Using physiology and behaviour to assess welfare in farm animals: research of the United States Department of Agriculture

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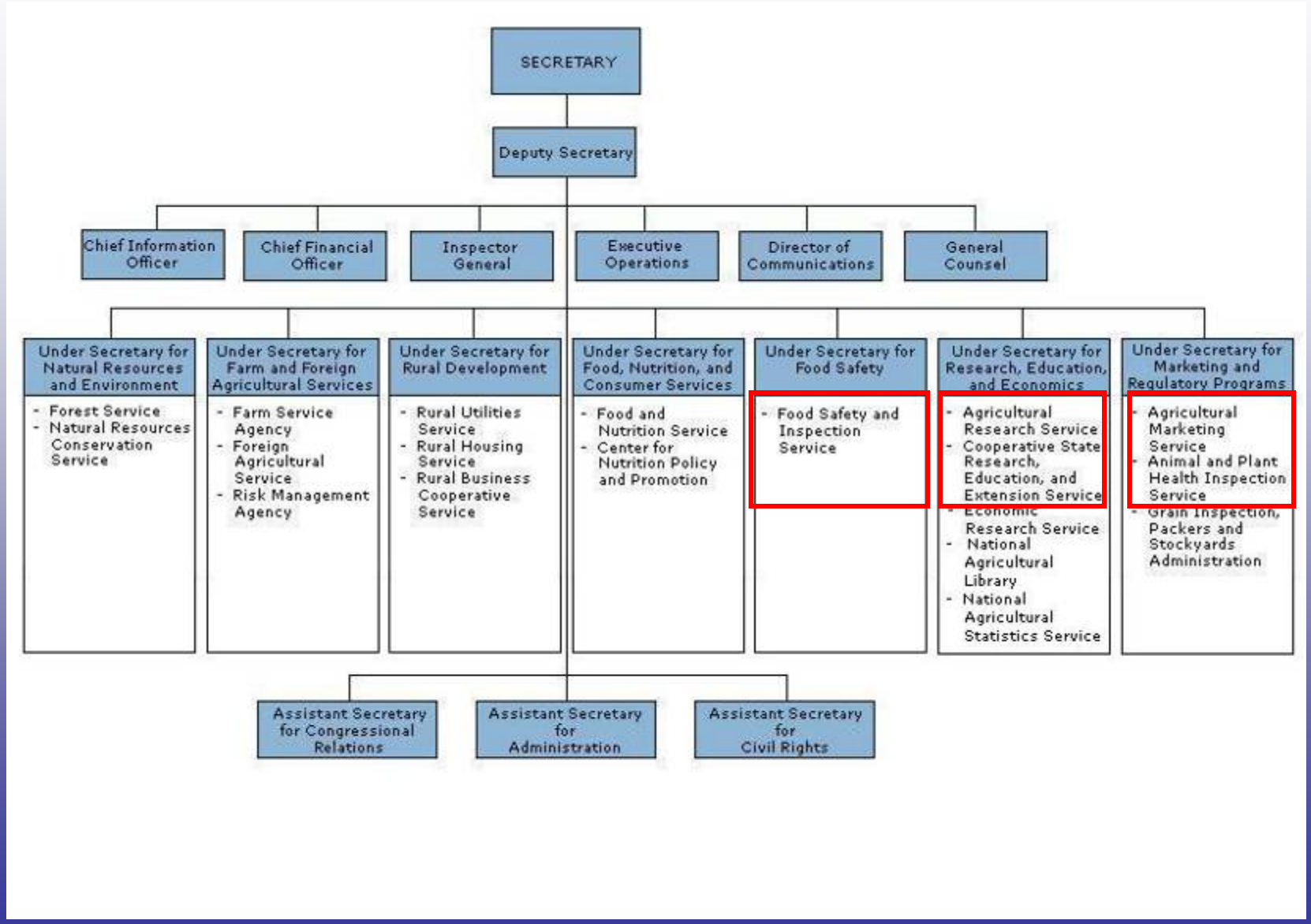
Outline

- Relative Role of USDA and the Agricultural Research Service (ARS)
- Animal Welfare Atmosphere in U.S.
- Relevant Research Projects of Our Unit

USDA - Organizational Chart



USDA Agencies

- Food Safety and Inspection Service (FSIS)
  - Charged with enforcing the Humane Slaughter Act
- Cooperative State Research, Education, and Extension Service (CSREES)
  - Support programs of the Land Grant University system and provides competitive funding for animal welfare research.
- Animal and Plant Health Inspection Service
  - Charged with enforcing the Animal Welfare Act
- Agricultural Marketing Service (AMS)
  - Transportation Branch provides information for successful travel
- Agricultural Research Service (ARS)
  - Charged with conducting research for agriculture, including animal welfare.

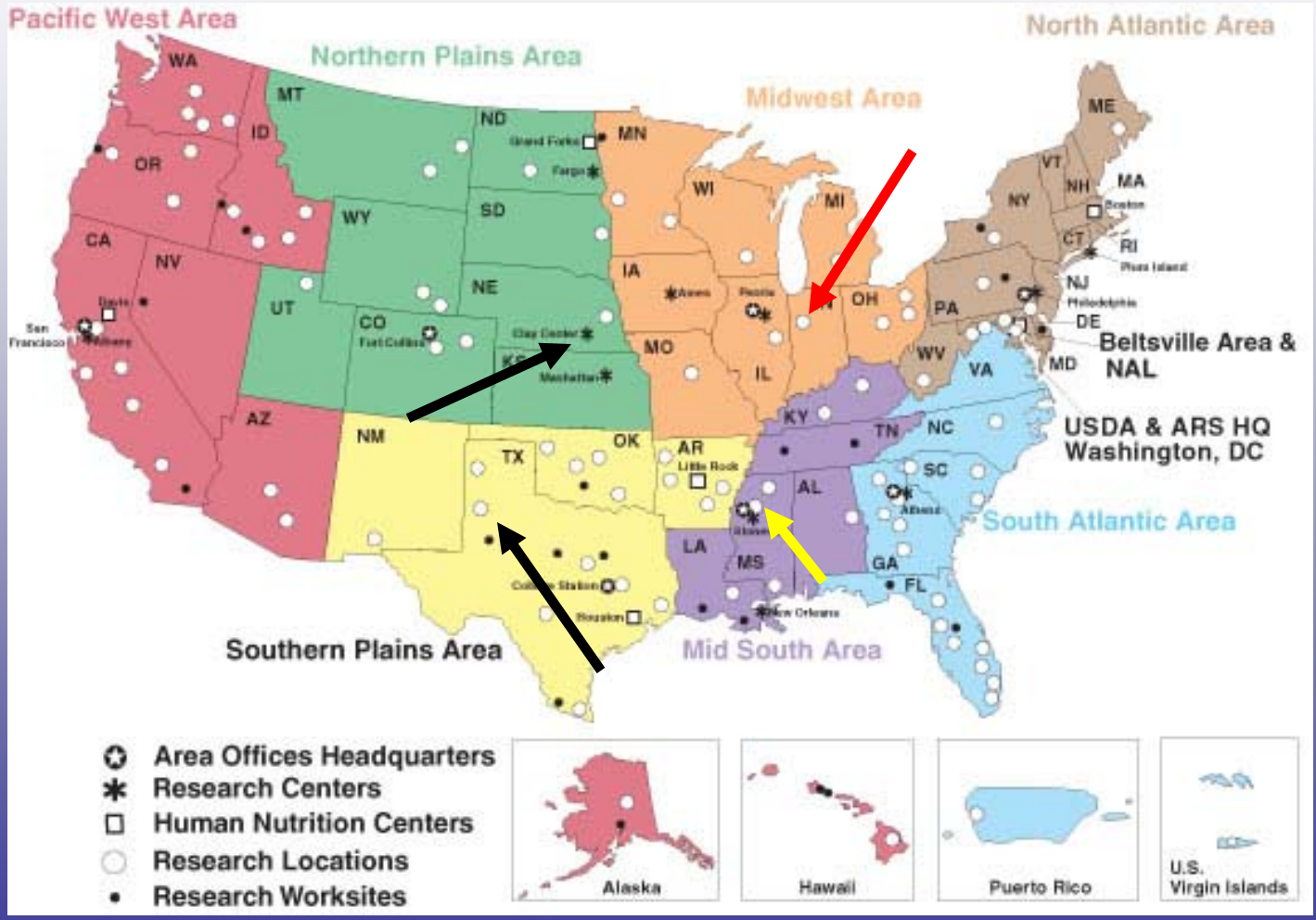
USDA
Agricultural Research Service

- Research is organized under 23 National Programs
- Approximately 1,000 research projects being conducted by ARS scientists
- Main projects are written and externally reviewed on a 5-year basis.

National Program 101- Food Animal Production: Mission

- Safeguard and utilize animal genetic resources, associated genetic and genomic databases, and bioinformatic tools
- Develop a basic understanding of the physiology of livestock and poultry
- Develop information, tools, and technologies that can be used to improve animal production systems, all to ensure an abundant, safe, and inexpensive supply of animal products produced in a healthy, competitive, and sustainable animal agriculture sector of the U.S. economy

ARS Research



Governmental, Industry, and Public Response?

- Awareness and regulations have/will increase
  - Government regulations
  - Producer group regulations
  - Food industry driven regulations
  - Pressure from special interest groups

U.S. National Laws

- Twenty-Eight Hour Law: (1873)
- Humane Slaughter law: (1958)
  - Requires insensibility to pain prior to being shackled, hoisted, thrown, cast, or cut.
  - Modified: 1978 prevent dragging/abuse
  - Modified: 2008 complete ban on slaughter of downers
- Animal Welfare Act: (1990-1996)
  - regulates the treatment of animals in research, exhibition, transport, and by dealers.
  - Birds, rats and mice are not currently included in the regulations, and they do not include farm animals used in agricultural research.

Laying Hen Industry Response

- United Egg Producers (1999)
  - Cage area increased
  - Beak Trimming to be phased out
  - Molting to be phased out

- American Egg Board, (Dr. Janice Swanson) 2008, $400,000+ to study entire industry: Economics, Environment, Human Health, Animal Health and Welfare, Consumer/Public Views

Food Industry Response:

Example, McDonald's Animal Welfare Program

- Inspection of slaughter houses
- Adopted UEP Guidelines for laying hens (2000)
- Oct. 1, 2008, Cargill announced it will purchase hogs only from farms that have been certified under the National Pork Producers Council's Pork Quality Assurance Plus (PQA+) program.
- May 2009, McDonald's (U.S.) announced its participation with leading animal welfare scientists, academics, Non-Government Organizations (NGOs) and egg suppliers in a commercial-scale study of housing alternatives for egg-laying hens.

