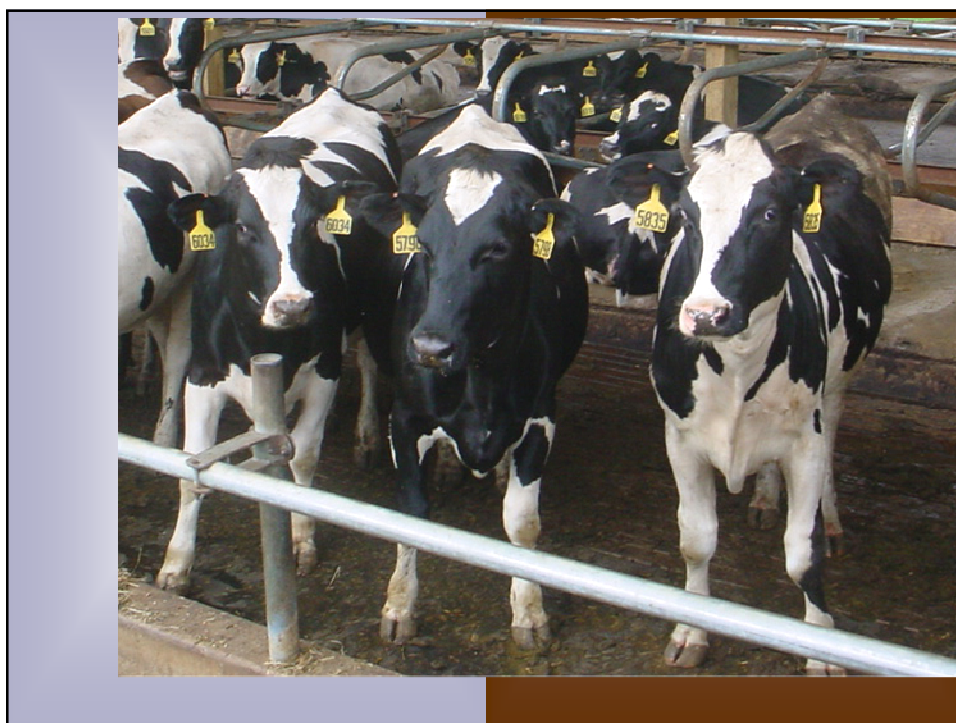


PENNSTATE



## Dairy Heifer Nutrition

Jud Heinrichs  
October 2007





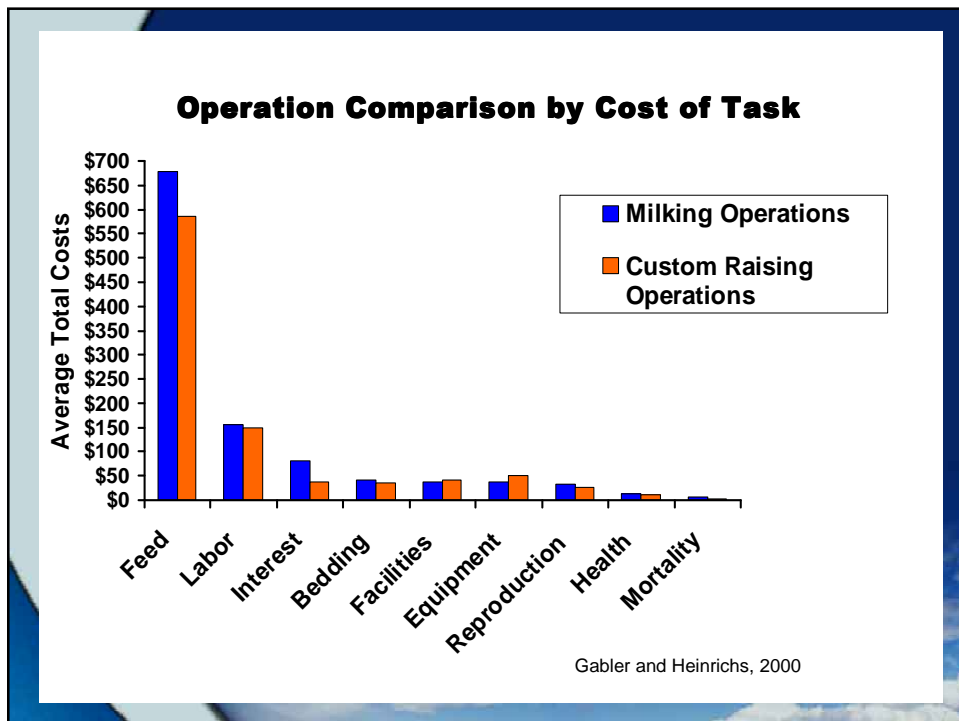
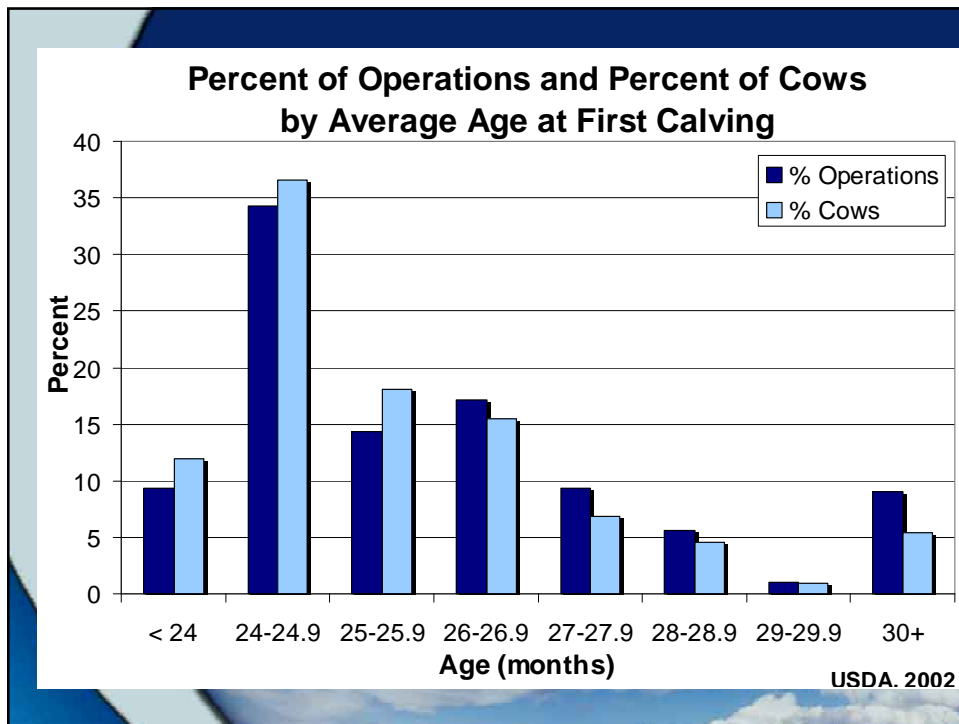
## **Time Before First Lactation is a Large Portion of the Average Cows' Life**

