

Selection for Parasite Resistance

Presenter:

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Host/Moderator: Jay Parsons

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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**



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.**



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).

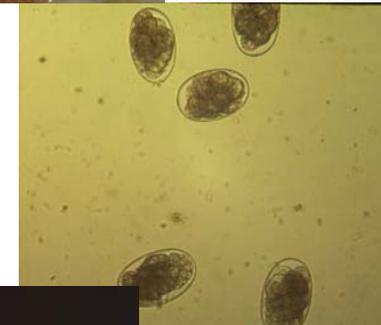
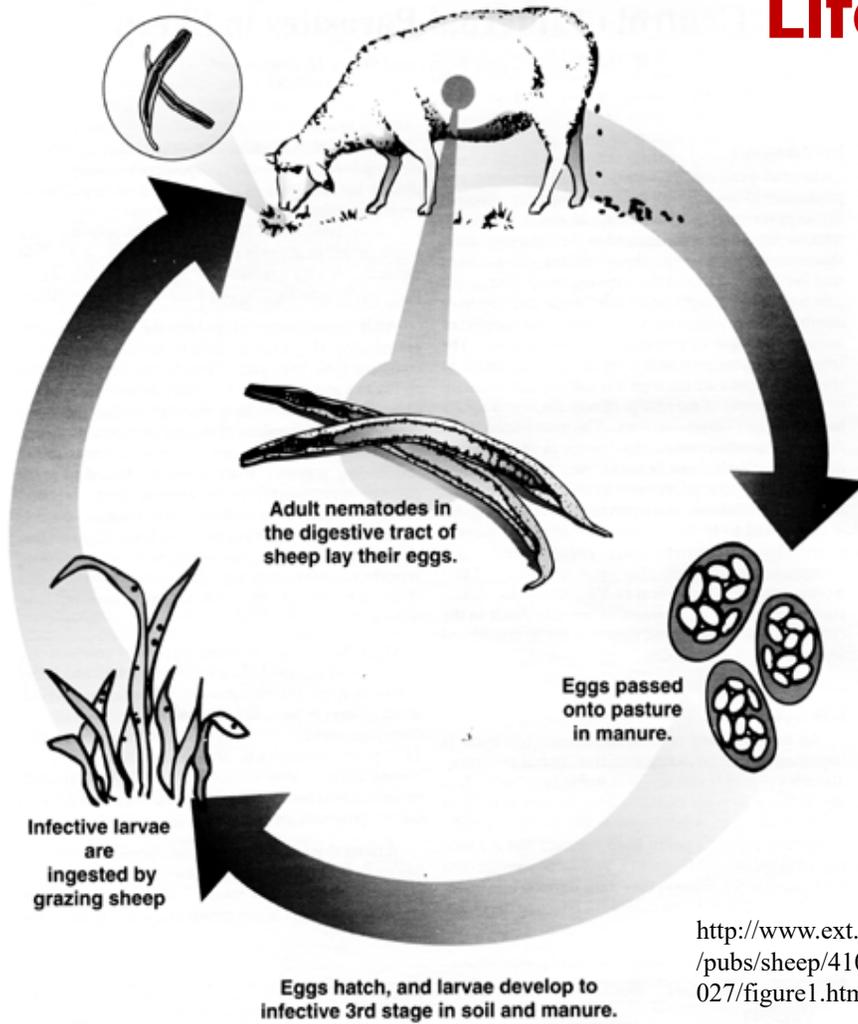


Haemonchus contortus

- **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**



Life cycle of GI nematodes



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

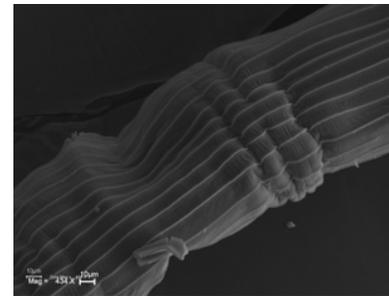
Parasite Control

- **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.**



Parasite Control

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



Resistance or resilience?

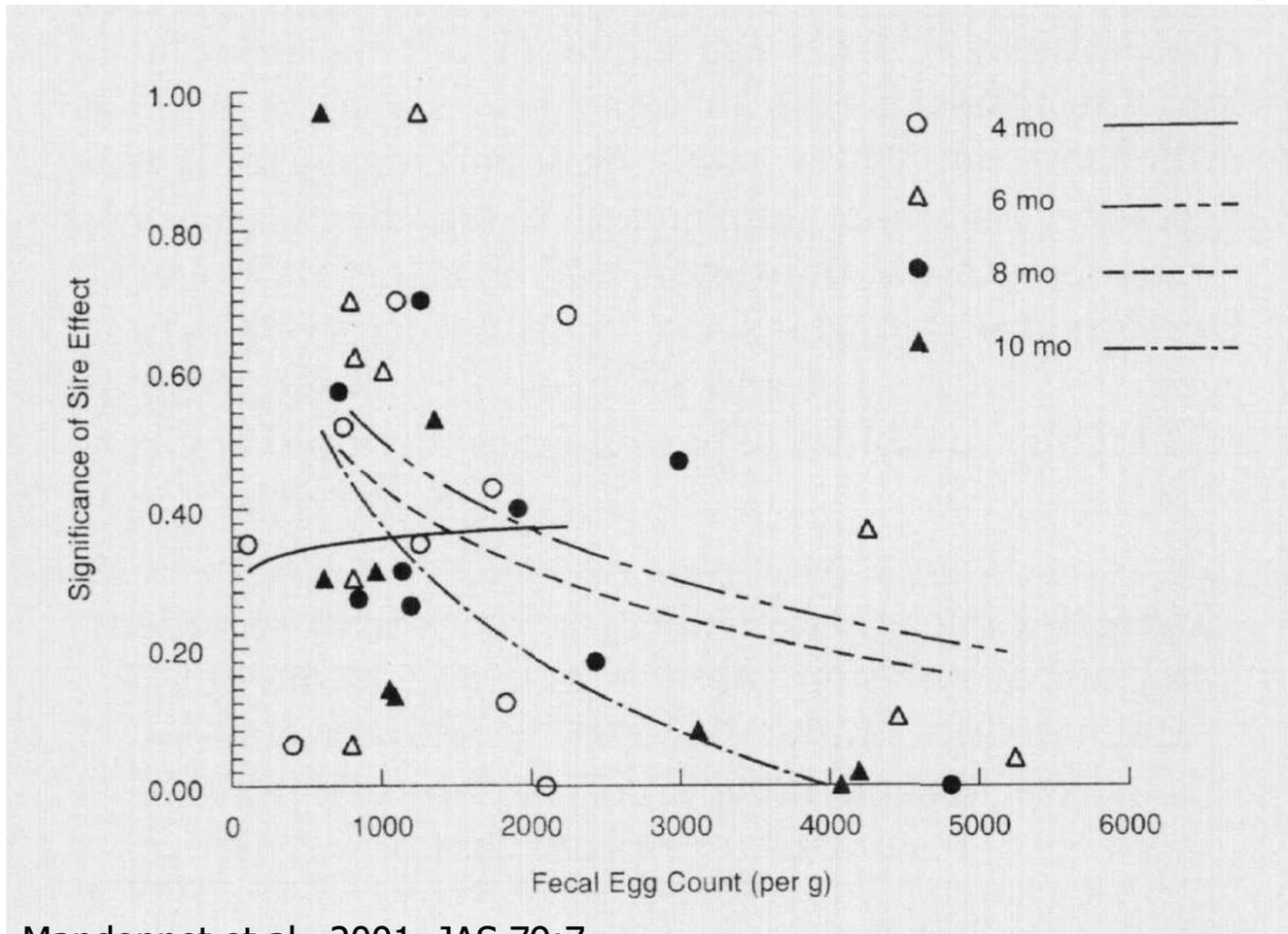
- **Parasite resistance –the ability of an animal to resist gastrointestinal parasite infection. Characterized by low FEC and no signs of anemia (high PCV).**
- **Parasite resilience or tolerance – the ability of an animal to tolerate gastrointestinal parasite infection. Characterized by moderate (can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