Example of Special Interest Group Driven

- Humane Society of the United States, Farm Sanctuary and many others.
- Activities are now focused on passing State laws to outlaw 'common' agriculture practices:
  - Confinement, laying hens and sows
  - Castration, tail docking
  - Molting, beak trimming
- Florida and Arizona outlawed gestation stalls for sows, Colorado agreed prior to legislation
- In November 2008, California voted the same for sows, hens, and veal calves.
- Activity currently focused on Ohio.

Livestock Behavior Research Unit
West Lafayette, IN

- Develop scientific measures of animal well-being, through the study of animal behavior, stress physiology, immunology, and neurophysiology, that will allow an objective evaluation of animal agricultural practices for swine, poultry and dairy cattle.

- Goal is to improve existing practices and develop new practices that can enhance animal well-being and increase animal productivity.

- In addition, this unit uses and develops its knowledge of stress physiology and animal behavior to address concerns of pathogen contamination of swine and dairy cattle due to the stress of handling and transportation.

Research Scientists

Dr. Eicher

Immunologist

Dr. Cheng

Neuroscientist

Stress physiologist/
Ethologist

Dr. Marchant-Forde

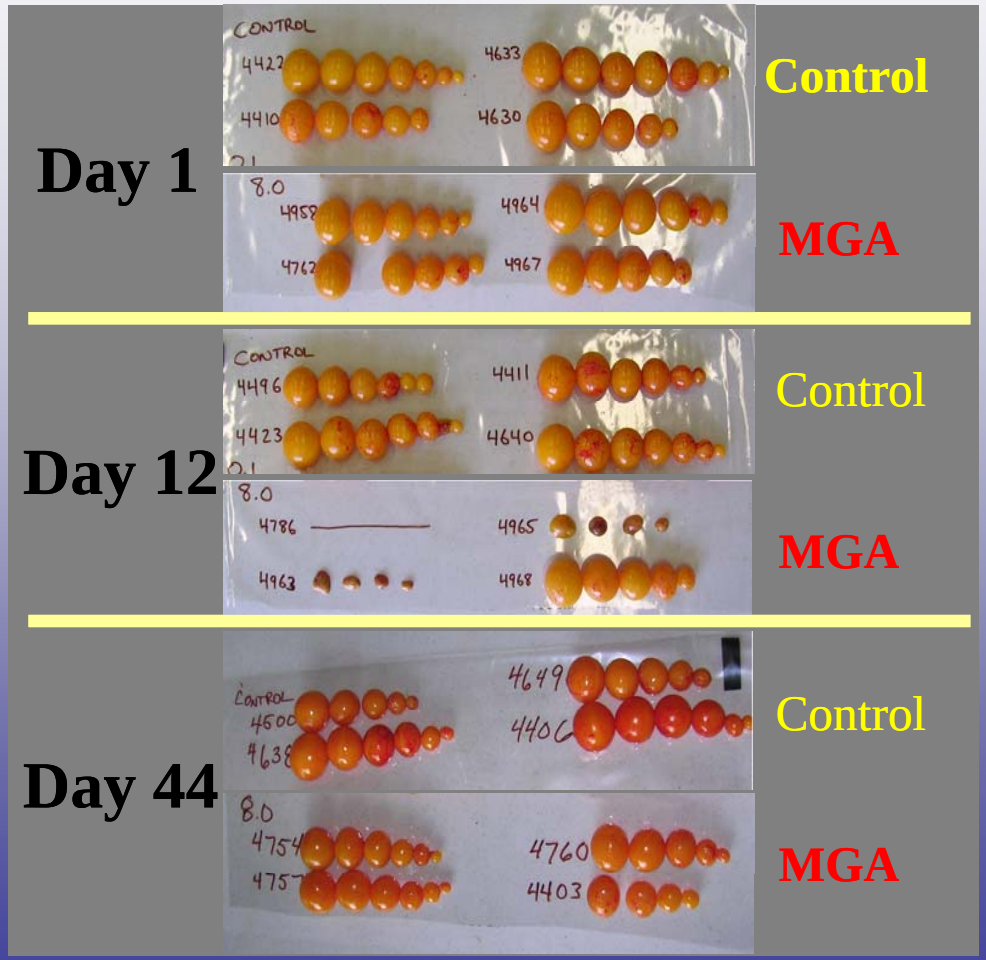
Ethologist

Dr. Marcos Rostagno

Bacteriologist

Molting Research (Lay, Wilson, Cheng)

Melengestrol acetate



Safety Considerations

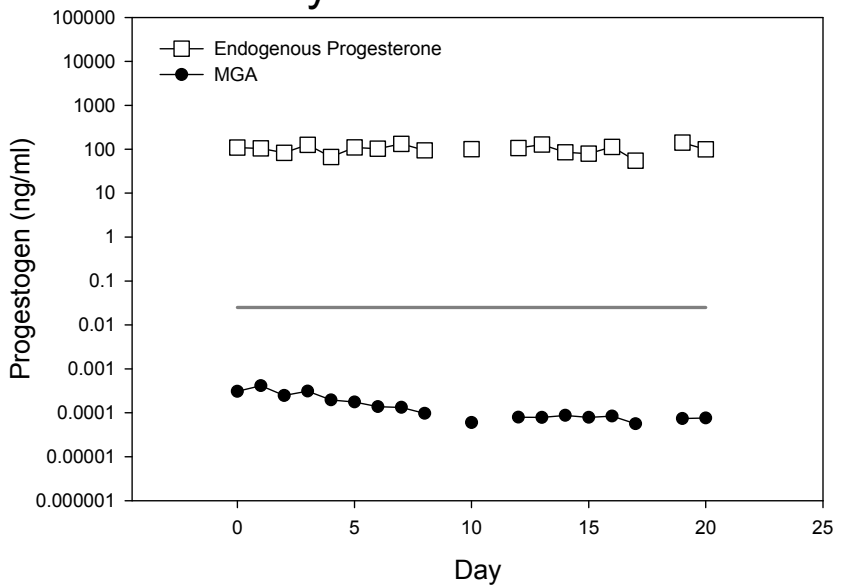
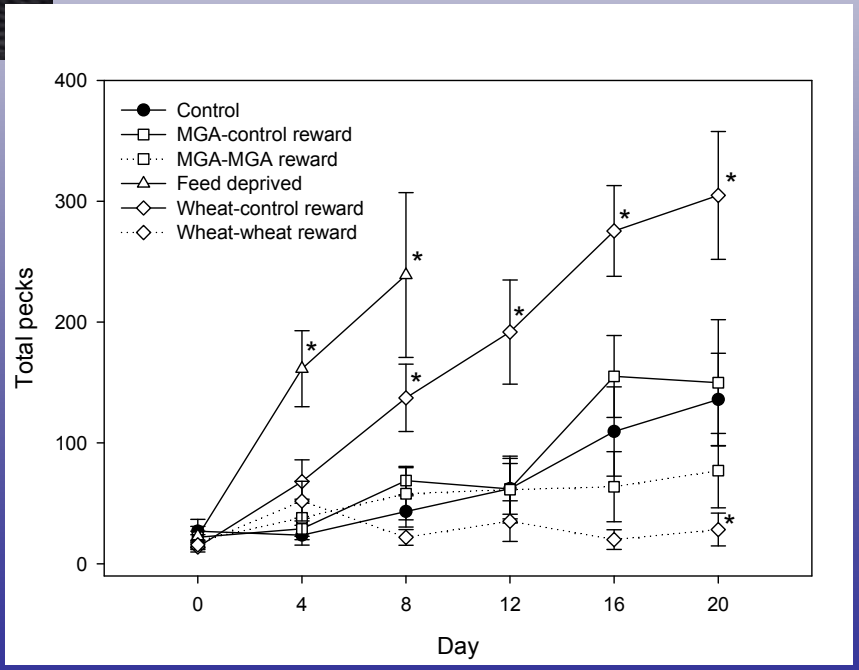


Figure. Yolk MGA and endogenous progesterone concentration in the days following removal of MGA from the diet, graphed relative to the FDA tolerance for MGA in edible tissue. Day 0 eggs are representative of the last egg laid while hens were on the last day of a 14 day MGA treatment.

Are they Hungry?

Hens fed a wheat middling, molting diet work for food much harder than hens fed a balanced diet with MGA, and as hard as feed deprived hens by 16 days on diet.

Feeding alternatives which simply provide the hen with non-nutritive substrate doesn't satisfy the welfare concern.



