Beef Cow Nutrition and Reproduction: A Systems Approach

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Mountains & Minds

Photo courtesy Janna Kincheloe

Topics for Today

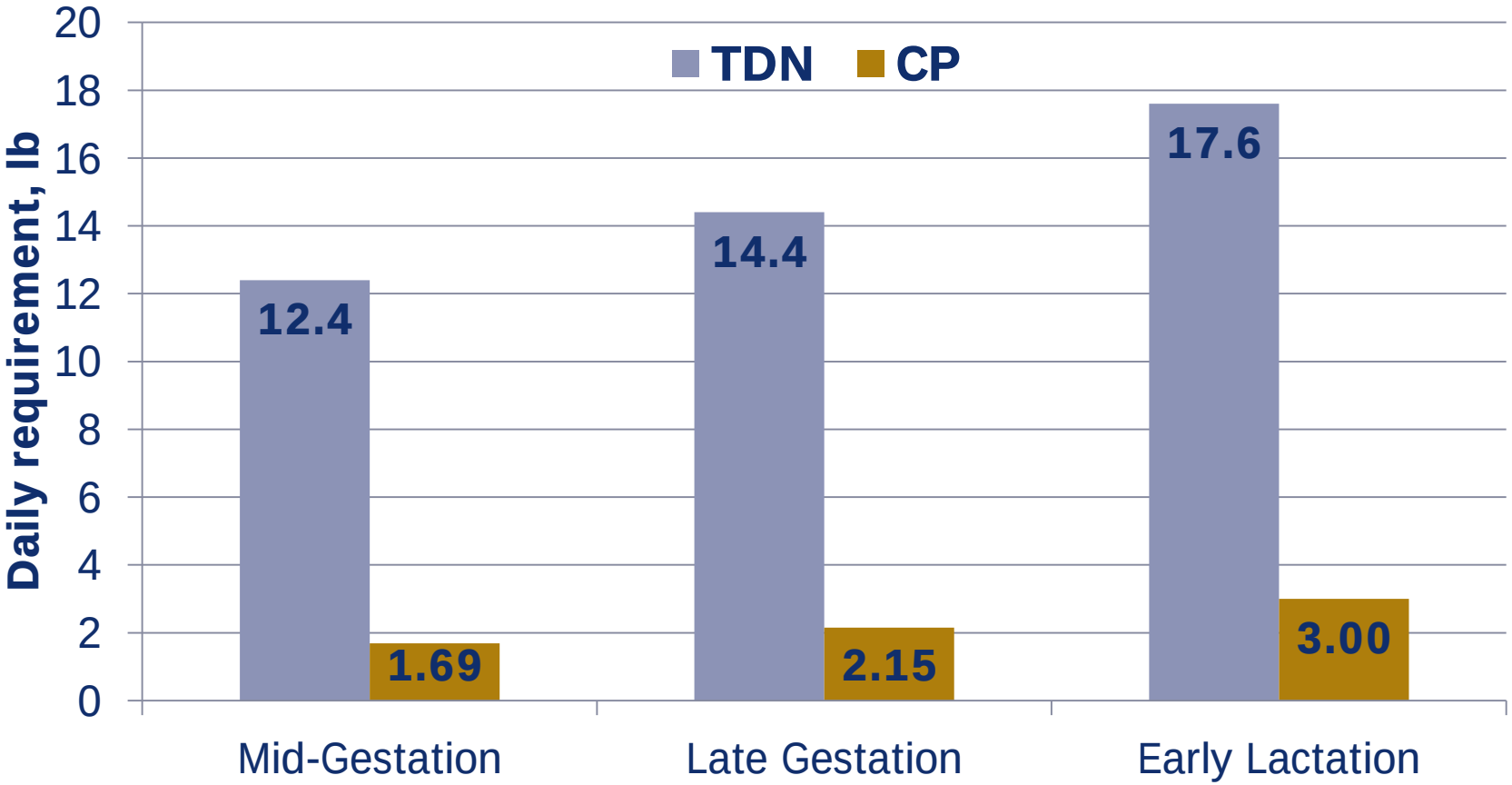
- Factors affecting nutrition and reproduction throughout production cycle
  - Late gestation
  - Calving season
  - Breeding season
  - Heifer development

Reproductive Traits

1. Puberty/Resume cycling
2. Fertile ovulation
3. Conception (cow and bull)
4. Maintenance of pregnancy
5. Give birth to live calf

- These interdependent traits culminate in a qualitative response, measured one time every year!

Energy and Protein Requirements by Physiological Stage



Nutrient Partitioning Review

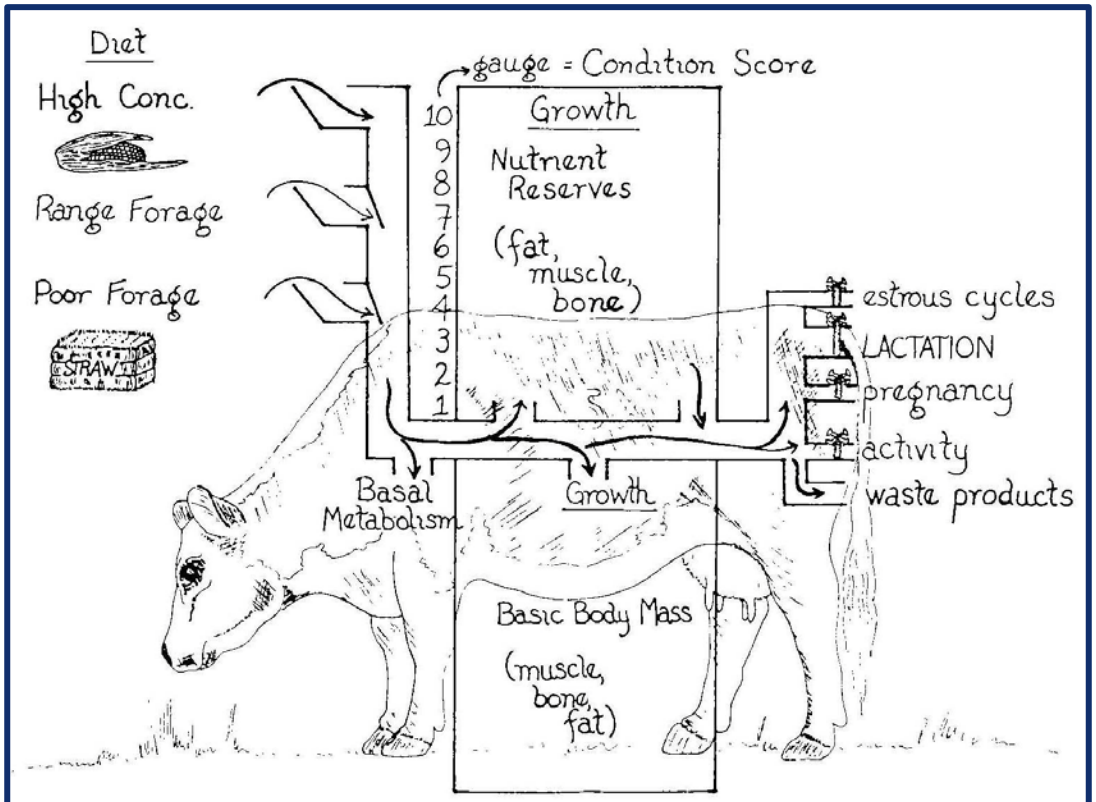


Fig. 1. Partitioning of nutrients in beef cows fed diets differing in quality.

Adams and Short, 1988

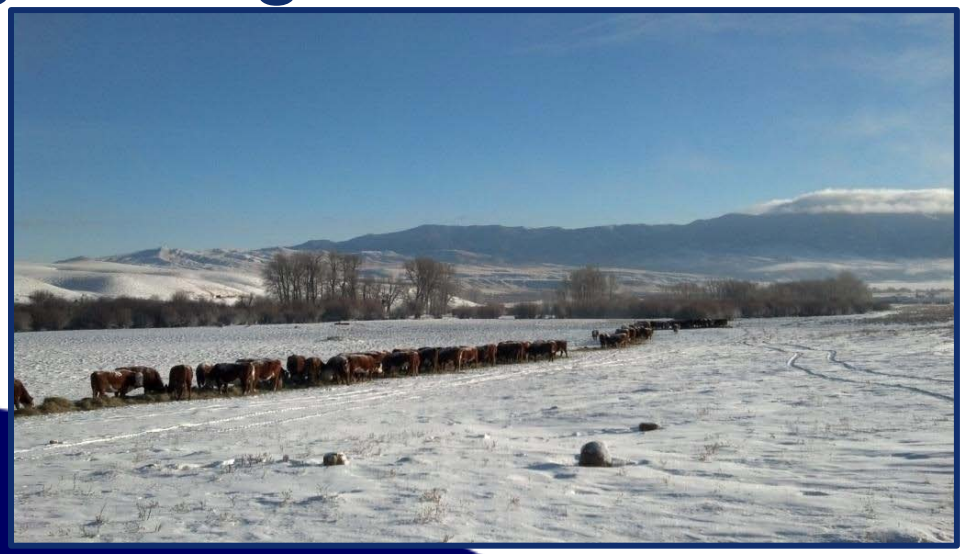
Nutrient Analyses of Feedstuffs

- Highly (very, very highly) recommended
- Feedstuffs <u>and water</u> should be sampled and tested!
- Can’t manage if you don’t measure
- Evaluate nutrient analyses vs cow requirements
- Balance appropriate ration

Late Gestation

What's Happening in Late Gestation

- 75% of fetal growth attained
- Conceptus requires 100 to 150 pounds of weight gain
  - Fetus plus membranes and fluids
- Young cows still growing



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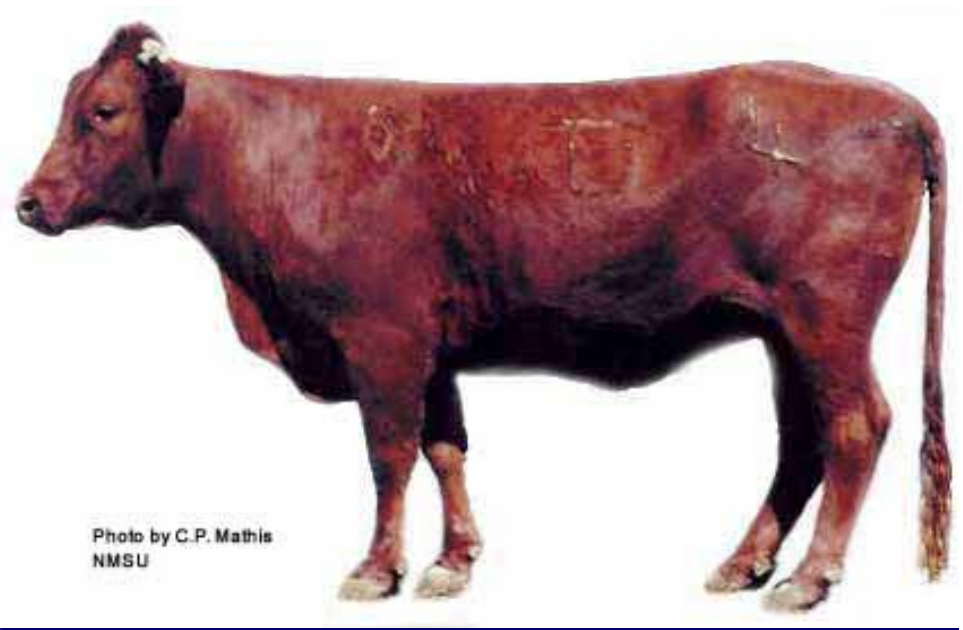
Rapid Fetal Growth During Third Trimester

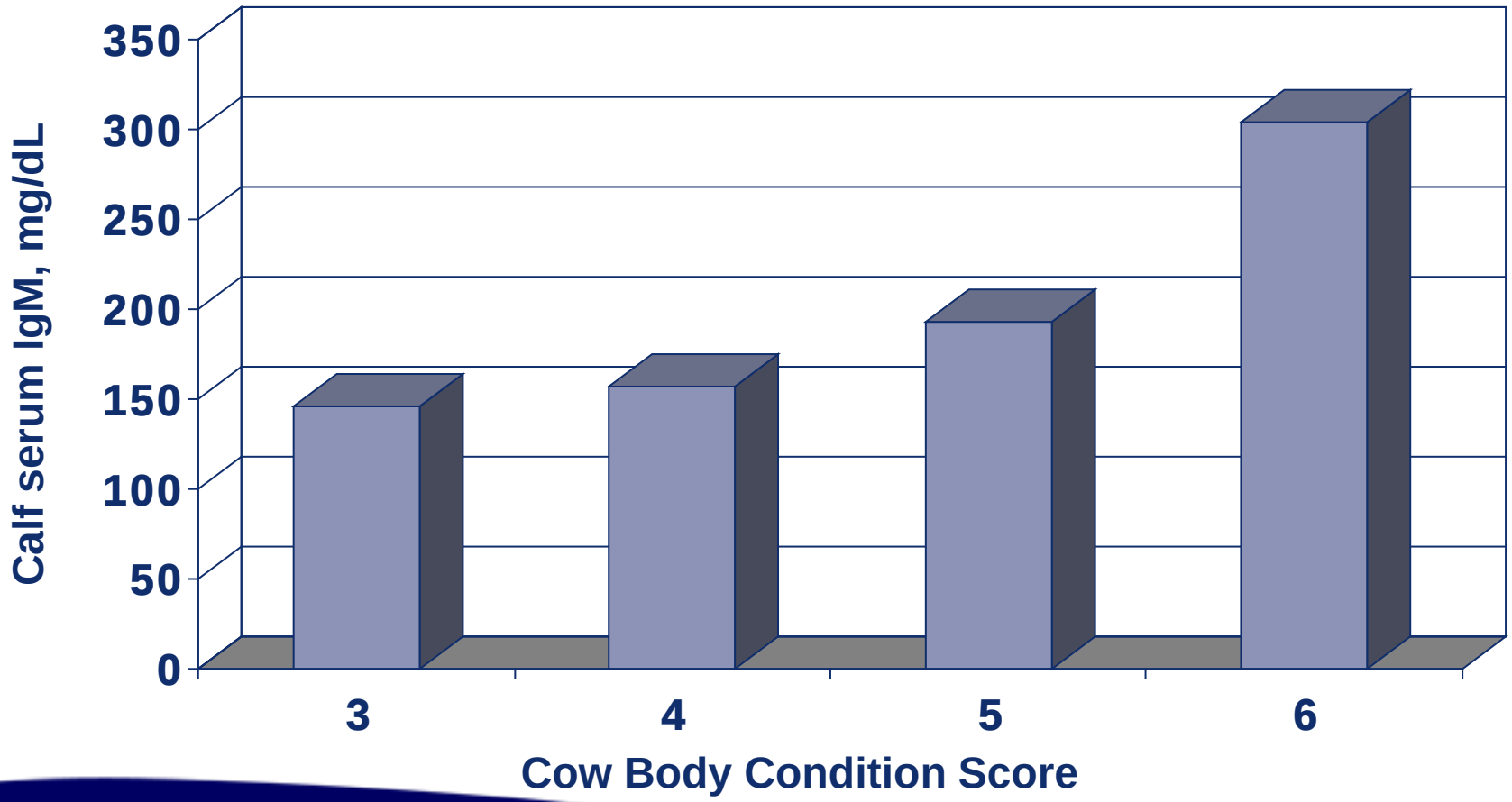
- Sometimes cow unable to meet fetal nutrient demands from diet
- Maternal reserves of energy and protein will be used
- Cow will lose body condition

Rapid Fetal Growth During Third Trimester

- Fetus gaining weight
- Loss in cow condition may not result in change in scale weight



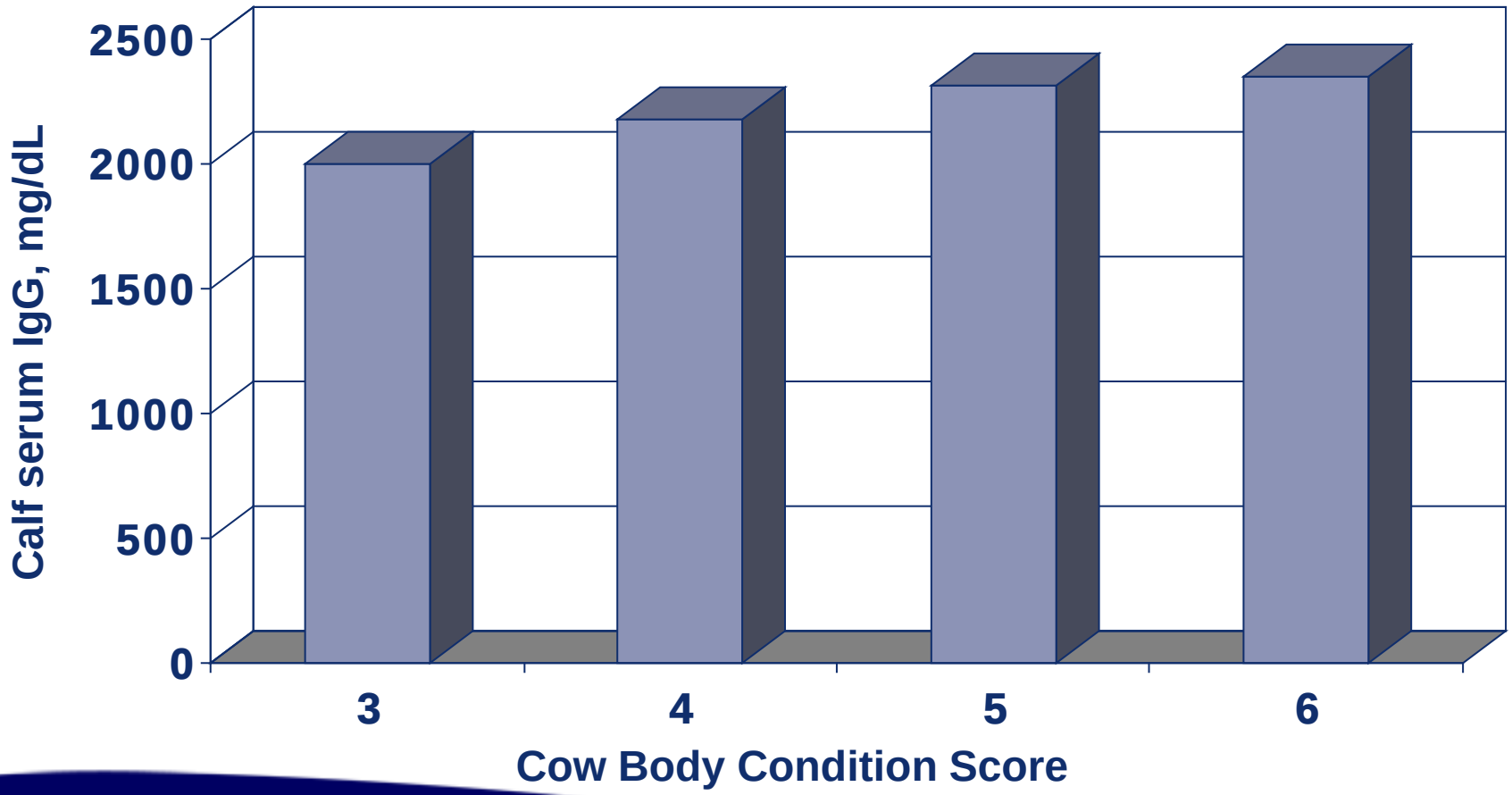
Cow Body Condition and Calf Serum Immunoglobulin M



