Utilizing Technologies to Enhance Beef Cattle Reproductive Efficiency

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Factors associated with pregnancy loss in beef herds

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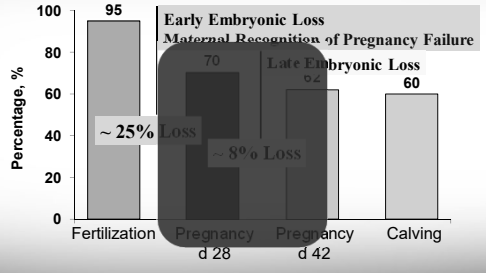
Fertility of a single service in beef cattle



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Embryonic mortality in beef cows

- Early embryonic mortality (< day 28)
  - Incidence 20 to 30%
    - 10-15% genetics abnormalities
    - Uterine asynchrony
    - Failure in maternal recognition of pregnancy
- Late embryonic mortality (≥ day 28)
  - Incidence 3.2 to 42.7%
  - Early pregnancy diagnosis
  - High economic consequences
  - Mechanisms poorly understood

Cartmill et al., 2001a; Silke et al., 2002; Sartori et al., 2002; Cerri et al., 2003

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Why it matters?

	Bred TAI (baseline)	Early Embryo Loss	Late Embryo Loss	Never Calved
Day of Calving	0	21	60	N/A
Weaning Weight (age * 2lbs/day)	**550 lbs**	**508 lbs** (-42)	**430 lbs** (-120)	**0 lbs** (-550)
Calf Value (weight* $1.60/lb)	**$880**	**$812** (- $68)	**$688** (- $192)	**$0** (- $880)

They all cost the same to maintain!

5

Maternal driven pregnancy loss

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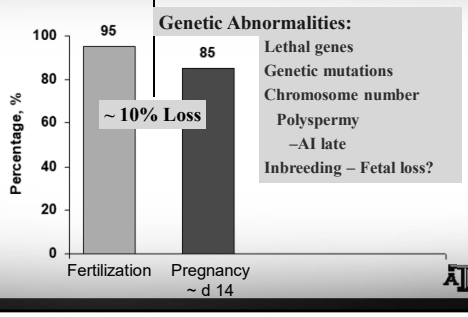
Genetic losses



Genetic Abnormalities:

- Lethal genes
- Genetic mutations
- Chromosome number
  - Polyspermy
  - –AI late
- Inbreeding – Fetal loss?

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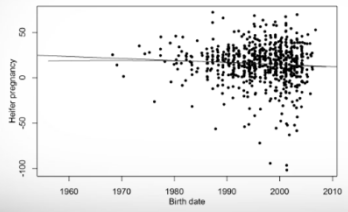
Estimated Breeding Values for Heifer Pregnancy Rate



- Records from 698 registered Angus bulls indicates that either as a correlated response to selection for production or due to accumulated inbreeding, Angus female fertility has decreased by 0.22% per year for about the last 25 years.

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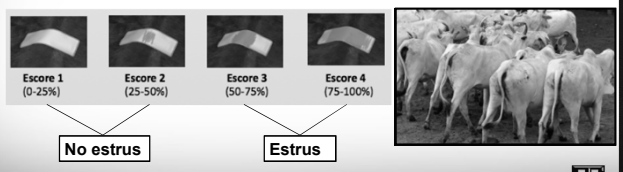
Estrus intensity prior to TAI

Patch score from 0 to 4

- 0 lost patch



Pohler et al., 2016

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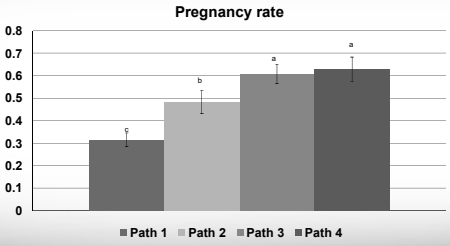
Estrus and pregnancy rate

AFB



Pohler et al., 2016

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Paternal driven pregnancy loss

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Variance of sire fertility

AI center	Number of AI	P/TAI	P/TAI range by sire
A	45,231	54.80%	38.3 to 79.1%
B	128,443	55.40%	30.9 to 70.2%
C	9,434	50.50%	38.1 to 57.9%
D	19,311	56.70%	42.8 to 76.9%
E	25,522	54.80%	28.2 to 72.4%
F	32,397	52.50%	32.1 to 62.7%
G	7,042	54.89%	22.8 to 81.3%

Adapted from Vasconcelos et al., 2017.

