EPDs: The Path to Alpaca Excellence

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At first blush, animal breeding seems relatively simple. If you believe *'like begets like'* all you need to do is mate similar animals. If you want a further edge up - study pedigree. If that is not good enough, you can measure phenotype making sure only the best are included in your breeding plan. The problem is none of these strategies is particularly effective, and many of the beliefs that breeders rely on are black magic. Myth makes the animal improvement equation more complex than it need be. Before we can get on to steady measurable improvement, we must sweep a few myths out of the closet.

One of the more pervasive myths in the alpaca industry is, *'The best way to select elite breeding stock is by analyzing their phenotype.'* It is closely followed in importance, by the myth that *'pedigree equals breeding value.'* I think is it is fair to say that breeders' faith in pedigree often takes on mythic proportions, but their faith is not born from the science of genetics. But, before I get to that we need to critically analyze the role that phenotype and pedigree play in breed improvement programs.

Phenotype is at least 50% environment, nurture and husbandry. Add that to Mendel's laws of inheritance, which states that dominant genes express themselves and recessive genes hide from view, and you begin to understand why phenotype is a poor guide to breeding value. If we are to breed for elite alpacas, we must have a dependable method of determining which animals will pass on superior traits in predictable fashion. Simply analyzing an alpaca's phenotype as a guide to the animals breeding value is an entirely ineffective improvement strategy. It is a fact that assessing an alpaca's phenotype to determine its breeding value is the least reliable method of selection.

Pedigrees document ancestors beautifully but are only of marginal assistance when being used to identify alpacas that will breed true. The great-grandsire of any given alpaca contributes 1/8th of his genes to the total genetic makeup of the grandson. Selection based on pedigree as the sole selection criteria, assuming a 30% heritability factor, is from 38 to 55% accurate (Understanding Animal Breeding, 2000, Richard Bourdan). This means if you use the pedigree to make breeding decisions you will be right about 50% of the time. When you add the measurement of individual phenotypic traits—records for fleece density, micron count, staple length and so on-- to your analysis the accuracy of selection increases to about 65%. However, if you add the production records of the parent's progeny to the analysis your ability to predict improvement increases to near 100%. There is simply too much that a pedigree does not tell you about an alpaca.

The critical flaw in using pedigree to select and breed alpacas is that the information most useful to the breeder, from a genetic improvement perspective, is not on the pedigree. ARI pedigrees 1) do not record an alpaca's phenotypic performance statistics; 2) do not identify siblings or progeny; and 3) do not identify prepotency or breeding value. Relying on a pedigree as an effective way to select superior breeding stock is based more on myth than fact.

Craig Wheaton-Smith made the following observation about the use of pedigree in his book Breeding Better Cows (1957).

> *"MAKING USE OF PEDIGREE: As things stand the vast majority of our dairy stock are sired by unproven bulls, and quite a few are by bulls proved to be bad (if the proof were fully available) the deficiency of merit being well compensated for by sales technique and management."*
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> *"Bulls, then, sold on their pedigrees and widely used before their merits are known, place considerable obstacles in the way of breeding from only the better half of the population."*

Wheaton-Smith is not the only one to point out the problems associated with using pedigree as a selection tool. The renowned geneticist Dr. A. L. Hagedoorn had this to say about the value of pedigree in the fourth edition of his famous text, Animal Breeding:

> *"The faith in a beautiful pedigree is often astonishing. I remember how the Dutch agricultural press wrote about the 'breeding value' of a bull sold to a Japanese delegation, in terms that made one think this must have been a bull proven by long lists of exceptionally good daughters. It was said to be a pity that such bulls were sold to foreigners. When the article went on to state that the bull was ten months old, one wondered about the faith Orientals still seem to have in ancestry."*

Pedigrees can be helpful in locating relatives of families known to have high breeding values for certain traits, and the higher the heritability factor for the trait being selected for, the more one can rely on the ancestor's presence in the pedigree. 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 their progeny.

PERFORMANCE RECORDS

Before we proceed to a discussion of progeny testing, a word about performance records. The primary reason that an animal breeder keeps performance records is to track the breeding value of a given dam or sire. In the alpaca business, these records are most often used to promote a specific animal's quality. You may have noticed the extensive use of a herdsire's histogram to hype the claim that he is potent and wonderful, simply based on his micron count. An astute observer might also notice that in successive ads, published over a period of time, the micron count never changes. This is physiologically impossible and, aside from being a misuse of the performance record, it should serve to make the point that one can't always believe the claims of a herdsire's potency offered by an owner. The idea of a "proven" stud is often misunderstood. Many people take the term to mean that the stud has simply sired a number of defect-free offspring. When a geneticist or a knowledgeable animal breeder uses the term, they mean that the sire has "proven" that he can consistently pass his positive production traits onto his progeny. In other words, he has a high breeding value.

