Starting a small ruminant enterprise – Selection and Production

Joan M Burke

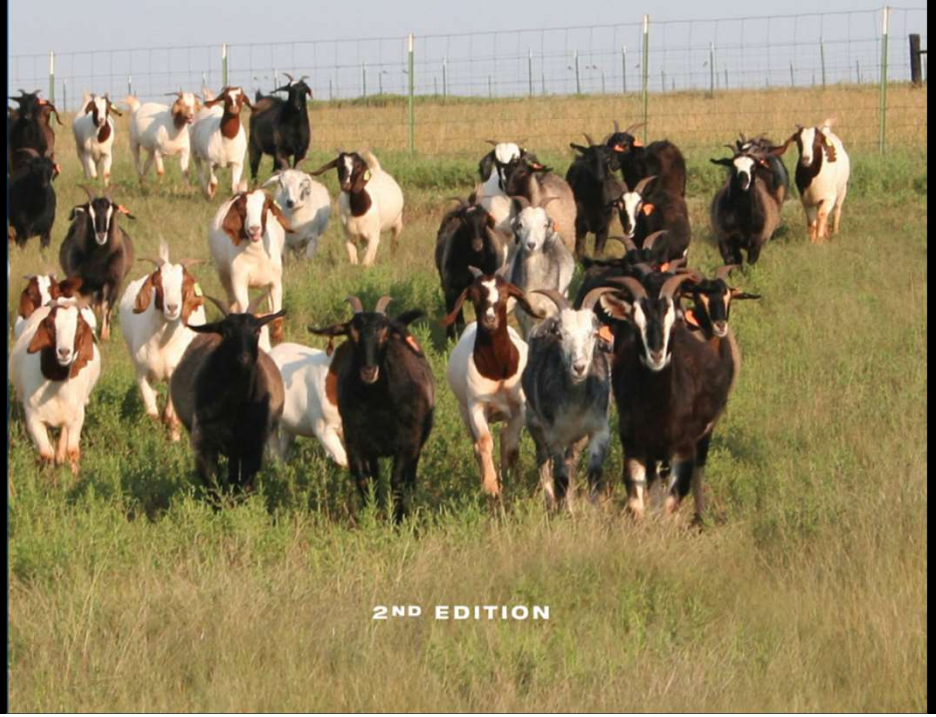
Research Animal Scientist

USDA, ARS, Dale Bumpers Small Farms Research Center
Booneville, AR

USDA
United States Department of Agriculture
Agricultural Research Service


DALE BUMPERS
SMALL FARMS RESEARCH CENTER
USDA
UNITED STATES DEPARTMENT of AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
NATURAL RESOURCES CONSERVATION SERVICE -
PLANT MATERIAL CENTER
AND
DIVISION of AGRICULTURE, UNIVERSITY of ARKANSAS
COOPERATIVE EXTENSION SERVICE
Mission: To develop scientific principles and technologies to enhance the profitability of small scale farms.

MEAT GOAT PRODUCTION HANDBOOK



2ND EDITION

Overview

- Desirable characteristics of small ruminants
- How do we achieve selection
- What is genetics?
- Determine breeding goals
- Records and data to record
- Considerations

Desirable characteristics

- Fast growth
- Heavily muscled
- Unassisted birth
- High number of offspring born/weaned
- Good milk production
- Easy keeper, robust
- Resistant to parasites/worms/disease
- Attractive (good bone structure, width, length, feet/legs)

How do we select animals? Do not judge a book by its cover!!

Need information

- Records, etc.

Need to understand genetic selection

- Genetic selection is based on phenotypic data, pedigree, contemporary group

Need to understand how environment, management and nutrition influence genetics

- Phenotype = Genotype x Environment x Management
- Some traits (low heritability) are more influenced by environment and management

Genetics

- Phenotype – What you measure
- Genotype – Genetic makeup. Does not change in an individual animal. Genes are translated into traits.
- Environment – climate, management, nutrition, etc.

Other lessons in genetics

Population mean. Measuring a trait and comparing with mean of other animals (within a population)

Contemporary group. Animals within a common management group. Example, lambs/kids born within a 30-day period.

Need to correct a trait for day of age (or season of birth, etc.). Lambs/Kids born later will be lighter in weight on same day as first born kid.