P = 0.05

Adapted from Odde, 1997

Cow Body Condition and Calf Serum Immunoglobulin G



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Adapted from Odde, 1997

Passive Immunity and Pre-Weaning Health

- Compared to calves with adequate passive immunity, calves with failure of passive immunity were
  - ~2 times more likely to be ill pre-weaning
  - ~5 times more likely to die pre-weaning

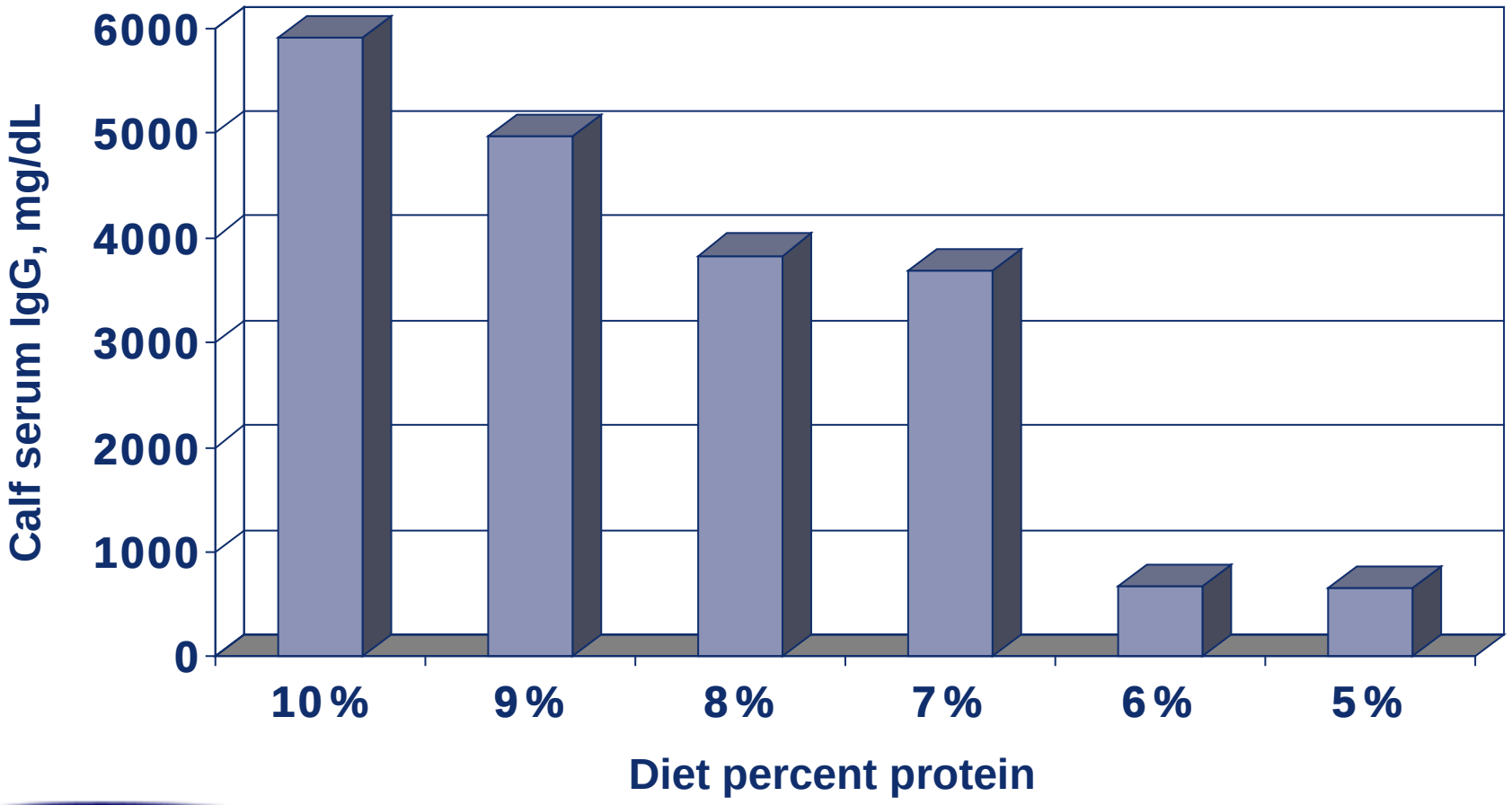
Dewell et al., JAVMA 2006

Cow Nutrient Restriction and Calf Passive Immunity

- Idaho study
  - First-calf heifers fed at one of six protein concentrations for 100 days pre-calving
  - Calves fed colostrum from dairy cows
  - Evaluated calf's ability to absorb immunoglobulins

Blecha et al., JAS 1981

Calves From Dams Fed Low Protein Diets Less Able to Absorb IgG



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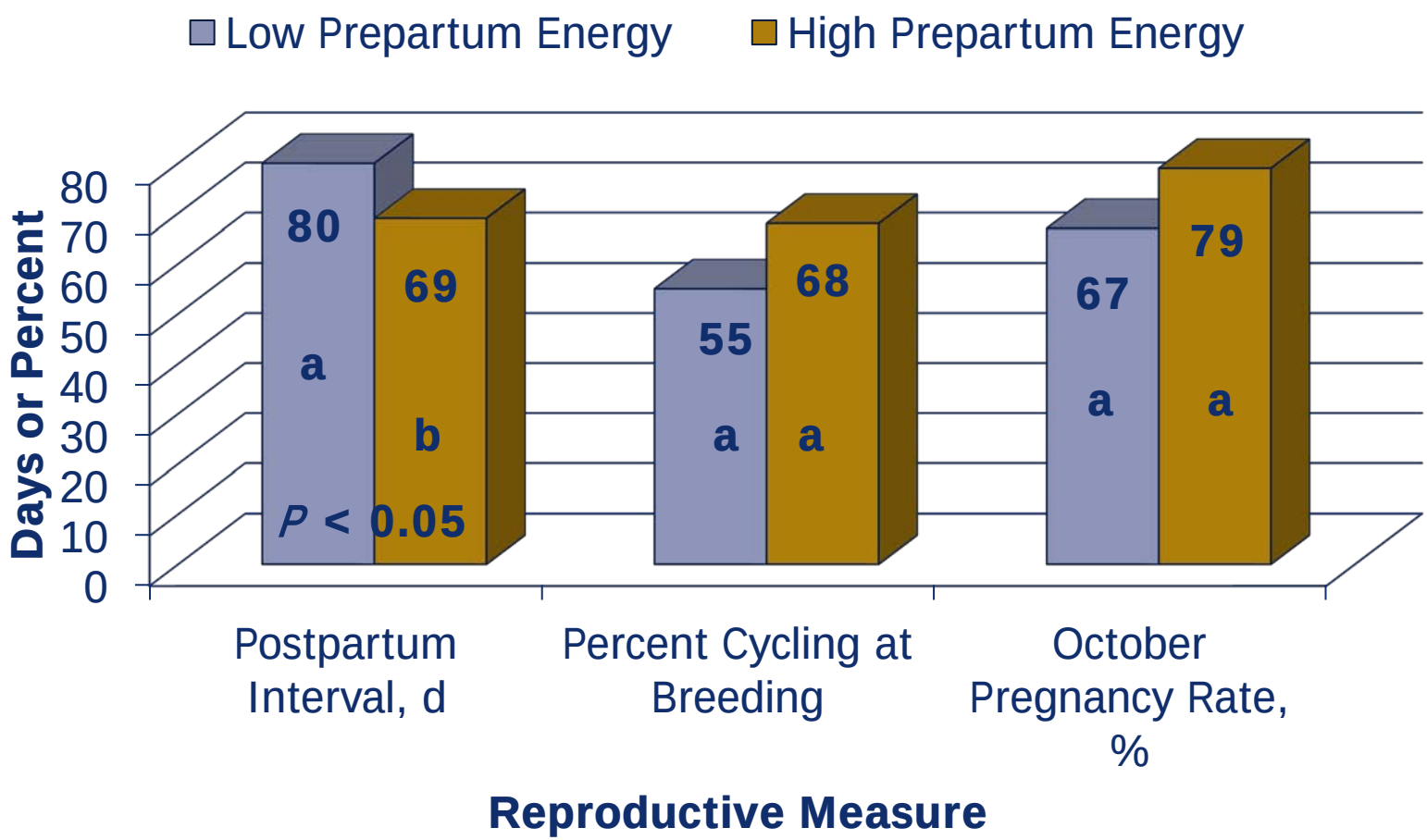
Blecha et al., JAS 1981

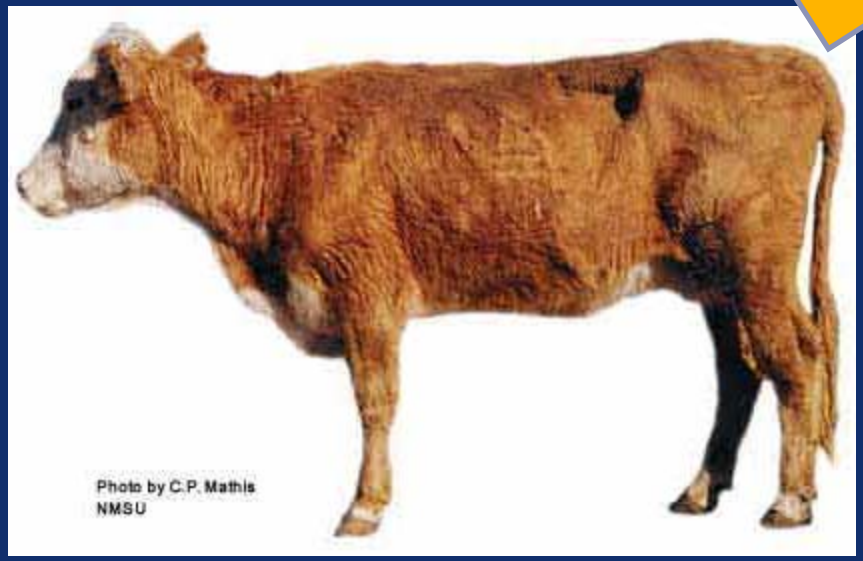
Prepartum Dietary Energy Can Impact Reproduction



Bellows et al., 1982

Inputs Required to Get Thin Cows to Gain Weight

?



Inputs Required to Get Thin Cows to Gain Weight

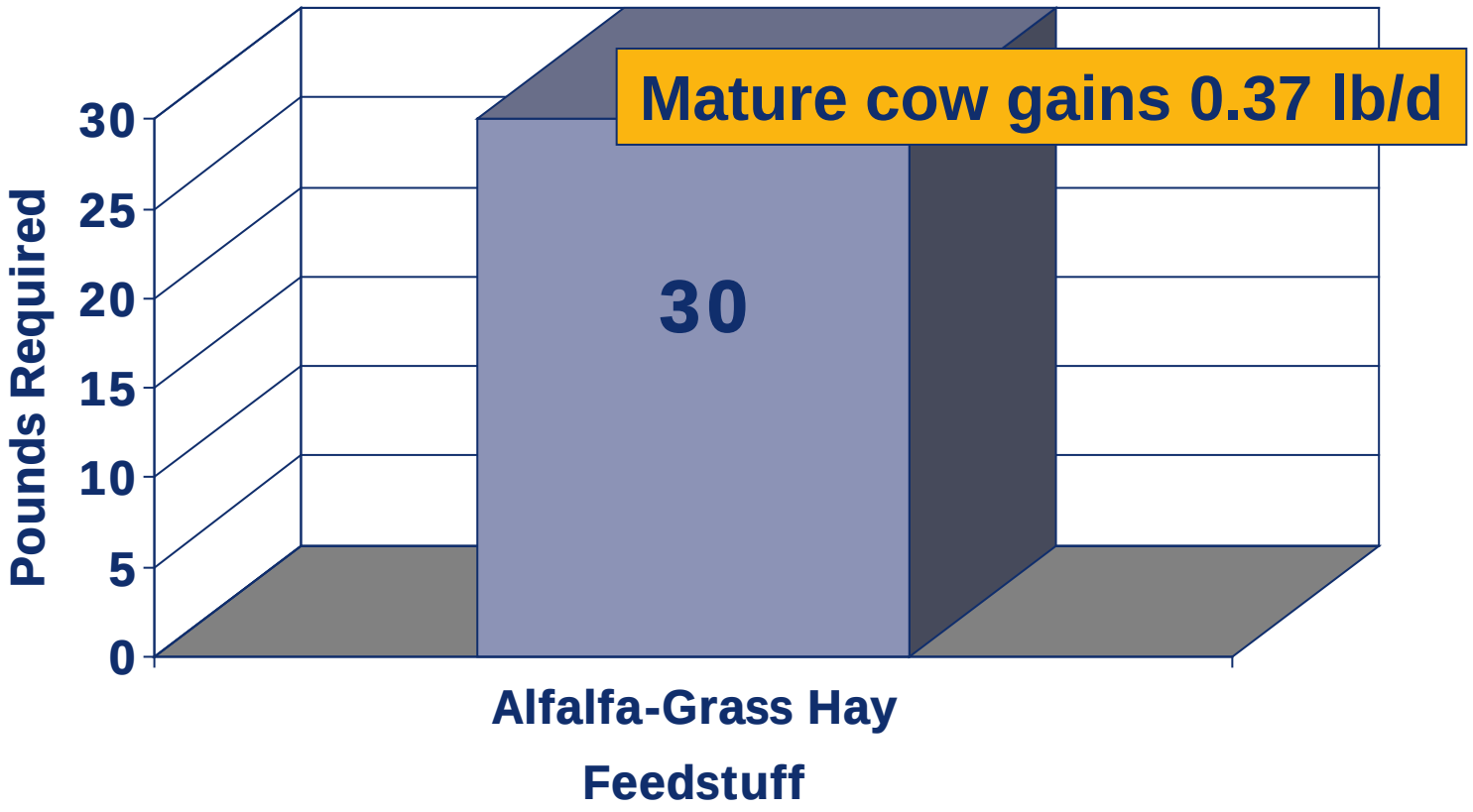
- BRaNDS ration balancing program

- Post-weaning
- Third trimester

Feedstuffs for Examples

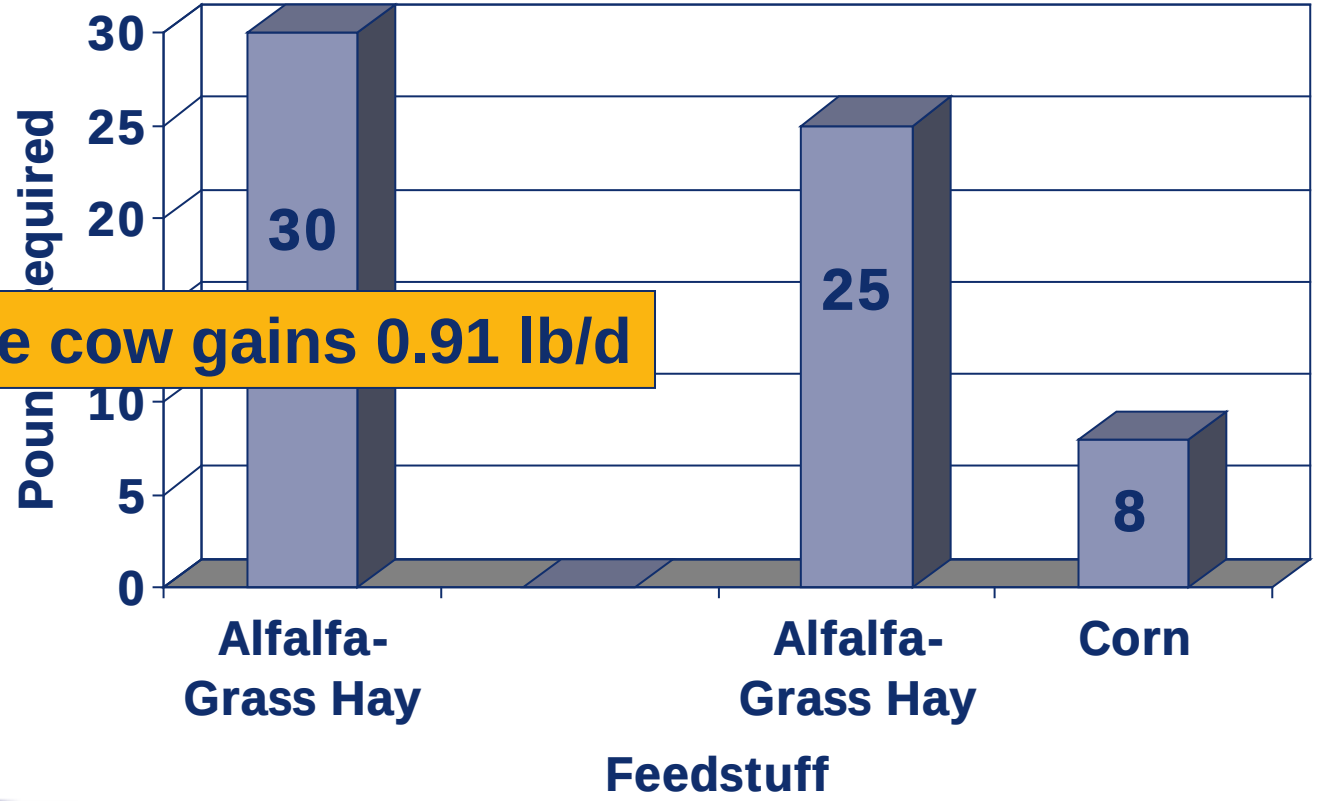
- Alfalfa-grass hay
  - 60% TDN, 14% CP
- Corn
  - 90% TDN, 9% CP

