance reported for 87 cows (REQ, n = 45; HE, n = 42), 6 pens per treatment.
[c] Subsequent reproduction reported for 82 cows (REQ, n = 44; HE, n = 38), 6 pens per treatment.

(Wilson et al., 2016)

36

Efeitos da nutrição pré-parto na reprodução da vaca

Effects of pre- and postpartum supplementation on lactational and reproductive performance of grazing Nellore beef cows

Daniel Mageste de Almeida[A], *Marcos Inácio Marcondes*[A,C], *Luciana Navajas Rennó*[A], *Leandro Soares Martins*[A], *David Esteban Contreras Marquez*[A], *Felipe Velez Saldarriaga*[A], *Valder Alberto Castarlo Villadiego*[A], *Roman Maza Ortega*[A], *Dolfen Full Sotelo Moreno*[A], *Felipe Henrique de Moura*[A], *Camila Soares Cunha*[A] *and Mário Fonseca Paulino*[A]

- 80 Vacas Nelore com 6 meses de gestação, 516 kg
- Suplementação Pré e/ou Pós-parto (fatorial 2x2) – 1 kg/vaca/dia

Table 1. Nutrient content of dietary supplement offered and pastures available to cows during the pre- and postpartum intervals

NDIN, neutral detergent insoluble nitrogen; apNDF, neutral detergent fibre corrected to ash and protein; NFC, non-fibrous carbohydrates; iNDF, indigestible neutral detergent fibre

		Pastures (day relative to calving)					
Item	Supplement	−75	−45	−15	+15	+45	+75
DM	887	455	588	469	356	275	252
Organic matter[A]	919	918	913	929	915	921	924
Crude protein[A]	286	80	62	70	87	99	109
NDIN[B]	172	215	154	204	201	262	232
Ether extract[A]	25	9	8	11	12	12	12
apNDF[A]	156	613	652	637	622	609	587
NFC[A]	452	216	191	211	195	201	216
iNDF[A]	28	321	402	342	253	214	184
Metabolisable energy[C]	14	–	–	–	–	–	–

[A]g/kg of DM.
[B]g/kg of total nitrogen.
[C]MJ/kg of DM.

(Mageste de Almeida et al., 2020)

37

Efeitos da nutrição pré-parto na reprodução da vaca

Table 2. Performance and body condition score of Nellore cows supplemented or not supplemented during the prepartum period

Item	Supplementation (90 days prepartum)		s.e.m.	*P*-value
	Minus	Plus		
Initial bodyweight (kg)	516	515	1.80	0.887
Final bodyweight (kg)	499	528	2.20	0.001
Average daily gain (g/day)	−182	149	24.03	0.001
BCS at calving	4.3	5.1	0.04	0.001
Calf birthweight (kg)	30.6	34.3	0.75	0.001

(Mageste de Almeida et al., 2020)

38

Efeitos da nutrição pré-parto na reprodução da vaca

Table 4. Postpartum concentration of progesterone and metabolites in Nellore cows not supplemented or supplemented during the pre- or postpartum intervals

NEFA, non-esterified fatty acids; BHB, β-hydroxybutyrate; M-M, not supplemented; P-M, supplemented prepartum only; M-P, supplemented postpartum only; P-P, supplemented both pre- and post-calving

Item	Supplementation strategy				s.e.m.	*P*-value[A]					
	M-M	P-M	M-P	P-P		Pre	Post	Pre × Post	Day	Pre × Day	Post × Day	Pre × Post × Day
Serum urea N (mmol/L)	3.29	3.18	4.00	4.25	0.580	0.412	0.001	0.113	0.001	0.956	0.105	0.564
Glucose (mmol/L)	2.55	2.84	2.90	2.95	0.860	0.172	0.003	0.106	0.001	0.871	0.719	0.864
NEFA (mmol/L)	0.42	0.30	0.31	0.21	0.021	0.001	0.001	0.449	0.001	0.117	0.001	0.627
BHB (mmol/L)	0.57	0.51	0.37	0.35	0.022	0.103	0.001	0.442	0.001	0.402	0.001	0.895
Progesterone (ng/mL)	1.51	2.20	3.28	3.60	0.277	0.210	0.001	0.638	0.001	0.702	0.001	0.791
Conception rate (%)	50	63	84	85	–	0.407	0.005	0.494	–	–	–	–

[A]Probability of the main effects of prepartum (Pre) and postpartum (Post) supplementation and interaction between pre- and postpartum supplementation (Pre × Post).

(Mageste de Almeida et al., 2020)

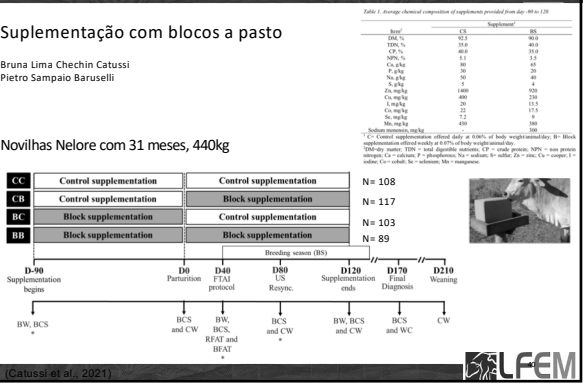
39

Estratégias de suplementação nutricional

Suplementação com blocos a pasto

Bruna Lima Chechin Catussi
Pietro Sampaio Baruselli

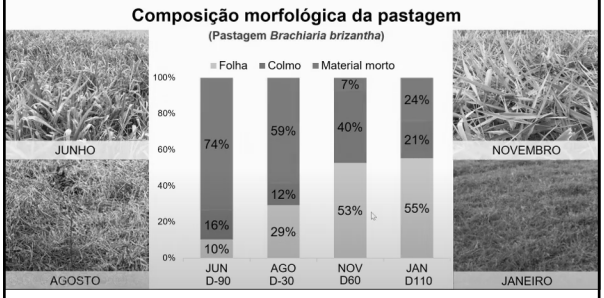
Novilhas Nelore com 31 meses, 440kg



(Catussi et al., 2021)

40

Estratégias de suplementação nutricional



(Catussi et al., 2021)

41

Estratégias de suplementação nutricional

Suplementação com blocos a pasto

Table 4. Effect of prepartum and/or postpartum supplementation with blocks on body weight (kg) and body condition score (1–5 point scale) of primiparous Nelore cows evaluated at different times.

Variable[1]	Time	Groups				Se	P value[2]		
		CC	CB	BC	BB		C1	C2	C3
BW, Kg	90 days prepartum[a]	380.3	385.4	382.3	387.0	1.66	0.42	0.39	0.66
	40 days postpartum[b]	376.4	379.1	375.3	382.1	1.36	0.41	0.18	0.31
	120 days postpartum[d]	385.9	383.4	385.1	381.1	1.64	0.51	0.44	0.71
BCS, (1-5)	90 days prepartum[a]	2.90	2.98	2.93	2.95	0.01	0.11	0.83	0.18
	Parturition	3.01	3.00	3.11	3.10	0.01	0.02	0.12	<0.01
	40 days postpartum[b]	2.83	2.90	2.90	2.95	0.02	0.01	0.15	0.99
	80 days postpartum[c]	2.84	2.91	2.85	2.98	0.02	0.05	0.02	0.22
	120 days postpartum[d]	3.00	3.07	2.99	3.04	0.02	0.48	0.74	0.07
	170 days postpartum[e]	2.78	2.87	2.74	2.84	0.01	0.22	0.25	<0.01

