Selection for Parasite Resistance

Presenter:

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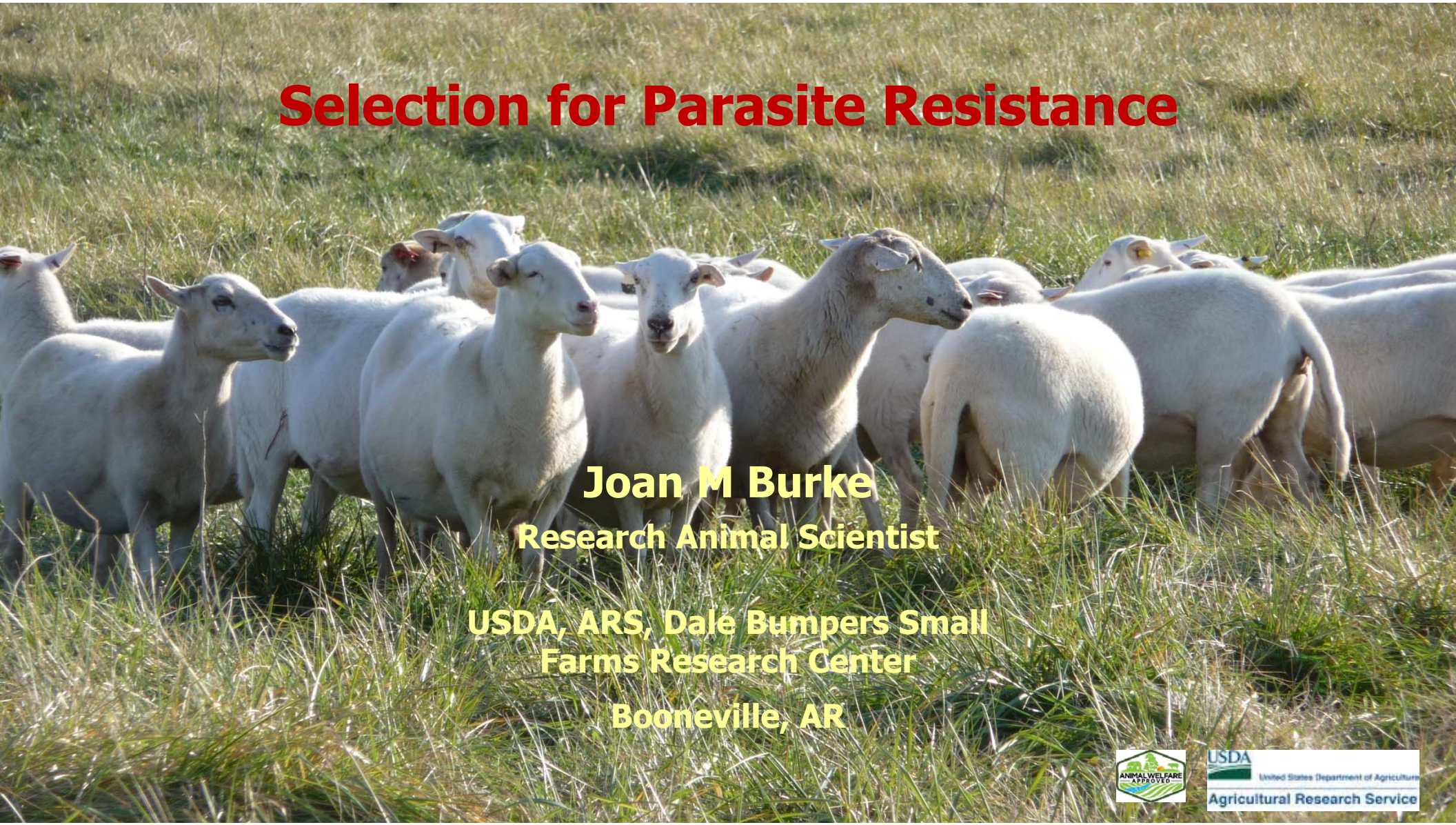

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Dale Bumpers Small Farms Research Center Mission: To develop scientific principles and technologies to enhance the profitability of small scale farms.

Outline

- Overview of worm parasites
- Control options
- Resistant breeds
- Genetic selection within breed
- Selection tools

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Gastrointestinal Parasites

- **Infect sheep and goats.**
- **One of greatest health issues, causing anemia, reduced weight gains, poor performance, and death.**
- **Widespread anthelmintic resistance limits tools to control.**

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Gastrointestinal Parasites

- ***Haemonchus contortus*** **or barber pole worm is the most pathogenic, and thrives in warm, humid climates.**
- **Others include *Trichostrongylus* spp., *Teladorsagia circumcincta*; *Cooperia*, *Oesophagostomum*, *Trichuris* and *Nematodirus* are less pathogenic.**

Gastrointestinal Parasites

- **Recent epidemiological studies indicate that *Haemonchus contortus* is present in most states and as far north as Canada.**
- **There is evidence that *H. contortus* can overwinter (OH, MT).**

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Haemonchus contortus

- **A blood sucking worm**
- **Very prolific – one adult female can produce 5,000 eggs per day**
- **Short life cycle – about 3 weeks from time of infection until eggs are produced**
- **Affects weak, young, pregnant, or lactating animal**

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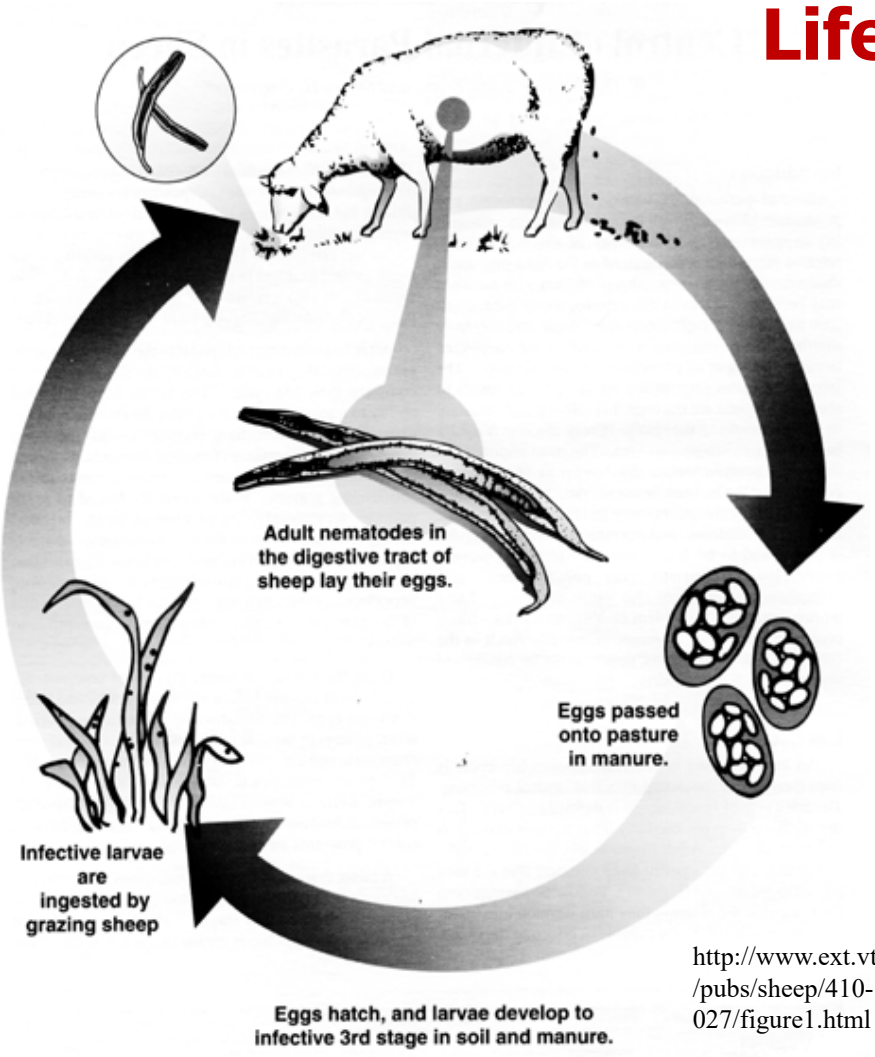
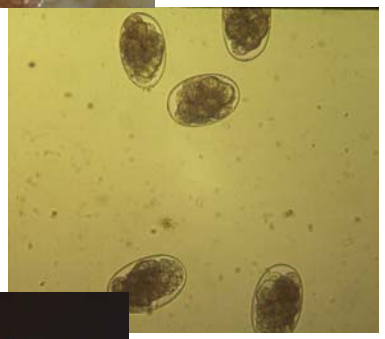
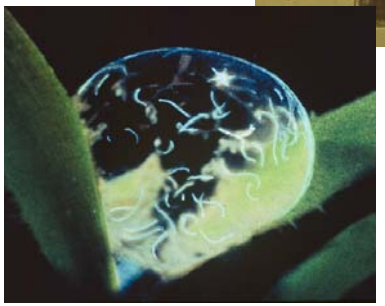
Life cycle of GI nematodes







http://www.ext.vt.edu/pubs/sheep/410-027/figure1.html

Parasite Control

- **Widespread anthelmintic resistance necessitates the use of alternative control measures.**
- **Selective treatment with anthelmintics – use 3-way combination (see www.wormx.info).**
- **Copper oxide wire particles – specific for *H. contortus*; combined with dewormer increases efficacy.**

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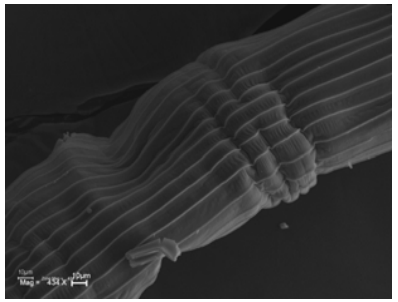
Parasite Control

- **Condensed tannin rich forages, fresh or dried – reduces fecundity of worms.**
- **Feedlot or avoidance.**
- **Grazing management.**
- **Genetics – breed or individual selection.**



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Resistance or resilience?

