

# Calf Nutrition and Management: Colostrum, Nutrition and Long Term Performance – It's all about getting more milk, believe it or not!

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# Overview

- **Introduction**
- **Colostrum management**
- **Nutrient status and immune function**
- **Early neonatal events and milk yield**
  - **Colostrum**
  - **Energy and protein intake**
  - **Mammary development**
- **Summary**

# Passive Transfer Target for Newborn Calf Health

- Want to target **10 mg/ml IgG** in calf serum following colostrum ingestion
- Calves with levels less than **10 mg/ml** have “**Failure of Passive Transfer**” (FPT)



# Failure of Passive Transfer Reduces Long Term Performance

- Calves with FPT:

- Delayed time to first calving

- (Can Vet J., 1986, 50:314)

- Decreased average daily gain to 180 days

- (J. Dairy Sci., 1988, 71:1283)

- Decreased milk and fat production at first lactation (J. Dairy Sci., 1989, 72:552)

- for each unit of serum IgG > 12 mg/ml there was a 18 lb increase in ME milk

# **Calf Program Goals:**

**1. Double birth weight by 56 days**

**90 lb birth weight       $\longrightarrow$       180 lb @56 days**

**2. Calf mortality less than 5%**

**3. Calf morbidity (treatments) less than 10%**

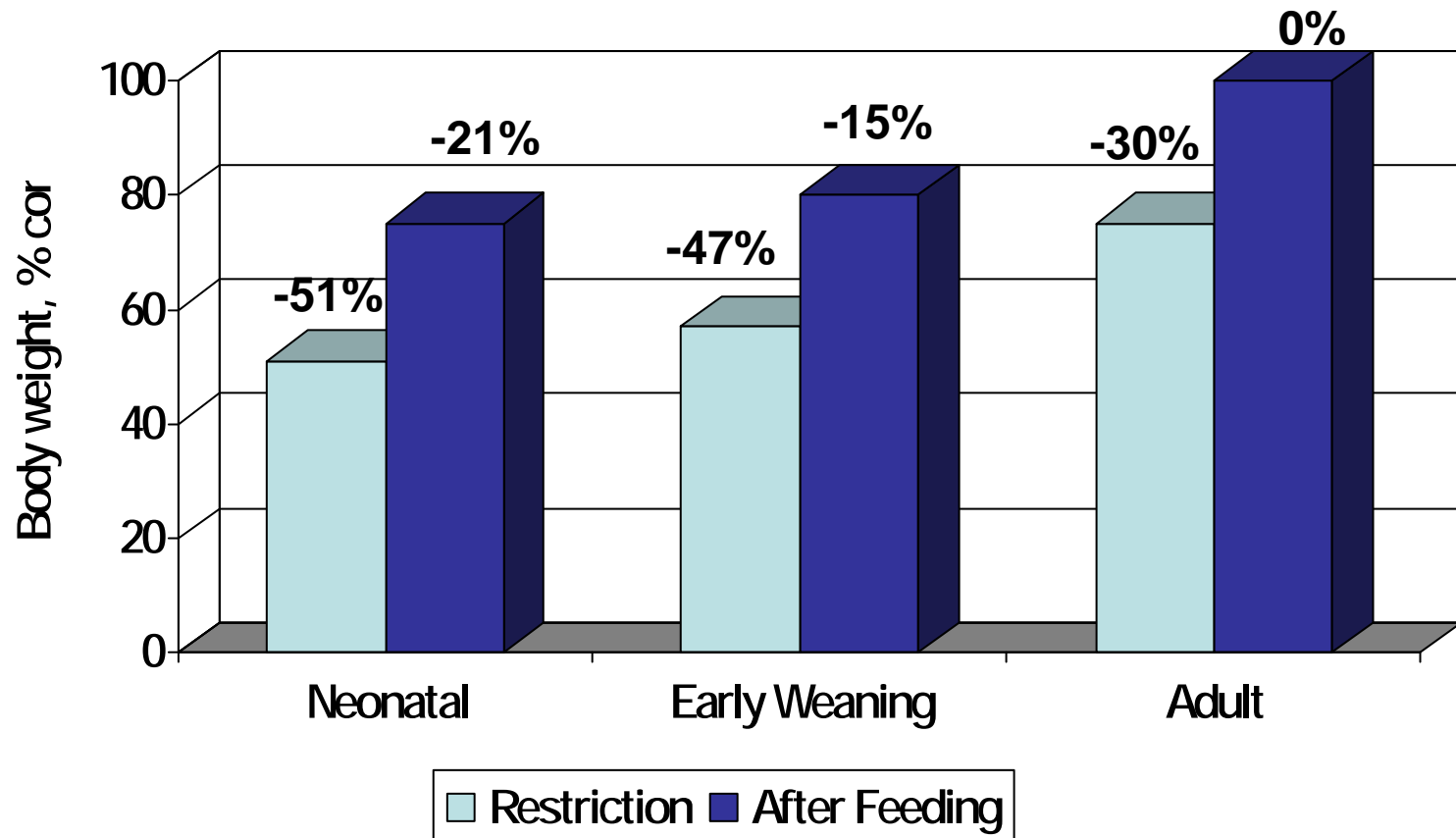
**Why do this?**

- Achieve breeding weight at an earlier age**
- Potentially reduce AFC/increase BW@calving**
- Increase potential for Internal Herd Growth**
- Potentially increase milk yield**
- Potentially increase herd life**

# Nutrient Requirements and Compensatory Growth

- Many producers believe that calves can “compensate” from early life nutrient restrictions
- Most neonates, including pre-weaned calves do not have compensatory gain mechanisms
  - Effects of early life nutrient restriction are difficult to overcome (immune system and normal growth)

