NUTRITIONAL INFLUENCES ON REPRODUCTION:
ENERGY AND PROTEIN

Applied Reproductive Strategies in Beef Cattle
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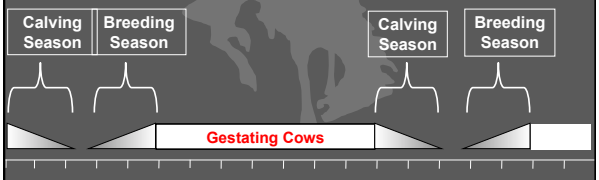
Reproduction is the single most important factor associated with the economic success of the cow/calf producer

Management cycle of a beef cow

- To have 1 calve every 365 days, a cow has ~83 days from calving to conceive.
- The interval of postpartum anestrus will dictate if she can accomplish this

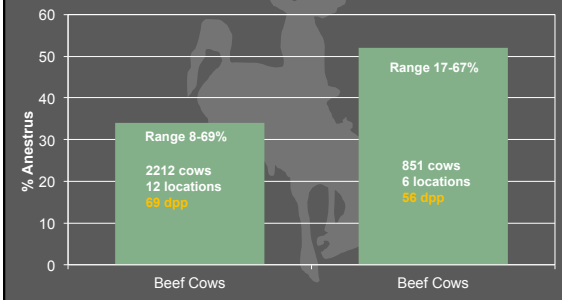


Factors that affect the postpartum interval

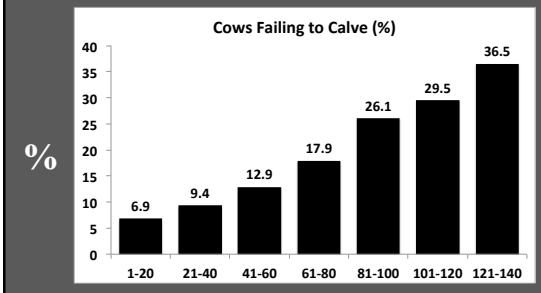
- The postpartum interval is dependent upon many factors and is very difficult to predict.

-Nutrition
-Calving season
-Body Condition (fatness)
-Age
-Genetics
-Calving difficulty
-Suckling of calf

Anestrus in US beef cattle at start of synchronization



Lucy et al., 2001; Larson et al., 2006



Effect of calving date on the number of cows calving the following year (adapted from Burris and Priode, 1958)

Factors effecting reproduction in beef cows

- #1 is Nutrition
  - Fat reserves (BCS) at calving and start of the breeding season
  - Weight loss between calving and breeding = long PPI
- Recommendations:
  - **Mature cows:** BCS 5 - 5.5 at calving and maintaining this BCS during the breeding season
  - **2 year-old cows:** BCS 5.5 - 6 at calving and maintaining this BCS during the breeding season

BCS is a practical indicator of nutritional status and its effect on reproduction in the postpartum cow

Short et al., 1990; Williams, 1990; Wagner et al., 1988; Randel, 1990

Body Condition Scores

- 1 - Emaciated
- 2 - Very thin
- 3 - Thin
- 4 - Moderately thin
- 5 - Moderate (ideal)
- 6 - Moderately fleshy
- 7 - Fleshy
- 8 - Very fleshy
- 9 - Obese

