Fetal Programming and Effects of Cow Nutrition

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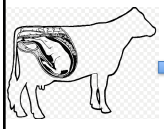
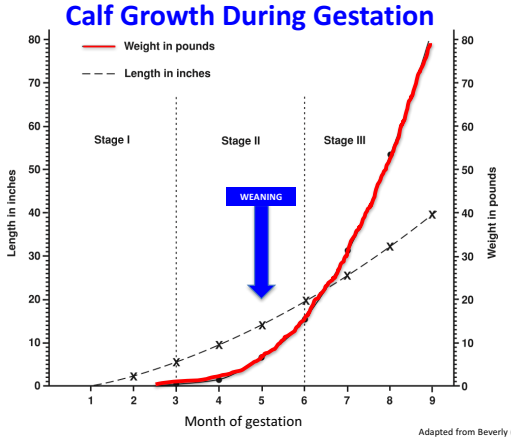
Fetal Programming?

"Maternal stimuli or insult at a critical period in fetal development has long term impacts on the offspring"
(David Barker – Southampton University)



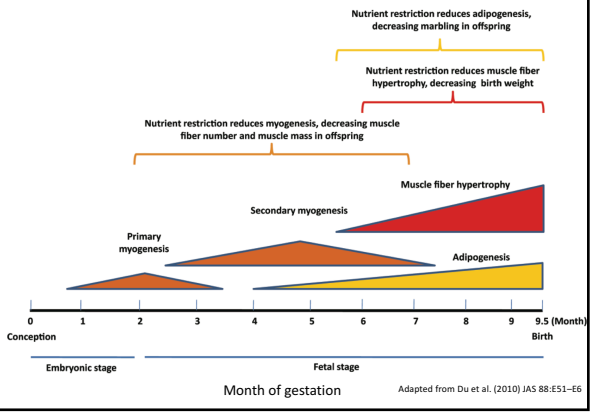
Calf Growth During Gestation



Adapted from Beverly (2008)

Organ Development Beef Cattle

Calf Growth Timeline



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What happens to future calf performance?

Early-gestation

Conception to 3 months of gestation

Angus x Hereford heifers fed 55 or 100% of their nutrient requirements for the first 83 days of gestation

	55% of requirements	100% of requirements
Body weight, lb		
Day 32 of gestation	859	839
Day 115 of gestation	722*	934*
Weight change	-137*	95*
Body condition score		
Day 32 of gestation	5.0	5.1
Day 115 of gestation	4.3*	5.5*
Weight change	-0.7*	0.4*

*$P < 0.05$

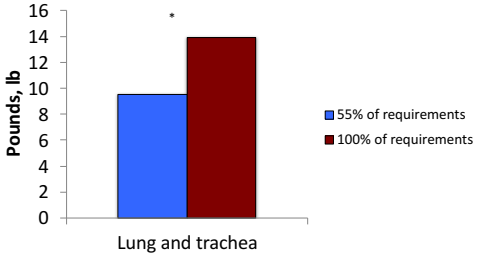
Long et al. (2010) JAS 88:3251-3261

Growth performance of steers born to heifers fed 55 or 100% of their nutrient requirements for the first 83 days of gestation

	55% of requirements	100% of requirements
Body weight of steers, Lb		
Birth	69	71
Weaning (228 days of age)	491	480
Average daily gain, Lb/d		
Birth to weaning	1.8	1.9
During finishing	4.9	4.6

Long et al. (2010) JAS 88:3251-3261

Lung and trachea weight of steers born to heifers fed 55 or 100% of their nutrient requirements for the first 83 days of gestation



*$P < 0.05$

Long et al. (2010) JAS 88:3251-3261

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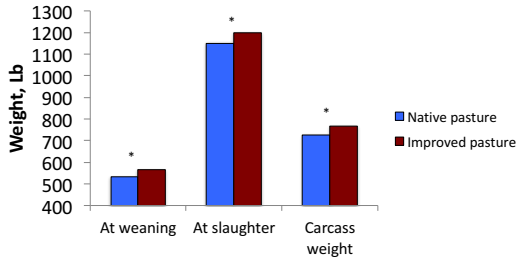
What happens to future calf performance?

