# What is Genetic Trend?

**By Steven D. Lukefahr**

KINGSVILLE, Texas: The breeding, promotion, and sales of high quality animals is a highly competitive business. Just look at the majority of the ads in the Directory Pages of each SGF issue. For breeders to be successful they must demonstrate that their animals are superior for traits of economic importance and(or) consumer demand. But how does the breeder really know if genetic progress is being achieved, and especially *over time*?

## THE HISTORY OF GENETIC TREND

Nearly one century ago, geneticists first conducted what today is considered as classic selection experiments in which the methodology was developed to determine genetic progress for specific traits over consecutive generations. Typically, both selected and non-selected groups of animals were involved that originated from the same foundation population. In the experiment, animals in both groups were similarly managed and maintained in the same location so that genetic change in selected group of animals could be separated mathematically from environmental influences that were common to animals in both groups. The published results of selection experiment articles were highlighted using line-plot figures where each data point represented the average trait performance of a specific group for each generation. Further, on a within-group basis, a line connecting these data points over consecutive generations quantified the *genetic trend*. This trend line was also used to calculate the average amount of genetic progress per generation (rate of genetic response) for the trait of interest. The consensus of many selection experiments is that genetic response to selection does occur for heritable traits, albeit usually at a slow rate (1 to 5% per generation change from the population average); however, genetic progress is both permanent and cumulative over generations so long as the breeder consistently follows a breeding objective - to selectively change or improve the herd average for the trait of interest.

Industry later adopted this innovation (especially breed associations) of using genetic trends as a yardstick measure of selection response and(or) progress over time. For example, at the website of the Red Angus Association of America (RAAA; redangus.org) from the Genetics/DNA menu there is a link to EPD Trends. A table then appears that contains links to genetic trend figures for different traits. In addition, when a genetic evaluation is conducted, records of new animals born that year are added. In the process an additional data point is computed, which is the average EPD of all new animals born that year; hence, the genetic trend line is updated.

The EPD (Expected Progeny Difference) is an estimate of the quantifiable or numerical value of half the genes that affect a trait of an animal as a parent which can influence the progeny. The word Difference is used because EPDs are relative to the population average for the trait, as well as to other animals.

**EPD SELECTION GONE AWRY**

In the beef cattle industry, breeders are well aware of the fact that cattle have become much larger at maturity in many breeds. Today we better understand that larger cows are less efficient, and they produce fewer total pounds of beef per acre, as opposed to the stocking of more cows that are smaller in size. However, this genetic change occurred more indirectly rather than directly because breeders placed too much emphasis on high EPD values for weaning weights. Some university educators even recommended this selection strategy. Besides mature weight, this same indirect response likewise affected birth weight. These associations are explained by positive genetic correlations that exist among growth traits. In other words, some of the same genes that increase weaning weight also increase other growth traits. This genetic antagonism accounts for the higher incidence of dystocia or calving difficulties in heifers when bulls with high EPDs for weaning weight are used for breeding. To address this problem or reverse this trend, several breed associations and breeders promote and choose bulls as herd sires that have below average or negative EPDs for birth weight and calving ease scores.

Like any tool, EPDs must be used properly and with caution. Of course, the cliché of "Bigger is Better" is not always true. When breeding objectives are established there must be some sound reasoning or justification, as well as limits. Genetic progress in a terminal breed or herd that produces quality meat animals can be achieved by emphasizing selection for specific growth and carcass traits. However, for a maternal breed or herd that produces breeding animals, selection for reproduction and other maternal traits, as well as environmental adaptability, of course are more important. Genetic trends should be closely monitored for traits that are critical to the breeder to ensure that progress occurs in the desired direction, or not at all for some traits where no further genetic change is desired.

