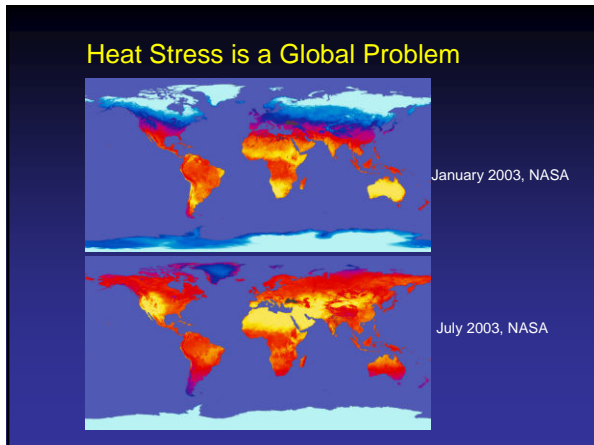
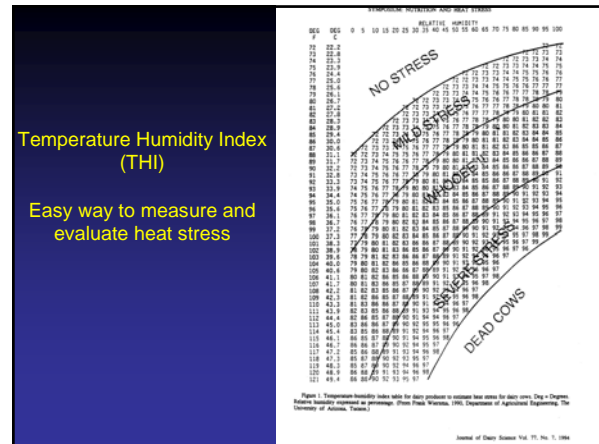


Effects of Heat Stress on Post-Absorptive Metabolism and Bioenergetics in Lactating Dairy Cows

L.H. Baumgard & R.P. Rhoads

The University of Arizona
Department of Animal Sciences



2007 forecast to be hottest year yet

Forecasters point to El Niño and global warming.

A record year forecasted

Temperature Index

El Niño in year

Billions metric tons of carbon

1980 1985 1990 1995 2000

University of East Anglia, National Meteorological Programme (NMP), British Crown and International Meteorological Organization, UK Meteorological Laboratory

Charlie Staples, U of FL

- ### Dairy Cows Respond to Heat in Several Ways:
- Reduced feed intake over 78° F (> 10 – 15%)
 - Increased respiration rate (> 80 breaths per minute)
 - Increased body temperature (> 102.5° F)
 - Changed blood hormone concentration
 - Increased water intake
 - Increased evaporated water loss
 - Reduced activity




Results of Heat Stress

- Decrease in milk production
- Reduced body condition

Annual loss to American Dairy Industry is \$897 MILLION!
St-Pierre et al., 2003 J. Dairy Sci. E52-E77.

- Rumen acidosis
- Significant drop in pregnancy rate
- High incidence of abortions
- High death loss




Added all up ...
costly!



Results of Heat Stress

- Decrease in milk production
- Reduced body condition

Rumen Acidosis:
 Reduced cellulose digestion
 Laminitis
 Milk fat depression
 etc...



Added all up ...
costly!

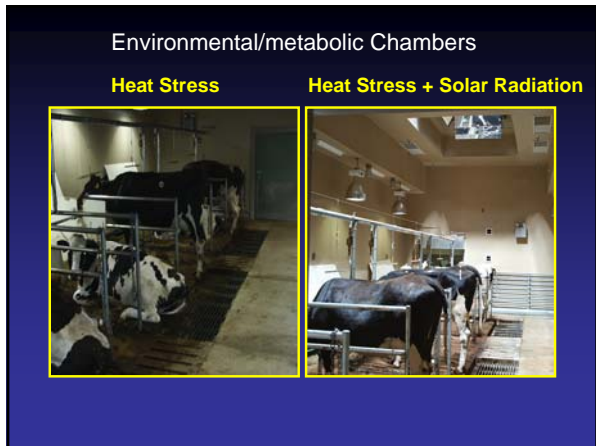
Heat Stress Induced Rumen Acidosis

- Originates via:
 - 1) Altered respiration
 - Loss of systemic buffering capacity
 - 2) Changes in feed and feeding behavior
 - Reduced feed intake
 - Increased concentrates
 - "sorting"
 - "bout/slug" feeding
 - Drooling
 - Less saliva production

Seminar Outline

- Heat Stress
 - Definition
 - Production effects
 - Rumen health
- U of Arizona heat stress trials
- Heat Stress vs. Transition Period
- Metabolic Summary
- Summary
- Conclusions





Heat Stress Questions??

Does the decrease in feed intake explain the reduced milk yield when cows are heat stressed?