Scenario: 1400-lb Cow, Maintain BCS 6, 3rd Trimester



Scenario: Same Cow, BCS 3, Gaining ¾ BCS/Month, 3rd Trimester

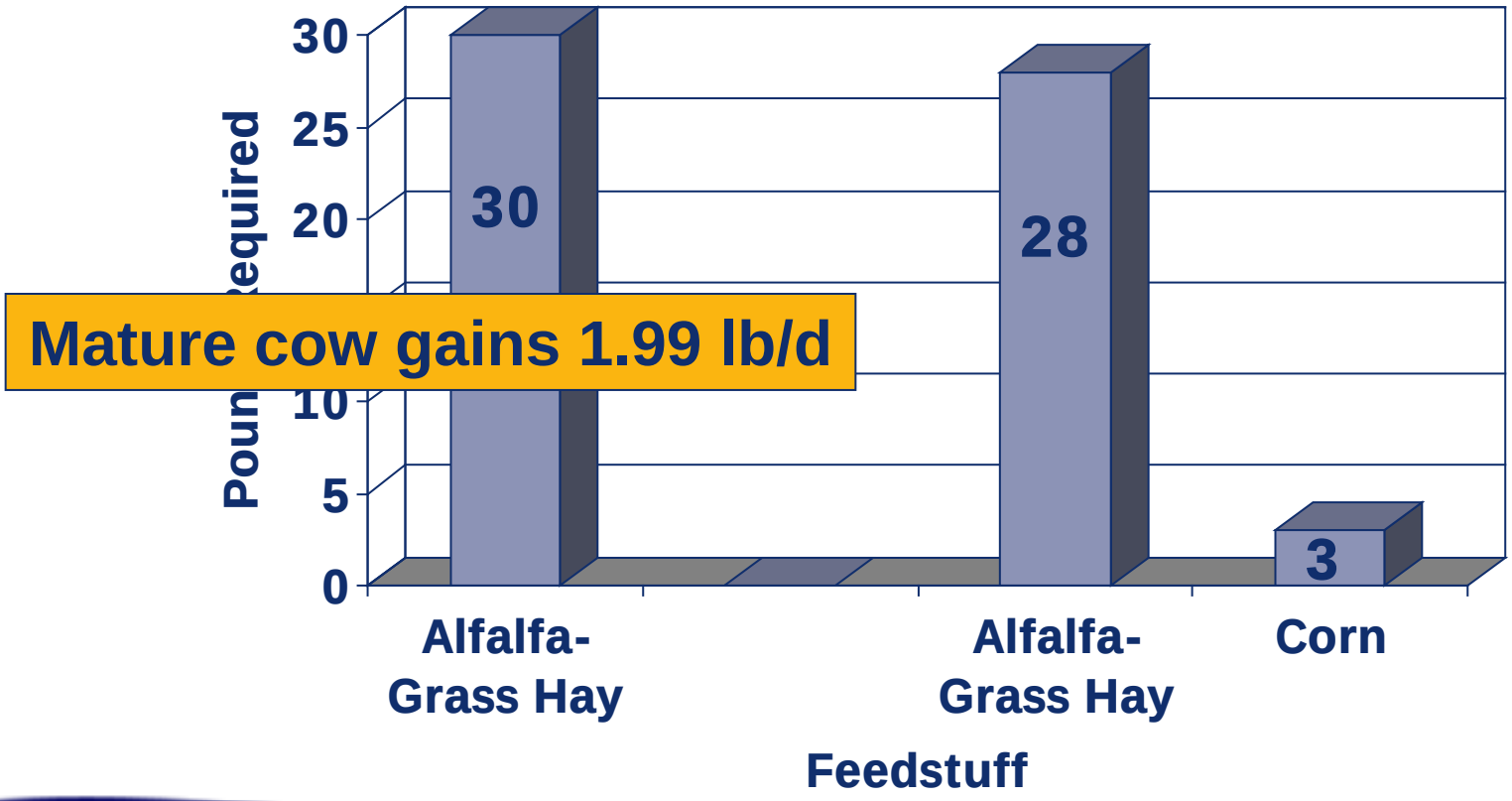
Mature cow gains 2.31 lb/d



Mature cow gains 0.91 lb/d

Scenario: Same Cow, BCS 3, Gaining ¾ BCS/Month, 2nd Trimester

Mature cow gains 2.35 lb/d



Mature cow gains 1.99 lb/d

Calving Season

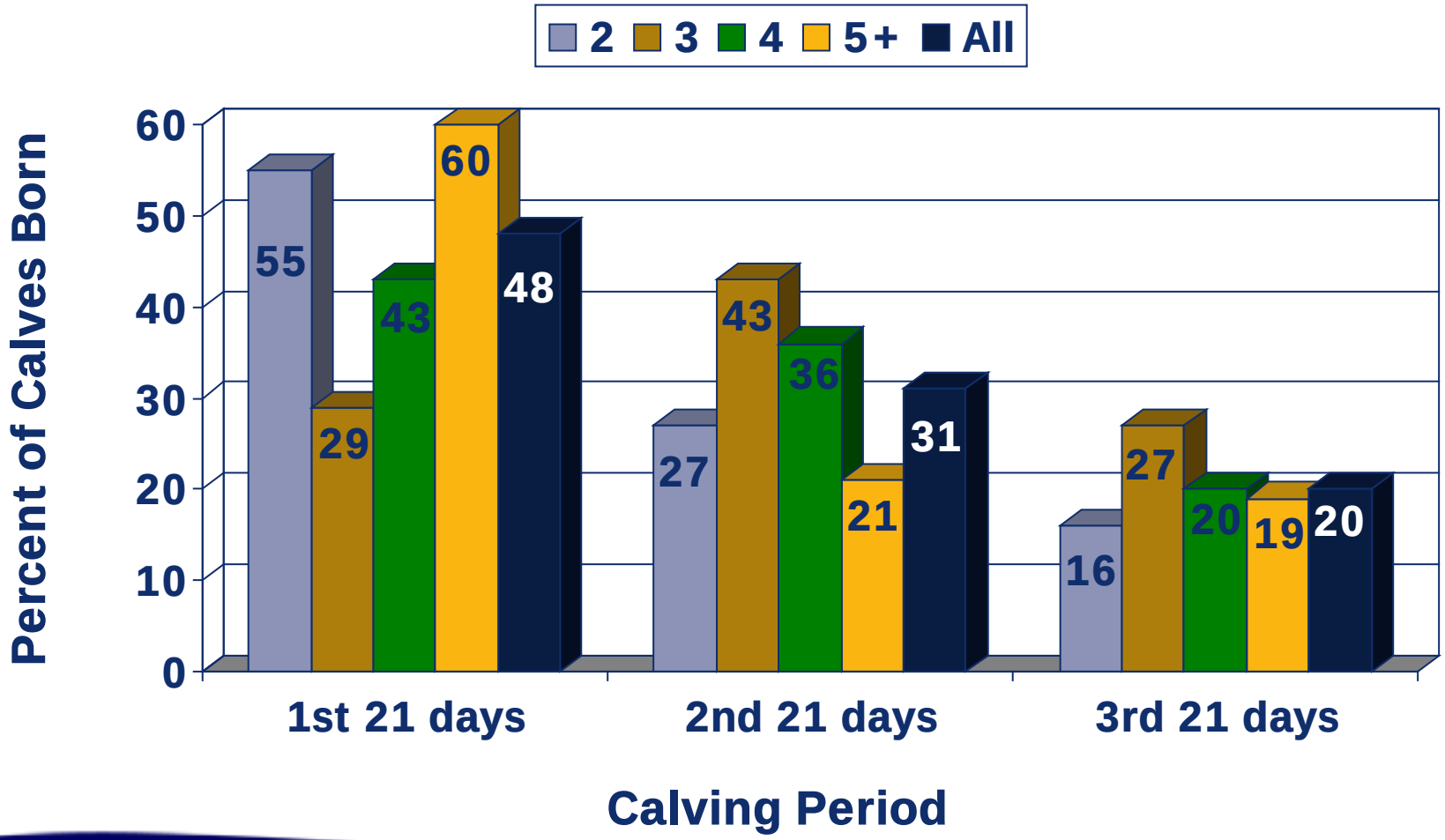
Calving Distribution

- Follows how cows are calving within the calving season
- Split into 21-day periods
- Starting date
  - Breeding date/bull turnout plus 283 days
  - When 3rd mature cow calves

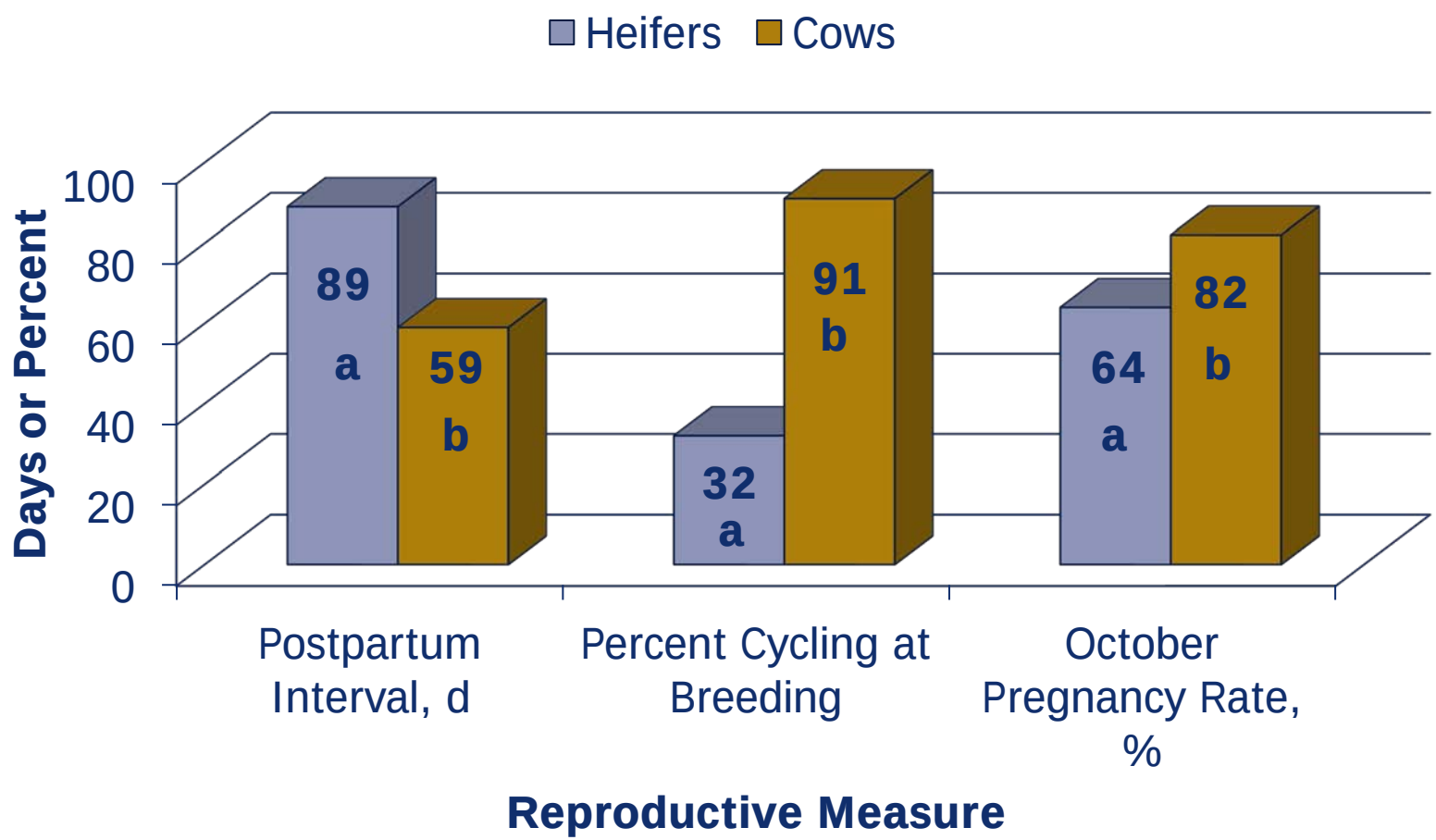
Calving Distribution Table

		% of Cows Calving		
Cow Age	**No. of Cows**	d 1-21	d 22-42	d 43-63
2	79	55	27	16
3	62	29	43	27
4	44	43	36	20
5+	70	60	21	19
Total	225	48	31	20

Calving Distribution Graph



Heifers Differ From Cows in Postpartum Reproductive Performance



Bellows et al., 1982

a,b $P \leq 0.05$

Calving Difficulty Impacts Subsequent Reproductive Performance

Cow Age	Calving Difficulty	% in Estrus During AI	AI Conception	Overall Conception
2	No dystocia	68	66	80
	Dystocia	59	51	71
3	No dystocia	72	64	87
	Dystocia	55	46	73
4 & 5	No dystocia	86	78	90
	Dystocia	77	64	64

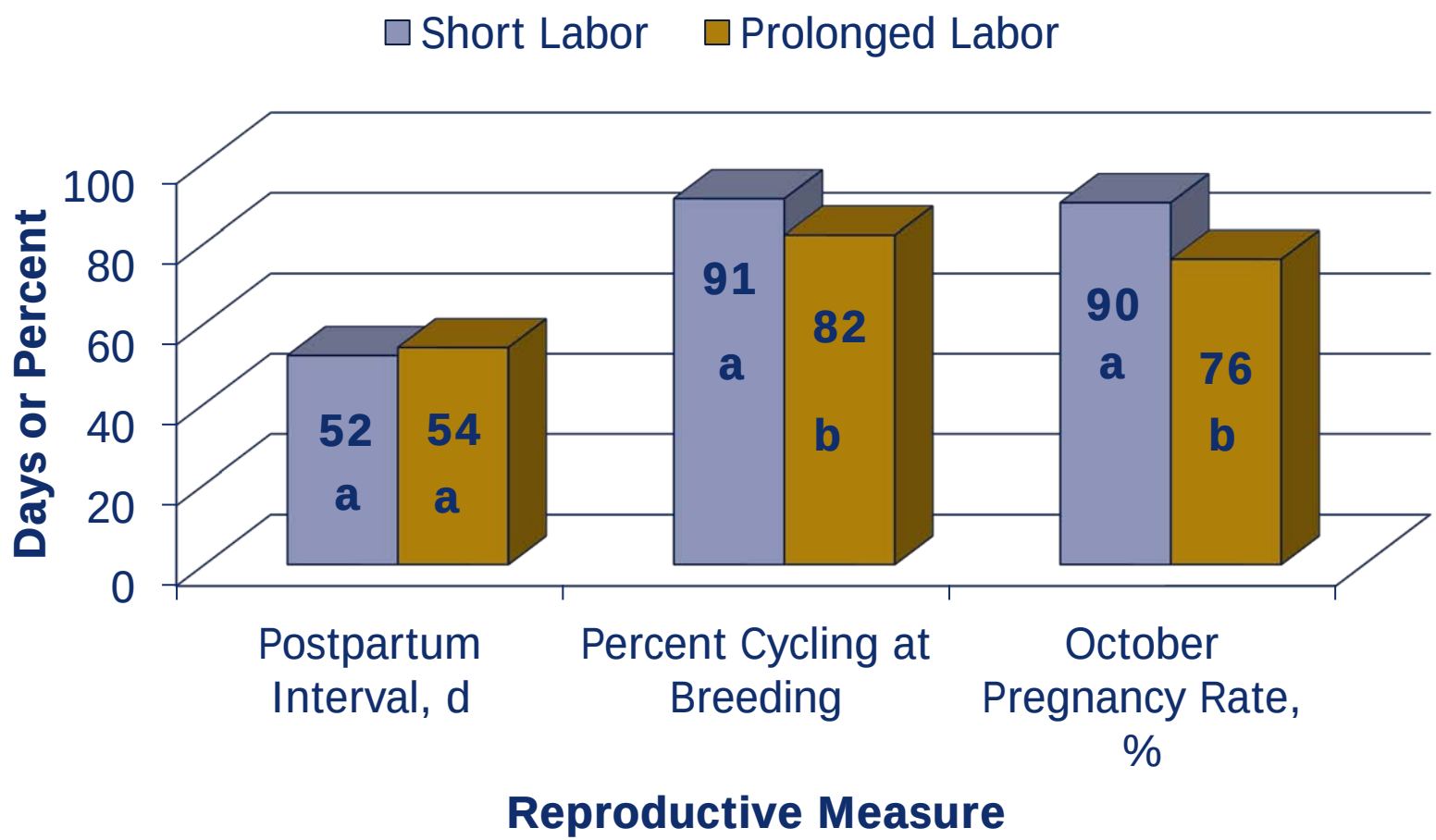
Laster et al., 1973

Calving Difficulty Impacts Subsequent Reproductive Performance

- Heifers experiencing dystocia as 2-year-olds weaned 14% fewer calves per cow exposed as 3-year-olds
- Calves from 3-year-olds who experienced dystocia as 2-year-olds were born 13 days later and 46 pounds lighter at weaning