Pré vs. Pós

[1] BW= body weight (kg); BCS= body condition score (1-5 point scale).
[2]Orthogonal contrasts: C1 (Block supplementation effect): control (CC) *vs.* block supplementation (BB+BC+CB); C2 (Block supplementation effect in both pre and postpartum periods): Pre and postpartum (BB) *vs.* Pre or postpartum (BC+CB) and C3 (Pre or postpartum effect): prepartum (BC) *vs.* postpartum (CB).
[a] 90 days prepartum= at the begin of supplementation (D-90)
[b] 40 days postpartum= at the onset of the synchronization protocol (D40)
[c] 80 days postpartum= at pregnancy diagnosis and resynchronization (D80)
[d] 120 days postpartum= at the end of supplementation and second pregnancy diagnosis (D120)
[e] 170 days postpartum= at final pregnancy diagnosis after two FTAI's and natural mating (D170)

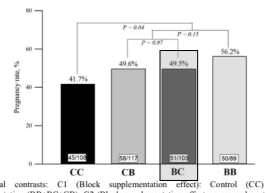
42

Estratégias de suplementação nutricional

Suplementação com blocos a pasto

Bruna Lima Chechin Catussi
Pietro Sampaio Baruselli

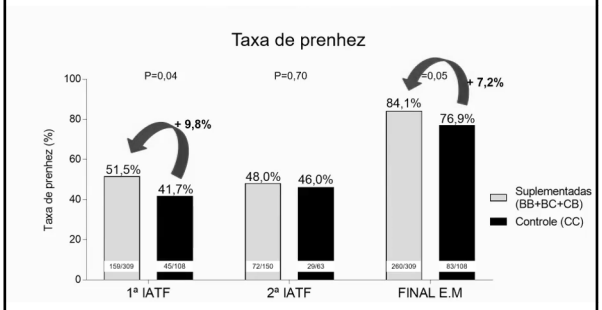
Figure 4. Pregnancy rate (%) at the first FTAI according to groups in primiparous Nelore cows.



Orthogonal contrasts: C1 (Block supplementation effect): Control (CC) *vs.* block supplementation (BB+BC+CB); C2 (Block supplementation effect on pre and postpartum): Pre and postpartum (BB) *vs.* Pre or postpartum (BC+CB) and C3 (Pre or postpartum effect): prepartum (BC) *vs.* postpartum (CB).

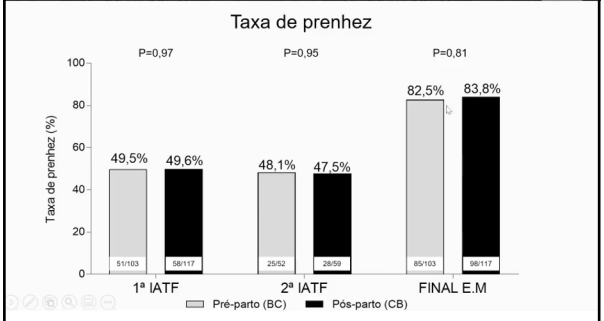
(Catussi et al., 2021)

43



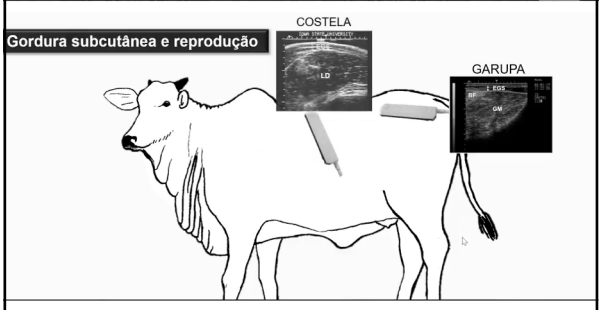
44

Efeitos da nutrição pré-parto na reprodução da vaca



45

Gordura subcutânea e reprodução

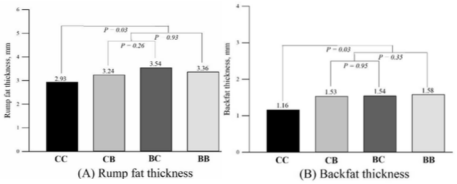


46

Estratégias de suplementação nutricional

Suplementação com blocos a pasto

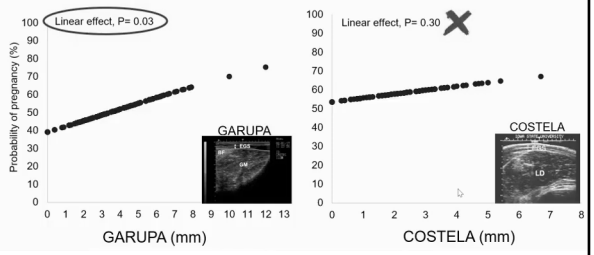
Figure 6. Subcutaneous fat thickness (mm) 40 days after parturition according to groups in primiparous Nelore cows. Subcutaneous rump fat thickness (RFAT; figure 6A) and subcutaneous backfat thickness (BFAT; figure 6B).



Orthogonal contrasts: C1 (Block supplementation effect): Control (CC) *vs.* block supplementation (BB+BC+CB); C2 (Block supplementation effect in both pre and postpartum periods): Pre and postpartum (BB) *vs.* Pre or postpartum (BC+CB) and C3 (Pre or postpartum effect): prepartum (BC) *vs.* postpartum (CB).

47

Probabilidade prenhez - 1ª IATF



48

CONCLUSÃO

C1. A suplementação com blocos independente do período:

- Maior ECC ao parto e até 80 dias após ✓
- Maior espessura de gordura subcutânea ✓
- Maior [ ] de glicose (D40) e insulina (D40-D80) ✓ Parcial
- Maior taxa de prenhez à 1ª IATF e Final E.M ✓
- Melhor desempenho dos bezerros até 120 dias ✓ Parcial

49

CONCLUSÃO

C3. A suplementação com blocos durante o pré-parto

- Maior ECC ao parto ✓ Parcial
- Espessura de gordura subcutânea ✗
- Menor [ ] ureia (D40), glicose (D80) ✗
- Taxa de prenhez ✗
- Menor peso bezerro aos 120 dias ✓ Parcial

50

Efeitos da nutrição pré-parto na reprodução da progênie

Subnutrição

- Reduz fluxo sanguínea para placenta
- Aumenta vilosidade dos placentônios
- Reduz Peso ao nascimento
- Menor CFA (primeiro trimestre)

Excesso de nutrição

- Alta PB reduz CFA
- Aumenta Peso e esqueleto
- Reduz produção de leite e longevidade
- Menor performance reprodutiva

Suplementação

- Pode aumentar o desenvolvimento na recria
- Antecipar puberdade
- Antecipar a prenhez
- Aumentar a taxa de concepção
- Maior desenvolvimento folicular

(Funston et al., 2013)

51

Efeitos da nutrição pré-parto na reprodução da progênie

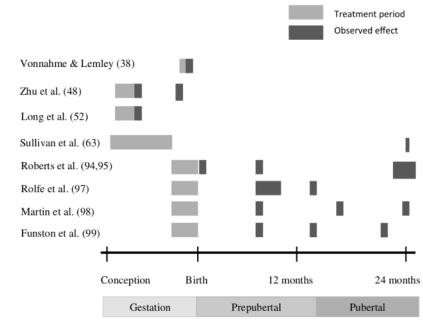


Fig. 1. Timing of maternal nutrient alteration (*light blue*) affects fetal development and progeny performance (*dark blue*) in beef cattle. (*Adapted from* Rhind SM, Rae MT, Brooks AN. Effects of nutrition and environmental factors on the fetal programming of the reproductive axis. Reproduction 2001;122:206; with permission.)