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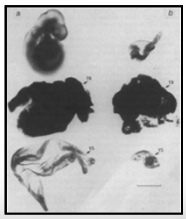
Male effect on placental development

NORMAL



ANDROGENETIC

Embryo

Trophoblast

Yolk sac

Barton et al., 1984

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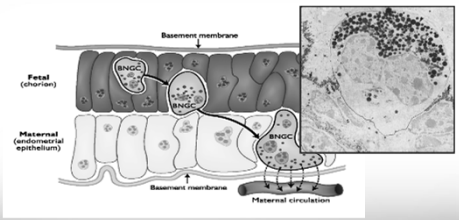
Pregnancy associated glycoprotein: marker of placenta function



Senger, 2012

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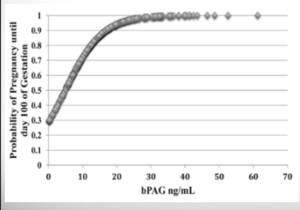
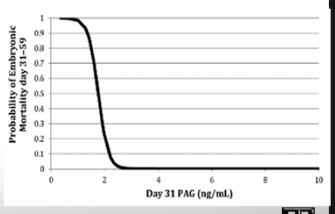
PAG as predictor of pregnancy success





Pohler et al. (2016 a, b)

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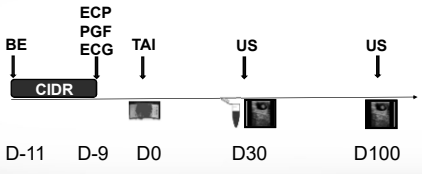
Experimental design



Franco et al., 2018

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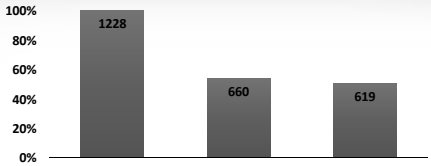
Sire classification



EM classification	Sires	Mean Late EM (% of pregnancies)	% of total EM
High	1, 2, 3	7.25%	66.67%
Low	4, 5, 6	3.93%	33.33%

Franco et al, 2018

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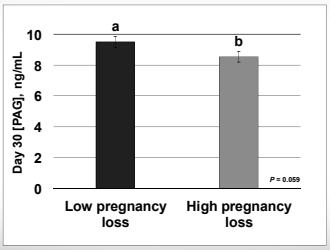
[PAG] by sire fertility



- Cows inseminated with high PL sires had 1.9 times greater rate of PL than cows inseminated with low PL sires (*P* = 0.123)

Franco et al, 2018

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Conclusions

- Pregnancy loss causes significant losses to a beef operations
- Increased early gestation PAGs (d 28 to 33) leads to an increase in pregnancy success
- Sire influences PAGs concentration and pregnancy maintenance
- Estrus/estrus intensity is related with increase in pregnancy success

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Relationship between Temperment and Fertility

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What is Temperament?

- Behavioral responses of cattle when exposed to human handling
- As cattle temperament worsens
  - Response to human contact becomes more excitable
- Selection for temperament (docility)
  - Heritable trait - Up to $h^2 = 0.50$
  - Mainly for safety reasons
  - Productive implications being established

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How to assess temperament?

- Chute Score
  - Cattle are individually restrained in the chute
  - Scored in 1-5 scale according to behavior
    1. Calm with no movement
    2. Restless movement
    3. Frequent movement with vocalization
    4. Constant movement, vocalization, shaking of chute
    5. Violent and continuous struggling

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How to assess temperament?

