The Benefits of Heterosis in the Goat Industry

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Dairy Goat Breeds

- Alpin
- Saanen
- Nubian
- Toggenberg
- Oberhasli
- LaMancha
- Nigerian Dwarf
Meat Goat Breeds

Spanish
Pygmy
Kiko
TexMaster
Boer
Myotonic
Savannah
Genemaster
Tennessee Meat Goat
Kinder
Practical Mating Systems for Meat Goat Producers

- Mating systems should be evaluated on several criteria. These include:
  - Merit and availability (physical or financial) of the breeds to be used.
  - Expected level of heterosis.
  - Complementarity of the breeds available.
  - Replacement stock considerations.
  - Simplicity.
Types of Heterosis

- Direct heterosis
  - The advantages of a crossbred kid
- Maternal Heterosis
  - The advantage of a crossbred doe
  - The biggest heterosis effect on doe/kid productivity
Impact on Profit

Profit = Revenue - Costs

Heterosis Impact
How Does Heterosis Help?

- More Efficient Does
  - Reproductive performance
  - Longevity
  - Growth (direct and maternal)
  - More pounds of kid
    - Function of # of head and weight
- Improve efficiency by changing input:output ratio
Mating Systems Goals

1. Optimize the utilization of kid and maternal heterosis.

2. Utilize breed complementarity to match does to their environment and their progeny to market targets.

3. Minimize variation in progeny phenotypes by stabilizing breed inputs.
Breeding Programs

- Rotational 2, 3, 4 breeds
  - Can be complex
- Terminal
  - Can require purchase of replacement females
- F₁, Hybrid or Composite Seed Stock
  - Retained Heterosis
  - Stabilization of Breed Percentages
Rotational Crossbreeding Systems

- Involve rotating sire breeds across the female population
- Advantages are:
  - Produce replacement females internally
  - manage to maintain acceptable levels of the original heterosis
  - Either purebred sires or crossbred sires can be used
  - You can use the breeds of sires simultaneously by placing them in separate physical locations; or you can use the breeds sequentially over time
Rotational Crossbreeding Systems

- Generally the system involves only 2 to 4 different breeds. Although adding more breeds will maintain heterosis at a higher level, it may be a challenge to identify more than four breeds that compliment one another.

- Two-breed rotational system
  - Simplest system available
  - You will maintain about 67 percent of the original 100 percent level of heterosis.
Two-breed Rotational System

Example: Kiko X Spanish Crossbreeding system

- Generation 1 - \( Kiko \times Spanish = (0.5 \text{ Kiko} + 0.5 \text{ Spanish}) \)

- Generation 2 - \((0.5 \text{ Kiko} + 0.5 \text{ Spanish}) \times Kiko = (0.75 \text{ Kiko} + 0.25 \text{ Spanish}) \)

- Generation 3 - \((0.75 \text{ Kiko} + 0.25 \text{ Spanish}) \times Spanish = (0.375 \text{ Kiko} + 0.625 \text{ Spanish}) \)

- Generation 4 - \((0.375 \text{ Kiko} + 0.625 \text{ Spanish}) \times Kiko = (0.6875 \text{ Kiko} + 0.3125 \text{ Spanish}) \)

- 3rd Generation 2/3 recently used breed 1/3 for next breed in rotation
Three-breed Rotational System

- Increases Level of Complementarity and Heterosis after first crosses compared to 2 breed rotation
- 86% of original level of heterosis is maintained
- After 5th generation the relative percentages in breed composition will settle down to ~ 57% currently used sire breed ~ 28% next most current sire and ~ 15% for the breed next in line
- Crossbred replacement does will be produced internally
Three-breed Rotational System
Know how. Know now.

Three-breed Rotational System

Generation 1 – Kiko x Spanish = (.5 Kiko + .5 Spanish)

Generation 2 – (.5 Kiko + .5 Spanish) x Boer = (.5 Boer + .25 Kiko + .25 Spanish)

Generation 3 – (.5 Boer + .25 Kiko + .25 Spanish) x Spanish = (.25 Boer + .125 Kiko + .625 Spanish)

Generation 4 – (.25 Boer + .125 Kiko + .625 Spanish) x Kiko = (.125 Boer + .5625 Kiko + .3125 Spanish)

Generation 5 – (.125 Boer + .5625 Kiko +.3125 Spanish) x Boer = (.5625 Boer + .28125 Kiko + .15625 Spanish)