Goal of genetic selection or change is to increase animal production on the farm

- Increase the number of offspring/female exposed to ram/buck
- Increase efficiency of small ruminant production on the farm

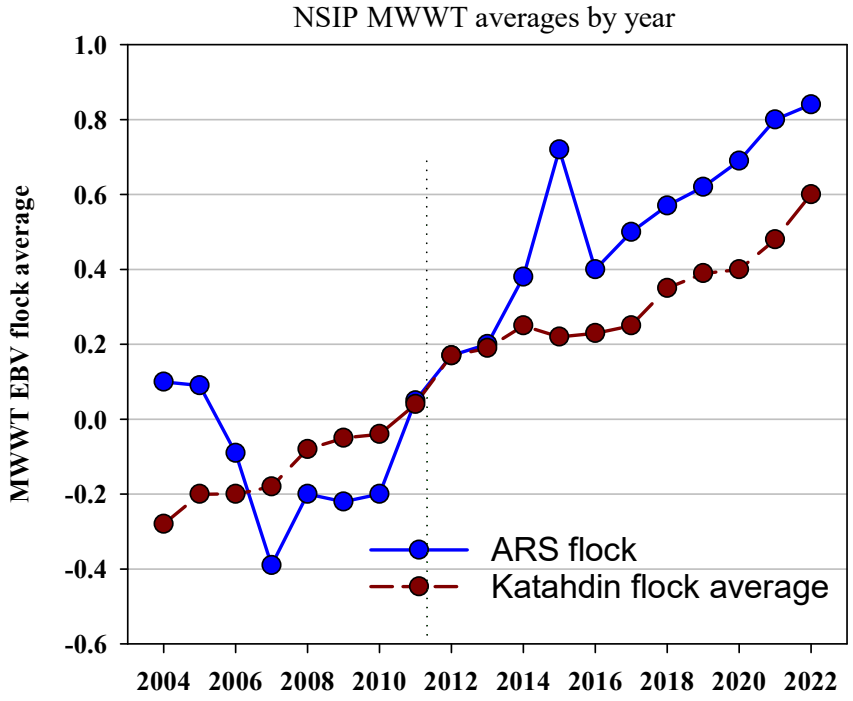
Example

- Single kid produced from a doe. Will grow faster and be heavier at weaning because it had more nutrition/milk. 45 lb. weaning weight/doe.
- Triplets produced from a doe. Won't grow as fast and individuals will be lighter at weaning. 30 lb. weaning weight x 3 = 90 lb. weaning weight/doe.

Through selection, improvements can be made with each new generation

- The ARS flock (blue solid line) has selected for maternal weaning weights (MWWT) in lambs (a reflection of genetic differences in milk production determined by weaning weight relative to parents).

- Note: Sheep and goat flocks in the U.S. can collect data (birth, weaning and post-weaning weights) on all animals and submit to the National Sheep Improvement Program which calculates Estimated Breeding Values based on individuals and pedigree.



First, determine breeding goals

- In ARS flock, first priority is parasite resistance because you cannot sell a dead lamb.
- Second is maternal weaning weight – ewes need to be able to produce enough milk for lambs on pasture
- Then weaning and post-weaning weights are important.
- Prolificacy is next - not highly heritable, but want at least average
- The more traits selected, the slower the progress. An index helps to make genetic gains in economically important traits.

Production traits – what we measure

- Fertility – getting bred to 1st cycle
- Prolificacy – number of offspring born/**weaned**
- Milk production – estimate by growth of lambs/kids (or actual milk production in dairy animals)
- Growth – body weights over time or average daily gain; gain per pound of feed
- Health – parasites, feet, mastitis, etc.
- Carcass traits – eye muscle depth, dressing percentage

Need to consider efficiency of production

- Ratio of outputs (lambs/kids marketed) to inputs (operating costs, labor, feed, cost of replacements).
- As an example, consider 2 does with same output, but one doe required more feed or health inputs. Or two does had same resources, but one had lower litter weight. She would be less efficient.

How to practice selection?

- Decide which animals will be kept for breeding and which sold for market
- Keep in mind how many kids to raise/produce – need to know current and target lambing/kidding rate
- How long will breeding animals stay in production?
- Culling rate
- Mating – matching females to sires (or AI), from within herd or purchased.

How can farmers measure phenotypes?

- Record keeping
- Phenotype – Indication of genetic merit
- Must collect DATA (body weights, death loss, FEC), make observations, examine disposition and behavior
- Ongoing process

Data to record

- Must have animal ID (tags, tattoo).
- **Pregnancy %** = No. exposed females pregnant or lambed or kidded/No. exposed X 100
- **Lambing/Kidding %** = No. offspring born/No. dams exposed X 100
- **Lamb/Kid death loss** = No. died/No. exposed X 100

Data to record

- Weaning weight and litter weaning weight. Adjust for 90-day weight (see table).
- **Average daily gain** (ADG) = weaning weight – birth weight/weaning age.
- **90-Day Weight** = (ADG X 90) + birth weight x (adjustments for litter size X age X sex) (see Table)
- **90-Day Weight** (if no birth wt) = (weaning wt/weaning age) X 90

Table 14-1. Goat 90 Day Weaning Weight Adjustment Factors.

