

Alpaca Builders: Breeding for Genetic Gain

Jack Armstrong

I am often asked by other alpaca breeders, "How do I choose which alpacas to sell, and which to keep as replacements within my herd?" As alpaca breeders we all are striving to improve the overall quality of our herds. At the same time most of us need to sell alpacas in order to provide income to achieve a return on our investment as well as covering our costs of operation. Maybe your herd has reached its desired size, or you have finally reached the point where it is no longer a clear-cut culling process. This is what I call the "oh no situation." As in "Oh no I don't want to sell this one or that one, but I need to sell a few alpacas." The challenge is how to grow and improve your herd, and still sell your quality alpacas. Breeders naturally want to both, sell – and keep -- their best alpacas.

The fact is there is no easy answer, and it becomes much more complicated when economics are involved. I am not going to delve into the economics because everyone has their own unique set of both short term and long term financial goals to consider. I am going to approach the question strictly from a scientific breed improvement point of view. If you are making good mating decisions, and thus producing better alpacas with each generation, then selling your best young alpacas each year is in direct conflict with maximizing the rate of genetic improvement within your herd. This is why you must set realistic goals for both genetic improvement and short- and long-term financial return.

Breeding for Genetic Gain

The purpose of alpaca breeding should be to genetically improve your alpaca herd. Don't we all want to improve the future generations of our alpacas? Genetic gain is defined as the increase in average levels of herd production from one year to the next. For alpaca breeders, production is influenced by several economically important traits. In addition to type or appearance, these include important fleece characteristics such as; fiber diameter and annual shear weight, uniformity, luster or brightness, and the absence of high micron guard hair.

To this task you as the breeder bring two basic tools, selection and mating. Both involve decision making. In selection, you decide which individuals reproduce, how many offspring they produce, and how long they remain in your breeding herd. In mating, you decide which male is bred to which female. The question of which alpacas to sell and which alpacas to retain in your herd is answered with selection.

A livestock breeder measures the effectiveness of his or her selection decisions by the rate of genetic gain within their herd. Ideally, you would like to maximize the rate of genetic gain. The task of selection is not a simple one. Here are a few questions you must consider:

1. Should I save lots of female replacements or only a few?
2. Should I use multiple males or just a few?

3. Should I use well-proven older males or promising young ones?
4. Should I base selection on individual performance, or should I consider information on relatives and progeny?
5. Should I select strictly within my own herd or should I look to other breeding programs for replacements?

These questions aren't always easy to answer. However animal breeding scientists can share with us the general factors that affect the rate of genetic gain, and thus herd improvement. An understanding of these factors can help you answer these questions.

The following concept is so fundamental to genetic herd improvement that animal scientists call it the **key equation**. There are four factors which affect the rate of genetic change. The rate of genetic change is directly proportional to three factors, **accuracy of selection**, **selection intensity**, and **selection differential**. The rate of genetic change is inversely proportional to a fourth factor, **generation interval**. Hang with me this really is pretty straight forward, and I promise I am not going to get into a lot of technical or mathematical jargon. While looking at the equation below keep in mind that the goal is to maximize the rate of genetic gain.

$$\text{Genetic Improvement per year} = \frac{\text{accuracy} \times \text{intensity} \times \text{selection differential}}{\text{average age of production alpacas within herd}}$$

Simply put, you can speed up genetic gain by increasing the accuracy of selecting replacement alpacas, by increasing the selection intensity, by having extreme phenotypes (selection differential) and by shortening the generation interval. When you speed up the rate of genetic gain within your herd you're speeding up the rate of genetic improvement in your herd.

Accuracy of selection

The idea behind selection is simply to let the individuals with the best genes reproduce so that the next generation has, on average, more desirable genes than the current generation. In selection we try to choose those alpacas with the best breeding values. In other words we want to select alpacas that will contribute the best genes to the next generation. A breeder's skill and ability to accurately select alpacas with the best breeding values will significantly impact the rate of genetic gain within his herd. How can a breeder increase his accuracy of selection?

Many alpaca breeders only select based on phenotype or the show record of the individual alpaca. These breeders would increase accuracy of selection by considering not only the merit of the individual, but also phenotype, production records such as histograms, annual shear weights, show records, etc. of close relatives and progeny. Ideally we would have individual estimated breeding values (EBV) to use. EBVs are considered the gold standard in other livestock. Unfortunately for various reasons we do not have estimated breeding values available for alpacas today. Currently there are several astute breeders working to

establish EBVs for their alpacas. Hopefully in the future these will become widely available in our industry.

Selection Intensity

This is how discriminating breeders are in deciding which individual alpacas are selected to reproduce. To select intensely means to choose only the very best individuals. Let's say for example that you want to improve the fineness in your herd. You decide that you are only going to select females that have less than a 20 micron AFD at 1 year of age. Selecting only alpacas that have an AFD of 20 micron or less at 1 year of age may improve the fineness in your herd. However choosing only females that have an AFD of 18 micron or less at 1 year of age will provide greater improvement. This two-micron difference is an example of increasing selection intensity.