# Effect of Malnutrition (50% normal intake for three weeks) and Refeeding (normal intake) During Different Stages of Life on Bodyweight



(Burrin, et al. Cornell Nutrition Conference Proceedings, 2001)

# Nutrient Requirements

- In the last 10 years we have made remarkable progress in understanding the nutrient requirements of calves and heifers (body composition data on over 400 calves and heifers from Cornell, Univ. of Illinois and Virginia Tech)
- Further we have learned how to manipulate the composition of gain through diet design



# **Environmental and Stress Effects on Maintenance Requirements**

**The thermoneutral zone for young (< 21 days of age) lightweight calves is 59 to 82°F**

**In New York, we spend at least 160 days/year below the lower critical temperature.**

**For calves > 21 days of age the lower critical temperature is 42 °F.**

# Amount of Milk Replacer/Milk Dry Matter Required to Meet Maintenance Requirements

Temperature, °F

68 50 32 15 5 -5 -20

Bodyweight, lb

60	0.6	0.8	0.9	1.0	1.1	1.2	1.4
80	0.8	0.9	1.1	1.3	1.4	1.5	1.7
<b>100</b>	<b>1.0</b>	<b>1.1</b>	<b>1.3</b>	<b>1.6</b>	<b>1.7</b>	<b>1.8</b>	<b>2.0</b>
120	1.1	1.3	1.5	1.7	1.9	2.0	2.3

# Amount of Milk Replacer/Milk Dry Matter Required to Meet Maintenance Requirements and Gain One Pound per Day

## Temperature

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68      50      32      15      5      -5      -20

## Bodyweight, lb

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60	1.1	1.2	1.4	1.5	1.6	1.7	1.8
80	1.2	1.4	1.6	1.7	1.9	2.0	2.2
<b>100</b>	<b>1.4</b>	<b>1.6</b>	<b>1.8</b>	<b>2.0</b>	<b>2.2</b>	<b>2.3</b>	<b>2.5</b>
120	1.6	1.8	2.1	2.2	2.5	2.6	2.8

# **Environmental and Stress Effects on Maintenance Requirements**

**Calves that are transported, experience significant alterations in temperature, social environment or dietary change experience stress.**

