Managing Bull Development to Optimize Fertility

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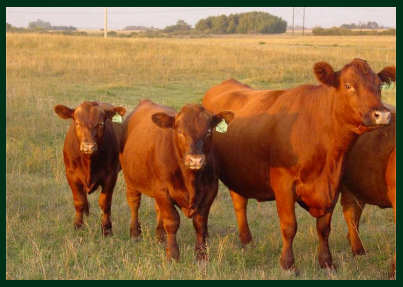
Rearing bulls for fertility



Effect of post weaning nutrition

(*after "normal" calf hood nutrition*)

- testis size
- age at puberty
- semen quality

Effect of energy level in bulls aged 6 -11.5 mo

(Two 77-day feeding periods, n ~25/gp) *Mwansa, 1991*

	High-high	High-low*	Low-high	Low-low
Scrotal Circumference	38.3	36.4	36.4	35.3
Abnormal Sperm**	24.2%	15.2%	17.1%	16.4%

* High – 3.39 Mcal DE, Low – 2.33 Mcal DE
**Abnormal Sperm ??? Bulls were only 11.5 mo old

Effect of energy intake on testicular development

Seidel, 1980

Fed Angus bulls from 7-11 mo of age
at 95% and 133% of TDN requirements

The higher energy diet resulted in:

- Larger scrotal circumference
- No difference in testis weight ($P > 0.05$)
- Heavier scrotal weight

Effect of energy intake on scrotal circumference

Ohl, 1996

Feeding period = 11.6 - 15.3 mo of age

	High gain 1.7kg/d	Low gain 0.86kg/d
SC	34.0 cm	31.7 cm
Testes Wt	532g	425g **

No histological differences in testes at 15.3 mo

Pruitt and Corah, 1986

Higher levels of energy in the postweaning period resulted in no increase in SC and did not hasten the age at puberty

Summary:

Effect of post weaning nutrition

- ± ↑ SC at 12 mo (partly fat in scrotum)
- Not clear whether age at maturity advanced
- Higher energy has no effect on semen quality until fat deposition in scrotum after 12 mo of age

Why so much variation in outcomes of postweaning feeding experiments?

Effect of Calf hood nutrition

Evidence for an effect of calf hood nutrition

SC was 1.5 cm smaller in yearling bulls with 1st-parity dams *(Lunstra et al, 1988)*

SC was 2.4 cm smaller in 11 mo. old bulls with 1st-parity dams *(Bagu, 2004)*

Less milk in calf hood ?
An in-utero effect ?

Effect of energy levels in feed on pubertal development in Holstein bulls *Bratton et al, 1956*

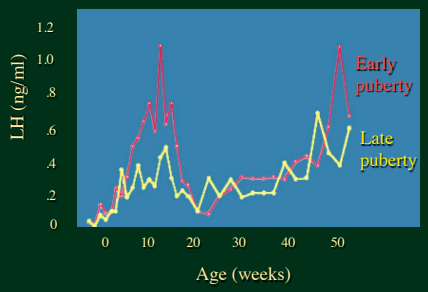
Calves fed from 1-80 wk of age, semen collected every 14d

	% of recommended intake		
	60-75	100	140-160
Age (wk) at Puberty	57	49	43
Weight at puberty	562	634	727
60-90 day preg. rate	74.1	72.9	74.2

The main basis of the calfhood effect on age at onset of puberty is gonadotrophin secretion from 8 to 16 weeks of age

LH in early and late maturing bull calves

Evans, 1994



Effects of augmenting LH before the early gonadotrophin rise

Chandolia et al, 1997

Treatment

200 ng LHRH every 2h for 14 d from 4-6 wk of age
Blood samples every 15 min for 10h at 4, 6, 12, 18, 24 wk of age

Results

↑'d LH pulse frequency
↑'d mean LH and T

At 1 Year:

↑ testis size, 30.6 vs. 28.6 cm
↑ sperm concentration
↑ spermatogenesis
↑ Sertoli cells (n)

Effect of inhibiting the early LH rise

Chandolia et al, 1997

Treatment

Leuprolide (*GnRH agonist*) at 6, 10, 14 wk of age
Blood samples every 15 min for 10 h at 12 wk

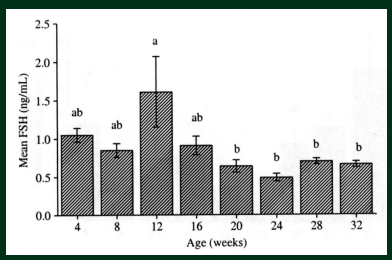
Results

↓ LH and FSH pulse frequency and amplitude
↓ FSH and T at 14, 16, 18 wk
↑ mean LH and LH/FSH pulse freq. at 24 wk (delayed rise)
↓ Scrotal Circumference, Spermatids and Sp'cytes