What dietary and management strategies can help alleviate some of the negative side effects of heat stress

If we have a better understanding of the biological reasons WHY heat stress reduces milk yield, we'll have a better idea of how to alleviate it.

U of Arizona Trials Study 1


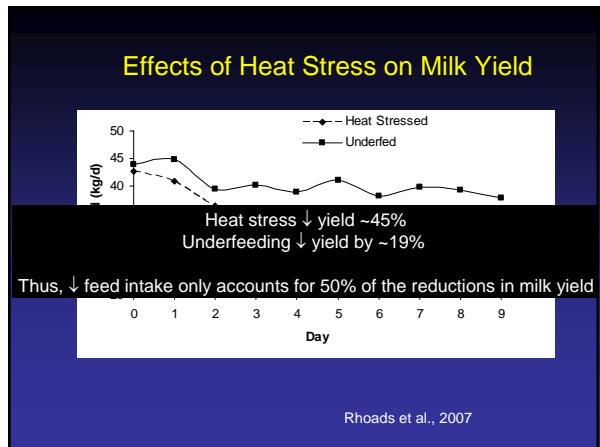
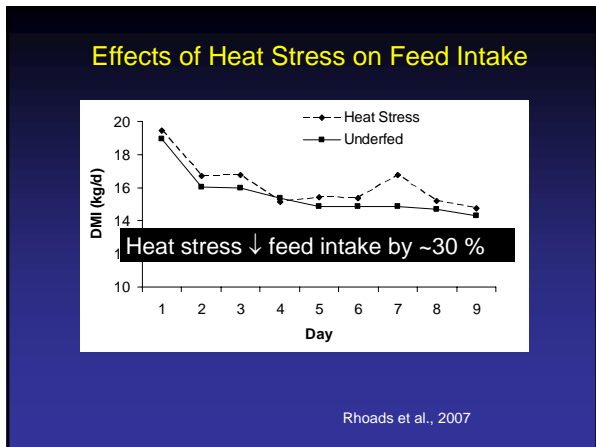
- Heat stress cyclic
- Pair-fed
- Heat stress

July day: keep

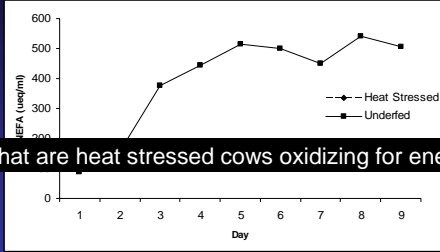
– 9 days

– Body

– Respiration rates went from 44 to 65 breaths/min

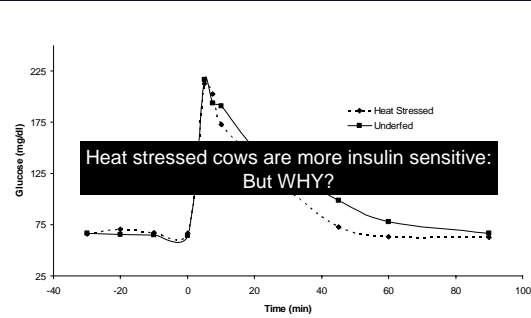
Effects of Heat Stress on Adipose Tissue Mobilization



What are heat stressed cows oxidizing for energy?

Rhoads et al., 2007

Glucose Tolerance Test



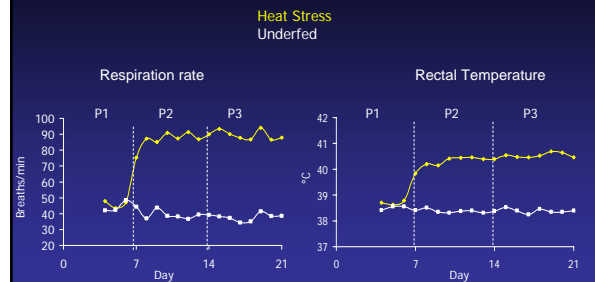
Heat stressed cows are more insulin sensitive: But WHY?

Wheelock et al., 2006

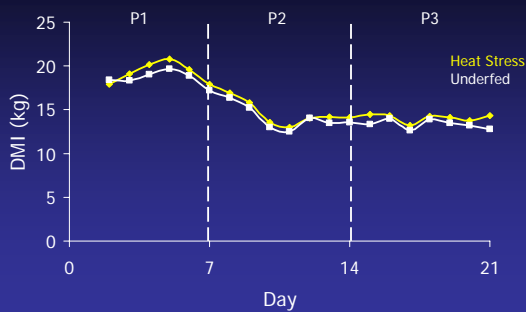
U of Arizona Trials Study 2

- 22 Multiparous Holstein cows (99.8 ± 20.2 DIM) were balanced for parity and production, and then randomly assigned to 1 of 2 trts
 - 1) Heat Stress (HS): cyclical temps (80-104°F)
 - 2) Underfeeding (UF): constant temp (70°C)
- Cows assigned to the UF trt were pair-fed with the HS cows to eliminate confounding effects of dissimilar nutrient intake
- Cows underwent 3 periods (21 d total)
 - Acclimation (7 d)
 - HS or UF (7 d)
 - HS or UF with rbST supplementation (7 d)
 - rbST: POSILAC, Monsanto Inc., St. Louis MO