Use of Resistant Breeds

- **Spanish and Kiko > Boer**



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.**

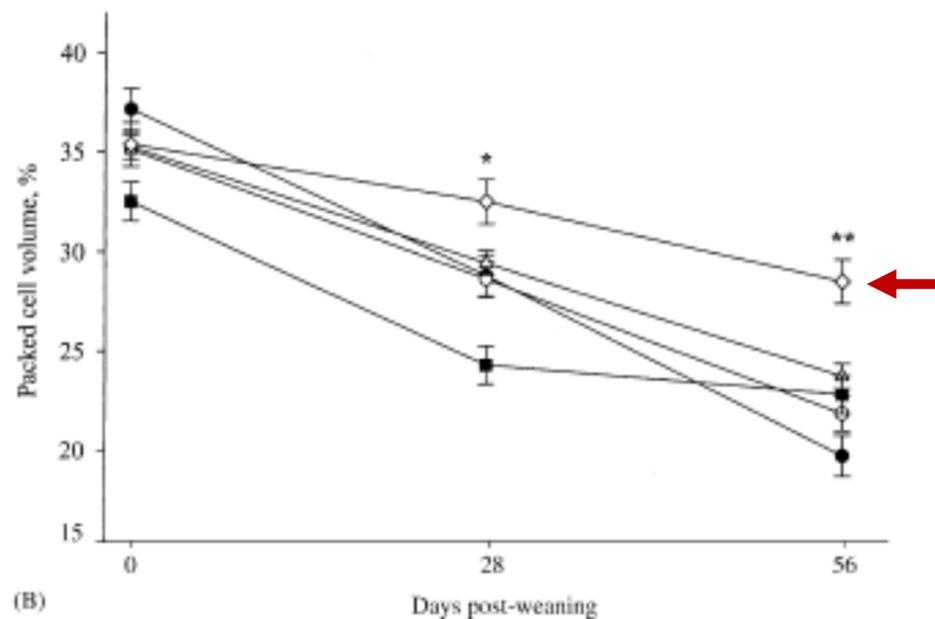
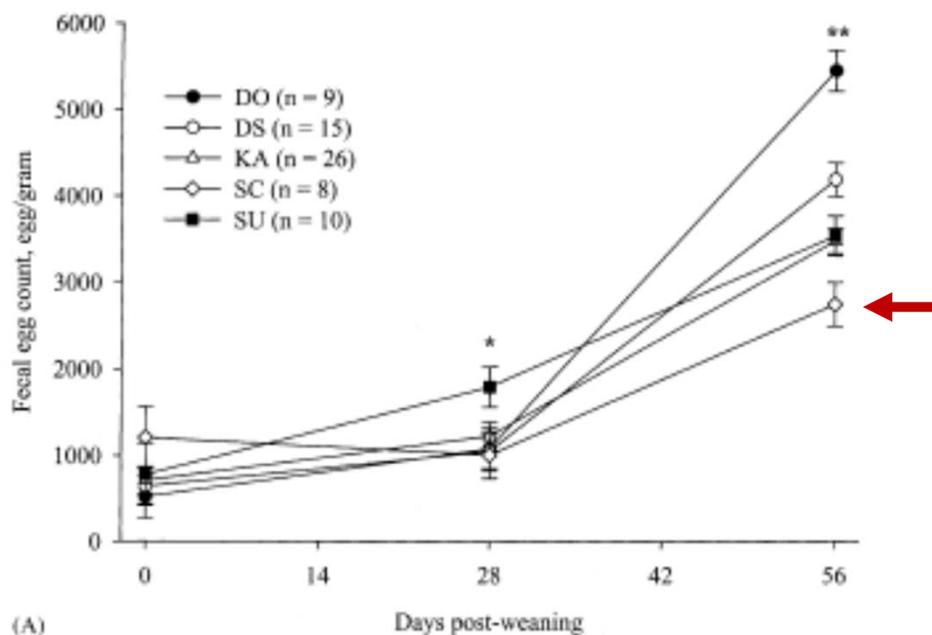
Use of Resistant Breeds



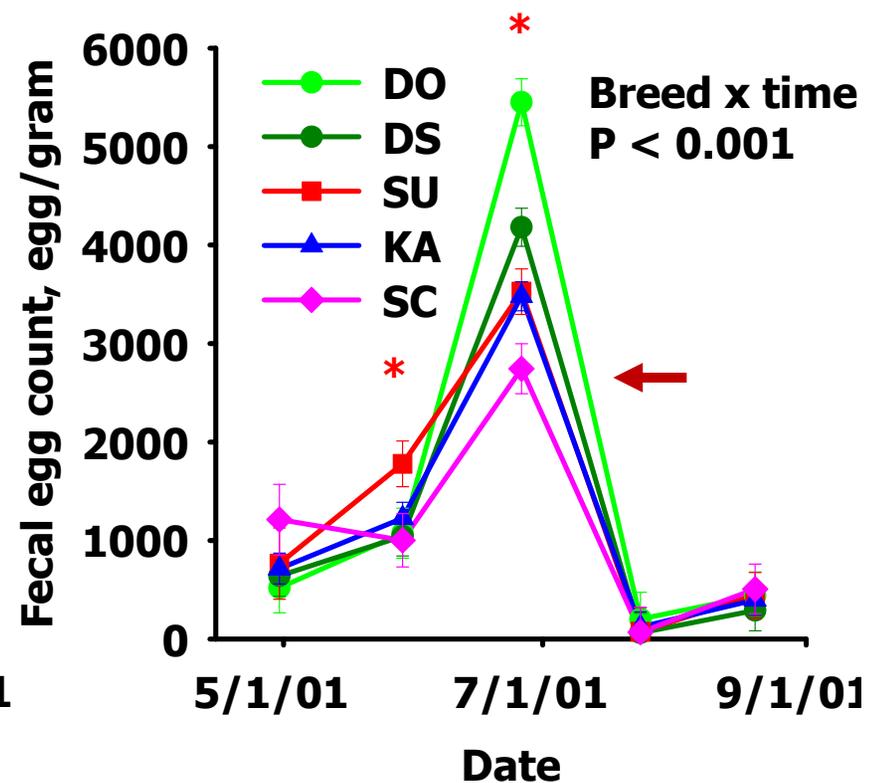
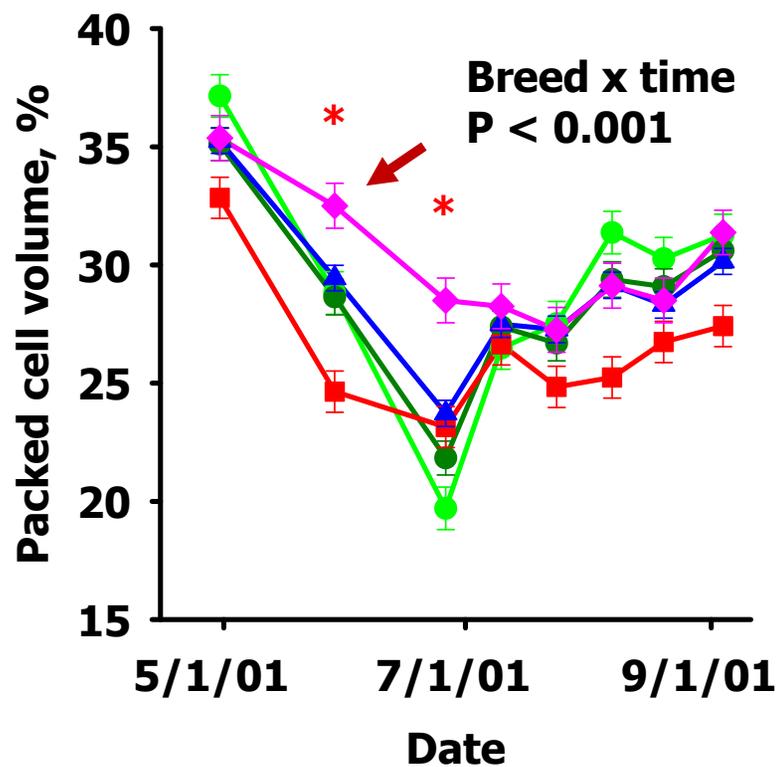
- **St. Croix**
- **Gulf Coast or Florida Native**
- **Barbados Blackbelly**
- **Katahdin**

Effect of breed of lamb on parasite infection

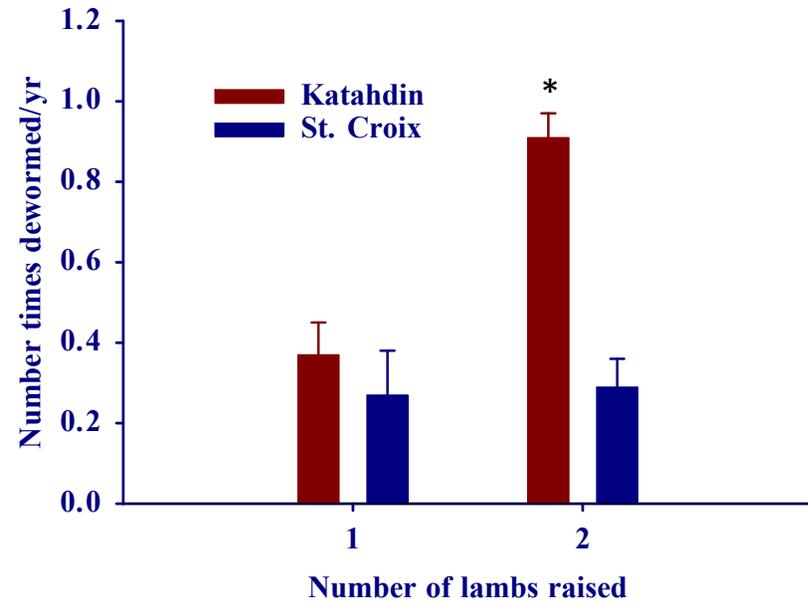
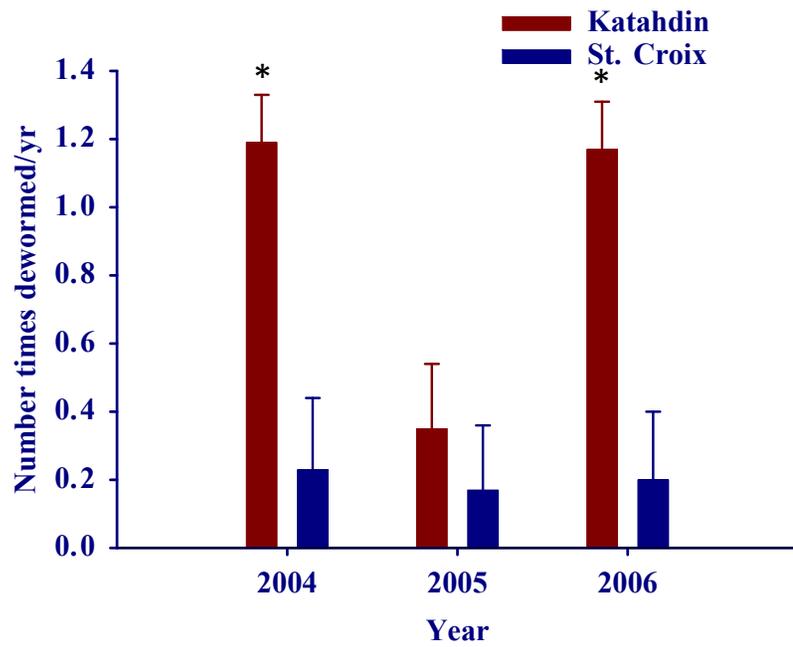
J.M. Burke, J.E. Miller / Small Ruminant Research 54 (2004) 43–51



