A Practical Approach To Our Next Big Breeding Challenge: Managing Fleece Traits Independently

Lynn Edens

Historically, U.S. alpaca breeders working to improve the fleece characteristics of their herds have benefited from the favorable correlations seen in the expression of some of these characteristics. For instance, while we don't yet know if this is because the same genes are involved in the expression of the traits, or because the relevant genes tend to "travel together" when they are inherited (or some of both,) it is broadly true that finer-fleeced animals generally show more micron uniformity than their coarser counterparts, and it has also been historically true that, looking across a broad micron range, finer animals have tended to be more densely fleeced. As a result, breeders seeking to produce animals that were finer, denser, and more uniform than the previous generation could seek to improve all these measures simultaneously. In fact, many sought for their breeding programs animals which would improve all of these characteristics *as much as possible*, to produce the greatest change in a single generation.

Now, however, many breeders have improved their herds to the point that this "everything all at once" strategy will not continue to benefit their herds. In fact, going forward, they will likely seek animals that can improve a single trait without changing the herd's phenotypic profile in other respects – or even seek to move aggregate individual traits within the herd in an opposite direction, on average, than that dictated by their underlying genetic correlations.

Let's look at one example of why breeders will likely want to manage correlated traits more independently going forward, and then consider how they might accomplish this.

Chart 1 at right, which illustrates histogram results for a group of juvenile and yearling animals, helps illustrate one correlation-based challenge breeders are facing. Many animals in this group are demonstrating a highly desirable degree of micron uniformity within their histogram samples, as evidenced by their low SDs. However, most if not all of these animals are also currently carrying fleeces that are too fine to earn top value for their owner. Few processors are willing to process fleeces (or bales of fleece) with AFDs less than 15, and those that will must

Chart 1: Examples of the Increasingly Problematic Link Between Uniformity and Fineness

AFD	SD	CV	%>30u
12.5	2.1	16.6	0.0
12.7	2.5	19.7	0.4
13.5	2.8	20.6	0.3
13.8	2.6	18.5	0.2
13.9	2.9	20.6	0.3
14.2	2.8	19.3	0.4
14.4	2.3	15.7	0.3
14.5	2.6	17.9	0.4
14.5	3.3	22.6	0.7
14.7	2.4	16.2	0.2
14.7	2.7	18.1	0.3
15.1	2.4	15.7	0.4

charge more to do so profitably. Those exceptionally fine fleeces also weigh less than their slightly coarser counterparts, further depressing their value. To improve the value of the fleece harvest in the offspring of these animals, they must be bred to produce animals that maintain that high degree of micron uniformity but carry somewhat coarser fleeces. But how can a breeder accomplish this when fineness and micron uniformity are positively correlated genetically?

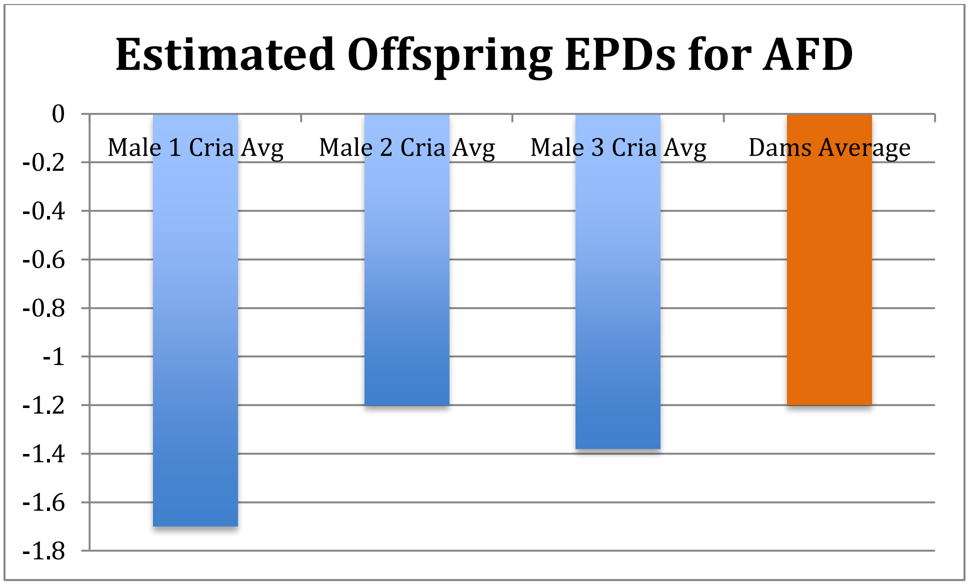
The answer is to actively manage the herd composition and breeding decisions so that in-herd correlations between traits that the breeder no longer wishes to move together are minimized. So, for instance, the breeder who wishes to continue to improve the micron uniformity of a herd without producing increasingly finely-fleeced animals must choose as breeding stock, and breed to produce, animals that are extremely uniform *relative to* their fineness and, more importantly, are prepotent to produce the same. This means identifying relative outliers by looking not at single trait measures but at measures that combine the results for two (or more) traits. And it also means breeding to produce more of these outliers over time, using a strategy of breeding "relative strength to relative strength," also known as positive assortative mating.

