Frequently Asked Questions about Estimated Breeding Values and NSIP

Roxanne Newton, Kathy Bielek & James Morgan, PhD
(reviewed by Dave Notter, PhD, Michelle Canfield, Lynn Fahrmeier & John Stenger)

What is an EBV? EBV stands for Estimated Breeding Value. An EBV is a computer generated prediction of the genetic merit of a sheep for economically important traits such as growth, milk, prolificacy, mothering and parasite resistance.

What is the difference between an EBV and an EPD? There is essentially no difference between an EBV and an EPD in terms of the information that is provided. An EBV is a predictor of the genetic merit of the animal itself. An EPD is a predictor of the genetic merit of an animal's progeny. Mathematically, the EBV is always equal to twice the EPD and an EPD is always equal to one-half the EBV. The U.S. beef industry uses EPDs, but most of the rest of the world uses EBVs.

Why do sheep breeders need EBVs? EBVs increase the accuracy of selection for superior performance. Typically, only a small portion of the differences between two sheep for a specific trait is genetic (10-20%). The rest of the differences are due to management, environment and chance. With good contemporary group structure and genetic linkages among flocks, an EBV can accurately predict if a ram from one flock has more growth or will pass on better prolificacy to his daughters than a ram from another flock.

What traits can be evaluated with EBVs? EBVs can be calculated for any trait for which data can be collected accurately and scientists understand something about the genetic control of the trait. Typically, these are developed for the economically important traits such as growth, milk, prolificacy, ultrasound of muscling, mothering and parasite resistance. In wool breeds, wool EBVs help with selecting for increased wool profitability.

What do all the initials stand for? EBVs (estimated breeding values) are reported in abbreviated form: MWWT = maternal weaning weight (milk); WWT = weaning weight; PWWT = post-weaning weight; WFEC = weaning fecal egg count; PFEC = post-weaning fecal egg count; NLB =: number of lambs born; NLW = number of lambs weaned; EPT = ewe productivity trait (Katahdin index or US Hair Index).

In general, how are EBVs calculated? Data collected on each lamb is entered into a computerized database program. The actual production is first adjusted for known, non-genetic influences such as the age of the dam, the type of birth and rearing of the lamb, and the age of the lamb to remove systematic, non-genetic effects on performance. The adjusted performance for each animal is then compared to the average production of a group of contemporary animals. The system then combines the performance record for each animal with the performance records of all its relatives and weights the relative's information in proportion to how closely the animals are related. Again, all records are expressed in relation to their contemporary groups to remove non-genetic differences (among years, flocks, and so forth) in average performance. Finally the numbers are adjusted for the heritability of each trait and the numbers of records available. The resulting EBV is the best estimate of the true genetic merit of any individual animal for any specific genetic trait measured. While the mathematics of EBV calculation are complex, the result is a straightforward reflection of the actual performance of the individual and its relatives, expressed relative to their contemporaries.

Which EBV traits are most important? It depends on your goals and your market. EBVs are tools and can be fine tuned to fit your production system. If your goal is to market grass-fed lambs, then parasite resistance EBVs may be important. If 60 pound lambs are the primary market, then improving number born and weaned increases profit and breeding value. However, if the market rewards 110-125 pound lambs, growth EBVs become increasingly important.

What is a "good" EBV? A "good" EBV differs between flocks and management systems depending on your needs. Most EBVs are expressed in the same units as the trait being measured, but occasionally are expressed as a percentage of the trait mean. In general most breeders will select for positive value EBVs. The main exception to this rule in Katahdins is the parasite resistance trait (Fecal Egg Count EBV). A negative EBV indicates the animal is predicted to have a lower fecal egg count compared to the breed average and therefore, more resistance to parasites. It is recommended for most breeds that selection be balanced across both growth and maternal traits to ensure that live lambs with acceptable weights are available to market. Beware of extreme EBVs. The quest for the fastest growing or the most prolific animal often involves the sacrifice of other important traits necessary for profit and/or productivity. Also, animals with extreme EBVs may be less efficient and less balanced. However, not all traits are affected to the same degree by selection for the extremes.

