Precision Feeding Dairy Heifers

Using feed efficiency principles and basic animal physiology to feed heifers correctly and cheaper

Jud Heinrichs
Animal Science Department
Penn State

Progress and change over the past 60-80 years in dairy nutrition/management.

- Genetics
- Health
- Reproduction
- Milking systems
- Cow comfort
- Dry cow nutrition/ management


6034
6034
5835

Dairy Heifer Management for Improved Profitability

- Strategies:
  - Reduce the time until first calving and lactation
  - Reduce the input expenses required

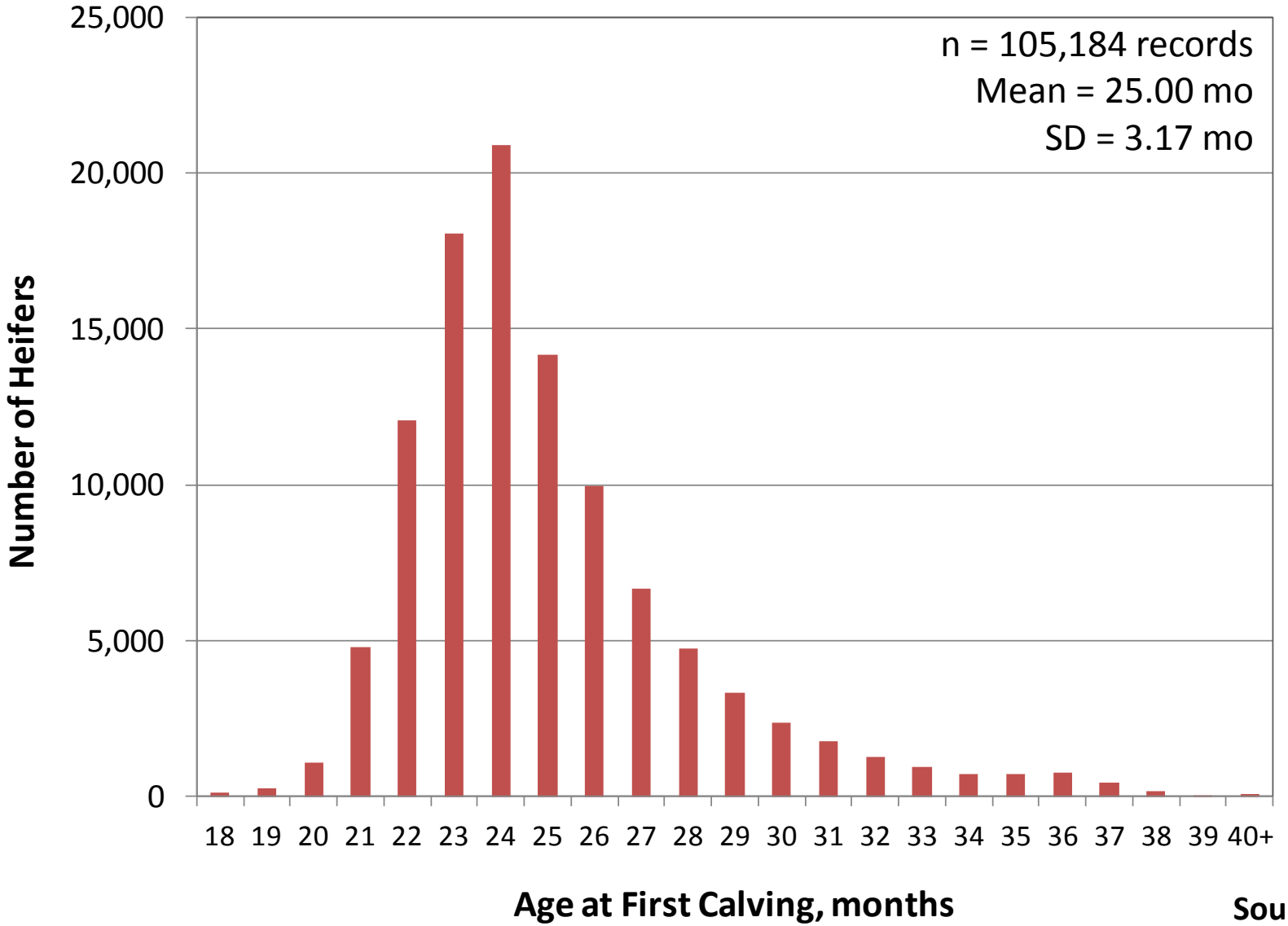
- **While not reducing the future productive potential**

Goals:

- Calf mortality <5% ; 2% better
- Double birth weight at 60-80 days
- Age first heat < 10 mo.
- Age bred 13-14 mo.
- Age to calve 22-24 mo. Average 23
- Weight at breeding 55% Mature Body Weight
  (750-800 lbs for Holsteins; 525-575 lbs for Jerseys)
- Weight at calving 85-90% MBW