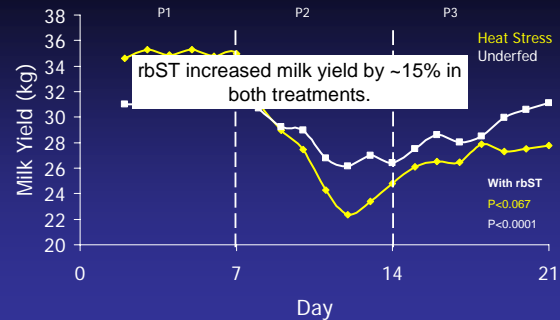
Heat Parameters

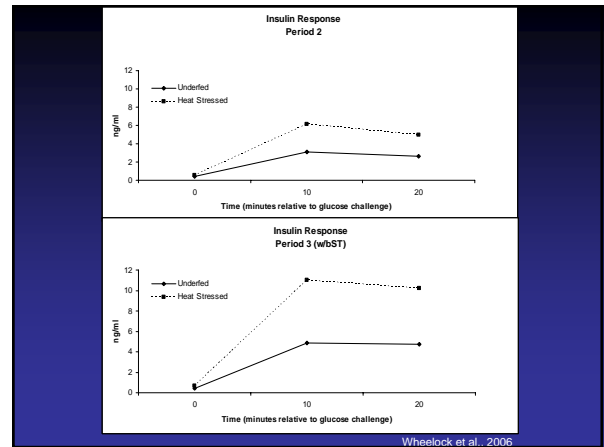
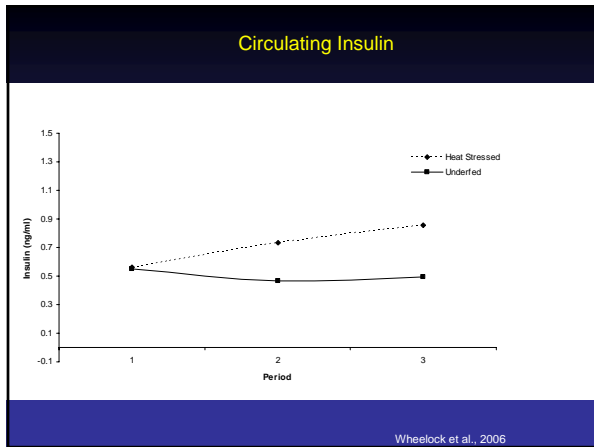
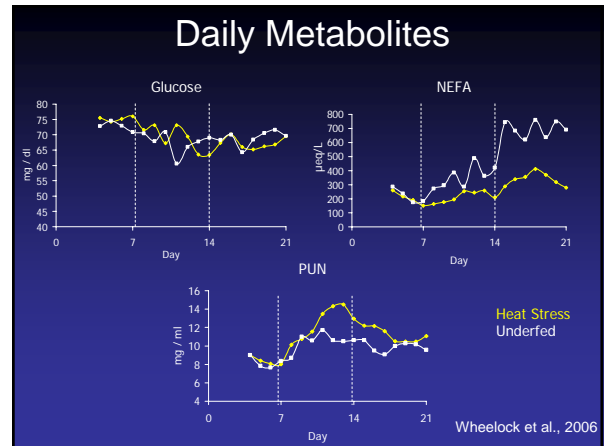
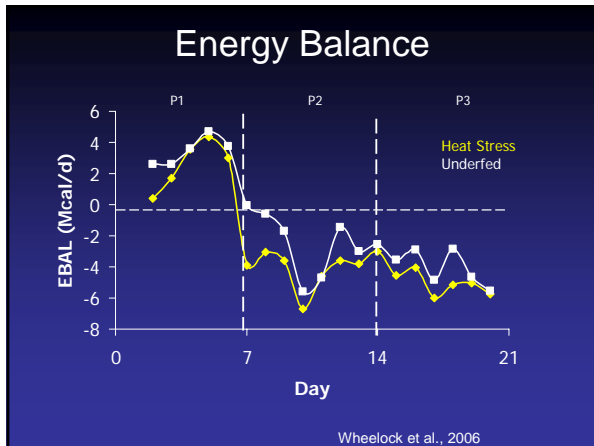