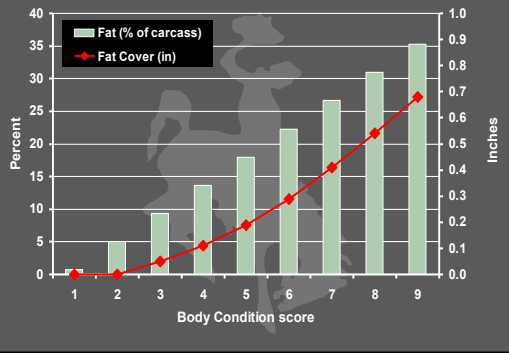
BCS Examples

BCS 3: To Thin

BCS 5: Ideal

BCS 8: To Fat

Estimates of body fat in beef cows relative to body condition score



Energy Reserves and Reproduction

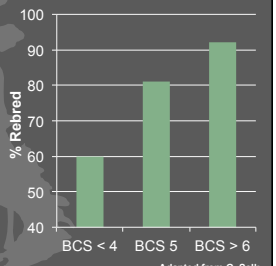
- Rapid weight gain is difficult after calving
  - especially late calving cows
  - need to reach target by calving
- Cows in good to moderate BCS
  - can lose some weight (BCS) after calving
- Thin cows at calving
  - must have ↑ postpartum E
  - Economics (sell or feed?)

BCS and the postpartum interval

Effect of body condition score (BCS) at calving on postpartum interval .

BCS	Postpartum Interval
3	88.5
4	69.7
5	59.4
6	51.7
7	30.6

Adapted from Houghton et al., 1990



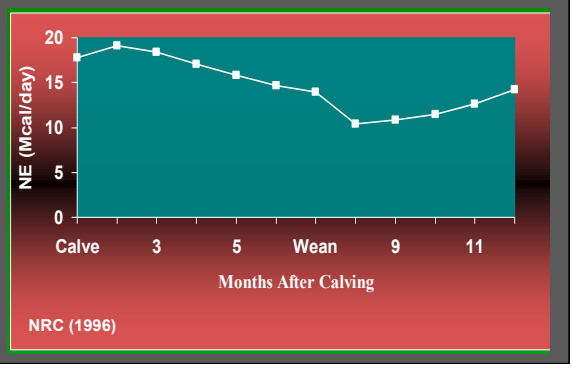
Adapted from G. Selk, Oklahoma State Univ.

Relationship of BCS with Cow/Calf Performance in Beef Cows

BCS	Preg %	Calving Interval, d	Calf ADG, lbs	Calf WW, lbs
3	43	414	1.6	374
4	61	381	1.75	460
5	86	364	1.85	514
6	93	364	1.85	514

Kunkle, 1994

Net Energy (NE) Requirements for a 1200 lb March Calving Cow with 23 lbs/day Peak Milk Production



NRC (1996)

NEEDED WEIGHT GAINS IN MATURE PREGNANT COWS IN DIFFERENT BODY CONDITIONS

Body Condition		Wt. Gain Needed to Calving, lbs				
At Weaning	Needed at Calving	Calf Fluids And Membrane	Body Weight	Total	Days to Calving	ADG
5 →	5	100	0	100	120	.8
4 →	5	100	80	180	120	1.5
3 →	5	100	160	260	180	.9
3 →	5	100	160	260	150	1.7
3 →	5	100	160	260	120	2.2
3 →	5	100	160	260	90	2.9

Wiltbank, 1982.

NEEDED WEIGHT GAIN IN MATURE, LACTATING COWS IN DIFFERENT BODY CONDITIONS

Body Condition		Wt. Gain Needed to Breeding, lbs.		
At Calving	Needed at Breeding	Body Weight	Days to Breeding	ADG
5 →	5	0	60	0.0
4 →	5	80	60	1.3
3 →	5	160	80	2.0
3 →	5	160	60	2.7
3 →	5	160	40	4.0

Wiltbank, 1982.