Laster et al., 1973

Duration of Labor Impacts Postpartum Reproductive Performance



Doornbos et al., 1984

a,b $P \leq 0.10$

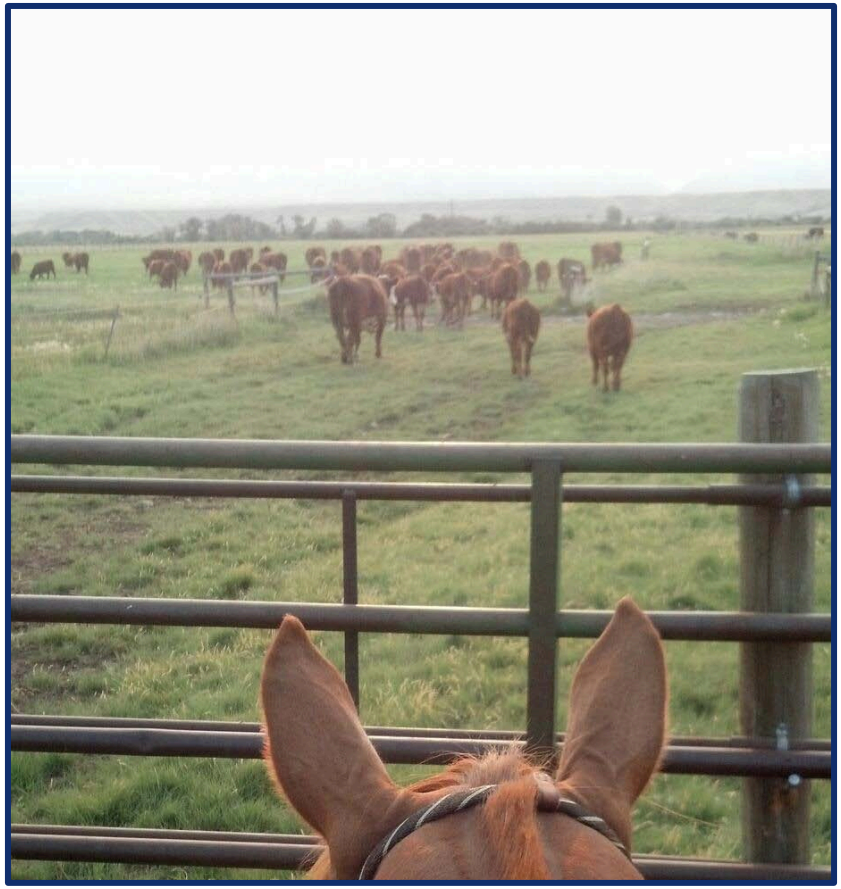
Strategies for Improved Young Cow Reproductive Performance

- Proper heifer development and pre- and post-calving nutrition
- Start yearling breeding season early
- Shorten yearling breeding season

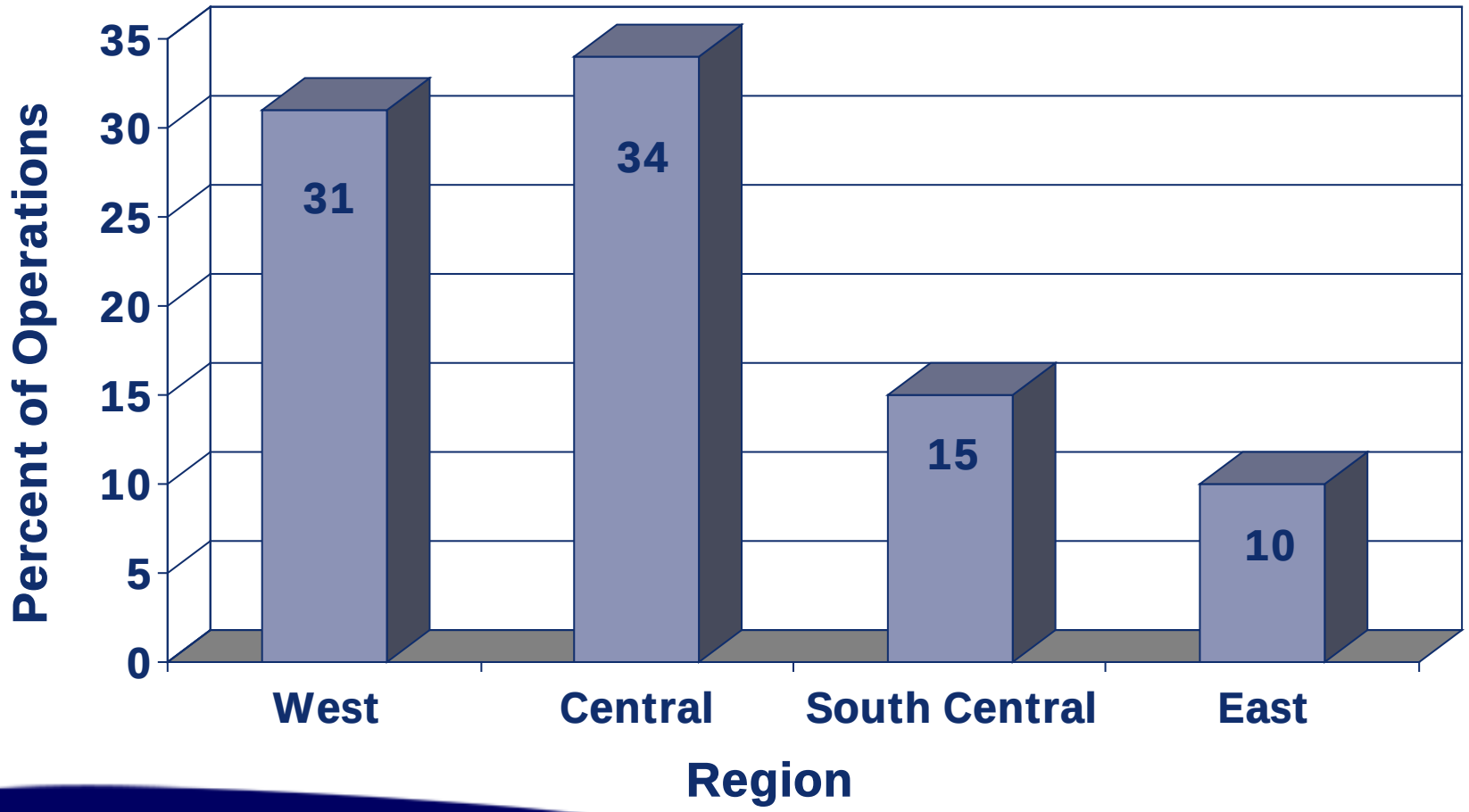
Strategies for Improved Young Cow Reproductive Performance

- Keep young cows separate from older cows
  - Before, after calving
  - Consider after breeding
- Early weaning?

Breeding Season

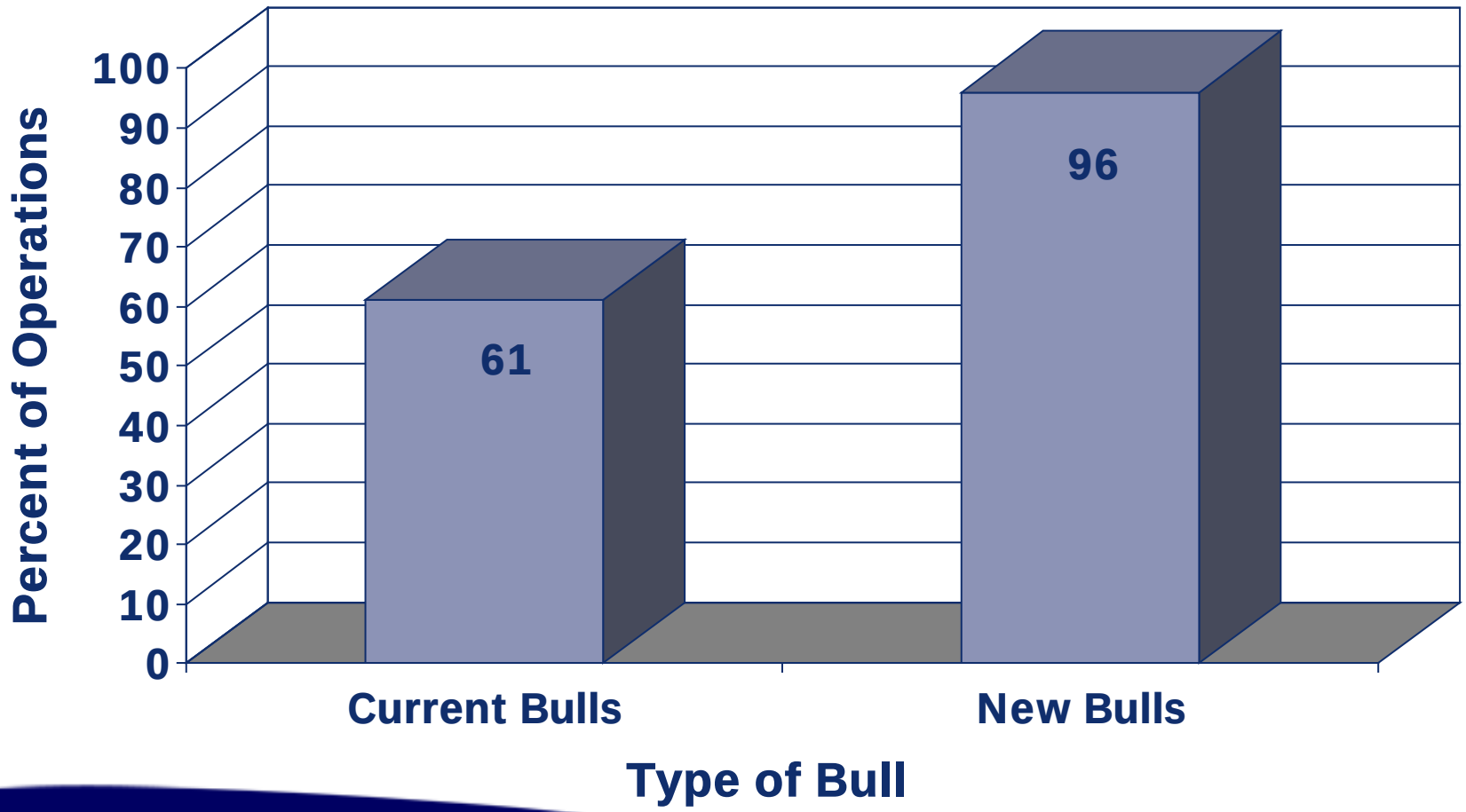


Percent of Operations That Test Bulls (Semen Evaluation)



NAHMS Beef, 2007-08

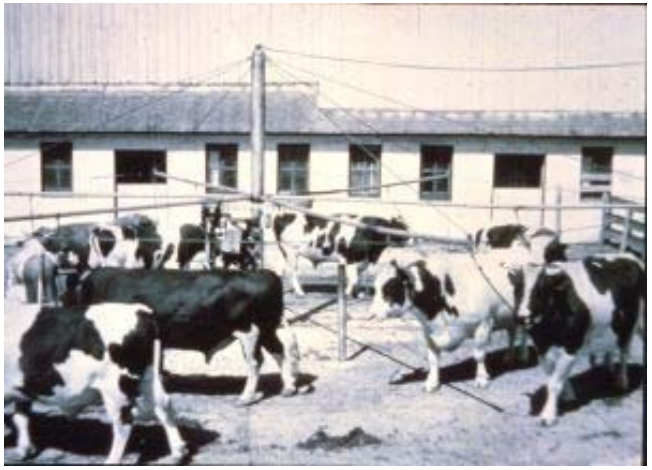
Bull Testing: Operations With 200+ Cows



NAHMS Beef, 2007-08

Bull Breeding Soundness Exam

- Conduct 30-60 days prior to breeding season
- Physical examination
- Measure scrotal circumference
- Evaluation of semen sample



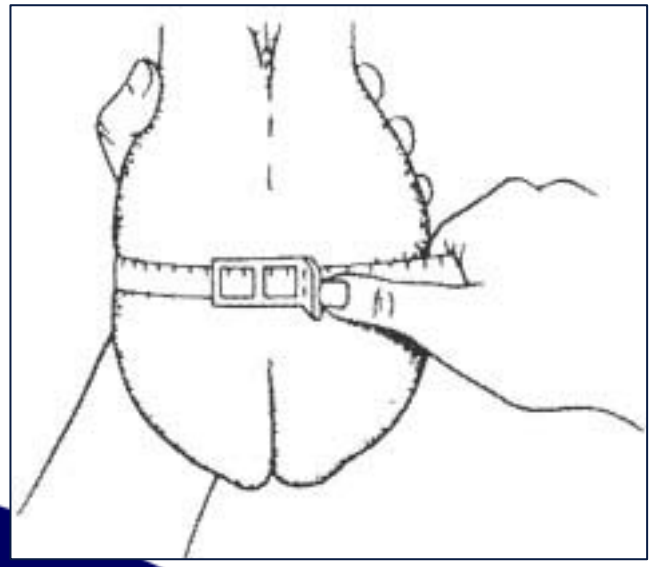
Bull Physical Exam

- Visual appraisal and rectal palpation
  - Good condition, structurally sound
- Good time to review previous management, disease, stress
  - Fat bulls or bulls on hot rations
  - Infection, fever
  - Frostbite

Bull Scrotal Circumference

- Primarily related to sperm production and semen volume
- Related to age of puberty in heifers

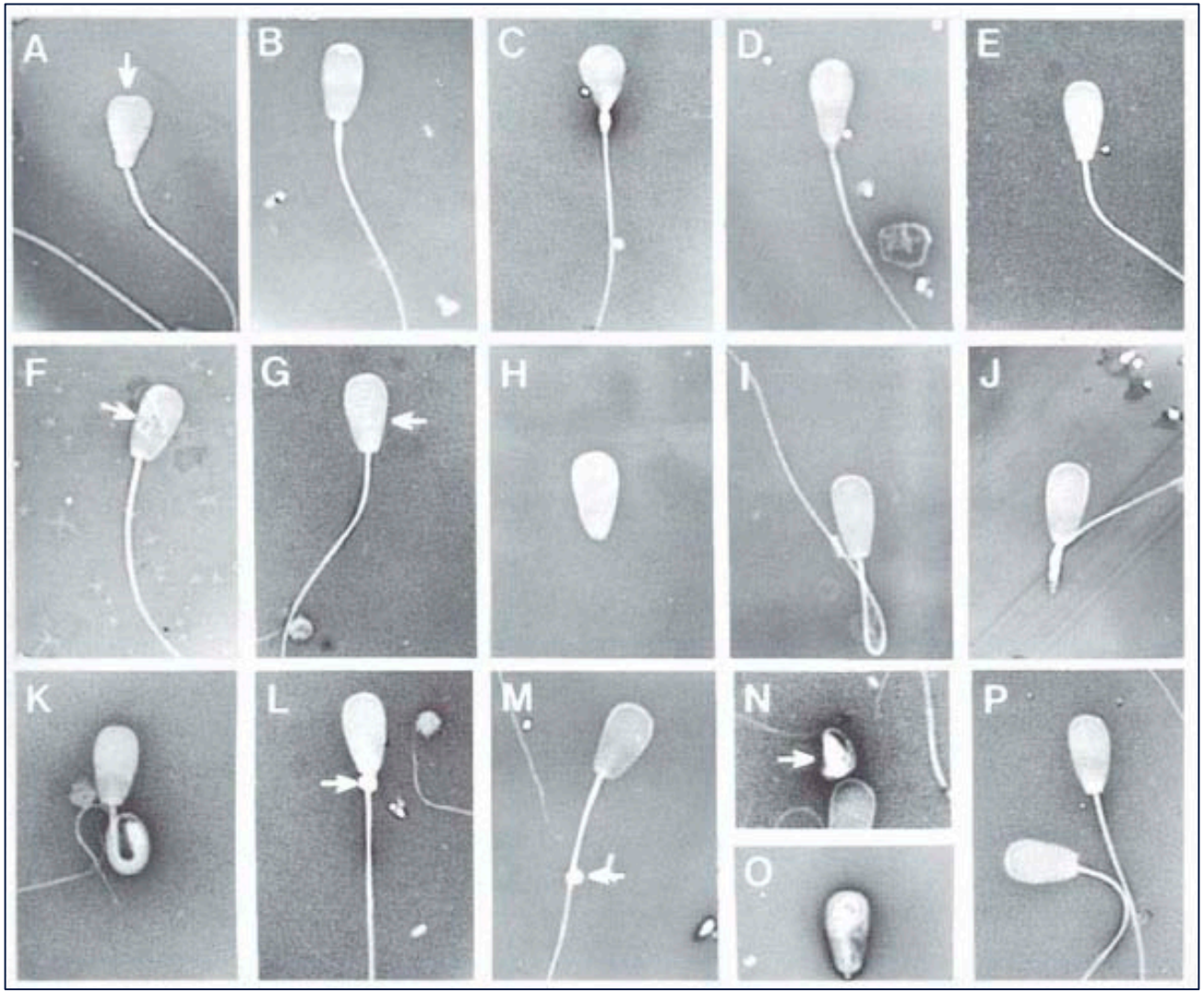
Age (months)	≤ 15	> 15-18	> 18-21	> 21-24	>24
Scrotal circumference (cm)	30	31	32	33	34



Bull Semen Evaluation

- Motility
  - ≥ 30% individual motility, “fair” gross motility
- Morphology
  - ≥ 70% normal sperm

Bull Semen Evaluation: Sperm Abnormalities



Bull Management

Conditioning for Breeding Season

- 30-90 days adjustment time for new purchases ideal
- Consult your veterinarian about an appropriate health program

Conditioning for Breeding Season

- Yearling bulls should continue to gain 1.5-2 lb/day
  - 11-12% CP, 70% TDN
  - Bulls consume 10-15% more than comparable weight steer

Turnout Body Condition Score of 6

- Visible bone structure
  - No distinct structure
  - Transverse processes felt with firm pressure
- Muscling
  - Hindquarters plump and full
- Fat cover
  - Spongy foreribs and tail head
  - Brisket has some fat

Breeding Season Management

- Plane of nutrition during breeding will be same as cows
- Ensure bulls enter breeding season in good condition
  - Will lose 100-300 pounds
- Monitor frequently for injury, etc.