Dry Matter Intake

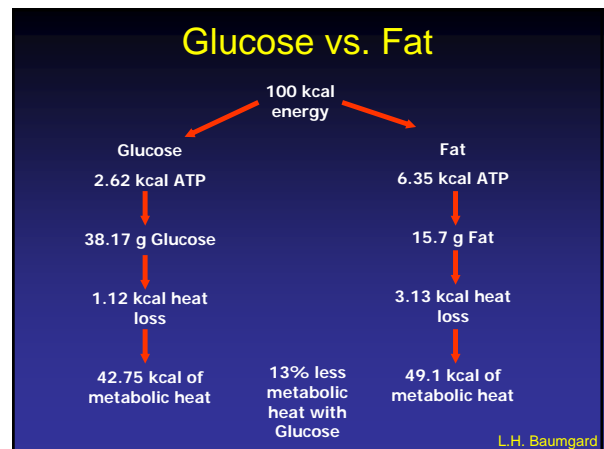


Milk Yield





- ### Energetic Summary
- Heat stress reduces milk yield (~40-50%)
 - Decreased feed intake only accounts for ~50% of the reductions in milk yield
 - Both underfeeding and heat stressed cows enter similar negative energy balances (~ -3.5 Mcal/d)
 - Why increase insulin action?
 - Heat stressed cows become hypersensitive to insulin
 - Decreased NEFA
 - Increased glucose disposal } But why?
 - Heat stressed cows require EXTRA ENERGY!
 - Especially glucose
 - Enhanced glucose utilization by the body may limit glucose availability to the mammary gland = ↓ lactose production



Seminar Outline

- Heat stress

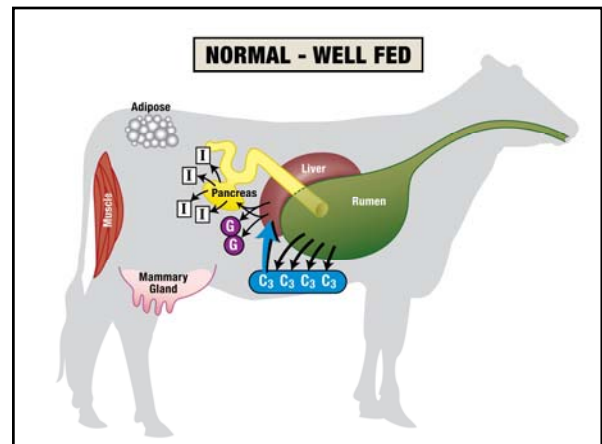
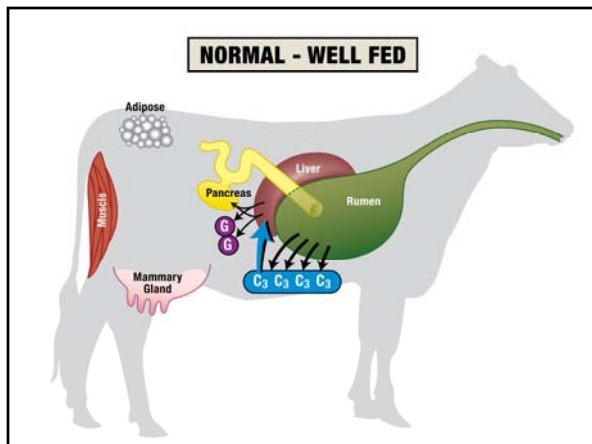
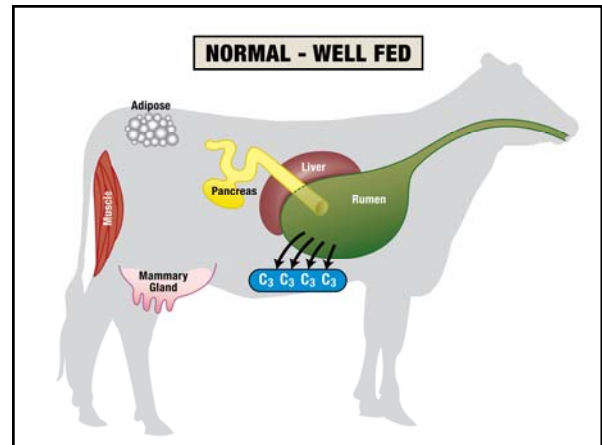
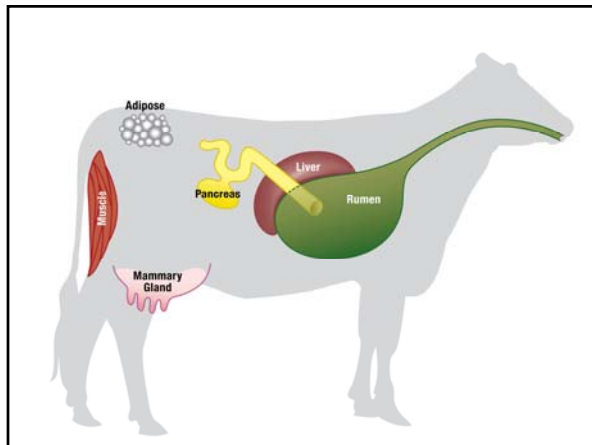
Could the health, reproduction and productive problems that both the early transition cow and heat-stressed cow experience, share a common cause?