Age at First Calving

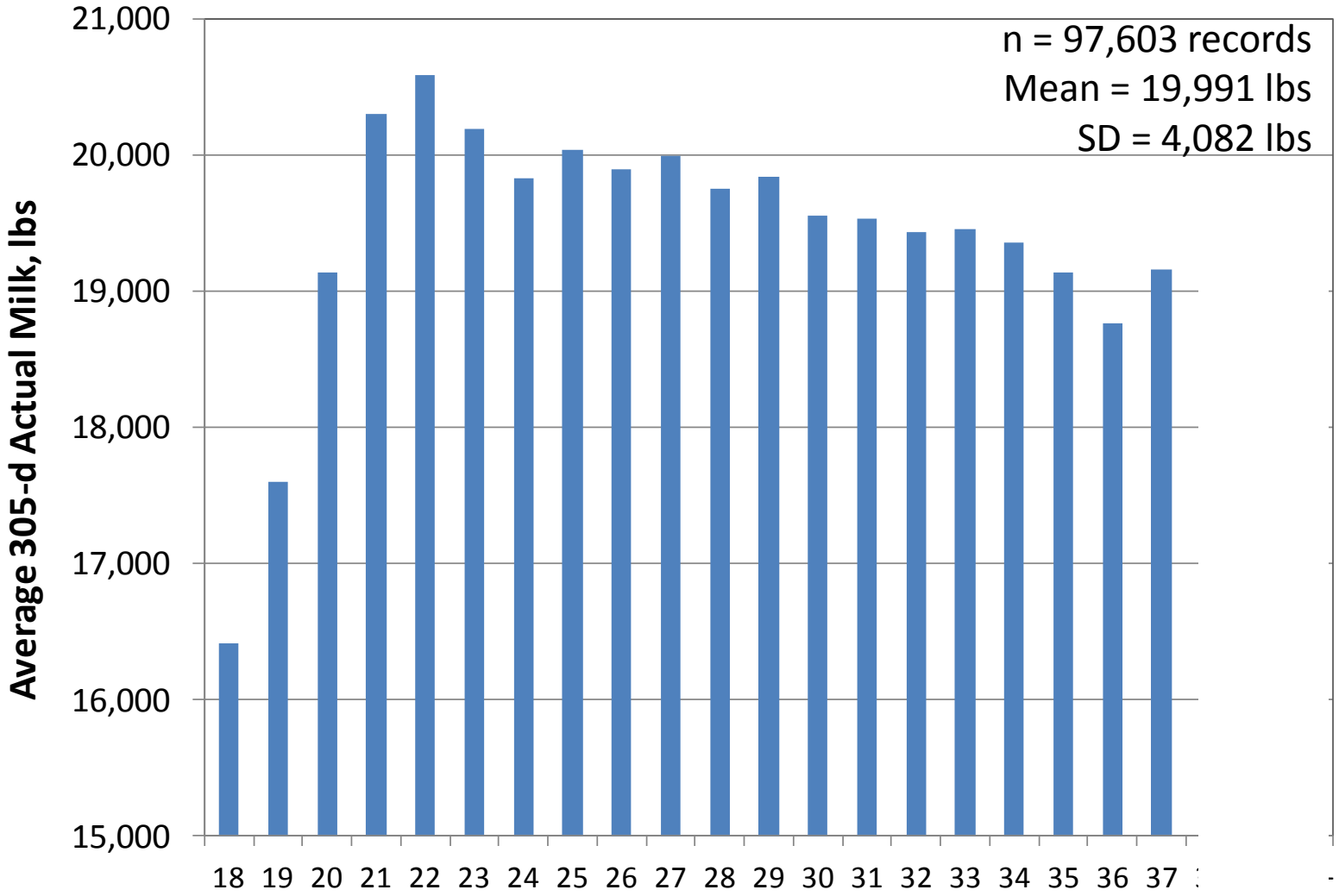
PA Holsteins calving in 2011



Source: DRMS

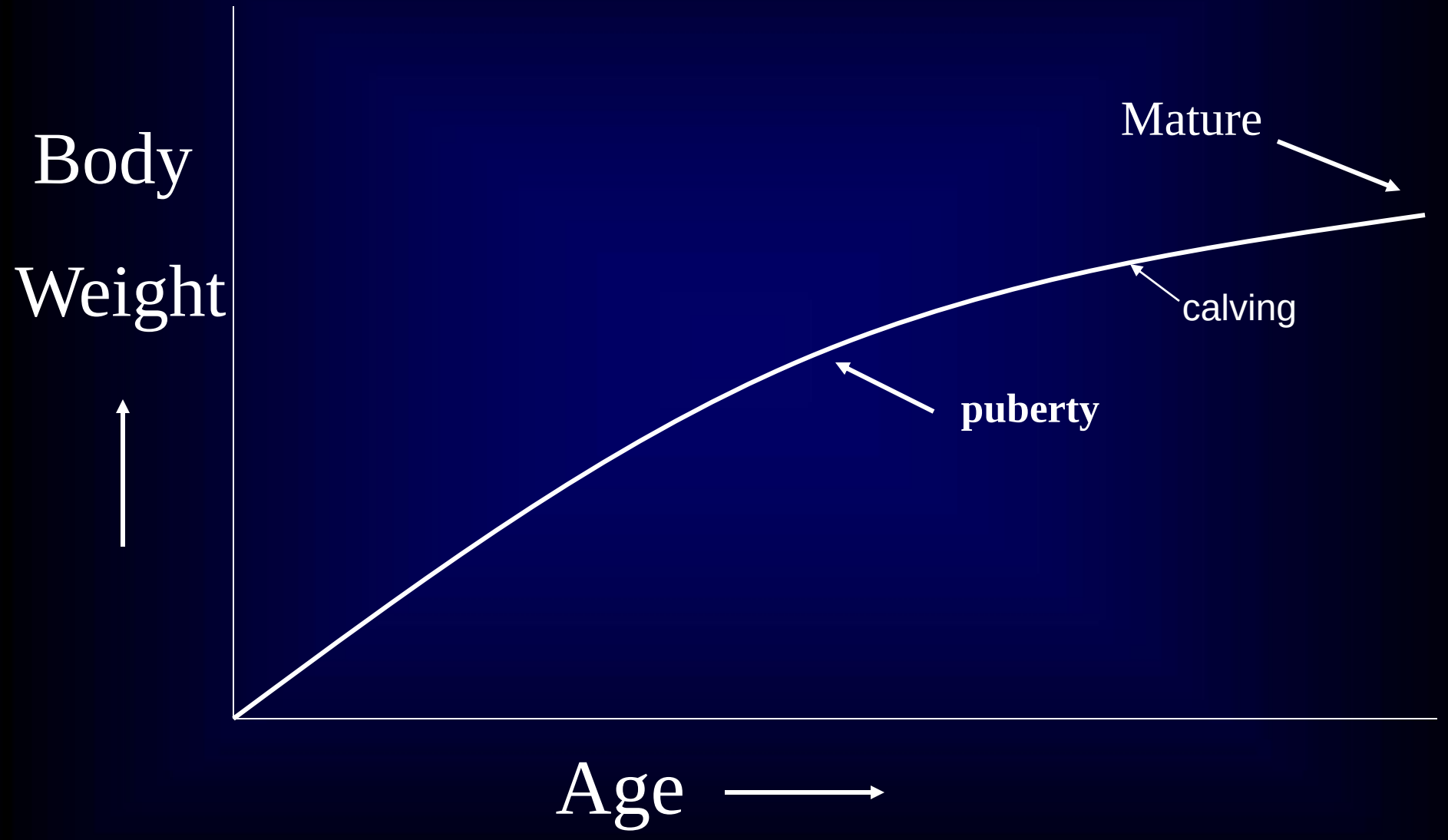
Actual 305-d Milk Production

PA Holsteins calving in 2011

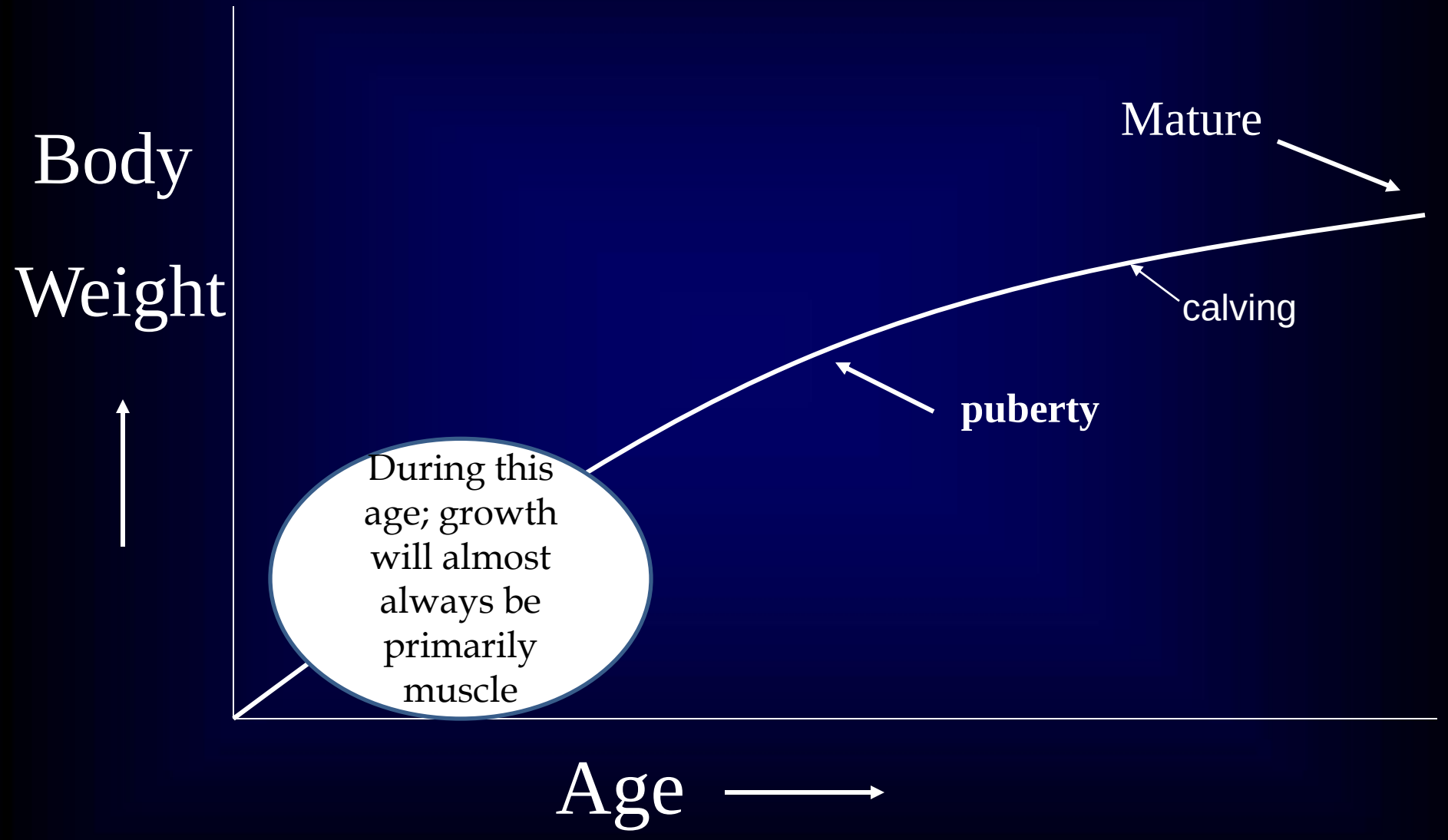


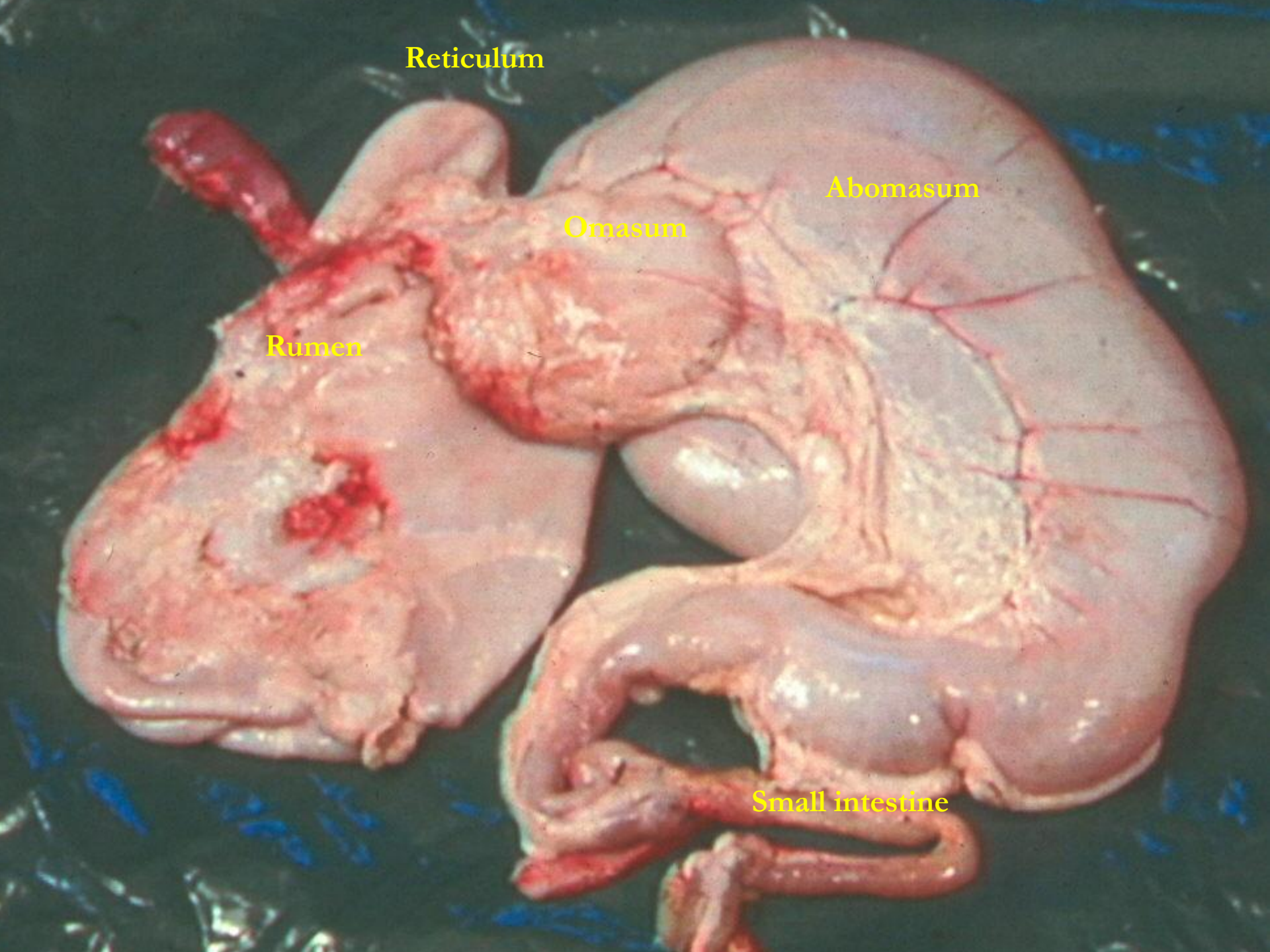
Source: DRMS

Animal Growth



Animal Growth



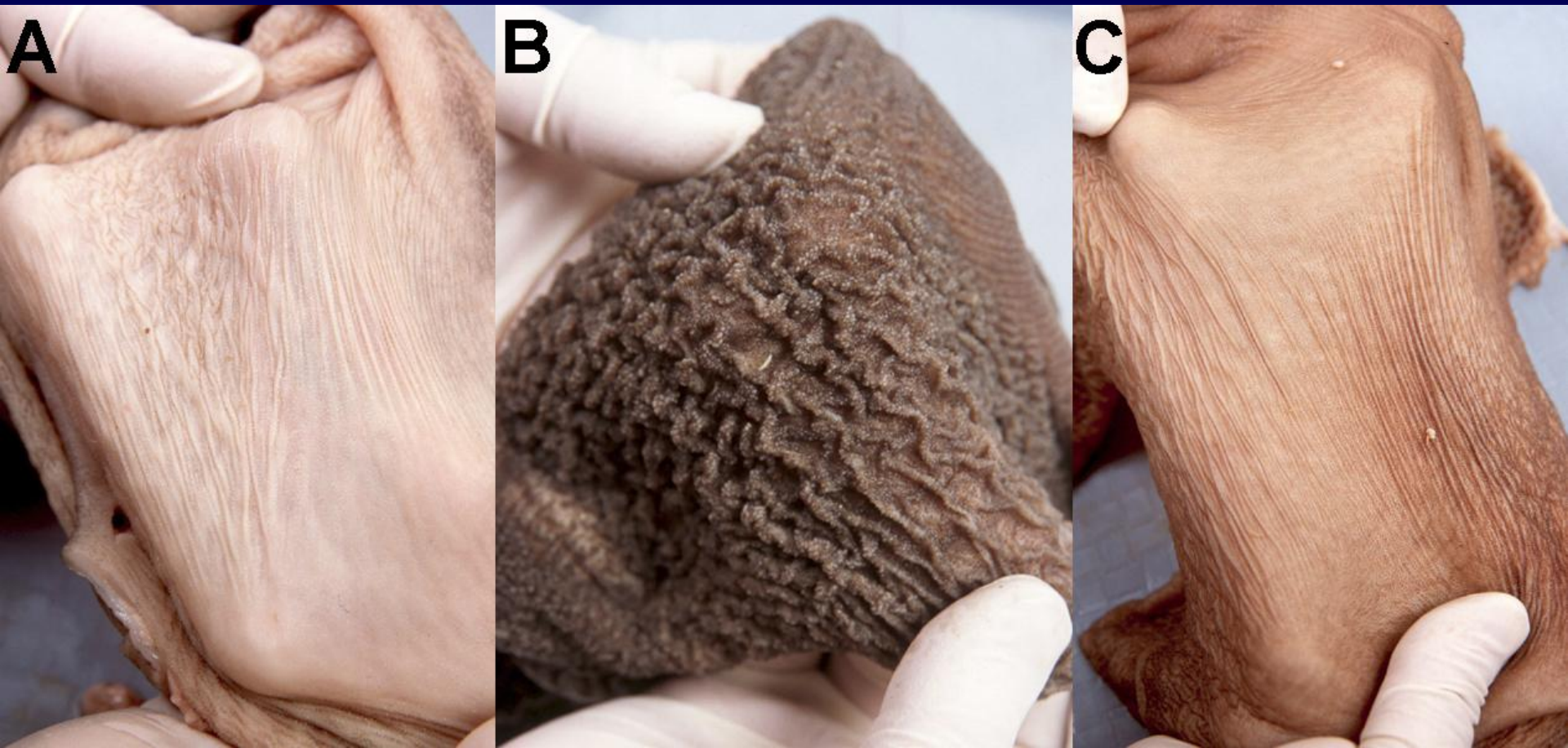

Reticulum
Abomasum
Omasum
Rumen
Small intestine


12 weeks old –fed TMR
PENNSTATE


capillary

Rumen papillae development in 6 week old calves fed 3 different diets