- Exit Velocity or Score
  - Speed of cattle after it leaves the chute
  - Methods for measurement
    - Electronic
      - Establish distance to be traveled by the animal (feet)
      - Measure time (chronometer, infrared sensor in seconds)
      - Classify animals according to speed (feet/second)
    - Visual
      1. Walks away from the chute
      2. Trots away from the chute
      3. Runs away from the chute

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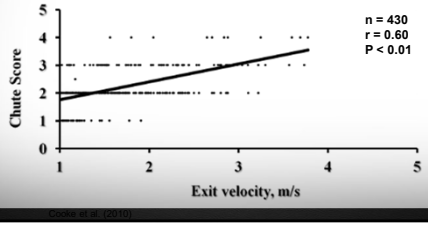
How to assess temperament?

Chute Score and Exit Velocity

- Use scores individually
- Average scores = **Temperament Score**



Cooke et al. (2010)

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How to assess temperament?

Temperament type

- Based on Temperament Score
  - **Adequate** temperament (TS ≤ 3)
  - **Excitable** temperament (TS > 3)
- Maintain "some" temperament in the herd
  - Without impairing safety and productive traits
  - Cow-calf systems
    - Pairs survive challenges of extensive environments
  - Feedlot systems
    - Competition for bunk space

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Factors affecting temperament

- Sex
  - Females are more temperamental
- Age
  - Young animals are more temperamental
- Production system
  - Range cattle are more temperamental
- Breed type
  - Greatest source of variation
  - *Bos indicus* cattle are more temperamental

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Temperament x Reproduction

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Temperament x Reproduction

Nelore heifers – Breeding @ 15 mo of age

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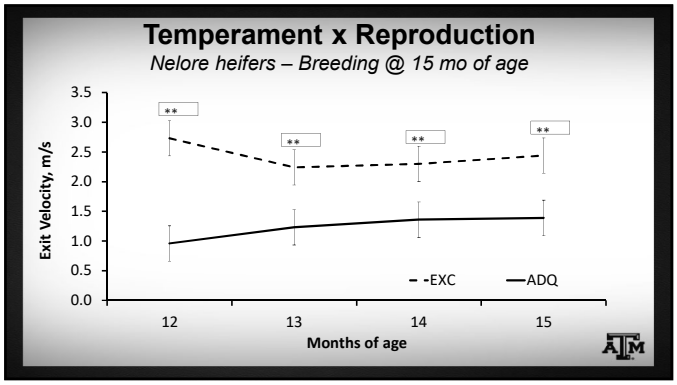

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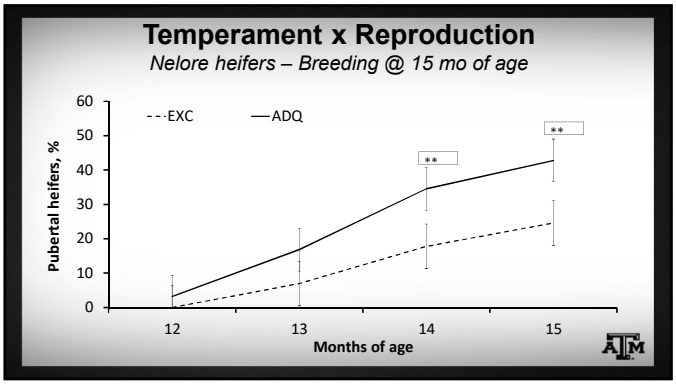

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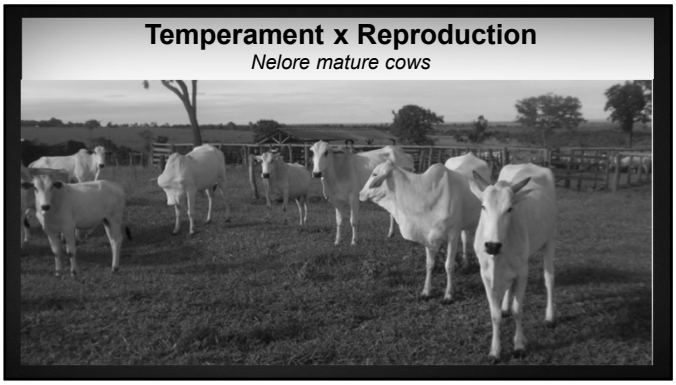