Early- to Mid-gestation

0 to 6 months of gestation

Growth performance of steers born to cows grazed on native (< 7% crude protein) or improved (9% crude protein) pastures for 60 d (during mid-gestation)



*$P < 0.05$

Underwood et al. (2010) Meat Sci. 86:588-593

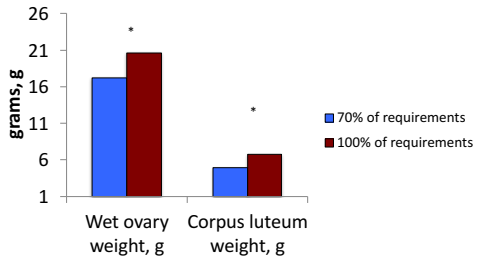
Angus x Gelbvieh mature cows fed 70 or 100% of their nutrient requirements from day 45 to 185 of gestation

	70% of requirements	100% of requirements
Body weight, lb		
Day 45 of gestation	1114	1039
Day 185 of gestation	1140*	1247*
Body condition score		
Day 45 of gestation	5.4	5.6
Day 185 of gestation	4.8*	6.3*

*$P < 0.05$

Long et al. (2012) JAS 90:197-206

Ovary and *Corpus Luteum* weight of heifers born to cows fed 70 or 100% of their nutrient requirements from day 45 to 185 of gestation



*$P < 0.05$

Long et al. (2012) JAS 90:197-206

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What happens to future calf performance?

Late-gestation

6 to 9 months of gestation

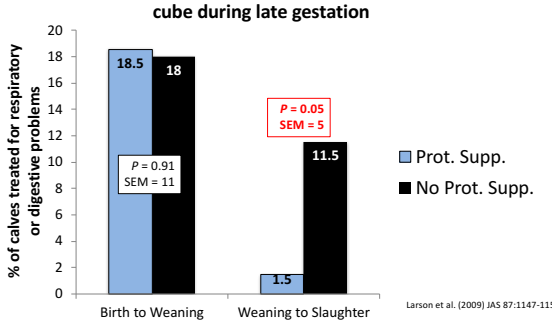
Growth performance of STEERS born to cows receiving no supplementation (No Supp.) or 1 Lb/day of 42% crude protein cube during late gestation

	Stalker et al. (2007)		Stalker et al. (2006)		Larson et al. (2009)	
	No Supp.	Supp.	No Supp.	Supp.	No Supp.	Supp.
Weaning weight, Lb	441*	463*	465*	480*	518*	531*
Carcass weight, Lb	764*	804*	800	813	802*	819*
Choice, %	-	-	85	96	71*	86*
Marbling	449	461	467	479	444*	493*

*$P < 0.05$

Stalker et al. (2006) JAS 84:2582-2589
Stalker et al. (2007) Rangel. Ecol. Manage. 60:578-587
Larson et al. (2009) JAS 87:1147-1155

Immune response of STEERS born to cows receiving no supplementation (No Supp.) or 1 Lb/day of 42% crude protein cube during late gestation



Larson et al. (2009) JAS 87:1147-1155

Growth and reproductive performance of HEIFERS born to cows receiving no supplementation (No Supp.) or 1 Lb/day of 42% crude protein cube during late gestation

	Martin et al. (2007)		Funston et al. (2010)	
	No Supp.	Supp.	No Supp.	Supp.
Weaning weight, Lb	456	467	496*	511*
Adj. 205-day weight	480*	498*	469	478
Age at puberty, days	334	339	366*	352*
Pregnancy, %	80*	93*	80	90

Martin et al. (2007) JAS 85:841-847
Funston et al. (2010) JAS 88:4094-4101

*$P < 0.05$

Growth and reproductive performance of HEIFERS born to cows receiving no supplementation (No Supp.) or 1 Lb/day of 42% crude protein cube during late gestation

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Effects on cost of developing heifers?

