Estimate Progeny Differences (EPD) – A Useful Tool for Herd Improvement

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Overview

EPD is a powerful tool based on quantitative genetics used by livestock breeders for decades to aid in sire selection and dam/progeny evaluation. The technology takes measurable, quantitative (and in some cases qualitative) data and applies a set of equations designed to discount the contribution of all inputs to a specific trait except the genetics of the individual animal of interest to predict the outcome "on the average" of matings of that animal to a set of females of similar quality.

EPDs can also be used to help evaluate traits of economic importance such as fiber fineness. Using this technology will help breeders to select sires that help to produce finer fleeced herds. This trait may be evaluated in conjunction with other production traits such as yearling and/or two year old weight as breeding for fineness tends to produce smaller and smaller animals over just a few generations.

An example of a trait for which most livestock industries develop an EPD is birth weight - bigger babies, whether they be crias or calves, increase the chance of birthing difficulties. Most livestock industries consider it important for a sire to contribute to smaller or at least not bigger babies, on average. Birthing difficulties bring significant costs in terms of animal loss, time, and money. Therefore, a consideration along with improvement of economic traits of importance is a neutral to negative impact on birth weight.

How can the typical alpaca breeder take advantage of EPDs?

- Develop goals for your herd
- Collect data and contribute to the ARI EPD program
- Keep careful records - the more accurate the data input the more useful the EPDs values
- Contribute data on all animals - not just the 'best' animals and on both males and females

The Alpaca Registry, Inc. developed its industry-wide EPD program to provide all ARI members with access to this powerful tool which was launched in May 2009. ARI provides a secure environment for all submitted data and can insure the integrity of the data and analysis results. ARI will provide users with easy access to their data and results through each herdcode's user account. ARI utilizes the scientific expertise of academic leader's in the field of livestock quantitative genetics to process member data and generate the EPD results.

EPDs Principles and Practice

EPDs are calculations based on mathematical models that describe the contribution of genetics and the contribution of environment on the expression of specific performance traits. EPDs are generated from data collected on individual animals and their relatives (progeny, parents, siblings, grandparents). EPDs estimate the genetic value of a specific animal for specific traits compared to others of same breed. The expected difference is that between the **average** trait value of a specific animal's progeny and the **average** trait value in the rest of the population. The performance of two specific animals can be compared by subtracting one animal's EPD from the other – this will give the **average** expected difference between the two animal's progeny for that trait. It is important to understand that EPDs do not give an absolute or individual performance prediction! They give average performance differences of progeny as compared to average performance of others in the population.

In the following tables we see some examples of how to 'read' the EPD results. The data shown is from a Beef Sire Summary. We are looking at EPDs from four traits: birth weight (BW), weaning weight (WW), maternal milk (Milk) and yearling weight (YW).

In any EPD report the EPD value is always reported in units of the trait that is being examined. In the example below all EPDs are in units of pounds because they address weight traits. In fiber analysis most of the EPDs will be in units of microns as it is fiber diameter and its derived values that are being examined.

The EPD for sire A for BW is -3.1 pounds which means that on the average Sire A's calves are 3.1 pounds smaller at birth than the average birth weight of the population. Sire B's calves are, on the average, 1.0 pounds heavier than the average of the population. To compare Sire A and B we subtract -3.1 pounds (Sire A) from 1.0 pound (Sire B) to see that Sire A's calves are, on the average, 4.1 pounds smaller at birth than Sire B.

To compare Sire C with Sire A for BW we subtract Sire A's BW EPD (-3.1 pounds) from Sire C's BW EPD (-1.9 pounds) to see that Sire A's calves are, on the average, 1.2 pounds smaller at birth than Sire C.

Now, let's look at Weaning Weight (WW). Again, comparing Sires A and B we see the difference between the two sires is that, on the average, Sire A's calves are 33 pounds heavier at weaning than Sire B. Similarly Sire A's calves are only 8 pounds heavier, on the average, at weaning than Sire C.

You may ask, what is the point of this example? In the cattle industry having calves that are born relatively small (especially if from heifers – or maiden cows) that grown quickly and 'wean heavy' is a good thing if you are selling weanling calves by the pound. The cattle rancher is less likely to have dystocias in his heifers and produce calves that are bigger at weaning and therefore bring him more money at sale.