“Pig Turn”: Non-invasive sampling of behavior and physiology

Marchant Forde

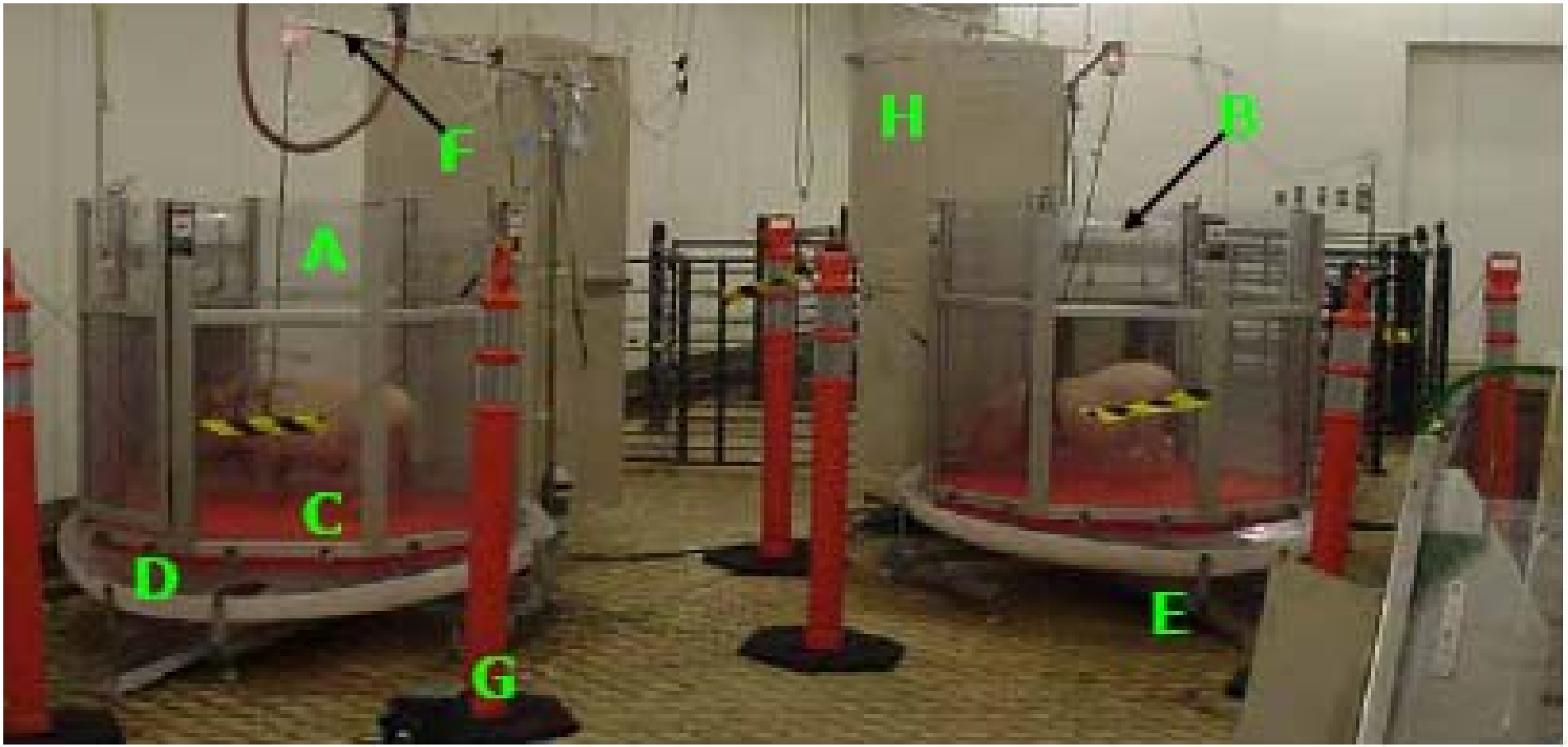
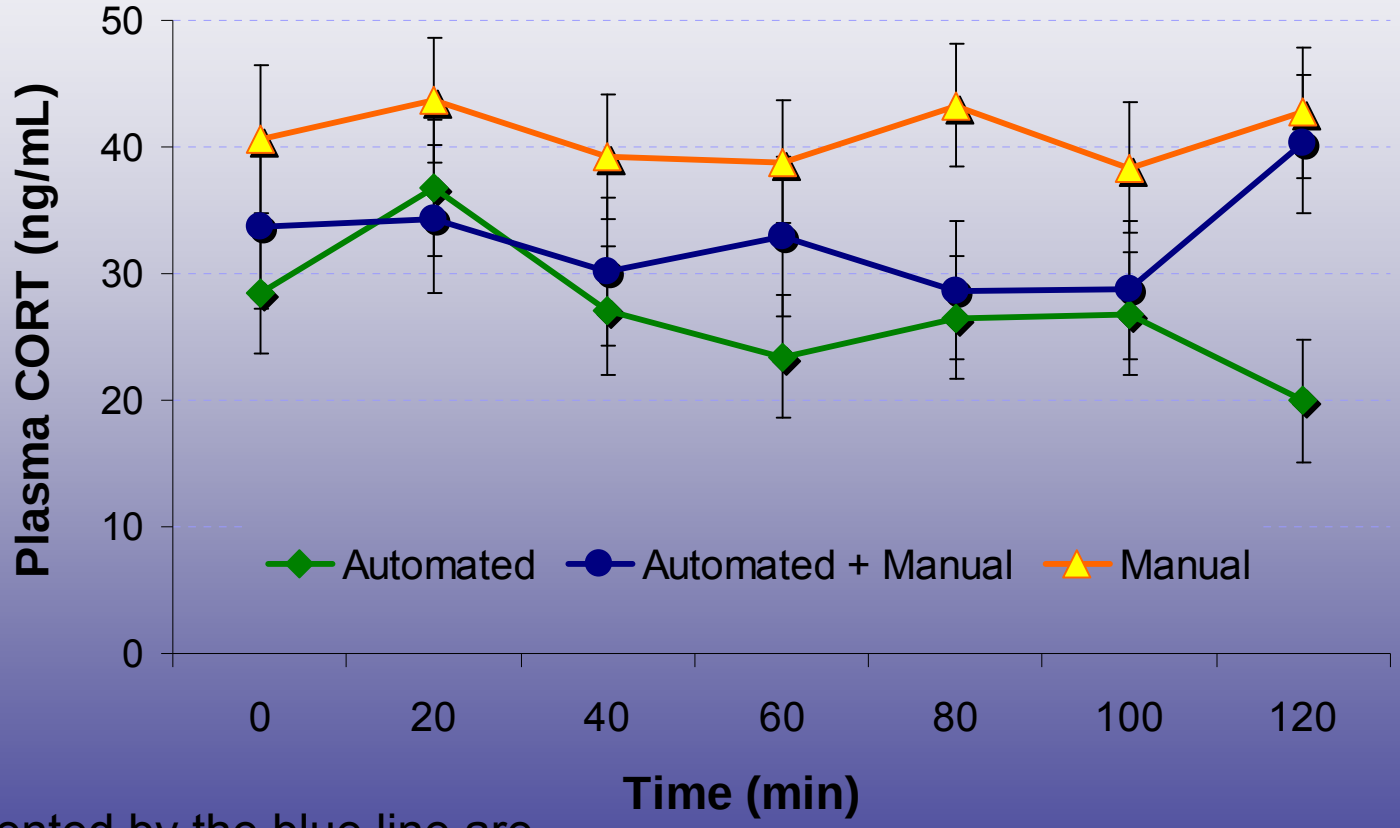


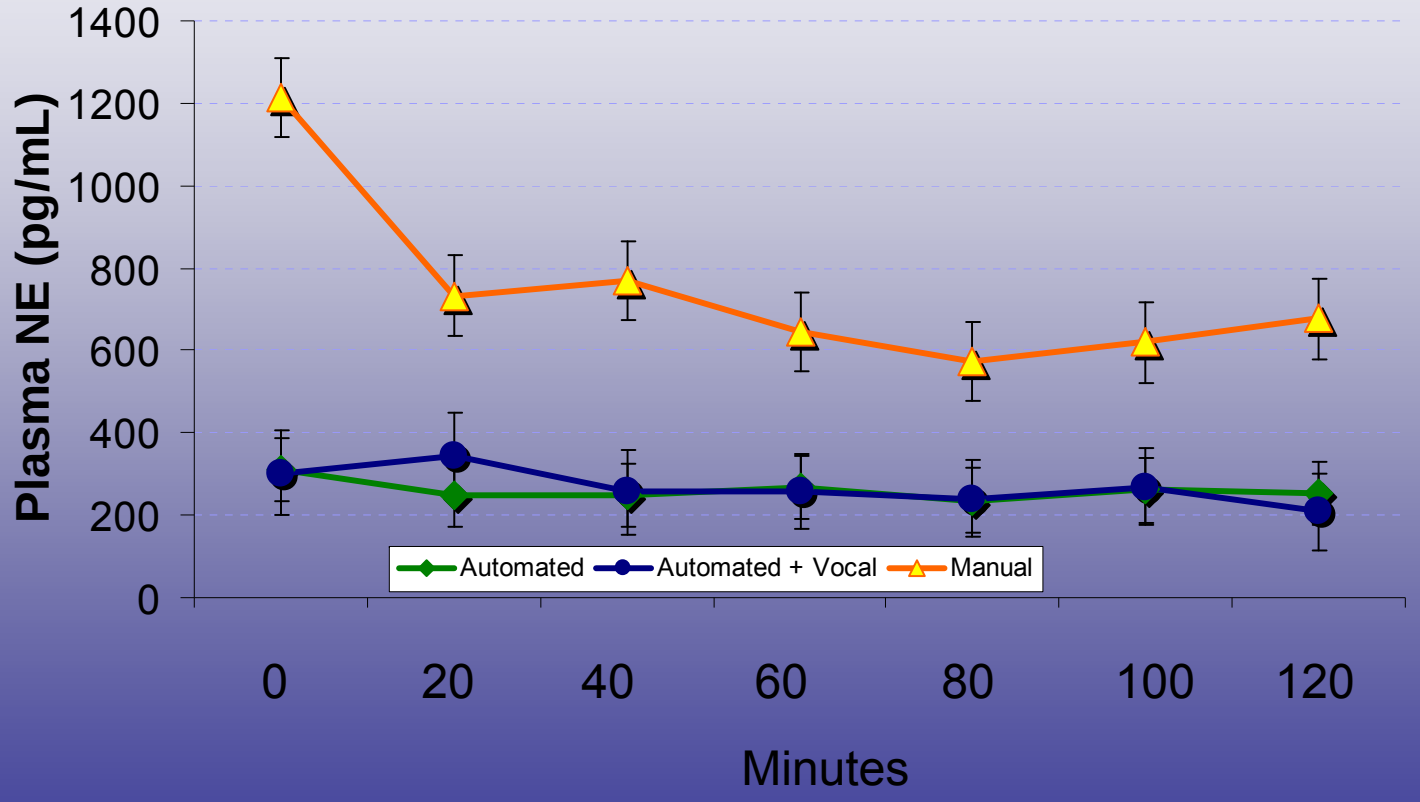
Fig. 2. Prototype movement-responsive cages in operation with 1 male and 1 female Gottingen minipig during a 24-hour study. A. Enclosure: plexiglas panels in aluminum frame B. Water reservoir C. Coated-steel mesh bottom D. Urine shield/collector E. Support struts F. Counterbalanced arm with warning light G. Safety perimeter system H. Housing for motor controller, data acquisition computer, and automated blood sampling system connected to a jugular catheter in each subject.

Pig Turn:
Effect of restraint during sampling - cortisol



Pigs represented by the blue line are being sampled by the machine, while a neighboring pig is being held in a V-trough for veni-puncture

Pig Turn: Effect of restraint during sampling - norepinephrine



Ractopamine & aggression

Marchant Forde, Poletto

Approach

- Identify dominant & subordinates
- Quantify ‘normal’ aggression in home pen
- Resident-intruder test to measure propensity to attack
- Measure catecholamines & serotonergics

Ractopamine feeding of pre-slaughter pigs

- Production:
  - ↑ production performance and carcass yield
  - ↑ hoof lesions
  - ↓ *Enterobacteriaceae* in the gut at slaughter
- Behavior:
  - ↑ activity, alertness, oral-nasal behaviors
  - ↑ aggression, specially when fed to gilts
- Neurophysiology:
  - ↓ peripheral 5-HT in gilts and ↑ NE in dominant pigs
  - ↓ 5-HIAA and ↑ DA turnover in the amygdala of gilts

Furnished Cage vs. Conventional cage, Cheng

Furnished cage

Conventional cage

Aim: Can welfare be improved by housing hens in an "enriched" environment

Design: Furnished cage with perches, dust bathing area, scratch pads, and nest box area with concealment curtain.

