Selection of Genetics for Meat Production in Goats and Sheep

Introduction

Selection of optimum genetics for meat production in goats and sheep can contribute to production, efficiency, and profit. Most producers select animals for breeding to produce their next crop of kids or lambs based on the phenotype or visual appearance. The phenotype is a reflection of the genetics plus the environment in which an animal is raised. Because the environment has a major effect on phenotype, the assumption that better looking animals are also genetically the best may or may not be true. Producers should select superior genotype to produce the next set of offspring. The question is what is best and how can we pick the best genetics?

Producers can identify the best genetics by ranking the individuals based on their estimated breeding values. The true breeding value or genetic merit of a particular trait cannot be measured directly; it must be estimated through evaluation of performance information based on the heritability of that trait, after accounting for environmental differences. Heritability is an estimate of the proportion of genes that control a particular trait that parents would pass to the offspring. Records of all available pedigree information on animals—the gene flow—are used to predict the estimated breeding values of individual animals. Therefore, the record of performance on individual animals is the best tool to make selection and culling decisions to improve your genetics. The heritability estimate of a trait affects the transmitting ability of genes in predicting estimated breeding value of animals for that trait. The genetic progress that you would expect in your herd or flock also depends on how many traits you are considering in your selection program. If you select for just one trait, such as average daily gain, you would make faster progress than if you select for a combination of two or more traits. Typically, serious producers put emphasis on a few traits, such as growth, conformation, or reproduction, to produce well-rounded animals for better market value. The

limited performance testing and absence of genetic evaluation programs make selections based on estimated breeding values unfeasible.

For small producers, a simple and quick alternative is to rank individual animals for a particular trait based on their performance data within a contemporary or management group and minimize environmental effects (Appendix A). For example, kids or lambs raised as a group in the same year or season, with the same sex, and in a similar environment can be considered a contemporary or management group. The primary purpose of recording animal performance is to determine which animals are phenotypically and genetically superior in a population. Individual performance records themselves have a limited value, but when all animals in a herd or flock or across many herds or flocks are recorded along with their pedigree information, the comparison of records becomes a valuable tool for evaluating an individual animal's merit for production and genetic superiority.

Tools for Genetic Improvement

The tools in tables one through seven can help producers achieve success in genetic improvement and profitability in goat and sheep meat production.

Table 1. Tools for Selecting Best Genetics

- Unique identification of all animals in the herd
- A performance and pedigree record keeping system
- Collection of data on breeding, reproduction, growth, carcass quality, etc.
- Equitable comparison of animals (Appendix A)
- Adjustment factors for environmental differences to adjust individual performance
- Utilizing the complete pedigree (parents, grandparents, great-grandparents, siblings, etc.) or gene flow information for computing genetic merit
- Participation in regional or national genetic evaluation programs

Table 2. Procedures Performed by Successful Producers

* Evaluate each doe's or ewe's production and identify top-producing does and ewes.
* Assess the performance of those bucks and rams used as sires in your herd or flock.
* Evaluate kids and lambs for growth and weight on the basis of their weights.
* Know the differences in feed efficiency in a group of kids or lambs.
* Check carcass quality to determine if you are producing desirable meat kids or lambs.
* Participate in any within- or across-herd genetic evalution programs.
* Keep track of herd health—parasite control, vaccination, etc.
* Evaluate the income and profit from your enterprise.

Table 3. Common Meat Production Traits in Goats and Sheep

Growth[1]	**Reproduction**[2]	**Carcass**[1]	**Health**[2]
Birth wt. Weaning wt. 60-, 90-day wt. Market wt. Av. Daily Gain (Pre-weaning / Post-weaning) Feed efficiency Conformation	Conception rate Number born per doe/ewe Number weaned per doe/ewe Percent of kidding/ lambing % kids/lambs weaned Fertility problems	Muscling Dressing % Loin eye area Fat thickness % bone conformation	Mortality rate Resistance to parasites Resistance to disease

[1]Growth and carcass traits generally have (medium to high: 20 to 60 percent) heritabilities.

[2]Reproductive and health traits are extremely important to production but have very low heritability estimates (less than 10 percent).

Breeds of Goats and Sheep for Meat Production

Many breeds of goats and sheep are available for meat production. Some common breeds and their production characteristics are shown in table 4. Although the supply of goat meat comes from the less-muscled dairy goat breeds (Alpine, La Mancha, Oberhasli, Saanen, and Toggenburg), only the Nubian, a dual purpose breed, is included in this list.