If selection criteria (annual shear weights, histograms, show records, estimated breeding values, etc) are reasonably accurate -- if they are reasonable indicators of underlying genetic merit -- then intensely selected parents should be far better than average, genetically speaking. Their offspring should be equally superior, and the rate of genetic gain should be fast.

If selection criteria are not a good indicator of genetic merit for the trait you want to improve, you can still choose what appear to be the best alpacas. You can still select intensely. Unfortunately intense selection in this case will vary (and not be very effective) because accuracy is so poor. In other words when the sum of accuracy and intensity is a small number, the rate of genetic gain will be slow.

Heritability plays a vital role in selection. Some traits are more easily transmitted to the offspring than other traits. The higher the heritability of a trait the more consistently it is passed on to the offspring. Selecting for a trait with low heritability will decrease the rate of improvement. Not only is the heritability different for different traits it also varies from population (herd) to population (herd) and from environment to environment. I will write more about this important concept in a future article.

Selection differential

In a herd with lots of genetic variation, the superior alpacas are far superior to the inferior. In herds with little genetic variation the range is small, the superior alpacas are only marginally better than the inferior. This basically means that if you have a few very good alpacas bred to average alpacas the rate of genetic change will be faster than if the differences in the breeding pairs are minimal. In the context of the selecting which alpacas you are going to keep as replacement alpacas this is an important consideration. Are the daughters you are considering keeping as replacement dams far superior to the rest of your herd? If so, then keeping them will greatly benefit your breeding program. If they are only a little better than the average of your herd then keeping them will not make a significant impact on herd improvement. Additionally if your accuracy of selection is poor and the replacement females you select only appear better, than you could actually be going backwards.

Generation Interval

This is the amount of time needed to replace one generation with the next. The generation interval of an alpaca herd would be defined as the average age of the producing alpacas within the herd, both males and females. The shorter the generation interval in your herd the faster the rate of genetic change will be. Generation interval can be decreased by replacing older females in your herd with younger ones. It can also be decreased by replacing older proven herdsires with promising young ones. To a lesser extent generation interval can be decreased by selecting for early maturing replacements. When you select for early maturing alpacas you may be selecting for better overall fertility as well.

So what does all this mean? Remembering that the purpose of being a livestock breeder is to genetically improve your alpaca herd. Ideally we would like to maximize accuracy of selection, increase selection intensity, have a wide selection differential, and minimize generation interval. Doing so will maximize the rate of genetic change.

However, can we do all these things at the same time? The answer is no, there are tradeoffs that we must deal with. For instance, a decrease in generational interval generally will decrease the accuracy of selection. Consider the prospect of selecting an 18-month old junior herdsire to replace your current 8-year old herdsire. You will decrease your generation interval but your selection accuracy may be decreased as well. Production records of progeny will be available for the old stud but not for the promising young fellow. This does not mean you should not replace your older herdsire with a promising new young one -- it simply means there are tradeoffs to consider.

Dam Selection

If you are confident that you can pick the genetically superior alpacas and you keep many young females to replace your existing foundation dams, you will see faster herd improvement. But if you can't accurately pick the genetically superior female then herd improvement will be slower. In the later case you may be better off selling more and thus keeping fewer of your young females as replacement dams.

With alpacas selection intensity for replacement females is generally fairly limited. Alpaca females only produce one cria per year and only fifty percent of these crias are going to be females. This means we don't have large numbers of females to select from. Additionally alpaca breeders generally need to keep a fairly large proportion of their females because they are still growing their herd or are replacing older or unsound females.

The important thing to remember here is to replace dams with daughters that are truly genetically superior to their dams. A rule of thumb is: If your herdsires are genetically superior to you dams, save many female replacements, and if your herdsires are only marginally better than your dams,

save fewer replacement females and be more selective in your choice.

Herdsire Selection

Relatively few alpaca herdsires are needed because each herdsire can breed multiple dams. Selection intensity can be increased by using only the most promising males as herdsires -- and very few of them. It is therefore possible to be much "choosier" in herdsire selection than dam selection. Your selection intensity should be considerably higher for your herdsires than your dams. The accuracy of selection for herdsires will have a much more dramatic impact on overall herd improvement, than the accuracy of selection for dams. This is because alpaca herdsires generally produce multiple offspring with each generation, as compared with one offspring per dam per generation. All of the great and well known herdsires within the U.S. have undoubtedly produced several sons that are superior to themselves. Replacing your favorite well-proven herdsire with one of these sons will decrease your generation interval, increase your selection differential and result in increasing the rate of genetic gain within your herd. The challenge lies in accurately selecting the truly superior young males, due in part to the fact that only limited production data is available on young males and EBVs are virtually non-existent for alpacas today.

Breeding livestock is part art, and part science. Rather than calling ourselves livestock breeders, perhaps we should consider ourselves livestock *builders*. By applying the science of genetic herd improvement we can build a genetically superior alpaca herd whose estimated breeding values will continue to increase over time.

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