### **A Pennsylvania Example**

#### **■ Lancaster County DHIA Holsteins (September, 2007)**

- Average age at first calving = 25.5 months
- Average animal age = 46.5 months

- **54.8% of an average cow's life is spent as a heifer**



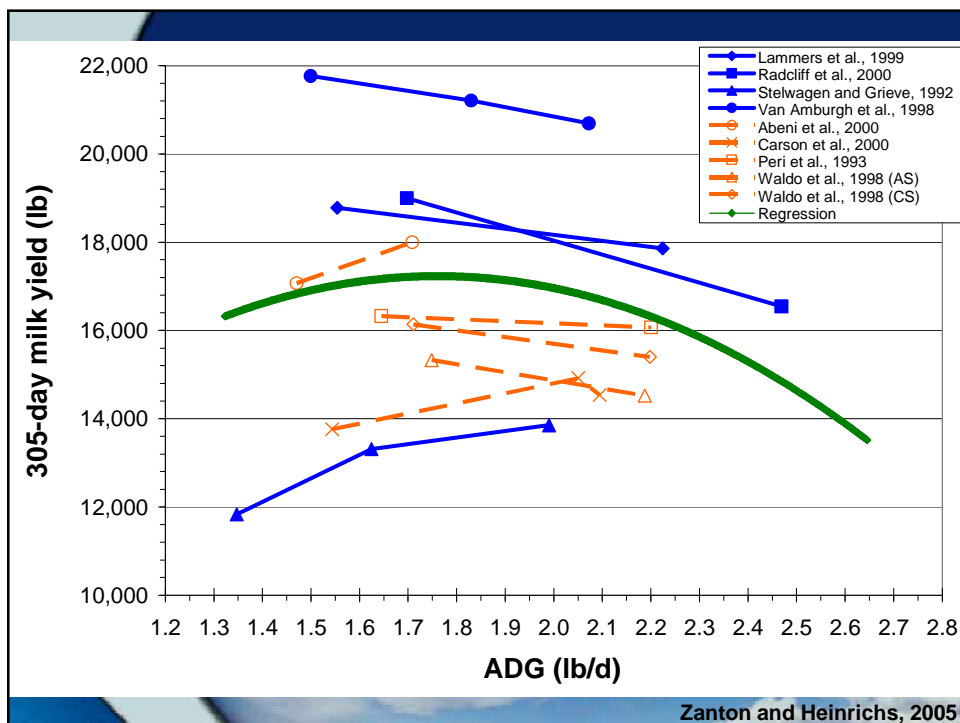
## Meta-Analysis:

### Effect of Prepubertal ADG on First Lactation Performance of Holstein Heifers

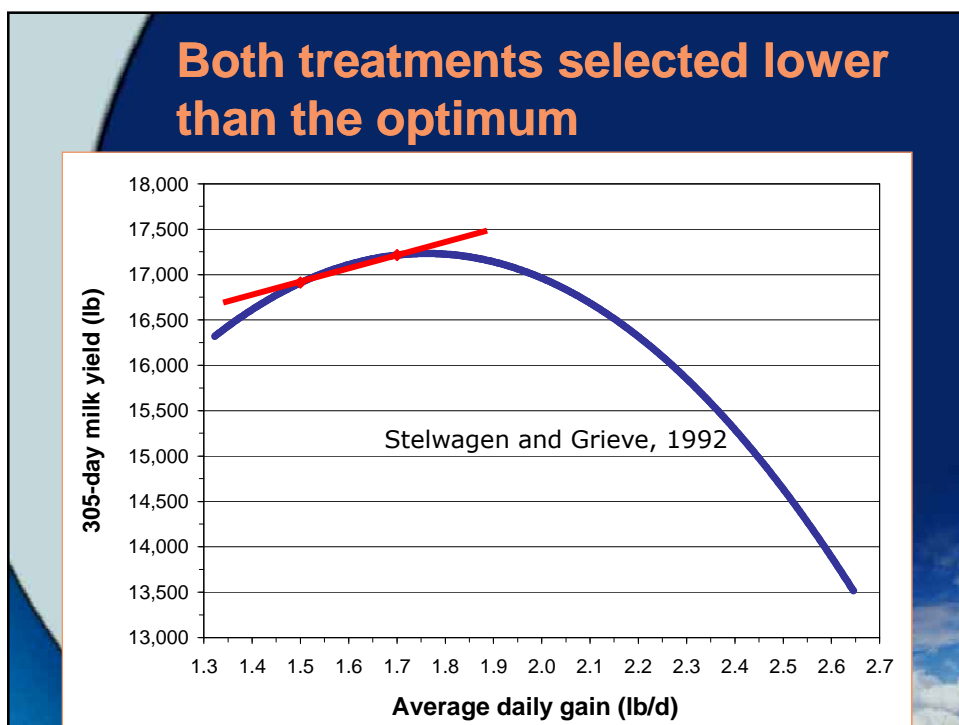
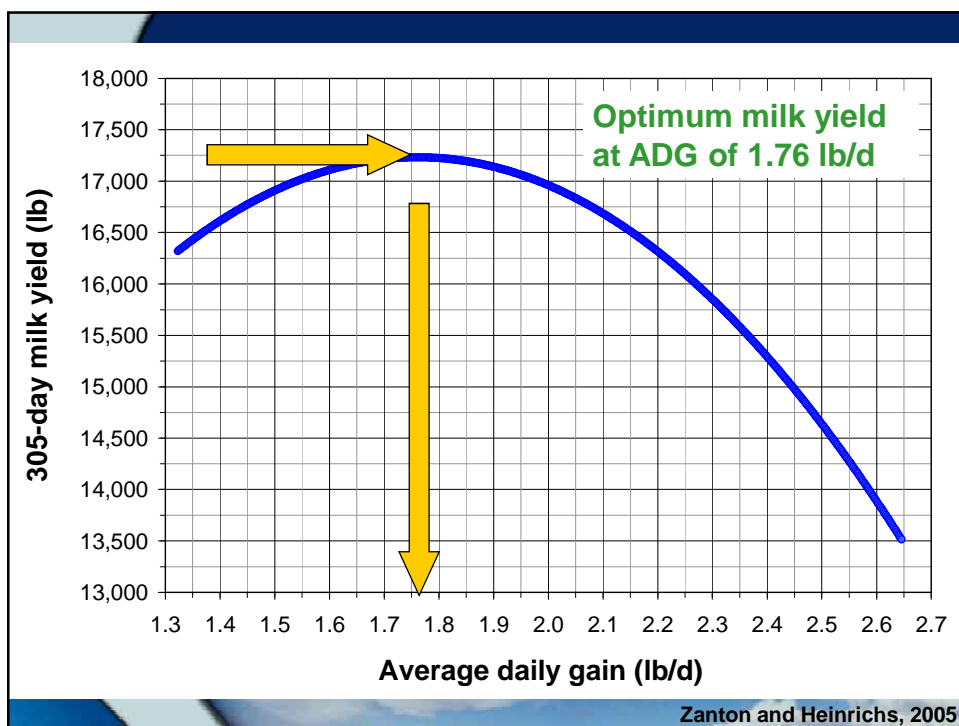
Summarized all world-wide published Holstein studies in the past 15 years.

Treats them as if they were one single study with many treatment groups and a more continuous ADG variable.