Table 4. Common Breeds of Goats and Sheep for Meat Production

Breeds	Average Mature Weight in Pounds		Growth Rate	Prolificacy	Milking Ability
	Male	Female			
Goats:					
Boer	240 to 300	220 to 225	H	M	M
Kiko	150 to 170	110 to 130	H	M	M
Nubian	170 to 200	130 to 160	M–H	M–H	H+
Pygmy	90 to 100	80 to 90	L–M	M–H	M
Spanish	90 to 200	80 to 130	M–H	M	M
Tennessee-Wooden-Leg	100 to 200	90 to 140	M–H	M–H	M

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Table 4. Common Breeds *continued*

Breeds	Average Mature Weight in Pounds Male	Female	Growth Rate	Prolificacy	Milking Ability
Sheep:					
Border Leicester	175 to 250	140 to 180	M–H	M–H	M–H
Cheviot	160 to 200	120 to 150	M	M	M
Columbia	225 to 350	150 to 225	H	M	M
Corriedale	175 to 275	130 to 180	M	M	M
Dorper	200 to 250	150 to 200	M–H	M	M
Dorset	200 to 250	140 to 180	M–H	M–H	H
Finnsheep	175 to 225	120 to 160	L–M	H++	H
Hampshire	250 to 325	175 to 225	H	M-H	H
Lincoln	250 to 350	200 to 250	M	M	L–M
Katahdin(hair sheep)	180 to 250	120 to 160	M	M	M
Merino	150 to 225	110 to 150	L–M	L–M	M
Oxford	200 to 300	150 to 200	M–H	M	M
Polypay	200 to 250	140 to 180	M	H	H
Rambouillet	250 to 300	150 to 200	M–H	L–M	M
Romney	200 to 275	150 to 200	M	M	L–M
Suffolk	250 to 350	180 to 250	H+	H	H
Southdown	175 to 225	130 to 180	M	M	M

L = Low M = Medium H = High

Source: Adopted from various sources of literature including *Breeds of Livestock,* Oklahoma State University; *Sheep Pocket Guide,* North Dakota State University Extension Service; and others.

Note: The weight ranges for some meat goat breeds (Spanish and Tennessee-Wooden-Leg) vary depending on the environment in which they are raised.

Record Keeping Systems

Record keeping can be simple or complex depending on the needs and goals of the producer. A good record keeping system provides an accurate and simple way to permanently organize and keep herd records. Records can be kept in some type of designed forms (see sample forms 1 through 4 that can be used for meat goats or adapted to sheep flocks) either in books, individual sheets, or in electronic spreadsheets. Records kept manually in books or forms and sheets often require that a user browse through the entire records to find a particular animal's entry. Records kept in a good database management system specifically designed for keeping goat or sheep records provides an efficient way to organize information that is easy to access. A database program also allows producers to make many pre-set queries to summarize each component of their operations.

Table 5. Common Types of Herd Management and Performance Records

- Pedigree data
- Breeding data
- Production data
- Carcass data
- Herd health information data
- Financial data

Table 6. Benefits of Having a Good Herd Management Record Keeping System

- Aids in the selection of parents and replacement animals.
- Identifies top-producing does and ewes and outstanding bucks and rams.
- Helps cull low producers in the herd.
- Documents progress.
- Makes changes in management style based on the business analyses.
- Eliminates guesswork; records speak for themselves.
- Helps in marketing your animals for a premium price.

Selection and Culling of Animals

Important considerations in a selection program for meat production in goats and sheep are rapid growth rate; multiple births and kidding or lambing three times in two years; good conformation (large body size, muscling, sound feet, and legs); and environmental adaptability (resistance or resilience to parasites and diseases). Systematic selection for the above traits will greatly improve the production efficiency (pounds of kid or lamb per doe or ewe bred) and the likelihood of making a profit. Culling is a more complicated process and is usually done for more than one reason.

Selection of Bucks and Rams for Breeding

Buck and ram selection is the most critical decision a breeder has to make. It is important to recognize that the buck or ram will contribute one-half of the genetics to the kids and lambs raised in one year but may quickly influence more than 80 percent of the genetic makeup of your herd or flock if you keep your own replacement does or ewes and breed to young bucks or rams raised in the same herd or flock. Inbreeding can be a problem if outside genetics are not brought into the herd or flock. Generally, sire selection is directed to improve growth, feed efficiency, and meat or carcass quality traits by selecting top sires for these traits. (Example: Average daily gain, growth: 60-d /90-d /120-d wt, conformation, dressing %, yield etc). Avoid selecting any bucks or rams with poor libido, genetic malformation, abnormal testicles, or poor temperament and bucks or rams from a closed herd because this will increase the inbreeding level.