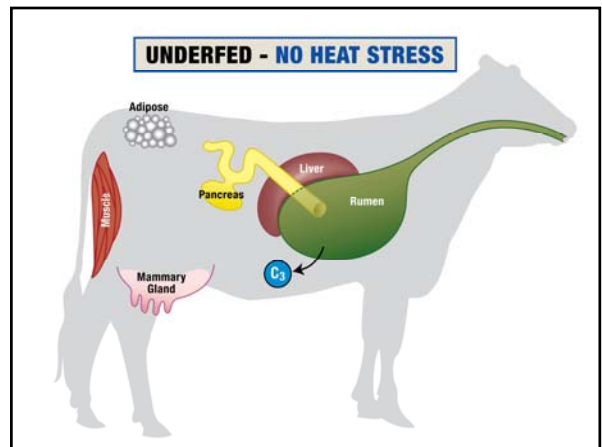
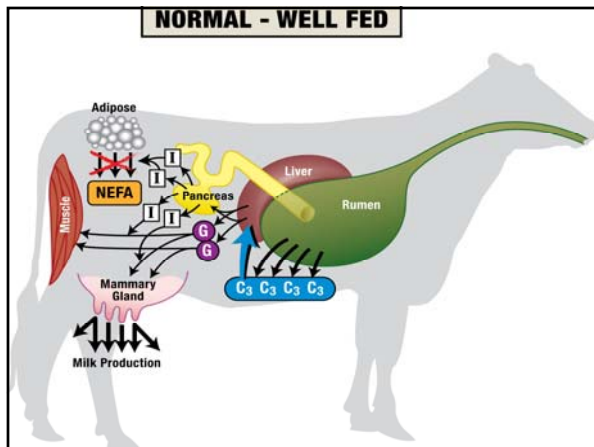
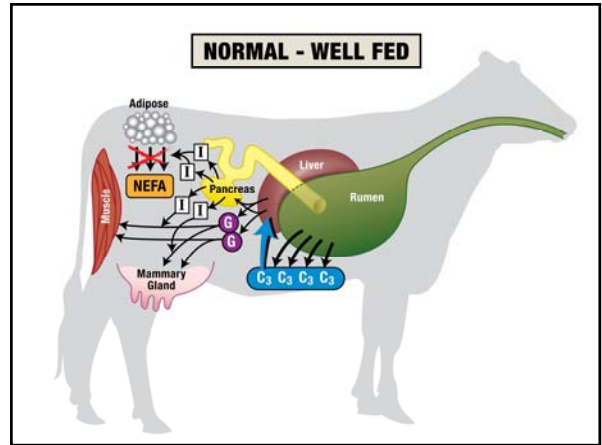
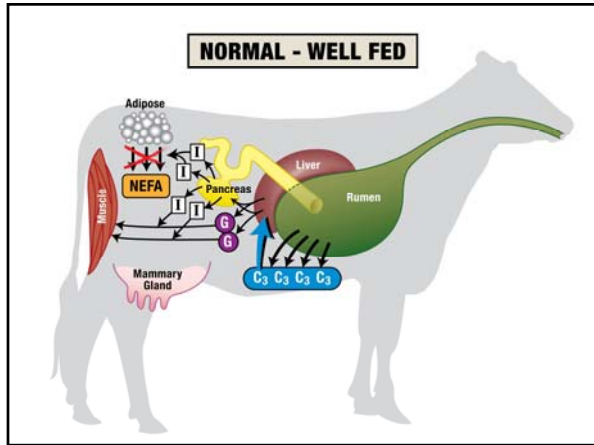
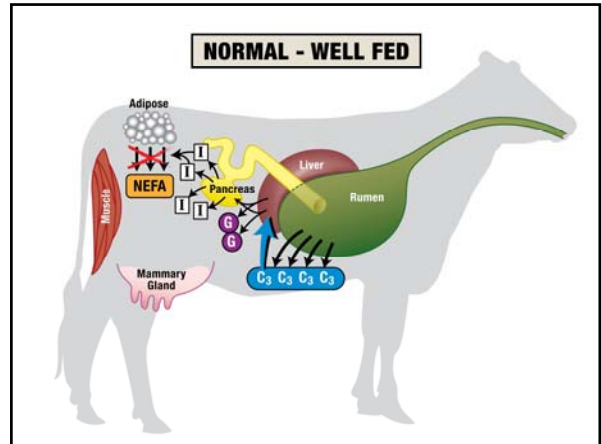
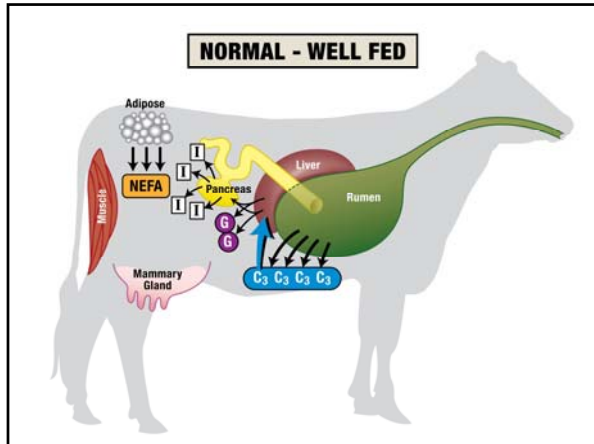
– Rumen health