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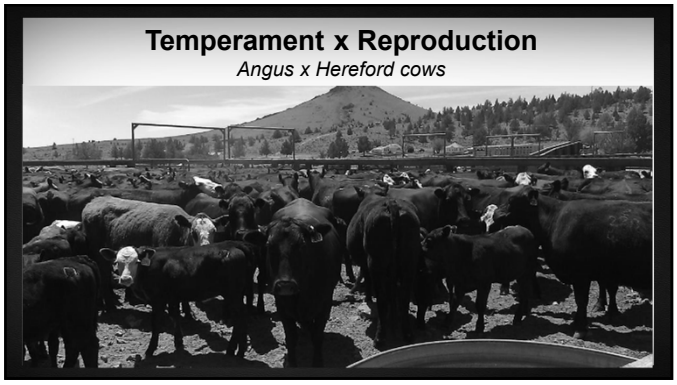

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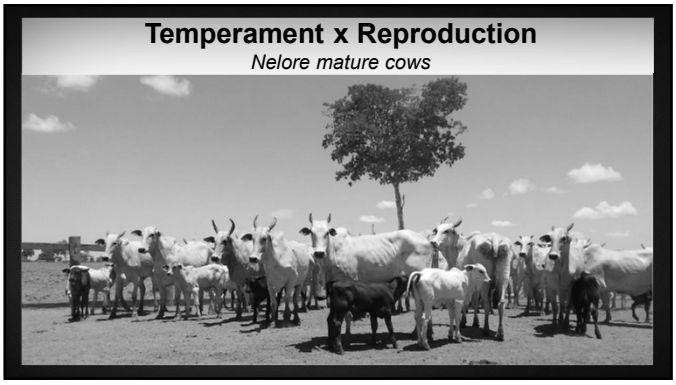

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Temperament x Reproduction

- Excitable temperament is detrimental to:
  - Reproductive performance of females
  - **Overall productivity of beef operations**
    - **Independent of breed type**
- How?
  - Nutritional status was accounted in studies
  - Physiological effects
    - Cortisol = during handling / 1st AI
    - Bull breeding? Pregnancy loss? Cattle not handled
  - Genetic relationship? Working on it

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Temperament x Reproduction

- Strategies to improve herd temperament
  - Benefit production in cow-calf operations
  - *Who wants $60 more cow/year?*
  - Temperament as selection/culling criteria
    - Selection of sires
    - Culling aggressive and unproductive females
    - Maintain "some" temperament in the herd
  - Adequate handling of cattle
    - Aggressive and docile animals

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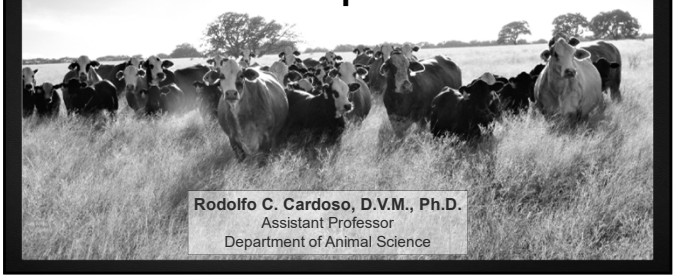
Puberty and Heifer Development



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PRESENTATION OUTLINE

- Importance of timing puberty in replacement heifers
- Economics of age at puberty
- Main factors regulating age at puberty
  - Genetics
  - Nutrition
- Strategies to advance puberty in heifers
  - Nutritional Management
  - Hormonal Technologies

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Introduction – Puberty in Beef Heifers

- Typical replacement rate in beef cattle operations: **15-25%**
- Pregnancy success in the first breeding season is determined by the time at which puberty occurs (1st ovulation)
- Age at puberty will influence the female's ability to rebreed in subsequent years and remain in the herd
  - 73% of heifers conceiving to timed-AI during 1st breeding season remained in the herd after 5 yr
  - Only 43% of heifers that did not conceive to AI but were bred by natural service in the breeding season remained in the herd

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Introduction – Puberty in Beef Heifers