Effect	*Group*	*Adjustment Value*
Litter Size		
born – raised	**1-1**	**1.00**
	1-2	**1.14**
	2-1	**1.04**
	2-2	**1.18**
	3-1	**1.08**
	3-2	**1.23**
	≥3-≥3	**1.27**
Age of Dam		
(years)	1	1.10
	2	1.09
	3+	1.00
Sex of Kid		
(weaned)	Buck	1.00
	Doe	1.11
	Wether	1.08

Source: http://sheepandgoat.com - David R Notter, PHD, Virginia Tech

Data to record

- Weaning weight ratio = (90-day wt/90-day herd weight average) X 100
- A ratio of 100 is equal to the group average. A kid with a weight ratio of 122 is 22% heavier than the group average. A kid with a ratio of 91 is 9% lighter than the group average.

Other concepts to consider

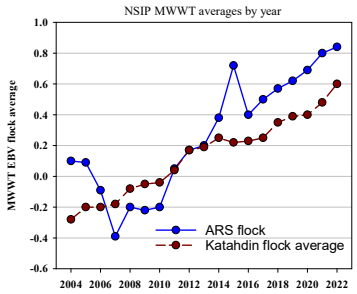
- **Randomness**. Breeding predictions are based on probabilities. Most economically important traits are polygenic (controlled by several genes). Tremendous genetic variability exists, especially in unrelated animals. The randomness of inheritance limits our ability to control the outcomes of mating. Can be difficult to know which traits will be expressed from sire and dam.
- **Heritability**. An estimate of the degree of variation in a phenotypic trait in a population due to genetic variation between individuals. It is the proportion of a trait not explained by environment (nutrition, management, etc.) or random chance.

Heritability estimates from sheep research with implications for meat goats

Trait	Heritability, %
Doe fertility	5-10
Kids born/doe kidding	10
Scrotal circumference	35
Age at puberty	25
Kid survival	5
Weight of kid weaned/doe exposed	20
Birth weight	3 - 36
90-day weight	25 - 30
Post-weaning gain	40
Carcass weight	35
Loin eye area	35
Dressing percentage	10
Milk yield	30 - 61

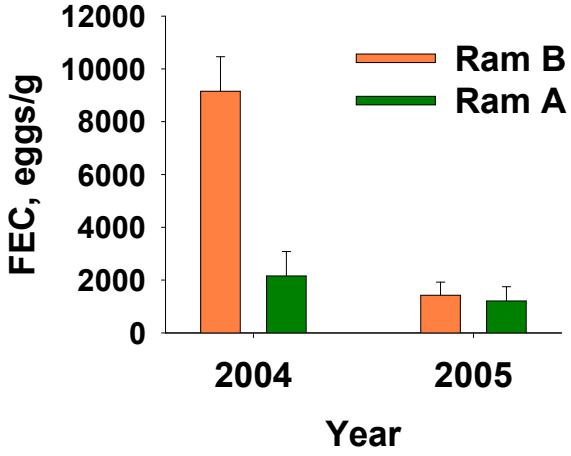
Adapted from WR Getz, Meat Goat Handbook, 2005

- Heritability estimates are determined within breeds and populations of animals and can vary based on diversity of population and other factors, and can change over time along with selection.
- Focus on moderately and highly heritable traits.
- Reproduction and survival traits are lowly heritable.



Using genetics for selection of parasite resistance

- An animal's ability to resist parasites is heritable (0.18 - 0.23)
- USDA, ARS progeny of sires have been evaluated since 2004 for parasite resistance (FEC) and tolerance (PCV and FAMACHA), growth, and maternal traits.