Recovery After Breeding Season

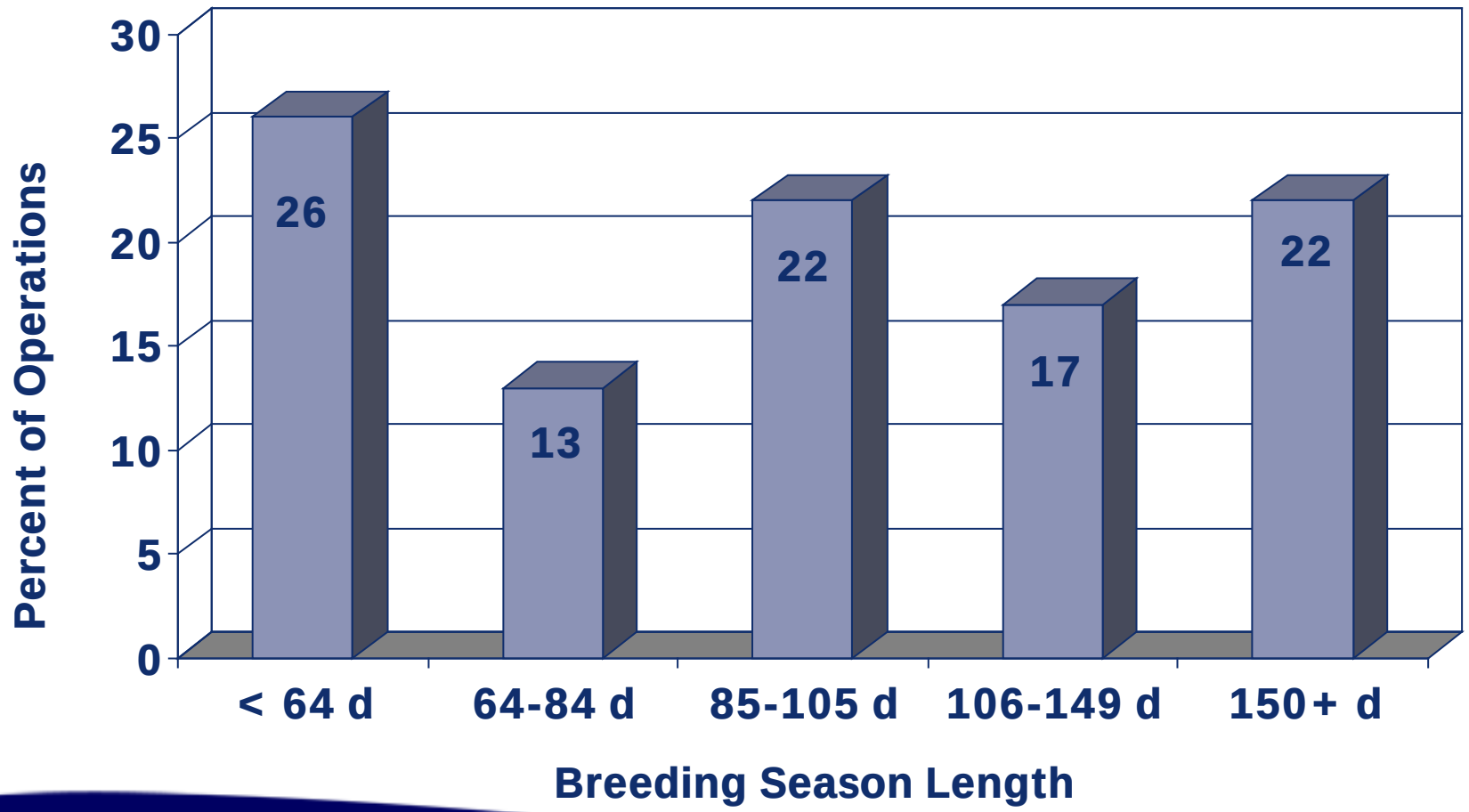
- Recommend bulls reach 75% of mature body weight at 2 years of age
- Example: expect 2000 lb mature weight
  - 1250 lb at turnout, needs to be 1500 lb at 2
  - Loses 200 lb during breeding = 1050 lb
  - Needs to gain 450 lb in 9 months
  - Average daily gain of 2 lb/day

Recovery After Breeding Season

- Mature bulls in good shape after breeding season can get by on all-roughage diet
- Young bulls may need supplemental energy, depending on forage quality

Establish Breeding Season

Breeding Season Length by Percent of Operations



NAHMS Beef, 2007-08

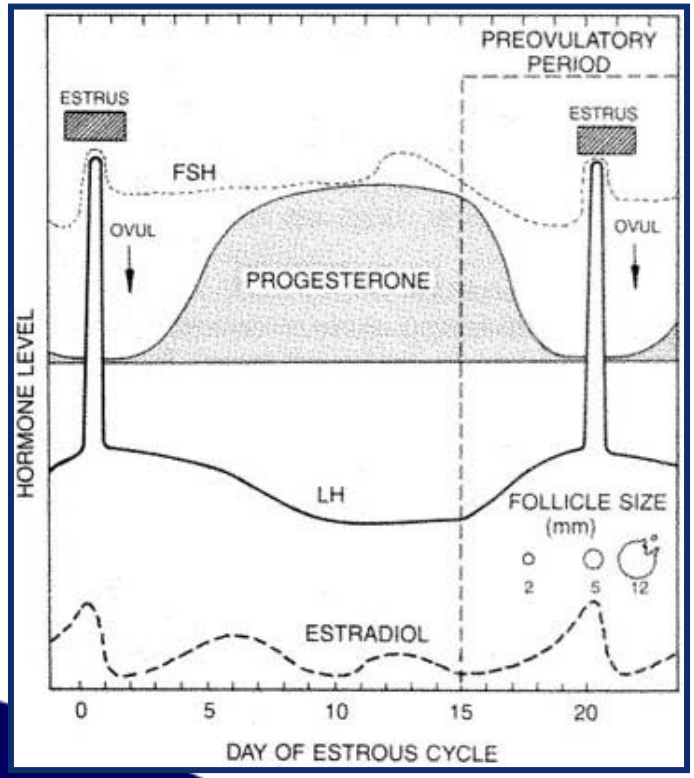
Some Reasons to Consider A Controlled Breeding Season

- Nutrition adjusted to physiological state
- Cattle observed for calving difficulty
- Calf crop more uniform in age & weight
- Facilitation of management
- Identification of reproductively unsound cattle

Heifer Development

Heifer Reproduction: Most Limiting Factor is Puberty

- Definition: First ovulation and show estrus
- Hormone sensitivity of receptors in the brain and ovaries



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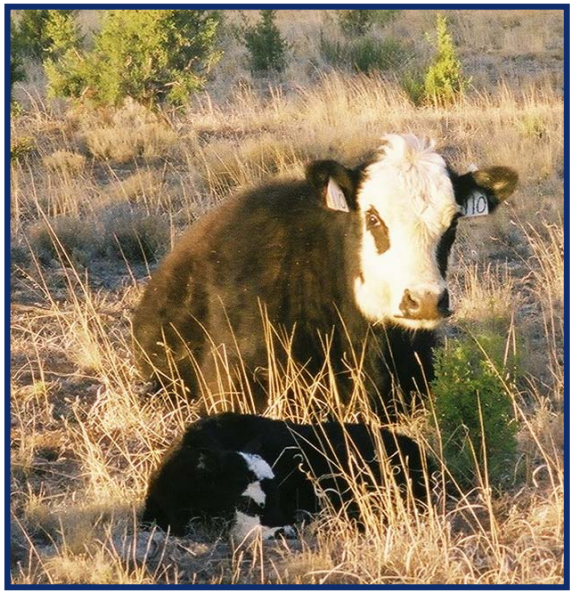
Age at Puberty is Important

- Goal: Calve as 2-year-olds (23-25 mo.)
- Then must conceive at 14-16 months



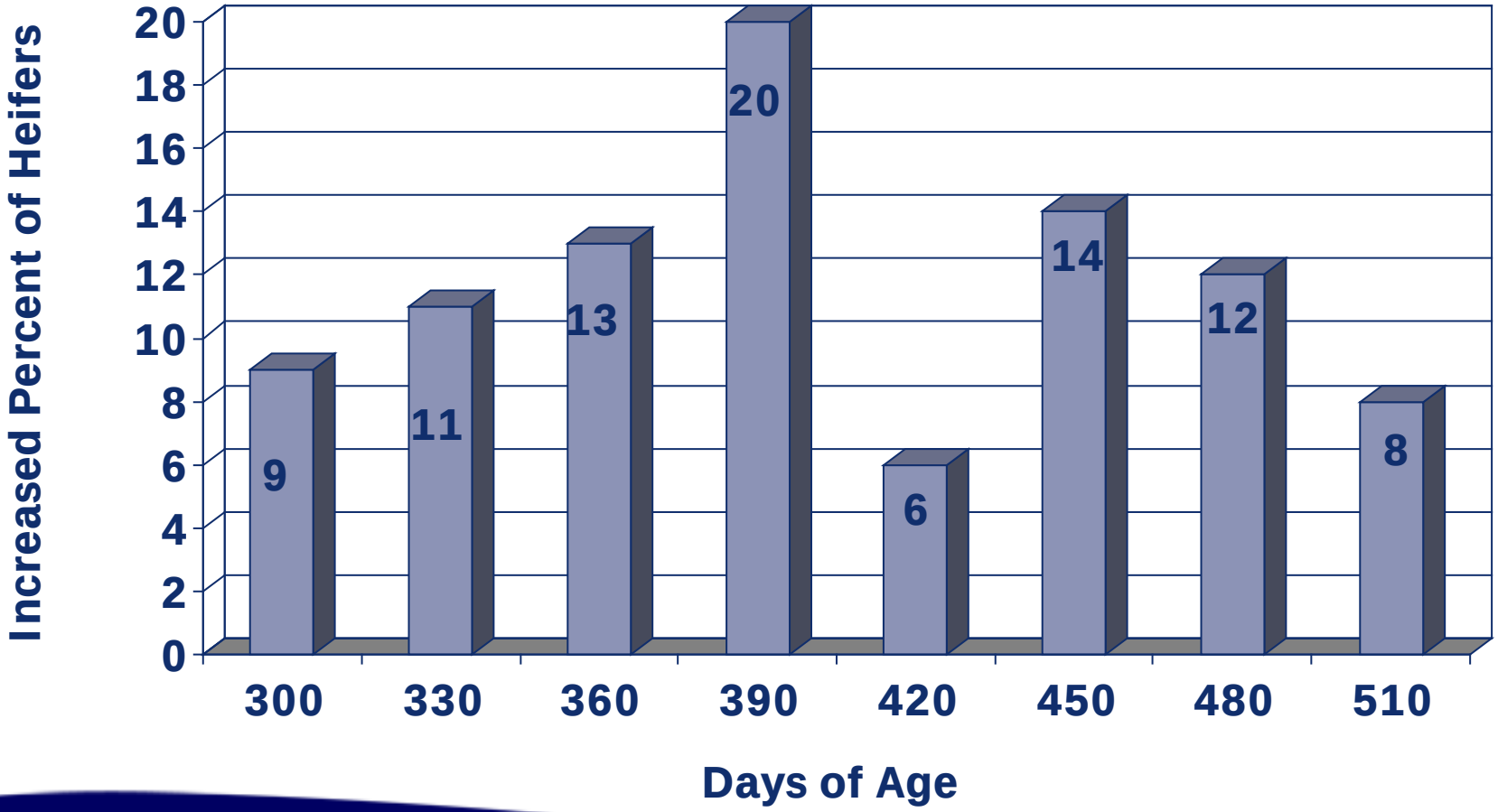
Breed Affects Age at Puberty

- Breeds selected for increased milk production
  - Younger at puberty
- Breeds selected for greater growth and mature size
  - Older at puberty

Heterosis Affects Age at Puberty

- Percent of heifers reaching puberty at a given age is greater for crossbreds than straightbreds
  - Heterosis effects decrease with increasing age

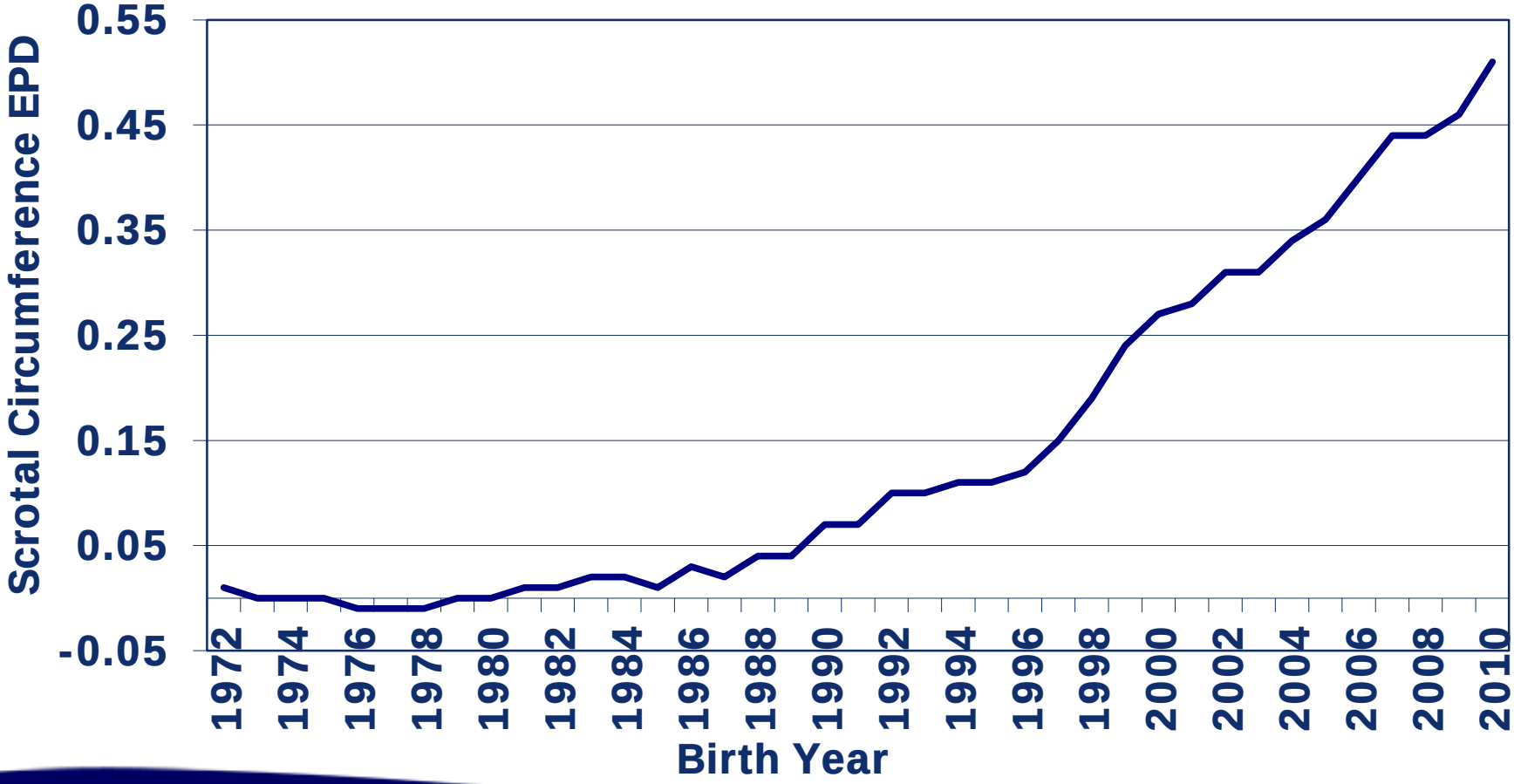
Increased Percentages of Crossbred Heifers Cycling vs Straightbreds



Sire Scrotal Circumference and Age at Puberty

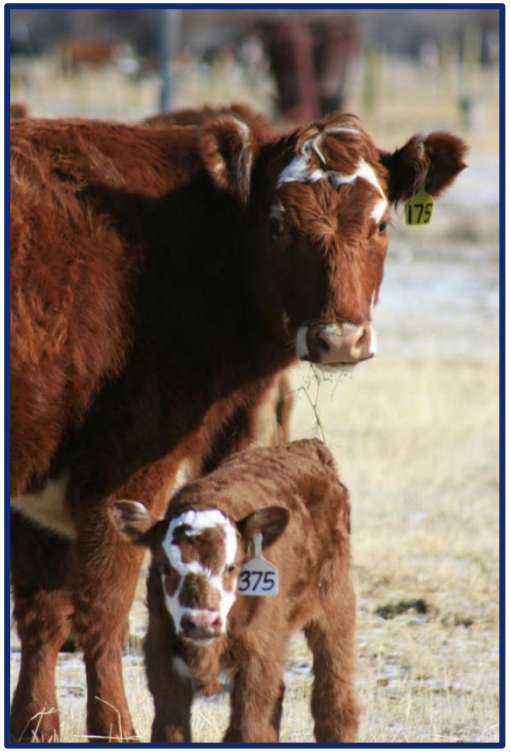
- Selection for larger scrotal circumference in herd sires is an indirect method of selecting for younger age at puberty in heifers

Angus Genetic Trend for Scrotal Circumference



Timing of First Calf and Lifetime Productivity

- Heifers that calved early in their first calving season continued to calve early and wean heavier calves throughout their lifetime
  - Lesmeister et al., 1973