PROGENY TESTING

To make accurate selection decisions about your herd, you must be able to assess the breeding value of a given alpaca – whether or not it will pass its genotype and phenotypic superiority on to its offspring. To assess a sire's breeding value, you must know how many cria it has and how consistently they express the parent's phenotype. In other words, you must progeny test. A geneticist tells the animal breeder that they must assess the progeny of a given ancestor before deciding if the ancestor is the appropriate sire or dam for a large number of their cria. A progeny test, involves multiple matings of an individual animal with a measured evaluation of its offspring that helps predict that individual's breeding value.

Progeny testing for alpacas involves using a phenotypic evaluation form to evaluate the phenotype of a stud's offspring for such important traits as, fleece weight and fineness. Other heritable traits such as size and bite can also be scored. The records that are gathered on phenotype evaluation forms or from the breeder's production, records become the basis for establishing Expected Progeny Differences (EPDs). EPDs allow the comparison of breeding values between multiple herdsires.

PROGENY TESTING AND HERD IMPROVEMENT

The most important decision any breeder makes is when they select the male that will breed their females. The next most important decision is when they select a replacement male. Once progeny testing is used to evaluate several males, breeders can select the superior animal as

a stud and avoid using the males with low breeding values. The males chosen by progeny tests will have higher breeding values. In this manner, the herd's quality will quickly compound.

Breeders who incorporate the information gleaned from progeny testing into their mating decisions will experience a steep improvement curve within their herd. The myth that '*pedigree equals breeding value,'* or that, *'the best way to select breeding stock is by analyzing their phenotype'* will cease to be a roadblock to improvement. The increased quality, herd wide, will quickly compound and be reflected in fleece weights, fiber fineness and other quantifiable economic and conformation traits. The additional gain made over three to four generations will be dramatic.

There are several factors which inhibit the ability of breeders successful deployment of the factors described above. They include small average herd size, a poor central record-keeping facility, lack of shared records, and lack of access to progeny tested males.

PREREQUISITES FOR IMPROVEMENT

There are four general industry prerequisites for rapid, breed-wide alpaca improvement.

1. Breeding objectives: There needs to be goal of excellence which focuses primarily on heritable, commercial traits;
2. Performance evaluation: There needs to be a central record keeping system established that measures and records performance for specific commercial fleece characteristics. These records form the basis for establishing heritability estimates for specific characteristics and expected progeny differences (EPDs) for specific animals.
3. Breeding systems: There needs to be mating systems established that maximize the rate of genetic gain in a predetermined direction.
4. Pedigree records: Clear, accurate records of ancestors should be recorded and available.

DRAMATIC GENETIC IMPROVEMENT

There are also four basic genetic prerequisites for rapid breed improvement:

1. genetic variability
2. selection intensity
3. selection accuracy
4. generational interval

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Genetic variation is extremely important to the rate of gain. The more variation for a particular trait in a population, the more potential there is for change. If breeders have a wide variety of animals to choose from–such as those with high or low fleece weights–they can select alpacas with high fleece weight and breed for the trait. Improvement in fleece weight will be rapid.

Selection accuracy is important if any improvement or gain is to be made. This means the traits you select for must be heritable. Accuracy assumes that we have the ability to separate superior and inferior animals. If you select for a heritable characteristic, such as fleece weight, you must identify superior stud males who historically have produced offspring with higher than average fleece weights to insure the trait is passed to the offspring. The same goes for fineness, crimp, staple length, etc. The single most effective way to do this is by establishing EPD's.

Selection intensity means being highly selective of progeny produced by the parents you have chosen for foundation stock, and retaining in your herd only the offspring that exhibit a superior expression of the trait under selection. This ensures that breeding values will remain high and that each generation of offspring should improve: The higher the selection intensity, the higher the rate of genetic gain.

Generational interval affects the rate of genetic change simply because the more rapidly one generation replaces the previous one, the faster the potential gain. Mice reproduce more quickly than humans, producing 150 generations in the time it takes humans to produce one. (This makes it much easier to effect change in mice than in humans. And improving people is a problem because there is very little culling undertaken.) Generational interval is determined by the average age of the producing males and females in a given herd. Alpacas have a generation interval of four to six years for females and approximately five years for males, although this interval will vary from herd to herd. The shorter the interval the faster the gain.

To construct an improvement model that allows each of these principles to work efficiently with our current industry organization, there needs to be a large group of alpacas sharing performance records and genetics. Many small breeders with smaller herds will, when acting together, out perform even the largest breeder. The "how" is EPD's.