**This is manifested by increased heat production and appears to last up to 14 days after the event**

**Equal to 0.25 lb DM/d in extra heat production**

## Updated Nutrient Requirements of a 100 lb Calf Under Thermoneutral Conditions

Rate of gain, lb/d	ME <sup>a</sup> , mcal/d	DMI, lb/d	ADP, g/d	CP, g/d	CP, % DM
0.44	2.35	1.12	87	94	18.0
0.88	2.89	1.40	140	150	23.4
1.32	3.48	1.67	193	207	26.6
1.76	4.13	1.98	235	253	27.5
2.20	4.80	2.39	286	307	28.7

Van Amburgh and Drackley, 2005

# Effects of Neonatal Nutrition on Productivity and Mammary Development

- Data are emerging that suggests early life nutrient intake has long term impacts on productivity
- Data are not conclusive
- Mechanism is not completely understood
- Might be certain cells in the mammary gland or other tissues, immune system stimulation and maturation – or all of the above!

# Summary of Published Data

<u>Study</u>	<u>Response</u>
Bar-Peled et al., 1998	+ 998 lb
Foldager and Krohn, 1994	3,092 lb
Foldager et al., 1997	<u>1,143 lb</u>
Mean response	+ 1,744 lb

These responses were achieved by increasing pre-weaning milk intake by at least 75% over conventional intake

## **Preliminary Data - Studies in Progress**

**Study**

**Response**

**Miner Institute, Chazy, NY  
and Zenoh, Japan  
(JDS Abst. 2005)**

**+1,543 lb  
@ 200 DIM**

**Again, responses were achieved by  
increasing milk replacer intake by at  
least 75% over conventional intakes**



# First lactation milk yields (Univ of Illinois)

Variable	Control	Enhanced
<b>Age at calving (mo)</b>		
Year 1	25.4	26.5
Year 2	24.0	24.4
<b>Calving BW (kg)</b>		
Year 1	1276	1338
Year 2	1278	1217
<b>ME milk* (kg)</b>		
Year 1	20,341	23,270 (2929)
Year 2	19,351	20,104 (753)

\*Treatment x year,  $P = 0.15$ . Year  $P < 0.05$  for all. Pollard et al., JDS abstr. 2007

# Michigan State Study

- Moderate feeding vs Intensified program
- Followed heifers up to 150 DIM
- Intensive fed heifers calved ~ 22 days earlier
  - Produced 1,100 lb more milk in first lactation  
(Based on projected ME 305 milk) not significant
- Concluded intensified feeding with earlier calving and milk difference was economically advantageous

