Reproduction is the single most important factor for profitable beef production.
Improving Efficiency

- [Dam Weight * Lean Value of Dam + No. Progeny * Progeny Weight * Lean Value of Progeny] - [Dam Feed * Value of Feed for Dam + No. Progeny * Progeny Feed * Value of Feed for Progeny].

- By simply increasing number of progeny per dam through either selection, heterosis from crossing, or better management, we will increase efficiency of production.

Time of Calving Affects Feedlot Performance

<table>
<thead>
<tr>
<th>Period of Calving, 21 day periods</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steer calves (n = 661)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weaning weight, lb</td>
<td>515</td>
<td>483</td>
<td>435</td>
</tr>
<tr>
<td>Feedlot ADG, lb/day</td>
<td>3.61</td>
<td>3.62</td>
<td>3.63</td>
</tr>
<tr>
<td>Carcass weight, lb</td>
<td>816</td>
<td>800</td>
<td>771</td>
</tr>
<tr>
<td>Marbling score</td>
<td>574</td>
<td>554</td>
<td>527</td>
</tr>
<tr>
<td>Yield grade</td>
<td>3.0</td>
<td>2.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Choice, %</td>
<td>84</td>
<td>83</td>
<td>73</td>
</tr>
<tr>
<td>≥ Average choice, %</td>
<td>30</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>Carcass value</td>
<td>$1632</td>
<td>$1600</td>
<td>$1512</td>
</tr>
</tbody>
</table>

Time of Calving Affects Heifer Progeny

<table>
<thead>
<tr>
<th>Period of calving, 21 day periods</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preweaning ADG, lb</td>
<td>1.83</td>
<td>1.83</td>
<td>1.90</td>
</tr>
<tr>
<td>Weaning weight, lb</td>
<td>483</td>
<td>470</td>
<td>434</td>
</tr>
<tr>
<td>Prebreeding ADG, lb</td>
<td>.86</td>
<td>.90</td>
<td>.90</td>
</tr>
<tr>
<td>Prebreeding weight, lb</td>
<td>653</td>
<td>644</td>
<td>609</td>
</tr>
<tr>
<td>Cycling, %</td>
<td>70</td>
<td>58</td>
<td>39</td>
</tr>
<tr>
<td>Breeding ADG, lb</td>
<td>1.59</td>
<td>1.63</td>
<td>1.70</td>
</tr>
<tr>
<td>Pregnancy rate, %</td>
<td>90</td>
<td>86</td>
<td>78</td>
</tr>
<tr>
<td>Calved in 1st 21 d</td>
<td>81</td>
<td>69</td>
<td>65</td>
</tr>
</tbody>
</table>

Summary of AI and final pregnancy rates of varying bull to female ratios obtained in cited studies.

- Normal bull to Female ratio was 1:20 to 30 in natural service setting
- Various synchronization methods
  - Both TAI & HD
    - Both heifers & cows
    - 2,800
    - Range from 64-120
    - 56.1% Ave
  - Half bull to cow ratio 1:50 to 60 bull to female ratio following estrus synchronization and AI
    - Both TAI & HD
      - Both heifers & cows
      - 5,057
      - 29 to 85 days
      - 55.6% Ave

Calving Distribution of Beef Cows that Conceived on a Single Day

- ~ 40% 1 week
What are the primary problems?
- Cattle are not good candidates for an estrus synch/AI program
- Protocol compliance
- Sire selection
- Semen handling
- Facilities
- Shipping (truck) stress
- Cattle lose weight during the breeding season
- Unlikely that the biological activity of the ES products is compromised

Stress and AI?
- Bucket Load of Estrogen
- Off Feed 24 Hours
- Pushed Around by Friends for 12 Hours
- Pack Her Own Weight 30 Times in 12 Hours
- Cowboy’s Arm in Rectum + .5 cm Rod in Vagina/Cervix = Stress is Maximized