Generation 6 – (.5625 Boer + .28125 Kiko + .15625 Spanish) x Spanish = etc
Terminal Sire System

- Applicable where breeds are unquestionably identified as maternal breeds.
- Maternal breed characteristics excel in
  - Conception rate
  - Number born
  - Milk yield
  - Mothering ability
- Paternal Breed characteristics excel in
  - Growth rate
  - Carcass yield
- Most important is breed complementarity
Terminal Crossbreeding Programs

- Two approaches
  1. Static terminal-sire crossbreeding programs
     I. Proportional breed composition does not change
     II. System does not provide for replacement females internally
     III. Uses purchased does all offspring sold
     IV. Provides for a large amount of heterosis

Generation 1 – Spanish x Boer = (.5 Spanish + .5 Boer)
Generation 2 – (.5 Spanish + .5 Boer) x Savannah
= (.5 Savannah + .25 Spanish + .25 Boer)
Terminal Crossbreeding System

- **Boer**
- **Spanish**
- **Boer/Spanish**
- **Boer/Spanish x Savannah**
- **All offspring sold**

- Purchased female

- Purchased female
Rotational/Terminal Systems

- They combine a maternal rotation for producing replacement females with terminal sires for producing market offspring.
- A portion of the herd is bred to maternal sires (this would be your best producing does or younger does) “All males marketed 25% females saved”
- Remaining does are bred to terminal sires to produce market offspring. “All offspring marketed”

Kiko x Spanish = (.5 Kiko + .5 Spanish) “save females”

Next generation bred to Spanish then Kiko alternating (.5 Kiko + .5 Spanish) x Boer = .25 Kiko + .25 Spanish + .5 Boer all offspring marketed.
Rotational Systems

- Disadvantages
  - Requires more pastures
  - More complicated
  - Producers tend to want to save Terminal sired females which are less productive

Keep best females to use in rotation

Sell all offspring
Composites

- Derived from crossbred foundation
- Can be considered new breeds
- Simplest way to use is, as one breed
- Considered a breed made up of two or more component breeds
- Composite systems can produce considerable hybrid vigor
- When two $F_1$s are mated to produce $F_2$s half of the heterosis is lost but half still remains in the $F_2$s, $F_3$s and subsequent matings.
- Stabilization of breeds occur using this method
Advantages to Composites

- Management similar to a purebred operation
  - Relatively simple
  - No longer need to keep several breeds around
  - Retained hybrid vigor even in small herds
- Composites work well when ever environment posses special challenges
- When developing composites it is critical that individual families with poor performance be culled
- Begin development of composite with a large population to guarantee success
Composite Breeds Developed

- **TexMaster**
  - Developed by Onion Creek Ranch over several generations
  - Made up of Tennessee Meat Goats crossed with Boer Goats
  - The purpose of the breed was to develop a meat goat breed to meet commercial demands such as low maintenance, efficient feed utilization, good mothering skills, rapid growth, and thrifty kids.
Composite Breeds Developed

- **Kinder**
  - developed in 1987 by the Showalter family
  - crossed a Nubian doe with a Pygmy buck
  - The breed was developed as a dual-purpose breed for milk and meat. Kids usually are born weighing 4 or 5 pounds and grow rapidly at a rate of about 7 pounds per month.
Composite Breeds Developed

- **Genemaster**
  - Developed on a foundation of 3/8 Kiko and 5/8 Boer
  - Goatex Group LLC developed breed to carcass specifications. It has identified a carcass in the weight range of 22-26.4 pounds (10-12 kilograms) as being potentially the most profitable for the following reasons: Purpose-bred goats correctly managed can deliver the target carcass weight at weaning or soon thereafter.
Summary

- Mating systems should be evaluated on several criteria:
  - Merit and availability of the breeds to be used
  - Expected level of heterosis
  - Complementarity of the breeds available
  - Replacement stock considerations
  - Simplicity

- Incorporate both direct and maternal heterosis into your breeding program
- Utilize breed complementarity
- Minimize variation in progeny phenotypes by stabilizing breed inputs
- Should improve profits from productivity increases
Thanks to the following contributors to this presentation!

- [http://www.sheepandgoat.com/](http://www.sheepandgoat.com/) Maryland Small Ruminant Website by Susan Schoenian
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