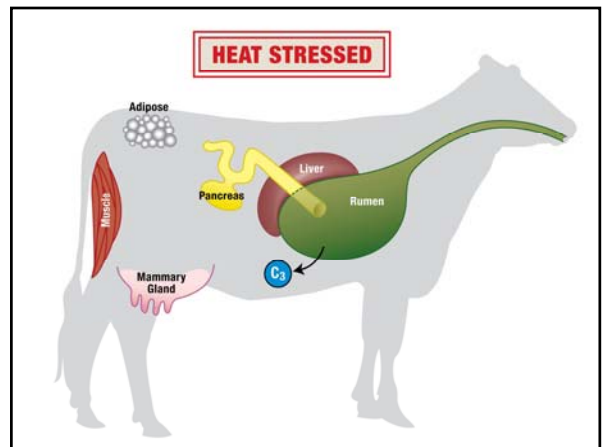
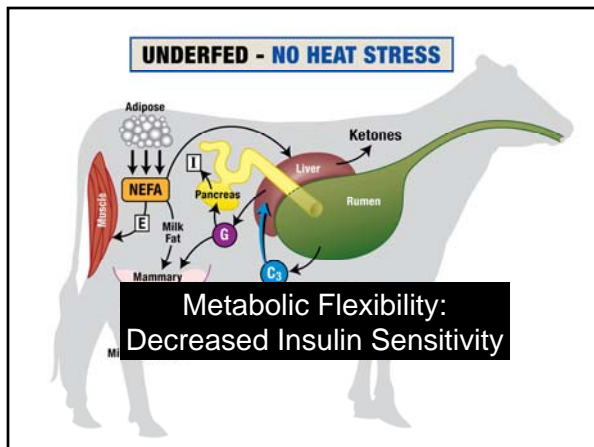
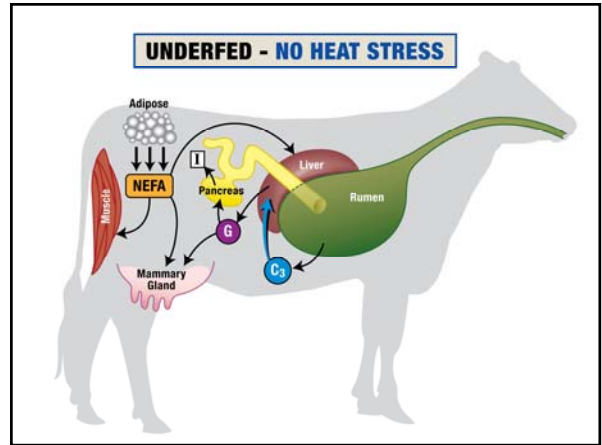
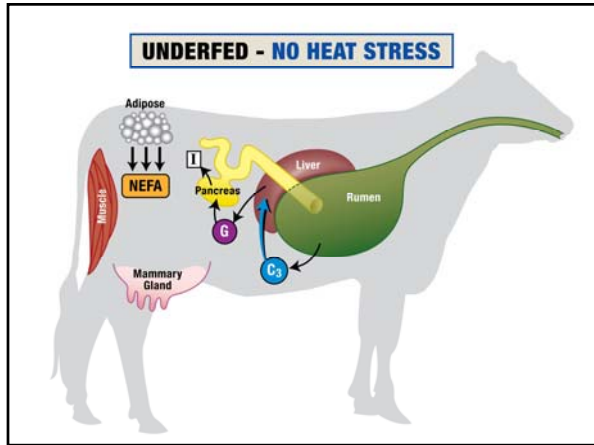
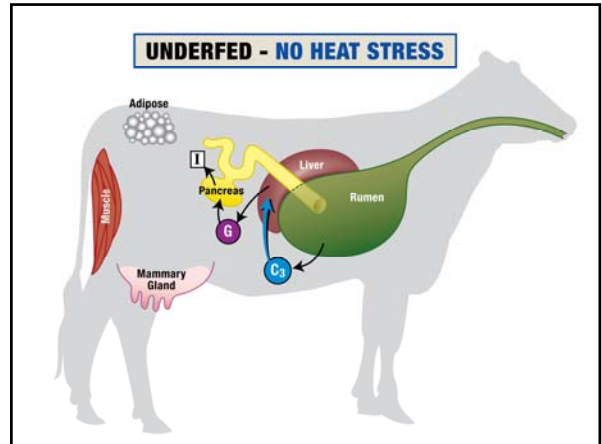
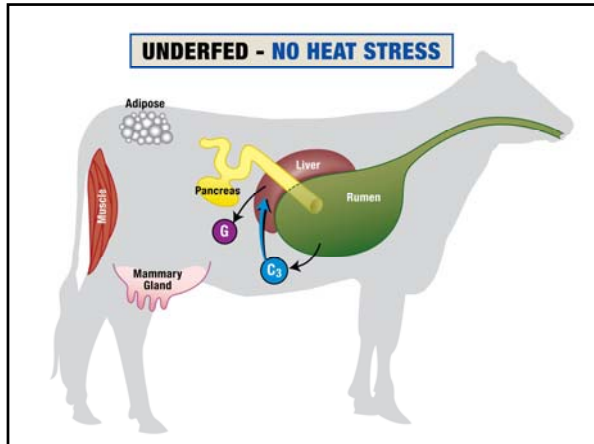
- U of Arizona heat stress trials
- Heat Stress vs. Transition Period
- Metabolic Summary
- Summary
- Conclusions