Selection of Replacement Does and Ewes

Many producers raise their own replacement does or ewes. Producers tend to select does or ewes to improve reproductive efficiency and mothering ability of breeding animals in their herds or flocks. A dam's milk production, size of kids at weaning, litter size or prolificacy, and extended pedigree are key factors producers should look for if they don't have breeding value estimates from genetic evaluation on young replacement stocks.

Crossbreeding and Heterosis

Purebred breeders generally stay with their breed of choice and continuously try to improve their genetics through selection. However, commercial meat goat and sheep producers mostly rely on purebred breeders for purchasing their breeding stock and try crossbreeding different breeds or breed types (F1 crosses, 2- or 3-way rotational crosses) to produce the best market meat kids and lambs. Through a planned system of crossbreeding, a breeder can combine superior genetics for certain traits with another set of traits of top genetics from another breed or breeds to produce the best from both parents. Progenies usually exceed their parents' performance for those traits. Here, the genes from both parents complement each other in a phenomenon known as hybrid vigor or heterosis. Traits that are known to have medium to high heritability estimates (growth and carcass traits) may not show much heterosis or hybrid vigor, but traits with low heritability estimates (reproductive or disease resistant traits) exhibit a relatively high amount of heterosis in their progeny.

Useful Tips for Producers

The additional tips in table 7 will guide producers in planning and formulating a genetic improvement program appropriate for their operation and based on their individual objectives.

Table 7. Useful Tips for Producers

- Use colored ear tags with numbers to identify animals; follow a pattern so you can easily spot animals by year of birth, breed type, etc.
- Update herd inventory bimonthly and try to computerize and summarize using a simple spreadsheet program.
- Beside actual breeding date also record date and heat cycle (estrus) manifestation in all does or ewes.
- Avoid the use of extremely large bucks or rams on young or small does and ewes.
- Diagnose pregnancy 45 to 90 days after the end of the breeding period and cull open does and ewes.
- Aim for 70 to 95 percent reproductive efficiency (percentage kid or lamb crop weaned for the total number of does and ewes of breeding age in the herd or flock each year).
- In case of low percentage of kid or lamb crop weaned, check for buck or ram fertility, diseases, poor body condition of does or ewes, vitamin and phosphorus deficiencies, and physical defects.
- Aim for a short kidding or lambing season of 60 days or less and a kidding or lambing interval of 8 months or less.
- Consider the use of artificial insemination using selected semen from proven bucks.
- Try to use semen or natural service using 3 to 4 bucks or rams.
- Schedule estrus synchronization and artificial insemination programs during the rainy season (July to August).
- Use a proven animal as a clean-up buck or ram, but don't use his relatives or inferior sires.
- Weigh the kids or lambs at birth, at weaning, 2 months post weaning or at 6 months, and at 8 to 10 months.
- Kids and lambs that are heavier at birth are expected to be heavier at weaning provided all management factors are positive.
- Kids and lambs with heavy birth weights from does or ewes kidding or lambing for the first time may result in difficult birthing, known as dystocia.
- Weaning weight is one of the most important weight and size traits affecting productivity. It is primarily determined by two factors: the kid's or lamb's genetic potential to grow or its own growth impetus and the maternal environment.
- At least 50 percent of the variation in weaning weight is due to the milk production of the dam and the kid's ability to obtain its share of that milk.
- Weaning weight is about 40 to 50 percent repeatable suggesting a doe that weans heavier kids one year will do so again the next year.
- Post-weaning weights: This trait is usually taken 30 to 60 days post weaning and is a further measure of the kid's or lamb's potential to grow or its own growth impetus.

SAMPLE RECORD FORMS

(Choice depends on producer's needs and options)

Sample Form 1. Pedigree Record

Pedigree Record		
Animal ID:	Animal Tag. No:	Birth Date: mm/dd/yy
Animal Name:	Breed:	Sex:
Buck ID:	Buck Reg. No:	Registry:
Buck Name:	Buck Breed:	
Doe ID:	Doe Reg. No:	Registry:
Doe Name:	Doe Breed:	

Comments: Buck and doe could be also named as sire and dam, respectively.

