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"Healthy fibre on a healthy body". How to implement Estimated Breeding Values and what does it mean to the average alpaca breeder. A German perspective.

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EBV, an acronym for Estimated Breeding Values, appears to be in every alpaca breeder's mouth around the world. Some people promote EBV's to be the ultimate tool for selective breeding; others claim EBV's even create cash flow during economically hard times. In order to bring some light into the darkness, let's just take a look what EBV's do, how they do it and what breeders can expect.

Estimated Breeding Values (EBV):

Definition by University of Missouri
(<http://extension.missouri.edu/xplor/aggv>)

"an estimate of an individual's true breeding value for a trait based on the performance of the individual and close relatives for the trait. EBV is a systematic way of combining available performance information on the individual brothers and sisters and the progeny of the individual."

Breeding value can be defined as the value of an individual alpaca as a parent. Parents transfer a random sample of their genes to their offspring. Breeding value gives an estimate of the transmitting ability of the parent.

Every alpaca breeder has his own technique to evaluate the quality of the adult herd and the offspring. To a certain extend, larger breeders learned to predict what their sires might produce with their own females by using classic record keeping or modern tracking systems. The question is how objective are those predictions and how do other people, breeders or beginners benefit from this data. The first problem one needs to solve is, who will be responsible for the creation, the maintenance and the dissemination of the data collected. It has to be an institution fully accepted and trusted by the majority of the participating breeders (nation), or the organisation probably will have a short life expectancy.

Since 2004, I have been the "Breeding Supervisor" within the BoD of the German Alpaca Association (AZVD). I am responsible for the development and implementation of our Herd- and Elite Book, the planning, conduct

and evaluation of our national screening program and the evaluation and dissemination of the collected data. I don't exaggerate by saying introducing something like EBV to the existing programs around the world can be very disruptive and confusing to breeders, if it's not accurately portrayed for its strengths and weaknesses and is truly beneficial for improving the breed. To a person hearing it for the first time the title EBV sounds like something sophisticated, but it is only a title. Its proof is in the content and execution. Most of us live in countries where the democratic process is the accepted way to make decisions. To establish a system that works well for everyone involved takes a great deal of patience and the ability to negotiate between different parties and interest groups in order to get overwhelming support which would be mandatory to get a comprehensive program to move the breed in a positive direction. A comprehensive program must deliver. A failed effort causes disappointment and disruption. In other words to last it needs accuracy, transparency, incorruptibility, and very good science supporting it.

In order to show you how and if EBV's can be your choice for future breeding decisions, we need to look at the system creation, the development, the functionality of EBV's. In Germany, the EBV projects for breeding livestock are very advanced and most of them are dated back to the early 1980's. They are well established. In the example of dairy cows, EBV's incorporate the performance data of up to 50 million animals of a certain breed. EBV's are in use for all agricultural animal breeds and for the majority of the medium to large pet animal breeds as well. All of the EBV programs I looked at included body conformation, reproductive capabilities and the individual productive performance for that particular breed (meat, milk, fibre, speed, etc.). So, in Germany we have many EBV programs to study and compare."

How to start EBVs?

Let's assume, we identified an organisation that will take on the task and all breeders accept this institution as the leading authority for the EBV project. The most important issue to decide on first is, who will be responsible for the project coordination. I highly recommend you look for a person with a concrete spine, leather skin and a steel forehead. Intelligence might help, too. This individual needs to coordinate between breeder's wishes, scientific research results and programming requirements. It has to be clear from the beginning that we are talking about high tech computer systems, 3D matrix mathematics and statistic programming capacity and a lot of man

power. That will cost money. The members need to pay for that.

Which phenotypic traits are we looking for?

As soon as we have all the resources, the organisation and its members need to agree on the phenotypic traits that will be evaluated. I was talking to a German rabbit breeder, who was astounded to hear that existing alpaca EBV programs do not incorporate body conformation and reproductive issues. About two years ago, his special Angora breed won an award by the Chinese government. Through the EBV assessment his breed was identified as the one with the best body conformation and fleece characteristic, thus providing good fibre over a prolonged healthy life. He made a fortune in selling breeding stock. An alpaca has hundred times the sales value, but is not graded in body conformation made no sense to the rabbit breeder.