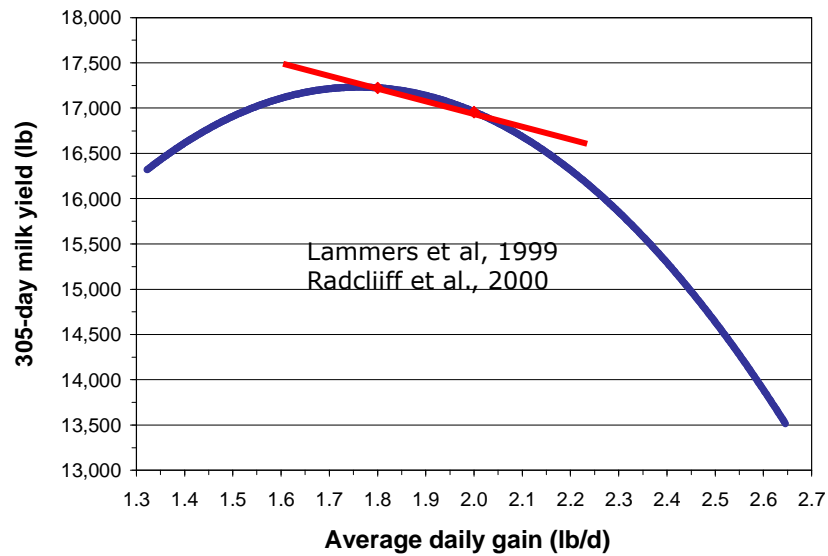
Zanton and Heinrichs, 2005



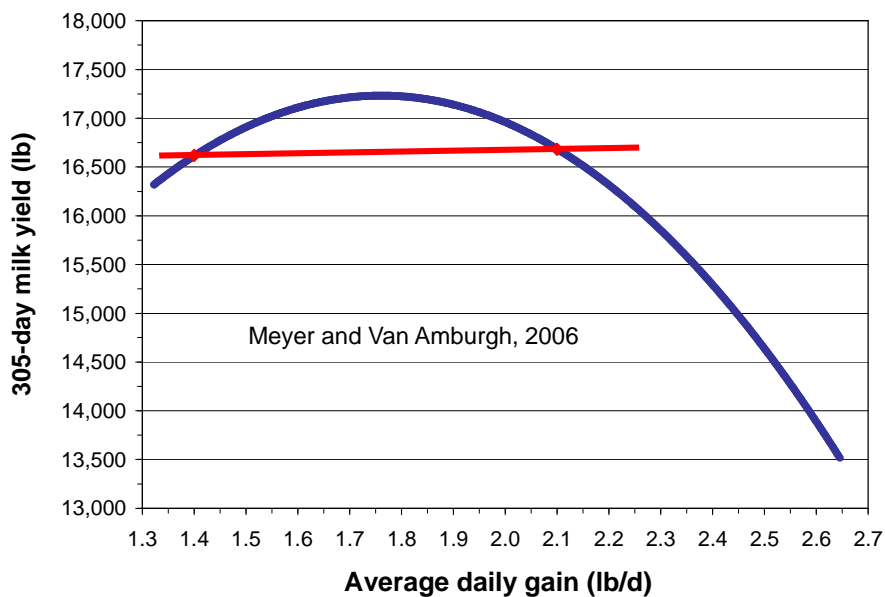


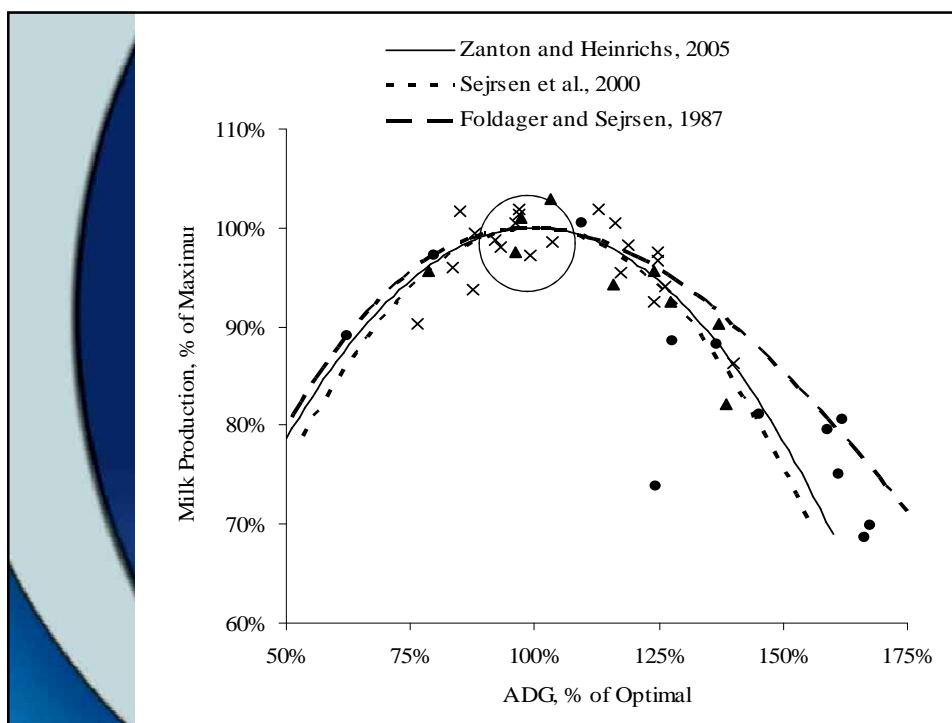


## Both treatments selected higher than the optimum



## Both treatments selected at parallel points



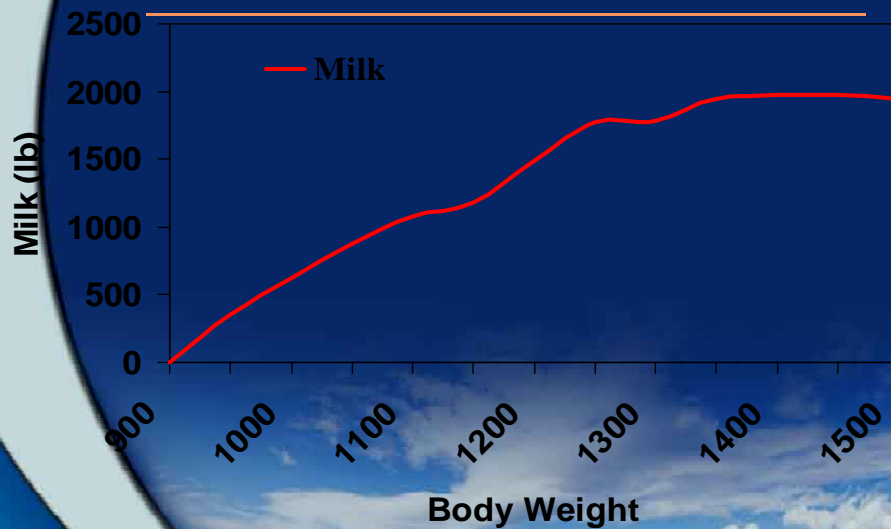


## ADG Post Puberty

- Hoffman et al., 1996 778 and 933 g/d
- Lammers and Heinrichs, 2000 1010-1106 g/d
- Longenbach and Heinrichs, 1999 840g/d (1.8 lb/d)
- Van Amburgh et al., 1998 580-670 g/d
- Waldo et al., 1998 609-648 g/d

## Body Weight and Milk Production

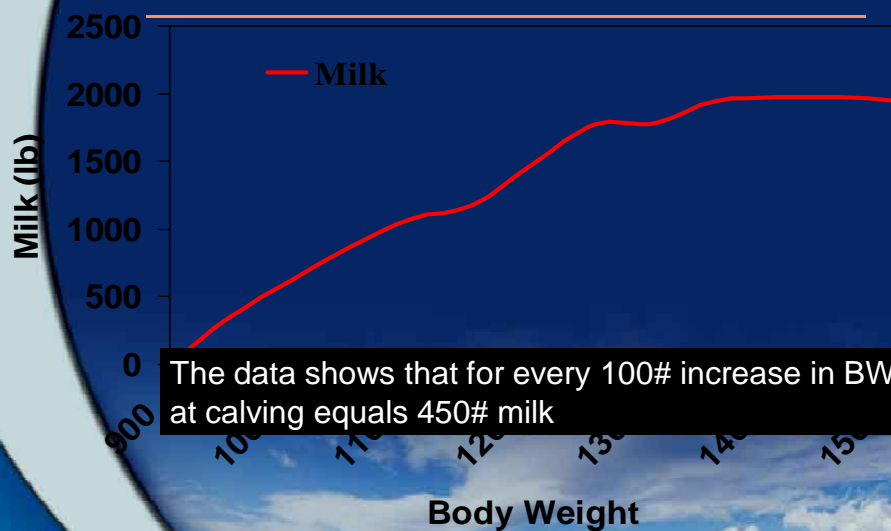
Difference from 900 lbs.