FSH has been considered the main driver of Sertoli cell proliferation in prepubertal animals

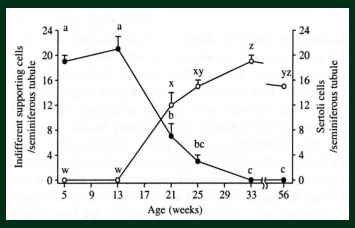
Mean FSH in blood samples collected every 15 min for 10 h, at 4 week intervals from 4 to 32 weeks of age

Bagu 2006



Sertoli cell numbers in calves from 5 -56 wk of age

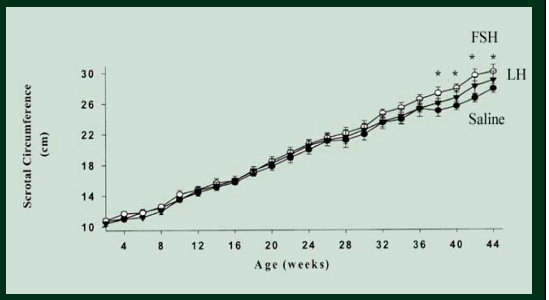
Bagu, 2000



Calves (n = 6) castrated at 5, 13, 21, 25, 33, and 56 wk of age. Sertoli cell numbers (open circles) and their progenitor cells (solid circles) per section of seminiferous tubule.

Effects of 4 mg FSH, 3 mg LH, or saline every 2nd day from 4-8 wk of age on the attainment of puberty

(Puberty: when SC ≥28cm) *Bagu, 2006*



Mean Sertoli and germ cell counts in calves treated every 2nd day with 4 mg FSH, 3 mg LH or saline from 4 - 8 wk of age *Bagu, 2006*

	Sertoli	Spermatids	Spermatocytes
FSH	6 ± 0.3[a]	38 ± 3[a]	57 ± 8[a]
LH	5 ± 0.2[b]	31 ± 3[b]	42 ± 2[b]
Saline	5 ± 0.3[b]	29 ± 2[b]	38 ± 5[b]

The magnitude of the early gonadotrophin rise is a critical factor in pubertal development

Sertoli cell numbers in bulls reach a final maximum life-time number at 20 to 25 wk of age

Final testis size is determined before weaning!

Why so much variation in outcomes of postweaning feeding experiments?

- Sertoi cell numbers no longer increase in the post weaning period
- Sertoli cells can run at half empty

Does calfhood nutrition have an effect on age at onset of puberty and maturity?

(Does nutrition affect the early gonadotrophin rise?)

Nutrition, metabolic hormones, and sexual development in bulls

PhD Thesis Leonardo Brito 2006

Bulls

- Angus and Angus x Charolais (1st-parity dams)
- Weaned at 8 wk

Stages of development

• Calfhood	10 - 26 wk
• Postweaning period	27 - 70 wk

Blood sampling (monthly from 10 - 20 wk and at 44 and 48 wk)

- Every 15 min for 10 h, then GnRH challenge with samples every 15 min for 90 min
- Single samples monthly

Effects of different levels of nutrition in calfhood or postweaning

Experiments I - IV, ~14 calves per group

I	Postweaning period	(low, med, high)
II	Calfhood and postweaning	(low, med, high)
III	Restricted in calfhood	(medium or high postweaning)
IV	Augmented in calfhood	(medium postweaning)

Results Experiment 1

Low, med and high postweaning nutrition after medium calfhood nutrition did not alter age at puberty or testis size

	Low	Med	High
Age puberty (d)	301[a]	328[b]	299[a]
Paired Testes Wt	619	573	610

(Sertoli cell numbers are determined before weaning)

Results Experiment II

Nutritional level throughout calfhood and postweaning affected age at puberty and testis size

	Low	Medium	High
Puberty (d)	327[a]	305[b]	292[b]
PTW (g)	524[a]	552[a]	655[b]

Results Experiment III

Restricting nutrition in calfhood
affected age at puberty and testis size

	Med/Med	Low/High	Low/Med
Puberty (d)	293[a]	334[b]	334[b]
Paired Testis Wt (g)	597[a]	548[ab]	503[b]

Results Experiment IV

Augmented nutrition in calfhood
hastened puberty and increased testis size

	Medium	High
Puberty (d)	327	314
Paired Testis Wt (g)	531[a]	611[b]

Conclusions

- Nutrition regulates GnRH secretion during the early gonadotropin rise
- Delayed puberty in bulls raised by 1st parity dams likely has a strong nutritional component
- Management strategies to optimize reproductive function should be focused on calfhood
- Target ADG during preweaning period > 1.2 kg/d