Are sheep with EBVs better than other sheep? Not necessarily. Think of EBVs as a report card showing how well an animal is expected to perform based on its own performance and on the performance of close relatives. Animals without EBVs could be valuable, but there is no way of knowing without being "graded". In the same way, when we see animals with poor EBVs, we can be confident that they are not very good.

How can I use EBVs to improve my flock? There are two simple and very effective approaches. One approach is to select sheep with "balanced EBVs". Don't worry about all the numbers, just select a ram that has solid favorable EBVs for the things you care the most about and is at least close to average or a little bit better for the other production traits, and if parasite resistance is important, select for a negative FEC EBV. A second approach is to use the EBV index for the breed. In Katahdins, this is the "US Hair Index" or Ewe Productivity Trait. It is a composite index that balances growth, milk, number born and weaned all into one number. Over time or with more study, a user can fine tune their selection by "dialing up" or "dialing down" specific traits to improve the performance of their flock.

How are differences in feed and management accounted for in the production of EBVs? In other words, can I compare sheep on different farms using EBVs? Yes, by comparing animal performance "relative" to the average of a group of contemporary animals, the calculation of EBVs is able to account for differences in management. Two things are necessary to compare sheep between the flocks: good contemporary group structure and good genetic connections to other participating flocks. With sufficient contemporary group structure and genetic connections, EBVs factor out differences in management.

What is a contemporary group? A contemporary group in NSIP is a group of lambs that are within 45 days of age and are all raised with the same management. Foster lambs raised on milk replacer cannot be in the same contemporary group as lambs that are raised with their dams. Also if you separate out your ewes with triplets and feed them separately from ewes with singles and twins, then you have two different contemporary groups.

I often hear about good contemporary groups. What makes a good contemporary group? A good contemporary group starts with having at least two breeding sires and 10-20 lambs per sire. By having more lambs per sire, and more sires represented in the contemporary group of lambs, the quality of the contemporary group increases. To further strengthen contemporary groups, each ram should be bred to a comparable group of ewes, meaning each group contains a mix of both mature ewes and ewe lambs with various strengths and weaknesses. In addition, it is preferable that full and half sibling sisters and mother/daughter pairs be divided between different breeding sires. The ideal contemporary group contains as many lambs as possible, but only contains lambs that are truly treated alike. Some breeders divide their lambs up into too many contemporary groups, and suffer reduced accuracy of EBVs because of it. Set up separate contemporary groups whenever there are real differences in the production environment, but don't over-do it.

Why are contemporary groups important? Contemporary groups are the foundation of the comparison process used to generate EBVs. If you do not have good contemporary groups then the computer cannot produce EBVs with good accuracy. Typical reasons for poor contemporary groups are: not using at least two breeding sires and not having enough lambs per sire to compare.

What are genetic linkages and why are they important? A genetic linkage or connection is created whenever animals in different flocks have a common ancestor. Genetic linkages allow the computer to fairly compare contemporary groups on two or more farms. The more linkages that exist between flocks, the more accurate the EBVs are calculated.

How do my sheep compare to others in the breed? EBVs are the best measure we have of comparing performance traits and important production values between sheep and between individual animals in different flocks. The accuracies increase with decent contemporary groups that have good genetic connections.

What does accuracy mean and do I need to worry about it? Accuracy is important. EBVs are "predictions", and, the more accurate the predictions, the more confident we are of their value.

What affects the accuracy of EBVs? The accuracy of the EBVs of a breeding ram increases with the number of offspring raised in good contemporary group structures and also increases with the number of flocks where the breeding ram was used as sire. Accuracies of maternal trait EBVs increase with the numbers of daughters that have lambs in good contemporary groups. The EBVs of a sire with 300 offspring in 5 flocks will be more accurate than a ram with 20 offspring in one flock. The accuracy of a ewe's EBVs increases with the number of litters she has, but not nearly as fast as they do for breeding sires.