Keown and Everett, 1986

## Body Weight and Milk Production

Difference from 900 lbs.



Keown and Everett, 1986

## Rate of gain limitations and body weight at calving limitations

- ▣ ADG pre puberty
- ▣ ADG post puberty

In 2007 and beyond:  
We have to measure  
heifer weights





## An example:

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- Grow heifers correctly 1.8# vs 2.1#
- Calve 1 mo earlier
- Increase BW by 100#

## An example:

---

- Grow heifers correctly 1.8# vs 2.1#
  - 750# milk or \$165.
- Calve 1 mo earlier
  - \$95
- Increase BW by 100#
  - 450# milk or \$99

## An example:

---

- Grow heifers correctly 1.8# vs 2.1#
  - 750# milk or \$165.
- Calve 1 mo earlier
  - \$95
- Increase BW by 100#
  - 450# milk or \$99
- Total of \$359/heifer

## What's a new scale cost?

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- About \$3000. or 8 heifers that were mistakes!!!!!!!
- Plus labor

## A Different Concept in Dairy Heifer Feeding

- Limit feeding
- High concentrate / highly digestible diets



### Visceral organ weights (g/kg EBW) of sheep fed ad lib or at maintenance levels for 21 d

	Ad lib.	Maint.
□ Liver	773	369
□ Kidney	98	70
□ Small intestine	680	425
□ Large intestine	601	379

Burrin et al. 1990; British J. Nutr.

## Forage to Concentrate level and intake

( weight as a % of empty body weight)

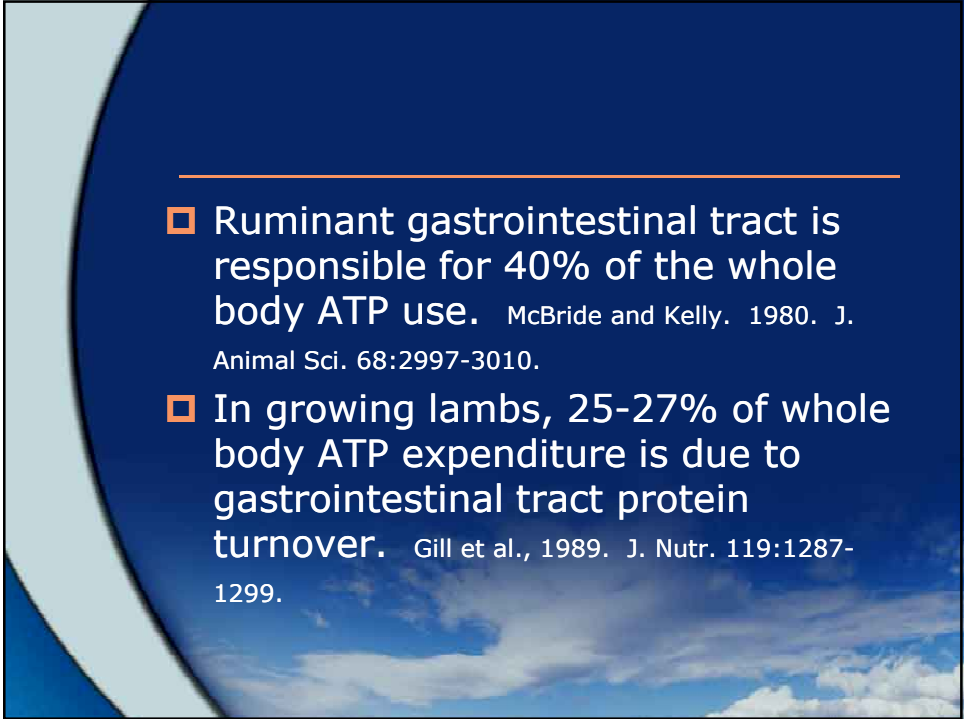
	75% Forage		75% Conc.		P value	
	Low Intake	High Intake	Low Intake	High Intake	Diet	Intake
Digestive Tract	5.67	7.65	5.26	5.79	.002	.0007
Small Intestine	1.69	2.30	1.56	1.61	.002	.009
Large Intestine	1.38	1.70	1.32	1.35	.05	-
Liver	1.40	1.93	1.48	2.00	-	.0002

McLeod and Baldwin, 2000; J. Anim. Sci.

## Rumen development, intestinal growth and hepatic metabolism in the pre- and postweaning ruminant

- Portal drained viscera (digestive tract, pancreas, spleen, and mesenteric fat) accounts for 20-30% of whole body oxygen consumption
- Liver accounts for an additional 25% of oxygen consumption (Seal and Reynolds, 1993. Nutr. Res. 6:185-208)

Baldwin et al., 2003. J. Dairy Sci. 87:E55-E65

- 
- ❑ Ruminant gastrointestinal tract is responsible for 40% of the whole body ATP use. McBride and Kelly. 1980. J. Animal Sci. 68:2997-3010.
  - ❑ In growing lambs, 25-27% of whole body ATP expenditure is due to gastrointestinal tract protein turnover. Gill et al., 1989. J. Nutr. 119:1287-1299.

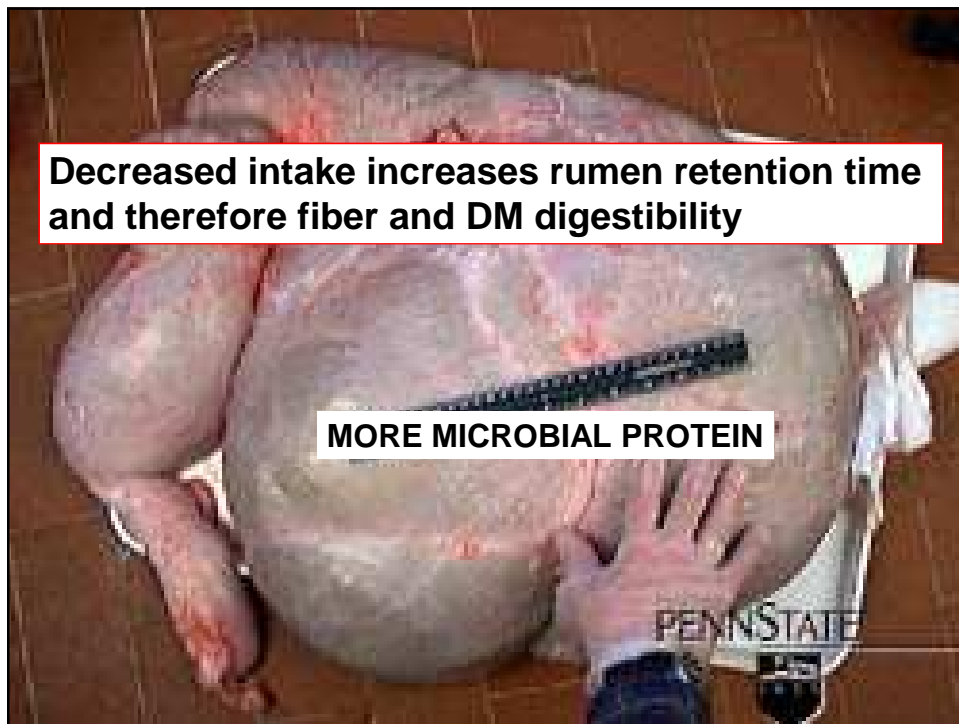


## **Restricted feeding of growing steers**

- ❑ Small improvements in feed efficiency
- ❑ Reduced maintenance requirements
- ❑ Greater lean tissue accretion