Alpaca breeders should also be interested in birth weight EPDs as our animals experience the same issues of increased dystocias when the crias are large. Weaning and yearling weights are likely of less interest to alpaca farmers and only weaning weight data is being collected at this time.

Fiber analysis will be of far greater importance in the alpaca industry and EPD results are read in the same way. Animals that have lower (negative) micron mean fiber diameter (MFD) EPDs will be useful in improving the overall fineness of our herds.

Example of Beef Sire Summary				
ID	BW	WW	Milk	YW
A	-3.1 (0.66)	+54 (0.66)	+28 (0.26)	+108 (0.57)
B	+1.0 (0.75)	+21 (0.74)	+19 (0.50)	+54 (0.67)
C	-1.9 (0.94)	+46 (0.94)	+28 (0.80)	+92 (0.85)
Breed Ave	+2.0	+28	+15	+54

Example of Birth Weight					
B	1.0 lb	C	-1.9 lb	Breed Ave.	2.0 lb
A	-3.1 lb	A	-3.1 lb	A	-3.1 lb
Difference	4.1 lb	Difference	1.2 lb	Difference	5.1 lb

Example of Weaning Weight					
A	54 lb	A	54 lb	A	54 lb
B	21lb	C	46lb	Breed Ave.	28 lb
Difference	33 lb	Difference	8 lb	Difference	26 lb

A Little Math

Following the principles of gathering data suitable for use in the mathematical equations developed by Henderson and others is important to establishing the ARI EPD program on sound scientific footing. The mathematics of complex matrix algebra and differential equations are used to estimate the portion of trait performance that can be attributed to the genetic contribution of one or the other parent. The mathematical models are derived from the basic equation:

$$P = G + E$$

P stands for phenotype or performance – these are the quantitative (and in some cases qualitative) measurements or observations that are reported.

G stands for the genetic contribution to the trait – most traits of economic importance in livestock animals are impacted to some degree by the genetics the animal inherits from its parents, but typical heritability is in the range of 10-60%.

E stands for the environmental contribution to the trait – most traits of economic importance in livestock animals are impacted in large measure by the environment. Typically in the range of 40-90% of the variation seen in animals between herds is due to the environment and is much less impacted by breeding selection.

We know from work on sheep as well as some initial work done in Peru and by others here in the US that alpaca fiber traits are sufficiently impacted by Genetics to be quite amenable to selection.

We will leave the math in a "black box" and will discuss some of the concepts we need to follow to collect good data that will give us useful EPDs.

Those concepts include:

- **Connectedness**

The first concept to grasp is that of genetic **connectedness** which simply means that in order for the mathematical models to work to discount the impact of environment on the performance trait we must provide data on animals that are genetically related and measured under different environmental conditions (i.e. in different herds).

Alpacas are well set up as an industry in this respect. Our original import animals have been thoroughly spread across the USA (and to other countries) and genetic material has been widely spread through the use of many herdsires across the country as well as the sale of animals across the country and to other countries. In other words, we have very good genetic connections between ARI registered herds so that the mathematical models can effectively separate the impact of genetics from environment.

The tables below show that herdsires that are used across multiple farms allow those farms to be genetically connected. In the first table we can see that Sire B connects Herds 1 and 2. Herd 3 is not genetically connected to either Herd 1 or 2 because the do not share any common genetics.

The second table shows that now all three herds are connected because Herds 1 and 2 are genetically connected by sharing Sire B and Herds 2 and 3 are genetically connected by sharing Sire C. Even though Herds 1 and 3 do not directly share genetics they are connected genetically by their mutual connectedness with Herd 2. Genetic connectedness allows the mathematics to 'discount' the impact of the environmental factors affecting each herd individually and compare their performance data based only on the impact of the genetics on the trait performance.

Disconnected Herds and Sires				
		Sires		
Herds	A	B	C	D
1	X	X	-	-
2	-	X	-	-
3	-	-	X	X

Connected Herds and Sires				
		Sires		
Herds	A	B	C	D
1	X	X	-	-
2	-	X	X	-
3	-	-	X	X

- **Contemporary Groups**

The second concept of importance is that of **contemporary groups** which are defined as uniformly managed groups of animals of the same breed, age and gender. Because the models will use genetic relationships among animals to tease out the separate influence of genetics and environment the data provided must be uniformly impacted by the environment under which the trait was expressed. In other words, for meaningful data to be collected all of the animals measured must have developed the trait's performance under the same environmental conditions.