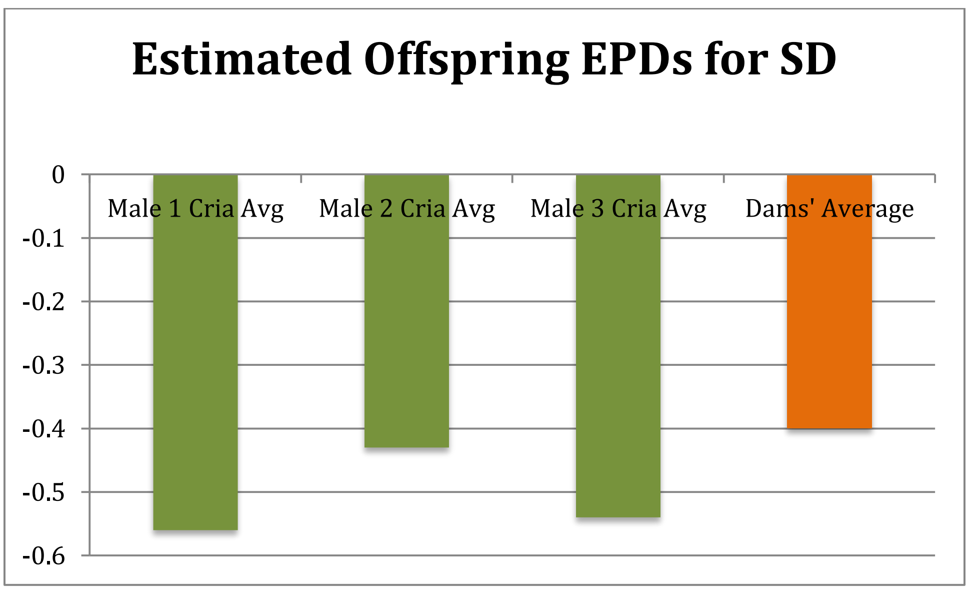
For a number of reasons, EPDs are the best trait measures to use for this type of in-herd analysis and strategic management, and so they have been used in the example below, where we explore an example of breeding towards a goal of improved *uniformity* of micron without an accompanying *reduction* in micron. But the same type of reasoning can be applied to an evaluation of histogram results, or an analysis of the subjective observations of the breeder, with productive results. In other words, this conceptual approach can be used within whatever evaluative framework a breeder currently uses.