- Regardless of the time of the breeding/calving season, the seasonal nature of beef production exacerbates the resultant loss in efficiency if puberty does to occur at the appropriate age
- **Main reproductive goals in beef cattle operations**:
  - Calve for the first time at 22-24 months of age
  - Continue to calve at ~12-month intervals thereafter

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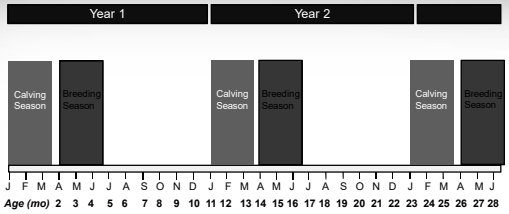
Typical Beef Cattle Operation in the U.S.



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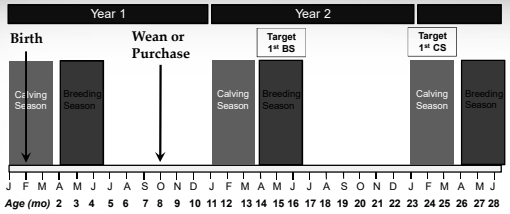
Typical Beef Cattle Operation in the U.S.



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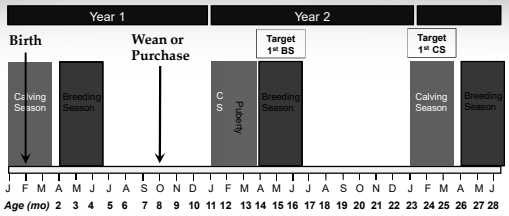
Typical Beef Cattle Operation in the U.S.



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Economics of Age at Puberty

- Cows must wean 3 to 5 calves to pay for the cost of their own development; thus longevity is extremely important

Benefits of calving for the 1st time at 2 vs. 3 years of age:

- Heifers bred to calve at 2 years of age produce ~ 138 kg more of weaned calf weight in their lifetime (approx. $450 more)
- 6 to 8 % greater economic efficiency
- First calves from heifers are lighter at weaning than from mature cows regardless if they calve first at 2 or 3 years of age

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MAIN FACTORS AFFECTING SEXUAL MATURATION IN THE HEIFER

- Genetics (Breed Type/Mature Body Weight)
- Pre- and Post-Weaning Nutrition

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PUBERTY - GENETICS

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PUBERTY - GENETICS

From a genetics standpoint, age at puberty can be decreased by:

- Selecting a breed with younger age at puberty
- Selecting within a breed for younger age at puberty (great potential for *Bos indicus* breeds)
- Crossbreeding with another breed that has a younger age at puberty (hybrid vigor)

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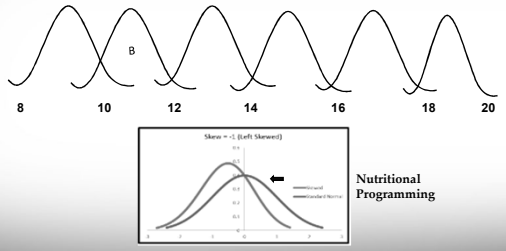
NUTRITIONAL PROGRAMMING OF PUBERTY IN HEIFERS

Jersey-Brown-Swiss-Angus-Hereford-Simmental-Limousine-Charolais-Brahman



Nutritional Programming

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PUBERTY - NUTRITION

- Plane of nutrition from weaning to the onset of breeding season can impact age of puberty
- Traditionally, the recommendation has been that heifers be fed to attain 60-65% of their expected mature BW by the onset of the breeding season.
- While effective in most *Bos taurus* breeds, this approach does not consistently induce puberty by 14 mo of age in *Bos indicus*-influenced heifers
- Additionally, constant BW gain from weaning to breeding is not the most efficient and cost effective approach

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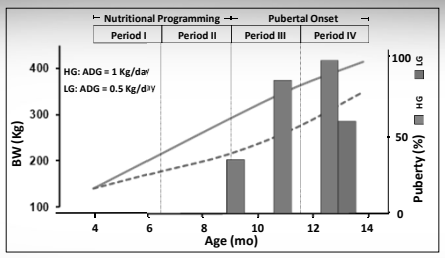