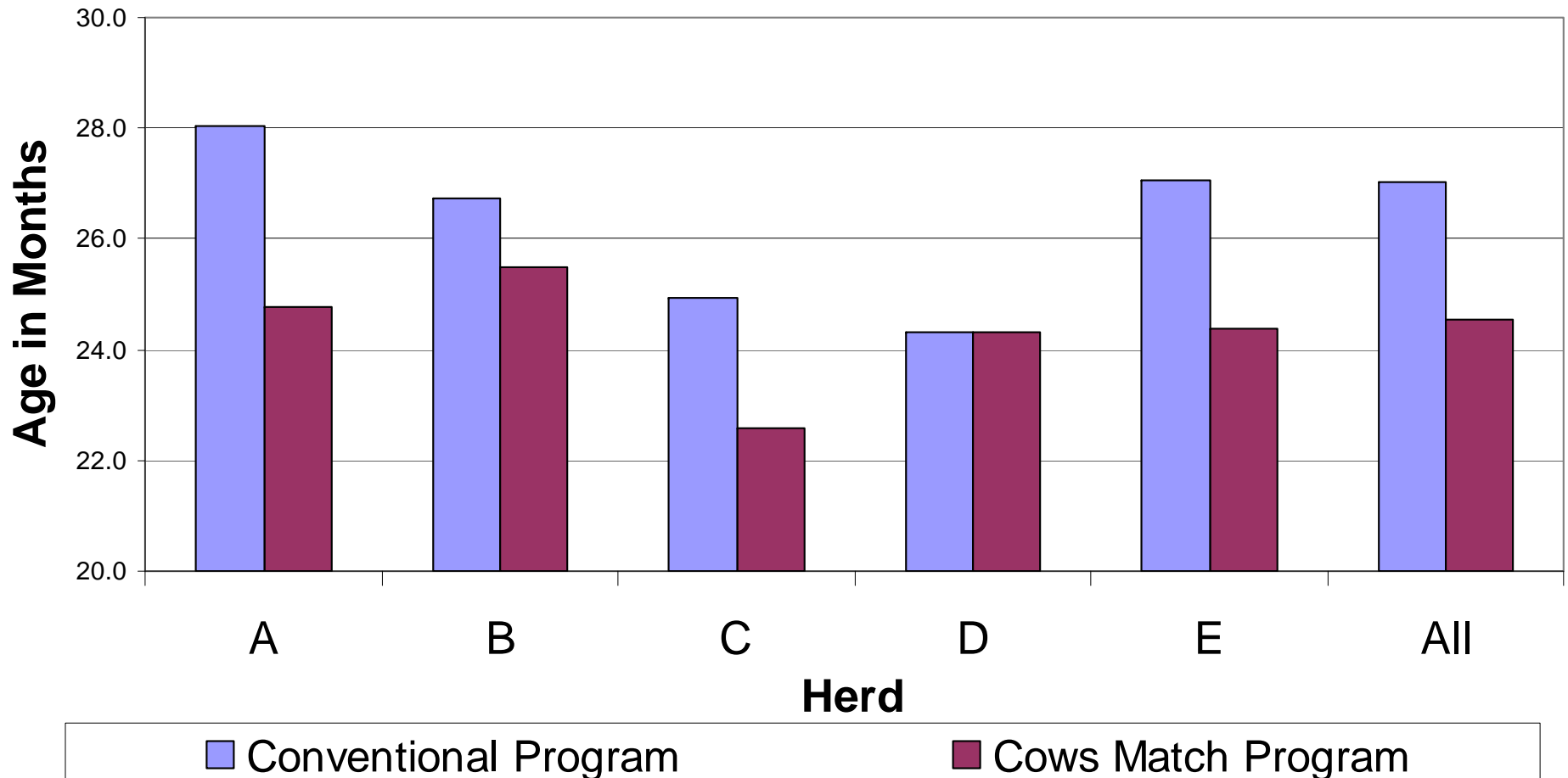
# Effects of feeding ad-lib milk vs ad-lib milk replacer with or without additional protein from 150 to 300 days of age

- Milk replacer (23% CP: 12% Fat – containing soy protein) vs whole milk to weaning
- From 150 to 300 days of age half of each group provided 2% additional protein (fish meal)
- Basal diet was low in protein (< 14%)
- Calves fed whole milk and supplemented with 2% added protein produced ~ 2,500 to 3,000 lb more milk in first lactation ( $P < 0.007$ ) (I had to interpret the graph... they didn't provide any means so those are my estimates)