## BREEDING PROGRAM AT LUKEFAHR RANCH

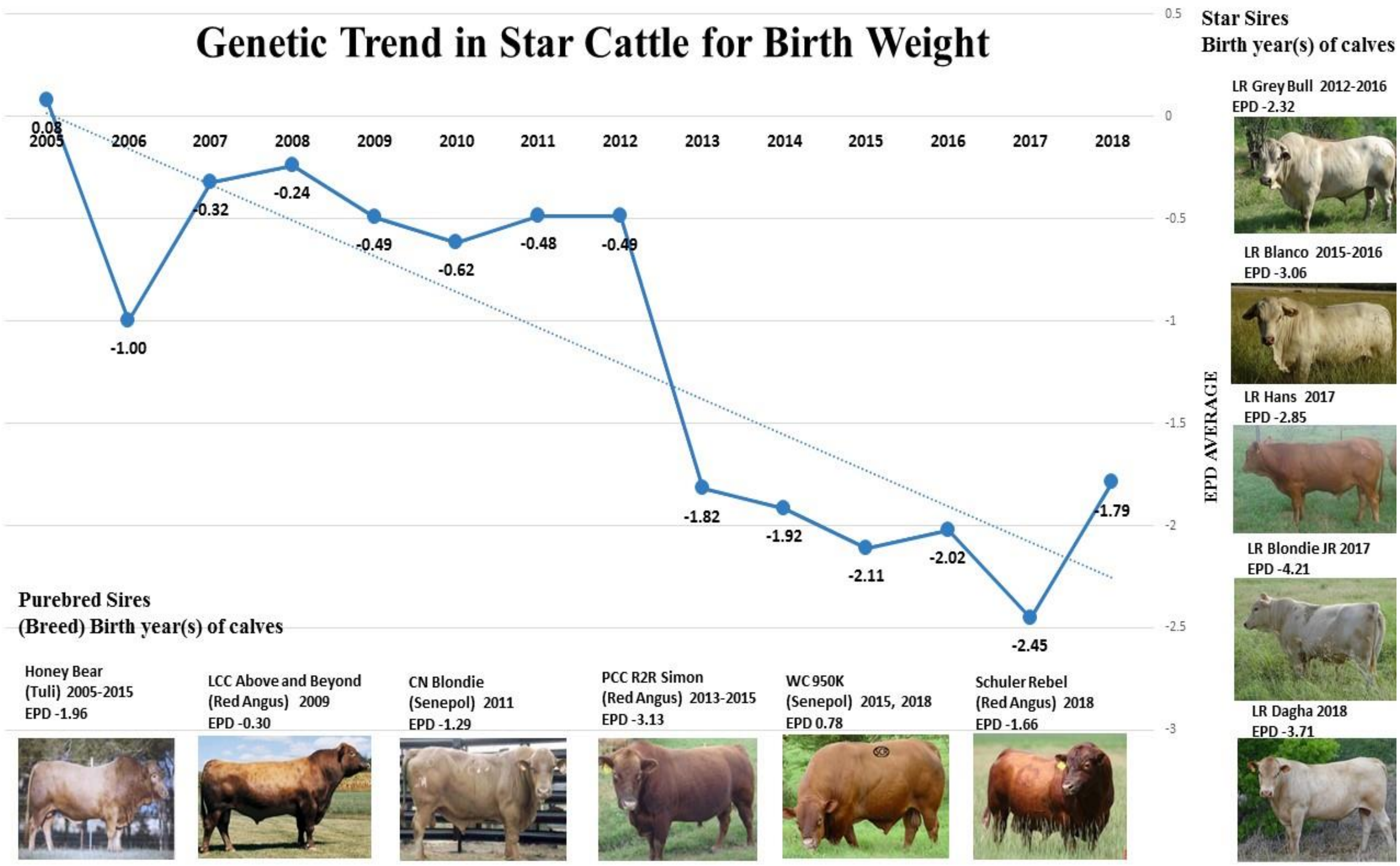
The Spring 2018 genetic evaluation was recently conducted at Lukefahr Ranch, located in deep south Texas. The evaluation was based on the addition of new calf birth weight records to a database that goes back to 1999 and presently consists of performance and(or) pedigree records on 749 animals. Across all years the average birth weight is 76.9 pounds and for 2018 was 72.1 pounds. Before 2005, average birth weights were well above 80 pounds in some years. In 2004, the breeding objective was made to decrease average birth weights using both breed and EPD selection. However, some background about the cattle population is first in order.

Several past articles in the SGF have described my cattle population, which is a composite of Red Angus, Senepol, and Tuli breeds. In 2005 the first crop of composite-bred, “Star” cattle (S – Senepol, T – Tuli, and AR – Angus Red) were born. The overall breeding goal is to produce a herd of polled, slick and light-colored STAR cattle of appropriate tropical genetics for the region where selection is applied to promote high fertility and survival in a low-input system while working closely with Nature. Initially, a three-breed rotational crossbreeding system was used followed by several years of within-herd composite matings but with periodic use of AI purebred bulls.

The addition of Senepol and Tuli breeds (and more recently Mashona) to the Red Angus base ensures tropical adaptation, especially in terms of heat tolerance and drought adaptation as related to performance. This year some calves are over 80% African breed-influenced. Briefly in terms of management, breeding occurs during summer, calves are born mostly in May, and calves are wintered on their dams and weaned at approximately 10 months of age in early March. Most calves are sold for breeding. In the past several years, total costs per cow were approximately $300. In 2017, over 50 pounds in weaned calves per are were yielded.