During the first World Alpaca Conference in Sydney, Australia, I had the chance to talk to a lot of breeders and their official representatives. The overwhelming majority of the prevailing opinion seems to be that for fibre animals, body conformation is not an issue at all. The A.G.E. (Across Herd Genetic Evaluation Program) is one example where only fibre data is collected to determine alpaca breeding values. The same applies for the Canadian EBV initiative: no body conformation data... yet.

I think we are all aware that simply discussing which fibre traits should be implemented could easily become a never ending story. Will it be only the data collected through "modern" histograms, do we need to measure fibre length, crimps per inch and amplitude or do we prefer curvature, fibre density, amount of guard hair, amount of medullated fibre, etc. p.p.. It could be a long discussion only for the fibre. During the implementation phase of the A.G.E. program there was no audible public discussion, no screaming and yelling. This appears to be only possible because the inventors borrowed an existing system created for sheep. Are alpacas sheep or are they alpacas? With sheep there is some expensive breeding stock but it is more about mass production than anything else. None of the early sheep breeders bought their breeding stock for 50.000 US \$ or more. The EBV program for sheep was developed for an animal breed, where the average base value of the animal itself is below 100 US \$. Income is generated through the sale of large product numbers, may that be meat or wool or a combination of both. To adopt the sheep EBV program for alpacas is simply not possible, because the total genetic value of alpacas do not derive only from its fibre coat and meat.

These animals have become prestigious luxury animals on a global scale. The individual sales value should reflect the genetic value. If the genetic value is limited to its fibre only, we all need to price our alpacas down to below 500 US \$. Can we do that? We could, but breeding alpacas would become a pet animal business. A professional breeder cannot produce an alpaca for the price of sheep. And who has the space and the money to run an alpaca farm with several thousand animals, developing enough volume in a program that produces meaningful data. This type of scale with consistent dietary and environmental factors is possible with large operations in South America like Rural Alianza, but most alpaca owners in Europe and North America have herds of not more than a dozen animals in a great variety of settings and experiencing widely different diets. In the European, Australian and North American settings there are only a few large entities, who would benefit more than the smaller owners because they could theoretically generate more meaningful data. The overwhelming majority of European Alpaca breeders see themselves as "Gentlemen Farmers", breeding alpacas for their beauty in the hopes that some day its fibre will be recognized by the fibre market. Please do not misunderstand me. We have to breed for a fine, uniform and soft fleece, otherwise the market recognition will never take place, but we should never forget body conformation. A good body will make the alpaca live a longer pain free life to hopefully produce a lot of fine fibre and great crias.

Let's compare alpacas with horses. Horses do not carry useable fibre, but need to show certain quality in walking different gears. Imagine horse EBV's would only look for the way the animal walks. A body defect could prevent the horse from carrying a rider, but it walks beautifully. Do you believe the horse breeders would accept a program like this? But horses are not that close to alpacas so you might discount this point. How about sheep?

If a sheep breeder does not like the EBV results of a particular animal, he does what all breeding ancestors did: the animal will be de-selected from the breeding program. It will get slaughtered even though that does not pay for the expenses.

Is there any other animal where we can borrow the EBV program and adopt it to alpacas? Maybe where genetic defects are of importance so they will be tracked? Maybe we can find an animal that carries fibre as a quality identifier or one that might have critical structural problems that prevents it from having a healthy long life?

To be honest, we probably won't, because alpacas are unique animals and should not be

compared with any other breed. Therefore, I recommend the organisation has to identify all critical phenotypic traits concerning the body conformation and the desired phenotypic traits concerning the fibre characteristics to come up with an animal specific EBV program. I don't want to tell you which traits you should use for your national programs, except that they should be relevant to alpacas, backed up by science, objectively measurable and accepted by all participating members. However, I also don't need to tell you which traits, because the base already exists:

I recommend using the ARI screening as the base for your EVB data collection and add or change whatever is vital to know for your national herd. That is exactly what we did in our AZVD Herd- and Elite Book system. We took the ARI screening and adopted it to meet our nation requirements. This so called "advanced screening" (or ZEP), is now the official tool to collect the required data. This data is the base for any further assessment in genotype and it is a lot more data per animal than any other existing EVB program.