# Field Data from Land O'Lakes

23 herds summarized – five with lactation data

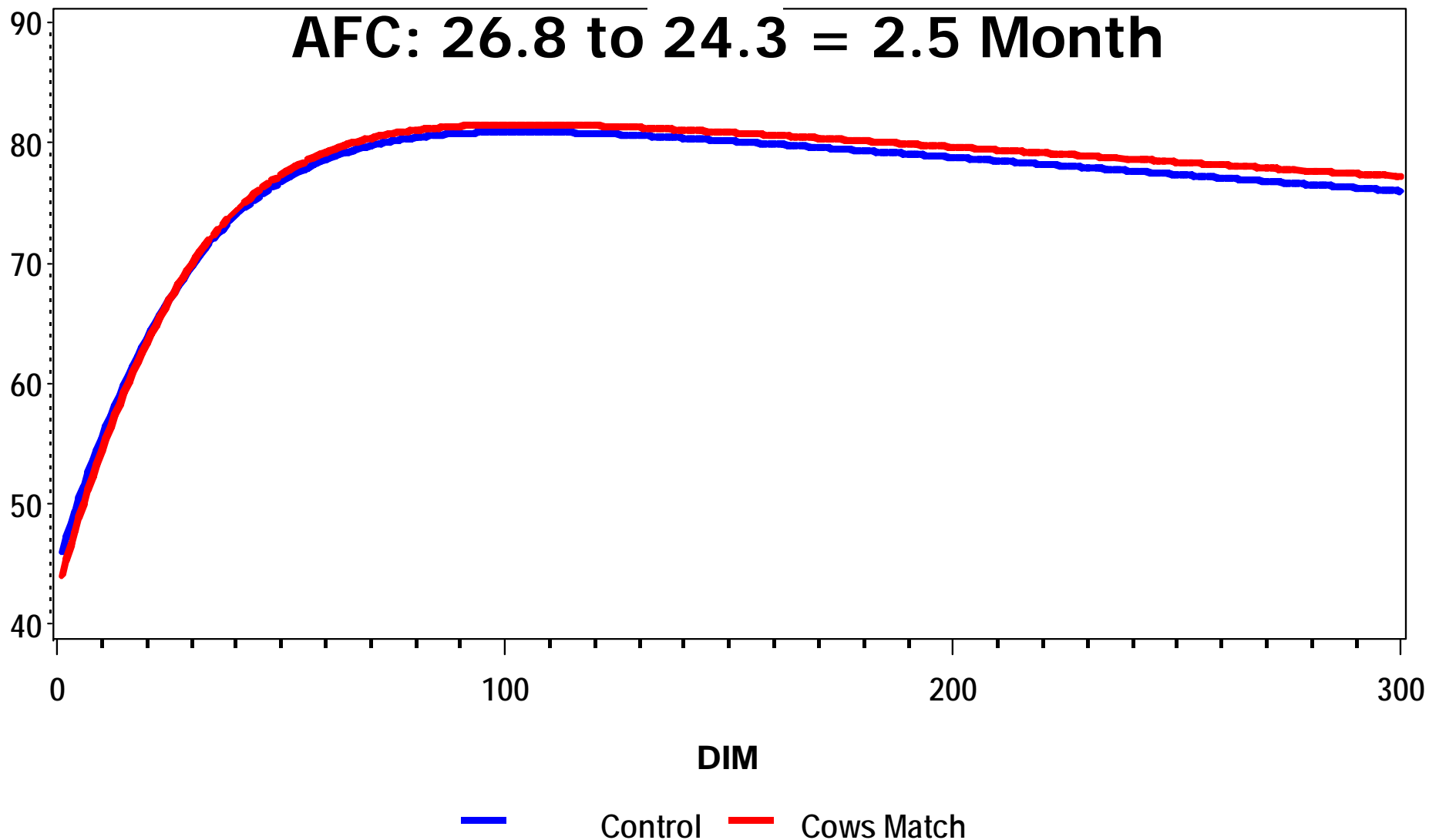
## Age at first Calving



# Field Data from Land O'Lakes

## Lactation Curves from Five Herds

**AFC: 26.8 to 24.3 = 2.5 Month**



# The Cornell T&R Herd

- We started feeding a “Intensified” milk replacer in 1998.
- We have over 1000 weaning weights from this data
- We have ~ 725 finished first lactations from this data
- We wondered if any calf measurement had any relationship to first lactation milk yield

# The Cornell T&R Herd

- We analyzed the lactation data with the Test Day Model (TDM) – allows us to control for year, season, genetics and management variation over the period of measurements
- Generated TDM residuals for lactation and then regressed the lactation data on all calf variables measurable

# Traits Evaluated

- Birth weight
- Weaning weight
- Average daily gain until weaning
- Hip height at birth
- Hip height at weaning
- Gain in hip height
- Wither height at birth
- Wither height at weaning
- Gain in hip height



# What We Learned is Consistent with the Previous Data

- Differences between years are highly significant
- Average daily gain to weaning is highly significant
- The top 2% of the gainers out produced the bottom 2% of the gainers by 1,477 pounds of milk in their 1st lactation as evaluated in the Test Day Model.