Milk Only **Milk and Grain** **Milk and Hay**



What we know about heifers in 2014

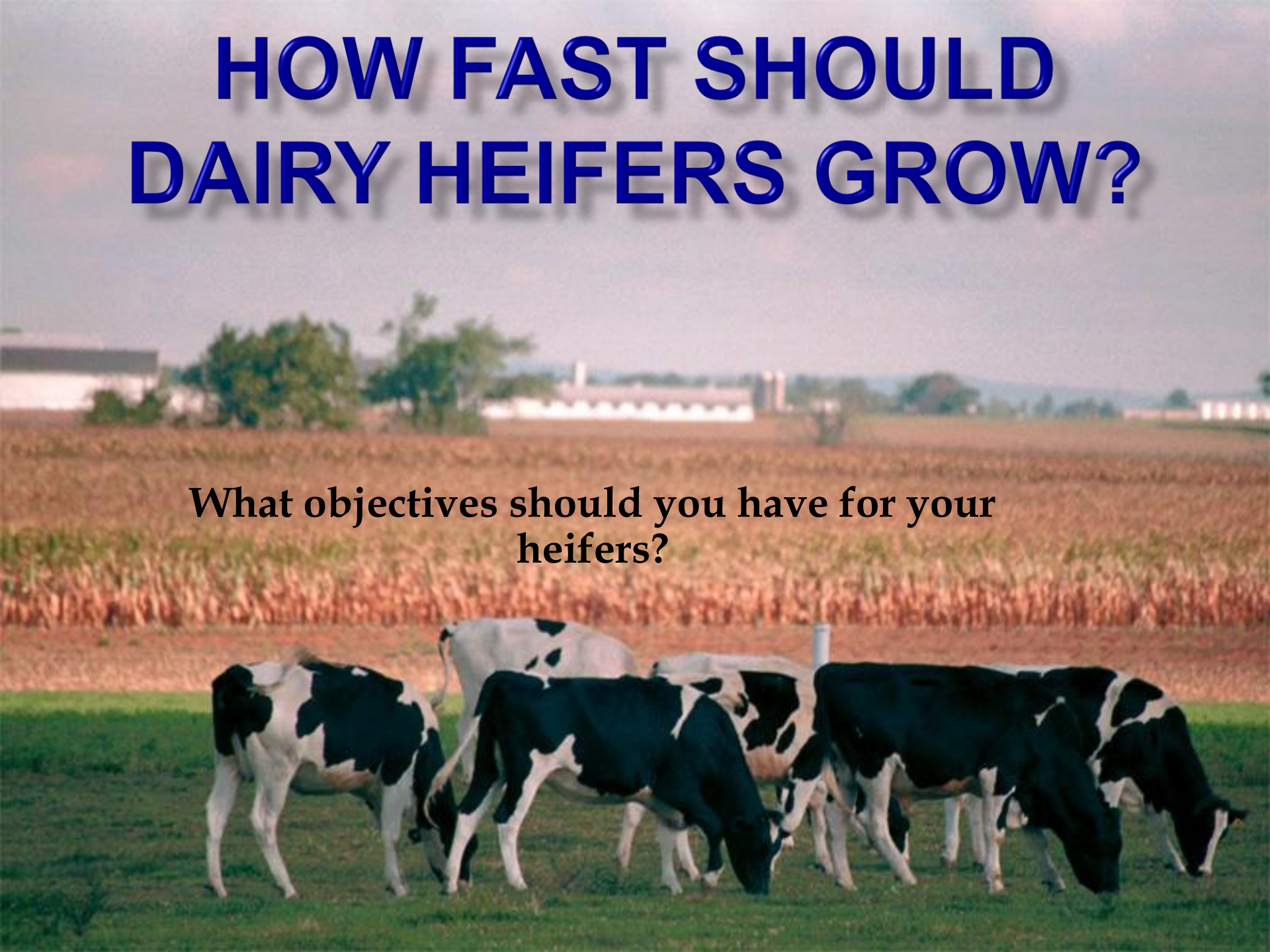
- Growth physiology- ADG limits

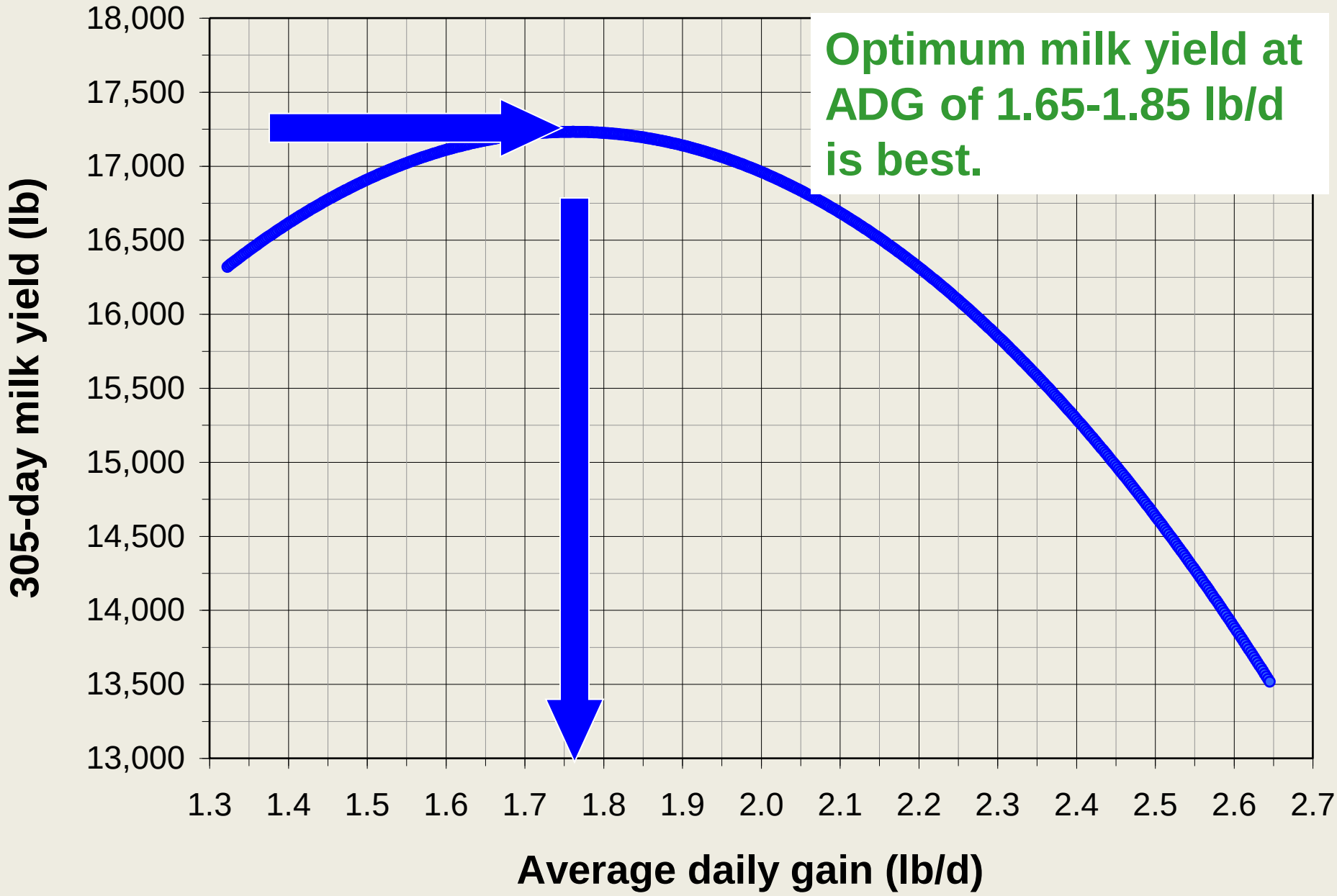
What is the best weaning weight?

- Depends on age at weaning
- By 8 weeks of age, calves should double their body weight- regardless of age at weaning.
- Weaning depends on grain intake

HOW FAST SHOULD DAIRY HEIFERS GROW?

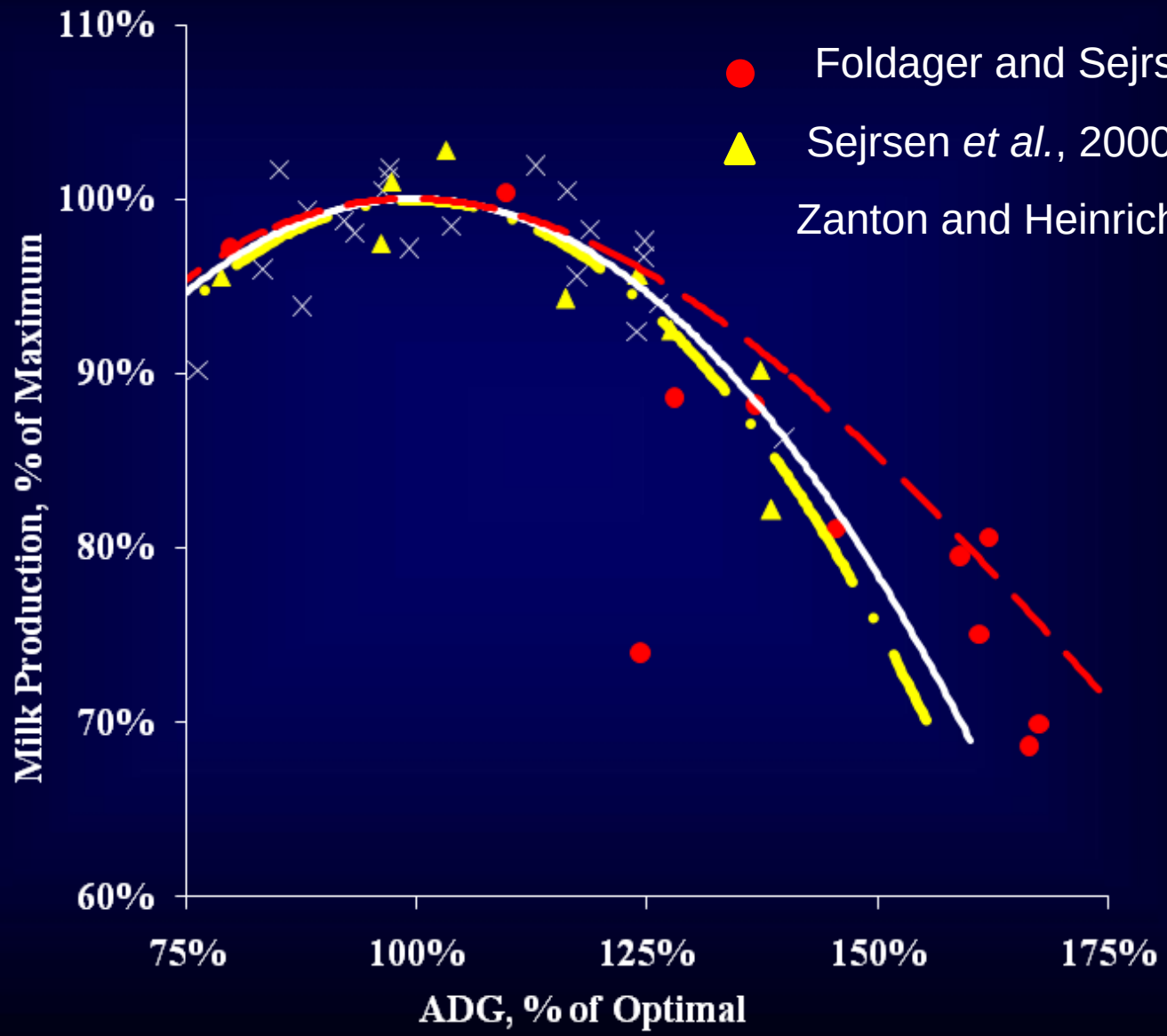
What objectives should you have for your heifers?