This is a little more difficult to manage and something that all breeders need to think about as they collect and report data. To be a good contemporary group animals' need to have been exposed to the same weather conditions, fed the same feed (hay and grain and any other supplements), subjected to similar levels of stress and measured at the same point in time.

Contemporary groups of 20 or more animals having at least 2 herdsires represented as a parent in the group are preferred. The numbers of animals that smaller farms are able to assign to a contemporary group may well be less than 20. This should not discourage smaller farms from participating! The smaller number of animals in a contemporary group may impact the accuracy/prediction error somewhat (see below) but are not too much of an issue.

For example, fiber samples for analysis should be taken from all animals within a contemporary group within a few days of one another so that the portion tested is all affected by the same growing conditions. This is the reason that the mid-side sample location and 2mm snippet base of staple sample will be used to address the trait of fiber fineness. There is a greater chance that a farm can maintain their animals within a contemporary group during at least a couple of weeks prior to shearing. This is crucial to produce fleece samples that will have grown under the same environmental conditions and therefore be a stronger contemporary group. It has been shown in the 1960s (Turner) that the environmental impact on fiber fineness is much greater along the length of the staple than across the animal (base of staple sample).

So, if you have an animal that has been off of your farm for the past 2 months and comes back on the day of shearing it should not be included in that year's contemporary group. Some farms may need to report separate contemporary groups for the fiber analysis. If males, pregnant females, weanling males and females, fiber animals or other groups are treated differently they should be labeled as such when the samples are submitted for analysis.

- **Prediction Error/Accuracy**

EPDs are accompanied by an **accuracy or prediction error** figure. This number (listed as a decimal number between 0 and 1) shows the reliability with which the estimate is made. It shows us the level of confidence that predicted values are near the true genetic value of the animal for the specific trait.

Accuracy/Prediction Error is dependent on the heritability of the trait and the number of records from the individual, relatives and progeny used in the evaluation. Accuracy is dependent on an animal having relatives in different herds, on the contemporary group and its size and on the number of sires represented in each contemporary group. It is important to note that animals with high accuracy EPDs will produce as much variation in offspring as animals with low accuracy EPDs, but the high accuracy EPD is closer to the true breeding value of the animal for the trait.

- **Heritability**

The percentage of variability in a trait due to genetic differences (or additive genetic effects) is defined as the **heritability** of the trait. The proportion of performance due to genetic effects is larger with higher heritability values. Heritability of a specific trait is considered fairly constant, but different traits can have very different heritability. Close relatives affect accuracy more than distant relatives have more genes in common.

The Accuracy of EPDs is dependent on the heritability of the trait in question as well as the amount of data that can be used in the calculations. As can be seen in the table below Accuracy values for mid and high heritability traits (as are most of the fleece traits of interest) are in the moderate to high accuracy range with as few data points as an individual and both parents (for traits with 50% Heritability). More likely scenarios are found with moderate heritability traits (30-50%) when an individual with 5-10 or more half-sibling progeny is being examined. The inclusion of the individual's parents and other close relatives such as the individual's own half or full siblings increases the accuracy further.

From this data we can see that an enormous amount of data is not required to generate usable EPD values that can help inform breeding decisions.

Accuracy Values – different sources of data and heritability levels			
	Heritability		
Source of Data	.10 (low)	.30 (mid)	.50 (high)
2 parents only	.23	.39	.50
Individual	.32	.55	.71
Individual + 2 parents	.38	.67	.76
Individual + 5 full-sibs	.41	.64	.76
Individual + 10 full-sibs	.48	.68	.78
Individual + 10 half-sibs	.34	.57	.72
Individual + 50 half-sibs	.46	.64	.75
Individual + 5 half-sib progeny	.44	.67	.79
Individual + 10 half-sib progeny	.52	.71	.84
Individual + 40 half-sib progeny	.73	.82	.93
Environmental correlation assumed to be 0 Source – Swine Genetics – Fact Sheet #7 – Purdue University Cooperative Extension Service			

Accuracy Values for EPDs	
Low reliability	< 0.65
Medium reliability	0.65 → 0.75
High reliability	>0.75

- **Data Collection**

Accurate performance records are critical to the success of genetic evaluation & selection programs. Remember the old computer saying GIGO – garbage in, garbage out – a truism for the EPD program as well. Consistent and accurate collection of data is important for generating EPDs with good accuracy in the nearer term.