Results: Birds housed in furnished cages showed:

1) lower levels of active behaviors (walking and exploratory pecking), lower repetitive bouts of pecking
2) lower concentrations of corticosterone
3) greater bone density
4) greater number of dirty eggs

Furnished cages may be a favorable alternative for housing laying hen

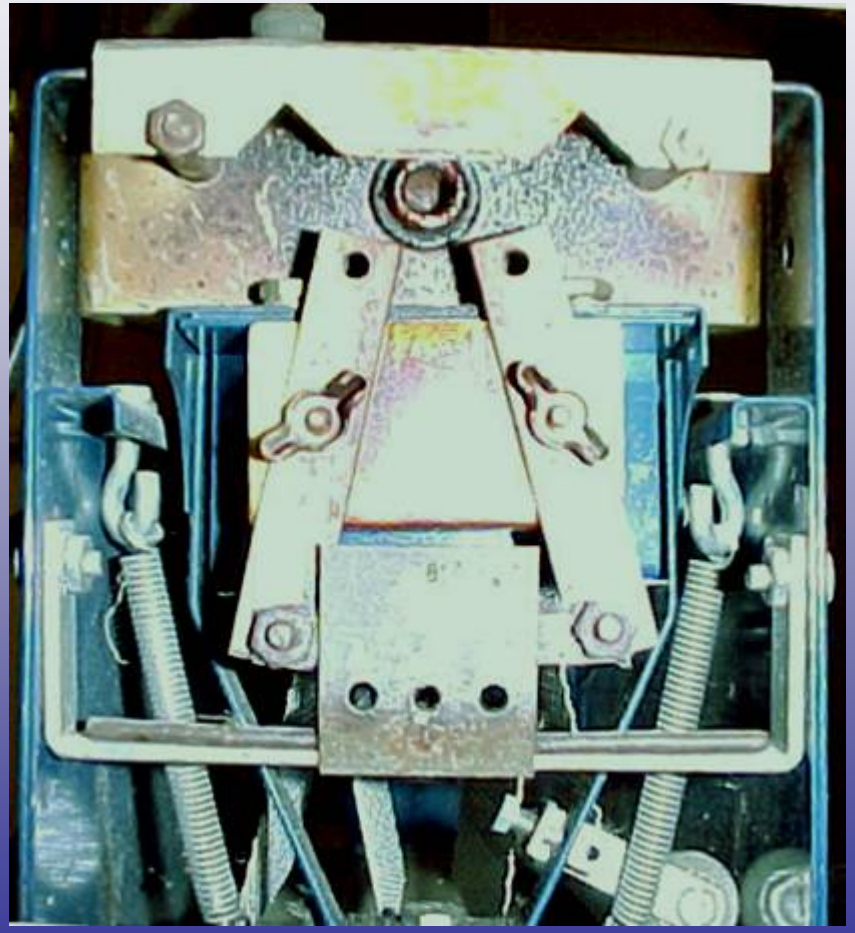
Beak Trimming, Cheng, Lay

Infrared beak trimmer

NOVA-Tech Engineering Inc. MN

Heated blade trimmer

Lyon Electric Company, Inc. CA



Infrared trimmed

Infrared chicks have:

1) less behavioral changes (eating, drinking, and exploring)

2) less epinephrine concentrations at 1 wk post trimming

3) less percentage of beak scar tissue and more feathers at 34 wks of age post trimming

Heated blade trimmed

Control

Sow Lameness Effect of Excercise:

Lay, Marchant Forde, Schenck

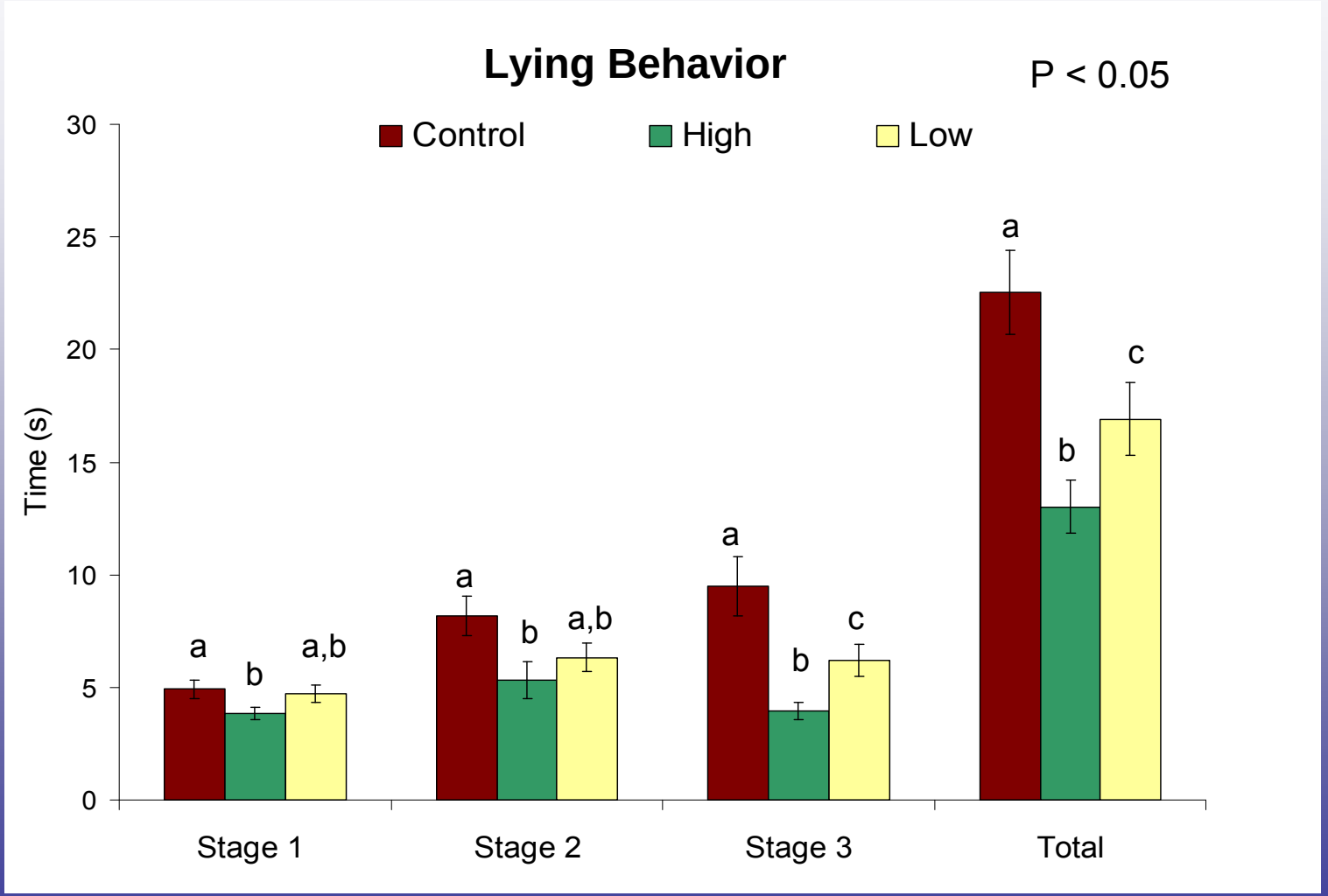
- Economic losses
  - > $60 million
  - #1 defect when culled

- Causes vary
  - Osteochondrosis
    - Most prevalent cause of structural lameness
  - Osteomyelitis
  - Foot lesions

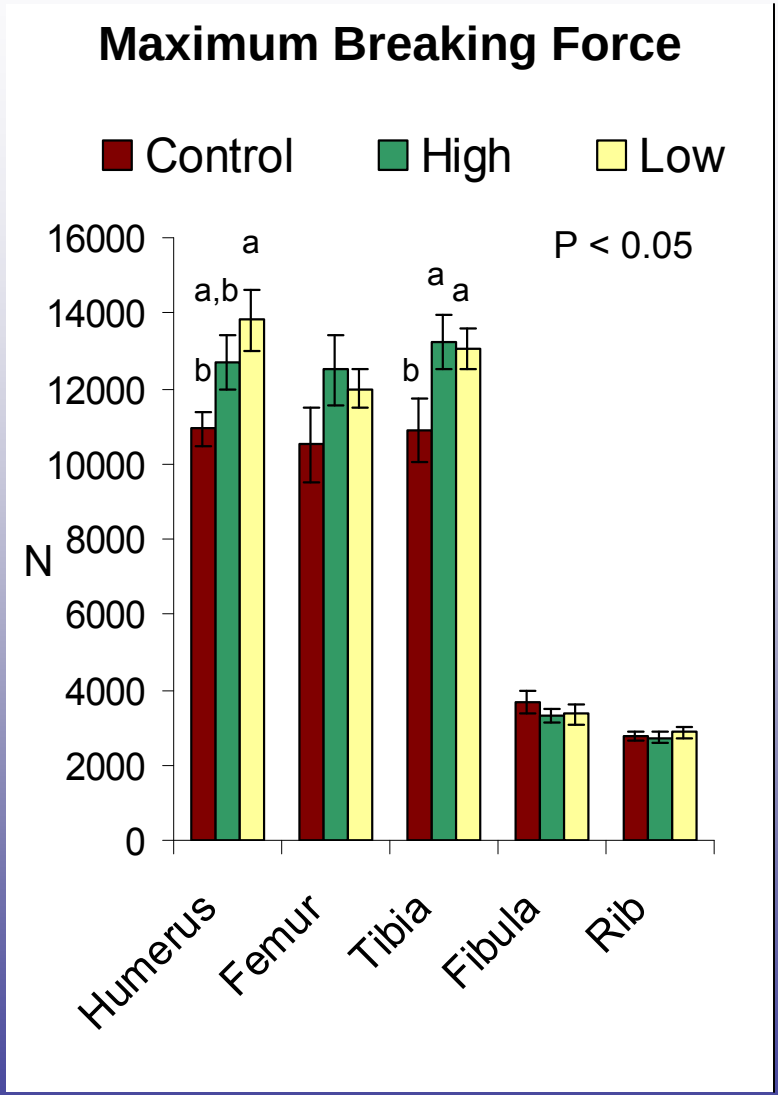
Hill, 1990; Dijkhuisen et al., 1989; Dewey, 1993; Crenshaw, 2006; Grondalen, 1974; Lew and Waldvogel, 2004; Reiland, 1975; Dewey, 2006