Adjusting Energy and Protein

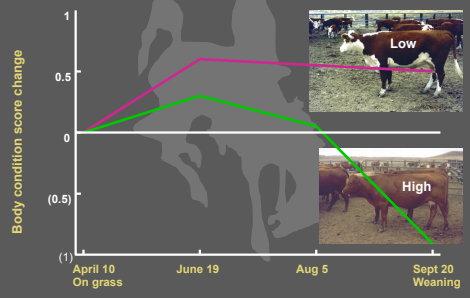
- NE_m Requirements, Mcal/d (1200 lb cow)
  - Mid-gestation 8.68
  - Late- gestation 10.83 **(25% increase)**
  - Early Lactation (10 lb milk) 12.09
  - Early Lactation (20 lb milk) 15.48 **(80% increase)**
- CP Requirements, lb/d (1200 lb cow)
  - Mid-gestation 1.4
  - Late- gestation 1.7 **(25% increase)**
  - Early Lactation (10 lb milk) 2.1
  - Early Lactation (20 lb milk) 2.7 **(95% increase)**

Use Body Condition as a Wake-up Call

Breed, Cow Type and Maintenance

- ↑ Milk production potential, ↑ NE_m (Mcal / $W^{.75}$) requirements
  - Ferrell and Jenkins (1984)
  - Ferrell and Jenkins (1985)
  - Anderson (1980)
  - Lemenager et al. (1980)
  - Byers (1982)
  - NRC (1996)

BCS Change for Cows With High or Low Milk Production During Summer Grazing



Adams et al. 1993

Effect of Nutrition on Reproduction

- Most cases of protein, mineral, and vitamin deficiencies are confounded with ENERGY

Lemenager et al., 1991

Sub-Maintenance ENERGY

- Delayed onset of puberty
- ↑ PPI
- ↑ effects of suckling on anestrus
- ↑ onset/duration of seasonal anestrus

Lemenager et al., 1991; Dunn and Moss, 1992

Source of Energy

- Several studies have examined source of energy on reproduction.
- As long as CP & TDN req. are met…….
  Forage/silage=CGF=SH=WM=CS

  Fat ≥ Carbohydrates

Importance of Fats

- Needed by all animals
  - Cell walls
  - Hormones
  - Nerves
- Most fatty acids are synthesized, but a few are essential
- Linoleic acid most important

Fats in Beef Cow Diets

- Fat is generally only 2 % of diet
- Limited to 5 to 8 % of diet
- Increasing fat in diet of cycling heifers and postpartum cows resulted in:
  - Increased progesterone
  - longer CL lifespan
  - Increased number of follicles

Heifers

- High fat diet tended to increase the number of heifers pregnant to AI.
- Effect appears to be dependent on length of exposure.
- High fat increased percentage of thin 1st calf heifers cycling at the start of the breeding season.

Inadequate protein intake can result in reduced pregnancy rates in cows receiving diets containing equal energy.

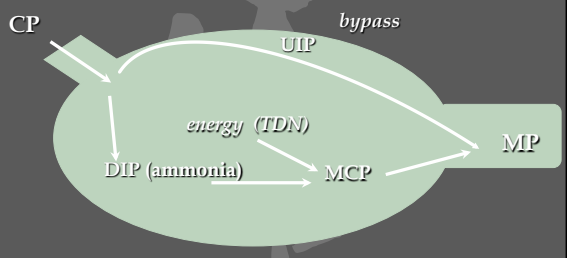
Sasser et al., 1989

Protein and Reproduction

- Equal energy, CP deficiency
  - ↔ calving difficulty
  - ↔ uterus involution
  - ↔ presence of first ovarian follicle
  - ↑ PPI
  - ↓ no. of females showing estrus
  - ↓ 1st service and overall pregnancy rate

Sasser et al. 1988

Metabolizable Protein



Protein Supplementation

- ↑ forage intake and digestibility
- ↑ reproduction
  (Caton et al., 1988; Short et al., 1990; Wheeler et al., 2002)
- After meeting DIP requirement, added UIP
  - May ↓ PPI and weight loss
    (Wiley et al., 1991; Appeddu et al., 1996; Anderson et al., 1996)
  - May ↑ conception rate
    (Triplett et al., 1995; McCormick et al., 1999)

Protein

- Balancing for MP vs. CP pre-calving
  - ↑ pregnancy rate in 1st calf heifers
    - No effect on BW or BCS
  - More effective in thinner heifers