Zanton and Heinrichs, 2005

Results for Holstein heifers are consistent with results from other breeds



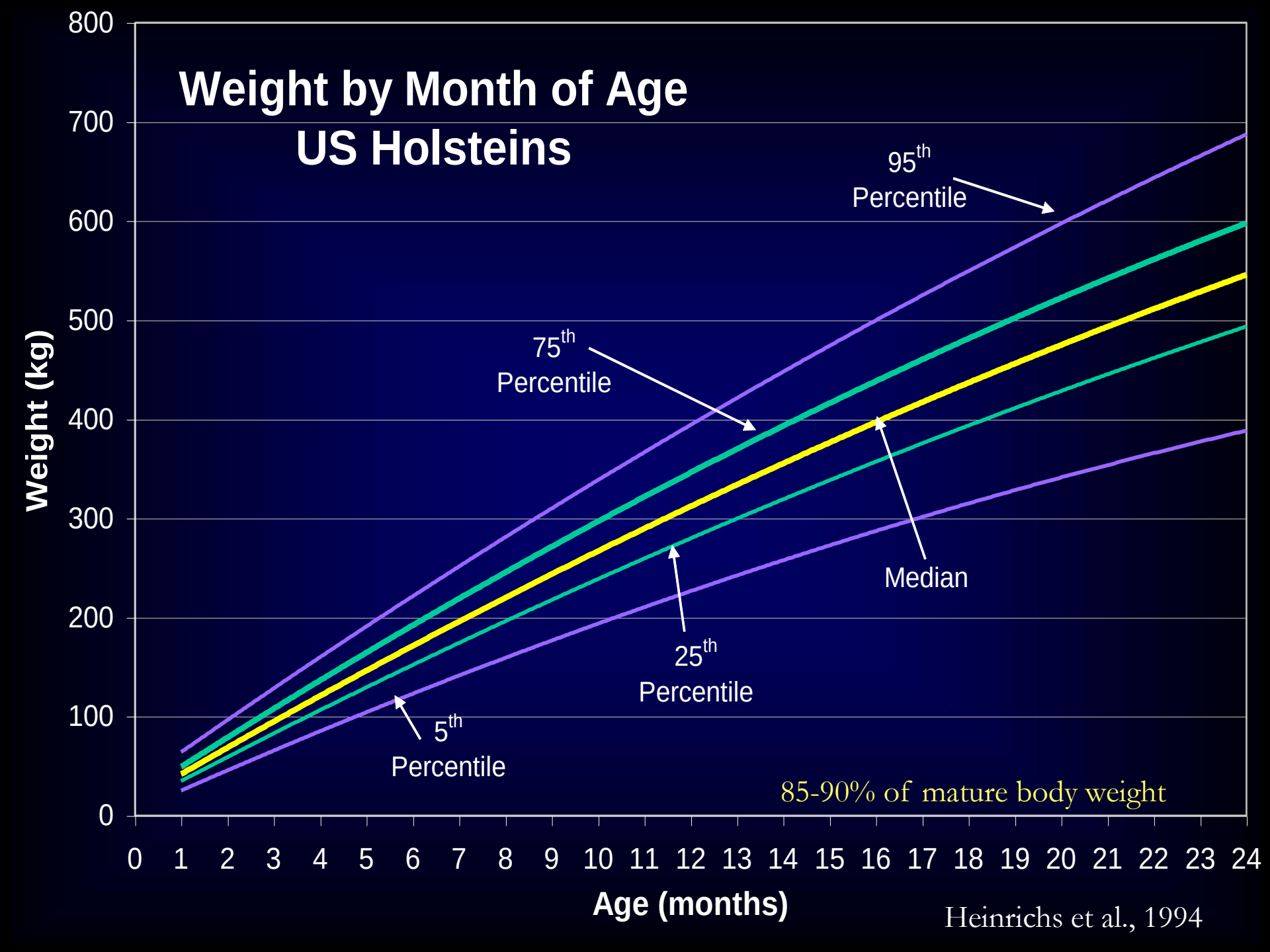
Zanton and Heinrichs, 2005

Calving between 1300 and 1375 pounds maximizes first lactation milk

From Keown and Everett, 1986

- Structural growth and body weight must be in proportion

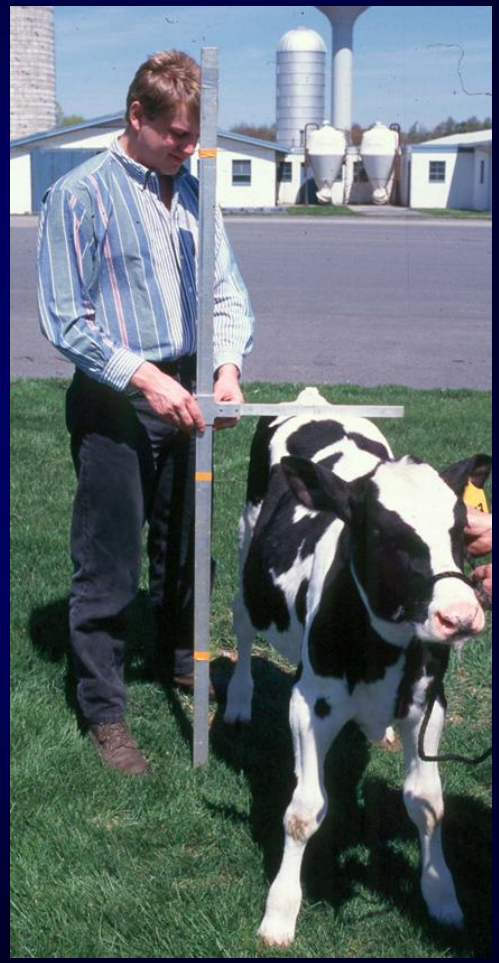
- Any structural measure is highly correlated to any other measure of structure


Weight by Month of Age
US Holsteins
95th Percentile
75th Percentile
Median
25th Percentile
5th Percentile
85-90% of mature body weight
Weight (kg)
Age (months)
0
100
200
300
400
500
600
700
800
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Heinrichs et al., 1994

Customized Heifer Growth Chart

- Herd mature body weight and height (withers or hip)
- Average birth weight of calves
- Average heifer services per conception