Results

Incidence of lameness was low and similar between treatments



Results



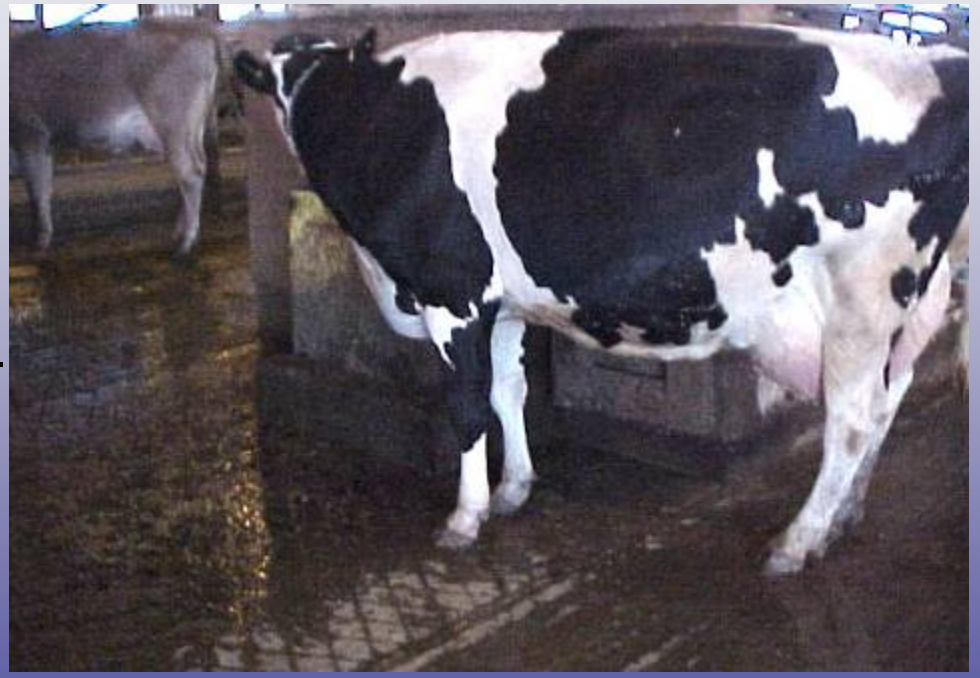
Productivity was Similar

Effect of Rubber Flooring on Lameness in Dairy Cows

Eicher, Marchant Forde, Cheng, Schutz, Lay

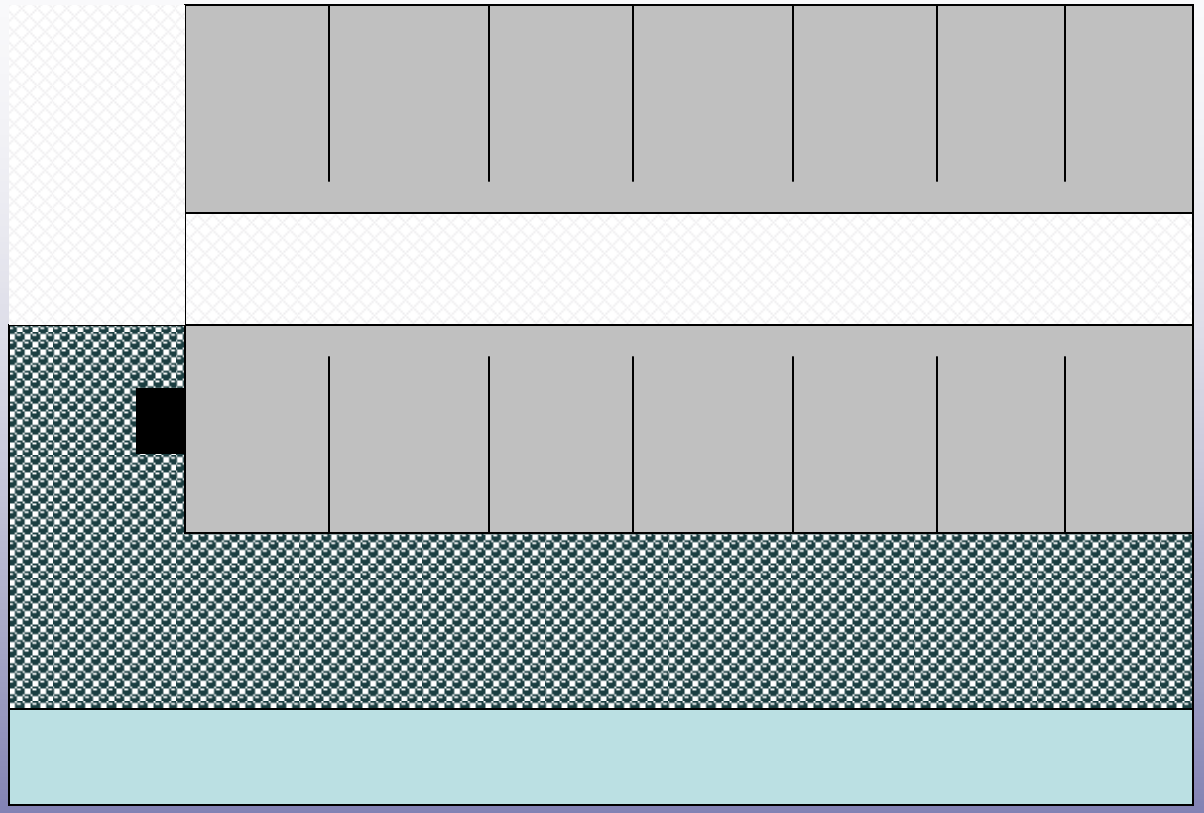
Objective:

To evaluate the effect of 2 free stall flooring systems on lameness and determine early signs of lameness



Experimental Design

Free-stall housing



Grooved concrete flooring

Free-stalls with mats

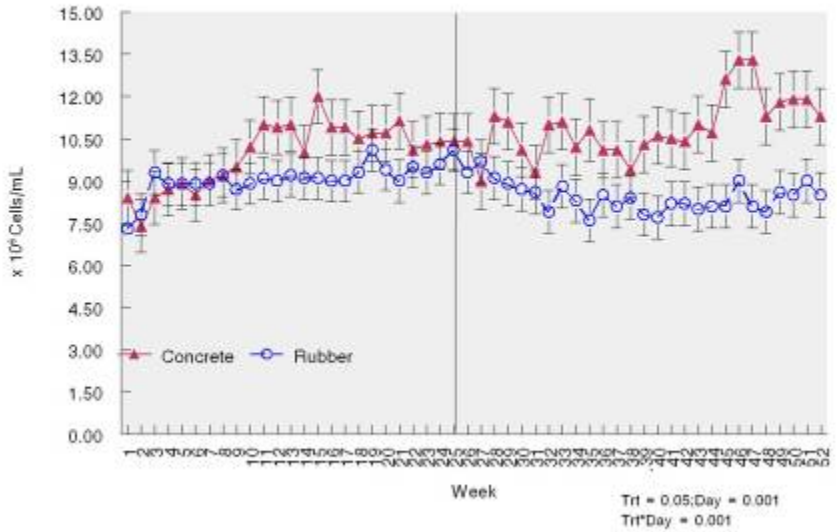
Feed bunk

Rubber mat area

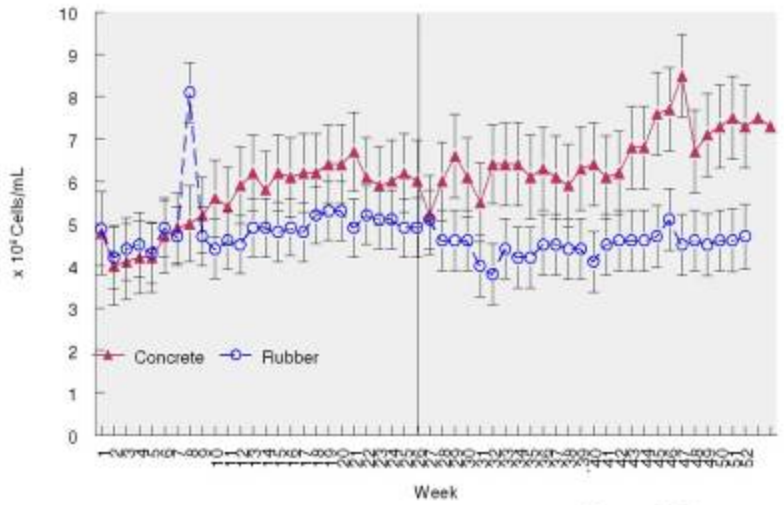
Data collected weekly for 3 years

- Blood samples:
  - Cortisol and hematology
  - Leukocyte function and RNA expression
    - RT-PCR; D -60, -30, 0, 7, 14 relative to 2nd or 3rd calving
      - MMP13 (metalloprotienase 13, activation of neutrophils)
      - HRH1 (histamine receptor H1,inflamation)
      - TAC1 (tachykinin 1 precursor to substance P, pain and inflammation)
- Locomotion: speed, lameness, and hoof lesion scores
- Behavior: activities as well as pedometers
- Productivity

WBC Counts

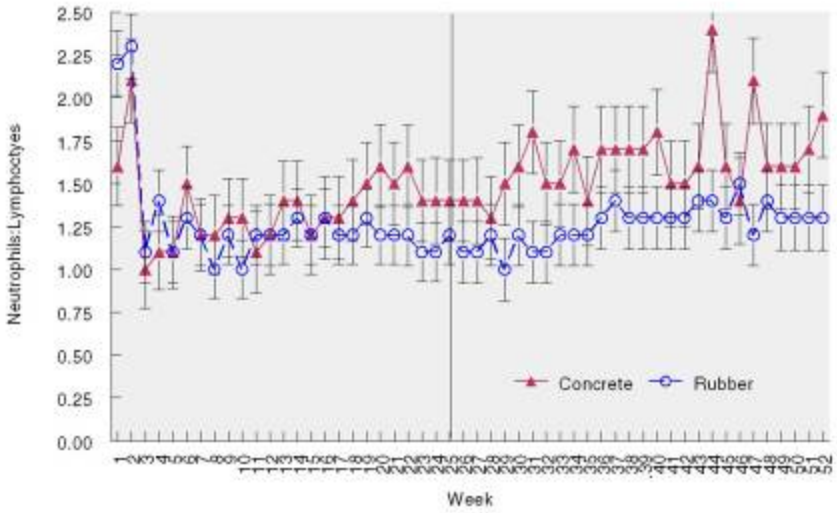


PBMC Counts



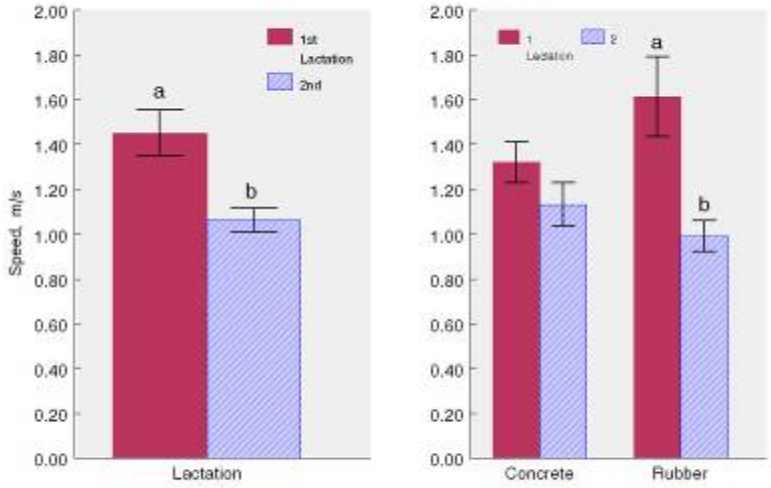
Trt = 0.04

Ratio



Trt * day (P = 0.05).