Patterson et al., 2003

Deficiencies

- Energy deficiency (65%): young females
  - ↓ calf birth weights (Corah et al., 1975)
  - ↓ weaning wt. (Corah et al., 1975)
- Protein deficiency: cows
  - ↓ Birth weight (Carsten et al., 1987)
  - ↔ Birth weight (Martin et al., 2007)
  - ↓ Weaning wt. (Beaty et al., 1994, Martin et al., 2007)
  - ↓ pregnancy rate, later calving (Martin et al., 2007)

"Under practical management conditions, much of the variation in reproductive performance of beef cows may be accounted for by differences in total energy intake and body condition."

Lemenager et al., 1991

Slow down……..

Thank you

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Supplemental Protein

- Needed when CP intake is below requirements
  - 7 to 10 %
- Improves forage digestibility
  - Enhances energy intake
- Beneficial effects on:
  - Cow weight & BCS
  - Cow reproduction
  - Calf health

Effect of prepartum supplementation to meet metabolizable protein (MP) or crude protein (CP) requirements on pregnancy rates in two-year-old cows

	Location A		*Location B*	
Year	MP req.	CP req.	MP req.	CP req.
1997-98[c]	95	95	84	75
1998-99[d]	95	88	89	85

aPatterson et al., 2003. bTreatment × Year × Location interaction (P = .07).
cTreatments differ at Location B (P = .01).
dTreatments differ at Location A (P = .01) and Location B (P = . 15)

What about RDP?

- High level of RDP are associated with high NH_3
- Inconsistent effects on reproduction
  - decreased pregnancy rates
  - abnormal follicular development
  - poor oocyte quality
  - uterine effects?
- Interaction with energy intake

RUP Could it Help?

- Protein supplementation is a major concern in some areas of the Southeast and South Central states.
- RUP increases performance in steers and dairy cows
- Could it be of benefit in reproductively active beef females?

Adding RUP to Cow and Heifer Diets

- 30% of protein as RUP decreased PP interval and increased number of first calf heifers bred in 1st 21 d of breeding season.
- 25% but not 50% RUP decreased PP interval in mature cows
- 250 g per head per day of RUP had no effect on replacement heifers

Effect of RUP on Developing Replacement Heifers

	RUP (Grams per day)	
	0	100
ADG, lb.	1.86	2.1
Pelvic Area	150.6	162.8
% Cycling	54.0	77.0

Graham, 1998

Nutritional Management for Proper Reproduction

- Use Target Weight for replacements
- Cows need to calve in BCS 5 or 6
- Heifers should calve in BCS 6 or 7
- Cows need to maintain wt. after calving
- Thin cows that gain weight after calving have improved conception rate

Weight-Cycling During the Year

- Normal fluctuation
  - Excess nutrients = weight and BCS gain
  - Limited nutrients = weight and BCS loss
- Timing of fluctuation is critical
- Economical recovery is critical
  - Moderate BCS at calving / breeding

Nutrients Required for Pregnancy

- Last trimester
  - Concept of energy balance vs. BCS per se (Houghton et al., 1990; Lake et al., 2005)
  - ↑E retention and uptake by the uterus (Ferrell et al., 1976; Reynolds et al., 1986)
  - Suggests this is a critical time for nutrients
  - Thin cows gaining weight in last trimester
    - No change in birth weight (Corah et al., 1975; DeRouen et al., 1994; Morrison et al., 1999; Freetley et al., 2000)

Managing Energy Reserves

- Maintenance energy requirements
  - 77 kcal/$W^{.75}$
    - Confirmed for mature cows (Buskirk et al., 1992)
    - Confirmed for gestating 1st calf heifers (Graffam, 1992)
  - Lactating 1st calf heifers (Ripberger, 1997)
    - 97.2 kcal/$W^{.75}$ (23%↑) for Angus
    - 106.9 kcal/$W^{.75}$ (38.8%↑) for Simmental