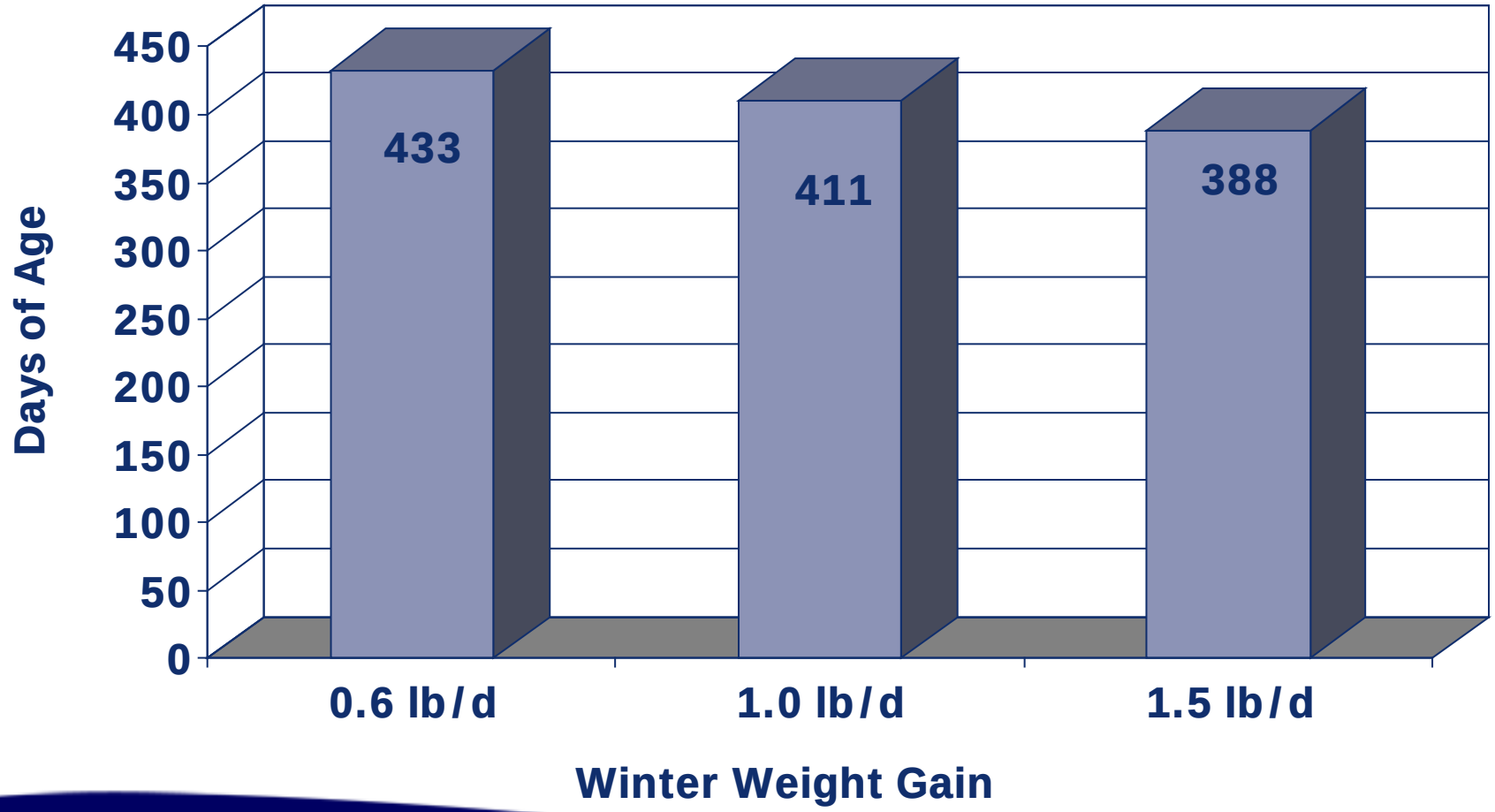
Puberty is Correlated with Weight

- Puberty will occur at a genetically predetermined size among individual animals
- High pregnancy rates can be obtained only when heifers reach that target weight

Target Weight Concept

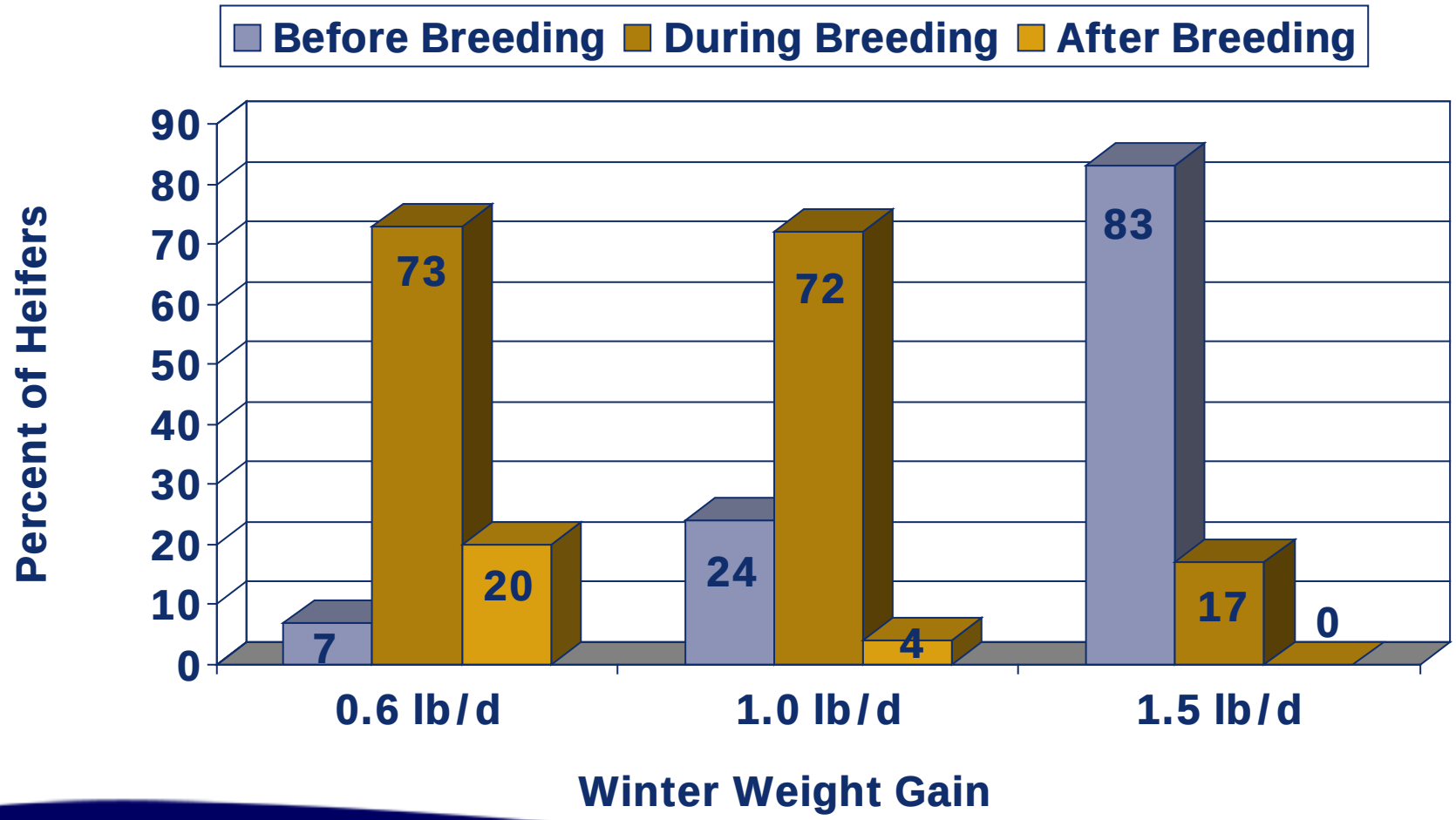
- The “sure-thing” approach
- Heifer should reach 60-65% of her mature body weight by breeding
- Idea is that 90% plus will exhibit estrus by the start of the breeding season