What is the difference between "within flock" and "across flock" EBVs and is it important? It is important. When a flock has small contemporary groups and no genetic linkages to other flocks, EBVs can only be used to compare animals "within" a flock. EBVs become more useful when they can be compared between or across flocks. Once you have larger contemporary groups and multiple genetic linkages, you can compare your animals "across flock" with other animals in the breed.

What is the Katahdin Index and how is it calculated? The Katahdin Index, also known as the Ewe Productivity Trait (EPT) or USA Hair Index incorporates the following into one indexed

value: weaning weight, number lambs born, number lambs weaned and milking ability. It is a measure of the predicted genetic value for the total pounds of lamb marketed by a ewe.

How do I match EBVs to my management system? EBVs can be successfully used to improve traits that are of particular significance to individual management systems. For instance, a flock with high prolificacy may make selection decisions to increase MWWT (milk) EBVs to enhance milk production and reduce the incidence of orphan lambs. Likewise, organic or grass-fed systems may select for parasite resistance to avoid the use of chemical dewormers and reduce loss due to parasites. EBVs are like "control knobs" that allow you to "turn up" or "turn down" traits, according to your management system needs, personal goals, and traits you already have in your flock. There are just as many reasons to "turn down the volume" on a certain trait as there are to turn it up.

Are all traits equally heritable? No, some traits such as growth and parasite resistance are more heritable than others. The higher the heritability of a particular trait, the faster that trait can be used to affect change. It is also easier to prove a ram for traits with higher heritability. However, some traits with low heritabilities, such as number of lambs weaned, have very high economic importance and still need to be considered when making selection decisions. EBVs are the most effective way to make progress and improve lowly heritable traits**.**

How do I use EBVs when purchasing a ram? Selecting a sire based on EBVs is of particular importance since the ram provides 50% of his genetics to his offspring. EBVs give producers an inside look at a ram's genetic merit for performance. First, select a ram with balanced EBVs and/or a good "Katahdin Index." Then look at the specific EBVs and other traits that are important to your flock (e.g. hair coat, structural correctness)

Should I try to find a ram that balances my ewes' EBVs (high where they are low, etc.)? Probably not. Using a ram with EBV values opposite your ewes' tends to result in lambs that are just average in all traits. A breeder will make the most progress by using his best ram on his best ewes and saving replacement ewes and rams from these matings. If you have a choice between two good rams that have similar EBVs, it is a good idea to select a balanced ram that is stronger for the trait your flock most needs for improvement.

What does having "balanced" EBVs mean? An animal with "balanced" EBVs is one with all EBV-measured traits close to or above average for the breed. A balanced ram with above average EBVs in all traits is particularly valuable because of his ability to positively affect all traits in his offspring.

I only want twins. Can I use EBVs to be sure I don't have any triplets or singles? Not for an individual animal. However, EBVs can be used to move a flock toward fewer triplets or fewer singles. Remember, all performance traits have both an environmental component and a genetic component. A ewe with twinning genetics, on a higher plane of nutrition, could easily have triplets. However, the same ewe grazing poor pasture could just as easily have a single.

Are balanced EBVs always desirable? This is often a desirable goal for breeders. However in some situations, below average EBVs in certain traits may be best. If your animals currently are too high on a particular trait, and this needs to be corrected, then selecting a sire with an unbalanced set of EBVs can be appropriate, and selection for a below average EBV can improve the efficiency and usefulness of your sheep. Some breeders also may choose to focus really strongly on a small number of traits to attempt to produce a truly "elite" flock for those traits.

Examples might be post-weaning growth or parasites. But beware of the risks of single-trait selection and closely monitor the other EBVs in your flock to catch any emerging problems.

What is the significance of birth weights? Low birth weights can lead to survivability problems in pasture settings. High birth weights can increase the risk of dystocia, especially in ewe lambs birthing one large single or in any ewe that is over fed during the last third of gestation. Birth weight is also statistically correlated to weaning weight, so lower birth weights will translate to lower weaning weights. Extremes in either direction may cause problems in your flock, and attention to birth weight EBVs is probably only warranted if you are having obvious problems with either underweight or overweight lambs.