Chart 2: Breeding For Micron Uniformity Without Increasing Fineness

	EPD for AFD	**EPD For SD**
Breeding Dams' Average	-1.20	-0.40
Herdsire #1	-2.20	-0.72
Herdsire #2	-1.20	-0.46
Herdsire #3	-1.56	-0.68

Consider a simple "Goldilocks" example, with some hypothetical breeding animals' EPDs for AFD and SD shown in Chart 2 above and the estimated offspring results in Graphs 1 and 2 below. Our example breeder's production females have an average EPD for AFD of -1.20 and an average EPD for SD of -0.40. And our breeder is seeking to improve the micron uniformity of the herd without decreasing its average EPD for AFD, and is evaluating three possible herdsires within the herd with that goal in mind. The first has an exceptional, "Top 1%" EPD for micron uniformity, making him seem like the obvious choice. However, he has a similarly exceptional EPD for AFD, and as the first bar in each chart shows, breeding to this male will result in offspring that are more uniform than their dams on average, but also much finer. Too hot!





The second sire prospect has an EPD for AFD that, at -1.20, is identical to the average for the herd's production females – so breeding to him will not continue to increase the propensity to produce fineness in the herd, and help meet one part of the goal. However, this male's EPD for SD is not significantly better than the females, either, so putting him across the herd will not improve its uniformity. Too cold!

The third sire prospect has an EPD for SD that is significantly better than the average of the production females. And he has an EPD for AFD that is only marginally lower than that of the production females'. Putting this male across the production females should result in offspring that are phenotypically appreciably more uniform but not significantly finer, and that are genotypically likely to produce similar results in their own offspring. As you will have guessed, this is our "Just Right" male for the breeder's strategy. It's worth emphasizing again that he would not have stood out as such based on a decision based on either single trait – he is an outlier in the context of this example in that he is prepotent for producing uniformity *relative to* fineness. Using him will help the breeder counter the genetic correlations that work to move fineness and uniformity closely together.

Of course, few breeders will choose to use a single sire over their entire herd in any given breeding season, and this will constrain the progress made to less than the optimized example shown here. And more broadly, the progression of the entire US herd (or any group of breeding animals) is constrained by the number of outliers, and their degree of outlying-ness, relative to the number and average of animals within the group. As a result, it is important to not just breed for improvement, but also to breed for outliers that can continue or even accelerate the rate of improvement within a group of animals. These outliers are most likely to be produced by positive assortative mating – breeding strength to strength.

In Chart 3, we see the results of such a strategy. In this case, our example breeder has analyzed the larger group of production females and identified the 10% among them that, like our "just right" sire, are best at improving the EPD for SD relative to the EPD for AFD. As implied by the relationships between the two males' EPDs, breeding these females to the "Just Right" male will increase the number of animals that are especially uniform relative to their fineness compared to breeding these females to the "Too Hot" male, which would result in offspring with a similar propensity to produce uniformity of micron in their offspring, but accompany it with the problematic propensity to produce a even greater degree of fineness. In other words, breeding to "Too Hot" does not help this breeder reduce the correlation between uniformity and fineness within the herd, but breeding to "Just Right" does.

Even more importantly perhaps, the strength-to-strength breeding strategy increases the likelihood that the breeder will produce a next generation outlier that is *even better* at improving uniformity relative to fineness. Meanwhile, our breeder can use the common "strength to weakness" breeding strategy, or negative assortative mating, to improve the offspring of the remaining females in his or her herd. This type of combination approach will make sense in many herds and will likely be preferable to most breeders, who must take into account not just other phenotypic traits but also marketability and related business issues when making breeding decisions.

Chart 3: Using a “Just Right” Male to Improve Uniformity Relative to Fineness

	EPD for AFD	EPD for SD
Best Females for Uniformity Relative to Fineness	-1.65	-0.62
“Just Right” Male Offspring Average	-1.61	- 0.65
“Too Hot” Male Offspring Average	-1.93	-0.67

In summary, it’s a worthwhile effort for alpaca breeders to consider which traits they need to improve on average within their herds, and use this type of relative trait analysis to discover how much room they have within their own programs to manage that improvement without creating issues with the results for other, genetically correlated traits. Thoughtful positive assortative breeding strategies will help breeders produce outlier animals that give them latitude to manage genetically correlated fleece traits with some degree of independence. Those who take the lead on this are likely to produce the breeding stock most in demand as the rest of the marketplace catches up.