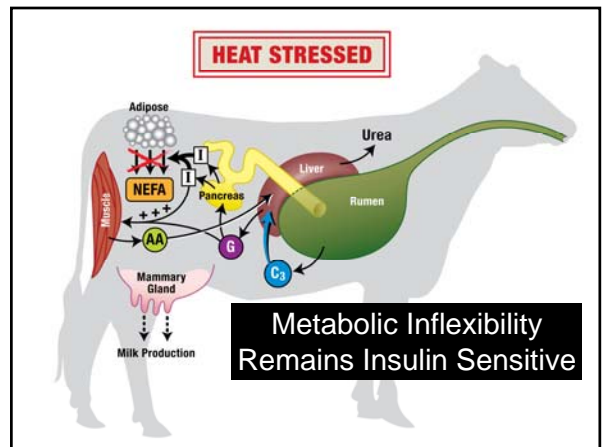
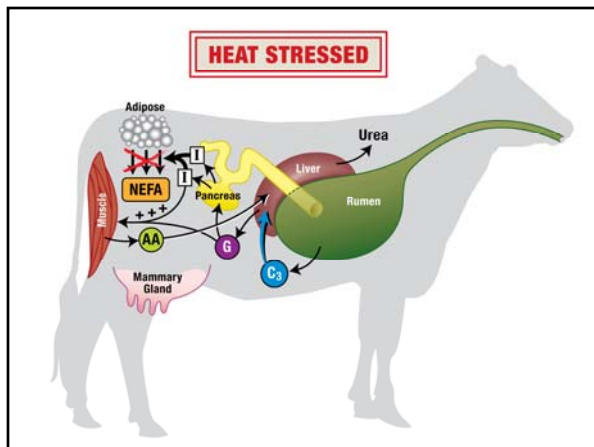
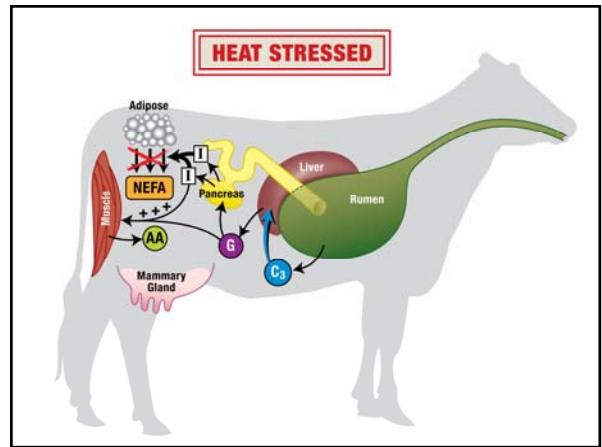
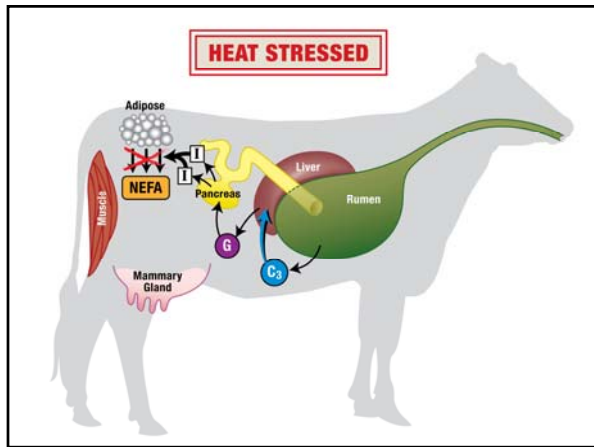
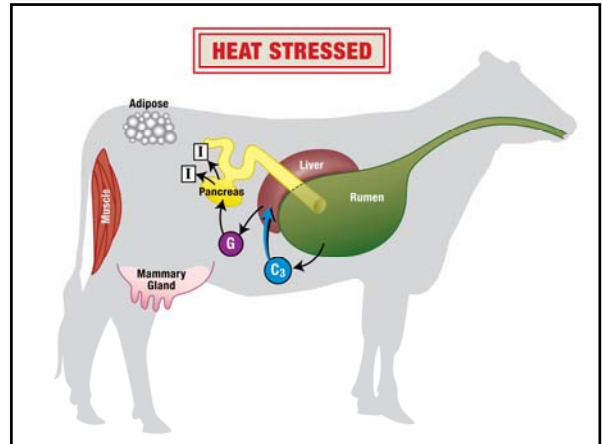
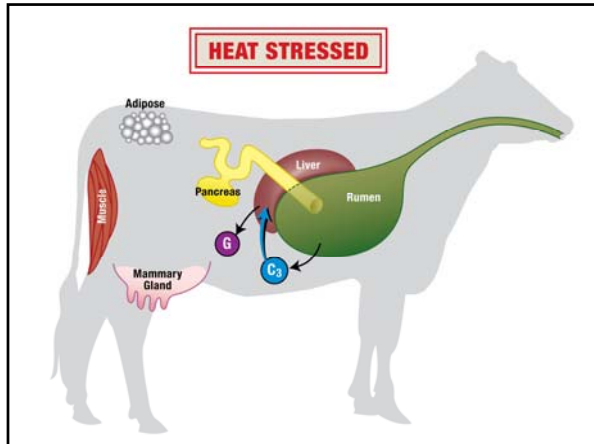
Metabolic Adaptation to Heat Stress