- **Parasite resistance –the ability of an animal to resist gastrointestinal parasite infection. Characterized by low FEC and no signs of anemia (high PCV).**
- **Parasite resilience or tolerance – the ability of an animal to tolerate gastrointestinal parasite infection. Characterized by moderate (can be high or low) FEC and no signs of anemia (high PCV).**

Use of Resistant Breeds

- **Spanish and Kiko > Boer**

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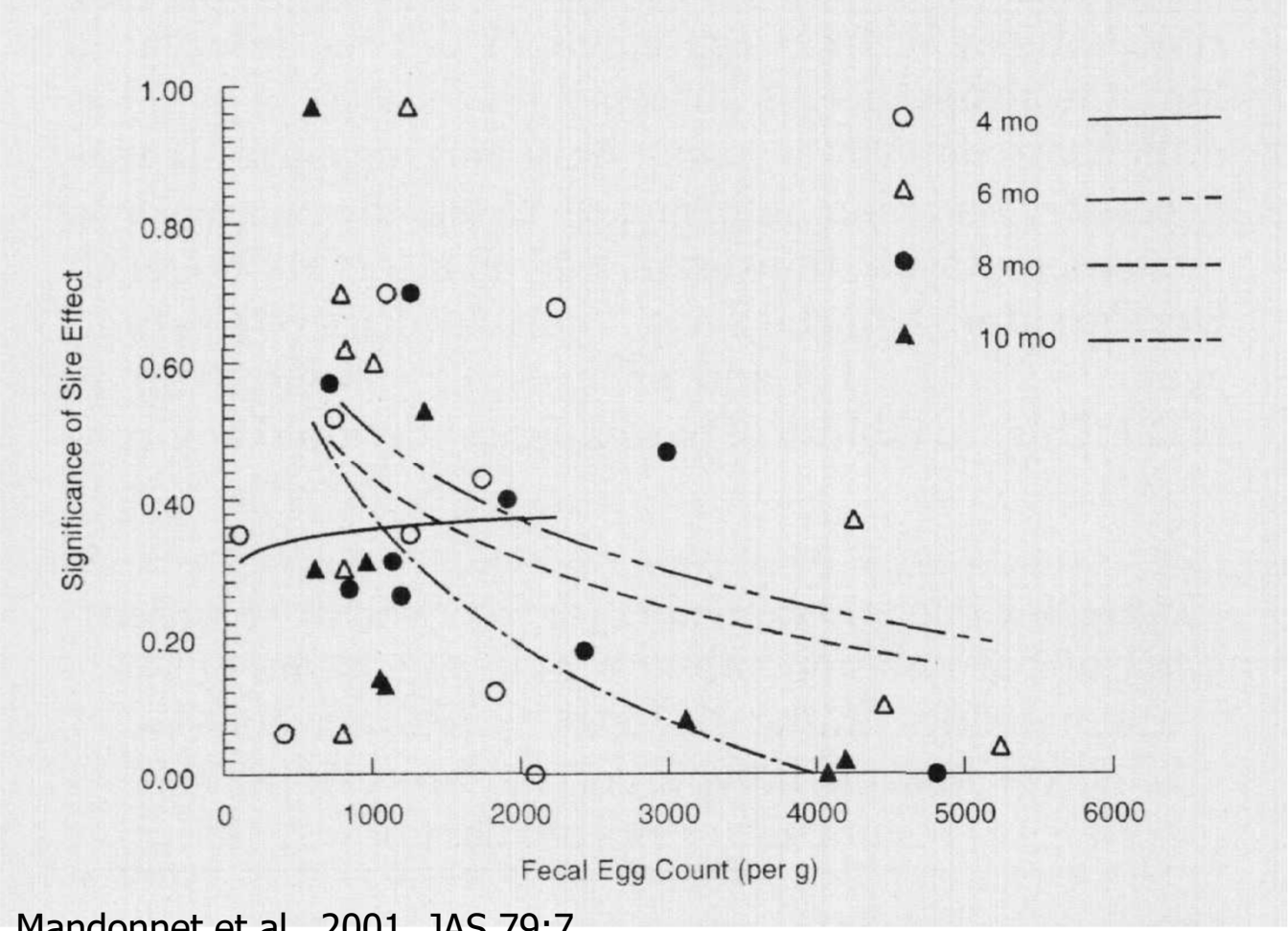
Parasite resistance in goats



Mandonnet et al., 2001, JAS 79:7

- **Relationship between FEC and sire effect – more significant as infection increased.**
- **Heritability as high as 0.37.**

Use of Resistant Breeds

- St. Croix
- Gulf Coast or Florida Native
- Barbados Blackbelly
- Katahdin

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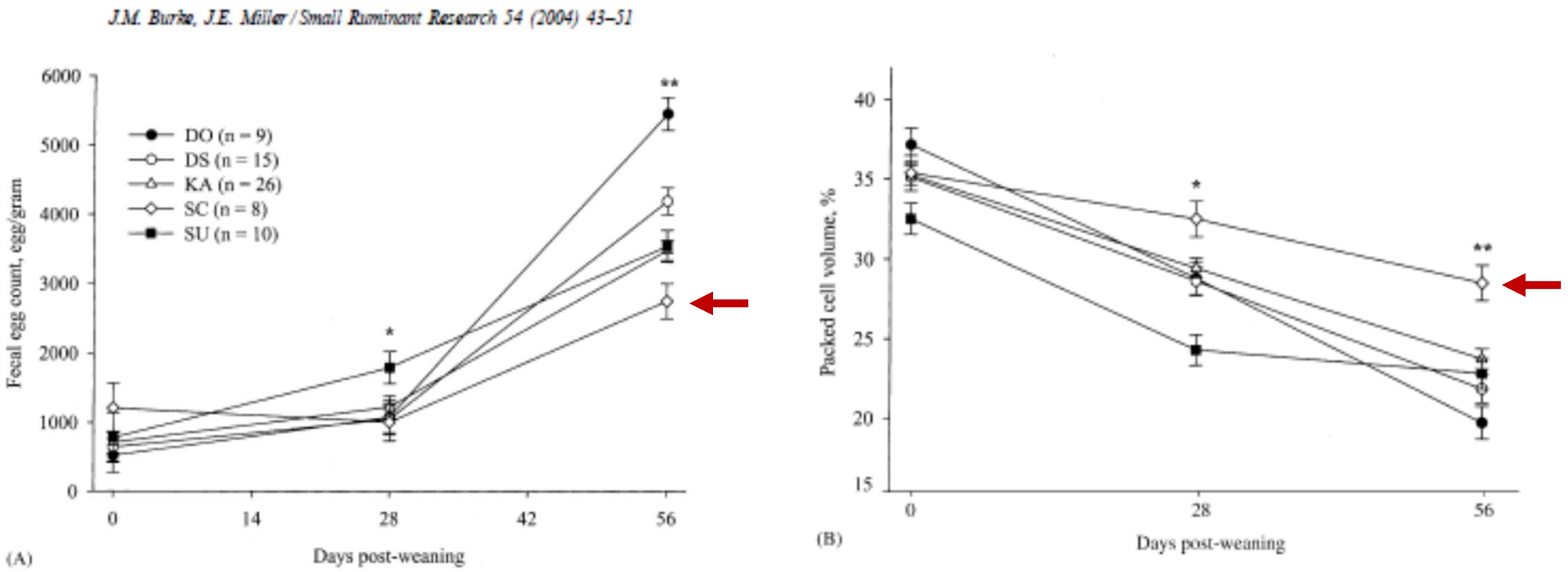
Effect of breed of lamb on parasite infection