How to collect data for the EVB program?

Let's assume the organisation has survived all hurdles and finally got all members to agree on the rules and regulations, the procedures and the traits to be evaluated. Now it is time to start thinking about the who and how to collect the required data.

The existing EVB programs totally rely on the breeder himself taking the fibre measurements and the sample, thus, entering the self-collected data into electronic reporting forms. I assume that the measurements will be different from breeder to breeder simply by the technique used to collect the sample. The difference in experience will aggravate the situation further. The major setback will be that the breeder himself will decide which animal will participate and which will be hidden from public eye. Let's not forget, we are still within democratic countries, so we cannot force anybody to participate with all of his animals. This may distort the picture completely. If only 10% of a sire's offspring is evaluated, the EBV will be reduced to an educated guesswork without reliable information.

Another problem with the self taken data is the accuracy. The absolute best samples are taken by the same person, with the same method, with the same tools, at the same time of the year, at the same spot, at the same age using the same analysis machinery and/or procedure. To achieve the best laboratory comparison, we want to change only one single parameter, and that is the animal itself.

Can we do that by having the breeder himself taking the sample? Most likely not. However, in

the moment that is the master plan of all existing EBV programs.

The AZVD approach is different:

We spent a small fortune on developing a training syllabus and hiring Eric Hoffman and Pat Long to train two groups of breeders and veterinarians to become the backbone of the German Screening System. A team of two phenotype screeners and a veterinarian are responsible for collecting all the required data. Screenings are organised through me and are scheduled throughout Germany every year. All collection methods are standardized, the procedures for data transmission are redundant secured from manipulation and negative results can be backed-up by additional scientific exams to exclude diagnostic errors. Presently we can operate 4 teams simultaneously throughout the world. The training by Eric guaranteed a complete standardisation with former ARI regulations. AZVD advanced screenings, or ZEPs, have been conducted from Chile to Switzerland, Belgium, Netherlands, Sweden and Germany. I should point this system was also used throughout North America, Australia and England, but was known as screening and only used on imported animals.

This gives us several tremendous advantages:

- all animals are positively identified prior the exams
- the exams are conducted anonymously, because the crew does not know who the animals belong to
- all samples are taken the same way and under the same conditions
- all fibre samples will be processed by the team and sent sealed to the lab
- Yocom McColl, as our prime contractor, does the OFDA 100 testing
- multiple redundant computer system store the retrieved data

By having our own personnel, we can offer the screening service for a low rate. About 80 EUR (105 US\$) is the price for an animal screening in Europe including fibre sample and a printed final report. Outside Europe or in remote European locations, an extra travel fee is charged. Overall, the price for the screening helped us getting the acceptance by the majority of the continental European alpaca breeders. Off course, taking the sample yourself is a lot cheaper. In my opinion, having the certainty that the data was collected objectively by an independent team of standardized specialists is worth every single penny.

How does the breeder benefit from EBV's?

Let's assume, our organisation found a solid way to retrieve the data necessary to create the EBV. The data needs to be transmitted to a centralized storage and processing partner. All the data needs to be processed by mathematical systems called Animal Model (AM) or its newer descendent the Reduced Animal Model (RAM). The reduced animal model can be used for **best linear unbiased prediction**, resulting in a large reduction in number of equations to be solved. Generalized inverses of coefficient matrices of mixed model equations are required for these methods of estimation of variances under both the animal and the reduced animal model. Consequently, use of the reduced animal model can markedly reduce the order of such matrices. Each individual trait needs to be processed through such matrices to constantly generate an up to date base for each trait. The more traits our organisations wishes to look at, the more complicated the entire process will become, which is probably the reason why most alpaca EBV programs are limited to a few characteristics.