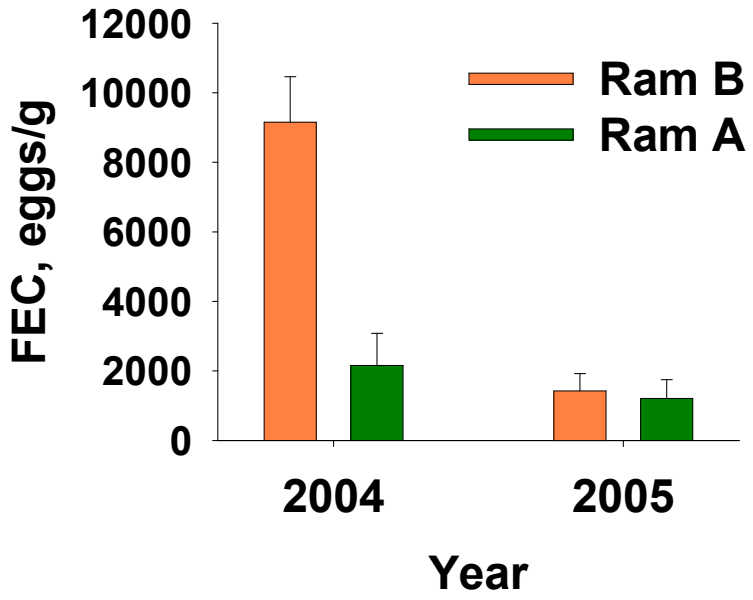


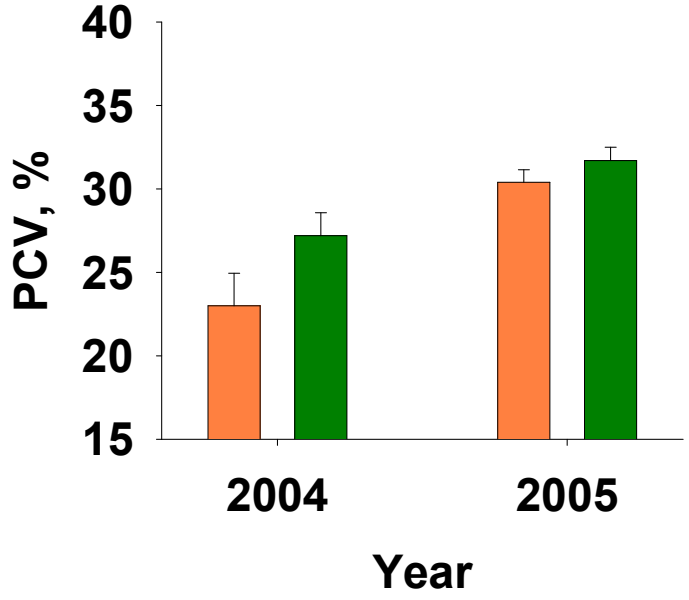
USDA United States Department of Agriculture
Agricultural Research Service