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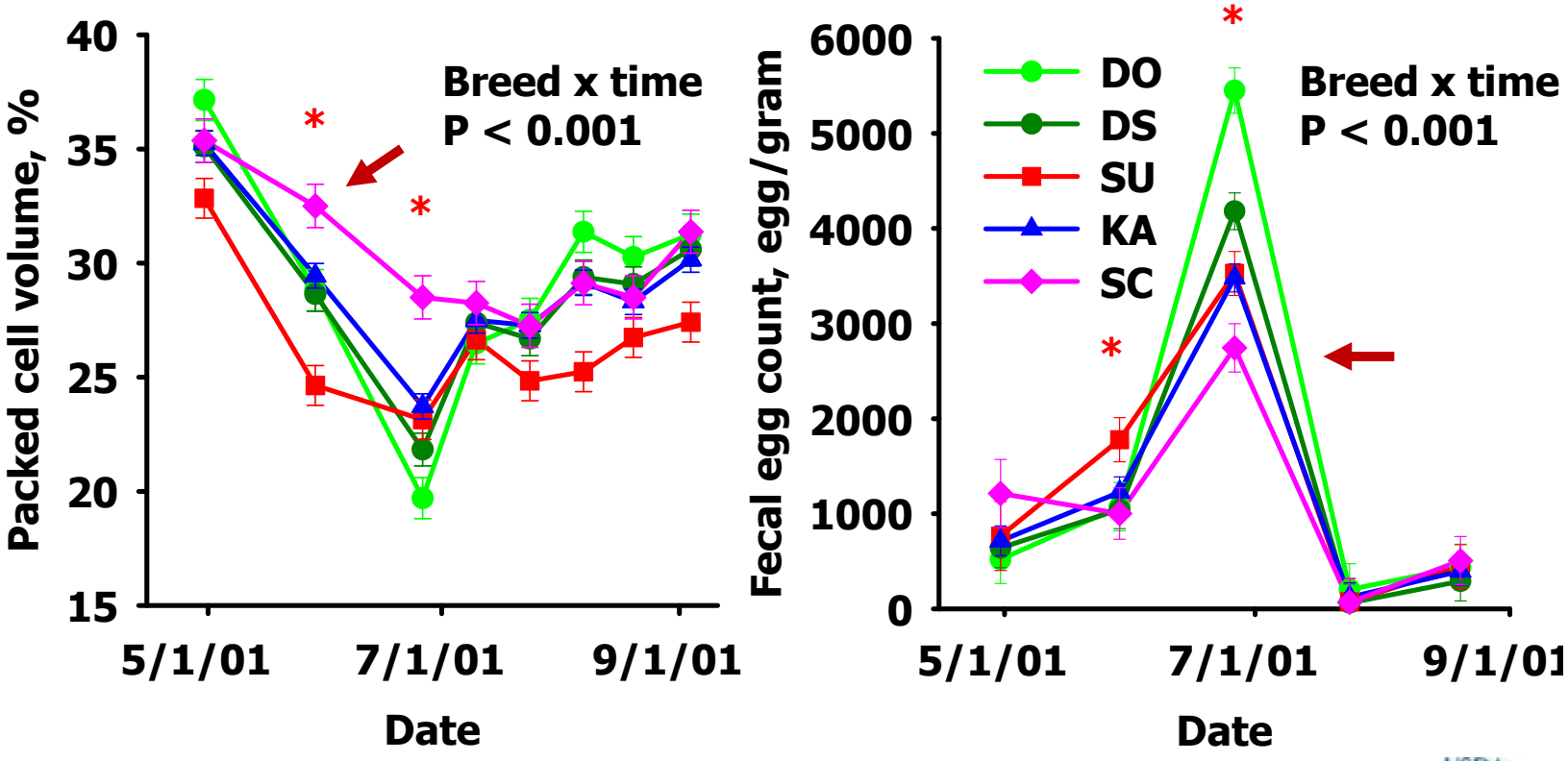
Effect of breed of ewe on parasite infection



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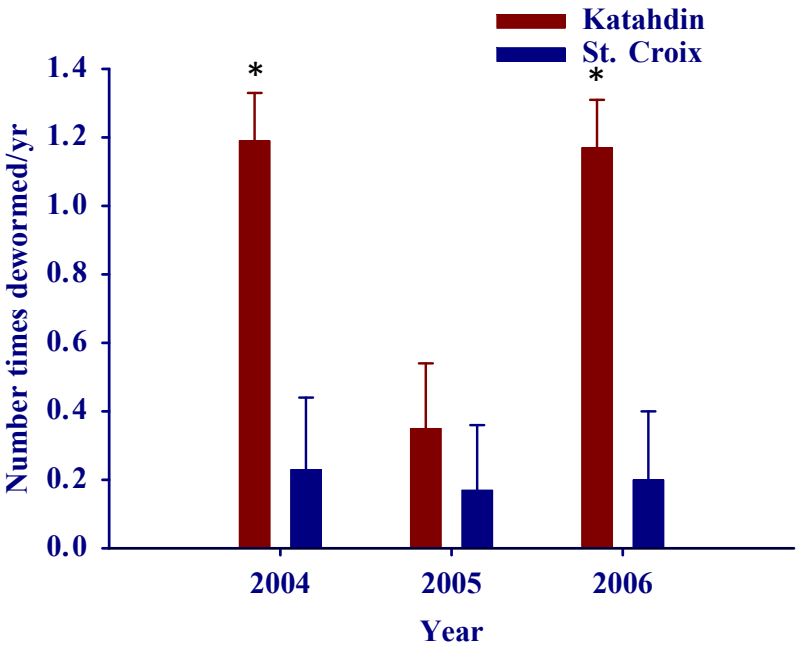
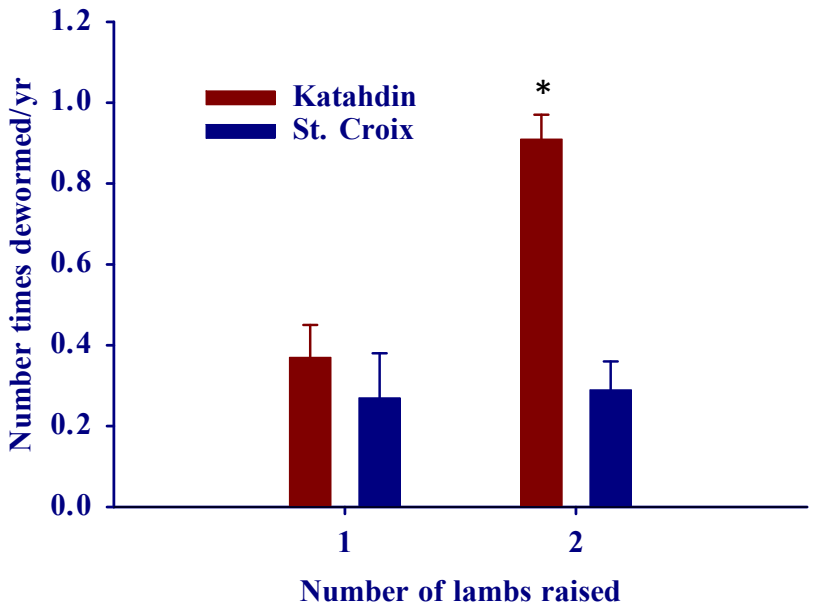
Impact of Resistant Breeds





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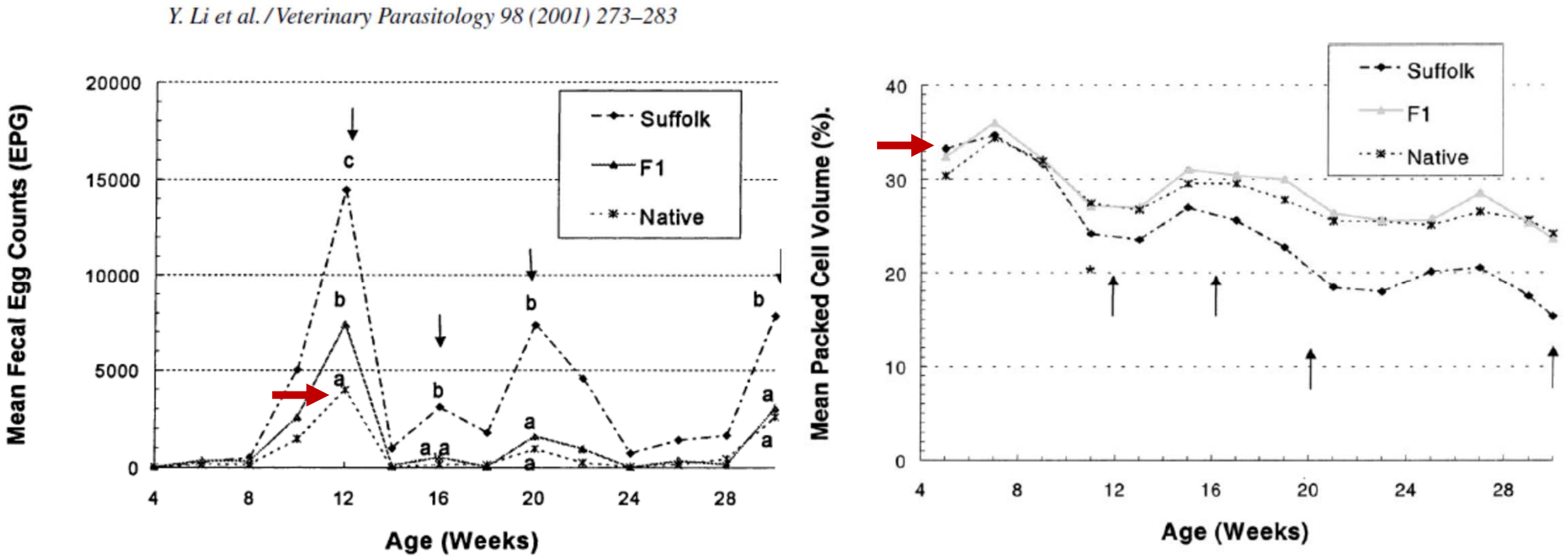
Effect of cross-breeding or heterosis on resistance

