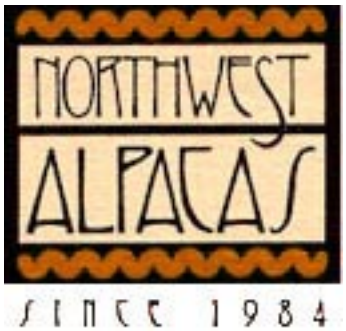

Pure Blood - Part II

By Mike Safley

It is every breeder's dream to select and breed beautiful, productive alpacas. If you closed your eyes and pictured your pastures populated with perfect alpacas, what would they look like? Everyone's vision will be a little different. Some would see suris, others huacayas. Colors would change and size might vary. If you walked out into this mythic pasture of your mind, your ideal animals' fleece might vary a bit from your neighbor's, but I am sure you could conjure up just how you would like it to look and feel.

These alpacas that you have in your mind's eye need not remain pure fantasy. Anyone with the passion for breeding alpacas can learn to breed their ideal. It will take time because alpacas don't have litters and it will take patience because the rules of inheritance depend a little on mathematical chance. But if you are willing to understand the basics of genetics and how to make selection work for you, the alpacas of your dreams can end up in the pasture behind your home.

PURE BLOOD OR PURE MONEY

The terms pure blood and pure bred are often used, but little understood terms in the alpaca industry. Webster's Collegiate dictionary defines pure as:

> "unmixed with any other matter; of pure blood and unmixed ancestry; homozygous in, and breeding true for one or more characters"

Animal breeders have always varied in their definition of the term pure blood. Back in 1881, one of the most successful pioneers of the Australian merino industry, John Hughes, had this to say about his competitor, William Macarthur, whose family was credited as being the original developer of the fine wool merino breed in Australia:

> "When I owned Bundaleer I went to Sydney, and saw some of the most valued Merino rams. I visited Camden, where Mr. William Macarthur showed me the fleeces of their best pure-bred wool, which they were then about to send to the Exhibition in Paris. He frankly gave me every information as to weight of fleece and price last realized per pound. I asked why he bred such sheep when mine in similar climate and country yielded me, as I showed him, nearly doubly the money per fleece. He told me with an air of pride that they bred the pure blood. I replied that in South Australia we bred for the pure money, which he characterized as a Yankee way of looking at it."

The Peppin merino, which Hughes championed, eventually became the most productive sheep in the world. The point being that in a sense, pure blood or pure bred is in the eye of the beholder. People have different opinions about what's pure and what's not. One breeder may be satisfied to create a "pure bred" animal that is individually outstanding, an alpaca which will do well in the show ring. Another breeder's aim may be to create uniform alpacas that have high breeding value who pass on their superior traits to their offspring. This is a different ideal and requires creating an animal whose blood is pure or genetically homozygous for certain positive characteristics that the breeder deems desirable.

For the purposes of these articles, we will be discussing pure blood within the context of creating genetically superior alpacas that will breed true for such quantifiable characteristics as fleece weight, body size, fineness, conformation, and fleece characters such as luster, crimp, lock, and staple length. As

breeders we need to answer questions such as: How do we identify prepotent studs? Which traits are heritable and repeatable? Will your offspring exhibit a high degree of variability or will they breed true and uniform? How do we select for a particular type of alpaca? Is progeny testing an answer? How can we avoid genetic defects?

MEASUREMENT

Record keeping is a must in every breeding program. If a breeder is not weighing fleeces on an annual basis, taking samples for histograms, and measuring staple length, any improvement is, in large part, by chance. Don Julio Barreda cautions against using your eye as a microscope and your arm as a scale. Without measurement, we are simply choosing animals like a show judge does, according to what pleases the eye. Without measurement, trying to improve a herd is like trying to steer a rudderless ship. Success is often found in the details.

PREPOTENCY

The search for superior stock is a common goal among breeders. Every livestock industry has their legendary sires. Everyone is looking for the perfect male. Too often in the alpaca business this means the best looking stud with the lowest micron count as reflected on a histogram. What breeders should be looking for is a prepotent or dominant male with the ability to transmit his excellence to the next generation. This means identifying a male who has homozygous genes for as many of the heritable traits under selection as possible and then using him as often as possible.