What should I consider when "fine-tuning" EBVs to fit my management system? In general, selecting for balance is the best strategy to improve overall flock performance. Maximizing any one trait can lead to problems and can decrease profitability. Understanding the tradeoffs and impacts of higher and lower values for each trait allows producers to make the best use of the EBVs. With this information you can "fine tune" specific EBVs to fit your operation.

MWWT (maternal milk) – Selection for higher MWWT EBVs is predicted to increase early lamb growth because of the intertwining relationship between milk production and mothering ability. The majority of this effect is through increased milk production and/or higher quality milk. An animal with a very low MWWT EBV could have difficulty raising triplets under some conditions. A very high EBV in some environments could cause undue stress on the ewe and negatively affect her body condition and also increase parasite issues (e.g. bottle jaw). High MWWT may also increase mastitis risk, especially in early weaning systems.

WWT (weaning weight) – WWT provides an estimate of pre-weaning growth potential, and most flocks will select for positive numbers for this trait. WWT level should be adjusted to fit target selling weight and the rate of growth needed to meet the market date. Growth EBVs including WWT can be used to help breeders select for early or later maturing lambs.

PWWT (post-weaning weight) –. PWWT is used to predict post-weaning growth. As with WWT, use PWWT EBVs to adjust growth to fit your target market. If you are selling bigger 100+ pound market lambs, then higher PWWT EBVs are needed. If you are selling lambs at light weights, selection for a modest PWWT EBV is preferred for most systems. Selecting for high PWWT EBVs will tend to move your flock towards later maturation, increased mature size, larger frame and delayed sexual maturity. Caution: single trait selection for extreme growth greatly increases the risk of dystocia.

NLB (number lambs born) – NLB and NLW are expressed as a percentage. A 0% NLB in Katahdins means a mature ewe is predicted to average 2.1 lambs per litter. A higher number here will mean more triplets and, if high enough, some quadruplets. This can increase management needs of the ewe flock and create more "bottle babies" or more lamb loss. However, it can also mean more lambs to sell and more profits, if managed in balance with nutritional inputs and other traits (good mothering, sufficient milk production, and strong lamb survivability genetics). If you have a low input system with outdoor lambing, little help and no facilities you might opt for near- zero NLB EBVs, which selects strongly for an average of twinning.

NLW (number lambs weaned) - This number gives credit to ewes that have multiple births, but also manage to keep them alive to weaning. High birth rate is of no benefit if a ewe doesn't raise the lambs or if she doesn't produce enough milk to feed them. In almost every commercial lamb operation, the number weaned is the most important predictor of gross income. In most situations, we would like to see the NLW equal to or greater than the NLB. This shows that the ewe has good mothering skills. You can use NLW in your flock to improve mothering, lamb survival and the number of lambs marketed. Note: when using NLW, be aware that non-genetic effects, such as predation, accidents or mismanagement, will result in a lower NLW for an individual ewe and an unfair comparison to ewes whose litters are not subjected to these non-genetic events. The program always assumes it's the ewe's fault that she lost a lamb and we know this isn't always the case.

WFEC (weaning fecal egg count) - This EBV is very important for all operations that raise lambs on pasture where internal parasites are a problem. A lower FEC EBV means fewer parasite eggs and less vulnerability to parasite loss. High FEC EBVs reflect a higher risk of parasitism, which often results in poor growth and decreased survivability. If you live in an area with little or no parasite problem, or raise your lambs in confinement, this EBV is of less importance.

US Hair Index (ewe productivity trait) - This EBV is a very good "all-around" measurement, and selection for a higher Index will increase production and profit in most systems. Higher numbers indicate more productive sheep resulting in more total pounds to market. However, since this EBV combines milk, growth and prolificacy, the same "bigger isn't always better" caution applies. Individual component EBVs need to be balanced with the operation's management and marketing system. This index does not predict parasite resistance.