52

Efeitos da nutrição pré-parto na reprodução da progênie

Effect of Prenatal Programming on Heifer Development

Richard N. Funston, PhD[a,*], Adam F. Summers, PhD[b]

Subnutrição

Table 1
Effects of level of feed input provided to dam and progeny on progeny performance

	Level of Winter Supplement to Dam[a]			
	Marginal		Adequate	
Heifer Development and Treatment[b]	Restricted	Control	Restricted	Control
Five-year BW[c], kg	515	530	490	505
BCS at 5 y[d]	4.9	5.1	4.7[e]	5.0
Retention at 5 y, %	48	46	39	49
Calf birth weight, kg	33.6[e]	35	35	35
Calf weaning weight[d], kg	196[e]	201	202	204

[a] Level of supplementation provided to cows from December to March. Marginal = equivalent of 1.1 kg/d; Adequate = equivalent of 1.8 kg/d.
[b] Dietary level offered to heifers during 140-day postweaning development period. Restricted = 80% of feed provided to control and 1.1 kg/d supplement each subsequent winter. Control = fed ad libitum during postweaning and 1.8 kg/d supplement each winter.
[c] $P<.01$ for effect of dam treatment and heifer development treatment.
[d] $P<.001$ for interaction of dam treatment and heifer development treatment.
[e] Differs from others in same row.
Data from Roberts AJ, Grings EE, MacNeil MD, et al. Implications of going against the dogma of feed them to breed them. Wes Sect Anim Sci Proc 2009;60:87–8; and Roberts AJ, Funston R, Mulliniks T, et al. Feed efficiency—how should it be used for the cow herd? Presented at Range Beef Cow Symposium XXII. Mitchell, November 30, 2011.

(Funston et al., 2013)

53

Efeitos da nutrição pré-parto na reprodução da progênie

Subnutrição no terço inicial da gestação

INFLUENCE OF PREPARTUM NUTRITION ON THE REPRODUCTIVE PERFORMANCE OF BEEF FEMALES AND THE PERFORMANCE OF THEIR PROGENY [1,2]

L. R. Corah[3], T. G. Dunn[4] and C. C. Kaltenbach[4]

University of Wyoming, Laramie 82071

- 59 Novilhas Hereford
- Controle vs. Restrição (65% da demanda)
- 100 dias pré-parto

TABLE 3. LEAST-SQUARES MEANS FOR PERCENT CALF SURVIVAL, CALF WEANING WEIGHT, HEIFER MILK PRODUCTION, INTERVAL TO FIRST ESTRUS AND DAYS TO PUBERTY FOR F_1 HEIFER PROGENY

	Energy level					
	High			Low		
Item	No.	Mean	SE	No.	Mean	SE
Calves alive at birth (%)	30	97	2	29	90	3
Weaning weight (kg)	26	160.6[a]	4.2	25	147.6[b]	4.2
Milk production (kg/day)	28	4.8	.22	28	5.0	.24
Interval to first estrus (days)	28	51	6	28	52	5
Percent showing estrus by 40 days postpartum	28	41	4	28	26	4
Age at puberty of F_1 heifer calves (days)	12	318	6	12	337	11

[a,b] Values with different superscripts are significantly different ($P<.05$).

(Corah et al., 1975)

54

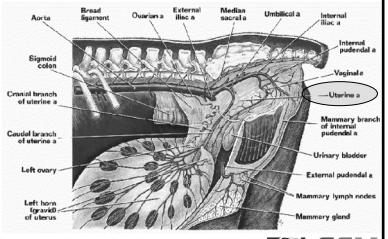
Efeitos da nutrição pré-parto na reprodução da progênie

Subnutrição até o terço médio da gestação

Maternal nutrient restriction alters uterine artery hemodynamics and placentome vascular density in *Bos indicus* and *Bos taurus*[1]

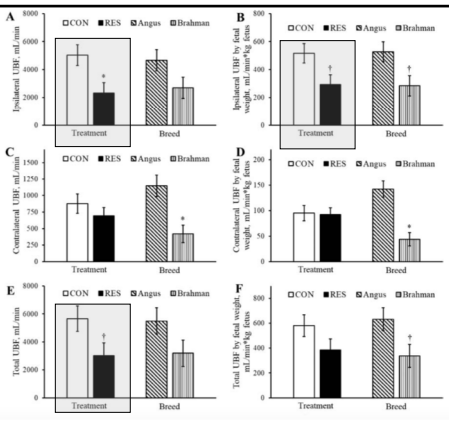
Caleb O. Lemley,[2,3,7] Caitlin G. Hart,[2] Racheal L. Lemire,[2] E. Heath King,[2] Richard M. Hopper,[2] Seong B. Park,[2] Brian J. Rude,[2] and Derris D. Burnett[2]

- Novilhas Angus e Brahman
- Controle vs. Restrição (60% da EM)
- - restrição do dia 50 ao 175 da gestação



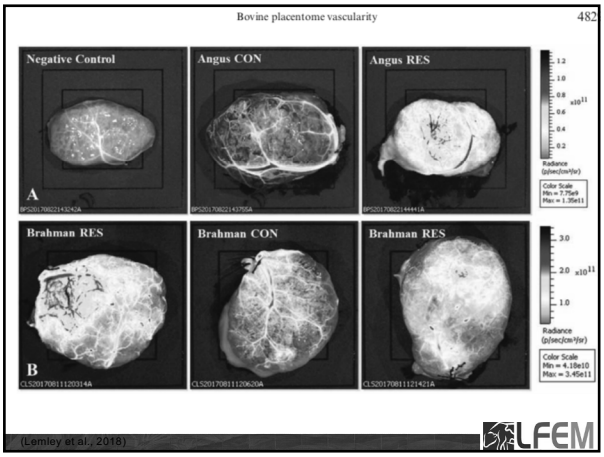
(Lemley et al., 2018)

55

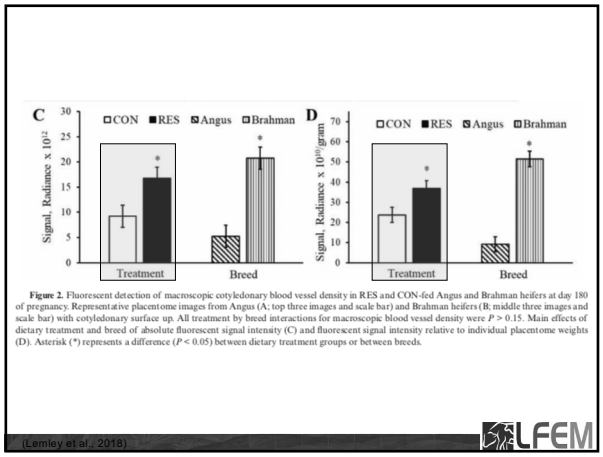


(Lemley et al., 2018)