Effect of breed of ewe on parasite infection



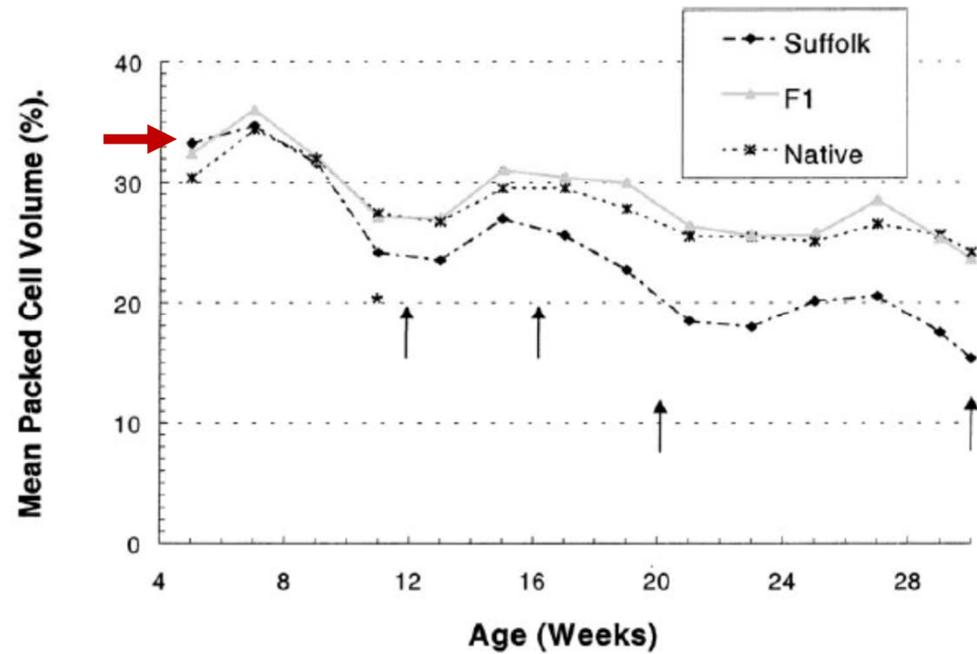
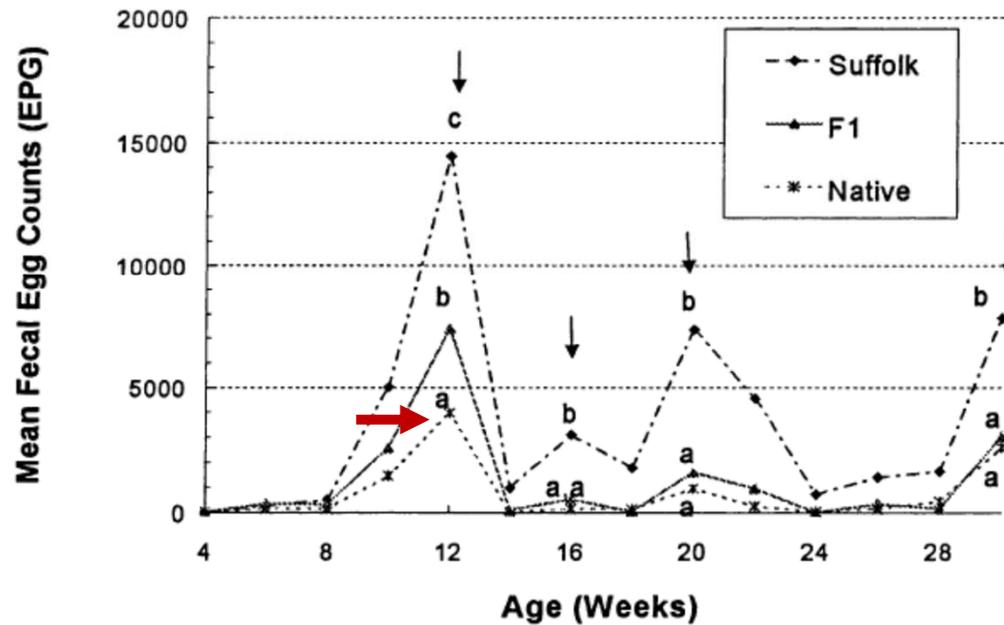
Impact of Resistant Breeds



Effect of cross-breeding or heterosis on resistance

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

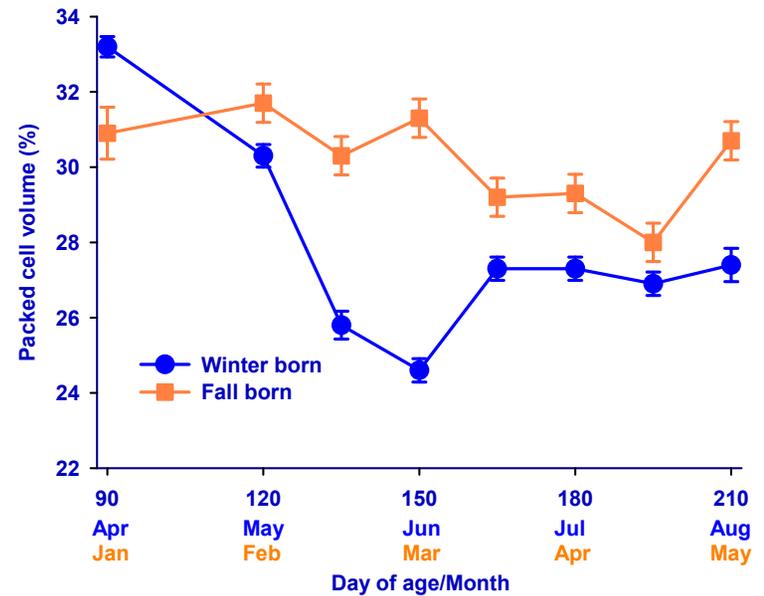
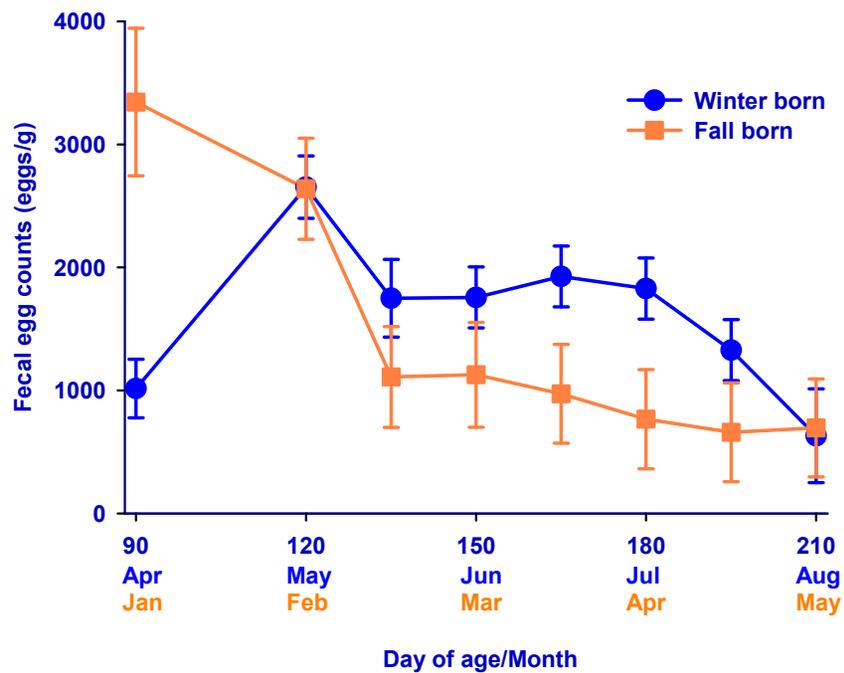
Y. Li et al. / Veterinary Parasitology 98 (2001) 273–283



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.