HERITABILITY

Most everyone has heard of heritability. In the broadest sense, heritability is defined as a measure of the strength of the relationship between performance or phenotypic values and genotypic values for a trait in a population. Breeders often assume that if an xtrait is genetically determined that it is heritable. That is not always the case. The concept of heritability involves identifying the difference in performance, for a specific trait, that can be transmitted to offspring.

For instance, an alpaca always has four legs. There is never any difference for the number of legs. Therefore, heritability for leg count is zero. Fleece weight, on the other hand, varies from alpaca to alpaca and the difference in this weight or performance is heritable, probably highly heritable. High heritability indicates there is a strong correlation between phenotypic values and breeding values in a population.

Heritability relates to certain traits in a population, such as crimp in huacayas or luster in suris. Other examples of heritability in populations include speed in race horses, egg production in chickens, milk production in cows, and litter size in pigs. In alpacas most, if not all, fleece characteristics are thought to be moderately to highly heritable. Heritability in a population should not be confused with the breeding value of a particular animal.

Typical heritability estimates for a number of traits and species are listed in Figure 1. As a rule, traits with heritabilities below .2 are considered lowly heritable, traits with heritabilities between .2 and .4 are considered moderately heritable, and traits with heritabilities above .4 are considered highly heritable.

Figure 1: Typical Heritability Estimates for a Number of Traits and Species

Species	Trait	Heritability
Cattle (beef)	Calving interval	.05
	Birth weight	.40
	Weaning weight	.30
	Yearling weight	.40
	Mature weight	.65
	Feed conversion	.40
	Scrotal circumference	.50
	Backfat thickness	.40
Cattle (dairy)	Calving interval	.10
	Milk yield	.25
	% fat	.55
	% protein	.20
	Teat placement	.30
	Rear leg set	.15
	Stature	.50
Horses	Wither height	.40
	Cannon bone circumference	.45
	Temperament	.25
	Walking speed	.40
	Time to trot one mile	.45
	Time to run one mile	.35
	Pulling power	.25
	Cutting ability	.12
Sheep	Number born	.15
	Birth weight	.30
	60-day weaning weight	.20
	Yearling weight	.40
	Loin eye area	.45
	Grease fleece weight	.40
	Fiber diameter	.40
	Fleece grade	.35
	Staple length	.50

If you study Figure 1, you will see that traits related to fertility and survivability tend to be lowly heritable. "Production traits," like fleece weight and fineness, tend to be moderately to highly heritable. The most highly heritable traits are typically traits that are related to structural size and mature body weight.

THE HERITABILITY OF PHENOTYPE AMONG RELATIVES

If a particular trait is highly heritable, all the relatives of animals exhibiting the trait tend to look alike. You have all seen this phenomenon in families of people as well as alpacas. Why? Relatives share the same genes. Close relatives -- full siblings, half siblings, parents and their progeny -- share a large portion of their parents' genes, fifty percent, twenty-five percent, and fifty percent respectively. When relatives share genes, they also share the effect of the genes. This creates a higher degree of uniformity.

Among relatives, the tendency to look alike actually has less to do with heritability and more to do with pedigree. Breeding value is increased when like or homozygous genes are concentrated in the animals under selection. Conversely, you can expect less uniformity among distant relatives.

BREEDING VALUE

Elite herds are built through the selection and retention of superior producing parents who transmit their qualities genotypically. This is breeding value, as opposed to phenotypic or aesthetic value. Remember, a castrated male can possess a perfect phenotype, but it can't reproduce. Selecting and retaining animals for your breeding program that transmits their qualities to their offspring is the essence of creating a productive breeding herd of elite alpacas.

Breeding value is defined as 1) the value of an individual as a genetic parent, and 2) the part of an animal's genotypic value that is due to independent and, therefore, transmittable gene effects. An alpaca has high breeding value when it breeds true or produces offspring which resemble itself.

REPEATABILITY

Repeatability is a measure of the consistency or reliability of the relationship between repeated records which measure phenotypic values of a trait in a population.

Repeatability can be determined for any trait in which individuals commonly have more than one performance record. The examples in Figure 2 illustrate repeatable traits, which include milk yield in dairy animals, racing performance in horses, litter size in swine, and fleece weight in sheep.