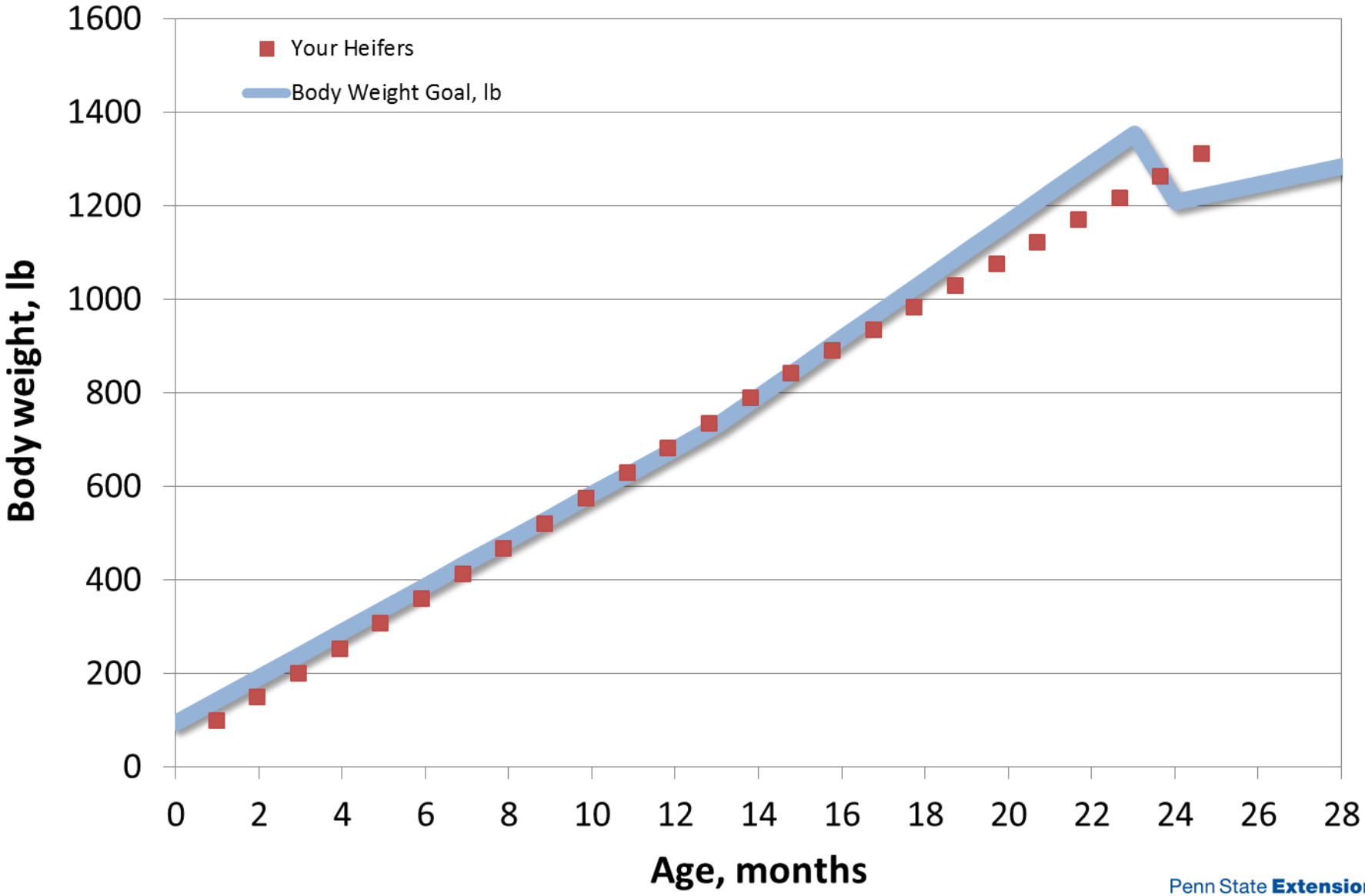
- Goal of age at calving



PENNSTATE

Customized Heifer Growth Chart

Based on Mature BW and Goal for Age at Calving

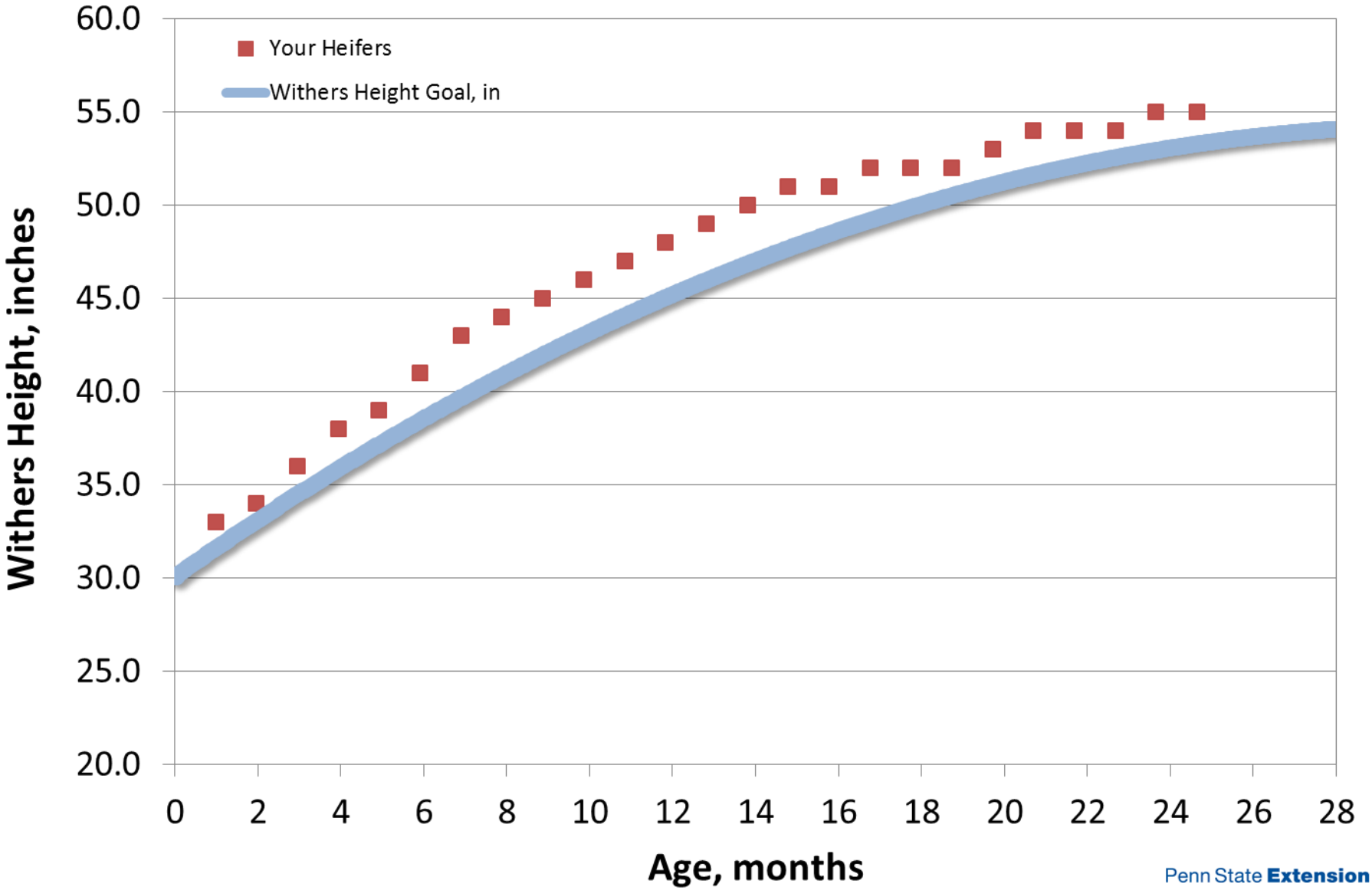


Penn State Extension

PENNSTATE

Customized Heifer Growth Chart

Based on Mature WH and Goal for Age at Calving



Penn State **Extension**

What we know about heifers in 2014

- Growth physiology- ADG limits
- ADG requirements to meet goals

Nutrient Requirements

Energy Requirements

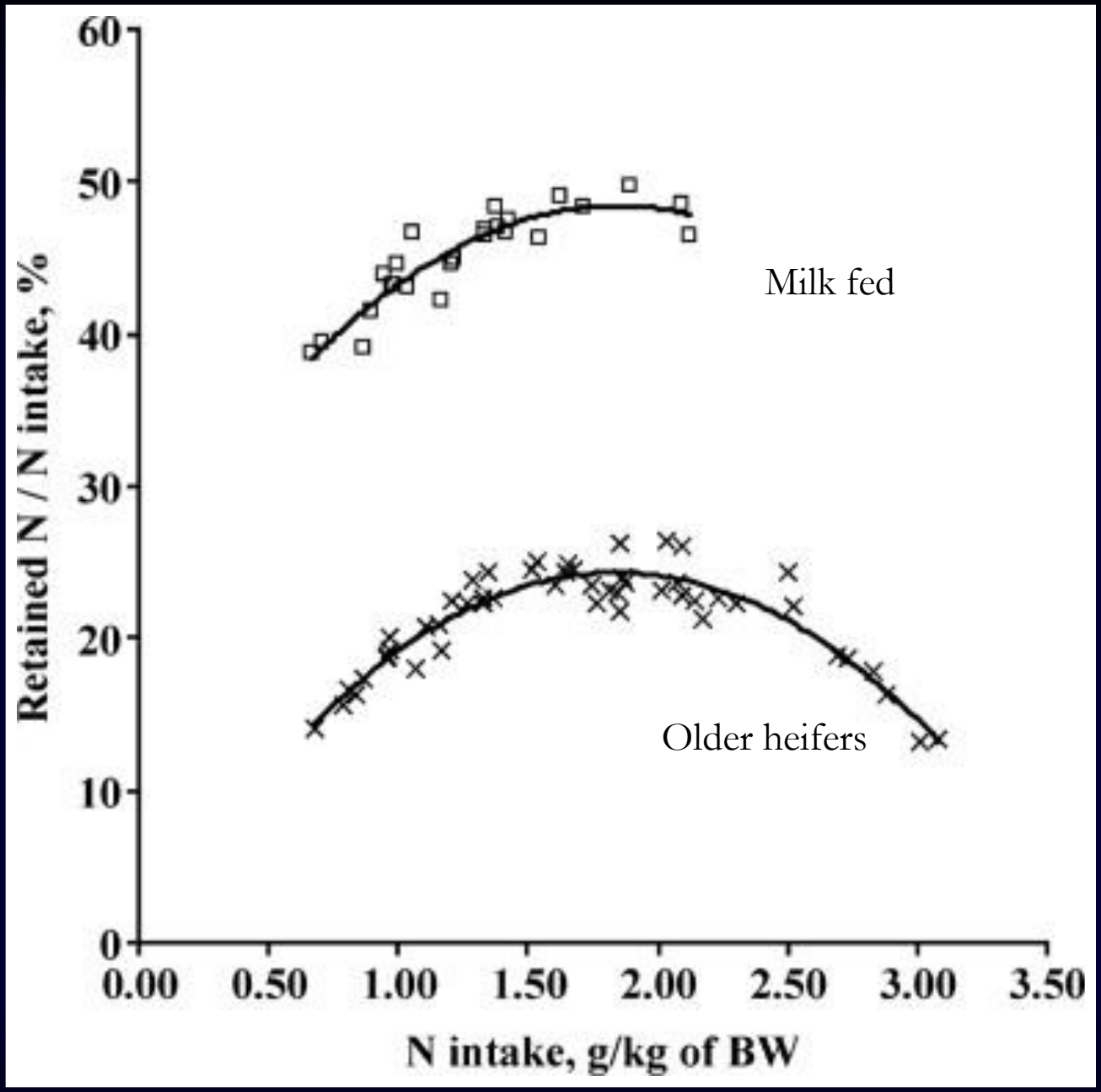
- Energy must be provided to meet maintenance and growth requirements (NRC, 2001)

- NE_m (Mcal/d)=0.0834*$BW^{0.75}$

- NE_g (Mcal/d)= 5.4185*(Current BW/Mature BW)$^{0.75}$ *$ADG^{1.097}$

Alterations in energy are required based on environmental conditions

Condition	Energy Requirements
Cold weather	Increase dietary energy
Wet/muddy conditions	Increase dietary energy
Wind exposure (winter)	Increase dietary energy
Cold, hard resting areas	Increase dietary energy
Heat stress	Increase energy needs-Intake depression
Well-managed freestalls	May decrease energy



Relationship of N intake (NI, g/kg $BW^{0.75}$) and GNE (g NR/g of NI)

Source: Journal of Dairy Science 2008; 91:1519-1533)

Protein requirements:

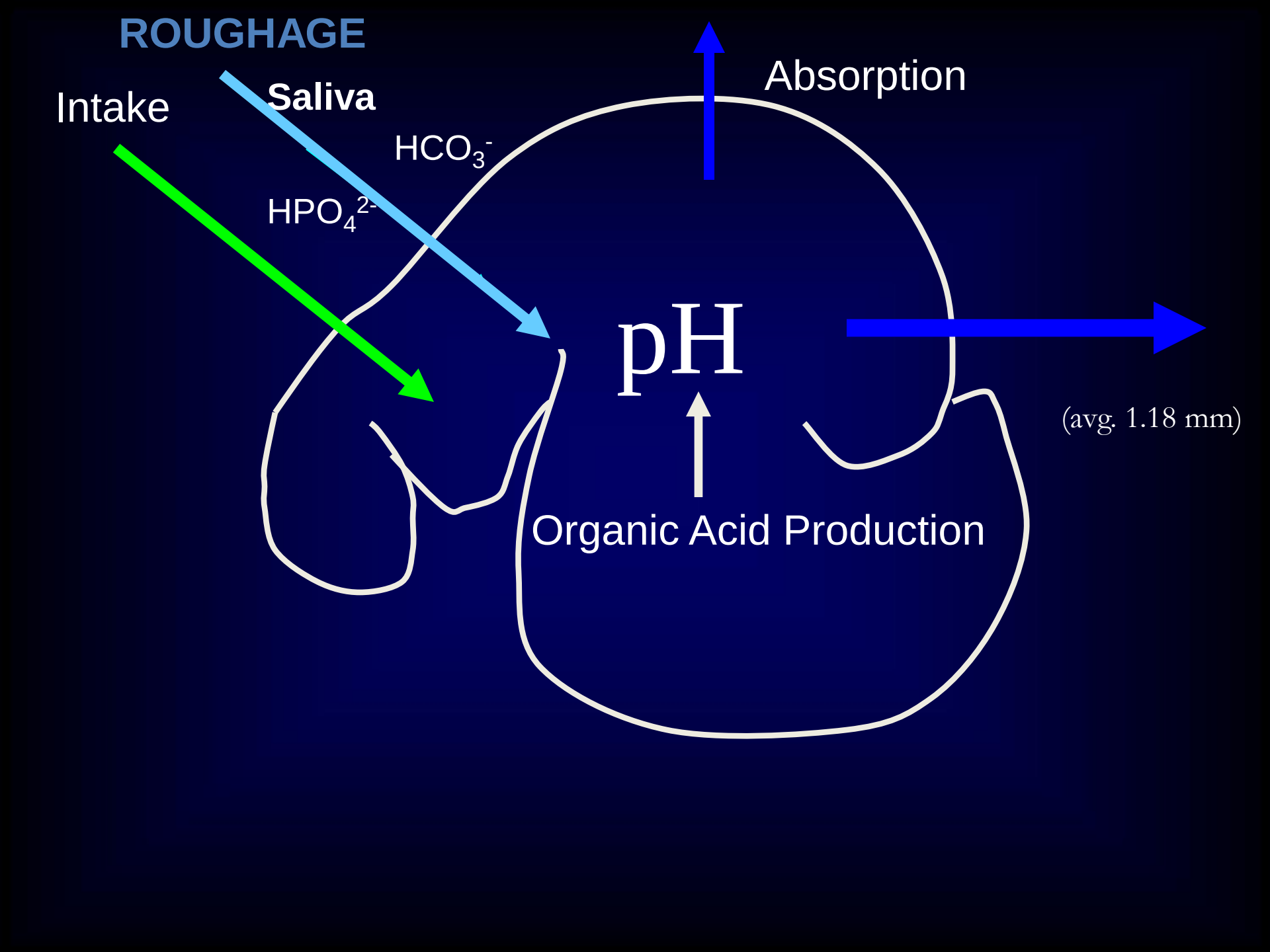
- NI = 1.84 g N/kg of $BW^{0.75}$ and 22% MJ of CP/MJ of ME
- **18.9% CP for milk fed calves**
- **14.2% for heifers**

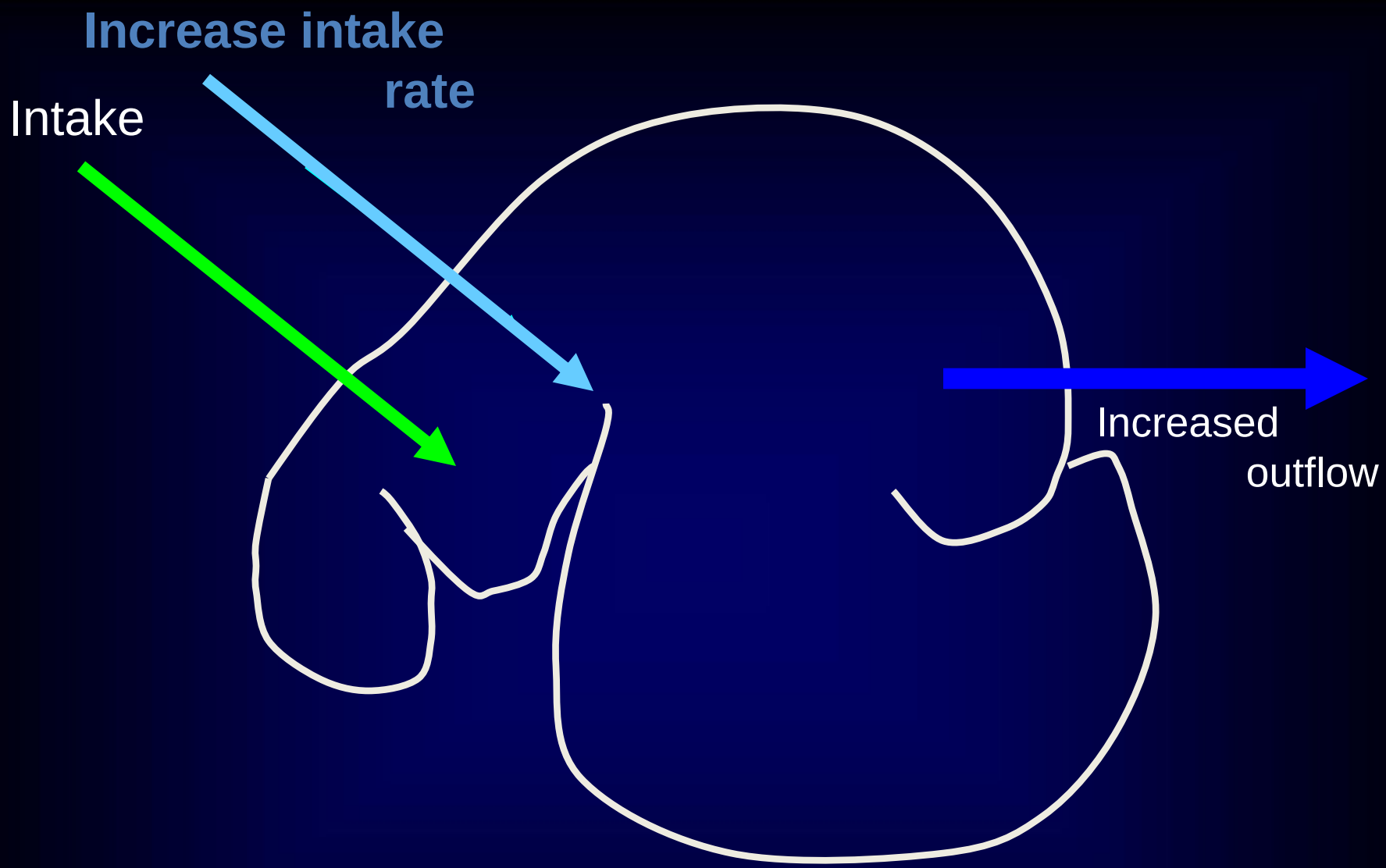
- Recommendations:
  - **14-15% CP for pre-pubertal heifers** based on 2.15% BW DMI/d
  - **13-14% CP for post-pubertal heifers** based on 1.65% BW DMI/d