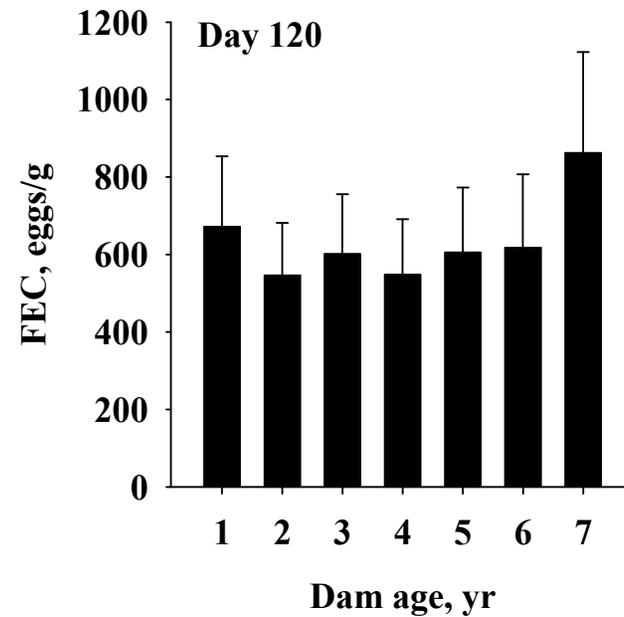
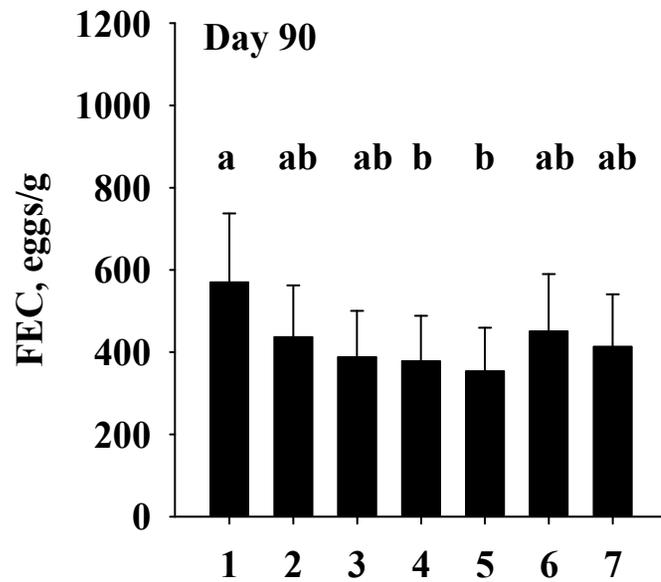


Body condition of the dam, litter size, and age will influence her performance and worm egg output, as well as the lamb's.



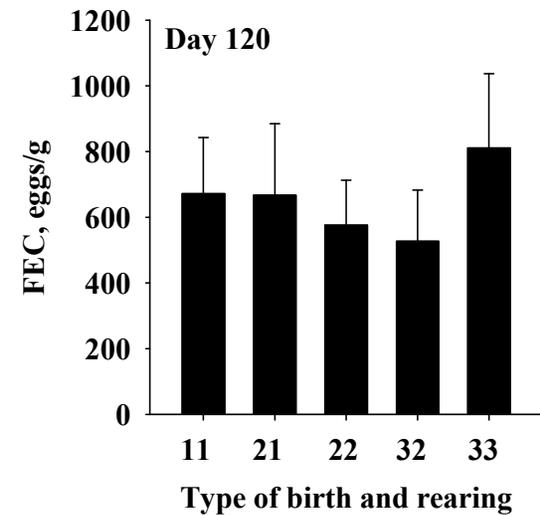
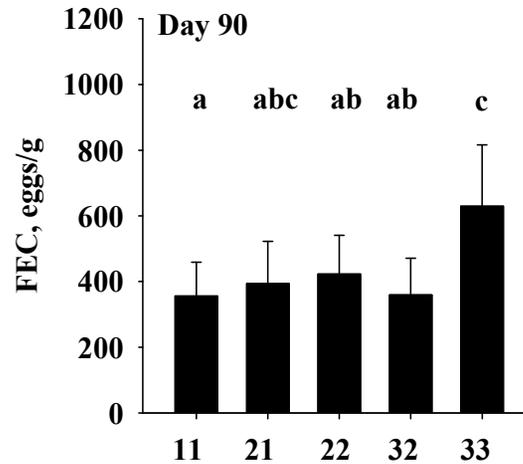
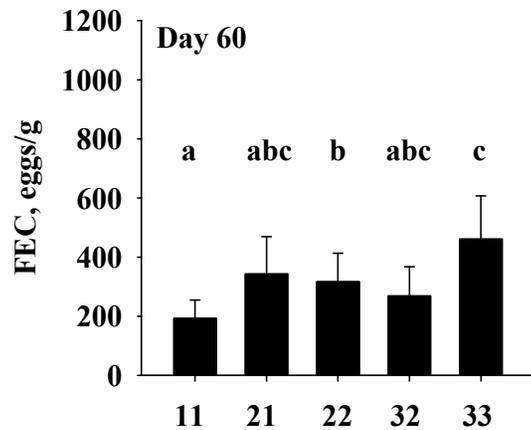
Effect of dam age on FEC

(Notter, Burke, et al., 2017)



Effect of number of lambs born/weaned on FEC

(Notter, Burke, et al., 2017)



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.

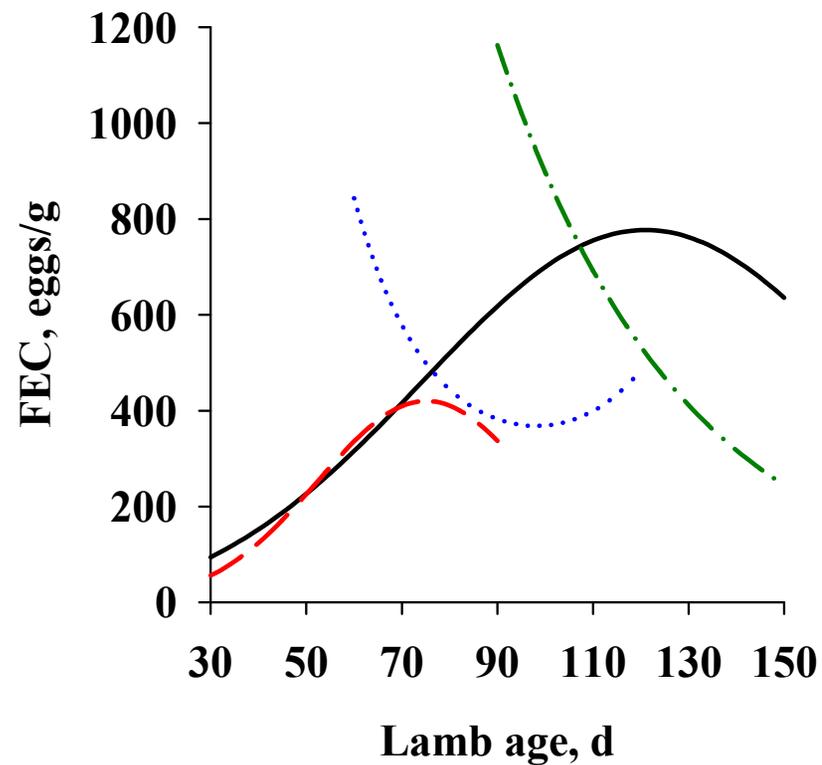
Using NSIP to select for parasite resistance



- **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.**

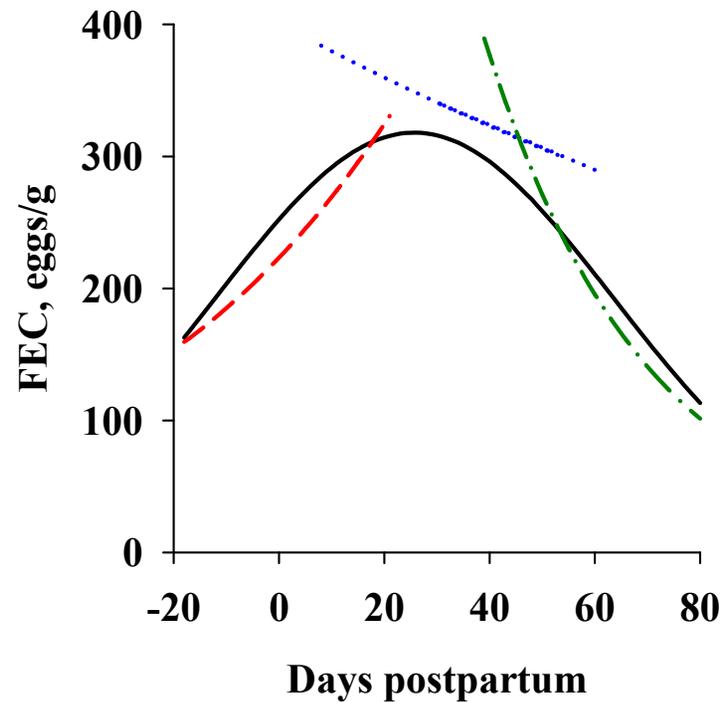
Changes in lamb FEC with age

(Notter, Burke, et al., 2017)



Changes in dam FEC during PPR

(Notter, Burke, et al., 2017)