Figure 2: Typical Repeatability Estimates for a Number of Traits and Species

Species	Trait	Repeatability
Cattle (beef)	Calving date (trait of dam)	.35
	Birth weight (trait of dam)	.20
	Weaning weight (trait of dam)	.40
	Body measurements	.80
Cattle (dairy)	Services per conception	.15
	Calving interval	.15
	Milk yield	.50
	% fat	.60
	Udder support	.50
	Teat placement	.55
	Rear leg set .30	
	Stature	.75
Horses	1/4-mile time	.32
	1-mile time (flat races)	.57
	1-mile time (trotters)	.39
	1-mile time (pacers)	.45
	Cutting score	.22
Sheep	Number born	.15
	Birth weight (trait of the dam)	.35
	60-day weaning weight (dam trait)	.25
	Grease fleece weight	.40
	Fleece grade (fineness)	.60
	Staple length	.60

Like heritability, repeatability is a population measure, or a characteristic of a trait in a population. It is not a value to be associated with an individual animal. Geneticists refer to the repeatability of racing performance in horses, but it is an incorrect use of the term to refer to a particular horse's repeatability for racing performance.

Like heritability, repeatability is not fixed. It varies from population to population and from environment to environment. A number of factors will contribute to variation in most production characters throughout the life of an alpaca. Factors such as age, season, and pregnancy can all affect measurements of a trait like fleece weight from year to year. In selecting alpacas, we often choose animals based on their superiority early in life, and hope that they retain that superiority throughout their life.
The extent to which this early-life superiority can be maintained is termed the repeatability of the character. There have been few, if any, repeatability studies done for alpacas. Research has established the repeatability of many key aspects of sheep production, a summary of these is seen in Figure 3. A repeatability of 1.0 indicates perfect agreement between the rankings of young animals on that character and the rankings of those same animals in later life. A repeatability of 0 indicates no relationship.

Figure 3 Estimates of repeatability for production characteristics in sheep

	Age of first assessment	**Age of first assessment**
Characteristics	weaning	later ages
Greasy fleece weight	0.4 – 05	0.5 - 0.8
Clean yield	0.4 - 0.5	0.5 - 0.8
Body weight	0.3 - 0.8	0.5 - 0.8
Fiber diameter	0.2 - 0.5	0.5 - 0.8

Figure 3 indicates that repeatability tends to be lower when animals are assessed for superiority as weaners (3 to 6 months of age). This is due to the influence of environmental effects on the animals at this age. High repeatability does not mean that an animal will have exactly the same level of a character every year. It means that an animal will tend to consistently rank the same, relative to other animals within its age group, even though the average value of the characters changes.

The measurement of an alpaca's fleece at the second shearing, for both fineness and density, is thought to be the most repeatable. Histograms, for fineness, from samples of six month old crias' fleece are not nearly as reliable as those taken at two years of age.

VARIABILITY

Based on the general rules of Mendelian inheritance, all discreet populations of alpacas, if mated randomly, will eventually breed to the mean of their genetic merit. On average, the herd will resemble the average of their ancestors.

Consider for a moment the most beautiful alpaca stud imaginable. His qualities are extreme in every regard, his fleece has high luster, low micron, abundant crimp, and weighs 20 pounds after one year. He will win in the show ring every time. But for breeding purposes his phenotype will be of little value if his genes were passed on from below average parents whose genes were inherited from ancestors that included llamas. This macho may simply be the product of a lucky mathematical combination, rather than the solid expression of high quality, high frequency homozygous traits transmitted from genotypically similar parents. The offspring of this beautiful stud would probably, on average, be ordinary or worse.

On the other hand, consider a rather ordinary stud, a bit small, not very dense, his fleece may be fine, but his legs are crooked. If you didn't know that his parents were the superior offspring of superior parents that his dam had died when he was one month old, and that his owner didn't bottle feed him, fearing the creation of a berserk male, it would never occur to you that he might be a superior breeding stud. The difference between the potential breeding values of these two males is simply the relative variability of their ancestors.

Variability creates the opportunity, when combined with genetic selection, to create rapid change for certain heritable characters. Understanding breeding value, heritability, and variability will provide breeders with the opportunity of selecting breeding stock based on genotype, rather than phenotype. These factors, when combined with selection, are the first step to creating blood which is pure in the sense that it has a high proportion of homozygous genes.