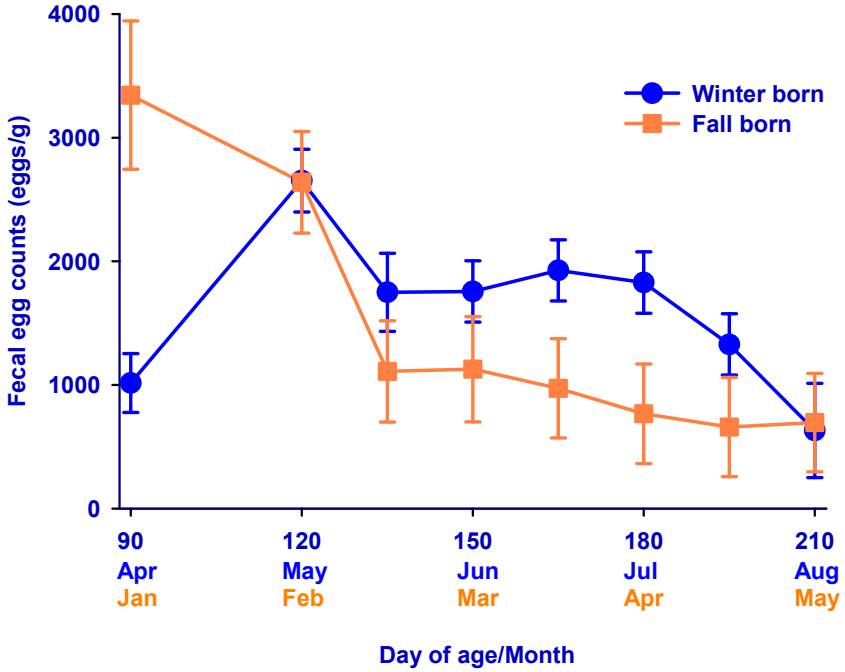
-34-82% for FEC, 0-21% for PCV

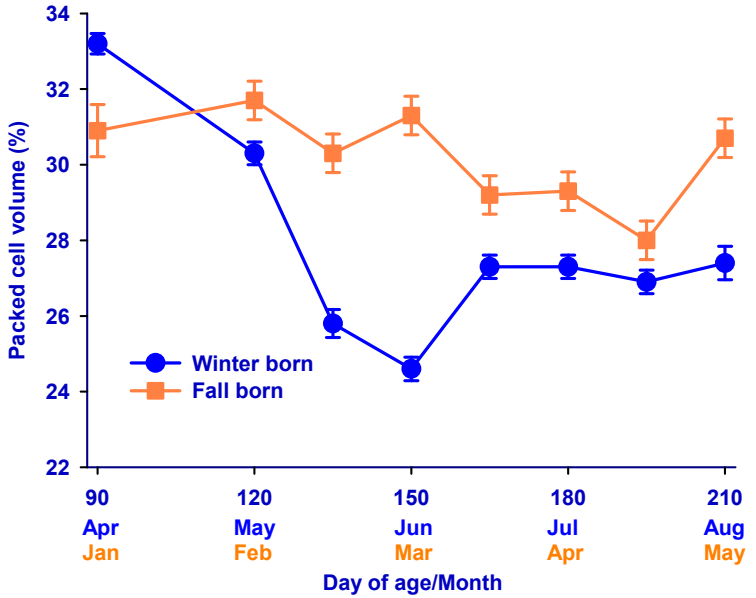


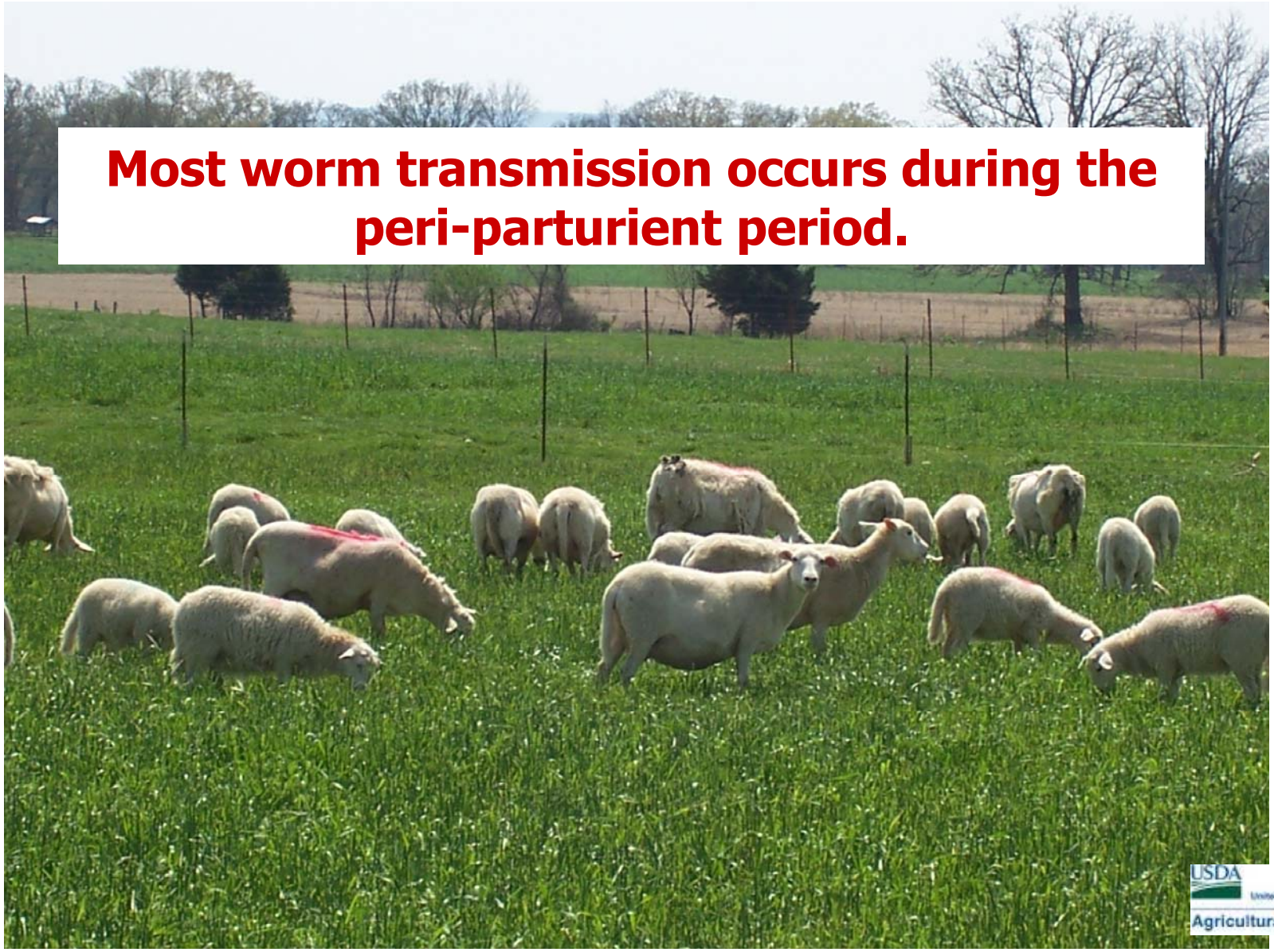
Environmental factors that influence GI infection

- Rainfall, humidity, temperature
- Season
- Management
- Stocking rate
- Nutrition/body condition
- Sex
- Stress

Effect of season of birth on GI infection






Most worm transmission occurs during the peri-parturient period.
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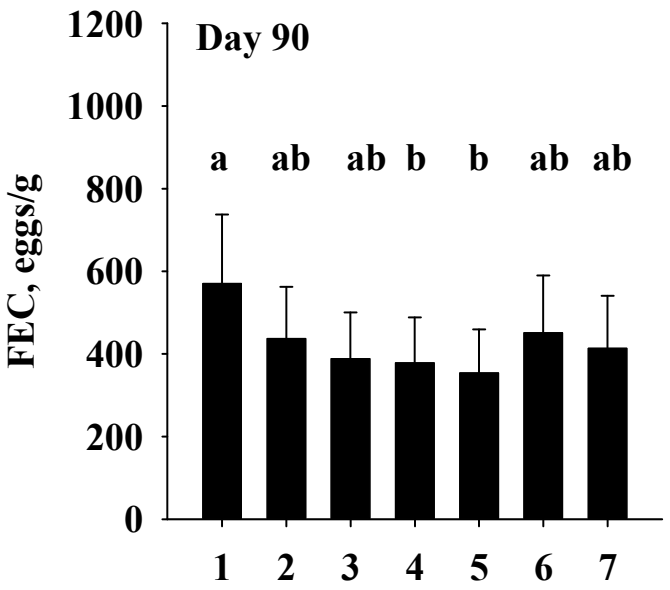
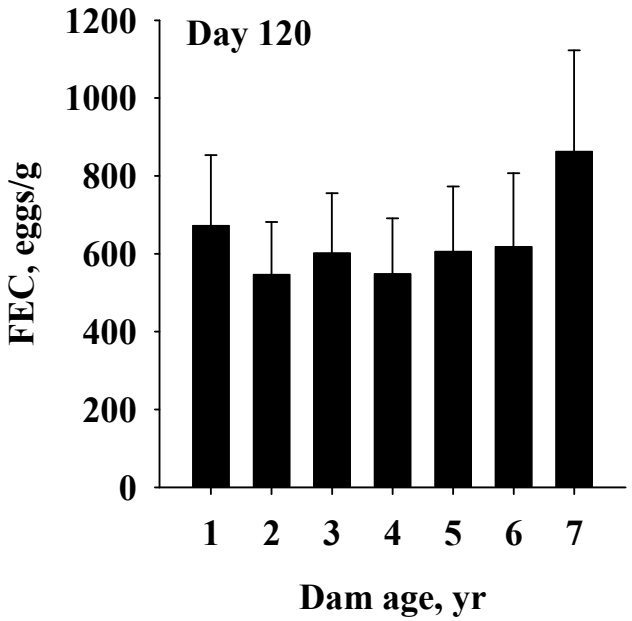
Body condition of the dam, litter size, and age will influence her performance and worm egg output, as well as the lamb's.