Murphy and Loerch. 1994. J. Anim. Sci. 72:2497





## Limit Feeding of Dairy Heifers

- Improves feed efficiency
  - Reduce visceral energy demands
  - Improves cellulose digestion
  - Improves DMD
- Allows animals to be fed to meet actual requirements or for specific growth rates

## A Different Concept in Dairy Heifer Feeding

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- ❑ Most farms with reasonably good quality forages and confined housing must limit feed intake somehow

## Overview of Heifer Studies

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- ❑ High concentrate (70-80%) vs. traditional US diets of 80% forage
- ❑ All age heifers 4-22 months of age
- ❑ Silage based TMR diets
- ❑ Corn grain and soy protein

## Objective

- ❑ Evaluate rumen fermentation in dairy heifers fed a **HC** or a **HF** ration at two ages (**Y** and **O**)
- ❑ Evaluate nutrient digestibility and nitrogen utilization



## Materials and Methods

### Treatment Ration Ingredients

Ingredient	HC	HF	SE
Grass Hay	12.82	3.04	0.02
Alfalfa Hay	1.97	34.99	0.23
Corn Silage	9.41	36.23	0.27
Ground Corn	56.96	14.73	0.04
SBM	6.96	3.93	0.02
CSH	4.91	2.02	0.01
Urea	0.93	0.05	0.00
Bicarb	0.96	0.99	0.01
Mineral Mix	5.07	4.02	0.04

## Results-Intake

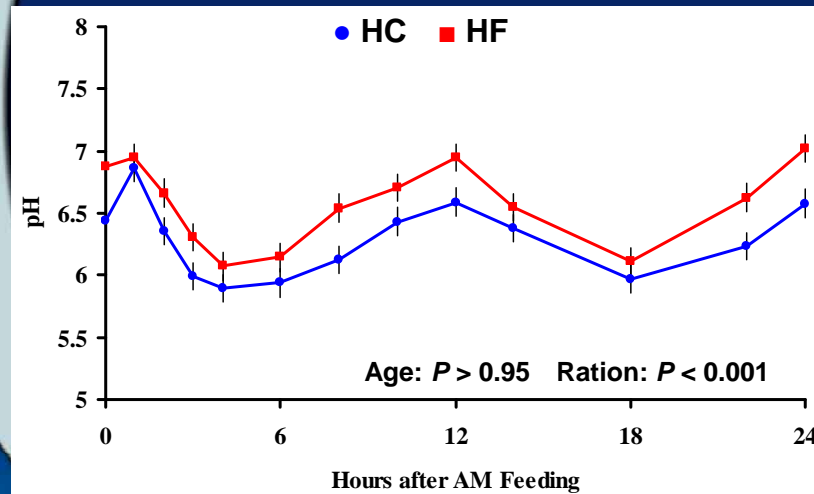
kg/d	Young		Old		SE	<i>P</i> < 0.05
	HC	HF	HC	HF		
DMI	4.85	5.19	9.07	9.69	0.08	A, R, I
Voluntary Water Intake	16.64	17.23	29.10	33.56	2.27	A, R, I

## Rumen Sampling

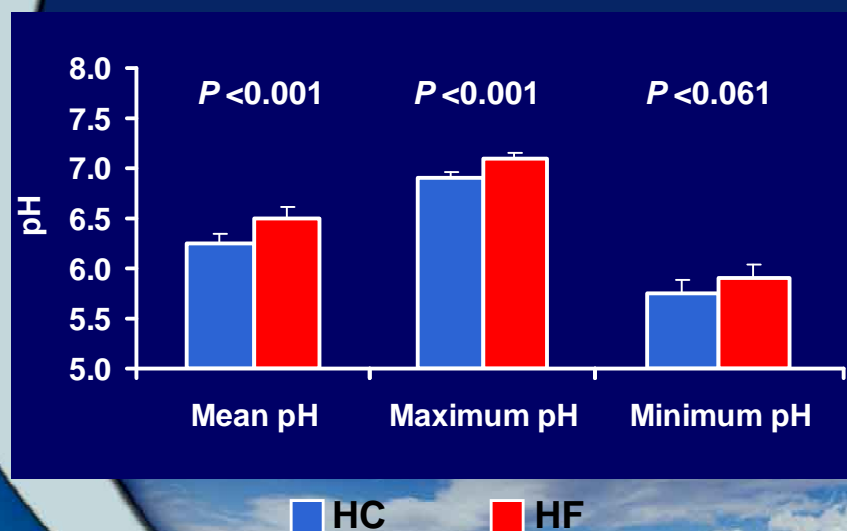


## Results-pH Profile

- pH profiles are similar, the levels differ

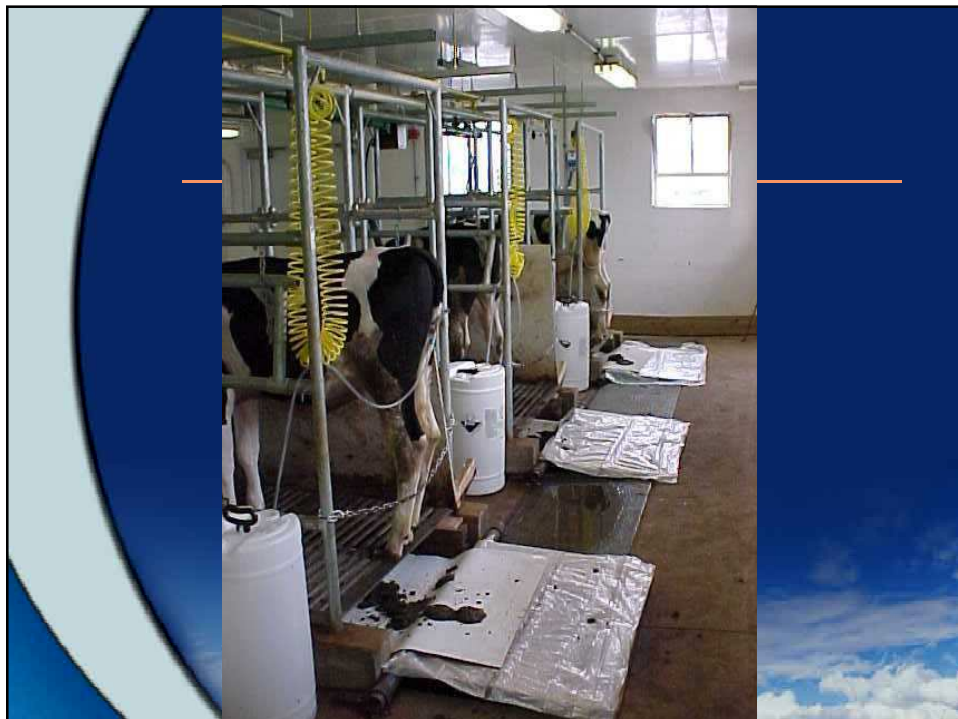
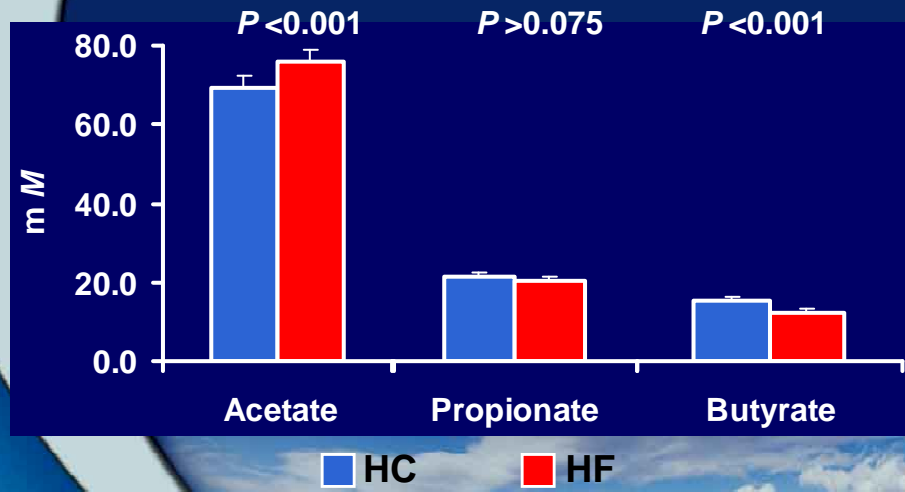