Handling Cattle after AI

<table>
<thead>
<tr>
<th>Day Transported after AI</th>
<th>1 - 4</th>
<th>6 - 12</th>
<th>29 - 33</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronized Pregnancy Rate</td>
<td>74%</td>
<td>62%</td>
<td>55%</td>
</tr>
<tr>
<td>Breeding Season Pregnancy Rate</td>
<td>95%</td>
<td>94%</td>
<td>94%</td>
</tr>
<tr>
<td>Mean Day of Conception</td>
<td>9.6</td>
<td>13.4</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Effect of Calving Date on the Number of Cows Calving the Following Year

- It takes the profit from two early-calving cows to cover the loss from one late-calver.
- A cow that calves in the first 21-day calving interval her entire 8 or 9-year life, will produce the weaning weight equivalent of 1 ½ to 2 ADDITIONAL calves in her lifetime compared to one that starts late and stays late.

Actual Profit Differences are Large

Length of Breeding Season and Pregnancy Rate
Extensive heifer development systems

- Lower Development Costs $100+
- Selling open heifers was profitable
- Determine adaptability early?
  - Short breeding season
  - Lighter breeding weights
  - Lighter mature weights?
- Must continue to grow through calving

Target Weight Method

<table>
<thead>
<tr>
<th>Heifer WW</th>
<th>Days/wt gain</th>
<th>Target BW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov. 1</td>
<td>180 d</td>
<td>May 1</td>
</tr>
<tr>
<td>500 lb</td>
<td>250 lb</td>
<td>750 lb</td>
</tr>
<tr>
<td>Gain needed</td>
<td>1.40 lb</td>
<td></td>
</tr>
</tbody>
</table>

Effect of Time of Gain From Weaning to Breeding on Heifer Performance

No difference in age at puberty, conception rate, or calf performance the next year. Clanton et al., 1983

Timing of Gain and Reproductive Performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Even Gain</th>
<th>Late Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSCR</td>
<td>56.4</td>
<td>71.1</td>
</tr>
<tr>
<td>Overall</td>
<td>87.5</td>
<td>87.5</td>
</tr>
</tbody>
</table>

Longevity and Heifer Development System

Advantages of calving early as a heifer
Advantages of calving early as a heifer

Heifer Development
- Weight, lb: 665, 727
- ADG Wean -> Pre: 0.84, 1.23
- AI Pregnancy rate, %: 86, 58
- WHY?
  - ADG Pre: 1.4, 2.14
  - ADG Post: 1.27, 0.81

Development Stalks vs Dry Lot

Restriction Re-feeding

Synchronization of Estrus in Cyclic Cows/heifers

Increased Calf Weaning Age and Weight with Estrous Synchronization
Hughes, 2005

- Opportunities for increasing profits lie in moving females from the later calving periods forward toward the first and second calving periods.
- High production herds see 61% of the calves born by day 21, 85% by day 42 and 94% by day 63.

FTA1 Pregnancy rate in Anestrous Cows

- 2341 Cows
  - 4 Studies
    - Bader et al., 2005
    - Schafer et al., 2007
    - Busch et al., 2008
    - Wilson et al., 2010
  - Estrous Cycling: 1329/2341 = 57%
  - Anestrus: 1012/2341 = 43%
Embryonic Mortality

- Fertilization rate in beef cattle has been estimated to be between 90-100%. (Sreenan and Diskin, 1983)
- Embryo death accounts for more than 30% of overall reproductive failure. (Diskin and Sreenan, 1980)
- Embryonic loss occurs throughout pregnancy in cattle, but mainly in the first 40 d after breeding. (Goeseels, 2000)

Can you cull a cow based on one year’s progeny carcass data when you don’t know who the sire is?

Sire Selection

- Determines more than 85% of the total improvement made in a herd

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 1 time every year.