- ***When does the metabolic programming for early puberty occur?***
- ***Can we nutritionally alter the timing of puberty while optimizing other aspects of growth and development?***

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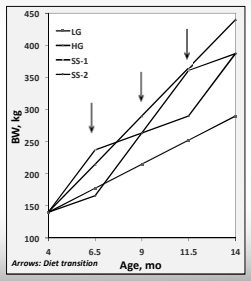
Stair-Step Nutritional Regimen

Nutritional Model



Cardoso et al., 2014, J. Anim. Sci.

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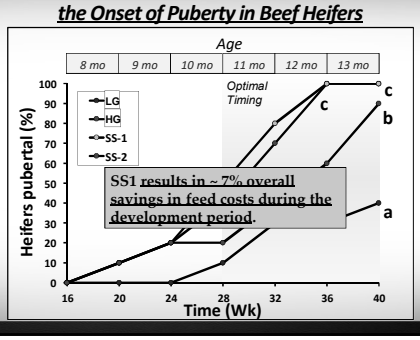
Stair-Step Nutritional Regimen Programs the Onset of Puberty in Beef Heifers



SS1 results in ~ 7% overall savings in feed costs during the development period.

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Puberty - Hormonal Technologies

- While nutrition can advance puberty, variation in occurrence of this event is inherent in all groups of replacement heifers
- Even with excellent nutritional management, it is impossible, or economically feasible, to provide a level of nutrition that ensures that all heifers reach puberty before the 1st breeding season
- Hormonal technologies can help induce puberty in prepubertal heifers while at the same time synchronize estrus
- In combination with adequate nutritional management, hormonal protocols provide most heifers an excellent chance to become pregnant early in their first breeding season.

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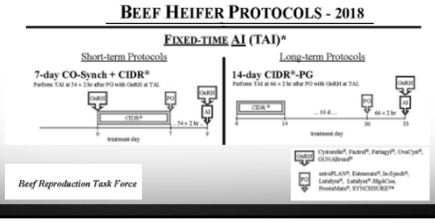
Puberty - Hormonal Technologies

- Progesterone: inhibits the neuroendocrine axis, thus reducing LH secretion
- However, once progesterone is removed, LH secretion increases and supports final follicular development and first ovulation



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Puberty - Hormonal Technologies

- Typically, more than 80% of prepubertal heifers are induced to ovulate with these protocols
- Acceptable pregnancy rates (~50%) in prepubertal heifers if approaching their spontaneous occurrence of puberty

Table 15. Pregnancy rates after FTAI based on reproductive tract score and protocol used to synchronize estrus. Missouri Show-Me-Select Replacement Heifer Program™[4] (Bonacker et al., 2018).

	Reproductive tract score (RTS)			
Protocol	Non-cycling (2&3)		Cycling (4&5)	
7-day CO-Synch + CIDR	173/466	37%[a,x]	429/981	44%[b,x]
MGA-PG	81/230	35%[a,x]	274/576	48%[b,x]
14-day CIDR-PG	4,765/10,280	46%[b,y]	11,674/22,674	52%[b,y]

[a,b]Percentages within rows with different superscripts differ (P < 0.01).
[x,y]Percentages within columns with different superscripts differ (P < 0.01).

- Hormonal approaches are not a substitute for proper heifer development and nutritional management

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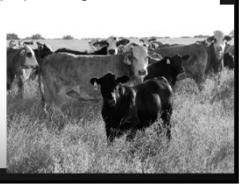
Puberty in Heifers - Conclusions

- Age at puberty influences economic efficiency of beef production through effects on both age at first calving and the time of conception in the first breeding season (longevity in the herd)
- The seasonal nature of beef production and the advantages to production efficiency of a breeding season of restricted duration exacerbate the resultant loss in efficiency if puberty does not occur at the appropriate age
- Key strategies to advance puberty in beef heifers:
  - ✓ Genetic selection
  - ✓ Nutritional management
  - ✓ Hormonal Technologies



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Thank You!!

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