THE CONCEPT OF SELECTION

Selection is the process of breeders exercising their control over which alpacas will become parents, how many offspring they will produce, and how long a given animal will remain in the breeding program. When under the control of humans, this process is artificial or arbitrary, as opposed to the control exercised by Mother Nature, who selects by survival of the fittest.

There are three ways to select animals. The most common method is based on phenotypic selection or how the animal looks. The second option is for selection to be based on pedigree or an analysis of an alpaca's ancestors.

The final option is to progeny test or select based on the dam or sire's production. Often, elements of each of these methods are combined when breeders are making mating decisions.

The aim of selection is to make the next generation of alpacas better than their parents. This is not as simple as it may sound. Breeders must be careful to select for traits that can be measured and gains recognized. Phenotypic traits are heavily influenced by the environment and may not always be heritable or repeatable. For selection to be ultimately effective it must be based on an alpaca's breeding value or ability to transmit superior characters genetically.

CULLING

Culling is the other side of the selection coin. Animals not selected as parents for a particular herd are, in essence, culled. New alpaca breeders "cull" by rejecting animals they are looking at with the intent of purchasing. In South America, culling results in the selection of alpacas meant to be "sacare" or meat to be sold and eaten.

Currently, in North America, existing breeders cull by gelding unworthy males and by selling females rather than adding them to their breeding programs. That is not to say that every female sold is a cull and remember the buyer selected the female, rather than "culling" or rejecting her. Some breeders sell all or almost all of their female production, which means that the purchaser, not the seller, is making all of the individual culling decisions. Ultimately breeders differ in their objectives and choose alpacas for different reasons. This difference of opinion creates variety and is the best way for our industry to experience improvement.

Most alpaca breeders consider whether they keep or sell their offspring, but few determine whether to keep or sell the parents of inferior stock. An adult female who produces marginal progeny should be every bit as much a culling candidate as the cria itself. The same goes for a stud male.

THE MYTH OF PHENOTYPIC SELECTION

Selection which is based solely on the evaluation of an alpaca's phenotype is the least reliable. Consider what Dr. A.L. Hagedorn had to say over fifty years ago in his classic book Animal Breeding: "It is very clear nowadays that personal merit, individual quality, is no guarantee of breeding value. The experienced breeders, aided by the geneticists, are gradually substituting methods of evaluating the genotype of each animal, its inherited make-up, for the old methods of trying to guess that breeding value from its other qualities."

Most breeders assume that breeding superior animals is the process of mating the best to the best. They believe that the superior characteristics will automatically transfer to the offspring. It may come as a shock to some, but this is generally not true. If it was true, we could turn thoroughbred horses into Shetland ponies just by selecting the smallest stallions and mating them to the smallest mares.

The main reason that straight phenotypic selection is unreliable is simple -- the environment. An alpaca's phenotype is at least fifty percent environment. An undernourished cria may be a runt, but that has nothing to do with his genes. The same alpaca on a higher protein diet will be bigger, coarser, and cut more fleece, but each are equal as breeding stock.

Most breeders underestimate the role of the environment in an alpaca's phenotype. This is particularly true when evaluating fleece histograms which many breeders seem to believe are the quantative evaluation of an alpaca's fiber genotype. There is a difference between genotype and phenotype as a basis for selection. The height of the black part of each column (which represents an individual) represents the part played by the inherited make-up in the development of the character appreciated. The cross-hatched part shows the part played by environmental (non-inherited) factors. The total height of each column shows the quality. Twelve individuals are arranged according to their genotype.

When we select the four individuals that show the character (phenotype) in the most perfect way, we select according to the line A-B, and the individuals selected are Numbers 2, 4, 6, and 9. When we select according to the best genotype, for instance by means of a progeny test, we select according to the line C-D, and we actually get the four individuals most valuable for breeding the next generation (9, 10, 11, 12)

When we select first according to appearance, this group (2, 4, 6, 9) only contains one of the really good breeders. It is safer to select according to genotype from the very beginning.