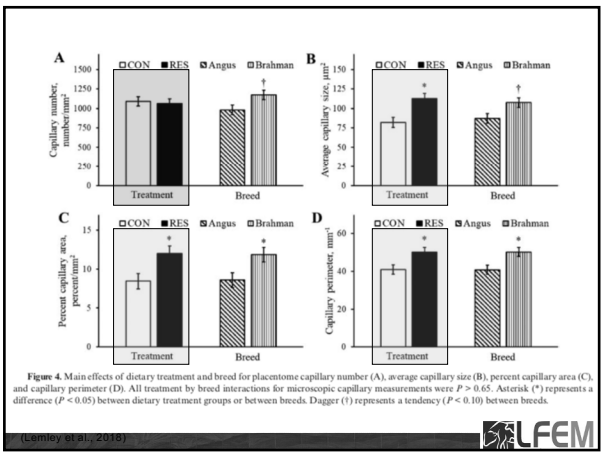
56



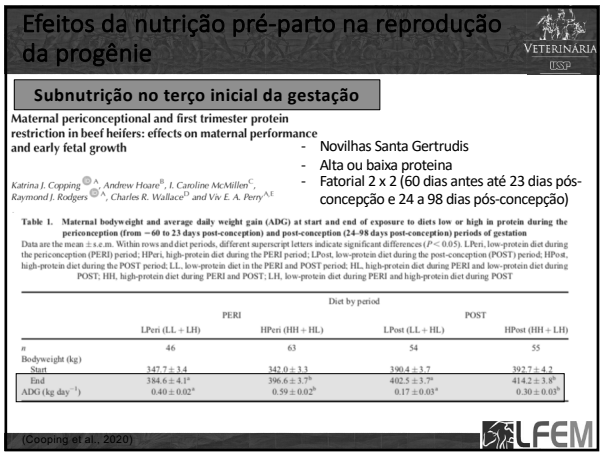
57



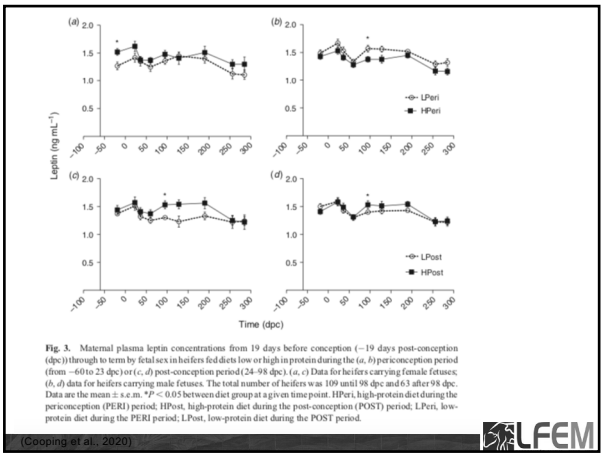
58



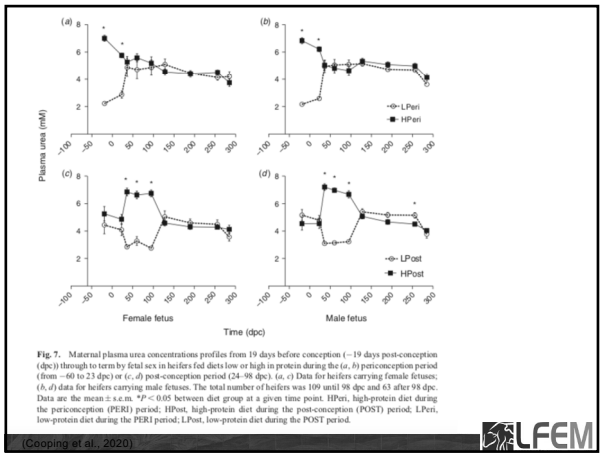
59



60



61



62

Table 2. Ultrasound measurements at 60 and 95 days post-conception (dpc) of fetuses exposed to maternal diets low or high in protein during the periconception (from −60 to 23 dpc) or post-conception (24–98 dpc) periods of gestation

Data are the mean ± s.e.m. AD, abdominal diameter; CNL, crown-nose length; ED, eye socket diameter; HPeri, high-protein diet during the periconception (PERI) period; HPost, high-protein diet during the post-conception (POST) period; LPeri, low-protein diet during the PERI period; LPost, low-protein diet during the POST period; *n*, number of fetuses measured at each ultrasound time point for each measurement taken; UD, umbilical cord diameter

	Treatment						*P*-value[B]	
	LPeri		HPeri					
	LPost	HPost	LPost	HPost	Sex	PERI	POST	PERI × POST
60 dpc								
AD[A] (cm)	1.73 ± 0.03	1.73 ± 0.02	1.72 ± 0.02	1.67 ± 0.02	0.033	0.142	0.320	0.327
n	21	25	33	30				
CNL (cm)	2.53 ± 0.03	2.50 ± 0.04	2.50 ± 0.03	2.49 ± 0.03	0.073	0.558	0.686	0.545
n	21	24	33	28				
95 dpc								
AD (cm)	4.51 ± 0.06	4.40 ± 0.06	4.46 ± 0.06	4.57 ± 0.06	0.273	0.510	0.770	0.020
n	21	25	33	30				
CNL (cm)	5.57 ± 0.06	5.64 ± 0.05	5.66 ± 0.07	5.58 ± 0.05	0.364	0.537	0.901	0.080
n	21	24	31	26				
ED (cm)	1.11 ± 0.02	1.12 ± 0.01	1.11 ± 0.01	1.12 ± 0.02	0.534	0.8362	0.385	0.843
n	21	25	33	29				
UD (cm)	1.04 ± 0.02	1.03 ± 0.02	1.03 ± 0.02	1.07 ± 0.02	0.445	0.573	0.497	0.301
n	21	24	33	30				

[A]Overall difference between fetal sexes ($P < 0.05$).
[B]The full model analysed was PERI × POST × SEX. The *P*-value for main effects and the PERI × POST interaction is shown for all variables. All other interactions were not significant ($P > 0.05$), unless expressly stated.

(Cooping et al., 2020)

63

Maternal periconceptional and first trimester protein restriction in beef heifers: effects on placental parameters and fetal and neonatal calf development

K. J. Copping[A], J. Hernandez-Medrano[B], A. Hoare[C], K. Hummitzsch[A], I. C. McMillen[D], J. L. Morrison[E], R. J. Rodgers[A] and V. E. A. Perry[A,F]

Table 2. Measurements and absolute organ weights of fetuses at 98 days post conception (dpc) following exposure to maternal diets low or high in protein during the periconception (PERI; −60 to 23 dpc) and postconception (POST; 24 to 98 dpc) periods

Values are given as the unadjusted mean ± s.e.m. Within rows, values with different superscript letters differ significantly ($P < 0.05$). AC, abdominal circumference

	Treatment					*P*-value		
PERI	Low		High		Sex	PERI	POST	PERI × POST
POST	Low	High	Low	High				
No. fetuses	9	10	15	12				
Gravid uterus (kg)	2.71 ± 0.06	2.87 ± 0.11	2.71 ± 0.09	2.83 ± 0.09	0.394	0.768	0.132	0.922
AC (cm)	14.39 ± 0.22	14.80 ± 0.23	14.48 ± 0.26	14.92 ± 0.10	0.007	0.862	0.036	0.709
Left ventricle (g)	0.50 ± 0.03	0.53 ± 0.03	0.51 ± 0.02	0.59 ± 0.03	0.073	0.326	0.040	0.376
Right ventricle (g)	0.39 ± 0.02	0.49 ± 0.02	0.44 ± 0.02	0.47 ± 0.03	0.340	0.532	0.016	0.210
Septum (g)	0.50 ± 0.03	0.58 ± 0.02	0.54 ± 0.03	0.58 ± 0.02	0.202	0.620	0.037	0.568
Atrial cap[A] (g)	0.61 ± 0.04[a]	0.75 ± 0.05[b]	0.69 ± 0.03[ab]	0.65 ± 0.02[ab]	0.007	0.539	0.115	0.031
Brain (g)	8.02 ± 0.12	8.32 ± 0.24	8.59 ± 0.16	8.51 ± 0.23	0.065	0.088	0.502	0.433
Left kidney (g)	1.17 ± 0.08	1.19 ± 0.06	1.21 ± 0.06	1.24 ± 0.07	0.087	0.637	0.667	0.773
Lung (g)	8.90 ± 0.16	9.26 ± 0.43	9.23 ± 0.33	10.06 ± 0.31	0.002	0.150	0.040	0.269
Pancreas (g)	0.17 ± 0.02	0.20 ± 0.02	0.19 ± 0.01	0.21 ± 0.01	0.047	0.660	0.044	0.831
Liver (g)	10.63 ± 0.68	11.55 ± 0.51	11.32 ± 0.39	11.57 ± 0.34	0.089	0.575	0.182	0.610
No. placentomes	47.44 ± 3.79	46.50 ± 4.57	57.47 ± 5.87	65.00 ± 7.60	0.095	0.027	0.653	0.609
Placentome weight (g)	158.96 ± 7.38	172.03 ± 9.17	164.85 ± 8.61	191.97 ± 13.20	0.909	0.250	0.075	0.552
Placentome volume (mL)	146.33 ± 7.34	151.10 ± 9.12	149.13 ± 7.59	185.42 ± 8.18	0.746	0.062	0.010	0.105

[A]PERI × POST × sex interaction ($P < 0.05$).

