How EPDs Help You Breed Better Alpacas

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Problem: In order to breed alpacas with better and better fleece traits, we want to choose superior alpacas for our herds. But how do we identify a "superior" alpaca? Genetic superiority cannot be reliably estimated just by measuring an animal's fleece traits or even by pedigree!

- Measurements of an alpaca's fleece do not reliably indicate the quality of its progeny's fleeces. This is because an animal's phenotype (what it looks like) for a given trait, such as its mean fiber diameter, is influenced not only by its genotype (i.e. genes for fiber thickness that it passes on to progeny), but also by effects that aspects of its environment (i.e. diet, stress etc.) may have on its fiber.

  So, looking at an animal in a pasture, or tracking its success in the show ring is not a foolproof method for picking good breeding stock. An animal that wins many ribbons may not have progeny with equally wonderful fleece.

- How about knowing an animal's pedigree? Again, this provides only a rough guide to its possible value as a breeding animal. Only half of a famous alpaca's genes will be passed on to a son or daughter, and a famous grandparent's genes only make up 1/4 of an individual's genotype. Even with prepotent males, prediction of the phenotype of progeny from pedigree information is not perfectly accurate because of the unknown genetic influences from the other relatives.

- **Together, using the phenotype and the pedigree only provide about 60% accuracy in making breeding decisions. That means, 40% of the time, the progeny won't be what you expect if you limit yourself to these tools.**

- To improve accuracy, we need an estimate of each individual's **genetic value** for the key fleece traits, and this cannot be obtained either by measurements of its fleece or by its pedigree.

Solution: A formal statistical estimate of genetic value, that is, its EPD (Expected Progeny Difference) is the best available way to predict whether an animal's progeny are likely to be above or below average for each trait.

- An Expected Progeny Difference (EPD) is the most reliable statistical estimate of the genetic value of a given individual for a particular trait that is currently available. Most major animal breeding programs (i.e., cattle, sheep, pigs) use EPDs to accelerate genetic improvement, and the statistical methods for obtaining these estimates are well worked out. This superior method is being made available for alpaca breeders in the IAC through collaboration with geneticists that have used these methods successfully in the National Sheep Improvement Program (Dr. David Notter and his group at Virginia Tech University).

- DEFINITION: An EPD for a given trait is the difference that is expected between the average trait value of a particular animal's progeny and the average trait value in the rest of the population (all the measured alpacas in the IAC virtual herd). So, an EPD value allows you to determine how much better or worse than average each animal is for every trait.

- An EPD will be generated for each of the 11 fleece traits measured, and each EPD is expressed in the same units as the traits themselves.
  For example, if the alpaca male named SuperStud has an EPD of +1 cm for staple length, it means that his progeny are expected to have an average staple length that is 1 cm LONGER than the average in the population.

- An accuracy for each EPD will also be generated. The accuracy allows you to interpret how much the EPD estimate might change when more measurements are available on the individual or its relatives. This helps when comparing individuals for which more or less information is available (more on this in a later fact sheet about using EPDs to make breeding decisions).

- An EPD for each trait of an individual is calculated from measurements of its fleece AND measurements from as many relatives as possible. Measuring many relatives (who share a known fraction of the individual's genes) essentially cancels out the effects of the environment, leaving a reliable estimate of the genetic merit of an individual for a given trait.

Once we know the genetic values for every alpaca in the IAC herd, each member can make breeding decisions that will produce the best possible offspring in the next generation. This will benefit not only IAC as a community, but also each individual IAC member (see below).

Interpreting Expected Progeny Differences

Animal ID	*EPD, fiber diameter* (microns)	*EPD, # > 30u* (percent)	*EPD, shear weight* (lbs)
Male #1	**- 0.5 micron**	**- 2.0 %**	**+ 0.50 lb.**
Male #2	**- 1.5 micron**	**+ 0.5 %**	**+ 0.01 lb.**
Male #3	**+ 0.8 micron**	**+ 0.1 %**	**- 0.05 lb.**
Male #4	**+ 1.5 micron**	**+ 2.5 %**	**- 1.00 lb.**

Imagine you are considering four possible junior herd sires, noted on the table above as Males 1-4. For each animal, only 3 of the 11 traits that we will have on a real table are shown for simplicity. For each trait, the EPD is indicated in the units of the trait. We will also get an estimated accuracy for each EPD, but I'll address how to use that in a future fact sheet. How do we interpret and use these EPDs?

- The EPDs for **Male #1** show that his progeny can be expected to have fibers that are **0.5 micron finer** than the average in the entire IAC herd. His progeny are also expected to have **2% fewer fibers >30 microns**, and **to shear 0.5 lb more** than the average in the IAC herd.

- **Male #2** looks even better for fiber diameter, with the **expected fiber diameter in his progeny 1.5 microns finer** than the average of the IAC herd. However, his progeny are expected to have slightly **more fibers > 30 microns (0.5 %), and about the average shear wt. (only 0.01 lb greater than average)**.

- So, if you would like to improve all three traits and are happy not making the maximum possible gain in fiber fineness, then Male #1 is a good choice (there are a few complications in selecting on multiple traits, but this is the basic idea if there are no antagonistic relationships among the traits). If, however, you want to breed a female specifically to lower the fiber diameter of the progeny, then Male #2 would be a good choice, because improvement would be made in fiber fineness, but nothing would be lost in the other traits.

- **Male #3 looks very close to the average for each of the traits,** and there is little advantage to choosing him to be a breeding male for your herd, though he may still be better than some of the males used by farms outside the IAC. **Male #4 is worse than average for all three traits**, and he should be eliminated from the breeding program.

- A similar table could be made for females, and this would be used to decide how to make specific matings. However, because males usually have more progeny than females, decisions about which males to have as herdsires have a much bigger impact on the overall genetic improvement than decisions about which females to breed. I will write a future fact sheet on how to use EPDs to make specific decisions about individual breedings).

Benefits of obtaining EPDs for individual IAC breeders

- You will know the genetic merit of each animal in your own herd, and it will be obtained through objective measurements and cutting-edge statistical methods.
- Knowing the EPDs allows you to make the most accurate decisions about what animals to buy and to breed in order to improve your herd to reach your breeding goals.
- You can use the EPDs to decide which animals to keep, which to sell, and which to geld.
- You can scientifically evaluate animals at all IAC farms that choose to publicly post or privately share their EPD results. This will make it possible for you to purchase animals and breedings that will improve your herd much more rapidly than if you were limited to only the animals you own for breeding.
- Above-average EPDs will be a strong selling point, and can be used to justify pricing. The large gains made in one generation in a "breed-up" program will be very evident from the EPDs of the progeny of an average or even below average female bred to a superior male. You can immediately show how rapid improvement can be made in just one generation. This makes even low EPDs valuable to your herd.

NOTE: it is crucial to submit fleece samples from ALL animals in your herd. The knowledge of which animals are underperforming is just as important for making good selection decisions as knowledge of which individuals are outstanding.

The IAC community as a whole will benefit from building a complete and accurate database of EPD values. Using EPDs to make breeding decisions will accelerate the genetic improvement of the IAC virtual herd. Within 5 years, it may be clear that the average IAC animal exceeds the quality of the average individual in the national herd, in which breeding decisions have been made only on the basis of phenotype and pedigree.

Please feel free to email me at svia@umd.edu if you have questions. I will publish additional fact sheets on the IAC web site during the next few months, and I welcome all questions and comments.