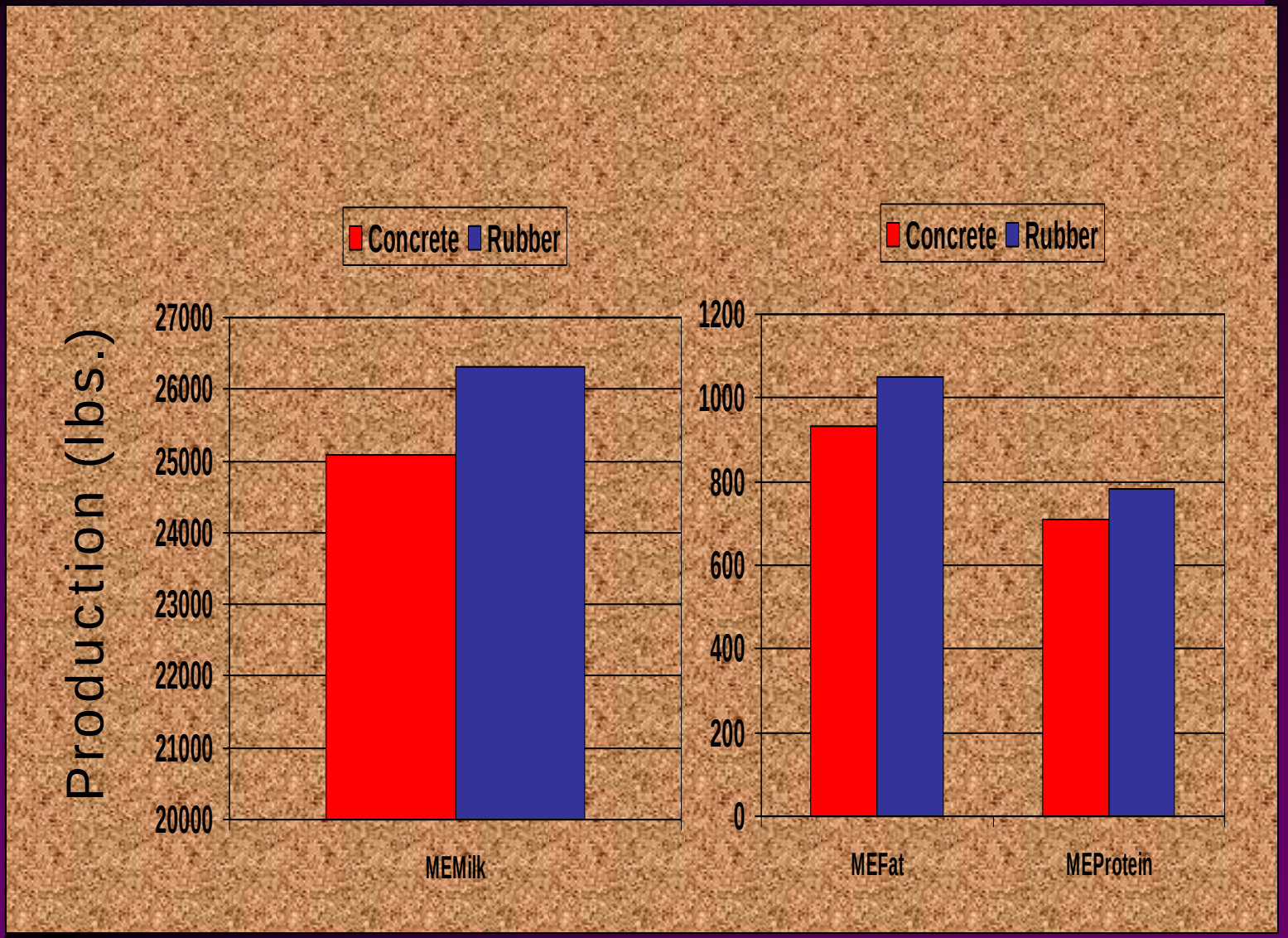
Locomotion



[a,b] Means within a treatment differ (P < 0.01).

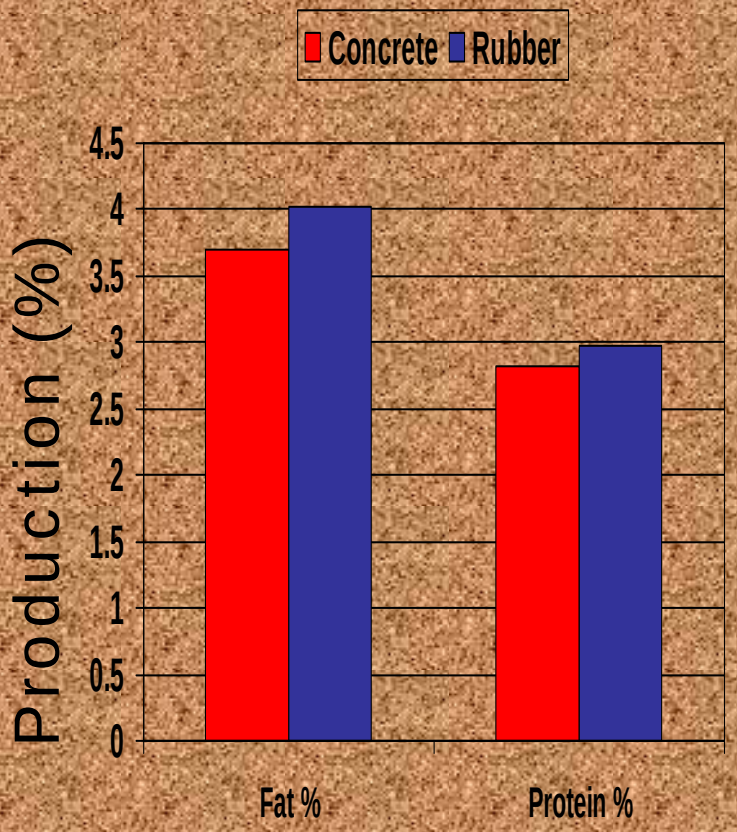
Production of heifers with concrete or rubber flooring in feed area

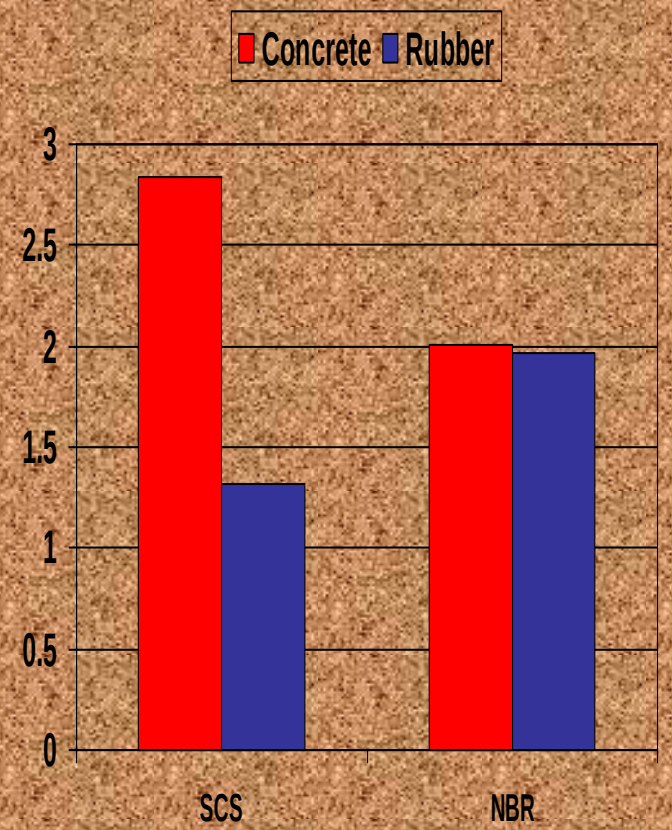
Eicher, Marchant Forde, Lay, Cheng, Schutz



Performance of heifers with concrete or rubber flooring in feed area

- For cows calving a second time, cows on rubber (96%) more likely than cows on concrete (89%) to survive 60 days.
- Similar survival rates thereafter.





TEMPORARY GLYCOSURIA ALTERS MOLASSES CONSUMPTION IN HOLSTEIN CALVES

Wilcox, C.S., N.M. Schutz, S.S. Donkin, D.C. Lay Jr., S.D. Eicher.

- Objective: to determine the effect of experimentally induced increase in glucose demand with phlorizin in neonatal calves on the voluntary consumption of molasses.
- Can we use a non-invasive measure such as molasses intake to 'measure stress'

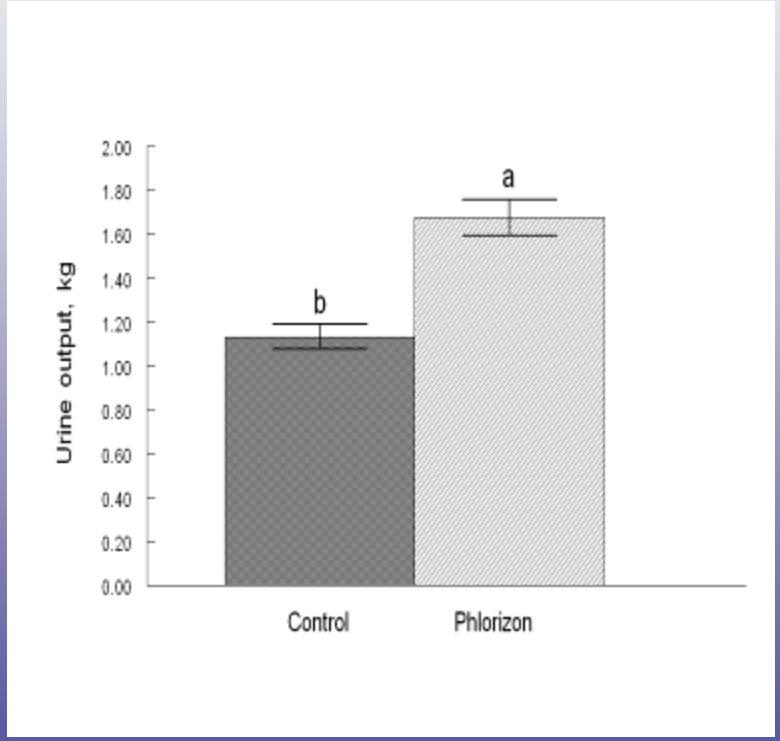
J. Dairy Sci. Wilcox et al., 2008; 91:1-4