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.**

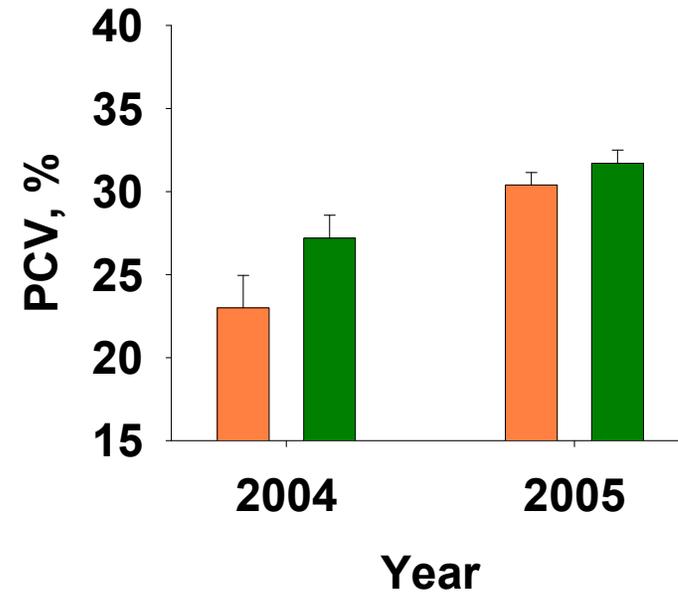
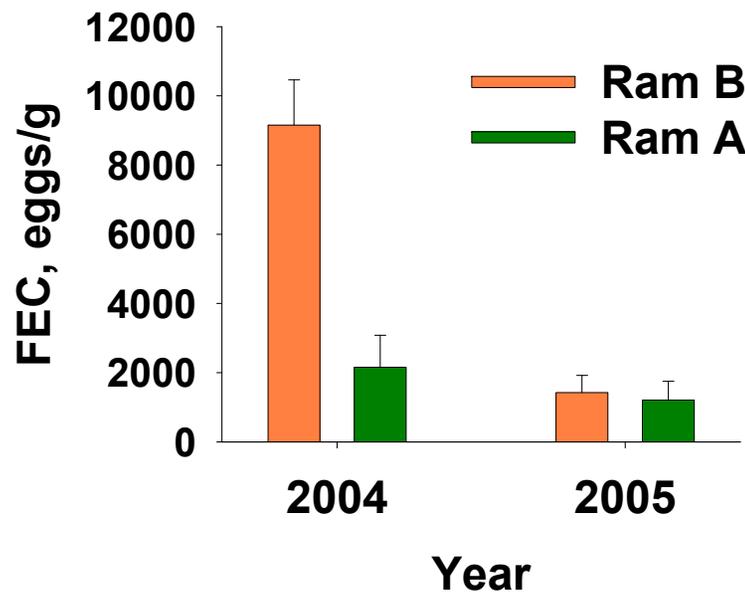
Heritability

- **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.).**

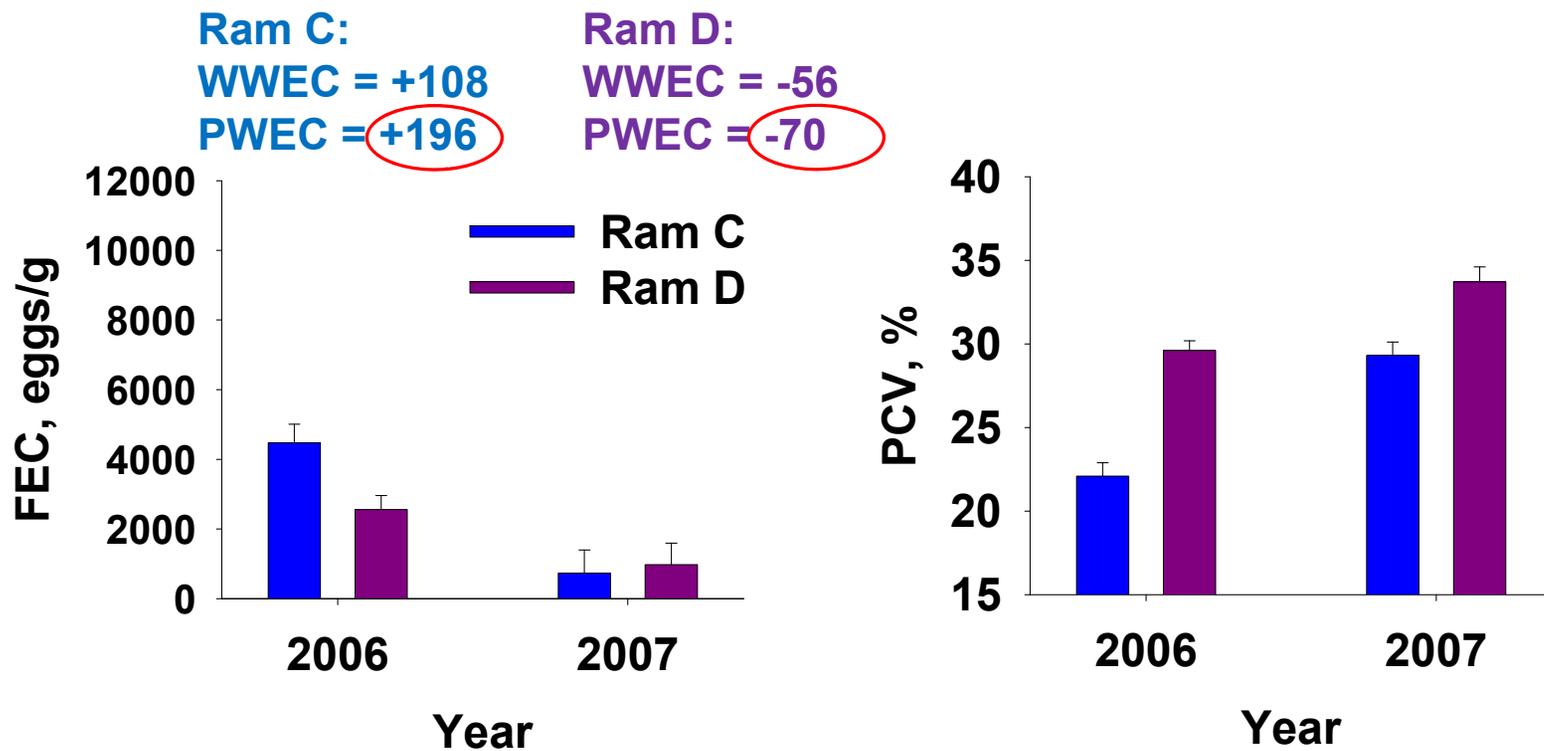
FEC and PCV of offspring sired by Katahdin rams A or B (Year 2004, 2005) at 120 d of age (Burke & Miller, 2008 Vet. Parasitol. 153, 85)

Ram A:
WVEC = -21
PWEC = -3

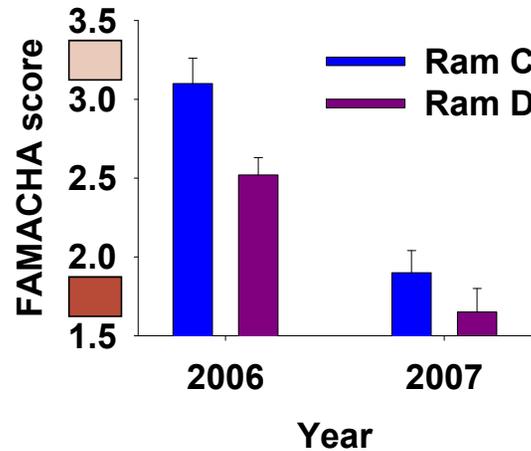
Ram B:
WVEC = +178
PWEC = +119



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

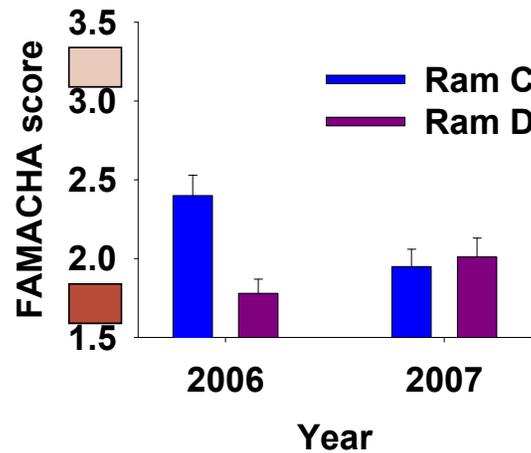


FAMACHA scores of offspring sired by rams C or D at 120 and 150 d of age

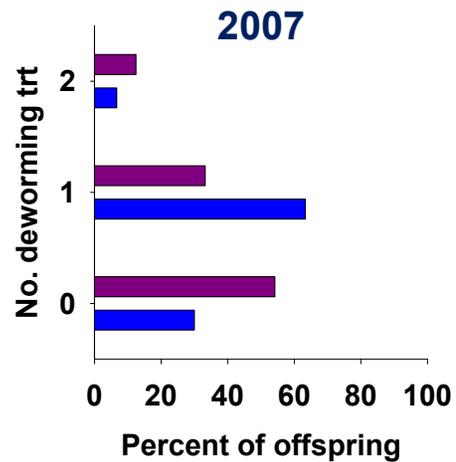
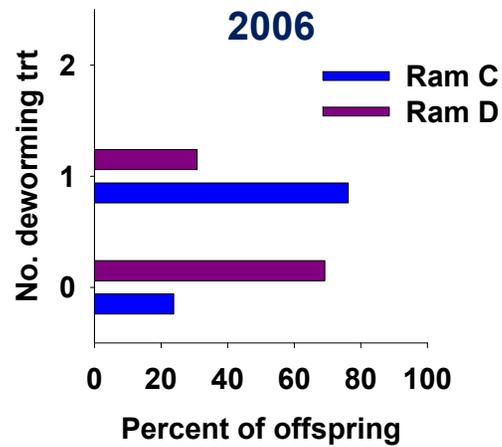