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

Ram A:
WWEC = -21
PWEC = -3

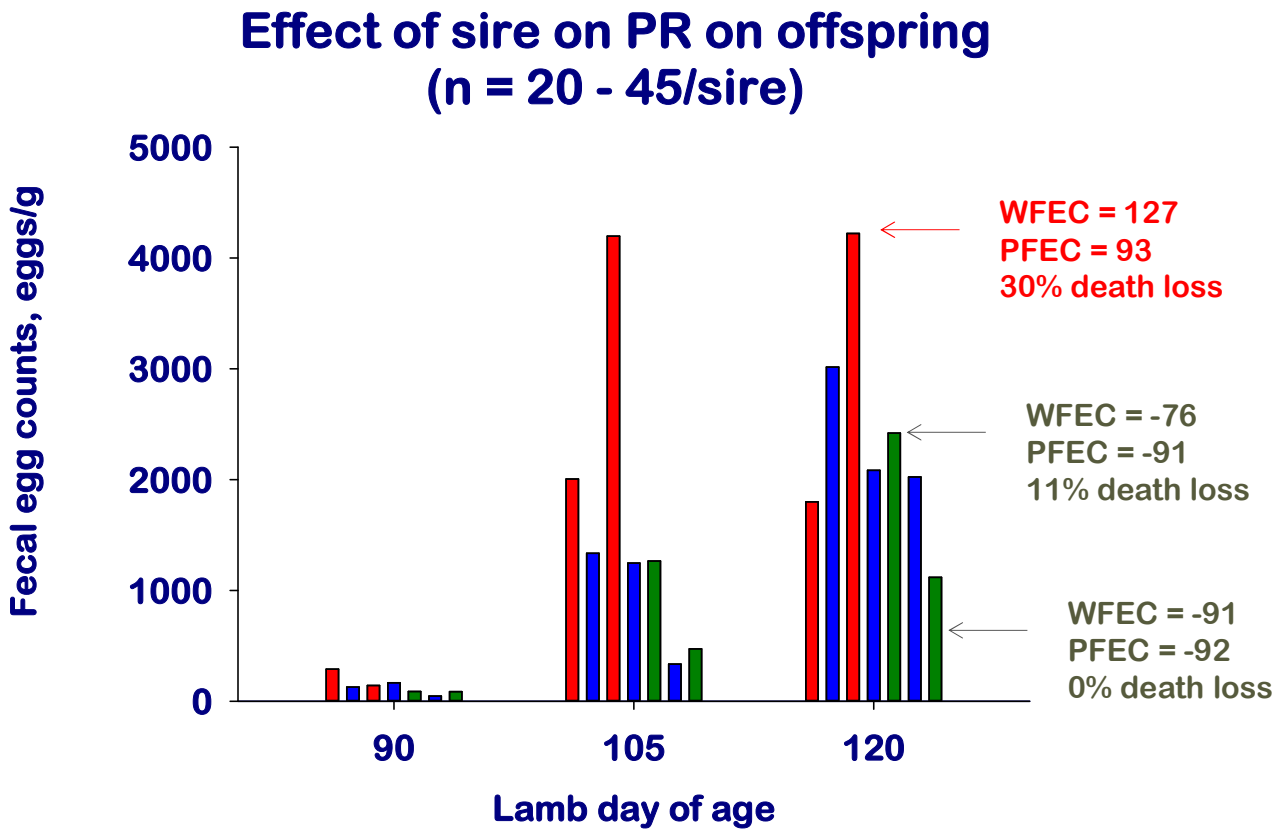
Ram B:
WWEC = +178
PWEC = +119





USDA United States Department of Agriculture