# Cornell Herd - Effect of Pre-Weaning Daily Gain on Milk Yield

- The range in growth rate in the data set was 0.52 to 2.67 lb per day to weaning
- For every 1 lb of gain above 0.5 lb per day, milk yield increased by 900 lb per lactation

Therefore, an ADG of 2 lb/d versus 0.5 lb/d prior to weaning is worth 1,350 lb of milk in first lactation

# Cornell Herd - Effect of Pre-Weaning Daily Gain on Milk Yield

- The standard deviation in milk yield for first lactation is approximately 3000 lb
- In this evaluation 20% of the variation in first lactation milk yield was explained by pre-weaning growth rate up to 42 - 49 days of age

# Effects of Pre-Weaning Gain and other effects on Milk Yield

- Year effects were worth 2,118 lb of milk in the first lactation
- We're not sure what that means relative to pre-weaning growth rate
- Possibly due to colostrum status (variation in dry cow vaccinations/heifer exposure)
- Could also be nutrient intake relative to version of milk replacer fed, housing, (or fetal programming, previous generation effect (imprinting or epigenetics))
- Month was not significant

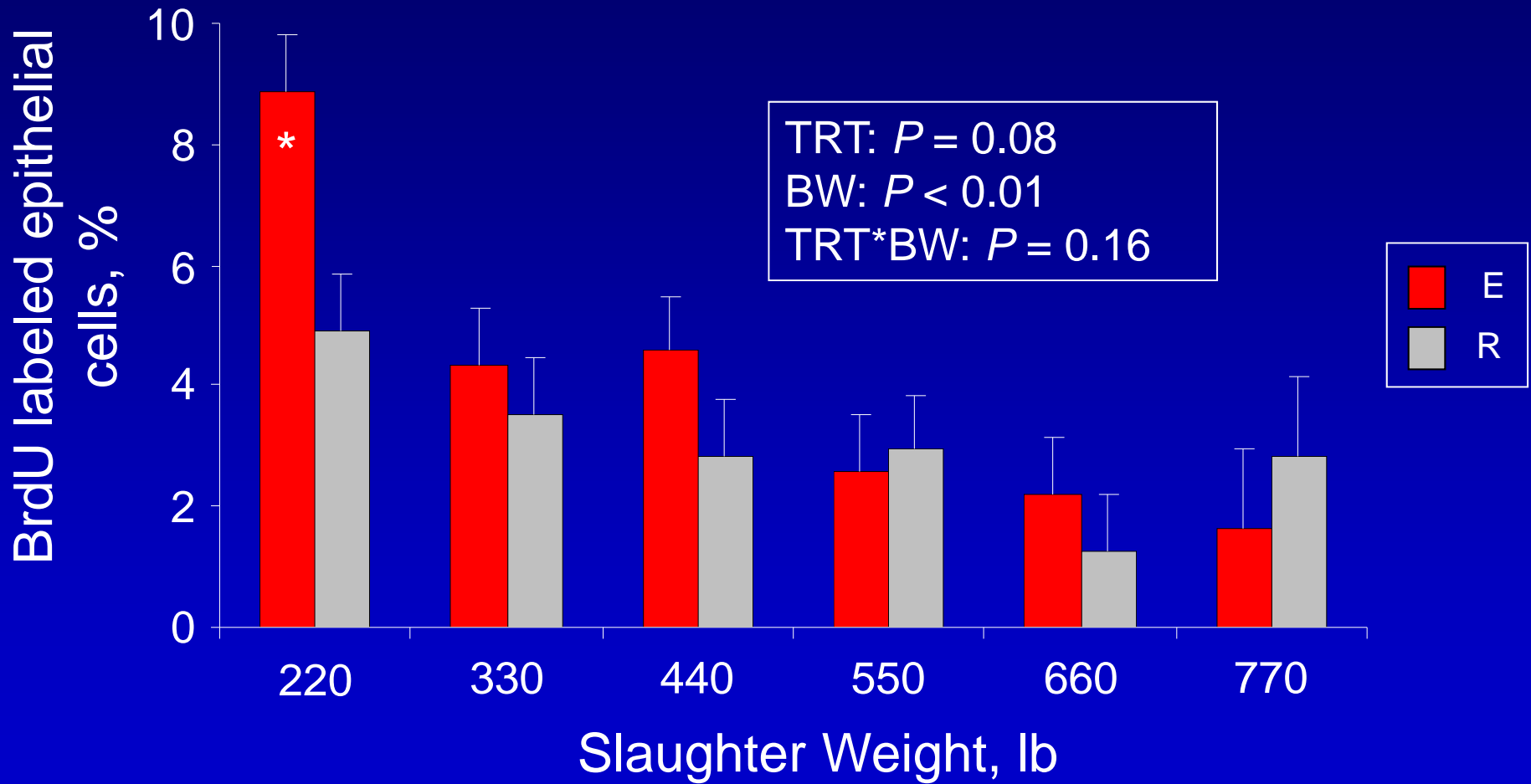
# Cornell Herd - Effect of Pre-Weaning Daily Gain on Milk Yield