Animal ID = Kid ID, Doe ID, or Buck ID is a Unique ID within a herd. By using an electronic spreadsheet such as MS Excel, you could adapt this table in a single row with all the other information in columns.

Sample Form 2. Breeding Record

Breeding Record									
Doe ID	Doe Breed	Doe Birth Date	Doe Reg. No.	Sire ID	Sire Breed	Mating Date	Preg. Check	Kidding Date	Remarks

Sample Form 3. Kid Performance Record

Kid Performance Record																
Preweaning									Weaning							Remarks
Kid ID	Birth Date	Sex	Type of Birth	Dam ID	Dam Breed	Sire ID	Sire Breed	Birth Weight	Weight Date	Weaning Weight	Creep/ Fostered	Weaning Group	Market Weight	Conf. Score	Kid Price	

Sample Form 4. Individual Doe & Kid Performance Record (This is another option.)

Individual Doe & Kid Performance Record															
Doe ID:				**Doe Birth Date:**							**Doe Weaning Weight:**				
Sire:				Sire Breed:			Dam:				Dam Breed:				
Source of Doe:				Reason for Culling:							Culling Date:				
Comments:															
Preweaning							Weaning					Doe Status			Remarks
Kid ID	Birth Date	Sex	Type of Birth	Sire ID	Sire Breed	Birth Weight	Weight Date	Weaning Weight	Creep/ Fostered	Market Weight	Kid Price	Condition Score	Preg. Check Date	Preg. or Open	

Appendix A: Compare animals equitably

Always compare animals equitably—"on a level playing field"—when ranking them for merit. For example, if you took the weaning weights of a crop of 50 kids on a particular day and started ranking them based on their weights, you would not get an accurate assessment because they were not born on the same day. We also know that there is a difference in weights between males and females as well as kids born from single births and those that are twins and triplets. In addition, kids born to first, second, third, or fourth parity does or older does also differ in weight because milk production of a fourth parity doe is much higher than that of a first parity doe. A single-birth kid from a fourth parity doe may have had an advantage in preweaning growth over a single-birth kid of a contemporary first parity doe in that crop. To compare animals equitably, consider all of these issues and make necessary adjustments to rank them for merit. Here are some ways to handle these issues.

Consider animals at a constant age and sex.

To handle the differences in age, you could consider all kids within the same crop at a constant or standardized age. Example, for weaning weight (approximately 8 weeks of age), adjust all of them to a 60-day weight. Here is how you do it:

Calculate the preweaning Average Daily Gain (Pre-w. ADG) and 60-Day-Weight as:

Pre.w. ADG =(Weaning Weight – Birth Weight) / Age at Weighing
Where age is the number of days between birth date and weaning weight date. Then,
60-Day Weight = (Pre-w. ADG X 60) + Birth Weight

Now group them by male and female kids and rank them within sex for merit. This works well for a purebred operation, but if you have both purebred and crossbred kids in the herd, evaluate them as separate groups.

Adjustment factors for sex, type of birth, and parity of doe

In general, male kids are heavier than female kids. If you know on average the difference in 60-day weights between the male and female kids by breed or breed crosses (from previous research and knowledge), you could add that difference to each female kid in a particular group and rank them as a whole group adjusted to a male base. That will take care of the sex differences only, but to handle the type of birth and parity of doe is more complicated. Some researchers or breed associations who have access to sufficient data on breeding and kid performance can do statistical analyses to obtain the factors to make the necessary adjustments for sex, type of birth (single, twins, triplets, etc.), and doe's parity from one to four. If that information is available, each individual 60-day weight of kids can be adjusted with appropriate factors to ensure equitable comparisons.

Finally, it's a common practice and more appropriate to compare individual animals relative to the average of all animals within a contemporary group. For example, for weaning weight, relative to the average of all kids weaning weight in a particular kid crop (born around same time and reared together), how did a particular individual kid perform? It is a ratio for a particular trait, thus the 60-day weaning weight ratio is calculated as follows:

$$\text{60-Day Weaning Weight Ratio} = \frac{\text{Individual's 60-day weight}}{\text{Average 60-day weight of all kids in group}} \times 100$$

Here the average ratio is set to a standard value of 100 as such all those individuals with a value above 100 will be considered as if they are above average and the rest are average or below average depending on their individual values. The above ratio allows you to rank individuals in a group to quickly visualize individual merit to make your selection decision.