Ram C:
WVEC = +108
PWEC = +196

Ram D:
WVEC = -56
PWEC = -70

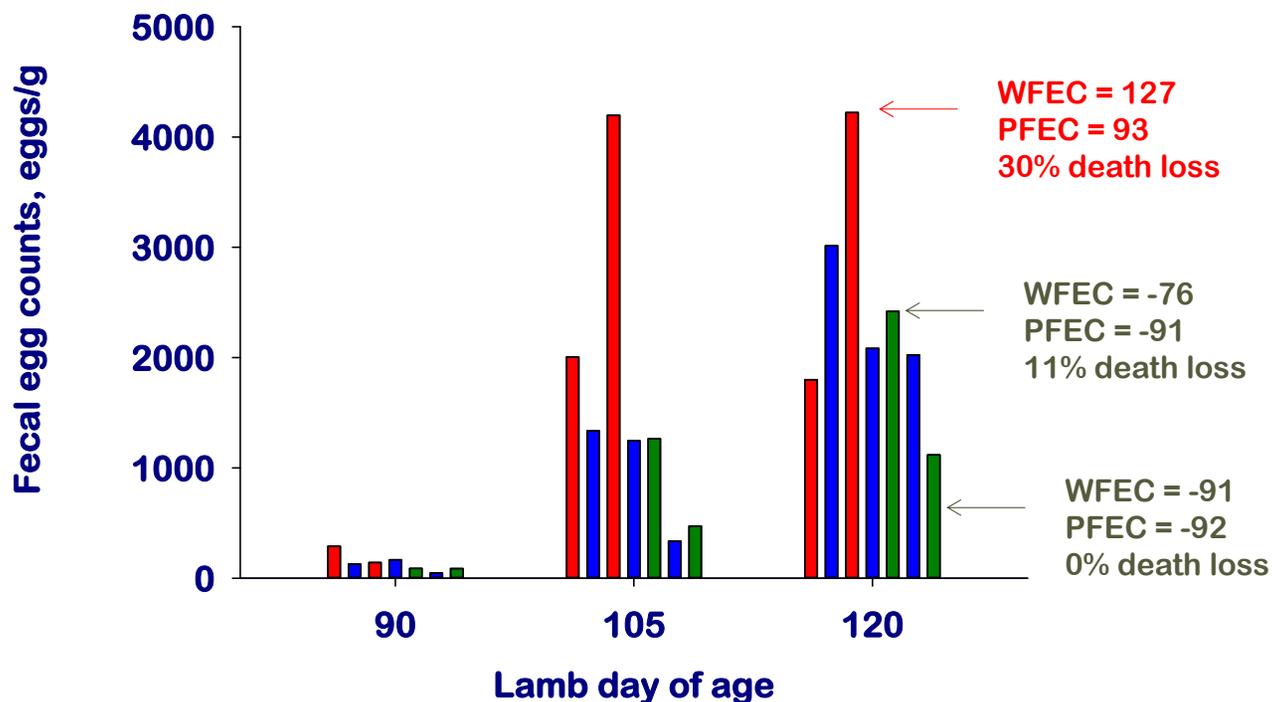


Percentage of offspring sired by rams C or D dewormed at 120 d of age

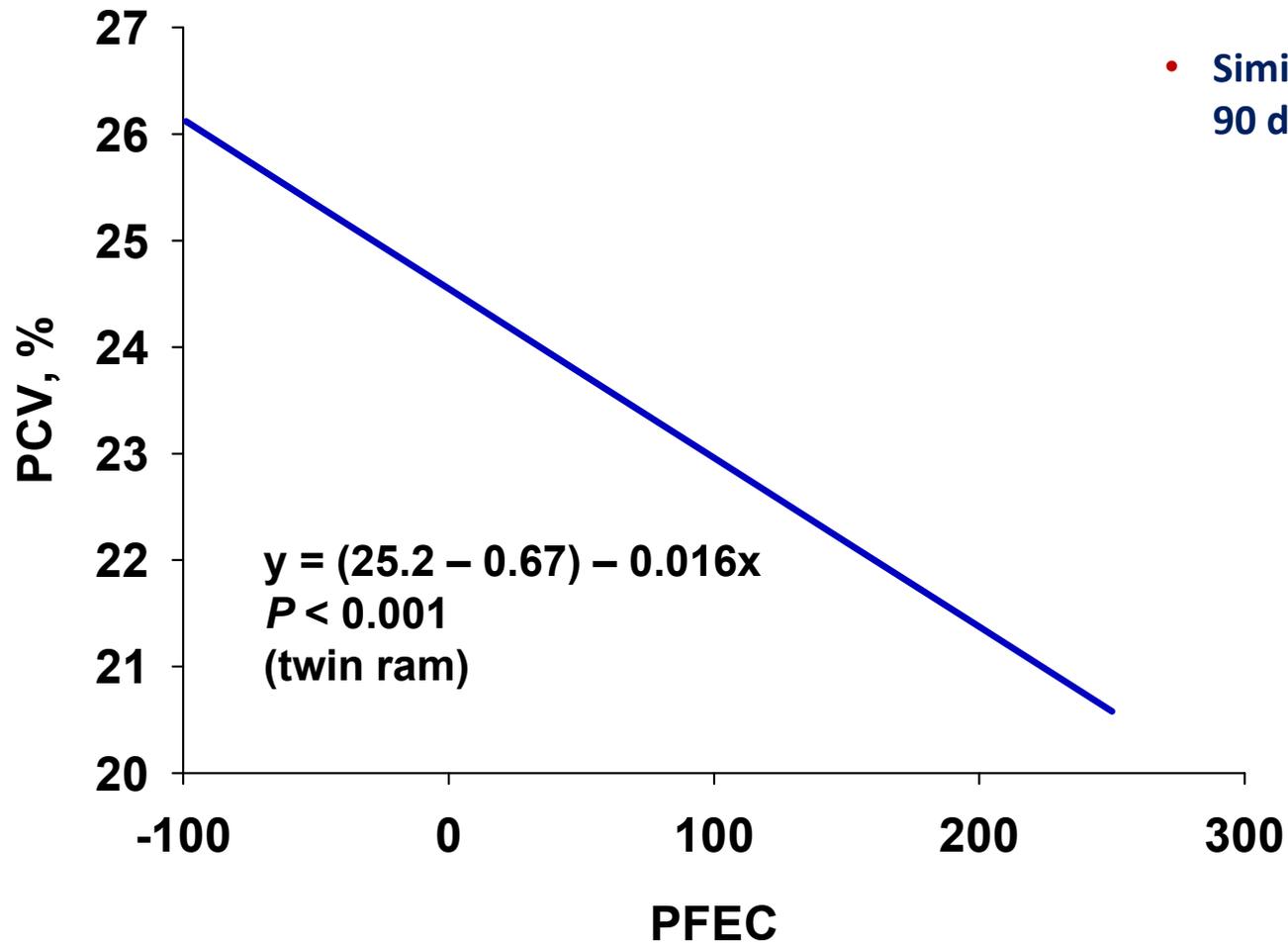


Comparing offspring FEC among sires

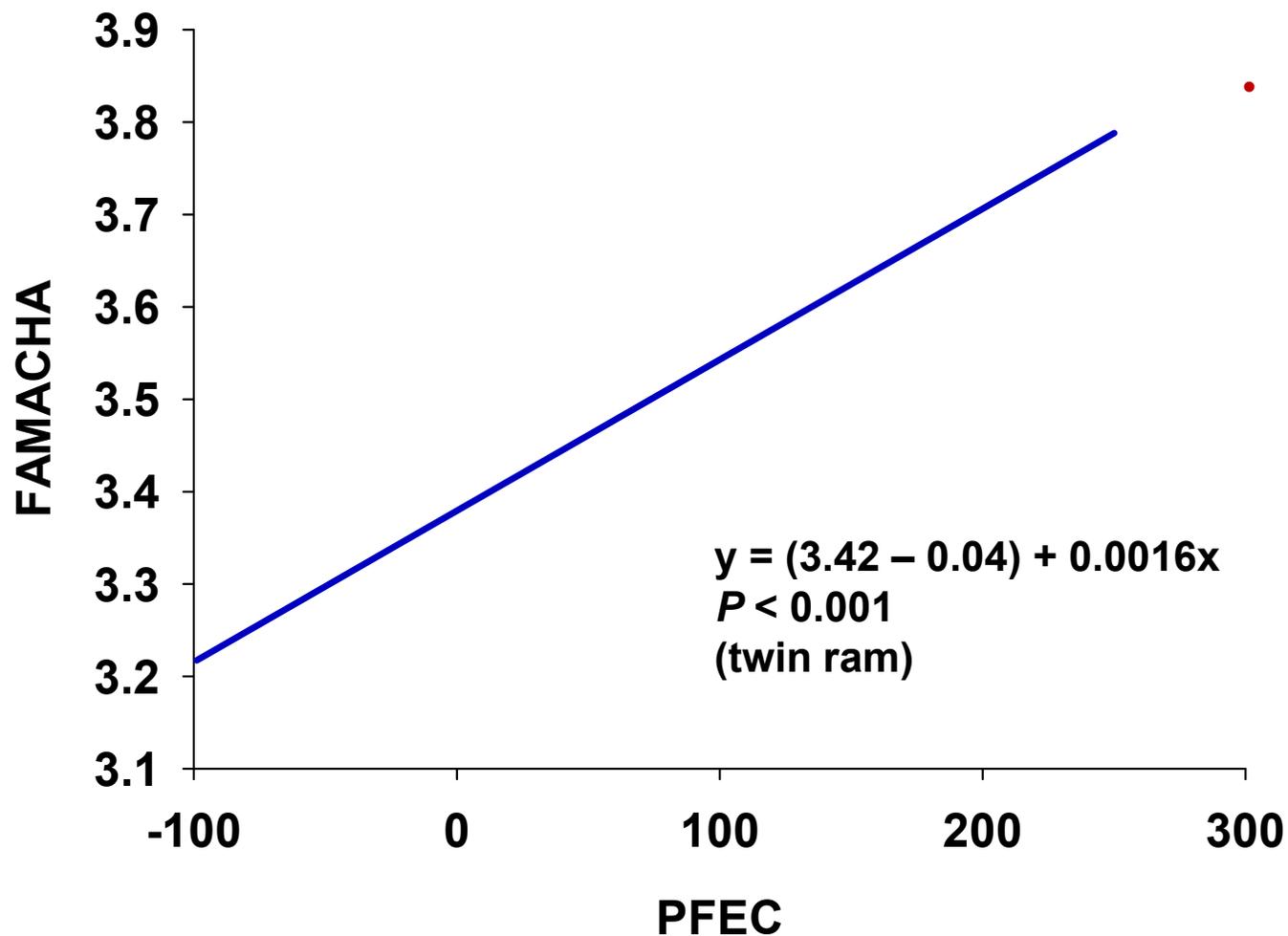
Effect of sire on PR on offspring
(n = 20 - 45/sire)



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

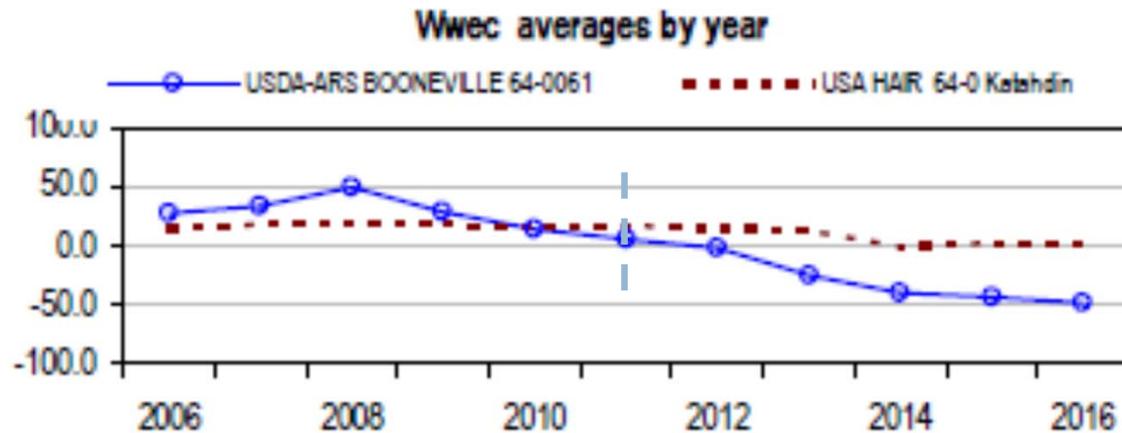
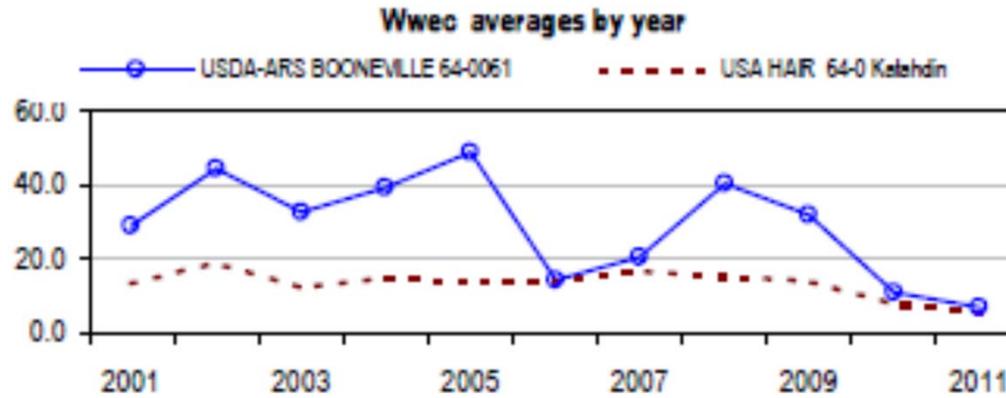