64

Efeitos da nutrição pré-parto na reprodução da progênie

Subnutrição no terço inicial da gestação

animals

Effects of Developmental Programming Caused by Maternal Nutrient Intake on Postnatal Performance of Beef Heifers and Their Calves

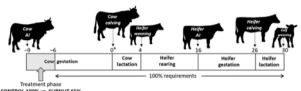


Figure 1. Experimental design. * month; CONTROL, cows fed 100% of their nutritional requirements during the first third of pregnancy; SUBNUT, cows fed 65% of their nutritional requirements during the first third of pregnancy; AI, artificial insemination.

85 vacas das Raças Parda de Montanha e Pirenaica

Table 1. Chemical composition of feedstuffs used in the experiment (on an as-fed basis).

Chemical Composition	Total Mixed Ration †	Concentrate ‡	Meadow Hay §	Barley Straw ⊹
DM (g/kg)	908	907	886	902
CP (g/kg DM)	124	152	154	40
NDF (g/kg DM)	466	262	569	796
ADF (g/kg DM)	253	62	320	456
ADL (g/kg DM)	40	8	58	58
Ash (g/kg DM)	113	60	98	65
ME (MJ/kg DM)	11.0	14.4	9.8	7.5

† Diet used during cow gestation (maternal nutrition treatment) and lactation and heifer lactation; ‡ § ⊹ diet used during heifer rearing; ‡ diet used during the last month of heifer pregnancy; DM, dry matter; CP, crude protein; NDF, neutral-detergent fiber; ADF, acid-detergent fiber; ADL, acid-detergent lignin; ME, metabolizable energy.

(Noya et al., 2019)

65

Efeitos da nutrição pré-parto na reprodução da progênie

Subnutrição no terço inicial da gestação

Table 3. Reproductive performance of heifers during rearing according to maternal nutrition and breed.

Items	Maternal Nutrition		Breed		RSD	*p*-Value	
	CONTROL	SUBNUT	Parda	Pirenaica		Maternal Nutrition	Breed
Age at puberty (months)	12.0	12.1	11.6	12.6	1.58	0.905	0.169
LW at puberty (kg)	341	336	350	327	23.8	0.659	0.076
Mature LW at puberty (%) †	59	58	61	56	4.8	0.723	0.055
Puberty reached by 12 months (%) ‡	63	50	63	60	-	0.210	0.272
Puberty reached by 16 months (%)	94	89	95	87	-	0.409	0.333
Fertility to a single AI (%)	78.6	81.3	82.4	76.9	-	0.343	0.328

† 580 kg of expected mature LW for both breeds; ‡ % of animals that reached puberty before the mean age at puberty reported in each group; CONTROL, heifers from cows fed 100% of their requirements in early pregnancy; SUBNUT, heifers from cows fed 65% of their requirements in early pregnancy; RSD, residual standard deviation; AI, artificial insemination.

(Noya et al., 2019)

66

Efeitos da nutrição pré-parto na reprodução da progênie

Subnutrição no terço inicial da gestação

Table 4. Follicle population, corpus luteum, and ovary size of heifers during rearing according to maternal nutrition and breed.

Items	Maternal Nutrition		Breed		RSD	*p*-Value	
	CONTROL	SUBNUT	Parda	Pirenaica		Maternal Nutrition	Breed
Small follicles (<5 mm)							
At 9.5 months (*n*)	8	9	10	7	4.4	0.365	0.217
At 13 months (*n*)	10	10	9	11	4.1	0.964	0.432
At 15.5 months (*n*)	16 [a]	11 [b]	13	14	4.5	0.011	0.418
Medium follicles (5 < x < 10 mm)							
At 9.5 months (*n*)	0.8 [b]	2.5 [a]	1.8	1.4	1.45	0.019	0.524
At 13 months (*n*)	0.9	1.9	2.1	0.7	1.79	0.234	0.100
At 15.5 months (*n*)	1.4	0.8	0.9	1.3	1.40	0.364	0.637
Large follicles (>10 mm)							
At 9.5 months (*n*)	0.8	0.4	0.8 [a]	0.4 [b]	0.49	0.108	0.044
At 13 months (*n*)	0.9 [a]	0.4 [b]	0.5	0.8	0.57	0.041	0.367
At 15.5 months (*n*)	0.4 [b]	0.9 [a]	0.9	0.4	0.51	0.032	0.056
Dominant follicle diameter							
At 9.5 months (mm)	11.2	9.5	10.9	9.8	1.69	0.054	0.227
At 13 months (mm)	11.1	10.2	10.9	10.5	3.19	0.544	0.807
At 15.5 months (mm)	10.5	11.4	12.4 [a]	9.5 [b]	2.31	0.451	0.017

(Noya et al., 2019)

67

Efeitos da nutrição pré-parto na reprodução da progênie

Subnutrição no terço inicial da gestação

Items	Maternal Nutrition		Breed		RSD	*p*-Value	
	CONTROL	SUBNUT	Parda	Pirenaica		Maternal Nutrition	Breed
Corpus luteum							
Heifers with CL at 13 months (%)	88	72	84	73	-	0.191	0.246
CL diameter at 13 months (mm)	19.2	17.9	18.6	18.5	4.25	0.601	0.968
Heifers with CL at 15.5 months (%)	94	83	95	80	-	0.282	0.186
CL diameter at 15.5 months (mm)	13.2	17.2	16.6	13.8	4.13	0.119	0.265
Ovary diameter							
At 9.5 months (mm)	14.0	14.4	15.5 [a]	12.9 [b]	1.41	0.639	0.009
At 13 months (mm)	18.6	17.5	18.3	17.7	2.02	0.325	0.608
At 15.5 months (mm)	17.8	18.8	19.9 [a]	16.7 [b]	1.73	0.292	0.003

(Noya et al., 2019)

68

Efeitos da nutrição pré-parto na reprodução da progênie

Subnutrição no terço inicial da gestação

Table 5. Heifer performance during gestation and first lactation according to maternal nutrition and breed.

Items	Maternal Nutrition		Breed		RSD	*p*-Value	
	CONTROL	SUBNUT	Parda	Pirenaica		Maternal Nutrition	Breed
Heifer performance							
Gestation ADG (kg/day)	0.334	0.283	0.298	0.319	0.0969	0.275	0.645
LW at calving (kg)	520	491	516	494	33.0	0.103	0.204
BCS at calving	3.0	3.0	2.8 [b]	3.2 [a]	0.16	0.425	0.001
Age at calving (months)	26.4	26.3	26.1	26.6	1.52	0.844	0.584
Calving assistance (%)	26.7	16.7	25.0	18.2	-	0.304	0.338
LW at weaning (kg)	469	452	478	443	42.0	0.445	0.124
Lactation ADG (kg/day)	−0.519	−0.349	−0.373	−0.494	0.2318	0.168	0.323
Calf performance							
Male/female calf ratio	8/7	3/9	8/8	3/8	-	0.109	0.163
LW at birth (kg)	35	34	36	33	3.7	0.321	0.134
LW at weaning (kg)	111	105	122 [a]	94 [b]	19.4	0.505	0.012
Lactation ADG (kg/day)	0.720	0.680	0.814 [a]	0.587 [b]	0.1918	0.684	0.031

CONTROL, heifers from cows fed 100% of their requirements in early pregnancy; SUBNUT, heifers from cows fed 65% of their requirements in early pregnancy; RSD, residual standard deviation; ADG, average daily gain; AI, artificial insemination; BCS, body condition score; calving assistance, assisted (from manual pull to caesarean section) or unassisted calving; LW, live weight; [a,b] means within a row with different superscripts differ significantly ($p < 0.05$).