Effect of dam age on FEC
(Notter, Burke, et al., 2017)





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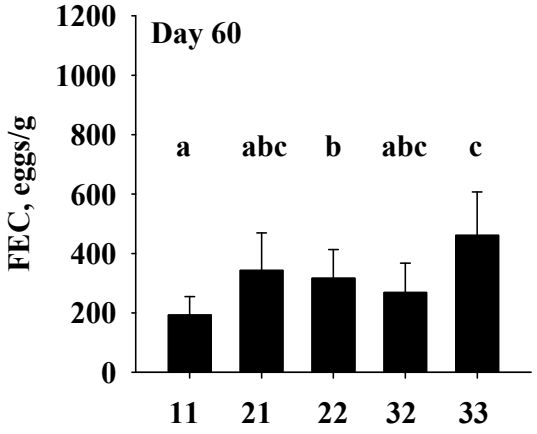
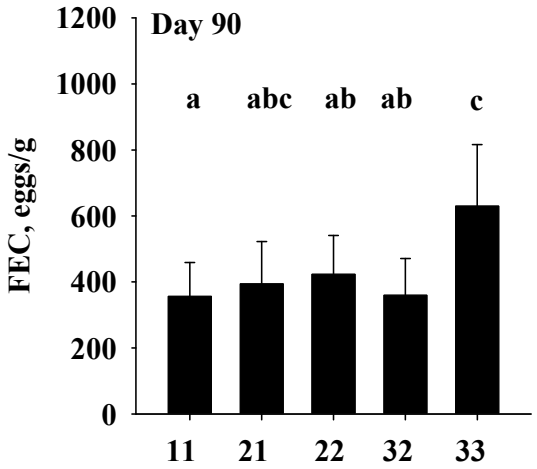
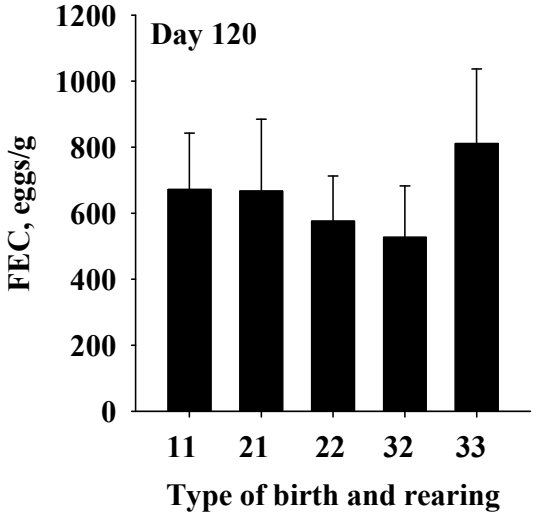
Effect of number of lambs born/weaned on FEC

(Notter, Burke, et al., 2017)







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Performance

- **Influenced by GENETICS and ENVIRONMENT.**
- **Want to separate these effects so that we know the genetic contribution to performance.**
- **Performance tests bring animals to a central location into the same environment (management, nutrition, etc.). Limited to traits recorded.**
- **NSIP**

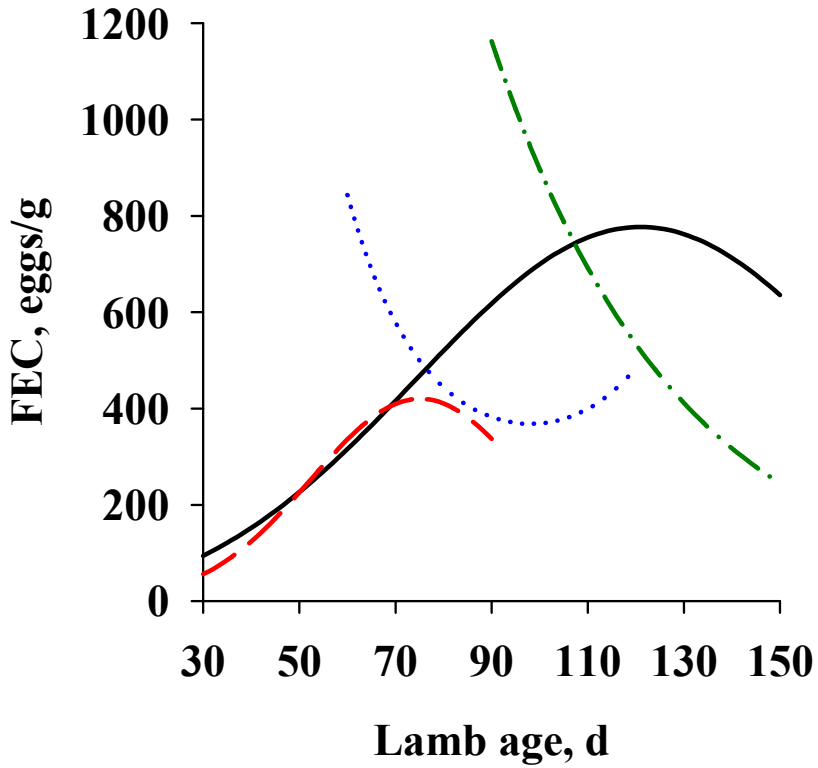
Tools for Selection

- **NSIP – provides predictable, economically important genetic evaluation information to the American sheep industry by converting performance records into relevant decision-making tools.**
- **EBVs – estimated breeding values; inherited genetic potential from sire and dam.**

Using NSIP to select for parasite resistance

- NSIP allows recording of FEC at 3 different ages:
  - Weaning (42 to 90 d)
  - Postweaning (90 to 150 d)
  - Yearling/adult
- Weaning FEC are generally collected at the time the lambs are first dewormed, but is influenced by anthelmintic resistance and use.

Changes in lamb FEC with age
(Notter, Burke, et al., 2017)



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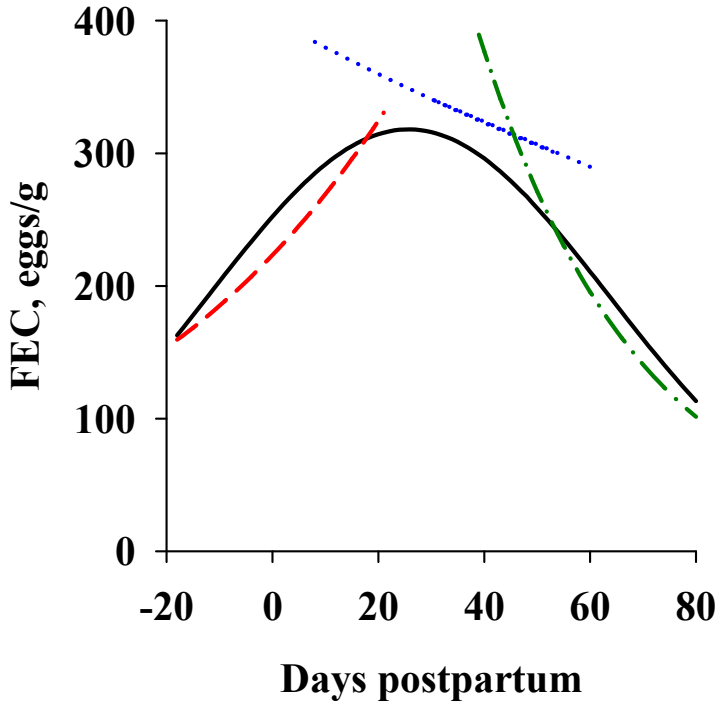
Changes in dam FEC during PPR
(Notter, Burke, et al., 2017)



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Rapid Genetic Improvement Requires:

- **Accurate animal evaluation = high heritability and/or progeny testing.**
- **Intense and timely selection - keep only the best**
- **Variation within the population: the more variation that is present, the easier it is to identify the best.**
- **Good contemporary groups.**

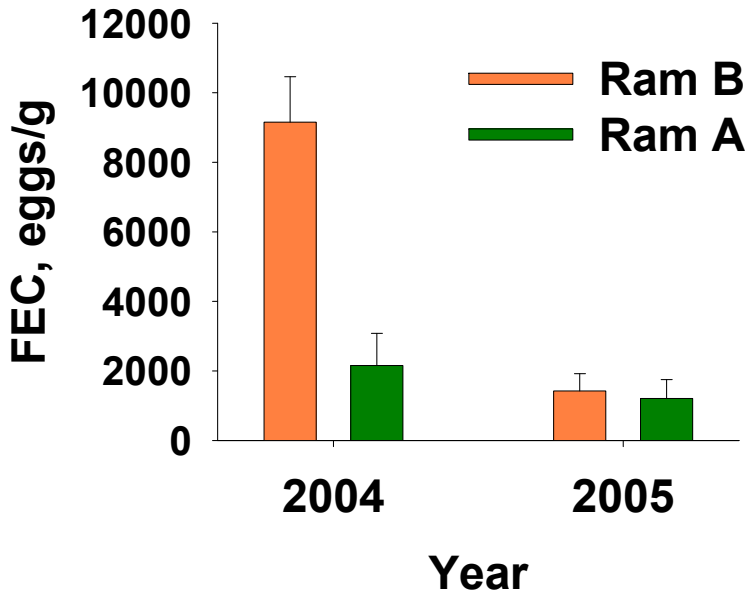
Heritability

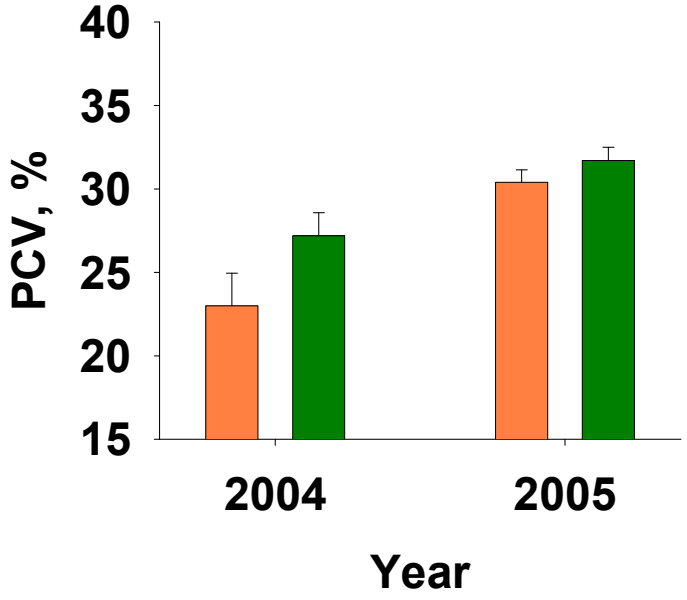
- **Parasite resistance – 0.18 – 0.46. Greater variability within the contemporary group increases heritability and ability to select the best.**
- **Parasite resilience or tolerance – FAMACHA, 0.06 – 0.24 (Riley and Van Wyk). PCV, 0.15 – 0.39 (Vanimisetti et al.).**