Agricultural Research Service

Comparing offspring FEC among sires



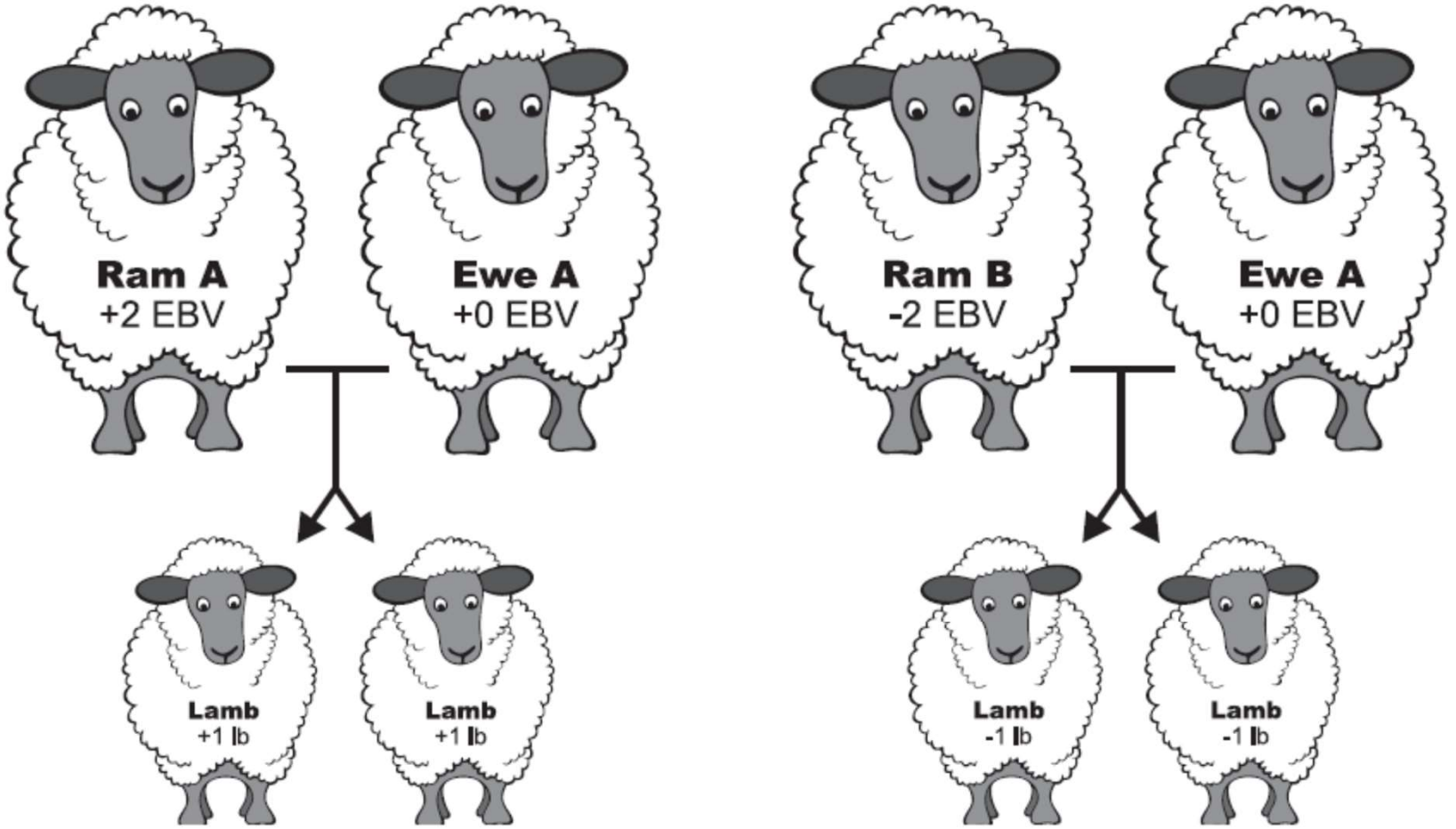
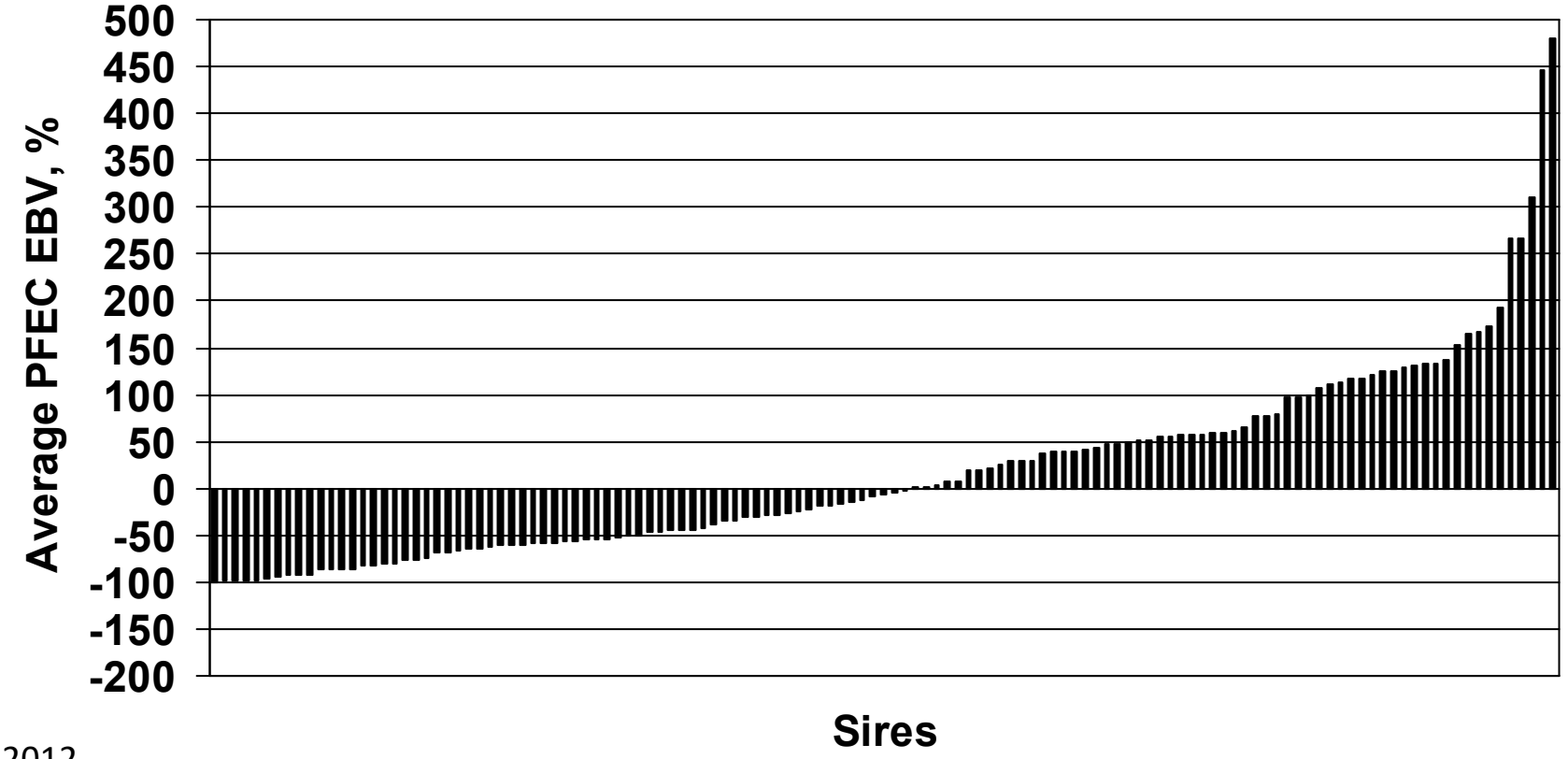


Figure 1. Example of differences in lamb weaning weight from Ram A and Ram B.