Calving Ease

- 16% advantage in conception rate to cows not having dystocia (2000 head; Laster 1973)
- Short duration of labor; 10% more in estrus at beginning of breeding season; 14% higher fall pregnancy % (Doornbos 1984)

Calving Assistance

<table>
<thead>
<tr>
<th>Item</th>
<th>Stage II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Late</td>
</tr>
<tr>
<td>Calf Vigor</td>
<td>1.1</td>
</tr>
<tr>
<td>PPI</td>
<td>51</td>
</tr>
<tr>
<td>% in heat</td>
<td>82</td>
</tr>
<tr>
<td>Services/conception</td>
<td>1.24</td>
</tr>
<tr>
<td>Fall Pregnancy</td>
<td>78</td>
</tr>
<tr>
<td>Calf ADG</td>
<td>1.63</td>
</tr>
<tr>
<td>Calf WW</td>
<td>387</td>
</tr>
</tbody>
</table>
Scrotal Circumference

- 21 day reduced age at first estrus; 1.6cm increase in scrotal circumference in progeny from 141 sires selected for scrotal circumference (Morris, 1993)
- Daughters of bulls with a high SC EPD reached puberty 62 days earlier than a low SC EPD line (Hough, 1991)

Has Age of Puberty Changed?

Milk Production

- Balance between productivity and resource availability and cost
- Selection for increased milk will not be profitable in all systems

Mature Size

- Increased feed requirements per cow.
- Related positively to other growth traits.
- Most desirable = cows that excel in early growth, but mature at moderate weight.

Genetic Trends for Yearling Weight, lb

If a producer was using angus bulls with average EPD for milk, WW and YW in 1998-2000, the same bulls would be ranked in the bottom 5% for these traits today.
FEED EFFICIENCY ≠ PRODUCTION EFFICIENCY

It’s more than a matter of perspective...

- Efficiency of growing animals (Individual)
  - Dilution of maintenance
  - Increased ADG
  - Lean vs. Fat accretion

- Cow Efficiency (Herd)
  - Driven by reproductive rate
  - Interaction of nutrient demand (given genetic potential for mature weight and milk) and nutrient supply
  - Metrics: lb of calf weaned/cow exposed; value of calves / $100 input cost

“Thus, as we strive to improve growth rate in the cattle industry and to make the commercial cow more efficient from the standpoint of utilizing nutrients, we must insure that we do not deviate from the goal of maintaining an optimum level of reproductive efficiency.”

—Dr. Larry R. Corah, K-State

Time of Calving

<table>
<thead>
<tr>
<th>Trait</th>
<th>March</th>
<th>June</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Pregnant</td>
<td>93.5</td>
<td>93.0</td>
<td>90.3</td>
</tr>
<tr>
<td>2010 3s</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Older</td>
<td>93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011 3s</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Older</td>
<td>93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heifers</td>
<td>High 64</td>
<td>Low 52</td>
<td></td>
</tr>
</tbody>
</table>
**Which Direction to Go?**

- Milk Production
- Lean Yield
- Reproduction
- Growth
- Efficiency
- Marbling

**Advantage of Crossbred Cows**

<table>
<thead>
<tr>
<th>Trait</th>
<th>Maternal Heterosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longevity</td>
<td>1.2 yrs (44%)</td>
</tr>
<tr>
<td>Calf Weight/Cow Exposed</td>
<td>74 lb (25%)</td>
</tr>
<tr>
<td>Net Profit/Cow Exposed</td>
<td>$100</td>
</tr>
</tbody>
</table>

**Fat Supplementation**

- Safflower
- Sunflower
- Cottonseed
- Rice Hulls
- Soybeans
- Canola
- Flax
- Fish Meal
- Ca Salts of FA
- Tallow, Yellow Grease

**BALANCED NUTRITION: KEY TO OPTIMIZING PRODUCTION**

- Protein
- Energy
- Minerals
- Vitamins
- Water
Factors Affecting Embryonic Loss

**GENETIC**
- Expression of lethal genes
- Abnormal chromosomal numbers
- Inbreeding

**ENVIRONMENT**
- Heat stress
- Transport
- Handling/chute work

**NUTRITION**
- BW & BCS at breeding
- Excess protein
- Toxins

**MISCELLANEOUS**
- Low progesterone production
- Age of dam
- Semen quality
- Infectious agents

Prepartum nutrition more important than postpartum nutrition in determining length of postpartum anestrus
- Inadequate dietary energy during late pregnancy lowers reproduction even when energy is sufficient postpartum
- Animals should be BCS 5-6 at calving