Martin et al. (2007) JAS 85:841-847
Funston et al. (2010) JAS 88:4094-4101

*$P < 0.05$

Growth and reproductive performance of HEIFERS born to cows receiving no supplementation (No Supp.) or 1 Lb/day of 42% crude protein cube during late gestation

Table 3. Effects of dam protein supplementation during the last trimester of gestation and meadow grazing vs. grass hay feeding during early lactation on reproductive and calving performance of heifers[1]

	Treatment[2]					*P*-value[3]	
Trait	PS	NS	M	H	SEM	LG	EL
Age at puberty, d	339	334	341	332	10	0.70	0.48
Cycling at beginning of breeding season, %	61	67	56	73	—	0.45	0.15
Calved in first 21 d, %	77	49	63	63	—	0.005	0.89
Overall pregnancy rate, %	93	80	83	91	—	0.05	0.18
Calving date, Julian	71	75	73	73	3	0.15	0.94
Calf birth wt, kg	33	33	32	33	1	0.94	0.25
Unassisted births, %	78	64	76	66	—	0.24	0.21

[1]Includes puberty data from 50 heifers born in yr 3, cyclicity and pregnancy data from 91 (PS = 45, NS = 46, M = 46, H = 45) heifers born in yr 2 and 3, and calving data from 77 heifers born in yr 2 and 3.
[2]No late gestation × early lactation treatment interactions were detected ($P > 0.10$); therefore, only main effects are reported. PS = dams supplemented 3 times per week with the equivalent of 0.45 kg/d of a 42% CP cake during the last trimester of gestation; NS = no protein supplement fed to dams during gestation; M = dams grazed subirrigated meadows between the end of calving and the breeding season; and H = dams fed cool-season grass hay from the end of the calving season until initiation of the breeding season.
[3]LG = late gestation treatment main effect; and EL = early lactation treatment main effect.

Martin et al. (2007) JAS 85:841-847

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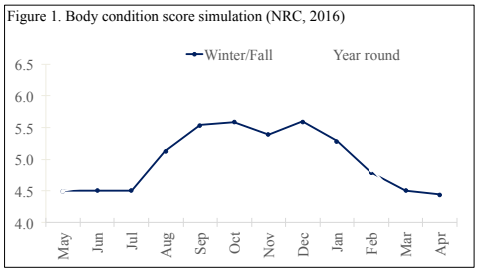
Does year-round supplementation of cows pay off?

Figure 1. Body condition score simulation (NRC, 2016)



Treatments	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May

lb of dry matter/cow daily

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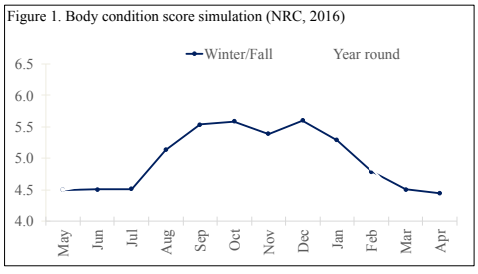

Treatments	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Fall/Winter Molasses	0	0	0	0	0	4.0	4.0	4.0	4.0	4.0	0	0

lb of dry matter/cow daily

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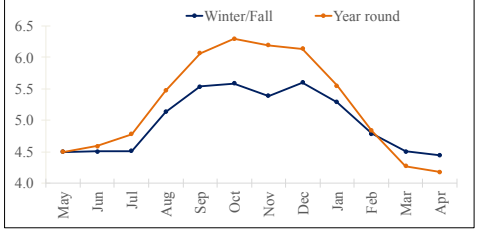

Treatments	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
	lb of dry matter/cow daily											
Year-round Molasses	0.5	0.5	1.5	1.5	1.5	2.5	3.0	3.0	2.5	2.5	0.5	0.5
Fall/Winter Molasses	0	0	0	0	0	4.0	4.0	4.0	4.0	4.0	0	0