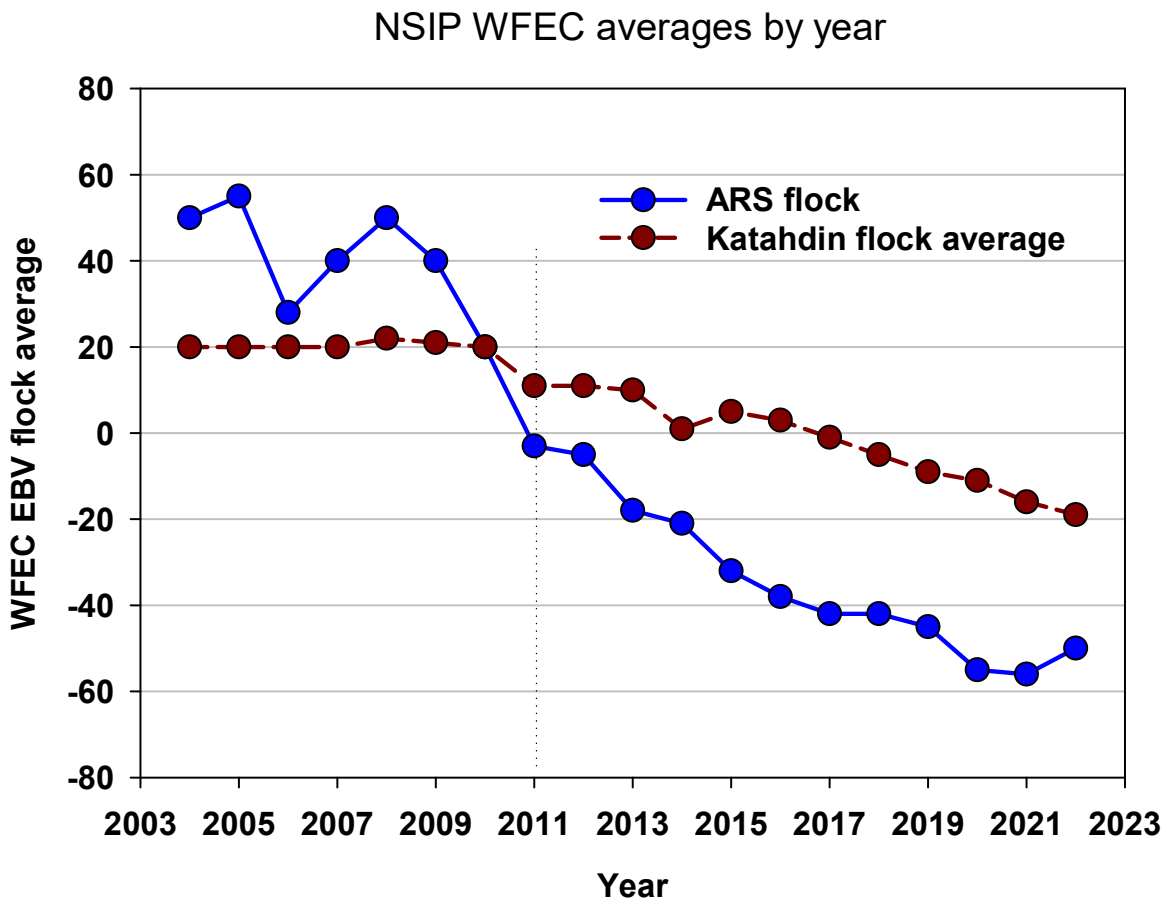
R. Redden, Understanding sheep estimated breeding values, NDSU, www.ag.ndsu.edu