## Results-Daily pH Responses

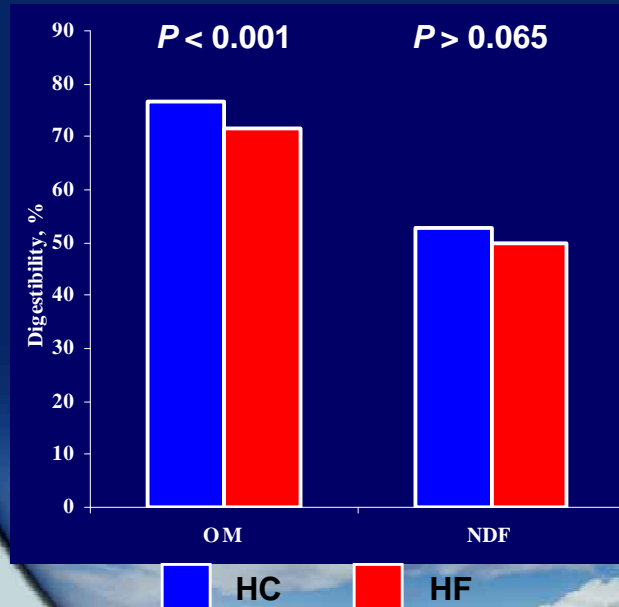




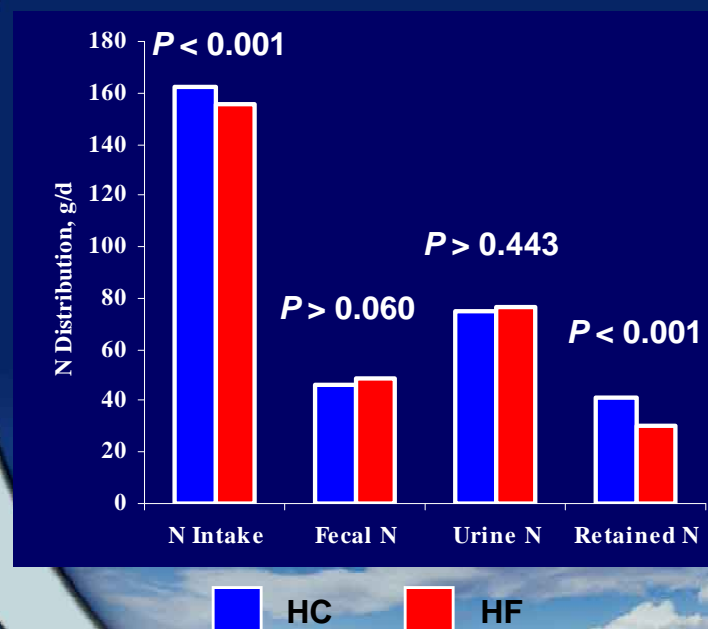
## Results-Mean Daily VFA



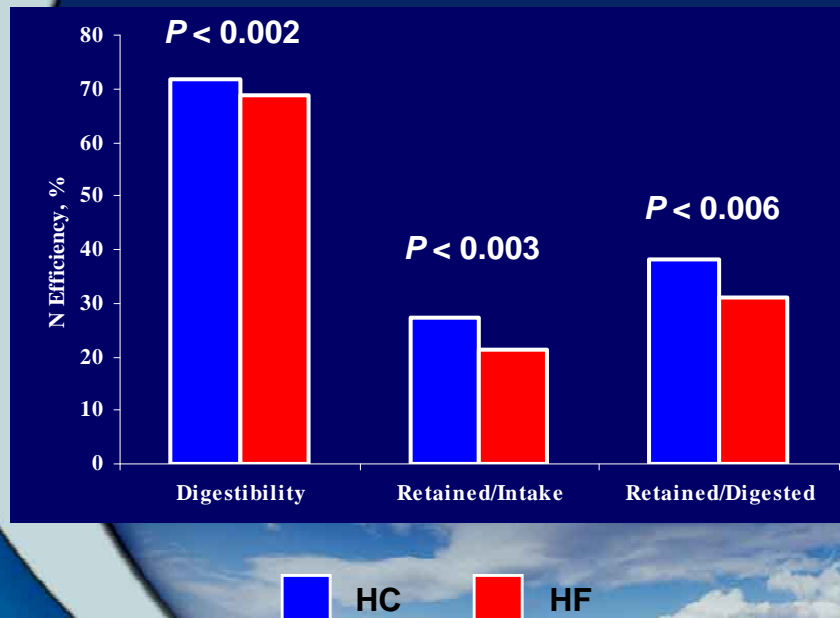
## Results-OM and NDF Digestibility



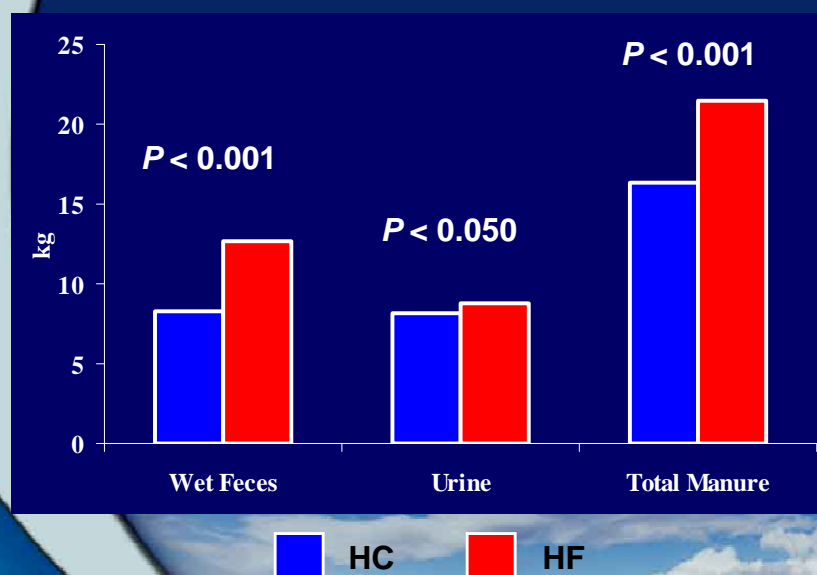
## Results-Apparent N Digestion



## Results-N Efficiency



## Results-Waste Excretion



## Results-Environmental Output

	HC	HF	SE	<i>P</i> <
Manure Output, kg	16.31	21.51	0.51	0.001
N Output, g	120.9	125.0	2.6	0.129
<u>NH<sub>3</sub> Volatilization</u>				
mg/g Manure	1.70	1.49	.06	0.008
g/d	28.54	33.16	1.03	0.001

