Genetics of Disease Resistance

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The Goal

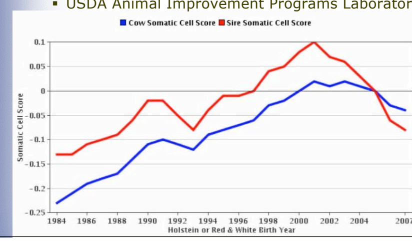
Reduce susceptibility to disease

Overview

- Background to genetic research in disease
  - Will not address simply-inherited genetic defects.
    - Relatively well characterized
    - Appropriate matings will completely eliminate these
- Preliminary results—Genetics of Feedlot Health

Previous Research other livestock

- Dairy
  - Somatic Cell Score (related to udder health) heritability = 12%
  - Currently produce EPD for this trait
    - USDA Animal Improvement Programs Laboratory



Previous Research—other livestock

- Sheep
  - Divergent selected lines of sheep for Somatic Cell Score (mastitis)
    - High lines were especially susceptible to subclinical mastitis
    - High lines had much longer duration of infection
    - Low lines
      - Better ability to limit peripartum infections
      - Better at eliminating infections during lactation
      - Better limited inflammation process

Rupp et al. 2009

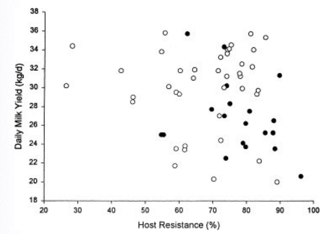
Previous Research—other livestock

- Sheep—Parasite resistance
  - Fecal egg count is an indicator of host resistance to gastrointestinal parasites
    - Heritability has been shown to be .2 at weaning and up to .65 at 400 days of age (Pollot et al., 2004)

Beef Cattle

- Horn Fly Resistance
  - Heritability estimates range from .59 to .78. (Brown et al., 1992)
- Tick resistance
  - Heritability estimates range from .30 to .49 (Seifert, 1971; Wharton et al. 1970)

But in a dairy cattle example…



Milk yield explains little variation in resistance to ticks
Jonsson, et al. 2000

The genetic case for improvement in cattle health

- Snowder et al. (2006)
  - Calves from 1987 to 2001 with incidence of BRD ranging from 5% to 44%
  - Heritability on observed scale was .04 to .08
    - .18 on the underlying continuous scale
  - Concludes that selection against susceptibility to BRD using producer/industry data is practicable

Heritability appears to increase with increasing incidence

- Low incidence versus high incidence years (Snowder et al. 2006)
  - True for other binary traits (yes/no)
    - Comstock, 2006
- What about correlated response… We don't know in beef cattle

The economic case for genetic improvement of cattle health

- 1997 estimates put prevention and treatment of disease in the feedlot at >$3 billion (Griffin, 1997)
- ~1.1 million cattle with an estimated value of over $692 million were lost to respiratory causes in 2005 (USDA, 2006).
- ~7.25 kg (16 pounds) reduction in hot carcass weight for treated animals in 1st 40 days (Snowder et al., 2007)
- Lung damage (yes/no) – 15.4 kg (34 pounds) of carcass weight (Engler, 2007)

Challenges to selection for reduced disease susceptibility

- Nature of disease outbreaks
  - High and low morbidity pens
  - Does that allow expression of genetic potential?
- Flow of data from the feedlot to the breeder
  - Similar to data for carcass traits
  - Potential for use of genetic markers for disease susceptibility

Encouraging results

- Quantitative trait loci for sheep parasite resistance (Gutierrez-Gil et al., 2009)
- Casas and Snowder, 2008
  - Using treatment records for BRD, pinkeye and footrot.
  - Reported a QTL for disease incidence

Value of markers

- Selection for reduced susceptibility to disease with more accuracy
  - Partially overcoming issues with data collection
- Identification of high risk animals and potential for better management of those.

Bottom Line

- Genetic variation exists among animals ability to react to different parasites and different pathogens
- The magnitude of this genetic variation is sufficient for successful selection resulting in genetic progress

Colorado State University study evaluating potential for genetic improvement in disease susceptibility

In the preliminary stages of analysis

Hypothesis

- Susceptibility/resistance to disease is, in part, genetically controlled and that genetic control can be characterized by DNA markers.
- Genetic control is potentially manifested through two mechanisms.