Animals

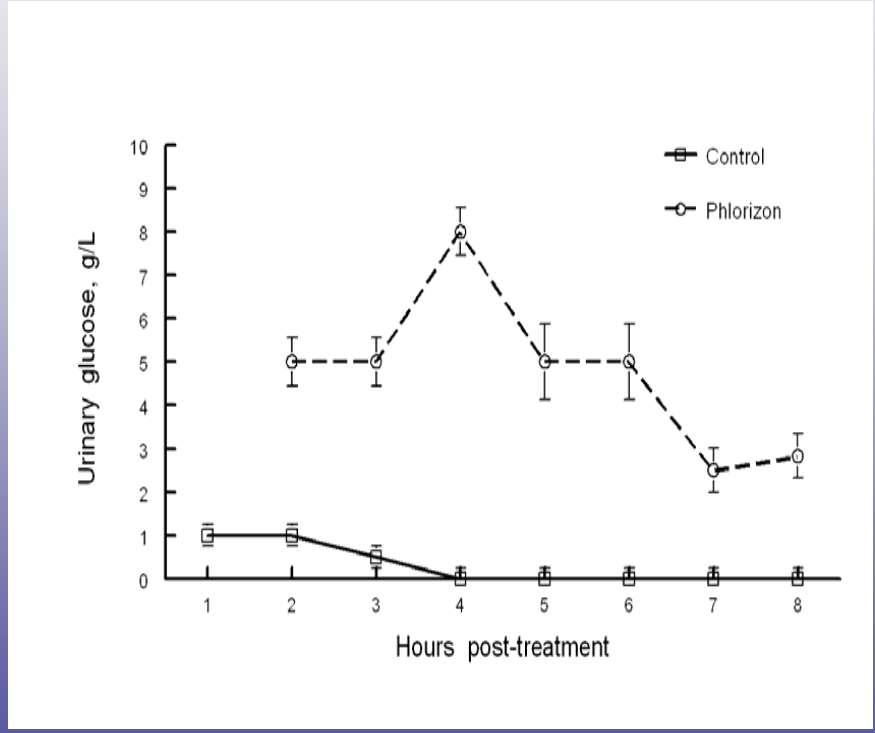
- 3 week-old bull calves
- Housed in individual hutches
- Fed milk replacer twice daily
- Grain starter omitted from diet
- Ad libitum access to water
- Ad libitum access to liquid molasses

Will calves consume molasses if they ‘feel’ a need for glucose?

Mean total urinary output

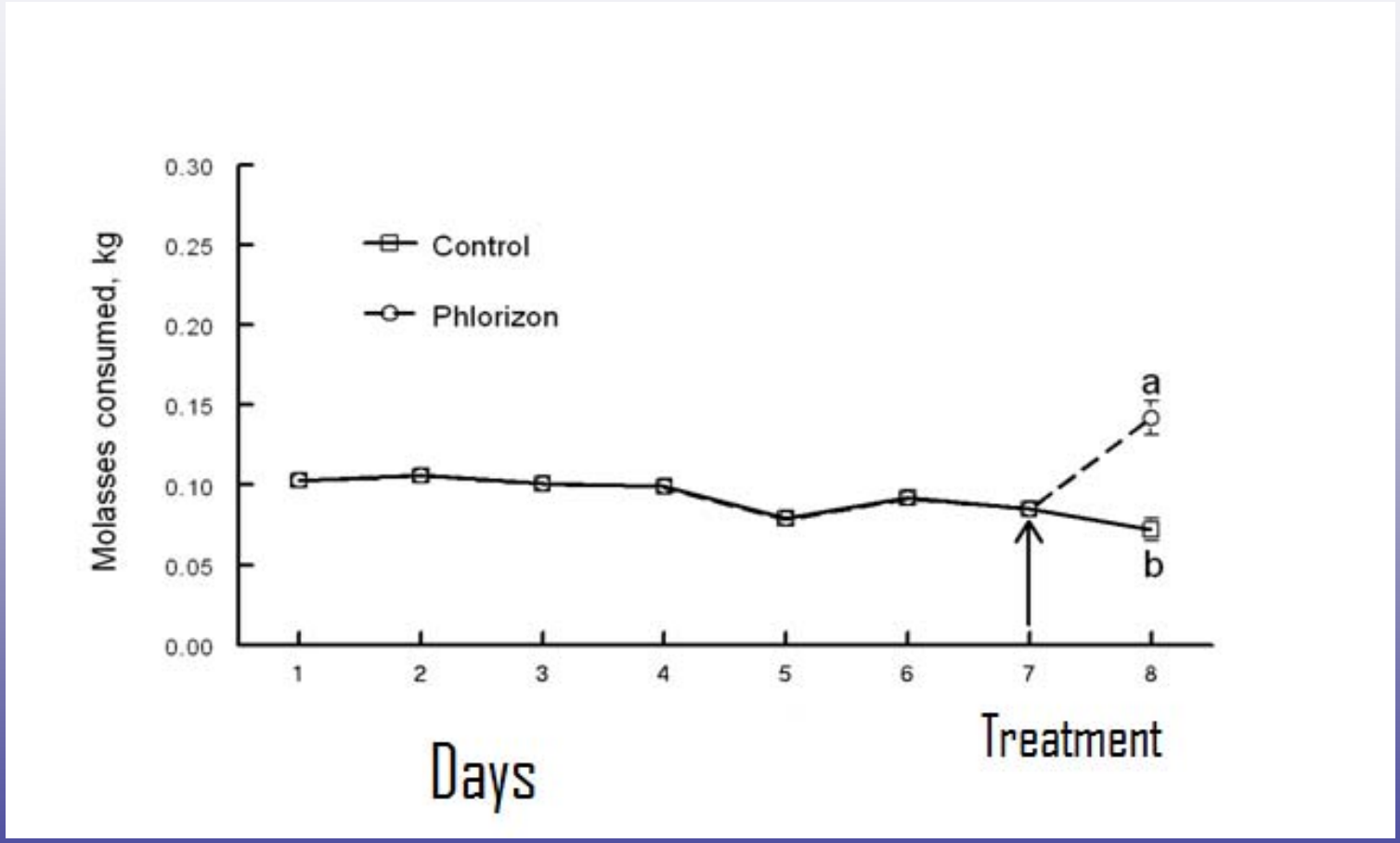


Mean urinary glucose concentration



[a, b] indicate treatment effect , ($P < 0.05$)

Results



[a, b] indicate treatment effect , ($P < 0.05$)

CHANGE IN MOLASSES CONSUMPTION OF HOLSTEIN CALVES AS AN INDICATOR OF REPEATED MILD INTERMITTENT STRESS

Wilcox, C.S., N.M. Schutz, S.S. Donkin, D.C. Lay Jr., S.D. Eicher

Objectives:

- to determine if calves which are stressed will increase consumption of molasses.

Animals

- 3 week old bull calves
  - N=20 Control n=4, Treatment n=16
  - Transported
  - Catheterized
  - Tagged, weighed
  - Placed in group pens

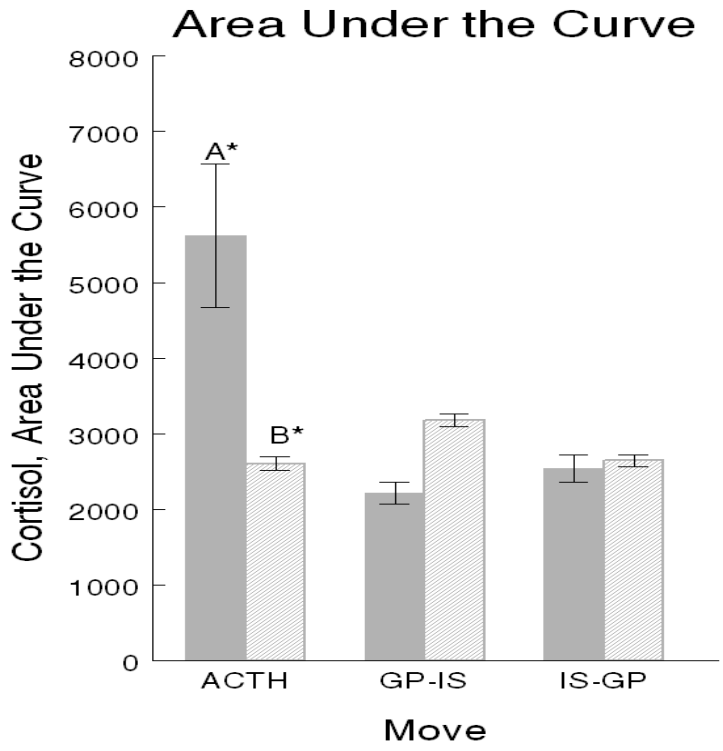
Stress Treatment

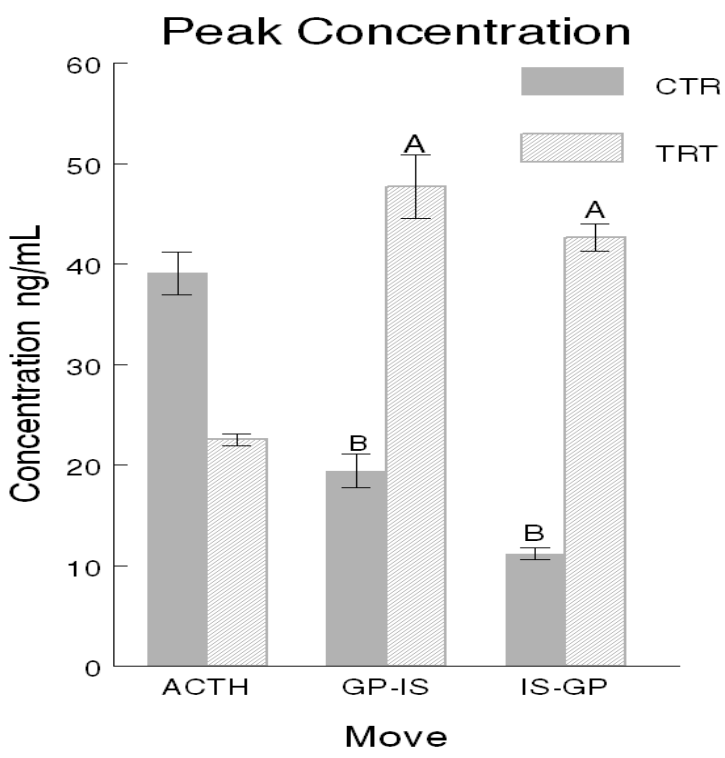
Group pen

Isolation pens

In group pen 36 h, then isolated 24 h; repeated until day 14 when they were challenged with ACTH.