Most breeds of animals are relatively stable. That is why they are considered pure bred. They breed true. Straight selection based on phenotype will do little to change the average of a breed in any dramatic fashion. Substantial change depends on breeding animals with significant genetic variation from the mean or average of the herd. Cross breeding uses variation in this manner to create new breeds. The corridale sheep, for instance, was created by breeding a Merino with a Lincoln.

Selection can only be effective if it identifies as parents, alpacas with a group of genes that are different than the general run of genes found in the breed as a whole. In other words, genetic variation is the most significant basis for improvement.

SELECTION SYSTEMS

Selection of animals for breeding can take many forms. They all share the common goal of improving the breed. Selection methods differ, and this is where the skill of the breeder is challenged. Most breeders have a fair idea of the meaning of selection, but have only a vague notion of the kinds of selection which can be employed.

The best results are obtained when it is possible to select for a single easily recognized character, such as density. This approach produces the nice upward curves, found in genetic textbooks. Remember the more traits under selection at any given time, the less progress you can expect for any one trait. There are several problems with single trait selection. The first is numbers. To obtain the maximum progress, large numbers of each generation's progeny must be examined with only a few being ultimately selected, say thirty percent. This is often impractical for a slow breeding animal like the alpaca.

The second problem is more fundamental. Breeders are rarely, if ever, in a position where they can concentrate solely on one character. Many characters have to be considered together if all-round excellence is to be achieved. You can not afford to ignore fleece weight in pursuit of fineness, or size and conformation, in pursuit of vigor and fertility.

An alternate long term plan to single trait selection might be to select first for one trait and then, later, another. This is called the "tandem" method. Unfortunately, this approach also has failings. For instance, considerable time is required to obtain results, even when only selecting for a few characters. It is often difficult to maintain the excellence of the early characters while selecting for the later characters. Deterioration of the first trait usually sets in when subsequently improving the second.

Whatever the selection method employed, the breeder must have, from the beginning, a clearly defined goal or breed standard in mind so that selection can continue generation after generation. It is fatal to chop and change between generations. That does not mean that a breeder should bravely follow a bad plan. Part of the skill of animal breeding is to know when to change. I will discuss breed standards and selection goals more fully in Part IV of this series of articles.

INDEPENDENT SELECTION LEVELS

Another method of selection, also based on phenotype, is to retain only those individuals which meet certain standards for a number of distinct characters. This method involves setting independent culling levels. It allows many characters, such as density, size, fineness, fleece character, and conformation, to be considered simultaneously. It is also easy to apply once an objective grading scale is created. The culling level for any individual character might be high or low. If an alpaca fails to meet the standard for any independently evaluated character, it is culled. One problem with this approach is that if selection levels are set too high, too many offspring will be rejected to form the next generation. The same problem occurs if a large number of characters are considered simultaneously.

One advantage of using individual culling levels is that it compels the breeder to focus on the various characters which contribute towards the ideal alpaca. He must also observe how these traits vary from animal to animal. But there is a better way.

THE SELECTION INDEX

The most effective method of phenotypic selection involves creating an index which is used to score the individual alpacas. This approach is a little more complicated to operate than a system with independent culling levels. The first step is to decide which characters should be scored. Next, each character must be "weighted" or assigned certain amount of points to be included in the total. Once this is done a total score for the ideal alpaca can be created.

One of the advantages of the total score or index method is that there is no limit to the number of different characters which can be scored. In fact, it is advisable to include as many as possible, because a relatively minor character may later turn out to be important.

I created a score card from the one I originally authored for the Alpaca Registry. That form has been amended over time, but was used very successfully in the ARI import screening program. I've made further changes in the form to adopt it for my own breeding program. As you can see, I place a high value on fleece qualities. They make up seventy percent of the score. This form can be adopted for use in your breeding program.

There are many ways to influence the overall score. You can weigh the various factors differently and put more emphasis on such traits as fineness or size. You can add your own criteria, such as color, which could even achieve additional points if the ancestors were also of the desired color. You could also add a section of negative traits, such as eye color, lack of coverage, or poor bite. Please note that in my system an alpaca can never score more than one hundred points or lose more points than are allotted for a particular trait.

This form assumes that the alpacas being considered for selection are free of genetic defects. No animals should be selected that lack vigor or exhibit a llama-like characteristic, such as large banana shaped ears.