Susceptibility to disease

- Two factors:
  - Immunological response to disease challenges
    - With or without previous challenge
  - Ability to cope with stress

Previous research

- Immune response to challenge effected by (Salak-Johnson & McGlone, 2007)
  - Stressor type
  - Duration of stressor
  - Genetics
  - Age
  - Social status
- "Nervous" cattle have significantly lower feedlot ADG and higher morbidity (Fell et al. 1999)

Objectives

1. Develop methods to identify animals that are genetically superior for feedlot health characteristics through both molecular and quantitative techniques.
2. Identify new traits and evaluate their relationship with feedlot cattle health to improve accuracy of selection for disease resistance.
3. Validate methodologies and techniques developed in Objectives 1 and 2.

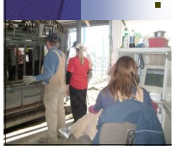
Study Design—Animals

- Single ranch source
- 2,870 steers
  - 1,551 in Year 1
  - 1,319 in Year 2
- Breed Composition
  - Composite
    - British and Continental
- JBS-Five Rivers Colorado Beef & South Eastern Colorado Research Center, Lamar CO

Feedlot Pens

General Procedures

- Vaccination
  - Year 1 – none
  - Year 2 – against vectors commonly associated with BRD
  - No "mass medicate"
- Paracitides were applied
- Implanted both years



Phenotypes

- Performance traits
  - Weights
    - Arrival, re-implant(s)
  - Growth composition (ultrasound)
  - Carcass traits
    - Hot carcass weight
    - Quality grade
    - Ribeye area
    - Backfat
    - Yield grade
- Stress and behavior
  - Temperament
    - Time in chute
    - Flight speed
  - Stress indicators
    - Cortisol
    - Cytokines
    - TNFα
- Disease and Immunological measures

Phenotypes

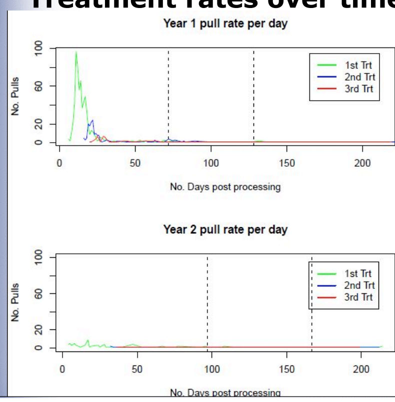
- Phenotypes characterizing disease
  - Sick (yes/no)
  - Time to recovery
  - Treatment records
    - drugs, temperatures, weight change
  - Mortality
    - Necropsy results
      - Bacteriology
      - FA tests
  - Lung lesion scores collected at harvest
  - BVD PI information
  - Respiration rates
  - Visual scores
    - Nasal discharge, Eye, Cough, Depression, rapid breathing

Treatment Rates

Treatment and Death Summar				
	1 TRT	2 TRTS	3 TRTS	Died
Overall	702	181	64	96
n = 1,55[illegible]	45.3%	11.7%	4.1%	6.2%

Treatment and Death Summa				
Ranch	1 TRT	2 TRTS	3 TRTS	Died
Overall	94	9	6	30
n = 1,319	7.1%	0.7%	0.5%	2.3

Treatment rates over time



Year 1 published results

- An animals entry weight into the feedlot does impact the probability of that animal may require treatment. Heavier animals should less likely to become sick.
- Processing stress, the time an animal spends in an ally awaiting processing and the actual time in the chute being processed, increases that animals susceptibility to future disease challenge

Year 1 published results

- Weather, average temperature and wind speed, does increase probability an animal will show signs of sickness.
- Temperament, measured by exit velocity, reduces weight gain in the first 45d of feeding.

Effects on Performance (compared to no treatment)

Number of Treatments	Early ADG	Late ADG	Total ADG
1	-.30	-.17	-.30
2	-.64	-.77	-.64
3	-1.12	-.70	-1.11

Heritability

- Over the entire course of the study the treatment rate was 27%
- Heritability of the probability of being treated (yes/no) was 0.19 ± 0.6 on the underlying scale

National Beef Cattle Evaluation Consortium

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