Winter Weight Gains and Age at Puberty



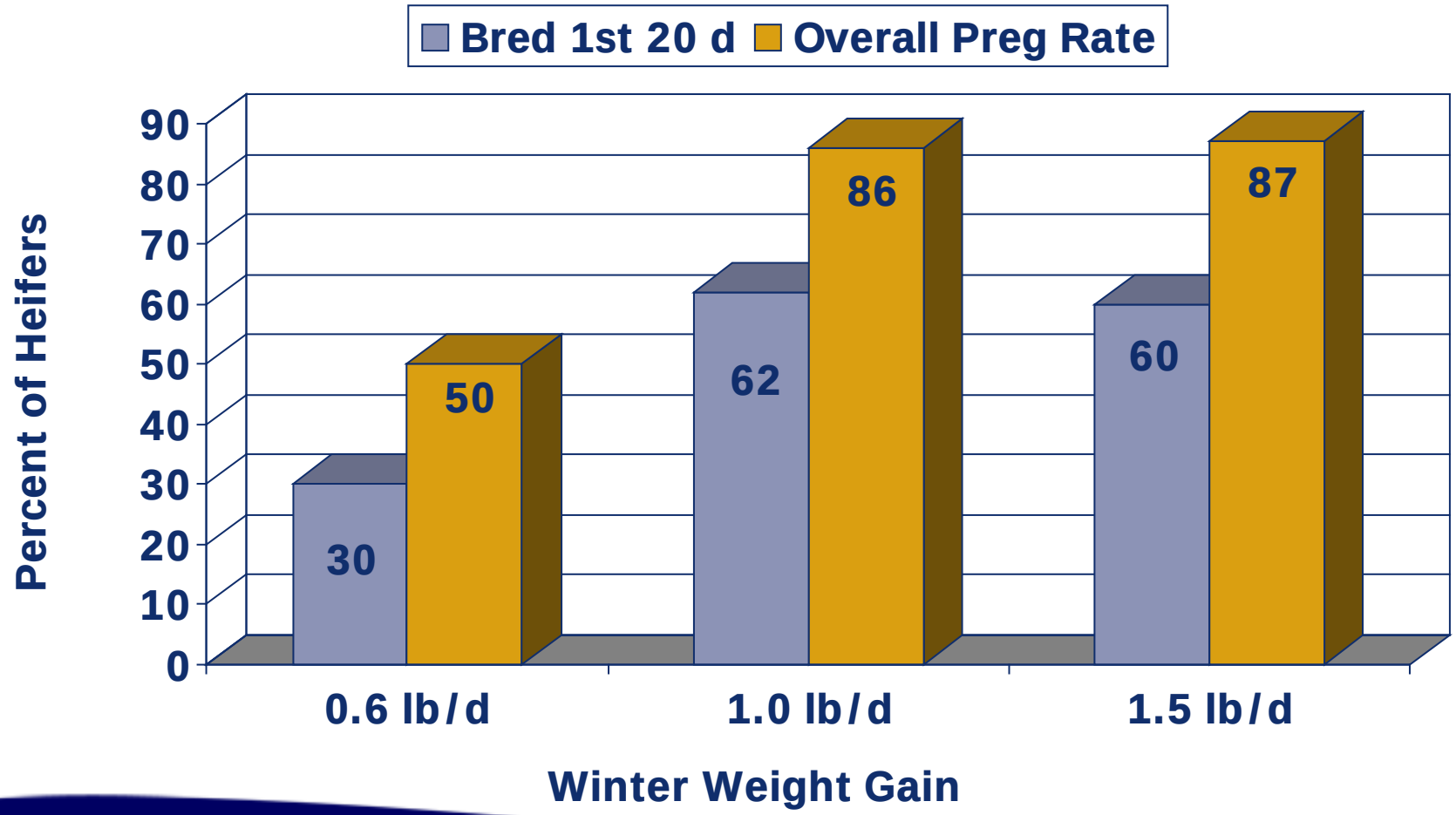
Short and Bellows, 1971

Winter Weight Gain & Timing of Puberty



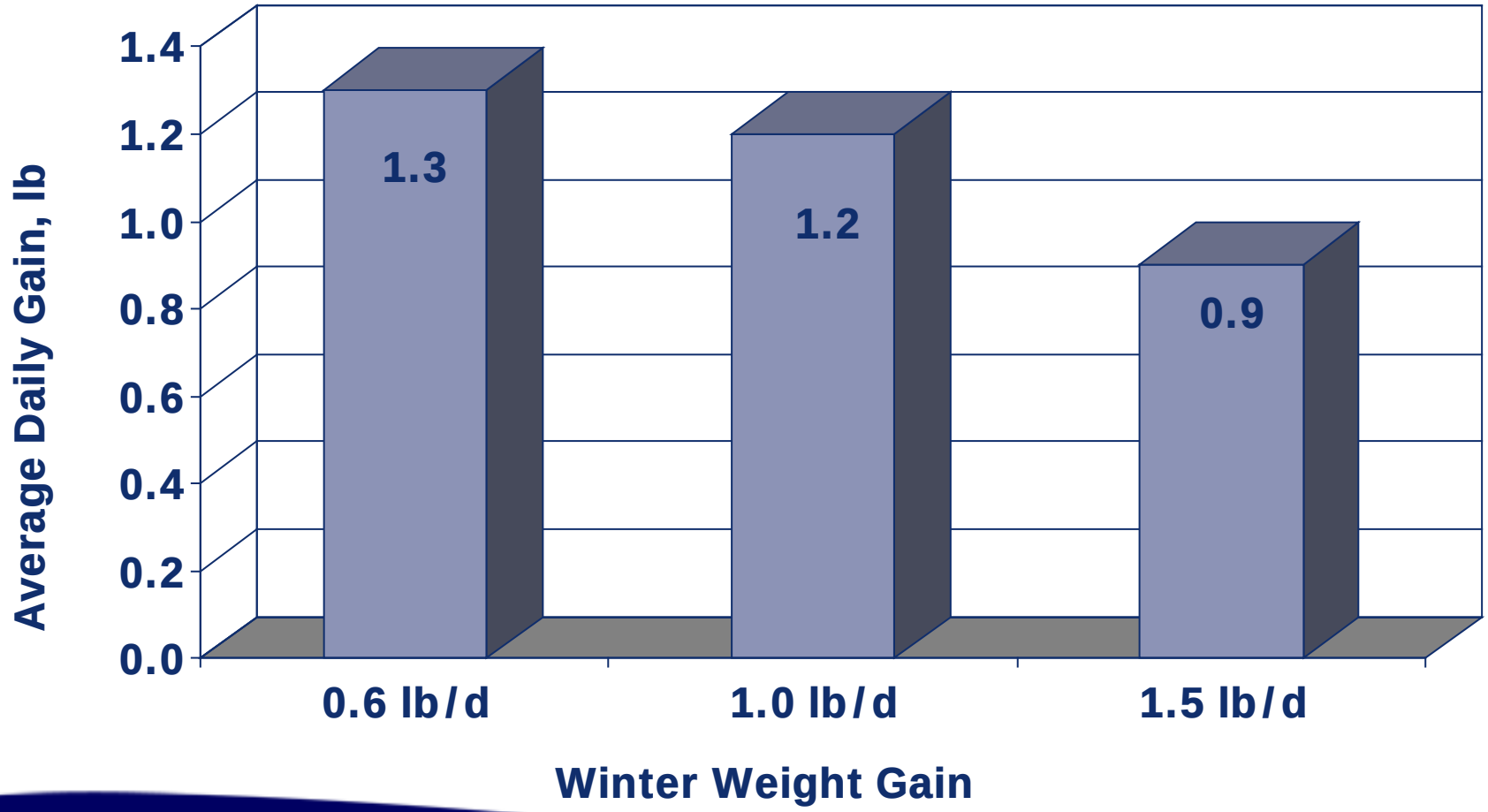
Short and Bellows, 1971

Winter Weight Gain and Pregnancy Rates



Short and Bellows, 1971

Summer Weight Gain of Three Winter Weight Gain Groups

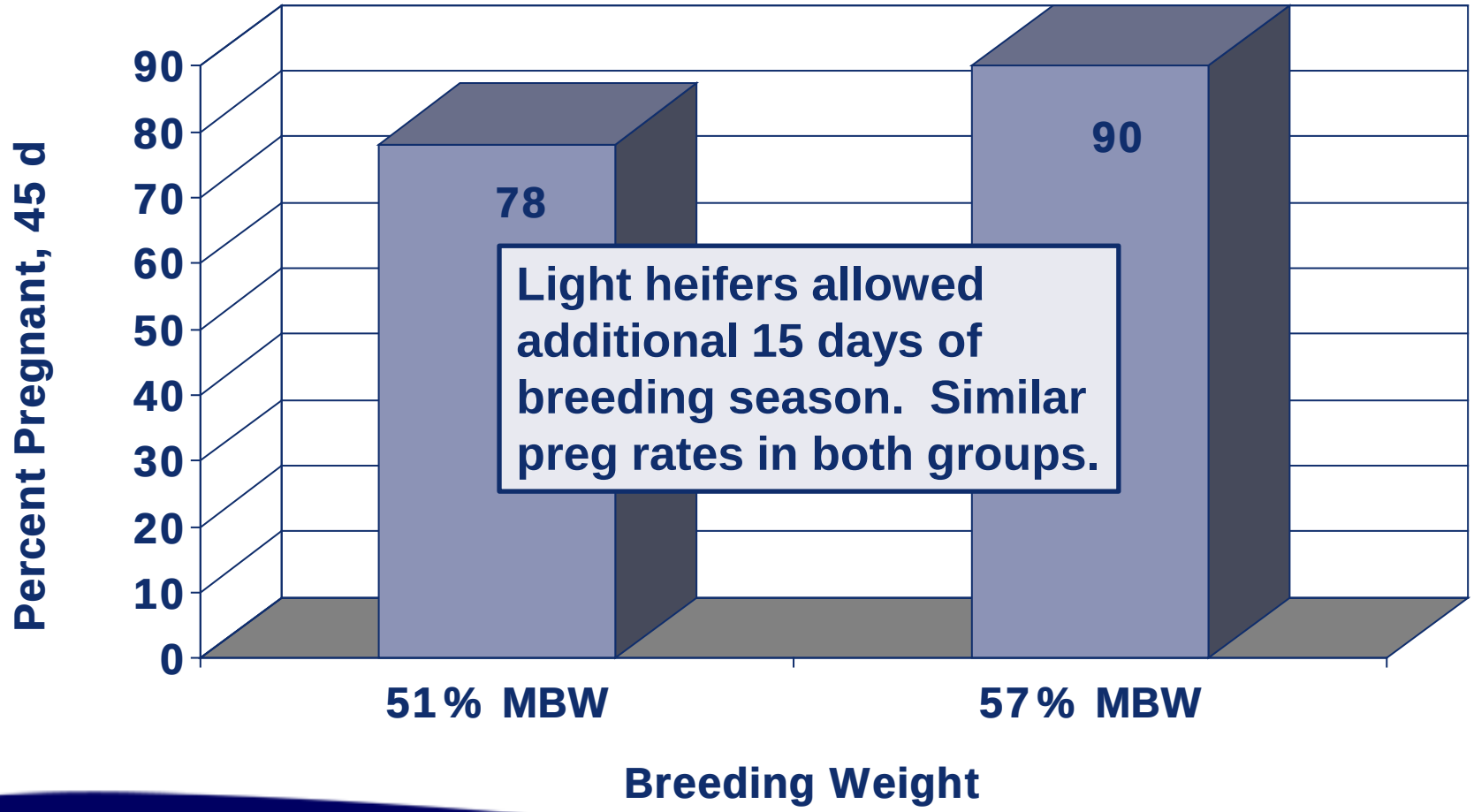


Short and Bellows, 1971

Overfeeding Not a Good Strategy

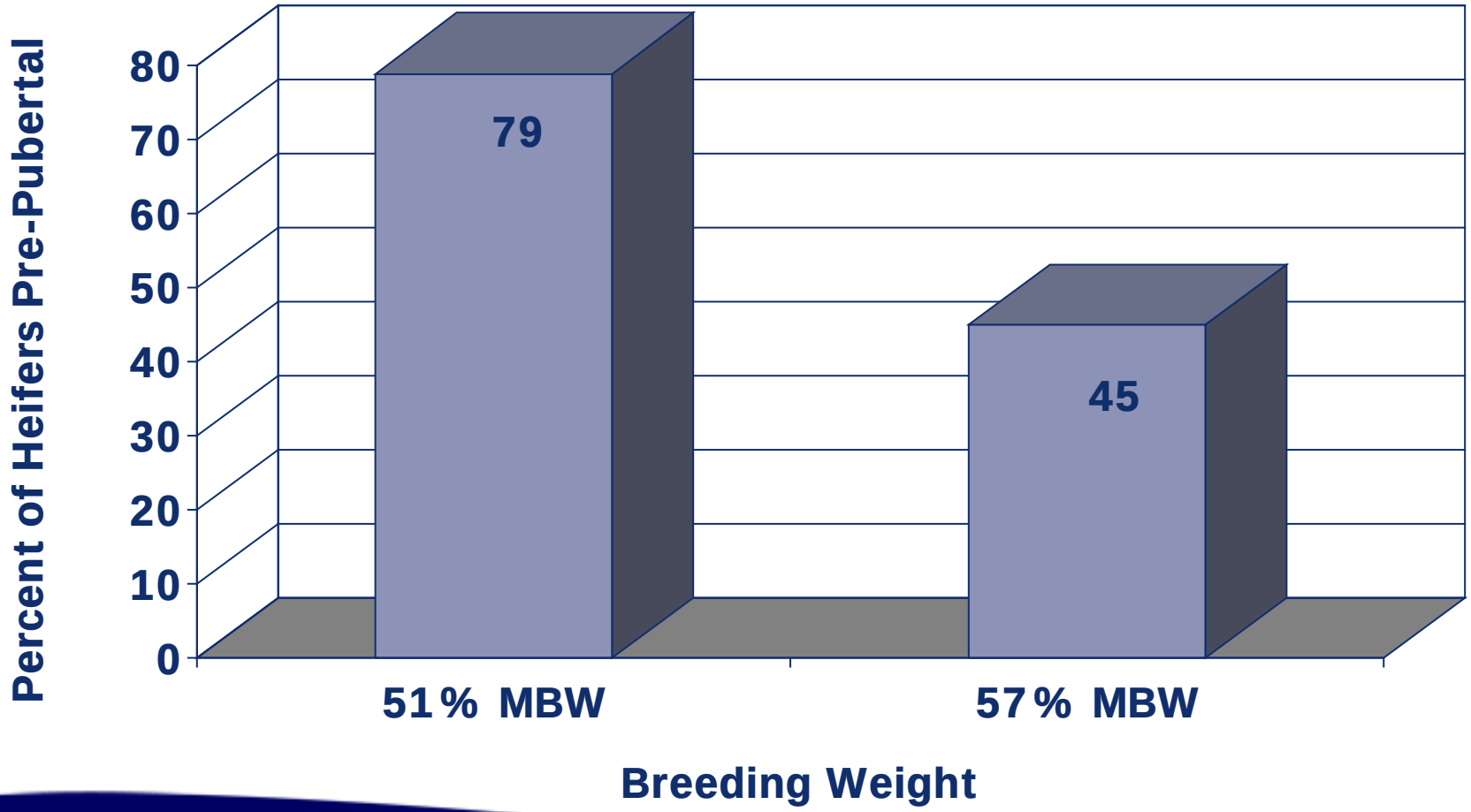
- Costly
- Weak estrous symptoms
- Reduced conception rate
- High embryonic mortality
- Decreased mammary development

Do “Modern-Day” Heifers Need to Grow to 60-65% of Mature Body Weight?



Martin et al., 2007

Some Non-Pregnant Heifers Didn't Reach Puberty Before Breeding

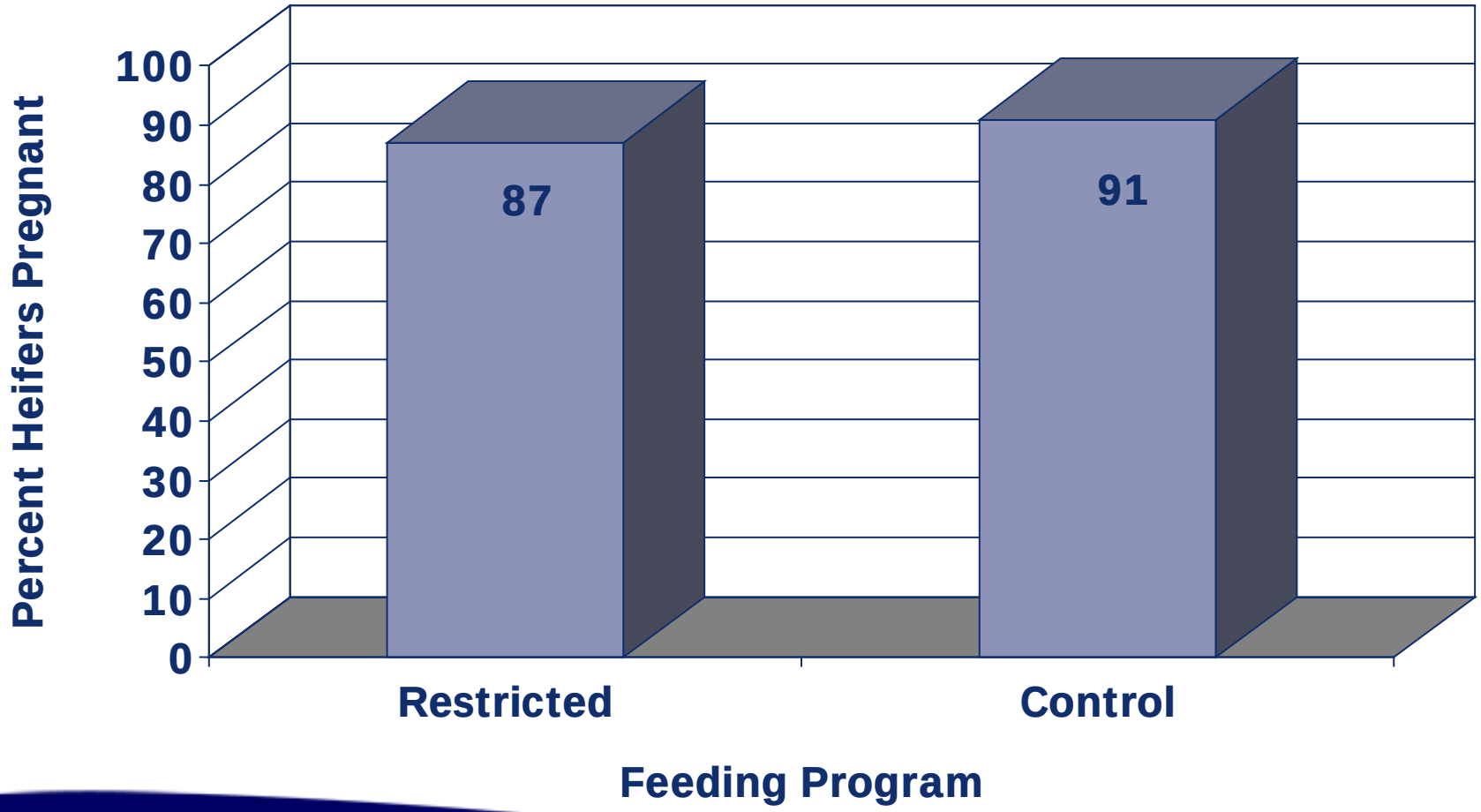


Martin et al., 2007

More on the Nebraska Data…

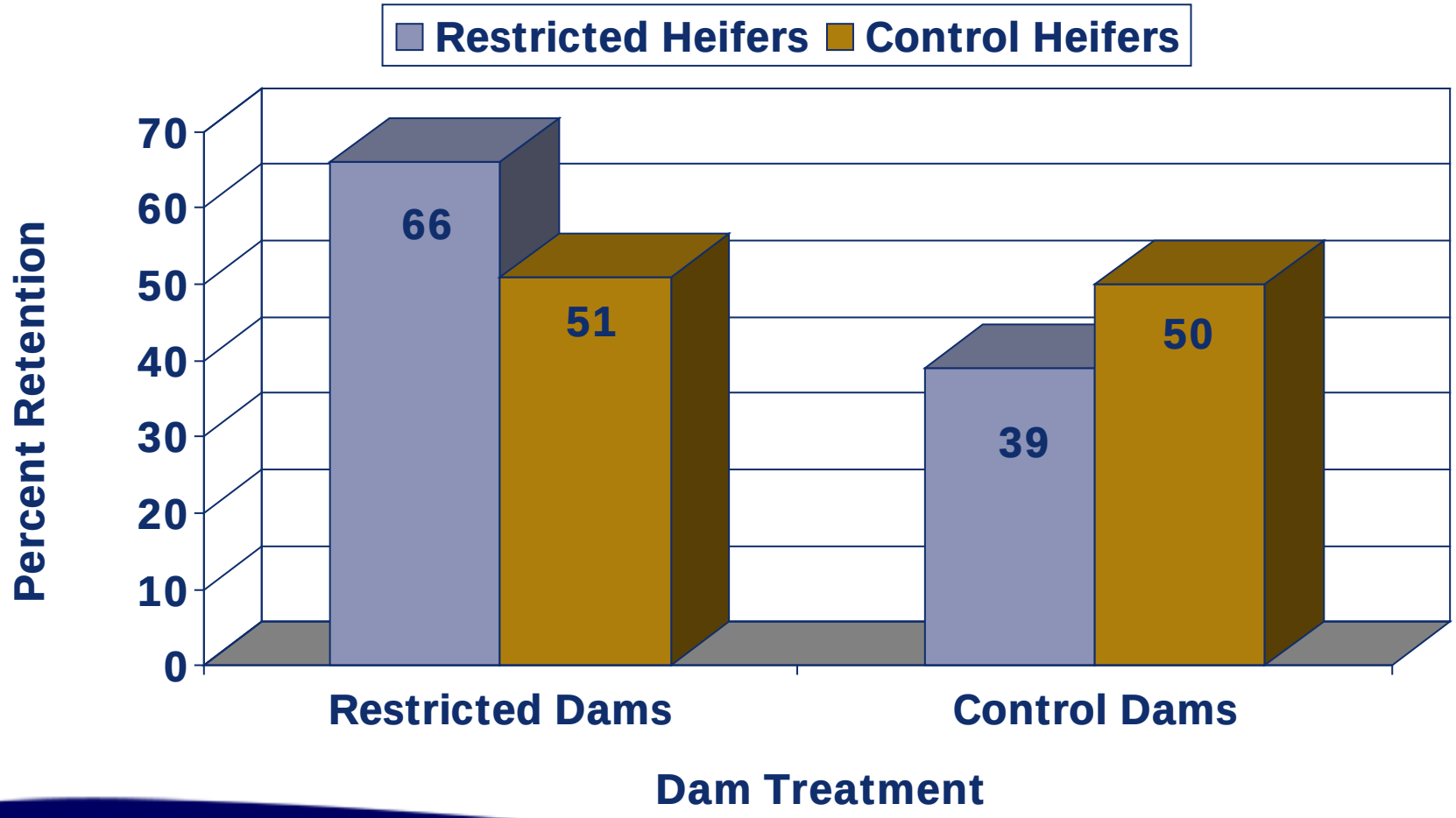
- Used lower quality diet to develop lighter group
- Lighter group allowed extra 15 days of breeding – similar preg rates
- Even with longer breeding season, was still more cost effective
  - Around $24/pregnant heifer

Fort Keogh Heifer Development Study Shows Similar Results to Nebraska



Roberts et al., 2009

Fort Keogh: Retention to 5th Breeding Season



Roberts et al., 2009

More on the Fort Keogh Data...

- Used lower quantity of same feed to develop lighter group
- Decreased harvested feed inputs 22%
- Increased efficiency of gain
- Restricted group more cost effective
  - $22 per pregnant heifer

Similarities Between Nebraska and Fort Keogh Data

- Composite cattle used – heterosis a factor?
  - Half Red Angus, half Continental breeds
- 10% decrease in pubertal heifers at breeding time in lighter groups
- Increased cost effectiveness for lighter groups
  - $22-$24 per pregnant heifer

Extensively-Developed Heifers Exhibit Compensatory Summer Gain

	Development Method	
Study	**Drylot**	**Extensive**
Olson, et al. 1992		
Year 1	0.56[a]	0.66[b]
Year 2	0.37[a]	0.80[b]
Funston & Larson, 2011	0.47[a]	0.67[b]
Mulliniks et al., 2012	0.61[a]	0.83[b]

[a,b] $P < 0.10$

What Happens if Nutrition Following Start of Breeding is Inadequate?

- Acute nutrient restriction (40% of maintenance) prevented ovulation in 70% of heifers with no change in condition
  - White et al., 2001
- Decreased pregnancy success for heifers moved from feedlot to grass post-AI
  - Perry et al., 2009

Nutrition Through Subsequent Calvings

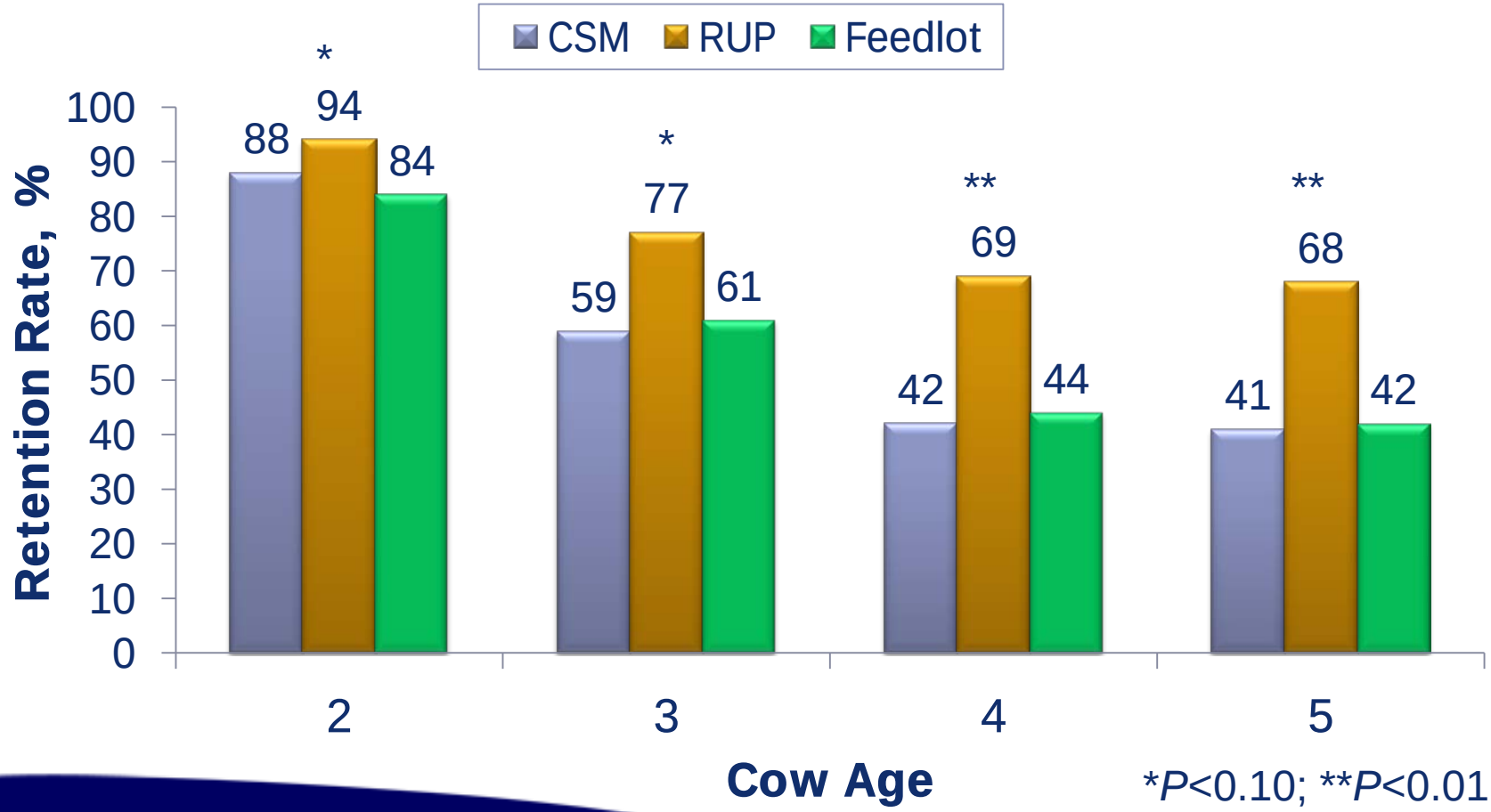
- Nebraska and New Mexico data – all treatment groups treated fairly similarly after heifer development
- Montana data – Ad libitum and restricted animals continue on their treatments for any supplemental feed throughout lifetime