FEC and PCV of offspring sired by Katahdin rams A or B (Year 2004, 2005) at 120 d of age (Burke & Miller, 2008 Vet. Parasitol. 153, 85)

Ram A:
WWEC = -21
PWEC = -3

Ram B:
WWEC = +178
PWEC = +119





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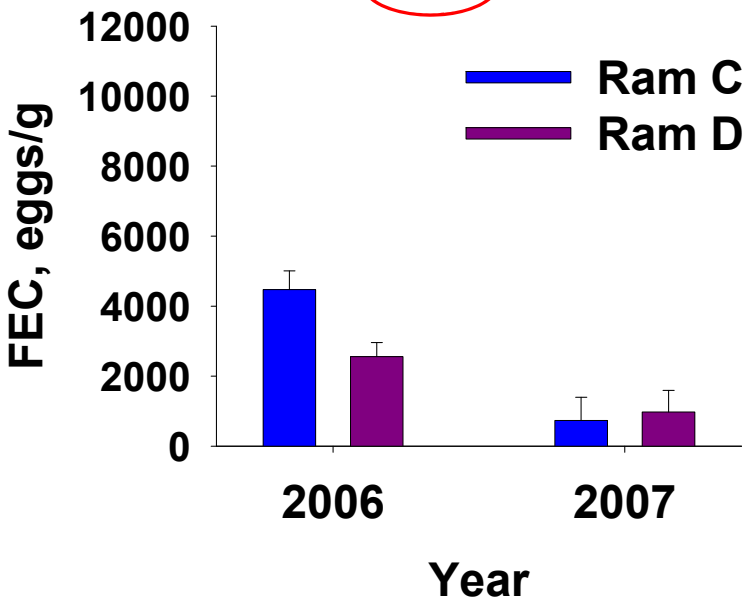
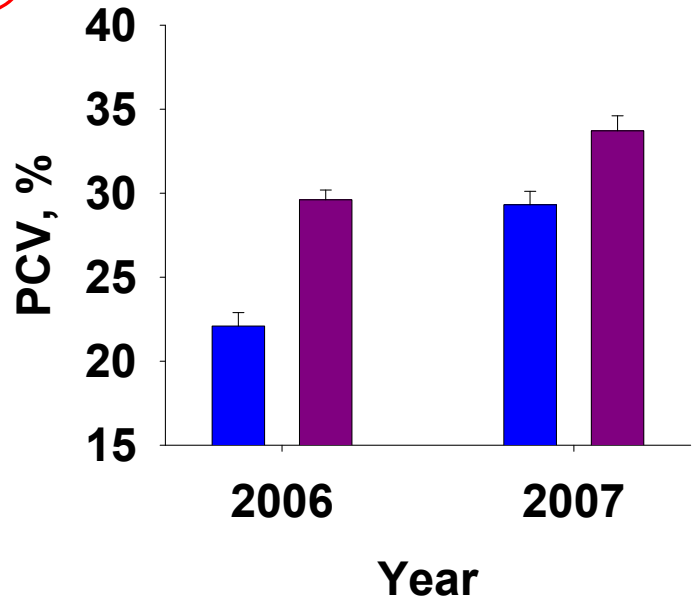
FEC and PCV of offspring sired by Katahdin rams C or D (Year 2006, 2007) at 120 d of age

Ram C:
WWEC = +108
PWEC = +196

Ram D:
WWEC = -56
PWEC = -70





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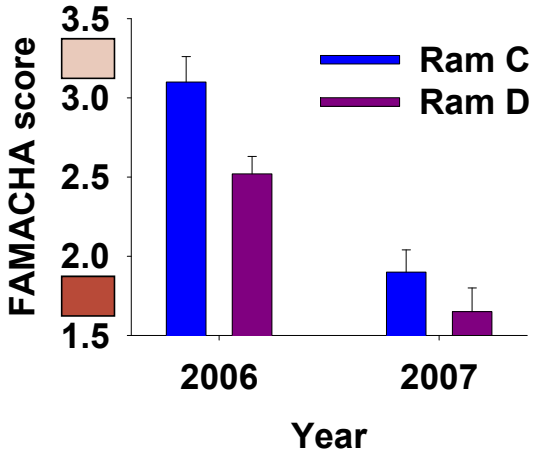
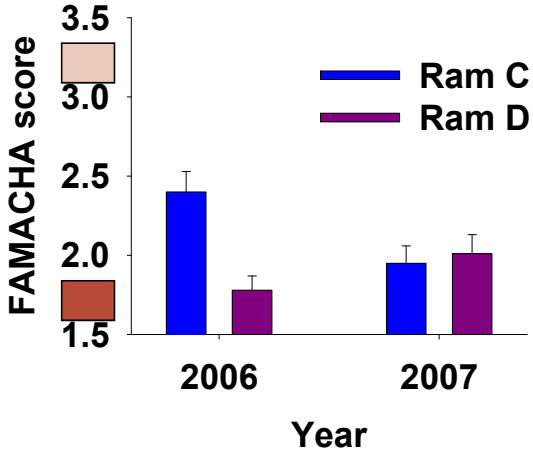
FAMACHA scores of offspring sired by rams C or D at 120 and 150 d of age





Ram C:
WWEC = +108
PWEC = +196

Ram D:
WWEC = -56
PWEC = -70

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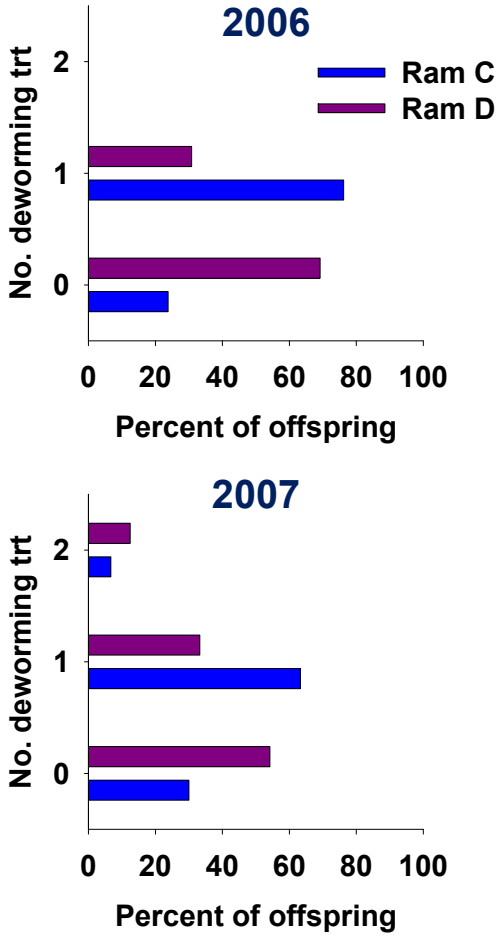
Percentage of offspring sired by rams C or D dewormed at 120 d of age



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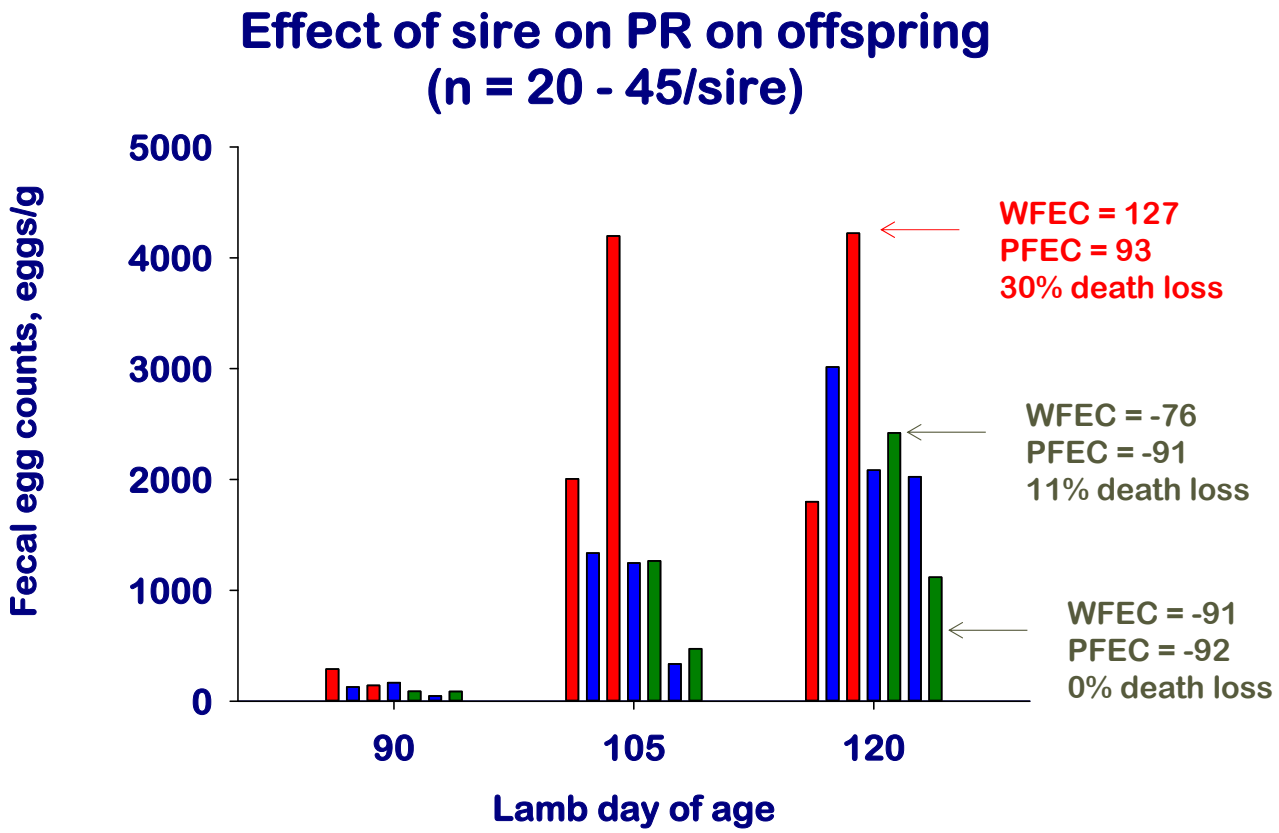
Comparing offspring FEC among sires