69

Efeitos da nutrição pré-parto na reprodução da progênie

Table 2
Effect of maternal protein supplementation on heifer progeny performance

	Dietary Treatment			
	Martin et al,[98] 2007[a]		Funston et al,[99] 2010[b]	
Item	NS	SUP	NS	SUP
Birth weight, kg	35	36	35	35
Weaning weight, kg	207	212	225[c]	232[d]
Adjusted 205-day weight, kg	218[e]	226[d]	213	217
Dry matter intake, kg/d	6.50	6.75	9.48	9.30
Average daily gain, kg/d	0.41	0.40	0.85	0.79
Residual feed intake	−0.12	0.07	0.08	−0.04
Final BW,* kg	290[f]	304[g]	—	—
Age at puberty, d	334	339	366[f]	352[g]
Prebreeding weight, kg	266[c]	276[d]	317	323
Pregnancy diagnosis weight, kg	386[c]	400[d]	364	368
Pregnant, %	80[c]	93[d]	80	90
Calved in first 21 d, %	49[c]	77[d]	85	77

[a] NS = dams did not receive protein supplement while grazing dormant Sandhills range during the last third of gestation; SUP = dams were supplemented 3 times per week with the equivalent of 0.45 kg/d of 42% CP cube (dry-matter basis) while grazing dormant Sandhills range during the last third of gestation.
[b] NS = dams did not receive protein supplement while grazing dormant Sandhills range or corn residue during the last third of gestation; SUP = dams were supplemented 3 times per week with the equivalent of 0.45 kg/d of a 31% CP cube (dry-matter basis) while grazing dormant Sandhills range or corn residue during the last third of gestation.

Suplementação no terço final da gestação

(Funston et al., 2013)

70

Efeitos da nutrição pré-parto na reprodução da progênie

Suplementação no terço final da gestação


Animal
The international journal of animal biosciences

Productive performance of beef cows subjected to different nutritional levels in the third trimester of gestation

J.L. Klein [a,*], S.M. Adams [a], A.F. De Moura [a], D.C. Alves Filho [a], F.M. Meidana [a], J.L. Brondani [a], J.M. Cocco [a], L.D.S. Rodrigues [a], L.A.D. Pizzuti [b], M.R. Da Silva [a]

Vacas Nelore x Charolês
N=27-28/grupo

Ganho de peso durante o terceiro trimestre
NP (só pasto) = -0,103kg/dia
SP100 = +0,025kg/dia
SP150 = +0,207kg/dia

Table 1
Bromatological composition of the concentrated fraction and nutrient intake by the cows in the third trimester of pregnancy.

Diet fraction	Treatments		
	NP	SP100	SP150
Bromatological composition of the concentrated fraction			
CP, %	–	18.00	15.00
Total digestible nutrients, %	–	85.00	85.00
DM and nutrient intake for pregnant cows weighing 475 kg[1]			
Native fodder, kg/day	9.98	9.98	9.98
Concentrated supplement, kg/day	–	1.32	4.69
Total digestible nutrients kg/day	4.69	5.81	8.60
CP, kg/day	0.45	0.70	1.15
Nutrient consumption against the National Research Council NRC, 1998			
Total digestible nutrients, %[1]	88.50	109.60	162.30
CP, %[1]	60.00	93.40	153.30

Native forage composition: CP 4.5%; total digestible nutrients 47.0% (Silveira et al., 2014).
NP = natural pasture; SP100 = 100% of the requirements; SP150 = 150% of requirements.
[1] Estimated forage consumption at 2.1% of BW (National Research Council NRC, 1998).

(Klein et al., 2021)

71

Efeitos da nutrição pré-parto na reprodução da progênie

Suplementação no terço final da gestação

Table 2
Effect of nutritional level in the third trimester of gestation on body condition score of beef cows.

Body score, points[1]	Treatments			*P*-value
	NP	SP100	SP150	
At pregnancy diagnosis	2.93 ± 0.04	2.94 ± 0.04	2.98 ± 0.04	0.7092
At the start supplementation	2.84 ± 0.03	2.81 ± 0.03	2.86 ± 0.03	0.6581
At the moment of delivery	2.81[b] ± 0.02	2.92[a] ± 0.02	2.99[a] ± 0.02	< 0.0001
At the start of breeding	2.80[b] ± 0.02	2.90[a] ± 0.02	2.95[a] ± 0.02	< 0.0001
At the end of breeding	2.83[b] ± 0.02	2.90[ab] ± 0.02	2.92[a] ± 0.02	0.0072
At calf weaning	2.79[b] ± 0.01	2.80[b] ± 0.01	2.85[a] ± 0.01	< 0.0001

Values are predicted means ± SEM.
[a-b] Values within a row with different superscripts differ significantly at $P < 0.05$.
NP = natural pasture; SP100 = 100% of the requirements; SP150 = 150% of requirements.
[1] 1 = very thin; 2 = thin; 3 = average; 4 = fat; 5 = very fat.

(Klein et al., 2021)

72

Efeitos da nutrição pré-parto na reprodução da progênie

Suplementação no terço final da gestação

Table 3
Effect of nutritional level in the third trimester of gestation and lactation days on blood metabolites of beef cows during lactation.

	Treatments			SEM	Lactation days				SEM	*P*-value		
	NP	SP100	SP150		7	21	63	110		T	Day	T × Day
Albumin, g/dl	3.05	3.10	3.18	±0.05	3.15[a]	3.02[b]	3.09[ab]	3.18[a]	±0.04	0.3084	0.0057	0.5665
Cholesterol, mg/dl	163.97	178.20	157.34	±8.64	126.88[d]	142.00[c]	177.21[b]	219.92[a]	±6.79	0.3296	< 0.0001	0.4903
Glucose, mg/dl	70.99	77.85	76.04	±2.33	77.73[a]	71.79[b]	74.14[ab]	76.17[a]	±1.80	0.1023	0.0100	0.9499
Proteins, g/dl	8.14	8.29	8.12	±0.16	8.35[a]	8.16[bc]	8.02[c]	8.21[ab]	±0.10	0.6706	0.0137	0.6430

[a-d] Values within a row with different superscripts differ significantly at $P < 0.05$.
NP = natural pasture; SP100 = 100% of the requirements; SP150 = 150% of requirements.

Table 4
Effect of nutritional level in the third trimester of gestation on follicular growth of the beef cows at the start of breeding season.

Follicular growth[1]	Treatments			*P*-value
	NP	SP100	SP150	
Cow follicles	6.78 ± 0.94	5.29 ± 0.88	6.42 ± 0.91	0.4789
Follicular presence, %[2]	94.96 ± 0.05	99.95 ± 0.05	91.91 ± 0.05	0.1337
Primordial follicles, %[3]	27.99 ± 0.10	45.04 ± 0.10	26.14 ± 0.10	0.3558
Dominant follicles, %[4]	55.94[a] ± 0.09	9.28[b] ± 0.09	23.20[b] ± 0.09	0.0031
Ovulatory follicles, %[5]	11.00[b] ± 0.10	45.68[a] ± 0.09	41.11[a] ± 0.09	0.0391

Values are predicted means ± SEM.
[a-b] Values within a row with different superscripts differ significantly at $P < 0.05$.
NP = natural pasture; SP100 = 100% of the requirements; SP150 = 150% of requirements.