Cortisol



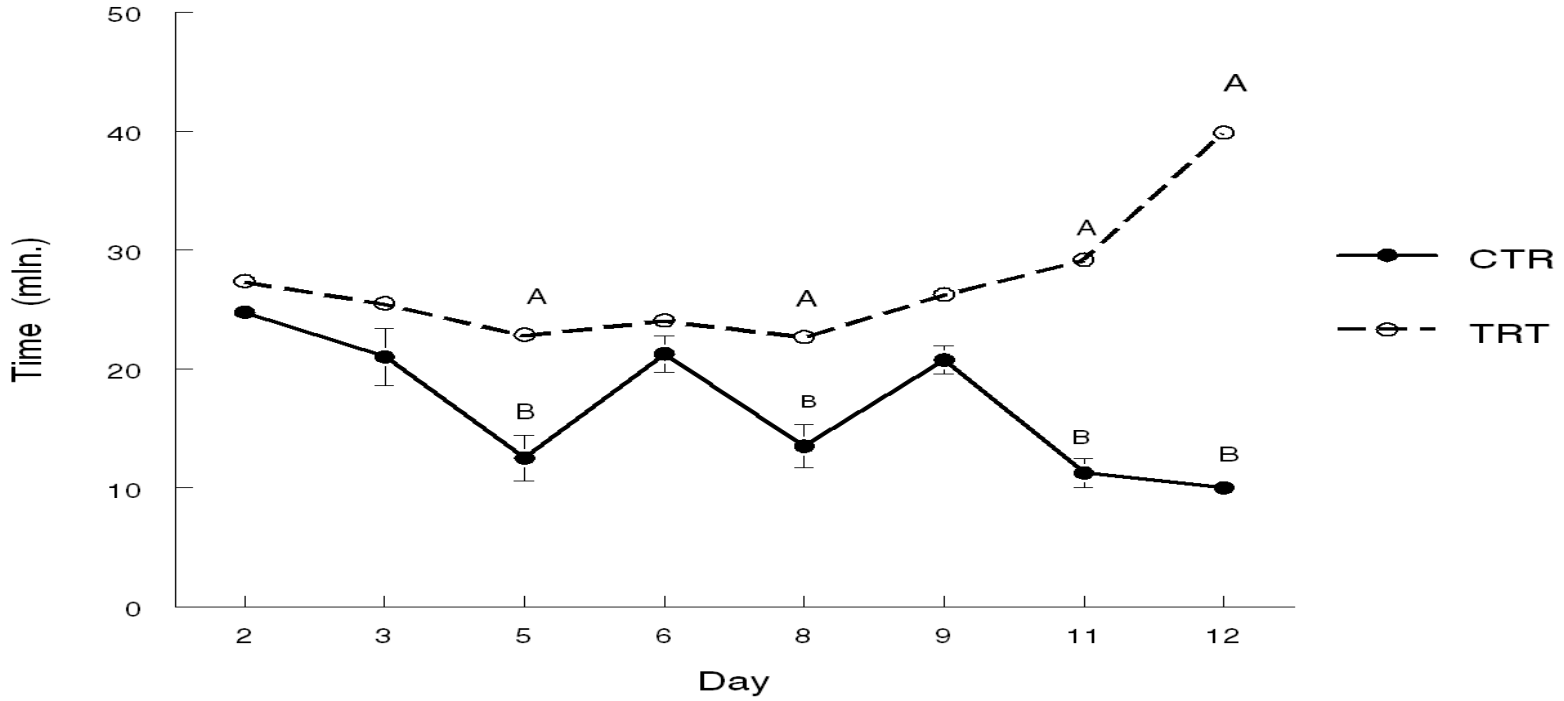


Means represent untransformed data.

[A, B] treatment means differ within time $P < 0.05$.

* represents trend $0.05 > P < 0.1$.

Latency to Lie After Eating



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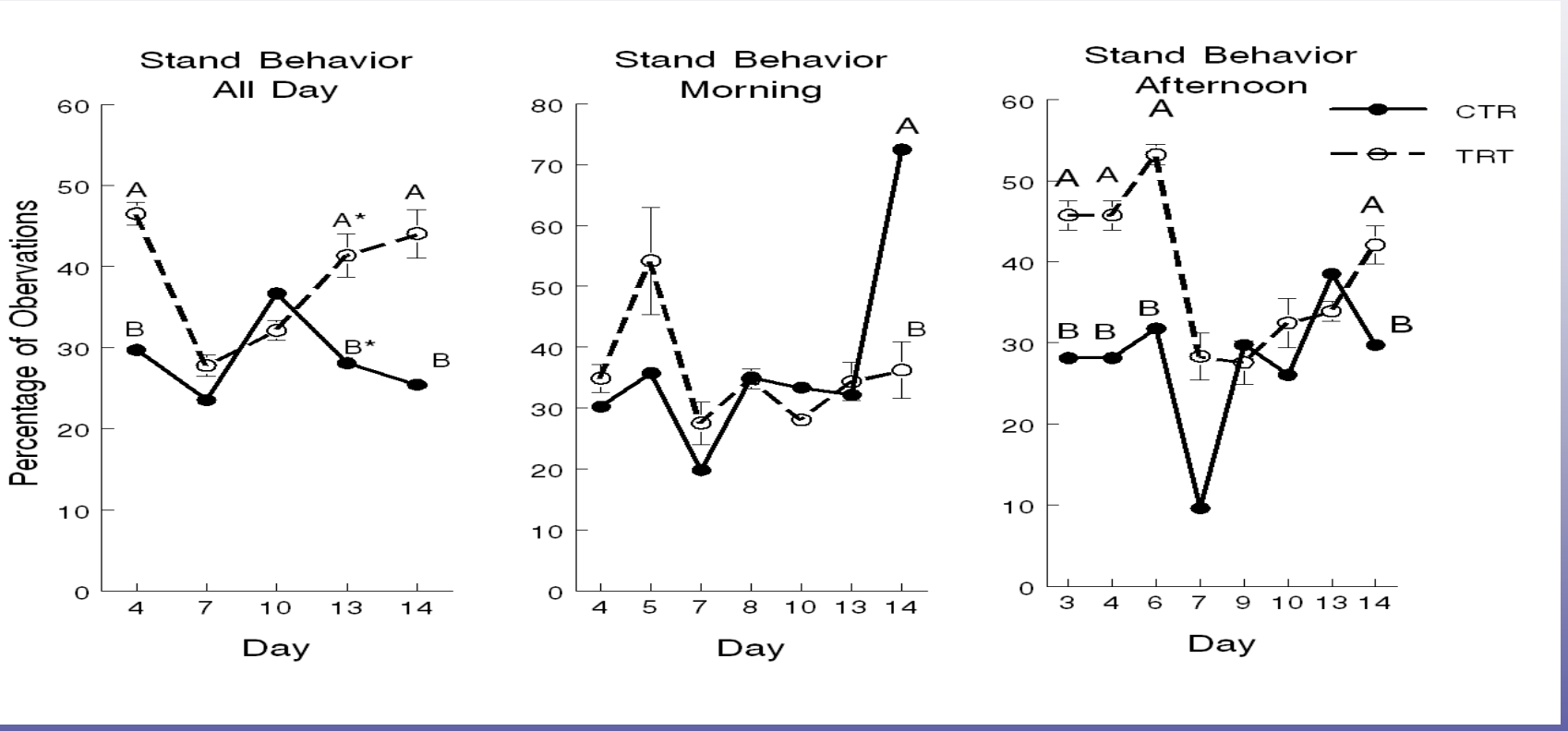
Standing Behavior



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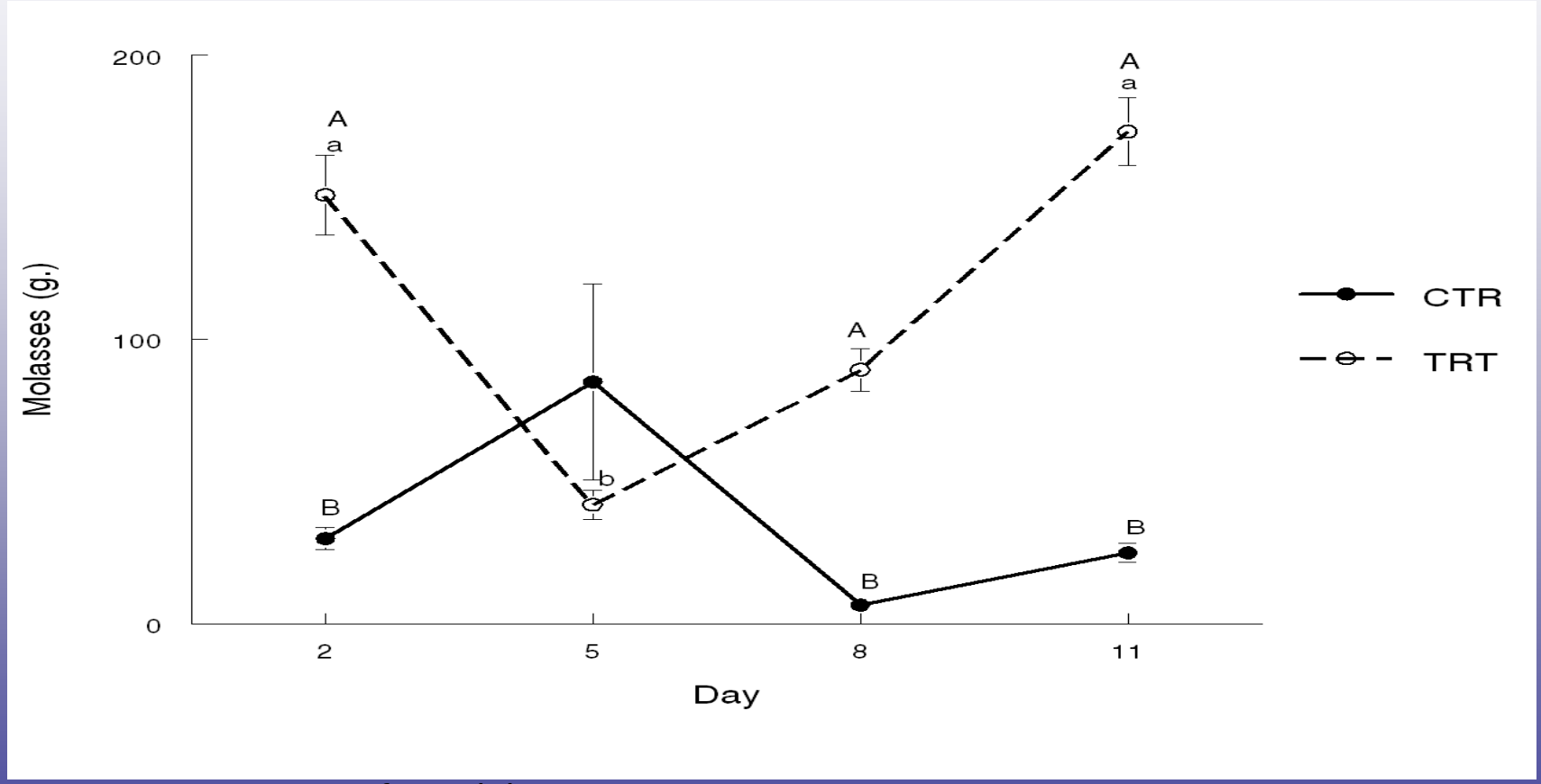
Molasses Consumption



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Questions?