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



D. Notter, 2012

Genetic Trend for ARS flock



Consequences of selection for parasite resistance

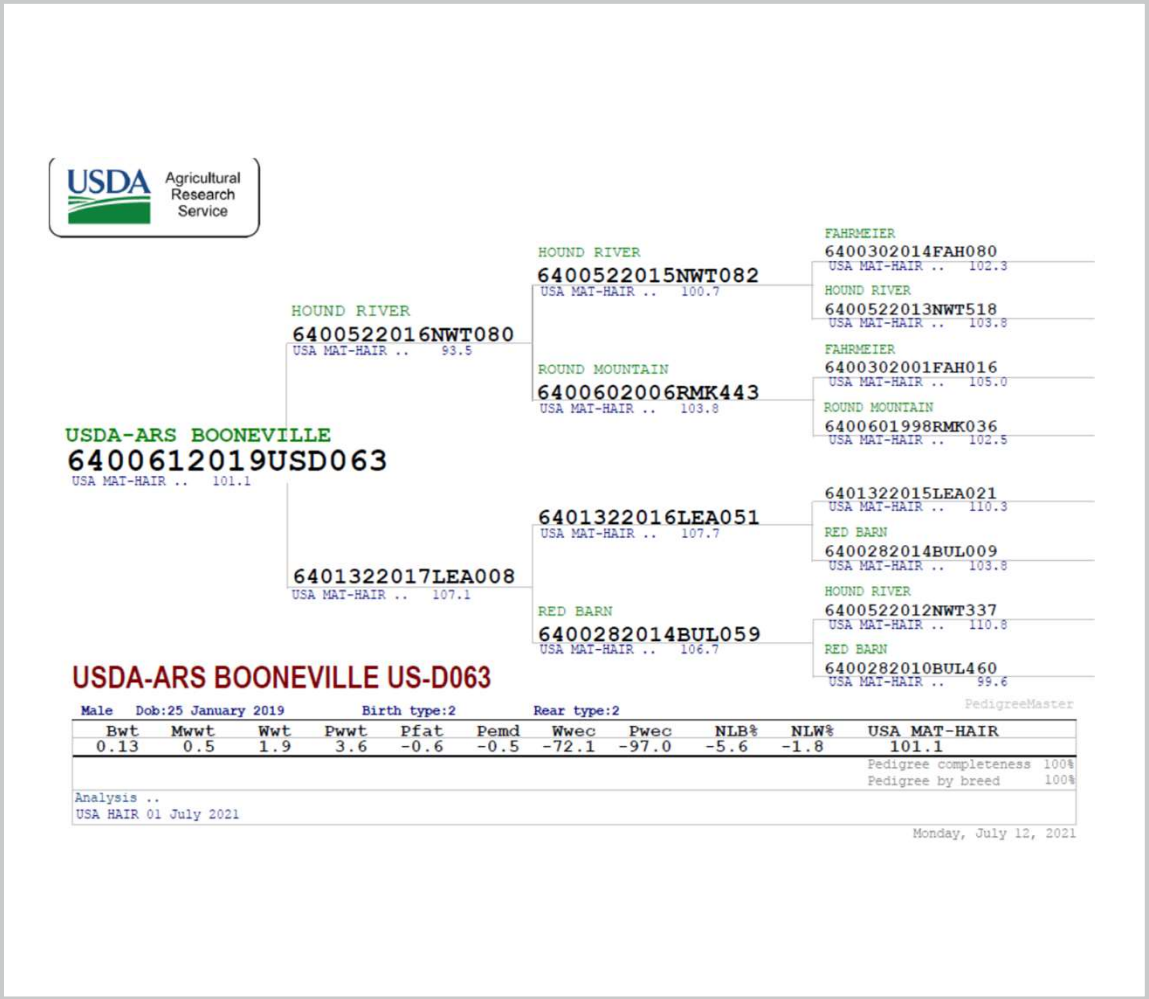
- Selection for parasite resistance does not occur in a vacuum.
- We (and others) found favorable genetic correlations between FEC and body weight in Katahdins (Ngere et al., 2018; Notter et al., 2018). This means that heavier lambs had lower FEC.
- Also found were genetic antagonisms with maternal traits such as prolificacy.
- Wool traits: there are favorable genetic correlations between FEC and fiber diameter, but unfavorable with clean fleece weight in SA Merino (Cloete et al., 2007) or small genetic correlations between PR and wool traits (Cunha et al., 2024).
- Dairy: There were unfavorable genetic correlations between FEC and milk yield in dairy goats (Heckendorn et al., 2017).

USDA Agricultural Research Service

Consequences of selection for parasite resistance

- **PR may impact other immune responses.**
- **Type of infection influenced genetic correlations – more strongly positive with natural infections (Hayward, 2022 meta-analysis).**
- **However, breeding programs that consider multiple economically important traits can result in genetic improvements in all traits simultaneously.**
- **Genetic index traits consider important traits dependent on breed goals. Katahdin includes lamb BW, maternal weaning weight, prolificacy. Considering adding FEC EBV.**

USDA Agricultural Research Service



Pedigrees

- Written record of ancestry
- Importance – particular lines of more productive animals will likely be more productive.
- Need performance records on pedigrees!

Distorted breeding objectives

- Competition among breeders
- Overselling traits such as color, ancestry, mature weight
- Not taking into consideration production traits

Strive for balance

- Selection for one trait at the expense of others is not balanced.
- Selection of 2-3 traits with other traits average or better reaches balanced goals.

Things to keep in mind

- Purchase animals from farms that are similar to yours in climate, environment, management, feeding/nutrition, care.
- Keep the end user in mind – consumer, butcher, feeder, etc.