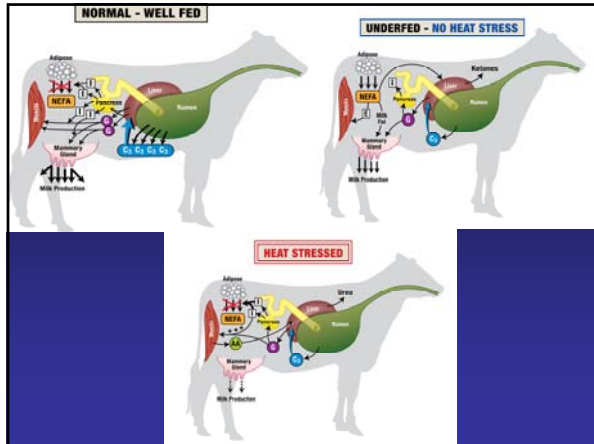
Summary











Summary

- Reduced feed intake accounts for only ~50% of the decreased milk yield.
- Large metabolic changes that are not associated with energy balance
- Maximizing glucose synthesis will benefit both cow health and production
- Practical solutions and long term effect discussed this afternoon.

Dietary and Management Strategies to Reduce the Negative Effects of Heat Stress

- Clean water tanks daily
 - Heat stressed cows become hyper-hydrated
- Dietary HCO_3^-
 - Helps prevent rumen acidosis
- **BUT the primary strategy to improve production during heat stress is shade and evaporative cooling** and body condition
- Ionophores
 - Increases propionate and therefore overall liver glucose production
 - Cows prefer to oxidize glucose during heat stress
 - Studies indicate Monensin can stabilize rumen pH during periods of stress
- Direct fed microbials
 - A product that increases rumen digestion, stabilizes pH, increases propionate and increases DMI should benefit a heat stressed cow
 - The inconsistencies in the literature regarding these variables is of interest
- rbST
 - Reduces insulin sensitivity and partitions dietary nutrients towards milk production
 - The directing of glucose towards muscle during heat stress probably limits the glucose supply to the mammary gland

Typical reaction to one of my lectures.....thanks for your attention!



Acknowledgments

- United Dairymen of Arizona
- Dairy Nutrition Services
- Southwest Regional Dairy Center
- Bob Collier
- Matt VanBaale
- Jessica Wheelock
- Morgan O'Brien
- Gilad Shwartz
- Rosemarie Burgos
- Laura Hernandez
- Sara Sanders
- Shannon Baker