The effect of sire's PFEC EBV on FAMACHA of offspring at 120 d



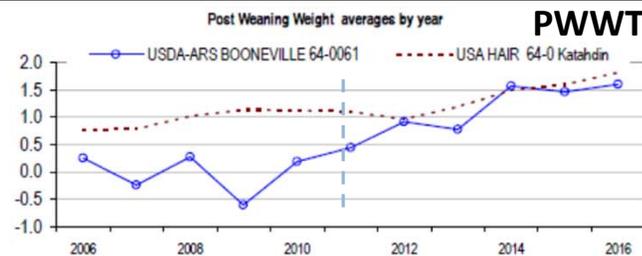
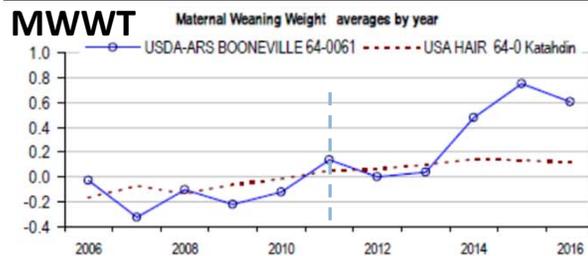
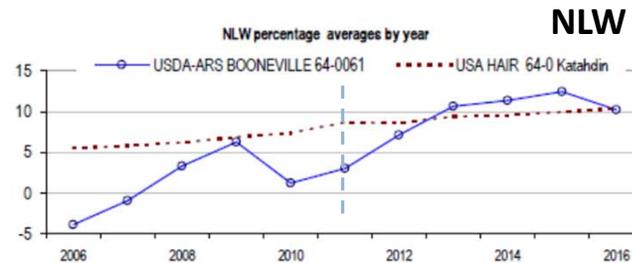
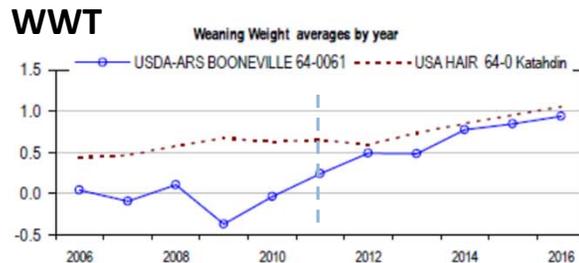
- Similar relationship at 90 d of age ($P < 0.001$)

Genetic Trend for ARS flock



Points to consider

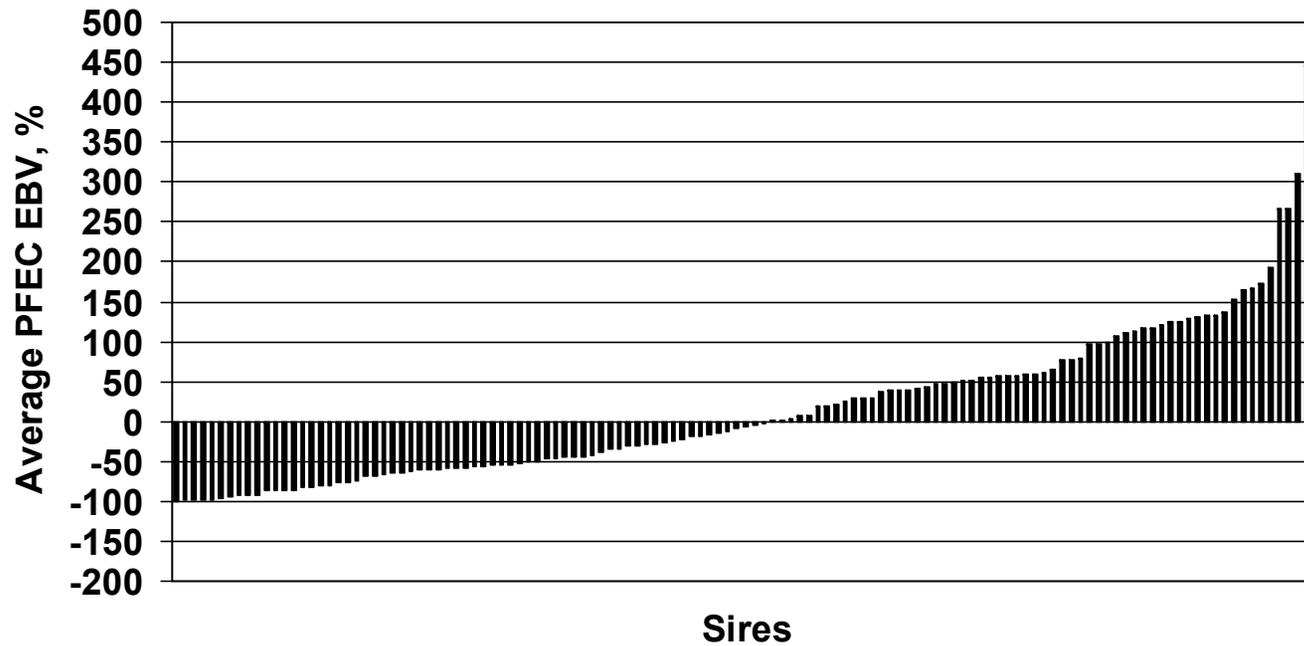
- For some traits, there are some slight antagonisms with FEC, but likely not to cause disruptions in breeding goals.