The **best linear unbiased prediction (BLUP)** is a statistical method to predict the breeding values of animals. Fixed effects of environment and genetics on observed phenotypic values are estimated simultaneously and, therefore, genetic differences between herds are accounted for. BLUP animal models are now used in many countries for a number of species, including dairy and beef cattle, swine, sheep, fish and now alpacas.

The BLUP constantly calculates for the overall average of a certain trait. This average represents the 100% marker, i.e. the average for AFD is calculated for 22 Microns, 22 becomes 100% for this trait. A offspring index of 107 indicates that the offspring of a particular animal is 7% better than the average animal. Even though the number is higher, in that particular trait it means that the fibre is finer.

By using high performance computer systems, we are able to do fast calculation, but that does not mean it gets easier. To understand the results of EBV's, the breeder needs to understand the meaning of each presented figure and what it means in its natural context. I'd like to give you a sample for a possible reading:

	AFD ^{*1}	SD ^{*2}	>30μ ^{*3}	Curvature ^{*4}
EBV	-3,5	+2	+4,1	+5,5
Accuracy %	80%	80%	80%	80%
Index	104	98	96	106

^{*1} AFD of the offspring is 3,5% below the overall average, which is an above average performance

^{*2} SD of the offspring is 2,0% above the overall average, which is a below average performance

^{*3} >30μ of the offspring is 4,1% above the overall average, which is a above average performance

^{*4} Curv of the offspring is 5,5% above the overall average, which is an above average performance

As you can see, depending on the individual trait plus and minus can have different meanings. And index above 100 indicates a better than average performance and the accuracy in percent indicates how close an animals estimated breeding value is to its true breeding value. For those of you, who don't like numbers, there is a graphical way of displaying the same results, a bit like the well known histogram. However, the breeder still needs to know what the individual figure means.

Summary

Every alpaca breeder heard the sentence before, "this male produces gorgeous crias". EBV's are one way of proving this statement, which should be an improvement to educated guess work. Personally, I think that EBV's can only be successful, if all the other pieces fall into place as well: a centralized organisation, body and fibre traits, a team of screeners and a result that is also understandable for less educated people.

Another important fact is the tendency to select only the best animals. I fear that the participation on a voluntary basis will lead to breeders only presenting their best animals distorting any data base. I do understand the reason for that. It is a certain amount of distrust. Breeders might fear that the retrievable information will be used to compare farm performance instead of animal performance leading to more sales for the best "manipulator" instead of the best breeder. This is a common problem when you rely on statistics. Never trust statistics unless you manipulated them yourself. I think that this can only be overcome with time.

Our Elite Book, which would be the equivalent to EBV's works a bit different. We do not only calculate a sires breeding value by comparing its offspring's performance with a calculated standard. The AZVD strongly believes that the DNA of an animal is responsible for its breeding value. Since it consist of moms and dads DNA, why only look at the herd sire. Our

Elite Book, which will start officially by end 2009, will display all relevant information to be assessed by the breeder himself. Whenever an animal has been screened, its performance data will be published together with the data from mom and dad. Now we do the first calculation on who was responsible for the crias performance. Just because a sire's offspring shows an above average EBV does not mean, he was solely responsible for this result. Maybe the dams were even better. In this case, the false impression of the good sire performance could lead to massive external matings based on a wrong assessment. The biggest problem with the EBV's in use is, once you have the results, they become imprinted in stone. What was intended as a breeding tool becomes a marketing tool to prove the superiority of an individual animal.

We all know the saying "a healthy mind in a healthy body". This is believed to bring us humans a long and prosperous life. Just change this saying to read "a healthy fibre on a healthy body" and your alpacas will have a longer and healthier life, providing good fibre and a lot of beautiful crias. The AZVD approach may be different and not representative for the alpaca breeding community on a world wide level, but we believe that equal emphasis should be put on body and fibre to succeed in the long run. Just food for thought for those creating EBV's.

"fibra sana in corpore sano"