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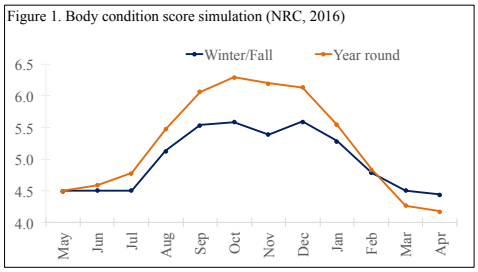

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	lb of dry matter/cow daily											
Year-round Molasses	0.5	0.5	1.5	1.5	1.5	2.5	3.0	3.0	2.5	2.5	0.5	0.5
Year-round cubes	0.5	0.5	1.5	1.5	1.5	2.5	3.0	3.0	2.5	2.5	0.5	0.5
Fall/Winter Molasses	0	0	0	0	0	4.0	4.0	4.0	4.0	4.0	0	0

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Does year-round supplementation of cows pay off?

Item	Treatments: Fall/Winter Only	Year-round Molasses	Year-round Range Cubes	SEM	P-value
Cow BCS					
June	4.70	4.60	4.40		
July	5.02	5.05	5.16	0.076	<0.001
Cow BCS change					
June to July	0.55	0.56	0.66	0.079	0.61
July to August	-0.12	-0.20	-0.18	0.069	0.66

Treatments	Jun	Jul										
	lb of dry matter/cow daily											
Year-round Molasses	0.5	0.5										
Year-round cubes	0.5	0.5										
Fall/Winter Molasses	0	0										

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Does year-round supplementation of cows pay off?

Item	Treatments CON	YCUB	YMOL	SEM	P-value Treatment
Cow plasma concentrations in July (day 56)					
IGF-1, ng/mL	40.6[a]	48.2[b]	38.7[a]	2.46	0.11
Glucose, mmol/L	3.80[a]	4.79[b]	4.71[b]	0.307	0.06

Treatments	Jun	Jul
	lb of dry matter/cow daily	
Year-round Molasses	0.5	0.5
Year-round cubes	0.5	0.5
Fall/Winter Molasses	0	0

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August					
October					
November					
Cow BCS change					
June to July	0.55	0.56	0.66	0.079	0.61
July to August	-0.12	-0.20	-0.18	0.069	0.66
Aug. to October					
Oct. to November					

Treatments	Jun	Jul	Aug	Sep	Oct
	lb of dry matter/cow daily				
Year-round Molasses	0.5	0.5	1.5	1.5	1.5
Year-round cubes	0.5	0.5	1.5	1.5	1.5
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July	5.02	5.05	5.16	0.076	<0.001
August	4.92	4.85	4.96	0.076	
October	5.55[a]	5.92[b]	6.00[b]	0.076	
November	5.18[a]	6.06[b]	5.92[b]	0.085	
Cow BCS change					
June to July	0.55	0.56	0.66	0.079	0.61
July to August	-0.12	-0.20	-0.18	0.069	0.66
Aug. to October	0.64[a]	1.07[b]	1.02[b]	0.094	0.08
Oct. to November	-0.37[a]	0.10[b]	-0.08[b]	0.107	0.01

Treatments	Jun	Jul	Aug	Sep	Oct
	lb of dry matter/cow daily				
Year-round Molasses	0.5	0.5	1.5	1.5	1.5
Year-round cubes	0.5	0.5	1.5	1.5	1.5
Fall/Winter Molasses	0	0	0	0	0

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Treatments	Jun	Jul	Aug	Sep	Oct
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Year-round Molasses	0.5	0.5	1.5	1.5	1.5
Year-round cubes	0.5	0.5	1.5	1.5	1.5
Fall/Winter Molasses	0	0	0	0	0

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Does year-round supplementation of cows pay off?