## Results-Feed Costs

	Young		Old	
Feed Costs	HC	HF	HC	HF
\$/Day	0.72	0.84	1.34	1.56



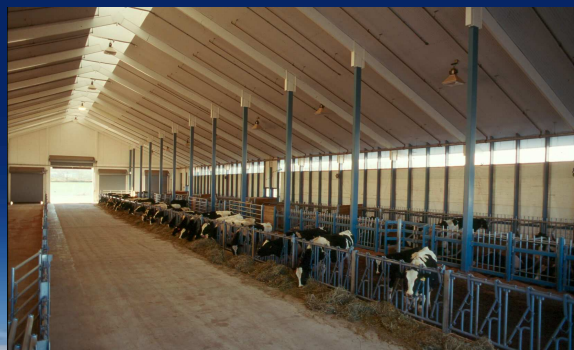


## High Concentrate Diets with Corn Silage

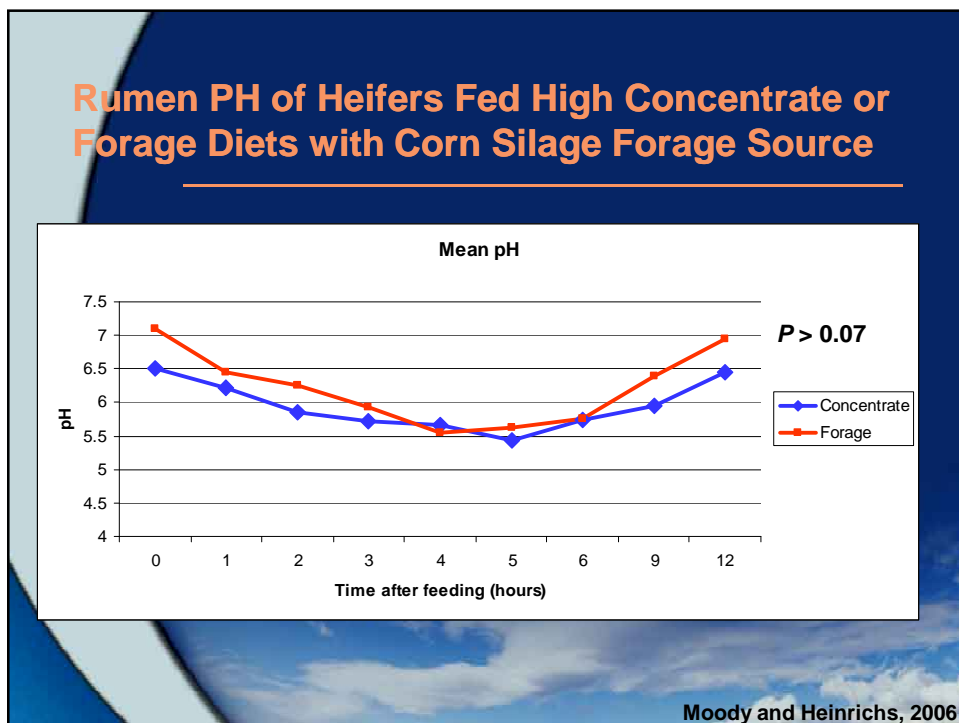
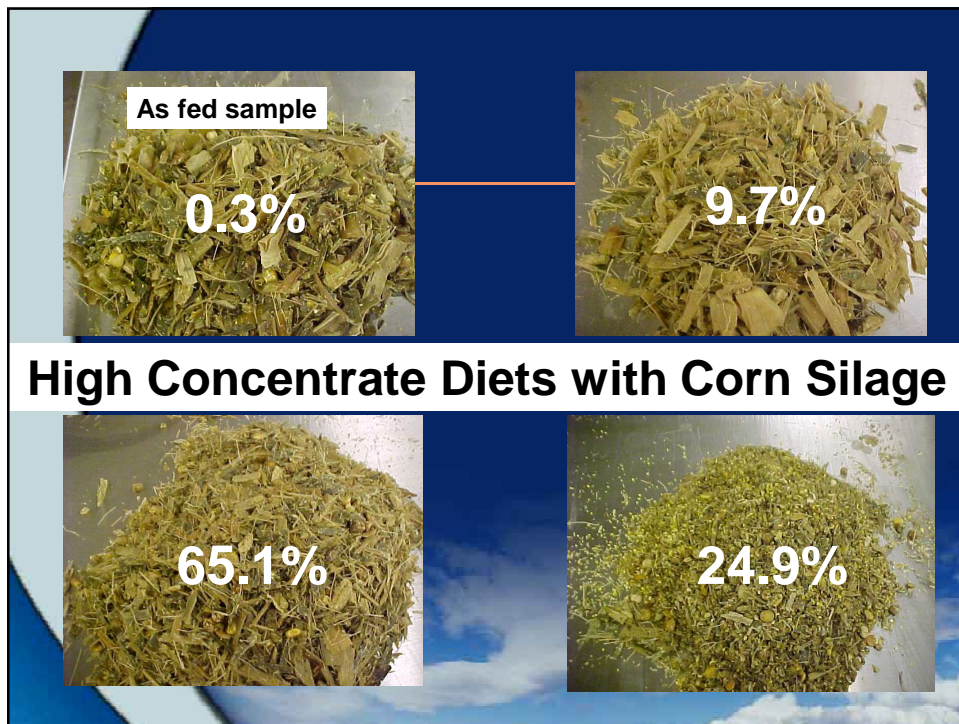


## Rations contained

- ❑ Corn grain
- ❑ Soy protein
- ❑ 1-2 lbs/d soybean hulls

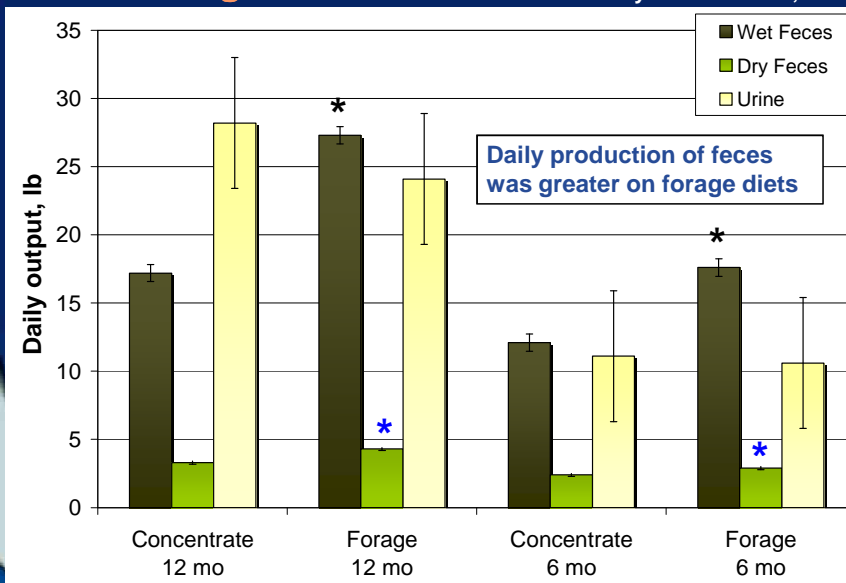






## Fecal and Urine Output of Heifers Fed Concentrate and Forage Diets based on Corn Silage

Moody and Heinrichs, 2006



## Conclusions

- Rumen fermentation is not altered greatly by feeding HC diets
- Limit-feeding HC rations may be used:
  - Reduce feed DM requirements for heifers
  - Reduce manure output
  - Reduce potential  $\text{NH}_3$  loss
- More efficient use of dietary N and OM

## Implications

- Dairy heifers can be **restricted-fed** a **HC** diet
  - Increase efficiency
  - Reduce waste output
  - Reduce feed costs
- If good heifer management is practiced and **if growth and milk production can be maintained:**

**If ADG is controlled, milk production has not been influenced by source of nutrients during rearing**

Source	Diet	n	ADG	Milk
Carson et al., 2000	High Forage	10	0.95	25.5
	Low Forage	9	0.93	26.1
Sejrsen and Foldager, 1992	High Forage	8	0.50	16.1
	Low Forage	8	0.48	16.5
Hof and Lenaers, 1984	High Forage	21	0.68	19.5
	Low Forage	17	0.66	20.4

## University of Wisconsin, J Dairy Sci 2007

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- 3 diets; control 11.3% CP, 2.46 Mcal/kg; 12.7% CP, 2.55 Mcal/kg; 14.2% CP, 2.68 Mcal/kg
- Fed at 90 and 80% of control (ad lib)
- Fed for 111 days to Holstein heifers, gravid, 464 Kg BW at start
- Six heifers per pen, 3 pens per treatment

Hoffman, Simson and Wattiau, 2006.