- Hip height and hip height change also carried some positive effects on milk yield
  - probably correlated with the ADG effect

# University of Illinois Data

- Similar responses to Cornell herd
- They had conventional versus “Intensified” milk replacer fed calves
- Calves fed conventional diets (1 lb DM milk replacer per day) had a negative regression slope for preweaning ADG and first lactation milk yield whereas Intensified calves had a positive slope
- Suggests the milk effect is in the first 3 to 5 wks of life

# Epithelial Cell Proliferation



\*Denotes treatment effect within slaughter weight. ( $P < 0.05$ )

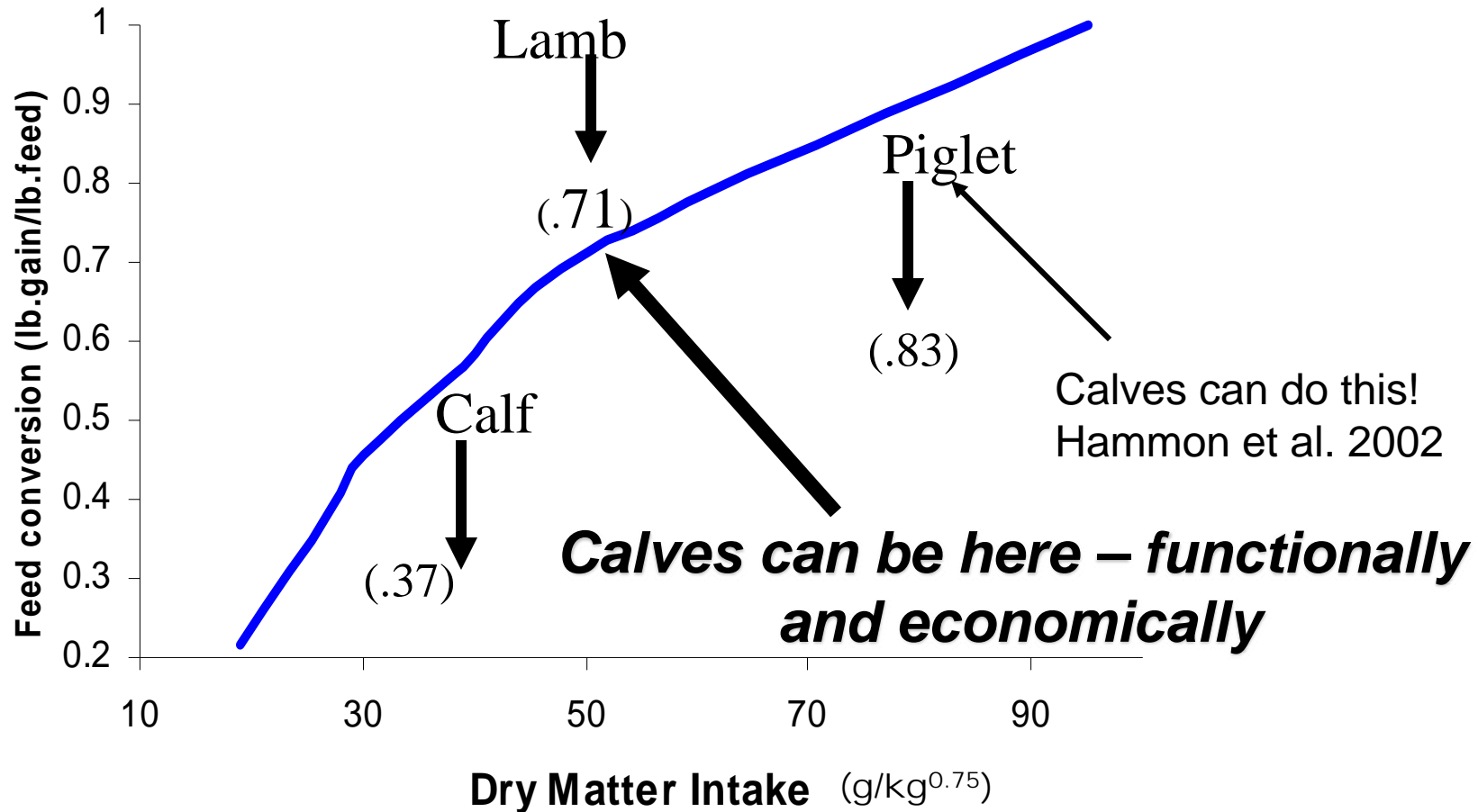
# Conclusions

- **Nutrient intake prior to weaning has a positive influence on both milk yield and specific aspects of mammary development**
  - **The most likely mammary candidate – stem cells in the neonatal mammary gland. Less than 5% of the cells present – responsible for up to 50% of the proliferation in the early gland. Capuco, 2006**

**BOTTOM LINE: THERE IS MILK IN THIS FIRST 3 TO 5 WEEKS OF EARLY LIFE NUTRIENT INTAKE**



# Efficiency of feed conversion with traditional calf feeding practices (Birth to 6 weeks)



# Pre-Weaning Feed Efficiency and Economics

**Data from Mills (2005):**

**Calves were fed milk replacer to maintain growth rates close to 2.2 lb per day – no dry feed**

**Ambient temperatures were less than 20°F, barn temperature less than 40°F**

**Feed efficiency was 0.78 lb gain per lb feed intake.**

**Milk replacer cost was ~\$0.90 per lb, thus the cost per lb of gain was \$1.15**

# Pre-Weaning Feed Efficiency and Economics

- **Feed efficiency is a function of colostrum status, health status, hygiene and energy intake above maintenance**