What we know about heifers in 2014

- Growth physiology- ADG limits
- ADG requirements to meet goals
- Protein requirements & reasonable requirements most nutrients

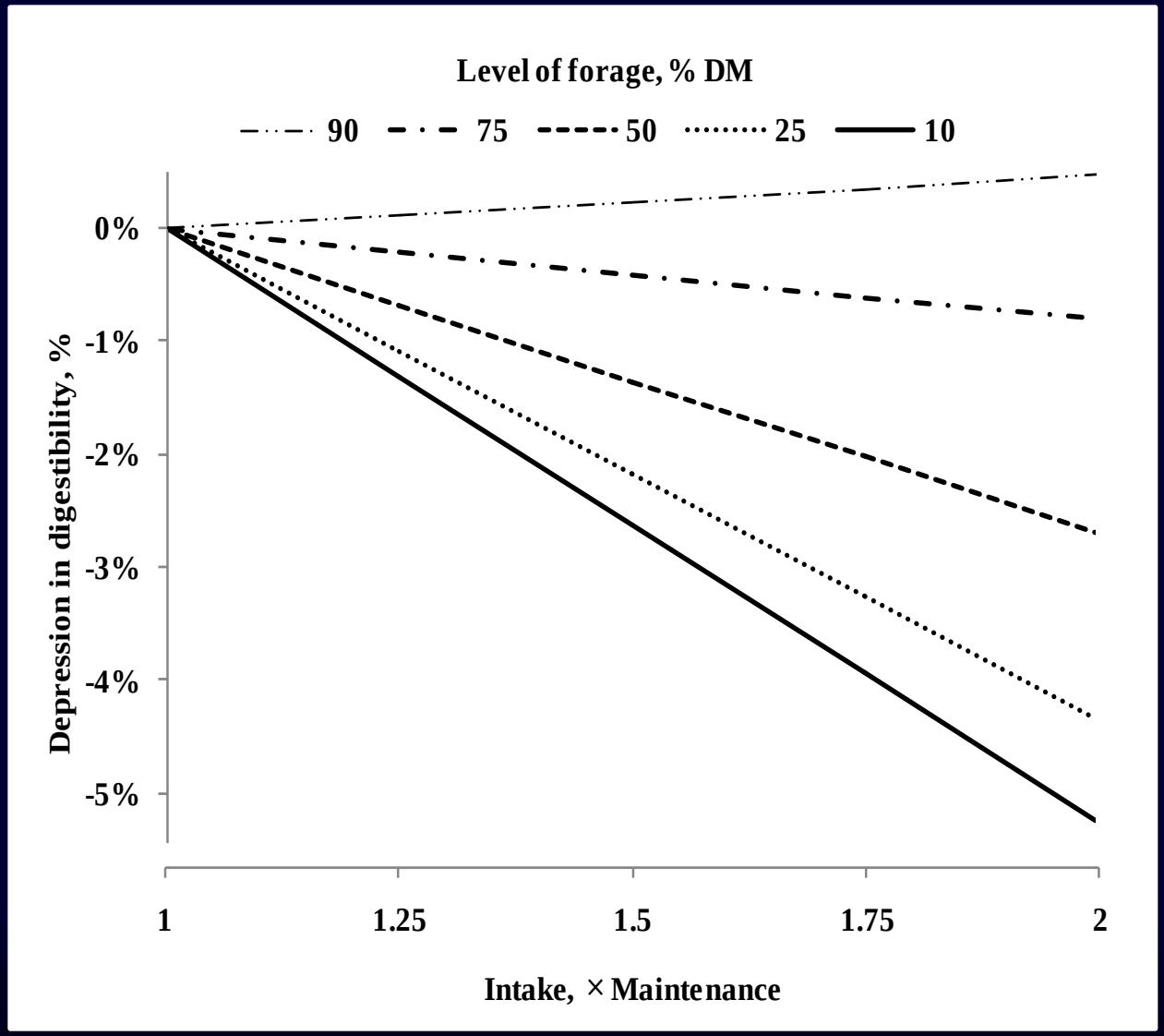
- **Precision Requirements for modern dairy heifers**


ROUGHAGE
Intake
Saliva
HCO_3^-
HPO_4^{2-}
Absorption
pH
(avg. 1.18 mm)
Organic Acid Production



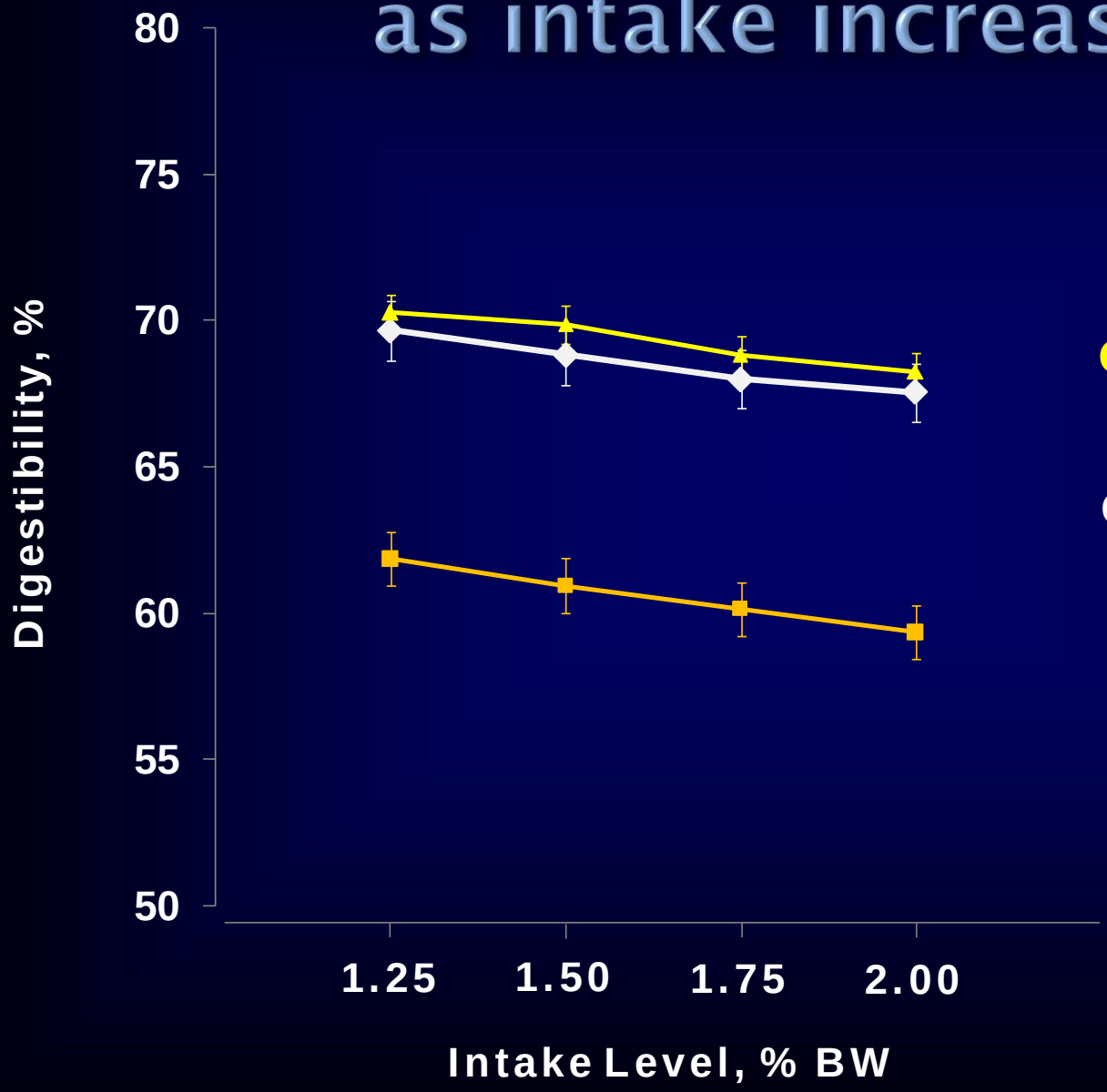
Longer rumen retention yields higher digestibility

As lactating dairy cows incrase intake, digestibility is reducd



Adapted from Tyrrell and Moe, 1975

Digestibility was reduced as intake increased



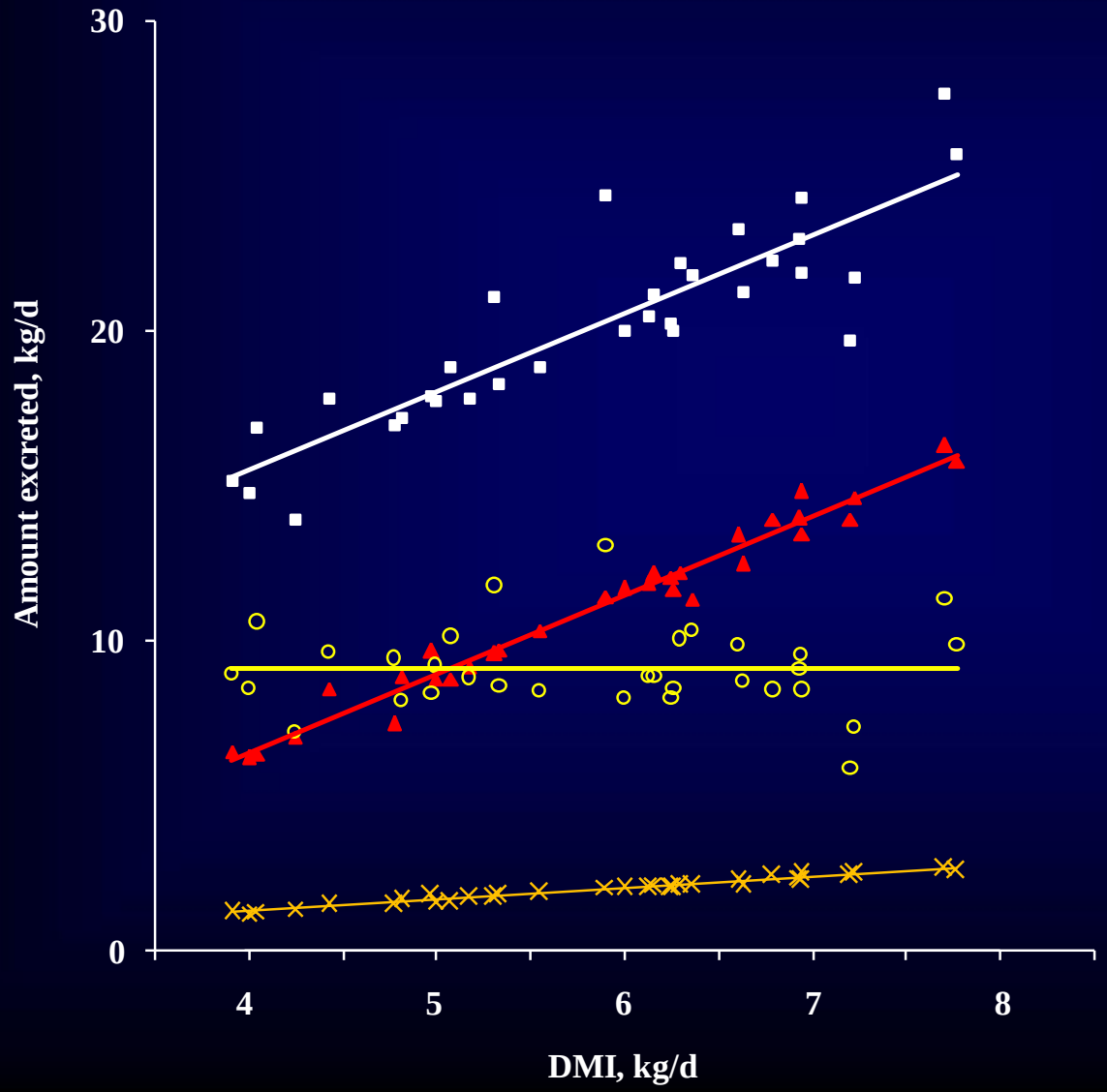
Crude Protein
Linear: P < 0.02

Organic Matter
Linear: *P* < 0.01

Neutral Detergent Fiber
P < 0.06

Zanton and Heinrichs, 2008

Total manure and wet fecal output decreases 2.54× faster than DMI



Total Manure

Fecal wet matter

Urine

Fecal dry matter

Zanton and Heinrichs, 2008

Mass of digestive tract (% EBW) of sheep fed HC and LC diets

75 % Forage		75% Concentrate		*P*-value	
Low Intake	High Intake	Low Intake	High Intake	Diet	Intake
5.67	7.65	5.26	5.79	0.002	0.007