All the traits shown on the form are considered to be heritable in alpacas, although the truth is there have been no heritability studies in alpacas. But characters, such as crimp, fineness, luster, density, uniformity, conformation, and size are all heritable in other species. My experience, based on observation, is that these characters are certainly heritable for alpacas. Crimp, for instance, is highly heritable among the alpacas in the Northwest Alpacas' breeding program.

SELECTION BY PEDIGREE

A pedigree which details an alpaca's ancestors is a helpful selection aide, but only to a limited extent. With a pedigree we may be able to research the phenotypic characteristics of the dam and sire and, if the information is available, the grand dam and grand sire. This alone does not allow us to assess the breeding value of a given alpaca.

Pedigrees for particular offspring also have a limited value in the selection process. They don't reveal any information about the siblings of a particular animal. The dam and sire's production are not noted. Estimates of breeding value based solely on pedigree are not very accurate. Pedigrees can be helpful in identifying family members from families known to have high breeding values for certain traits. But the truth of the matter is that the only accurate way to determine the breeding value or dominance of a particular parent is to research the progeny.

SELECTION AND PROGENY TESTING

How can we effectively marry the selection index, which is based on phenotype, with the concept of selecting alpacas based on their breeding value? There is only one sure fire way -- progeny testing. This means that a stud's offspring must be measured for important traits, such as fleece weight and density -- which means not evaluating just his outstanding cria. Either all of the offspring, or a random sample large enough to ensure accuracy, must be measured. This testing, to be accurate, must be done in an environmentally neutral manner.

There are two approaches to progeny testing. The first method is to test the males progeny as described above. The second method involves using the dam's statistics to create an index that measures how much a sire improves the cria over the dam. This process is far more complex. Analyzing just the male's progeny is easier and testing all the offspring, or a representative random sample, of a particular male creates a high degree of selection accuracy for breeding values.

SUCCESSFUL PROGENY TESTING

Many livestock industries have successfully adopted progeny tests. Dairy cows are bred by prospective bulls and their daughters are milked to determine volume and fat content before the bull is put into general service. Boar pigs are bred to a limited number of sows to determine their influence on litter size, survivability, and weaning weight before they are used further. The same system is employed in poultry breeding operations.

Why is progeny testing not more widely used in the alpaca breeding business? I believe the show ring often gets in the way. At shows, animals are judged strictly based on their phenotype and how well they are presented. The animals in the ring have often received special attention, preparation, the best nutrition, and husbandry. Alpaca purchasers and breeders are often guilty of putting way too much emphasis on show points and awards when making breeding decisions. The show ring is primarily a promotional vehicle and should not be viewed as a substitute for sound selection based on genetic principles.

To succeed, progeny testing must be applied rigorously. It is of little value if a breeder measures only the best cria or only cria from his best dams. Alpaca shows have a class called 'get-of-sire' where three offspring are shown together, hopefully representing the male's production capacity. As a breeder looking to purchase a replacement male, would you rather base your buying decision on the three offspring that the exhibitor brought to the show or a survey of the cria from the stud's entire production?

Don't misunderstand, I love to show my alpacas and I believe shows are a critical part of our industry's success. There is no other class that I would rather win than Get-of-Sire! Halter class shows have historically played an important promotional role in many livestock breeds. Anyone who has been to their local county fair understands that Americans love to show their animals. But shows should not be the basis for selection in an alpaca breeding program.

Another essential ingredient for effective progeny testing is an accurate registry. The alpaca industry is fortunate to have an elite registry, the Alpaca Registry, Inc. (ARI). It is possible, even easy, to accurately determine the number of a particular stud's offspring. From these records one can research ownership and inquire about the offsprings' qualities. This can be done by computer by simply accessing the ARI web site at www.alpacaregistry.net.

Large operations should keep their records by stud and make them available to prospective purchasers. At Northwest Alpacas we analyze each of our male's statistics and make breeding decisions accordingly.

In practice, breeding a prospective male to ten or twenty females and then waiting for the offspring to mature is crucial. These progeny can then be assessed before using the male across a large number of females. If this method is employed using several males, a breeder avoids using males with low breeding values across his entire herd. The males that are finally chosen and most frequently used will have higher breeding values. So will their offspring over time.