Effect of BCS at Calving on PPI

<table>
<thead>
<tr>
<th>BCS</th>
<th>Postpartum Interval (90d)</th>
<th>Pregnancy % (90d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>88.5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>69.7</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>59.4</td>
<td>81</td>
</tr>
<tr>
<td>6</td>
<td>51.7</td>
<td>88</td>
</tr>
<tr>
<td>7</td>
<td>30.6</td>
<td>90</td>
</tr>
</tbody>
</table>

Effect of Age and Time on Return to Estrus

<table>
<thead>
<tr>
<th>Age of Cow</th>
<th>Days after calving</th>
<th>% Cycling</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 or older</td>
<td>40</td>
<td>55 70 80 90 90 95 100</td>
</tr>
<tr>
<td>2-3 years</td>
<td>50</td>
<td>15 30 40 65 80 80 90</td>
</tr>
</tbody>
</table>

Requirements for Protein and TDN

<table>
<thead>
<tr>
<th>Animal</th>
<th>Protein</th>
<th>TDN</th>
<th>TDN:CP Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 lb heifer, not pregnant</td>
<td>7</td>
<td>54</td>
<td>7.7</td>
</tr>
<tr>
<td>Pregnant heifer, 1.25 lb/d gain</td>
<td>8</td>
<td>55</td>
<td>6.9</td>
</tr>
<tr>
<td>Lactating cow, 15 lb milk/d</td>
<td>11</td>
<td>62</td>
<td>5.6</td>
</tr>
</tbody>
</table>

Moore and Kunkle, 2000

Crude protein in cattle diets on Sandhills range

Moore and Kunkle, 2000
**Instantaneous growth rate of the bovine fetus**

- **Day of gestation**: 50, 100, 150, 200, 250, 300
- **Kg/day**: 0.0, 0.1, 0.2, 0.3, 0.4

**Winter Supplementation**

- **Crude protein in cattle diets on Sandhills range**
  - Protein, %OM: 0, 2, 4, 6, 8, 10, 12, 14
- **Month**: APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC, JAN, FEB

**Net Energy (NE) Requirement for a 1200 Lb March Calving Cow With 23 Lbs/day Peak Milk Production**

- **NE (Mcal/day)**: 0, 5, 10, 15, 20
- **Months After Calving**: Calve 3, 5, Wean 9, 11

**Effect of Protein Supplementation on Cow BCS**

- **P<.0001**
- **Pregnancy**: 93.8%, 95.5%
- **WT**: 1142, 1058, 1204, 1184
- **BCS**: 5.2, 4.8, 5.4, 5.2
- **PG**: 96, 94, 98, 95

**Heifer Pregnancy Diagnosis and Weights**

- **Treatment** | **BW** | **Pregnancy (%)**
  - Range S | 810 | 91
  - Range NS | 783 | 77
  - Stalks S | 808 | 88
  - Stalks NS | 826 | 83

**Final Live Weight and ADG**

- **Treatment** | **WT** | **BCS** | **PG**
  - RS | 1371 | 5.2 | 96
  - RNS | 1303 | 4.8 | 94
  - SS | 1343 | 5.4 | 98
  - SNS | 1354 | 5.2 | 95

45 day breeding season
The consequences of nutrient restriction must be considered not only for individual animal performance… but also for the developing fetus.

Fetal Programming: Stimuli experienced during fetal development may impact postnatal growth and physiology

Nutritional Mediation of Reproduction is Extremely Complex

Closing Thoughts
- Focus on high percentage pregnant early
- Begins with heifer development
- Consider synchronization
- Supplementation, what, when, timing
- Segregate high risk animals
- BCS at calving
- Sound herd health program
- Genetics that fit the environment
- Heterosis