McLeod and Baldwin, 2000. JAS; 78:760–770

Energy requirements of digestion

- Shown to be approx. 40% of gross ME intake
- Reynolds, 1991

Control Intake/Higher Quality Feeds

- Metabolic nutrient costs are increased when higher amounts of DM are consumed
- ↓ tissue energy is retained ↑ heat energy produced
- Feed efficiency is decreased
- **More intake = less digestibility & more energy used to move it through**

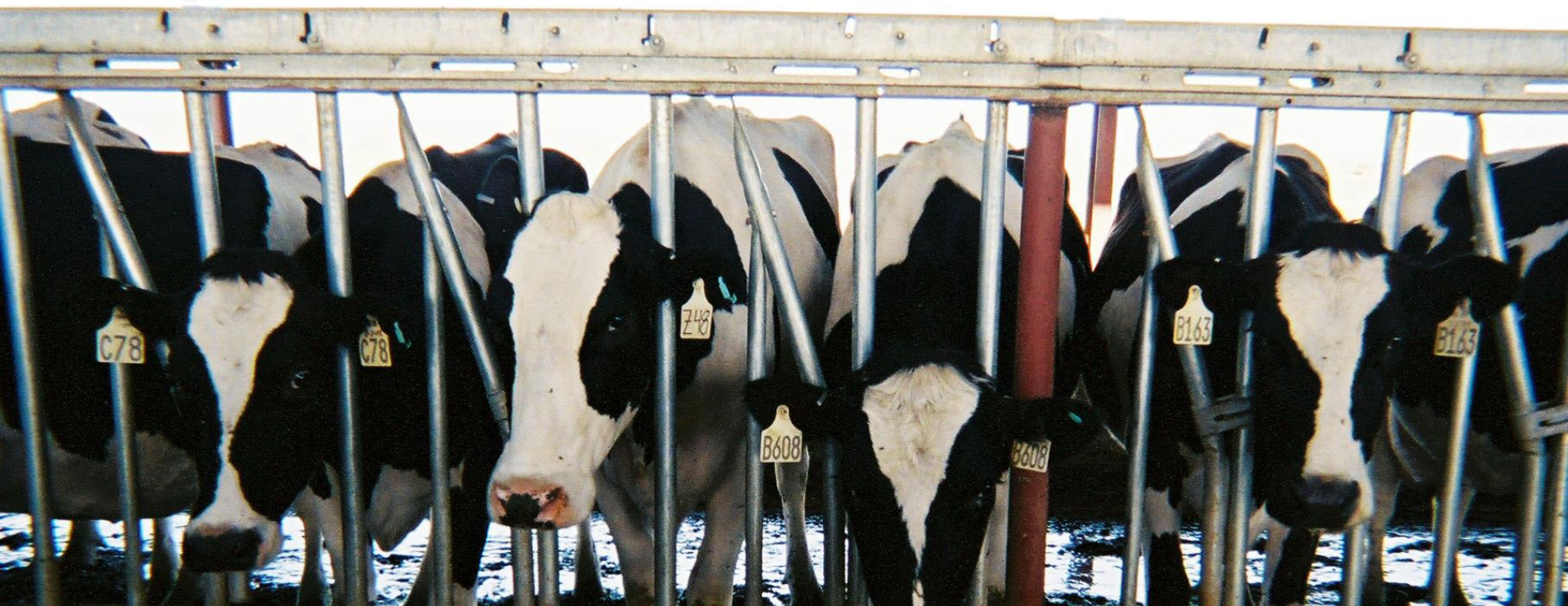
Forage Quality Issues

Many farms with reasonably good quality forages must limit feed intake somehow

Forage Quality Issues

Many farms with reasonably good quality forages and confined housing must limit feed intake somehow

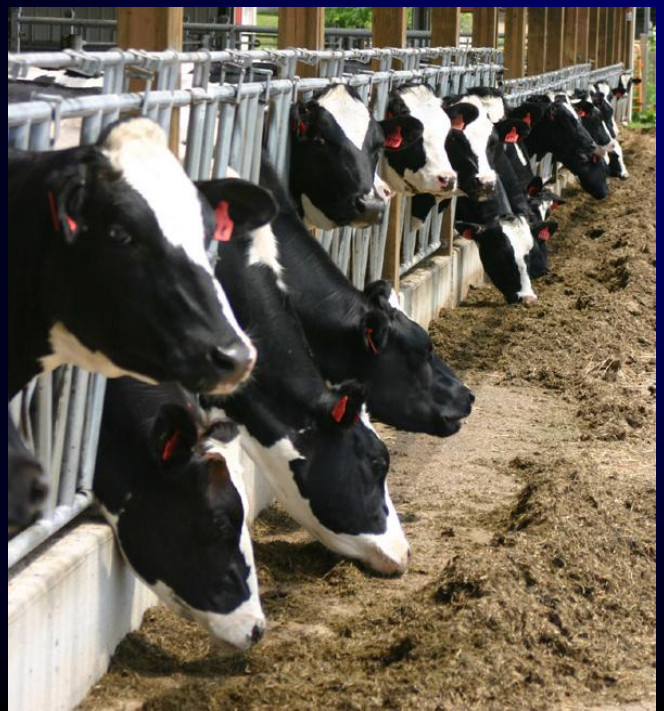
The problem with precision feeding heifers is……

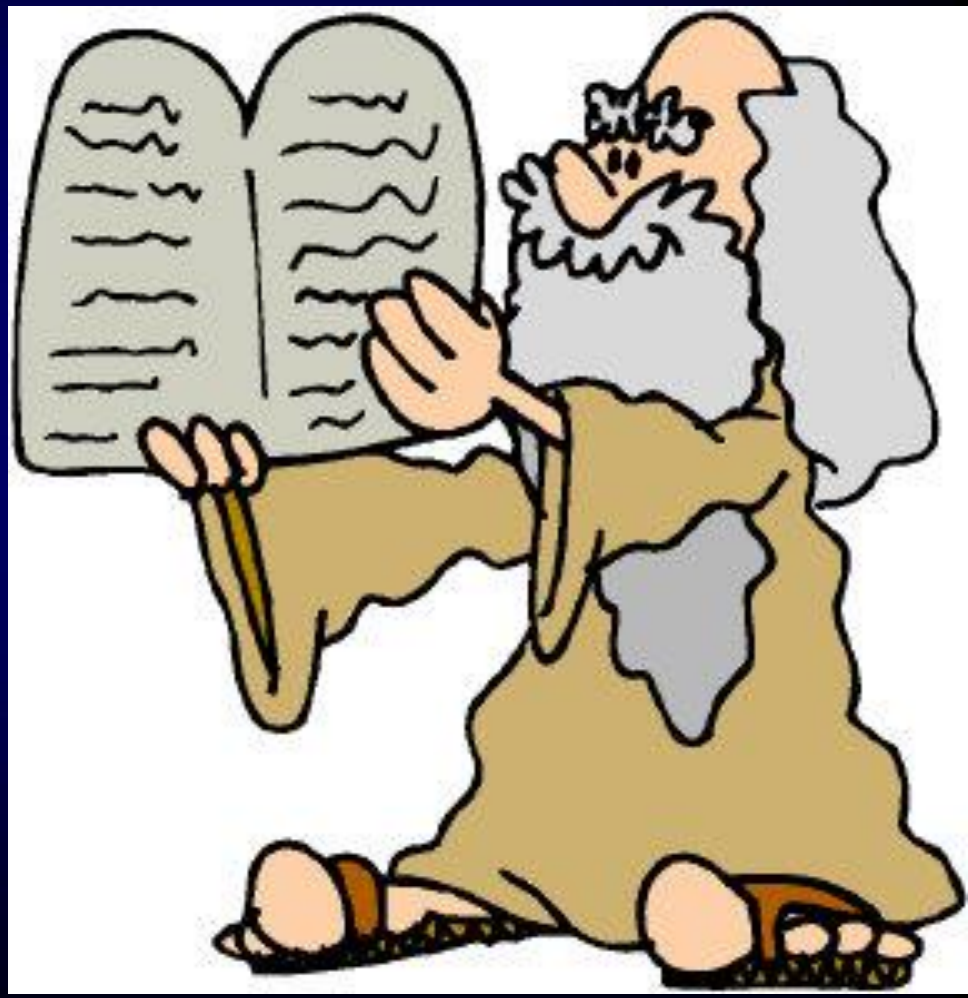


Turns heifer nutrition and management upside down!

The Eleventh Commandment ?

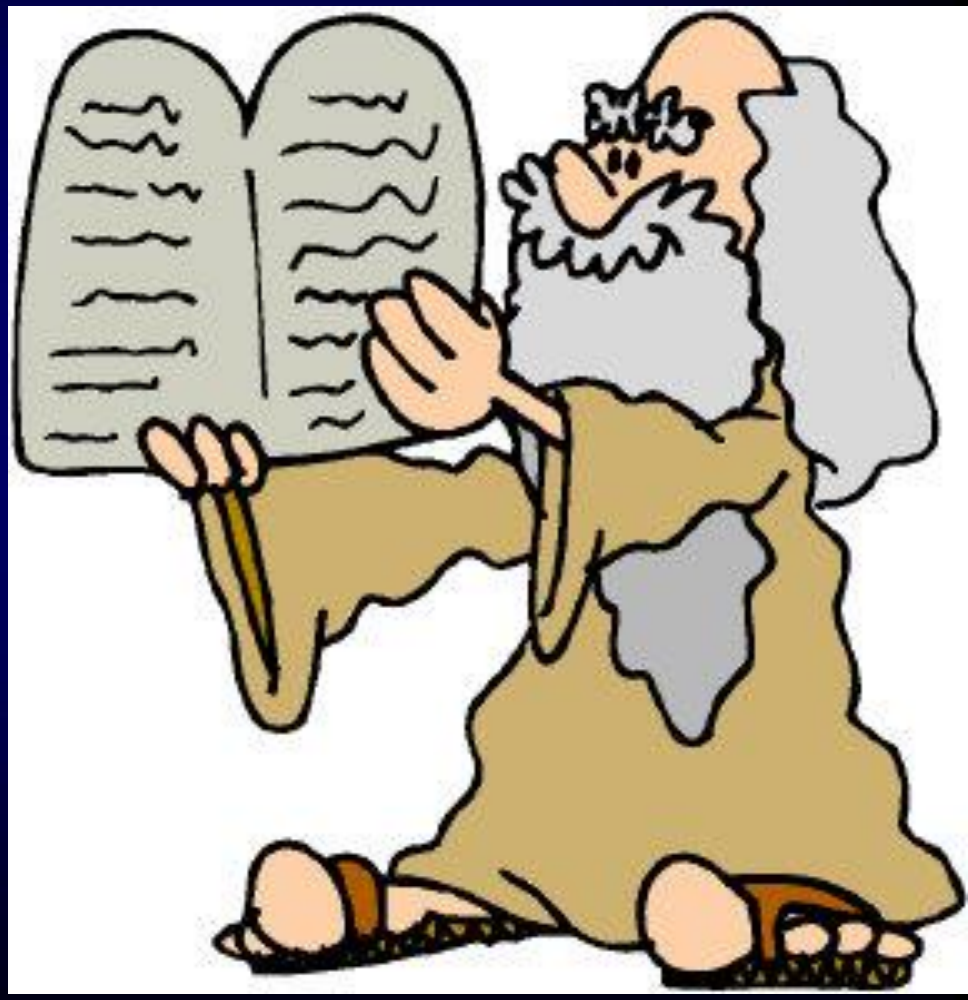
Thou shall have feed in front of heifers 24 hours a day.





The Eleventh Commandment ?