Progeny testing is not just a strategy for large breeders. Small breeders can use the concept to choose service sires for outside breeding. Purchasers can use it to select foundation breeding stock. If employed industry wide, the rate of genetic gain would accelerate dramatically.

WARNING BLOOD

Everyone in the alpaca business wants to avoid genetic defects. Many birth defects arise from environmental factors, but others are the result of bad or lethal genes. Defects, such as holes in the heart, choanal atresia, and atresia ani, are all deadly. It would be best for the breed if none of these genes were passed on to progeny.

Many lethal defects are thought to be double recessive genes found at a single location on the DNA map. In other words, a cria would have to be homozygous for lethal genes to die. Another theory of genetic defect holds that lethals are polygenic and that a larger number of genes combine to influence or create the defect. This could mean that a cria could inherit 95% of the lethal genes from one parent and 5% from the other. Once there is a critical mass of genes present, the lethal defect engages and the cria dies.

The problem with identifying these lethal genes is that many animals are heterozygous for them or, in the case of polygenic traits are below the threshold levels for expressing them and do not manifest the defect. In other words, they are carriers. There are no blood tests for genetic defects in alpacas.

A sure fire way to identify warning blood and eliminate lethal recessives is to test mate. Livestock industries, such as the dairy industry, use this approach to certify that a bull is not a heterozygous carrier of genetic defect.

One of the most effective test mating methods involves breeding the sire to his daughters several times. Geneticists' opinions vary on the number of breedings required before a male can be considered free of defects. Eleven is thought to be the average number required. Eleven matings should ensure that a male is ninety-eight percent free of defects. Any matings beyond that push certainty toward one-hundred percent.

The incidence of even one such defect from a father-daughter test mating is a strong indication that the sire is a carrier. The good thing about this approach is that it tests for all lethal genes simultaneously.

This may seem like an aggressive remedy, but it is far preferable to having a carrier male spreading defective genes throughout a population. The masking effect of heterozygosity is compounded when entirely unrelated animals are bred. Defects do not often manifest until they become frequent throughout the population.

BREEDING AS AN ART

Animal breeding is not all science. Most major breeds were created before Mendel ever thought of breeding his sweet peas. Think of the individual breeder as a painter whose uses genes as pigment and germ cells as oil. The breeders-artists use genetics as their pallet from which they paint animals according to their personal vision.

The score card was composed to help me create an alpaca with a certain form and function. For instance, I allocated five points to wool cap and leg coverage because I think they create a pleasing appearance and also correlate to density. Head and ear shape are important because they allow me to guard against huarizos and I allocated 5 points for these traits. I put heavy emphasis on fineness and density, giving a total of forty points out of one-hundred for these two characteristics. I also think luster is an important quality for both huacaya and suri and I have allocated points accordingly.

You will also notice that I have put less emphasis on conformation. This is because I have been able to achieve consistently well structured animals and am now able to focus on fleece. The point is that you need to adjust your own selection index to reflect what's possible in your herd. If conformation is a problem, you should place greater emphasis on this trait. In general, I think it is wise to put emphasis on "cash value" characteristics, such as fineness in huacayas and luster in suris. We will discuss the concept of cash value characteristics in a later article.

Each breeder needs to firmly establish his vision of an ideal alpaca. Then by crafting your selection priorities in that image, you will begin to take control of the creative process. The alpacas that flow from this approach will be pleasing to your eye and produce in the manner you deem appropriate. This is the art of animal breeding.

FOLLOWING THE GENETICISTS' ADVICE

The alpaca industry is in a unique position to take the advice of geneticists. There are currently no traditional breeding systems established. Most breeders come to alpacas from other fields of endeavor. There is no vested interest in ignoring science and practicing genetically unsound methods.

If alpaca breeders pursue the identification of an alpaca's breeding value rather than merely assessing phenotype, they will make rapid gain for specific characteristics. Selection should be environmentally neutral and breeders need to focus on cash value traits, such as fleece, weight, fineness, character, and staple length. Vigor, conformation, and fertility should not be ignored. The next article will focus on specific breeding systems, which can be combined with selection to accomplish the goal of creating elite alpacas. We will look at linebreeding, outcrossing, and like-to-like breeding.