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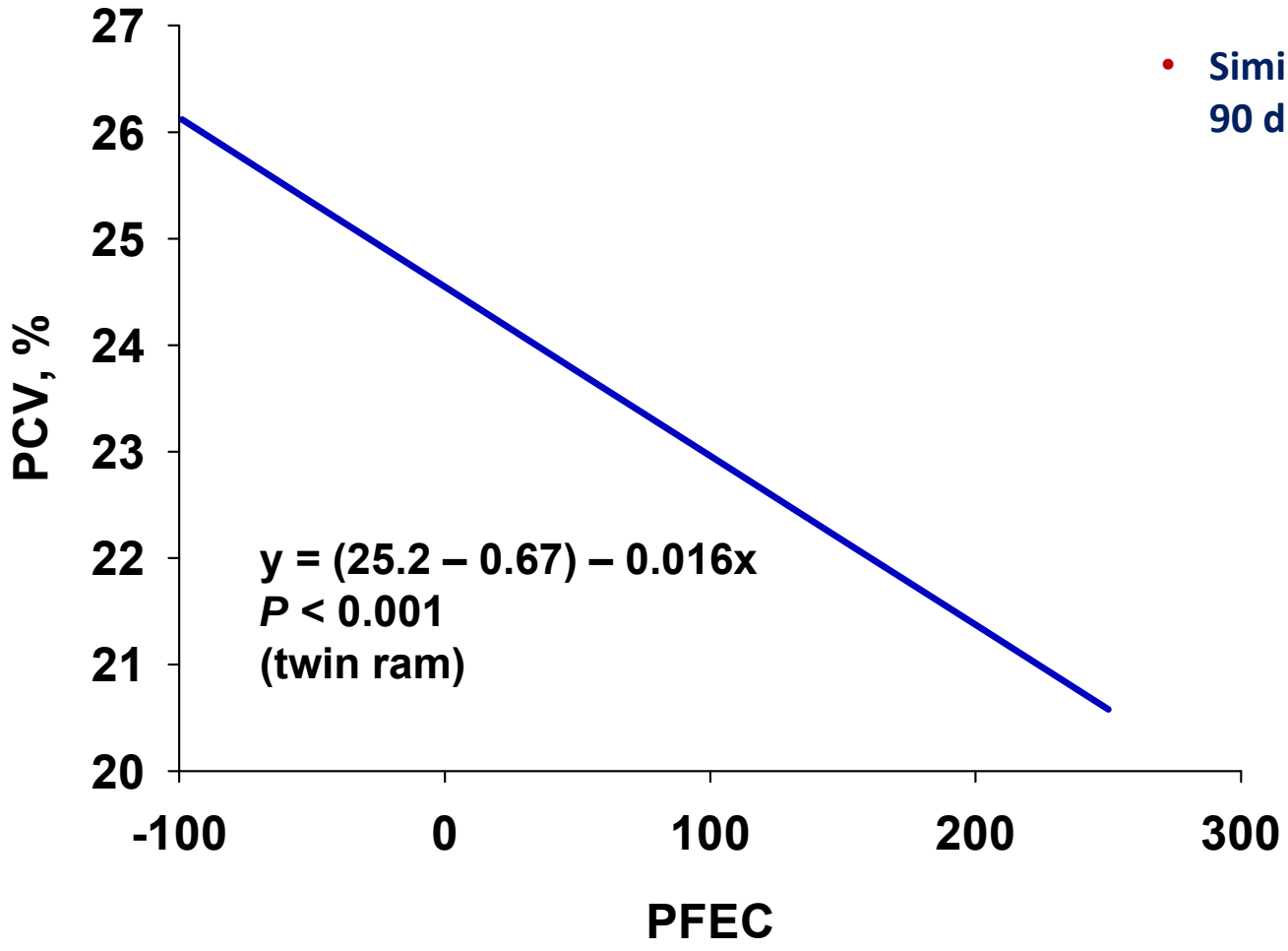
The effect of sire's PFEC EBV on PCV of offspring at 120 d



- Similar relationship at 90 d of age ($P < 0.02$)

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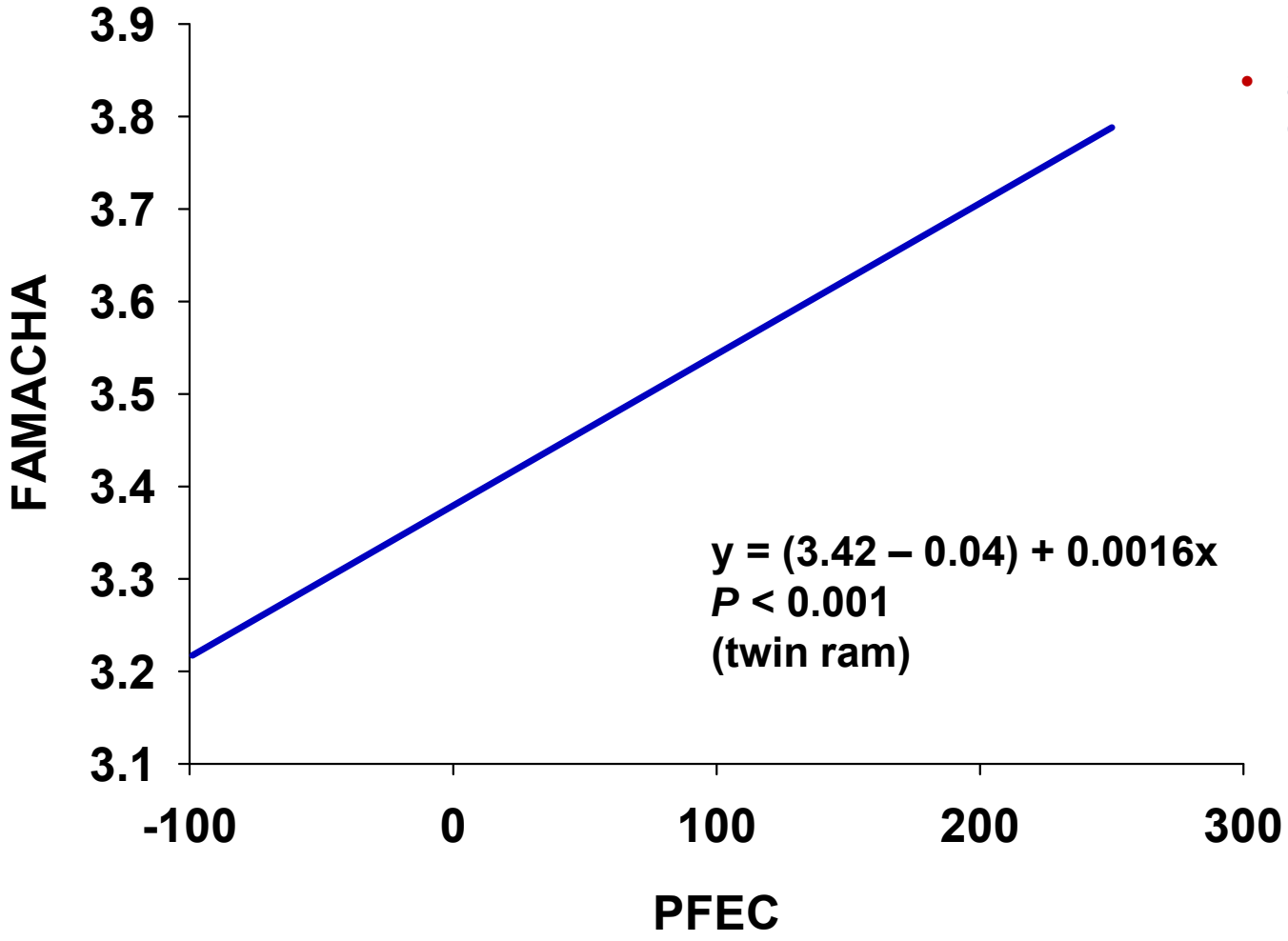
The effect of sire's PFEC EBV on FAMACHA of offspring at 120 d



- Similar relationship at 90 d of age ($P < 0.001$)