WHAT ARE EXPECTED PROGENY DIFFERENCES?

An EPD is an estimate of the genetic merit of an animal for a single trait. The EPD is the expected difference between the performance of a specific animal's progeny for a specific trait and the average performance of all progeny for that trait.

CREATING AN EPD DATABASE

Alpaca breeders will need to record performance values for their animals. This information can be posted via a web-based tool. Most of the necessary information would be compiled from a histogram, (Information graph) and then downloaded to the database. The data from alpacas reared under many different management systems is combined into one file.

A computer software program (BLUP: Best Liner Unbiased Prediction) then identifies the genetic linkages between the alpacas. The dataset for the alpacas includes all the data from previous years, for all the relatives, across generations. The EPD calculations include data from related traits, because an animal's performance in any trait gives information on how it will perform in a similar trait (for example, fleece weight and staple length). These calculations produce EPD values on every trait for every alpaca herdsire, dam and cria in the system. And these EPDs are recalculated, annually, after the performance records from each new production cycle is entered into the database. EPDs are not constants; they are estimates of genetic merit that change over time as new information accumulates on an animal and its relatives. Thus each year results in a new set of EPDs for all animals, with progressive increases in the accuracy of the estimates and in the breeders ability to discriminate among prospective breeding animals.

HOW ARE EPDs REPORTED?

An EPD is reported in the normal units for the trait, such as +0.75 pounds (for fleece weights) or -0.4 microns (for fiber diameter). It's important to note that an EPD value is not a ratio or an index. EPDs are expressed as deviations (+ or -) from the average population value, which is considered to be zero. This average of the herd's performance, which is used to establish the baseline (zero) for comparison purposes, might be recalculated periodically, probably every five years. EPDs always have a positive (+) or negative (-) sign in front of them.

The positive and negative symbols don't always mean better or worse--it depends on the particular trait. For example, a fleece weight of +0.75 pounds is good (more fleece than the average of the herd under evaluation) but a Fiber Diameter EPD of -0.3 microns is also good, i.e. finer fiber than the average. These EPDs are used to compare herdsires, for instance, a stud with a fleece weight EPD of +3.0 is good, but a different stud with a fleece weight EPD of +4.0 is better. EPDs may take a little getting used to, but once you get the hang of them, they give the most objective and reliable estimation of genetic value possible.

The calculation of EPDs uses data from many different herds, and this procedure is mathematically valid across herds, so long as none of the herds is genetically isolated from the others. But the feed regimen at all farms must be good enough to permit good performance.

ACROSS-HERD GENETIC EVALUATION

For cooperating breeders, the purpose of large-scale genetic evaluation is not complicated: They simply want to compare the performance of their animals to one another and those in different herds. Why is this important? Suppose an alpaca breeder has what he or she believes is the best stud male in the world. Without a method of comparing this male's performance to that of other males in other herds, the owner can never know the truth of their belief. Across-herd or large-scale genetic evaluation allows the truth of excellence to be proven and then shared. Almost as important as the EPDs of excellent sires is the identification of *underperforming* animals. The value of culling inferior genotypes cannot be overestimated.

Across-herd evaluation provides an honest way to assess an animal's potential, and this creates the opportunity for rapid genetic gain. The process of evaluating individual alpacas through direct comparison with alpacas in different herds enables cooperating breeders to more accurately select from a more genetically diverse, yet increasingly improved, gene pool.

THE VALUE OF EPDS

Richard Bourdon makes the value of large scale evaluation clear. *"Just as it is easier to field quality athletic teams at a big school than at a small school because the big school has more athletes to choose from,"* Bourdon writes, *"so it is easier to find truly outstanding breeding animals in a large population than in a small one."*

When a group of cooperating breeders shares records by using a central database, they create, for themselves, an enormous advantage. They control, for their collective benefit, many times the information of a single breeder. In the animal breeding business, this information is the key to success. When across-herd data is gathered, the accuracy of prediction increases by the sheer volume of the information available. The EPDs for the various sires and bloodlines can be readily and accurately established.

People often ask me how long I believe the alpaca market will last. In view of the fact that alpacas are one of the worlds oldest domesticated livestock I think it is fair to say that there will be a market in alpacas long after you and I are gone. I also believe that so long as breeders see improvement and potential in the breed they will remain passionate about alpacas. I have been raising alpacas for almost twenty-five years and I am more excited about them today than ever before. Shortly before he died, I asked Don Julio Barreda if he had any regrets about spending his entire life raising alpacas, "No, he said, I only wish I had another 50 years to spend with my herd." I hope, at the end of the day, we all look back and feel the same.