Submitting all data is important as well. Because different environments will impact the traits differently animals might well have better genetic value than appears under some conditions. In order for the industry to quickly produce useable data it is important for you to submit data on all animals that you maintain whether they are herdsires, prize females, young unproven stock or fiber animals. So, collect samples from all your animals and let the calculations sort out the differences!

Realistically, cost is a factor in determining how many animals you may want to submit for fiber analysis and inclusion in the EPD program. Submitting samples that represent a good cross section of your herd is needed – do not submit only the youngest animals at this point in the program. Be sure to include animals that are in the one to 5 year age range. Animals that are less than 9 months of age at time of shearing will not be included in the analysis.

ARI EPD Program Participation

Fiber analysis may be ordered from Yocom-McColl, Inc. The required order form is available on their laboratory website. However, ARI has developed a new form that can be printed and used for sample submission to Yocom-McColl. It is accessible from your User Account. Please do not be stymied from participating by the request to submit fleece weight. If you cannot easily get your fleece weighed just leave that blank.

Fiber analyses that were performed on previous years fleece samples by Yocom-McColl, Inc. may be submitted to the ARI EPD program as well. Please contact Yocom-McColl to request that your historical data be submitted to the ARI EPD program. **ONLY** data that was **originally** labeled with the animal's ARI registration number and sampling date will be accepted in the ARI EPD program.

ARI is collecting data on a set of fleece traits and husbandry traits. All of this data will be submitted directly by the testing laboratory. Birth weight, weaning weight and birthing ease are traits that may be submitted directly to the program through your ARI account page.

Vendor Submitted Data

Mean Fiber Diameter	Standard Deviation	Coefficient of Variation	Spin Fineness
Fibers >30 microns	Comfort Factor	Mean Curvature	Standard Deviation of Curvature
Mean Staple Length	Length Standard Deviation	Length Coefficient of Variation	% Medullated Fibers (white/light fleeces)

Breeder Submitted Data

Birth weight
Weaning weight
Birthing ease
Fleece weight

Other traits will follow and ARI is ready to include:

Suri luster
Skin biopsy data
Conformation

Additional traits, methods, analyses will be added or changed as the program and industry grow and evolve!

The breeder supplied data may be uploaded individually or in batch via Excel spreadsheets from your ARI account. To accurately record birth weight we suggest weighing the cria after it is dry and before it is 12 hours old. Weaning weight should be determined at about 6 months of age. Report both birth and weaning weight in units of pounds and tenths of pounds. The date of birth and weaning will also be reported.

Sheared fleece weight should be reported on the Fiber Analysis form when submitted to the fiber testing laboratory and should be done by weighing the entire fleece that is sheared from the animal. Be consistent in how you collect the parts of the fleece. Weigh all that is collected from each animal. If you cannot easily get your fleece weighed just leave that blank.

Please visit www.alpacaregistry.com or www.AlpacaAcademy.com for further information regarding EPDs, data collection and submission.

In summary, the ARI EPD program follows decades of livestock industry use of quantitative genetics to improve animal production. The use of EPDs was pioneered in the 1950s/60s at Cornell by Henderson and colleagues for use in the dairy industry and was taken up by the beef cattle, swine, poultry, sheep industries and even in plant breeding.

ARI has recently acquired the entire Ideal Alpaca Community EPD program and is in the process of integrating the IAC member's data into the ARI program ensuring a single, robust and industry –wide EPD program for the future of the industry.

The ARI EPD program will be as successful as our members make it. Given the enormous investment that most of you have made in your alpaca breeding stock and fiber herds, it is imperative that you continue to support your investment with wise breeding decisions to meet the goals that YOU set for your herd. EPDs are a tool that will assist you in making good breeding decisions. EPDs are not the only tool that you will need, though. It is still critical to look at conformation, seek information on maternal and studly qualities, as well as consider other aspects of fiber, reproductive, husbandry and show quality values when making breeding decisions.