(Klein et al., 2021)

73

Efeitos da nutrição pré-parto na reprodução da progênie

Suplementação no terço final ou toda gestação

frontiers in Genetics

Effects of Maternal Nutrition on Female Offspring Weight Gain and Sexual Development

*Roberta Cavalcante Gracco[1], Fernando de Oliveira Bussiman[2], Guilherme Henrique Gebin Polizel[1], Diogo Angelo Schmidt Poli[3], Guilherme Pugliesi[3] and Miguel Henrique de Almeida Santana[1]**

- 126 Vacas Nelore
- Controle vs. Suplem no terço final vs. Suplem. Toda gestação

TABLE 2 | Ingredients and nutrients content of the dams supplement.

Ingredients	Mineral supplement	Energetic-protein supplement
Corn (%)	35	60
Soybean meal (%)	–	30
Dicalcium phosphate (%)	10	–
Urea 45% (%)	–	2.5
Salt (%)	30	5
Minerthal 160 MD (%)*	25	2.5
Total digestible nutrients (%)	26.76	67.55
Crude protein (%)	2.79	24.78
Non-protein nitrogen (%)	–	7.03
Acid detergent fiber (%)	1.25	4.76
Neutral detergent fiber (%)	4.29	11.24
Fat (%)	1.26	2.61
Calcium (g/kg)	74.11	6.2
Phosphate (g/kg)	59.38	7.24

*Mineral pre-mix composition: (guarantee levels per 25 kg): calcium, 200–300 g; cobalt, 160 mg; copper, 2,700 mg; sulfur, 60 g; fluorine, 1,600 mg; phosphor, 160 g; iodine, 135 mg; manganese, 2,700 mg; selenium, 80 mg; zinc, 8,100 mg; sodium monensin, 4,000 mg.

(Cracco et al., Accepted manuscript)

75

Efeitos da nutrição pré-parto na reprodução da progênie

TABLE 3 | Performance traits of Nellore heifers submitted to fetal programming.

Traits	Age	Control[As]	PELT[Bs]	PEWG[Bs]	*p*-Value[b]	*p*-Value[c]
Weight (kg)	Weaning	216.4 ± 4.4	210.1 ± 4.7	208.3 ± 5.4	0.78	0.017
	Year	271.2 ± 4.1	263.9 ± 5.1	257.5 ± 5.4	0.37	
	Yearling	398.5 ± 5.5	384.9 ± 7.5	384.2 ± 7.3	0.39	
	24 months	428.7 ± 4.5	410.0 ± 6.6	410.7 ± 7.2	0.13	
Ribeye area (cm²)	Weaning	42.7 ± 1.2	43.5 ± 1.1	43.3 ± 1.5	0.92	0.929
	Year	55.7 ± 1.7	57.5 ± 1.1	56.3 ± 1.5	0.63	
	Yearling	73.5 ± 1.2	73.30 ± 1.5	75.0 ± 1.7	0.46	
	24 months	70.8 ± 1.1	70.8 ± 1.1	70.8 ± 1.5	0.83	
Backfat thickness (mm)	Weaning	2.85 ± 0.4	3.28 ± 0.4	2.72 ± 0.4	0.55	0.115
	Year	1.91 ± 0.3	1.94 ± 0.4	1.15 ± 0.4	0.19	
	Yearling	6.52 ± 0.6	7.41 ± 0.5	6.55 ± 0.6	0.27	
	24 months	5.70 ± 0.7	6.97 ± 0.5	6.90 ± 0.6	0.87	
Rump fat thickness (mm)[d]	Weaning	4.90 ± 0.4	4.46 ± 0.4	4.35 ± 0.3	0.53	0.373
	Year	3.69 ± 0.4	3.36 ± 0.4	3.07 ± 0.5	0.51	
	Yearling	10.1 ± 0.7	10.2 ± 0.5	10.3 ± 0.7	0.95	
	24 months	8.81 ± 0.7	8.25 ± 0.5	8.99 ± 0.7	0.72	

Note. The data are expressed as means of the characteristics ± standard error of the mean.
Control, without protein-energy supplementation; PELT, protein-energy last trimester (0.3% BW protein-energy supplementation in the final third of pregnancy); PEWG, protein-energy whole gestation (0.3% BW protein-energy supplementation upon pregnancy confirmation).
[a]*Refers to contrasts on weight characteristic.*
[b]*p-Value between groups on the same age.*
[c]*p-Value on repeated measures over time.*
[d]*Sire effect found on repeated measures over time (p < 0.05).*

(Cracco et al., Accepted manuscript)

76

Efeitos da nutrição pré-parto na reprodução da progênie

TABLE 4 | Maternal nutritional effect on reproductive traits of Nellore offspring heifers.

Traits	Age	Control	PELT	PEWG	*p*-Value[a]	*p*-Value[b]
Ovary size	15 months	22.7 ± 0.6	22.0 ± 0.6	21.0 ± 0.6	0.32	0.37
	18 months	23.6 ± 0.6	24.6 ± 0.5	23.8 ± 0.5	0.34	
Endometrium thickness	15 months	6.2 ± 0.1	6.2 ± 0.2	6.2 ± 0.1	0.85	0.53
	18 months	5.6 ± 0.1	5.6 ± 0.1	5.3 ± 0.1	0.33	
AFC	15 months	15.1 ± 1.4	16.4 ± 1.0	17.1 ± 1.4	0.18	0.31
	18 months	5.6 ± 0.1	16.0 ± 1.2	16.4 ± 1.9	0.92	
Age at Puberty		475.76	474.94	475.33	0.87	

Note. The data are expressed as means of the characteristics ± standard error of the mean.
Control, without protein-energy supplementation; PELT, protein-energy last trimester; PEWG, protein-energy whole gestation; AFC, antral follicular count.
[a]*p-Value between groups on the same age.*
[b]*p-Value on repeated measures over time.*

(Cracco et al., Accepted manuscript)

77

Efeitos da nutrição pré-parto na reprodução da progênie

FETAL PROGRAMMING

Supplementing organic-complexed or inorganic Co, Cu, Mn, and Zn to beef cows during gestation: postweaning responses of offspring reared as replacement heifers or feeder cattle

Kelsey M. Harvey,[1§] Reinaldo F. Cooke,[‡] Eduardo A. Colombo,[‡] Bruna Rett,[‡] Osvaldo A. de Sousa,[‡] Lorin M. Harvey,[‡,#] Jason R. Russell,[¶] Ky G. Pohler,[‡] and Alice P. Brandão[‡]

- 190 Vacas ¾ *Bos taurus* ¼ *Bos indicus*
- Suplementação com complexo orgânico ou inorgânico

Table 1. Ingredient composition and nutrient profile of supplements containing INR or AAC

Item	INR	AAC
Ingredients, g/d (as-fed basis)		
Dried distillers grains	193	193
Macromineral mix[1]	60.0	60.0
Inorganic trace mix[2]	4.67	0.00
Organic trace mix[3]	0.00	7.00
Nutrient profile[4] (dry matter [DM] basis)		
DM, %	90.8	90.9
Net energy for maintenance[5], Mcal/kg	1.58	1.57
Net energy for lactation[5], Mcal/kg	1.50	1.49
Crude protein, %	26.0	25.7
Ca, %	4.52	4.53
P, %	2.91	2.88
Mg, %	0.64	0.63
K, %	1.13	1.13
Na, %	1.89	1.93
Co, mg/kg	62.0	65.0
Cu, mg/kg	605	600
Fe, mg/kg	1,883	1,931
Mn, mg/kg	983	967
Se, mg/kg	6.44	6.39
Zn, mg/kg	1,791	1,695