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.**

**Average PFEC EBVs by sires--sires with at least
10 and minimum accuracy of 0.75 for WFEC or
PFEC EBVs
(N = 127)**



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.**

Resources

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

National Sustainable Agriculture Information Service
 703.648.1234 | A program of the National Center for Sustainable Agriculture | 1000 21st Street, Davis, CA 95618 | www.nasais.org

Tools for Managing Internal Parasites in Small Ruminants: Animal Selection

By Cindy Colby, NCAE
 Agriculture Specialist
 12/16/2012

For long-term animal health, improving their gut and parasite resistance in ruminant production is a very important part of raising. Internal parasites can reduce average maximum weight of stock 20 percent and severely compromise the gut and overall health of young animals. They can also reduce milk production and overall health of the animals and their owners. It is important to use the right management tools to help your animals and to the health of your own operation.

Introduction

Internal parasites are a major health problem for sheep and goats raised in small ruminant production. They can reduce animal health and productivity, and they can be a major production challenge. Control of internal parasites, especially gastrointestinal nematodes, is essential for the success of small ruminant production. Internal parasites have caused the loss of sheep and goats in many areas, and they can be a major health problem for the animals and their owners. Internal parasites have developed resistance to anthelmintic treatments. Today's drug or dewormer products are not all available with high average animal production.

Many parasites feed inside the gut and the "gut" which pass through the gut and are shed in the feces. After the eggs pass out of the host, they hatch into larvae. Worms, based on anatomy, are divided into three groups: roundworms, tapeworms, and lungworms. The most common internal parasites are roundworms. They are most common in sheep and goats, and they can be a major health problem for the animals and their owners. They are most common in sheep and goats, and they can be a major health problem for the animals and their owners. They are most common in sheep and goats, and they can be a major health problem for the animals and their owners.



Animals are selected for their resistance to parasites, resulting in stronger flock. Photo: Cindy Colby, NCAE

Agricultural Innovations 

Sustainable Control of Internal Parasites in Small Ruminant Production

By Cindy Colby, NCAE, National Center for Sustainable Agriculture, The National Sustainable Agriculture Information Service (ATTRA) and Extension Specialist for Small Ruminant Health, NCAE

Geographic Applicability:
 Internal areas, including the tropical regions of North America and the southern United States.

Sheep and goat production is a growing enterprise for small and large-scale producers. Profitable production and growth are critical to success. However, parasites are a major production challenge. Control of internal parasites, especially gastrointestinal nematodes, is essential for the success of small ruminant production. Internal parasites have caused the loss of sheep and goats in many areas, and they can be a major health problem for the animals and their owners. Internal parasites have developed resistance to anthelmintic treatments. Today's drug or dewormer products are not all available with high average animal production.

Finally, this fact sheet:

- Identifies the most common internal parasites of sheep and goats.
- Describes the life cycle of internal parasites.
- Discusses the impact of internal parasites on animal health and productivity.
- Provides information on the use of anthelmintic treatments.
- Discusses the importance of animal selection for parasite resistance.
- Provides information on the use of natural and synthetic anthelmintics.
- Discusses the importance of pasture management for parasite control.
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- Discusses the importance of pasture management for parasite control.
- Provides information on the use of vaccines and other parasite control strategies.

In response, the Southern Consortium for Small Ruminant Health (SCSRH) has developed several methods of sustainable, profitable parasite control, including: Roundworm (including F402, F403), Tapeworm (including F404, F405), Lungworm (including F406, F407), and other internal parasites (including F408, F409, F410, F411, F412, F413, F414, F415, F416, F417, F418, F419, F420, F421, F422, F423, F424, F425, F426, F427, F428, F429, F430, F431, F432, F433, F434, F435, F436, F437, F438, F439, F440, F441, F442, F443, F444, F445, F446, F447, F448, F449, F450, F451, F452, F453, F454, F455, F456, F457, F458, F459, F460, F461, F462, F463, F464, F465, F466, F467, F468, F469, F470, F471, F472, F473, F474, F475, F476, F477, F478, F479, F480, F481, F482, F483, F484, F485, F486, F487, F488, F489, F490, F491, F492, F493, F494, F495, F496, F497, F498, F499, F500, F501, F502, F503, F504, F505, F506, F507, F508, F509, F510, F511, F512, F513, F514, F515, F516, F517, F518, F519, F520, F521, F522, F523, F524, F525, F526, F527, F528, F529, F530, F531, F532, F533, F534, F535, F536, F537, F538, F539, F540, F541, F542, F543, F544, F545, F546, F547, F548, F549, F550, F551, F552, F553, F554, F555, F556, F557, F558, F559, F560, F561, F562, F563, F564, F565, F566, F567, F568, F569, F570, F571, F572, F573, F574, F575, F576, F577, F578, F579, F580, F581, F582, F583, F584, F585, F586, F587, F588, F589, F590, F591, F592, F593, F594, F595, F596, F597, F598, F599, F600, F601, F602, F603, F604, F605, F606, F607, F608, F609, F610, F611, F612, F613, F614, F615, F616, F617, F618, F619, F620, F621, F622, F623, F624, F625, F626, F627, F628, F629, F630, F631, F632, F633, F634, F635, F636, F637, F638, F639, F640, F641, F642, F643, F644, F645, F646, F647, F648, F649, F650, F651, F652, F653, F654, F655, F656, F657, F658, F659, F660, F661, F662, F663, F664, F665, F666, F667, F668, F669, F670, F671, F672, F673, F674, F675, F676, F677, F678, F679, F680, F681, F682, F683, F684, F685, F686, F687, F688, F689, F690, F691, F692, F693, F694, F695, F696, F697, F698, F699, F700, F701, F702, F703, F704, F705, F706, F707, F708, F709, F710, F711, F712, F713, F714, F715, F716, F717, F718, F719, F720, F721, F722, F723, F724, F725, F726, F727, F728, F729, F730, F731, F732, F733, F734, F735, F736, F737, F738, F739, F740, F741, F742, F743, F744, F745, F746, F747, F748, F749, F750, F751, F752, F753, F754, F755, F756, F757, F758, F759, F760, F761, F762, F763, F764, F765, F766, F767, F768, F769, F770, F771, F772, F773, F774, F775, F776, F777, F778, F779, F780, F781, F782, F783, F784, F785, F786, F787, F788, F789, F790, F791, F792, F793, F794, F795, F796, F797, F798, F799, F800, F801, F802, F803, F804, F805, F806, F807, F808, F809, F810, F811, F812, F813, F814, F815, F816, F817, F818, F819, F820, F821, F822, F823, F824, F825, F826, F827, F828, F829, F830, F831, F832, F833, F834, F835, F836, F837, F838, F839, F840, F841, F842, F843, F844, F845, F846, F847, F848, F849, F850, F851, F852, F853, F854, F855, F856, F857, F858, F859, F860, F861, F862, F863, F864, F865, F866, F867, F868, F869, F870, F871, F872, F873, F874, F875, F876, F877, F878, F879, F880, F881, F882, F883, F884, F885, F886, F887, F888, F889, F890, F891, F892, F893, F894, F895, F896, F897, F898, F899, F900, F901, F902, F903, F904, F905, F906, F907, F908, F909, F910, F911, F912, F913, F914, F915, F916, F917, F918, F919, F920, F921, F922, F923, F924, F925, F926, F927, F928, F929, F930, F931, F932, F933, F934, F935, F936, F937, F938, F939, F940, F941, F942, F943, F944, F945, F946, F947, F948, F949, F950, F951, F952, F953, F954, F955, F956, F957, F958, F959, F960, F961, F962, F963, F964, F965, F966, F967, F968, F969, F970, F971, F972, F973, F974, F975, F976, F977, F978, F979, F980, F981, F982, F983, F984, F985, F986, F987, F988, F989, F990, F991, F992, F993, F994, F995, F996, F997, F998, F999, F1000.

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