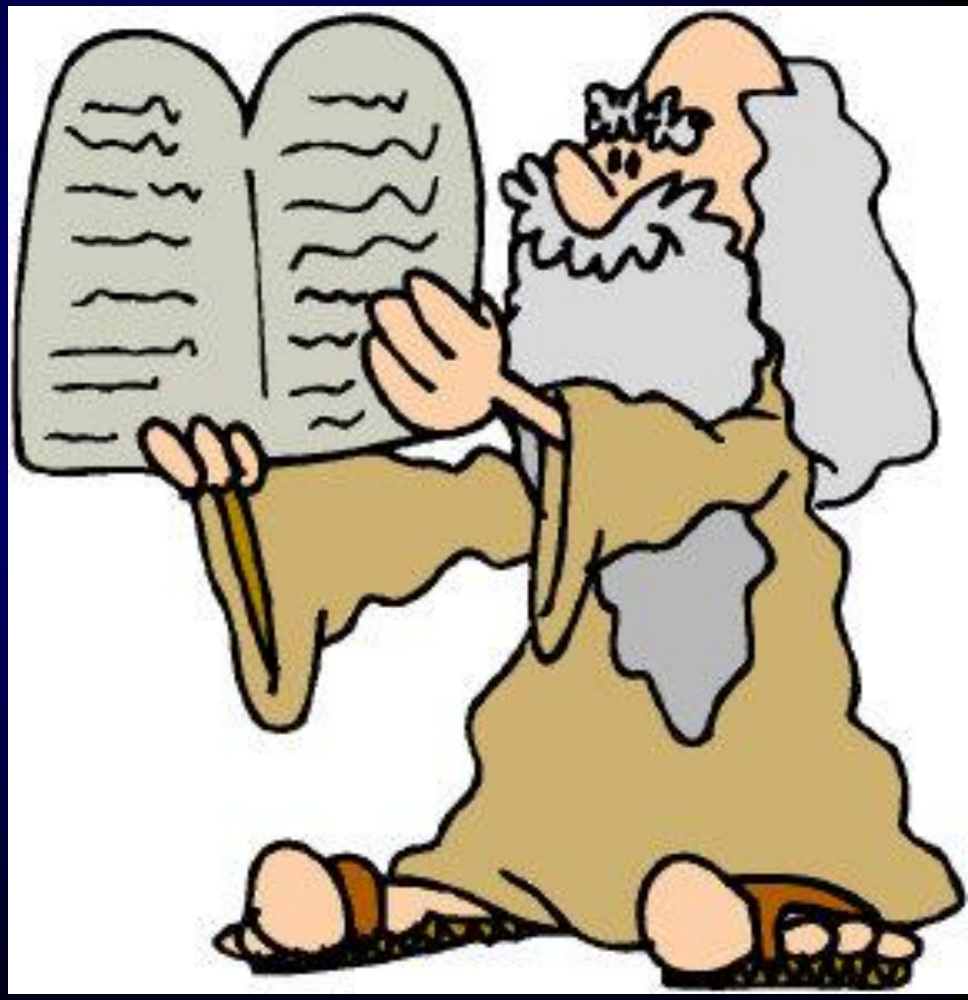
Thou shall have good pasture in front of heifers
24 hours a day.



NO

THERE WERE ONLY 10

But lactating cows need feed 24/7



Dry Matter Intake
of Precision Fed Heifers

Age (mo)	DMI (% body weight)
4	2.2
6	2.1
9	1.9
14	1.8
18	1.7
20	1.6
23	1.6

Hoffman study

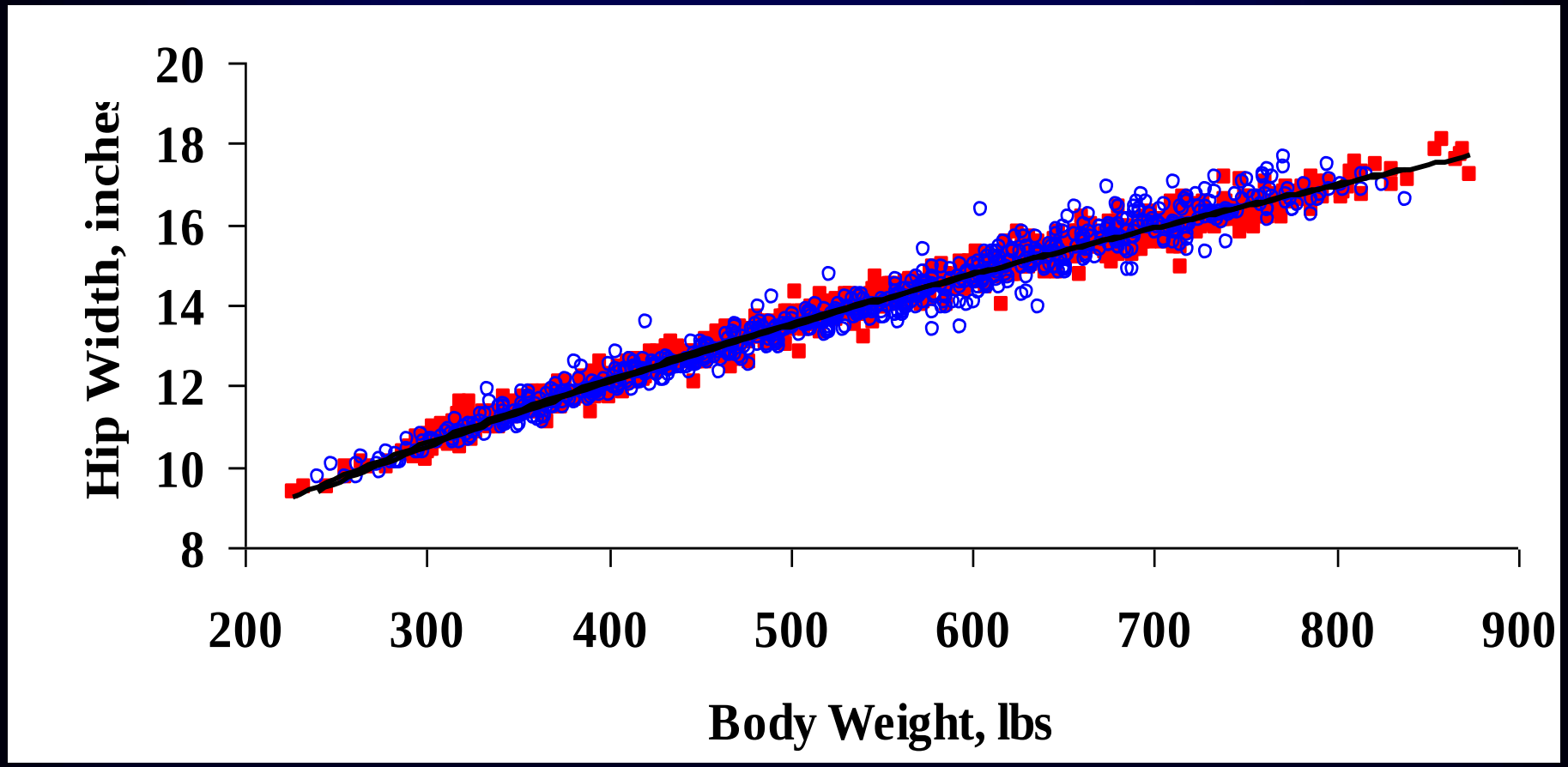
- Control diet
- Limit fed 85%
- Limit fed 80% + Bovatec

- 800-900 g/d ADG

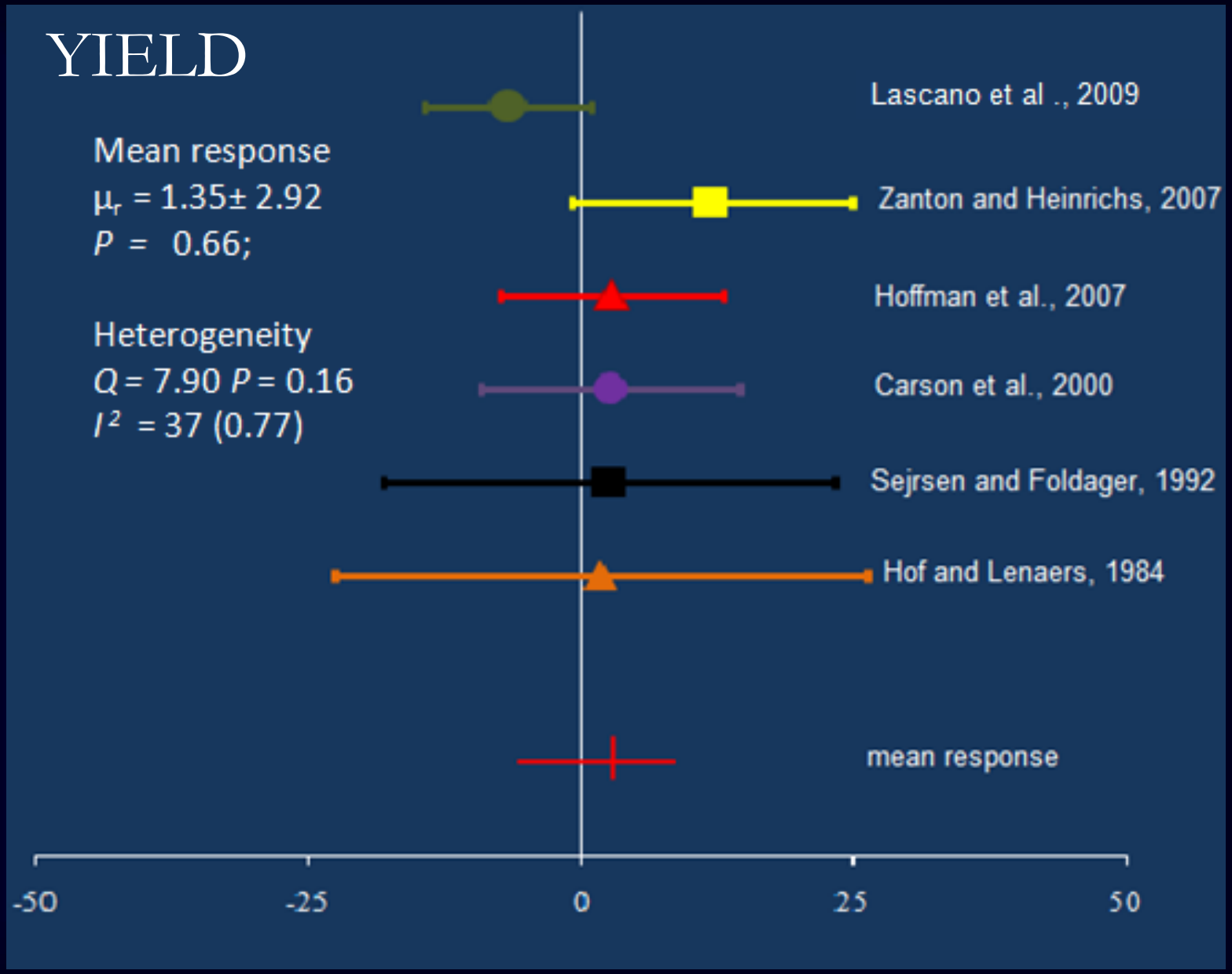
- F:G increased 29% LF

- FE 13.0 vs 9.1 vs 9.3

Hip width gain in heifers fed a HC or HF diet before puberty



MILK YIELD



Zanton and Heinrichs, 2010

What have we learned?

- Similar growth and first lactation milk yields (Hoffman et al., 2007; Zanton and Heinrichs, 2007; Lascano et al., 2009)
- Improvement in total tract digestibility…
- Reduced excretion (Moody et. al., 2007; Lascano et al., 2009a)
- No effects on pH (Moody et. al., 2007, Lascano and Heinrichs., 2009)
- Increased bacteria numbers (Lascano et al., 2009b)
- Optimal N intake (Zanton and Heinrichs, 2009)
- No effects on NH_3 emissions (Lascano et al., 2008)
- Room for supplementation of additives (Lascano et al., 2009; Kruse et al. 2010)
- Feed behavior changes (Kitts et al., 2009) but can be mitigated (Kruse et al. 2010)

Is this heifer feed?

Or just a desperation move when you are out of any forage or dry matter?

Summary: Precision Fed Dairy Heifers

- Optimize feed intake NOT maximizing
- Increase forage NDF digestibility
- Increase diet digestibility (F:C)
- Stimulate rumen function and microbial digestion
- Maintain adequate environment (excess heat or cold increases ME requirements)
- Maintain optimal health and management

Precision Feeding Dairy Heifers

- Improve feed efficiency
  - Reduce manure
  - Reduce feed costs
  - Maintain heifer growth and first lactation production levels

Conclusions

- Current Penn State heifer requirements are:
- DMI - approx 2% BW (2.2% young ; 1.8% older)

- FEED to desired RATE OF GAIN
  - 1.75 -1.85lbs/d pre-pubertal; 800- 840g/d Holsteins; less for Jerseys
  - 1.5-2.5 lbs/d post pubertal 600-1100g/d: 85+% MBW for any breed of animals

Thank you.