My flock has 10-15 ewes. Can I participate in NSIP and will it have value? Yes**,** you can participate by buying or leasing rams with EBVs because common genetic connections will improve the accuracy of your flock's EBVs. In addition, a small flock with ten to 15 ewes must still use two service sires, but never more than two. Accuracy can be increased by using the same breeding sire for 2-3 years or by sharing a service sire with a larger breeder. However, overall, the rate of progress will be slower for smaller flocks**.**

What information do I need to get started? To generate EBVs, the following data must be collected: Lamb ID, Date of Birth, Sire ID, Dam ID, Number born, Number raised, Sex, and 60 day weight (weaning weight). Collection of 120 day weight (early post-weaning weight) and birth weight are not required, but are highly recommended.

What do I measure and when? Birth weights are recorded within 24 hours of birth. Weaning weights (taken on all lambs on the same day) are recorded between 45-89 days of age and when the majority of the lambs average 60 days of age. Note that this is when you should record your "weaning" weights, but lambs do not have to actually be weaned if that does not fit your management. Early post-weaning weights (taken on all lambs on the same day) are recorded between 90-150 days of age and when the majority of the lambs average 120 days of age. Optional Data – Fecal egg counts are taken at or around weaning and at or around 120 days of age. Scrotal circumferences are suggested to be taken between 150-240 days of age. Note: all lamb measurements (weights, fecal egg counts, scrotal circumferences, loin eye depth) need to

be collected on the entire contemporary group on the same day when all, or at least most, fall within the age range for that measurement.

When can I submit data? Anytime after birth weights are collected. Most members will re-submit after weaning and again after early post-weaning weights are entered into Pedigree Wizard. There is no limit to how often you can submit. However, if animals in your flock are closely related to animals in another flock, re-submitting after those flocks have submitted will give you the most accurate numbers, because EBVs can change based on the performance of close relatives. Data is run on the 1st and 15th of every month and EBVs are returned approximately 1 week after each run.

Some of my lambs didn't grow as well. Should I submit their data? EBVs are all about increasing the accuracy of selection. Since poor doing lambs are part of the contemporary group, including their data improves accuracy, will better evaluate the sires and dams, and will make your best lambs look even better. If you are tempted to not submit the "low data", it will make your top performers appear less strong. Submitting all the data collected from the entire contemporary group will allow a breeder to make more progress and better selections.

How much does it cost? There are two fees: a flock fee and a data fee. The flock fee is based on the number of breeding ewes in the flock. The data fee is based on the number of lambs with post 90 day data submissions. Using the 2013 fee structure as an example, Joe has 43 ewes, so he pays $150 for the annual flock enrollment fee (based on number of breeding ewes in his flock). He has 83 lambs born, including three stillbirths. He is able to mark 25% of his lamb crop as culls, which equals 21 lambs. He is charged a database fee of $2.35 per animal on the remaining 62 lambs totaling $145.70. Therefore, his total NSIP investment for 2013 is $295.70. While $295 sounds like a lot, the use of EBVs to improve weight gains and/or lamb survival (NLW) can greatly increase economic returns for the flock. Marketing three additional meat lambs or one registered lamb could pay for the enrollment fee.

Do I have to pay a data fee for every lamb born? No. A fee will be assessed only on animals with post 90 day data submission. So, any lambs that die or that you sell before that age will not be charged. Also, up to 25% of your lamb crop can be submitted as cull or commercial at the first post 90 day data submission on the sheep and no data fee is assessed. This is done by putting the characters "CU" or "CO" in the 11^{th} and 12^{th} characters of the 16 character ID in Pedigree Wizard when submitting the data to LAMBPLAN. Once lambs are marked cull or commercial, EBVs will not be generated for that animal. You still need to include as much data on these lambs as possible (birth, 60 day weights, 120 day weights, FECs, scrotal circumference, ultrasound), since this information will increase the accuracy of the EBVs of the lambs you keep. It's also important that you <u>not</u> mark potential breeding animals as cull or commercial because EBVs will not be generated for those animals.