[1]Containing (DM basis) 339.7 g/kg $CaHPO_4$, 312.7 g/kg $CaCO_3$, 197.5 g/kg NaCl, 39.1 g/kg KCl, 18.9 g/kg MgO, 4.0 g/kg Fe_2O_3, 2.5 g/kg S, 0.9 g/

(Harvey et al., 2021)

78

Efeitos da nutrição pré-parto na reprodução da progênie

Table 6. Growth and reproductive responses of replacement heifers from beef cows supplemented with sulfate sources (INR; *n* = 95) or organic complexed sources (AAC; *n* = 95) of Co, Cu, Mn, and Zn during gestation[1]

Item	INR	AAC	SEM	*P*-value
Initial BW,[2] kg	202	197	5	0.61
Final BW,[2] kg	332	326	5	0.37
Average daily gain,[2] kg/d	0.618	0.604	0.011	0.39
Final puberty attainment,[3] %	83.5	86.4	5.1	0.49
Age at puberty, d	418	399	6	0.04
Body weight at puberty, kg	319	310	6	0.24

[1]INR and AAC cows received the same amount of supplemental Co, Cu, Mn, and Zn from sulfate sources or Availa4 (Zinpro Corporation, Eden Prairie, MN). Cows were assigned to the experiment at 117 ± 2 d of gestation (day 0). Heifers were weaned on day 367 (202 ± 3 d of age), preconditioned for 45 d (days 367 to 412), and managed as a single group on pasture (*Avena sativa* L.) pasture until day 620 (33 heifers from INR cows and 45 heifers from AAC cows)

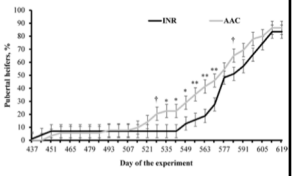


Figure 3. Puberty attainment of replacement heifers from beef cows supplemented with sulfate sources (INR; n = 95) or organic complexed sources (AAC; *n* = 95) of Co, Cu, Mn, and Zn during gestation. Cows were assigned to the

(Harvey et al., 2021)

79

Efeito da desmama

Projeto temático – FAPESP: Prof. Paulo R. Leme

"Desmame precoce de crias de vacas Nelore e seu efeito na programação fetal e no desempenho produtivo e reprodutivo da próxima progênie"

Efeitos do desmame antecipado no desempenho reprodutivo de vaca Nelore, da cria ao pé e da próxima progênie

Beneficiário: Thiago Kan Nishimura

Responsável: Prof. Dr. Guilherme Pugliesi

80

Efeito da desmama

- Efeitos na vaca

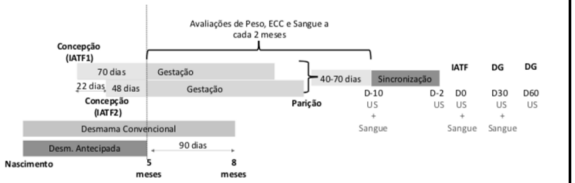
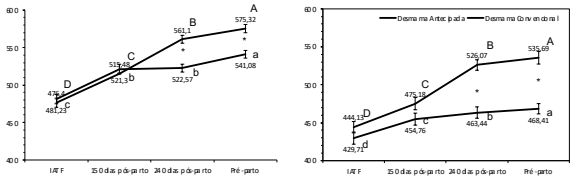


Figura 5. Esquema ilustrando o desenho experimental para as avaliações durante a gestação e das vacas submetidas à desmama convencional (controle) ou desmama antecipada.

81

Efeito da desmama

• Efeitos na vaca



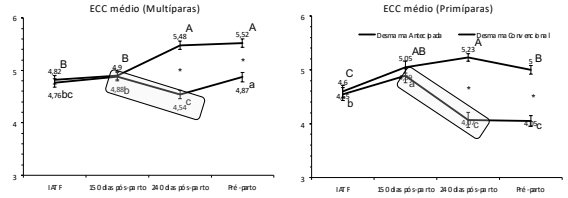
Letras maiúsculas – efeito de tempo na desmama antecipada
Letras minúsculas – efeito de tempo na desmama convencional

*P<0,05 – grupo e categoria

82

Efeito da desmama

*P<0,05 – grupo e categoria



Letras maiúsculas – efeito de tempo na desmama antecipada
Letras minúsculas – efeito de tempo na desmama convencional

83

Efeito da desmama

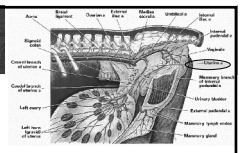
• Efeitos na progênie

Figura 4. Esquema ilustrando o desenho experimental para as avaliações durante a gestação e das bezerras e novilhas dos grupos desmama convencional (controle) ou desmama antecipada.

84

Efeito da desmama

• Efeitos na vaca/progênie → Perfusão sanguínea na artéria Uterina média (5,5 gestação)



	Primíparas		Multíparas		Valor de P		
	Antecipado (n=12)	Convencional (n=13)	Antecipado (n=13)	Convencional (n=12)	CAT	TRAT	CAT*TRAT
Diâmetro Ipsi (mm)	7.65 ± 0.42	7.76 ± 0.39	7.50 ± 0.30	7.66 ± 0.31	0.10	0.76	0.32
Diâmetro Contra (mm)	4.43 ± 0.31	4.17 ± 0.25	4.88 ± 0.45	4.92 ± 0.45	0.02	0.21	0.11
IR Ipsi	0.50 ± 0.02	0.49 ± 0.02	0.50 ± 0.02	0.50 ± 0.02	0.91	0.79	0.91
IR Contra	0.57 ± 0.02	0.56 ± 0.02	0.57 ± 0.02	0.58 ± 0.71	0.71	0.83	0.63
TAMV Ipsi (cm/s)	112.7 ± 8.61	112.9 ± 8.22	107.7 ± 5.53	107.5 ± 0.05	0.05	0.37	0.97
TAMV Contra (cm/s)	43.4 ± 5.51	47.6 ± 5.00	49.7 ± 6.15	47.8 ± 0.86	0.86	0.38	0.59
Volume Ipsi (L/min)	3.20 ± 0.40	3.29 ± 0.38	2.89 ± 0.28	3.00 ± 0.89	0.89	0.37	0.36
Volume Contra (L/min)	0.45 ± 0.10	0.44 ± 0.08	0.63 ± 0.13	0.60 ± 0.12	0.12	0.15	0.14

85

Tópicos

- Relação da Nutrição durante a gestação e Reprodução
- Estratégias para alterar a nutrição fetal
- Impactos na Reprodução da Vaca (mãe)
- Impactos na Reprodução da Progênie (programação fetal)
- Considerações Finais

86

Considerações Finais

Desempenho Reprodutivo da vaca

- **Restrição ou Suplementação:**
  - **Peso e ECC**
  - **Metabólitos**
  - **Gordura subcutânea**
- **Potencial para impactar na Reprodução**
  - **Terço Final da gestação**
  - **Primíparas**

Evitar Subnutrição !!

Desempenho Reprodutivo da progênie

- **Maiores alterações em casos de restrição (Subnutrição)**
  - **Menor desenvolvimento da placenta**
  - **Menor peso ao nascimento e desmama**
  - **Crescimento e carcaça**
  - **Saúde na cria e recria**
  - **Atraso na puberdade e prenhez**
- **Suplementação**
  - **Resultados inconsistentes**
  - **Estratégica**

87

Agradecimentos

Pesquisadores, empresas e fazendas parceiras

PPGRA Programa de Pós Graduação em Reprodução Animal

LFEM

88

89