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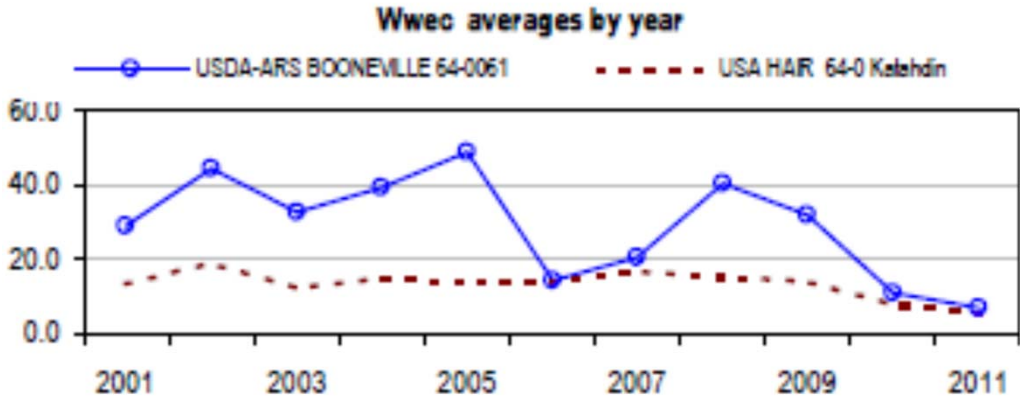
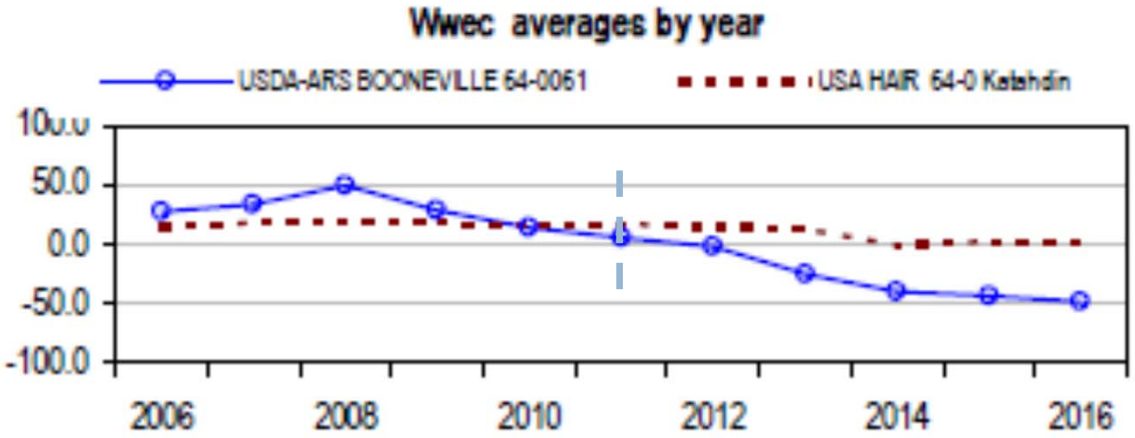
Genetic Trend for ARS flock





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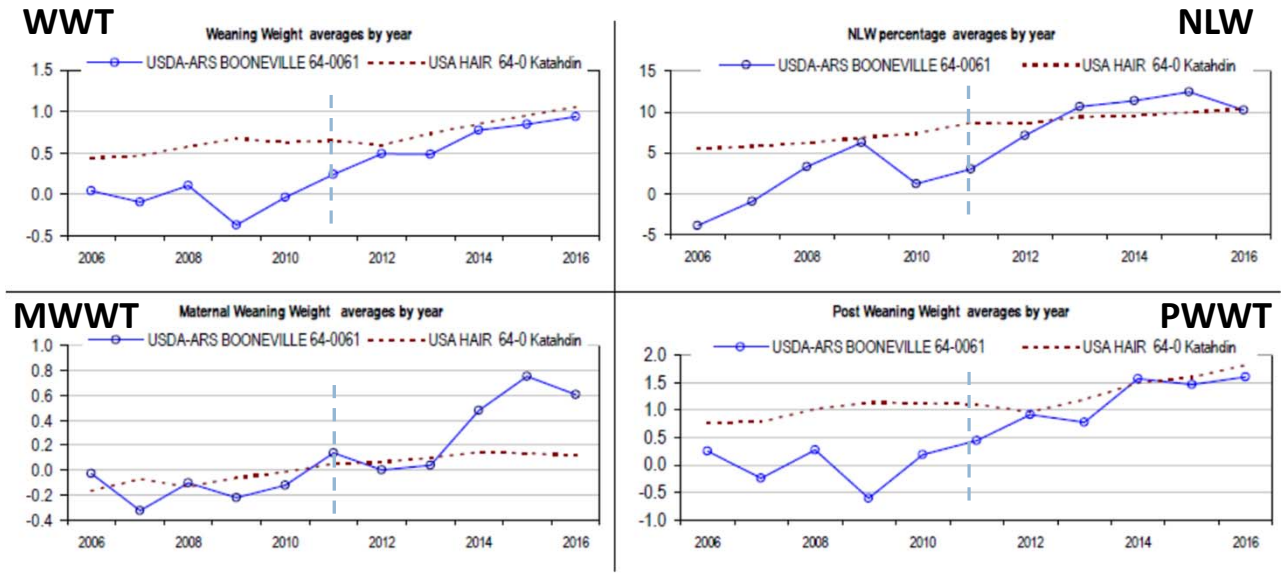
Points to consider

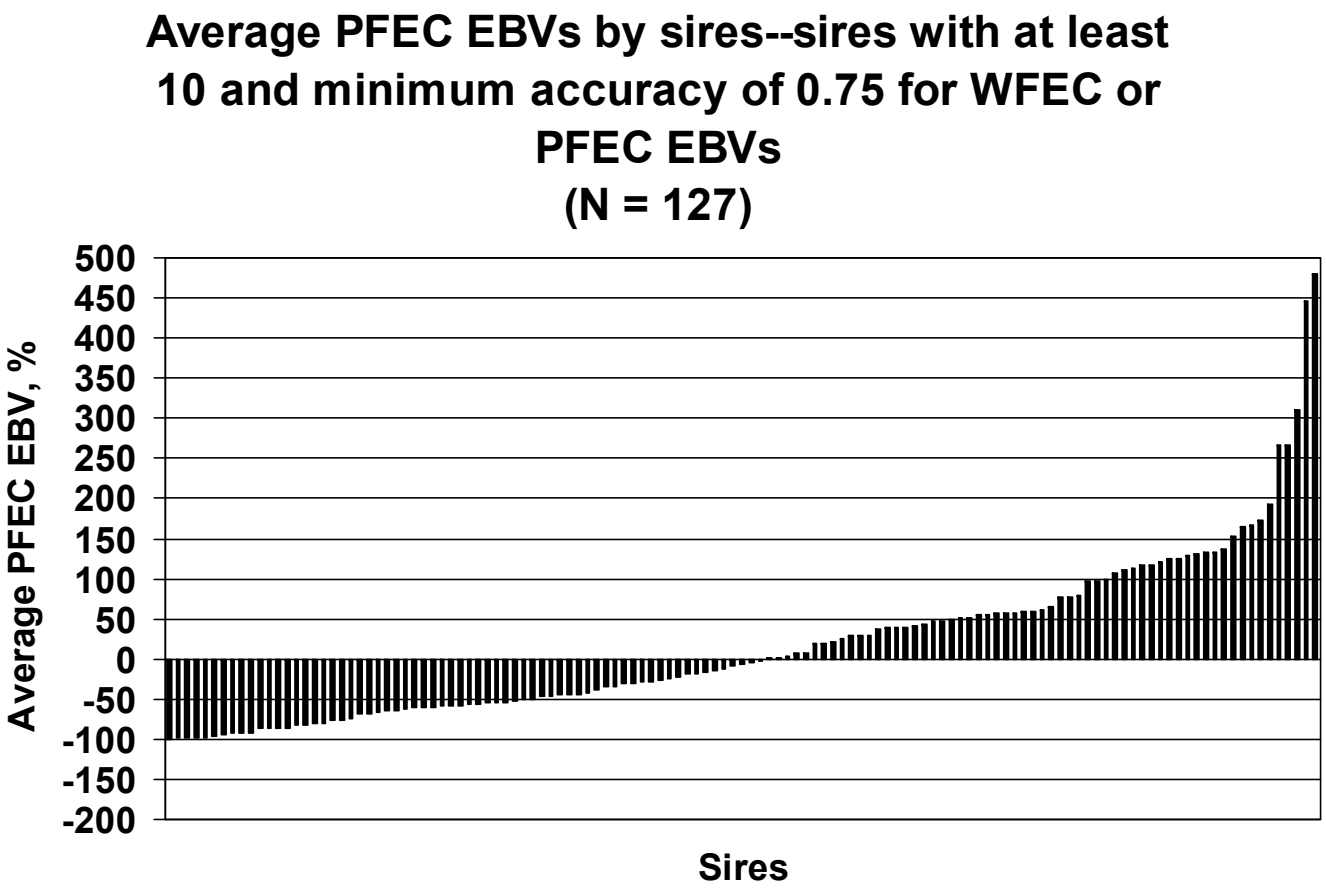
- For some traits, there are some slight antagonisms with FEC, but likely not to cause disruptions in breeding goals.



Progeny-Tested Katahdin Sires in NSIP

- **A -100 EBV thus predicts a 100% reduction in average progeny FEC relative to the mean, and is the lower limit for FEC EBVs. Note that a number of sires approach that limit.**
- **There is no upper limit. For example, a +150 EBV predicts that progeny will have means for FEC that are 150% above average.**
- **Variation within the population: the more variation that is present, the easier it is to identify the best.**

D. Notter, 2012; NCERA-214 Symposium, Spencer, IA



D. Notter, 2012; NCERA-214 Symposium, Spencer, IA

Summary

- Genetic resistance to GIN infection is one of the most promising means to control worms in a flock.
- Resistance and/or resilience can be gained in particular breeds or in individuals.

Summary

- Selection of resistant sires using EBVs leads to lower FEC and FAMACHA scores and higher PCVs in offspring.
- Producers should select sires with balanced EBVs, including +EBVs for weights and maternal traits.
- Commercial flocks can benefit from a flock using selection by purchasing resistant sires.

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Resources

- **American Consortium for Small Ruminant Parasite Control: www.wormx.info**
- **University of Maryland: www.sheepandgoat.com**
- **ATTRA publications: https://attra.ncat.org/**

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Acknowledgments

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- Contributions from D.R. Notter, and the ACSRPC.

American Consortium for Small Ruminant Parasite Control (www.wormx.info)

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