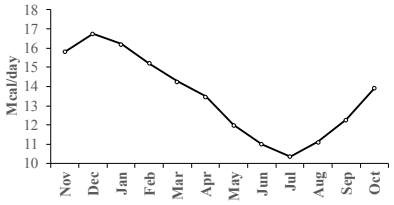
Liver trace mineral concentration in October, ug/g of dry tissue	Treatments: Fall/Winter Only	Year-round Molasses	Year-round Cubes	SEM	*P*-value: Treatment
Cobalt	0.32[a]	0.27[a]	0.43[b]	0.022	0.0001
Copper	141	133	196	20.0	0.17
Iron	254	248	253	17.3	0.98
Manganese	9.31	9.8	9.78	0.482	0.72
Molybdenum	3.76	3.85	4.18	0.264	0.57
Selenium	0.75[a]	0.84[a]	1.00[b]	0.073	0.05
Zinc	114	119	128	6.8	0.36

Treatments	Jun	Jul	Aug	Sep	Oct
	lb of dry matter/cow daily				
Year-round Molasses	0.5	0.5	1.5	1.5	1.5
Year-round cubes	0.5	0.5	1.5	1.5	1.5
Fall/Winter Molasses	0	0	0	0	0

2016 FCA Proposal #2

Evaluating cost-effective supplementation programs for cows during late-gestation

Figure 1. Total daily energy requirements (NEm), Mcal/day



Treatments	Weeks after weaning: 1	2	3	4	5	6	7	8	9	10	11	12
No supplementation	0	0	0	0	0	0	0	0	0	0	0	0

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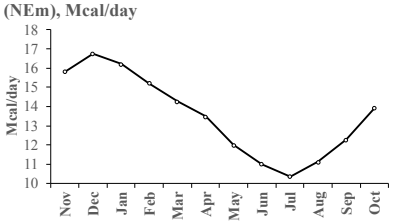

Total = 189 lb/cow

	Weeks after weaning											
Treatments	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
No supplementation	0	0	0	0	0	0	0	0	0	0	0	0
Supp. 12 weeks (SUP12)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25

Dried distillers grain, lb/day

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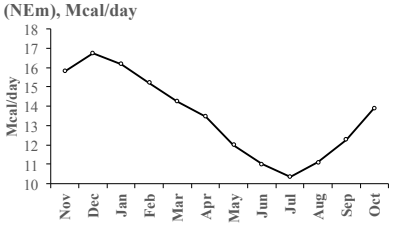

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	Weeks after weaning											
Treatments	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
No supplementation	0	0	0	0	0	0	0	0	0	0	0	0
Supp. 12 weeks (SUP12)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
Supp. 6 weeks (SUP6)	4.5	4.5	4.5	4.5	4.5	4.5	-	-	-	-	-	-

Dried distillers grain, lb/day

2016 FCA Proposal #2

Evaluating cost-effective supplementation programs for cows during late-gestation

Item	Treatments CON	SUP6 Aug. to Oct.	SUP12 Aug. to Nov.	SEM	P-value
Cow Body Condition Score					
August (day 0)	5.00	5.00	5.20	-	-
October (day 45)	5.61[a]	6.15[c]	5.81[a]	0.087	<0.0001
November (day 84; calving)	5.29[a]	6.36[c]	6.18[b]	0.090	
Cow Body Condition Score change					
August to October	0.53[a]	1.04[c]	0.74[a]	0.096	0.0001
October to November	-0.31[a]	0.22[b]	0.37[b]	0.129	0.0001

	Weeks after weaning											
Treatments	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
No supplementation	0	0	0	0	0	0	0	0	0	0	0	0
Supp. 12 weeks (SUP12)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
Supp. 6 weeks (SUP6)	4.5	4.5	4.5	4.5	4.5	4.5						

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Evaluating cost-effective supplementation programs for cows during late-gestation

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No supplementation	0	0	0	0	0	0	0	0	0	0	0	0
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Supp. 6 weeks (SUP6)	4.5	4.5	4.5	4.5	4.5	4.5						

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No supplementation	0	0	0	0	0	0	0	0	0	0	0	0
Supp. 12 weeks (SUP12)	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
Supp. 6 weeks (SUP6)	4.5	4.5	4.5	4.5	4.5	4.5						

Thank you

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