Pregnancy Rates Through 4th Calf for Low vs High Gain Heifer Development

	Development Method	
Pregnant with	**Low Gain**	**High Gain**
1st calf	92%	88%
2nd calf	91%	91%
3rd calf	94%	92%
4th calf	96%	96%

Funston and Deutscher, 2004

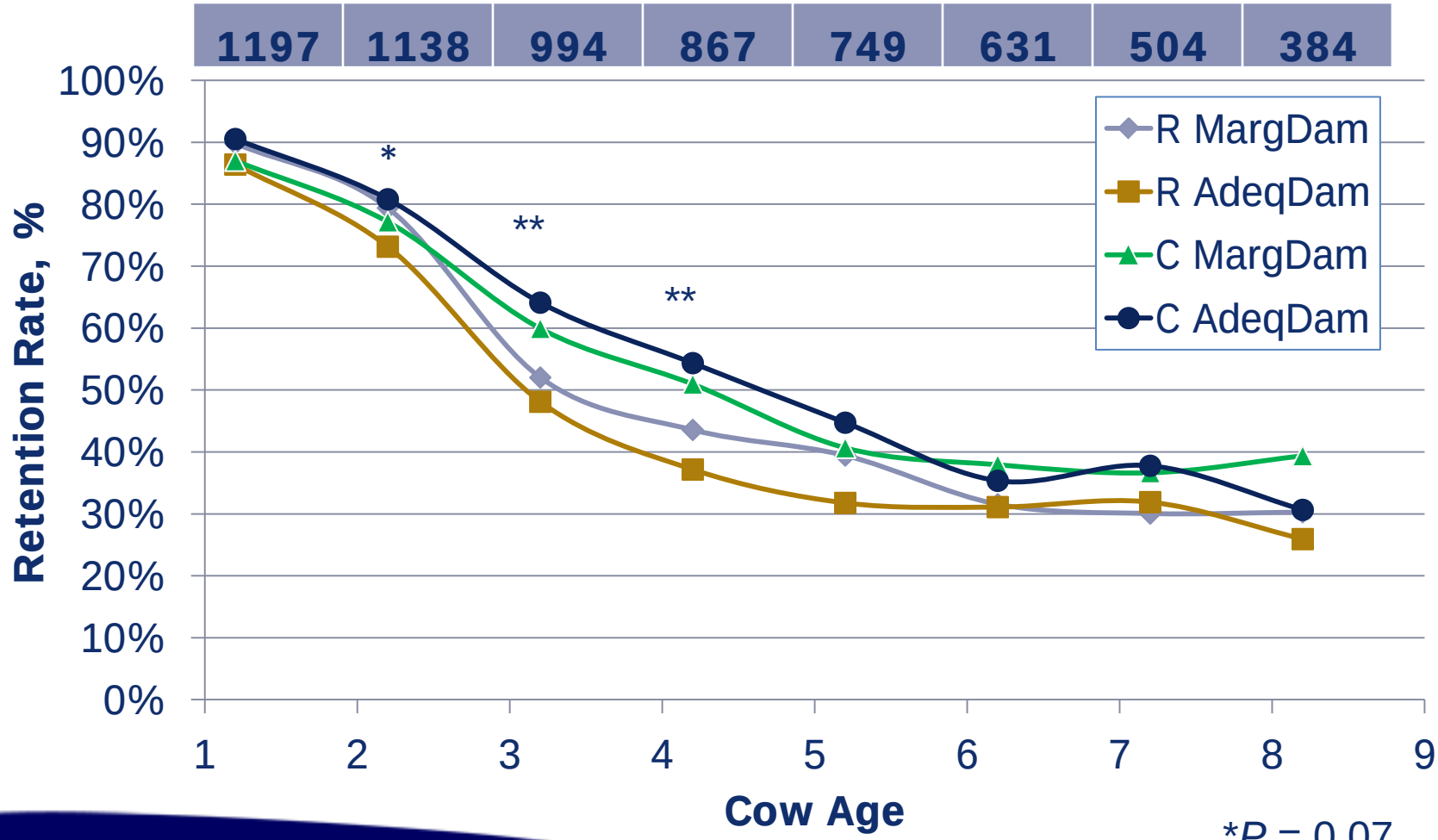
New Mexico: Increased Retention Rate in RUP-Supplemented Range Heifers



*P<0.10; **P<0.01

Mulliniks, et al., 2012

Fort Keogh CGC Retention Rate



*P = 0.07
**$P \leq 0.02$

What About Calving Difficulty?

- Adequate growth and development to ensure little calving difficulty important to longevity

Similar Calving Difficulty Between Development Methods

Study	Development Method	
Funston & Deutscher, 2004	Low Gain	High Gain
1st calf	1.25	1.22
2nd calf	1.07*	1.17*
3rd calf	1.07	1.04
Funston & Larson, 2011	Cornstalks/Range	Drylot
	1.3	1.4
Larson et al., 2011	Range	Cornstalks
Exp. 1	1.2	1.4
Exp. 2	1.4	1.7

*$P < 0.05$

Summary: Heifer Development

- There is no “one size fits all” answer
- Each operation is different
- Choose development program that fits your resources, environment, and goals

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Monitoring Nutrient Status

- Body weight and body condition score
  - At weaning
  - Start of third trimester
  - At calving

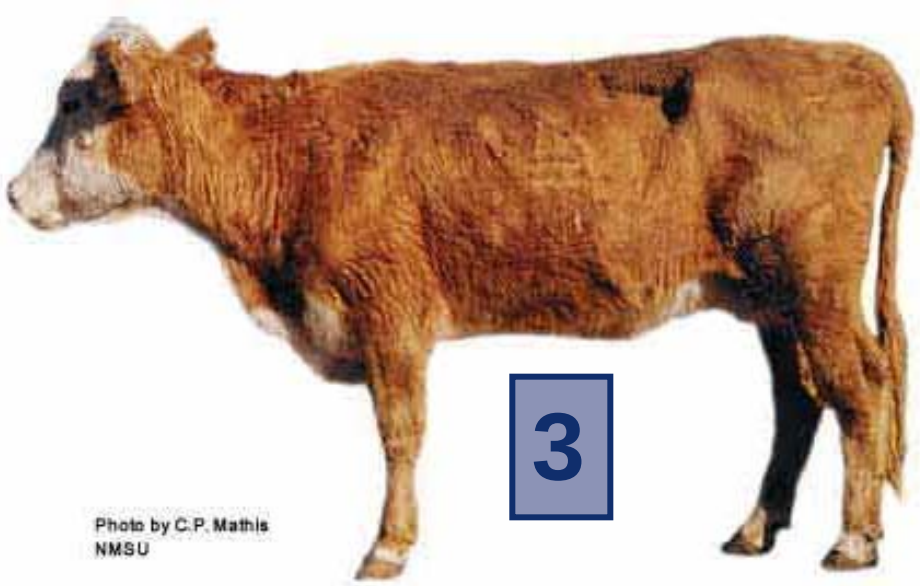
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Photo by C.P. Mathis
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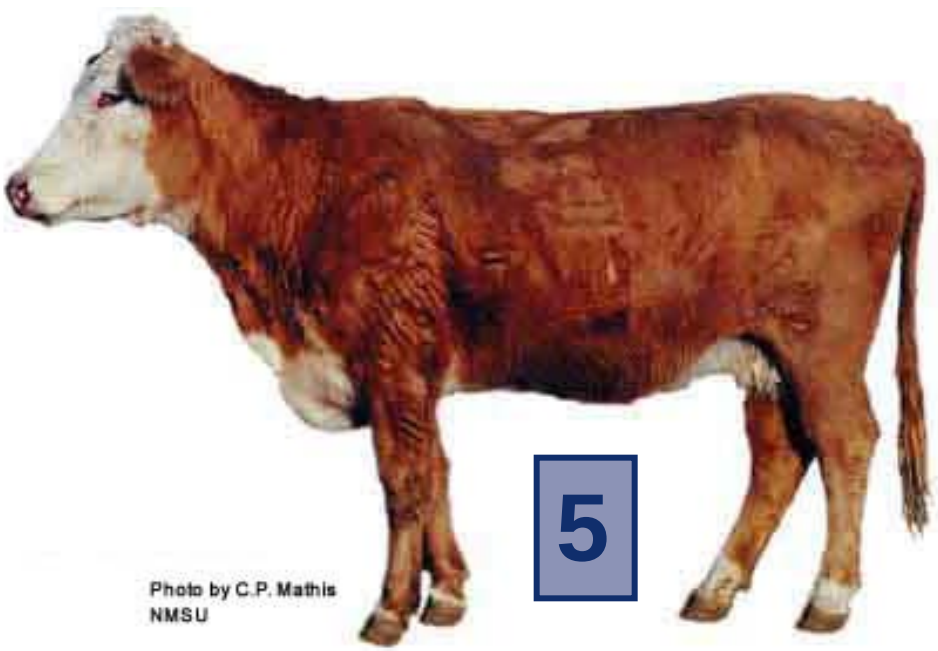
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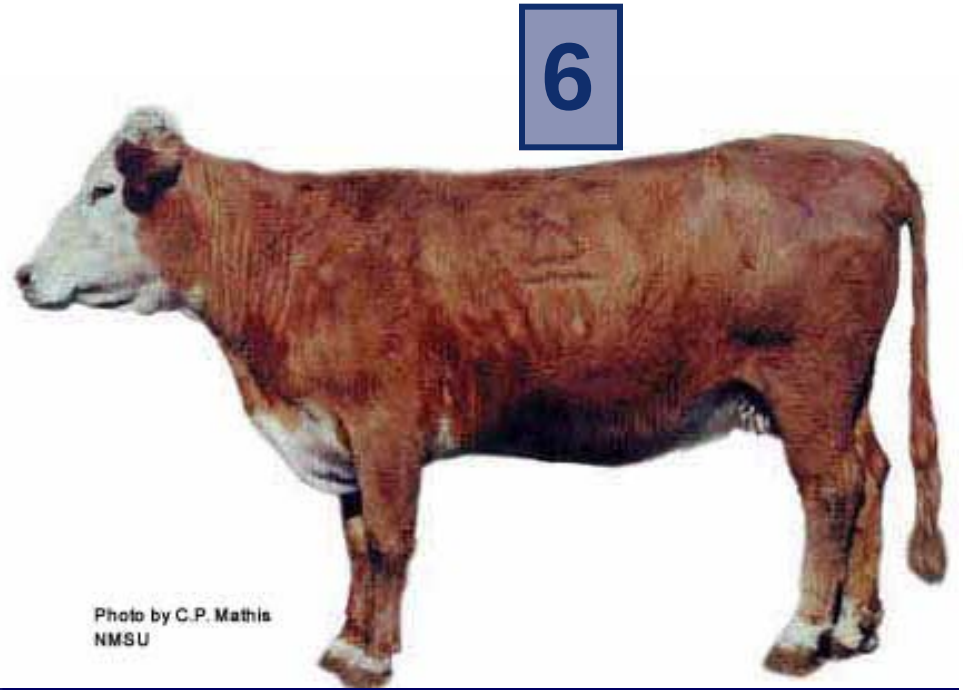
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Photo by C.P. Mathis
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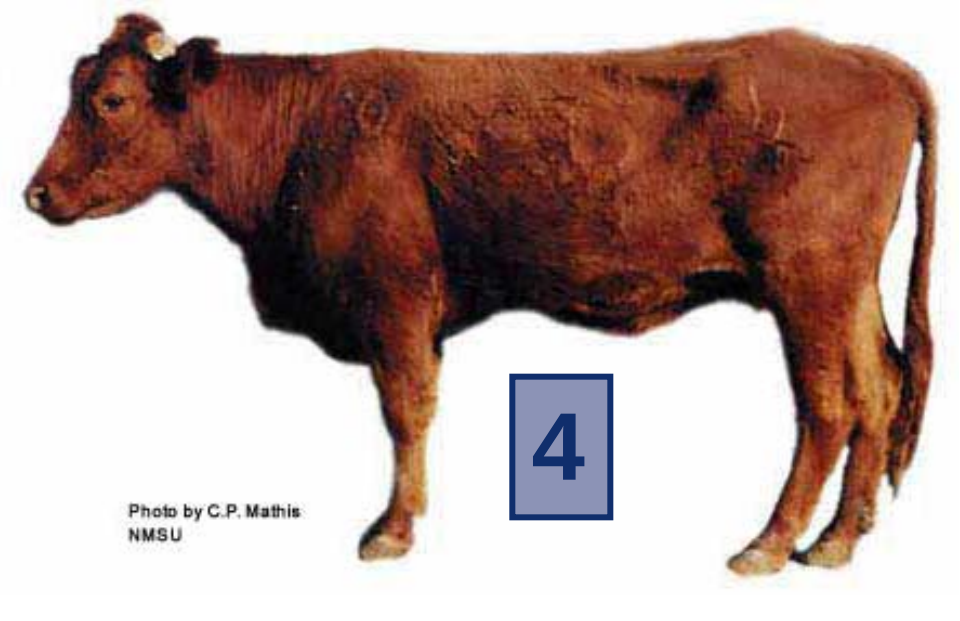
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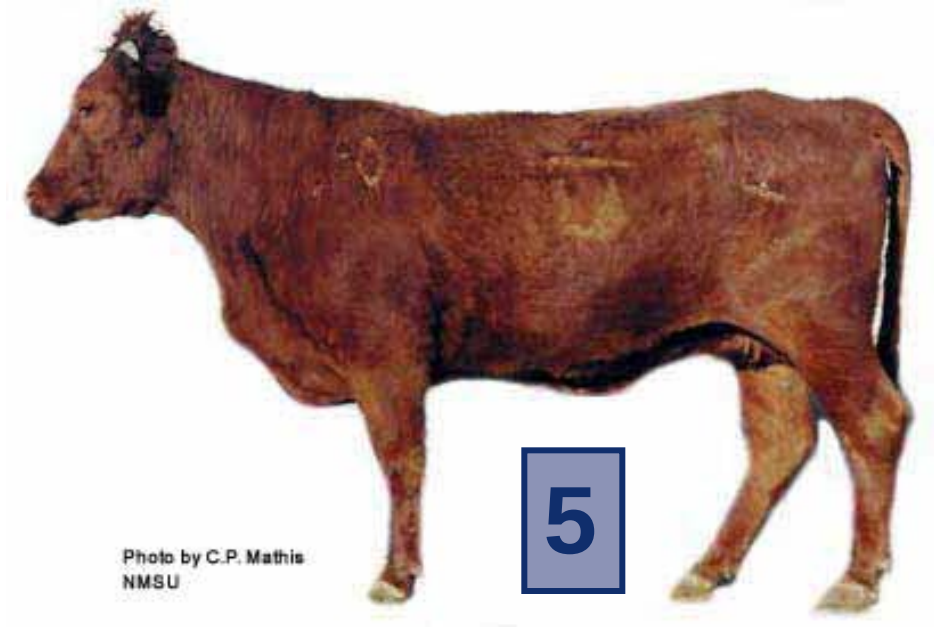
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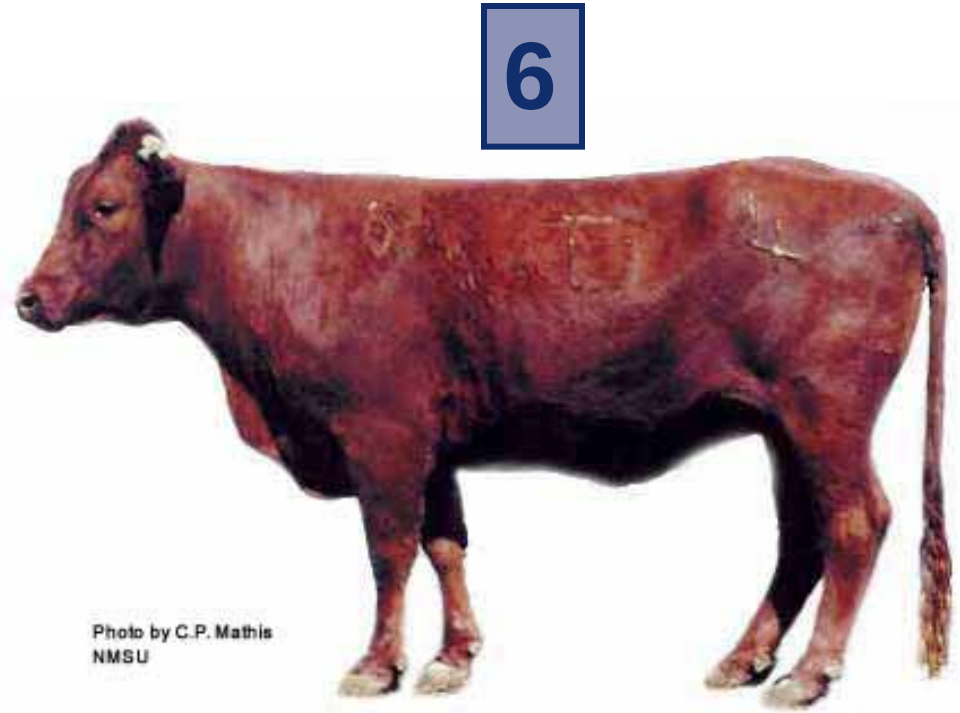
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Was Goldilocks Right About “Just Right”?

Nutrient Consumption	Reproductive Consequence
Excessive energy intake	Low conception, abortion, dystocia, retained placenta, reduced libido
Inadequate energy intake	Delayed puberty, suppressed estrus and ovulation, suppressed libido and spermatozoa production
Excessive protein intake	Low conception rate
Inadequate protein intake	Suppressed estrus, low conception, fetal reabsorption, premature parturition, weak offspring

More Goldilocks Theory…

Nutrient Consumption	Reproductive Consequence
Vitamin A deficiency	Impaired spermatogenesis, anestrus, low conception, abortion, weak offspring, retained placenta
Phosphorus deficiency	Anestrus, irregular estrus
Selenium deficiency	Retained placenta
Copper deficiency	Depressed reproduction, impaired immune system, impaired ovarian function
Zinc deficiency	Reduced spermatogenesis

Topics for Today

- Factors affecting nutrition and reproduction throughout production cycle
  - Late gestation
  - Calving season
  - Breeding season
  - Heifer development

The End

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