- **Feed efficiency on most farms: 0.29 – 0.35 lb of gain per pound of feed.**
- **Example: milk replacer @ \$0.80 per lb**
- **Feed efficiency of 0.30 lb gain per lb feed**
- **Cost per lb of gain: \$2.67**

# Summary

- Early life events have long term effects on calves
- Decisions on nutrient status and requirements need to be more dynamic
- We need to create tools that allow us to make integrated management decisions on a systems basis and not day to day
  - Example is economics of a feeding system

# Feeding Program

- 1.5% BW DM intake day 2 to day 7
- 2% BW DM intake day 8 to day 35 or 42
- Offer starter from day 8 and clean fresh water
- On day 43, reduce milk or milk replacer by 50% and feed once per day for 7 days
- On day 51, remove all liquid feed
- Calf should be consuming ~1.5 lb starter per day over the week period

# Feeding Program

- Calves tend to prefer textured starters – pellets with corn/oats on the outside with a little molasses
- For best growth results – starter should be 21 to 23% CP on a DM basis
- NO dust, fines, mold
- Sugar content – less than 8% - calf has a hard time buffering the rumen – watch molasses applications
- Major criteria for starter – something they will readily consume
- Minimize hay and forage intake prior to 8 wks of age

## Passive Immunity Achievement

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- Blood IgG >10mg/ml or  
Blood serum protein ✓  
>5.5g/dl  
(at 48 hours of life)  
≥85% achieving  
(95% is achievable)  
(59%\* Koval)

*\*spurred improvements  
in colostrum mgmt.*

## Optimize Pre- Weaning Gains

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- Double birth weight  
In 56 days  
≥90% achieving

1.90 x

33% achieve

(using group avg.)



93 lbs. → 173 lbs.

1.86 x

(Koval)

# Questions