- 
- No differences in production
  - More time spent standing
  - More vocalization

## PSU long term heifer study Treatment Rations

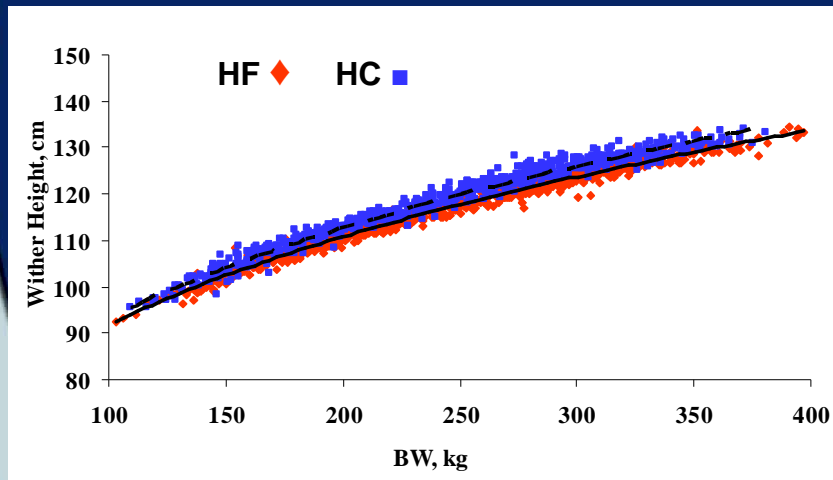
<b>Ingredient, % Ration DM</b>	<b>HC</b>	<b>HF</b>
<b>Grass Haylage</b>	12.71%	38.65%
<b>Corn Silage</b>	12.06%	36.40%
<b>Ground Corn</b>	47.72%	9.27%
<b>Soybean Meal</b>	8.71%	7.05%
<b>Cotton Seed Hulls</b>	12.40%	5.09%
<b>Urea</b>	1.10%	0.17%
<b>Bicarbonate</b>	0.88%	0.85%
<b>Mineral Mix</b>	4.43%	2.50%

## DMI and daily gains in heifers fed a HC or HF diet before puberty

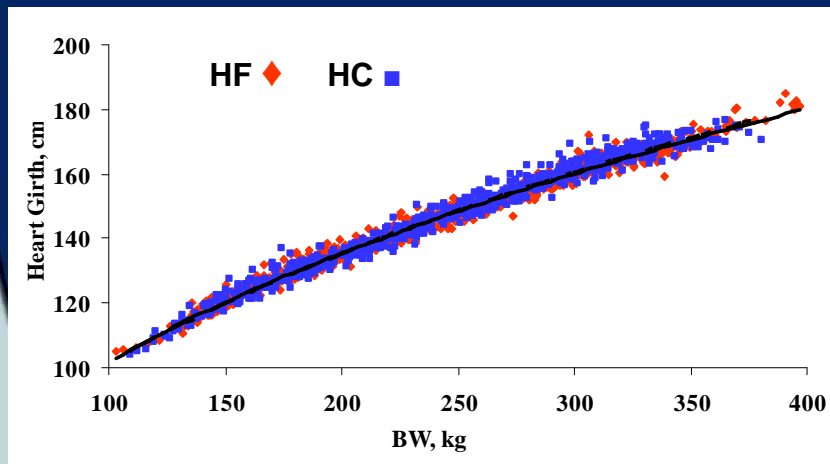
	<b>HC</b>	<b>HF</b>	<b>SE</b>	<b>P &lt;</b>
<b>DMI, lbs/d</b>	11.9	13.1	0.2	0.001
<b>FE, DMI/ADG</b>	6.56	7.30	0.15	0.001
<b>ADG, lbs/d</b>	1.81	1.83	.02	0.582

Zanton and Heinrichs 2007

### Wither height gain in heifers fed a high concentrate or high forage diet before puberty



### Heart girth gain in heifers fed a high concentrate or high forage diet before puberty



### Reproduction measurements in heifers fed a HC or HF diet before puberty

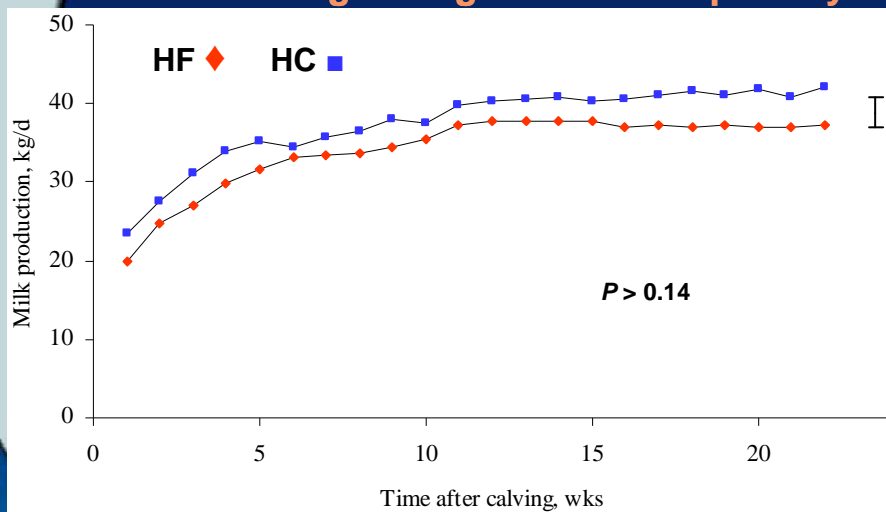
	HF	HC	SE	<i>P</i> <
<b>Age at puberty, d</b>	337	324	8	0.166
<b>BW at puberty, lbs</b>	645	631	20	0.590
<b>AFC, mo</b>	23.1	23.4	0.3	0.511
<b>BW after calving, lb</b>	1146	1201	33	0.168

### Projected 305d ME milk production in heifers fed a HC or HF diet before puberty

	HF	HC	SE	<i>P</i> <
<b>Milk, lbs</b>	20761	23041	1045	0.081
<b>Fat, %</b>	3.74	3.98	0.13	0.138
<b>Protein, %</b>	3.05	2.95	0.05	0.118
<b>Fat, lbs</b>	779	915	42	0.013
<b>Protein, lbs</b>	634	682	29	0.144



## 150d milk production in heifers fed a high concentrate or high forage diet before puberty



## Key Points of a Successful Heifer-Feeding Program

- Know Desired ADG Required
  - Current Body Weight—Weigh or Measure heifers
  - Future Body Weight—For the cows on your farm
- Balance rations and feed  
To desired ADG
- If manure or ammonia emissions are a concern; consider high concentrate rations



## Economics of Heifer Raising

Feed / manure / bedding / nitrogen efficiency /  
labor? housing?