## GENETIC TREND FIGURE – USE OF PUREBRED AI SIRES

The figure that accompanies this article shows genetic trend for birth weight between 2005 and 2018. To explain this figure, each data point is the calculated average EPD for all calves born that year. To address the breeding objective to decrease average birth weights, several purebred AI bulls (Red Angus, Senepol, and Tuli) with low birth weight EPDs have been used since the Star population is an open herd. Semen was purchased from AI companies and private breeders at a cost of around $15 per straw.




A Tuli bull named Honey Bear sired several calves starting in 2005. Honey Bear was the first live Tuli bull in North America and both of his parents had negative EPDs for birth weight. Over the years, he has sired nineteen calves and his birth weight EPD at present is -1.96 (0.83 ACC). A photo of Honey Bear appears in the bottom left corner of the figure. Photos of some of the other influential AI purebred bulls, as well as the birth year(s) of their calves and EPDs (estimates obtained from the 2018 genetic evaluation performed at Lukefahr Ranch), are shown at the bottom of the figure.

Between 2007 and 2012 there was little change in average birth weight EPDs, mostly for practical reasons relating to years of extreme drought where more natural rather than AI matings were done. The natural sires used mostly had EPDs for birth weight that were closer to zero rather than negative. During these years, AI bulls of all three breeds: LCC Above and Beyond (Red Angus), CN Blondie (Senepol), and Honey Bear, were used but again on a limited basis. LCC Above and Beyond was a trait leader in the Red Angus breed for several years. From the Spring 2011 RAAA genetic evaluation, Above and Beyond had an incredible -8.6 birth weight EPD with 94% accuracy (ACC), classifying him in the top 1 percentile relative to proven sires of the Red Angus breed. Ideally, AI bulls should be chosen not only for their desirable trait EPDs and high accuracies (among other attributes), they should also sire enough calves in the herd so that some are truly outstanding (if not better than their own sire) in order to be more selective. CN Blondie was from a foundation Senepol herd in St. Croix. For years he had the reputation of being a “heifer bull”. His current birth weight EPD is -1.29.

Of relevance, the EPD values of Star cattle are within-herd estimates that are computed from genetic evaluations conducted at Lukefahr Ranch using genetic software programs. The database also includes pedigree records that include purebred ancestors, including AI sires. EPD values are estimated for these animals as well. However, EPD estimates for purebred AI sires can widely vary from those reported by breed associations. Several reasons can account for this discrepancy. First, an animal’s EPD is relative to the overall average of the population from which estimates are obtained (e.g., Red Angus versus Star populations). And secondly, EPD estimates reflect the sample of the calves that are produced in the herd. Obviously, a large number of calves with records should contribute an EPD estimate that is closer to the true EPD value of the sire as opposed to a small number of calves.

In 2012, a purebred Red Angus bull (PCC R2R Simon) was purchased from Pharo Cattle Company. Simon had several desirable trait features, including at the time of sale a negative EPD for birth weight. His actual birth weight was 66 pounds. Simon was used for three years and sired 42 calves. Besides Simon, a Star herd sire named Grey Bull was also influential in causing a noticeable downward genetic trend between 2013 and 2016 (see figure). Adjusted for age of dam, calf heterozygosity levels (the basis for heterosis) and birth year, the average birth weight of Simon's calves was 70.6 pounds while that of Grey Bull's 56 calves was 72.2 pounds. The birth weight EPDs for Simon and Grey Bull were -3.13 (0.79 ACC) and -2.32 (0.85 ACC), respectfully, based on the latest genetic evaluation. The larger sample size of calves from both bulls allowed me to be more selective in choosing outstanding herd replacements to further advance genetic progress. In fact, several sons and daughters from both bulls were kept as well as sold for breeding. Of relevance, in this composite population, hybrid vigor contributes to heavier birth weights by as much as 4.9 pounds (an estimate obtained from the latest genetic evaluation) for calves that were fully crossbred, but again EPDs were not biased by this effect.

More recently, other purebred AI bulls have been used, for example Schuler Rebel (Red Angus) and WC 950K (Senepol) which are popular heifer bulls. Of relevance, these bulls are only remotely related to bulls previously used, which effectively expands the Star population's gene pool to minimize inbreeding while maintaining a high level of hybrid vigor. Again, this opportunity is possible when a composite population remains open rather than closed. Last year a Mashona bull ("Tarzan") was purchased and used extensively in the breeding herd. Mashona is an African breed that is tropically adapted. Although the bull had an EPD for birth weight of -1.66 (ACC 0.67), this value, although negative, is not as large in sign as the EPD values of Star bulls used in recent years, which mostly explains the lower negative average EPD of -1.79 for 2018 from the genetic trend figure.

**GENETIC TREND FIGURE – USE OF COMPOSITE SIRES**

On the right side of the genetic trend figure are photos, birth year(s) of the sire's calves, and EPDs of several of the most influential Star composite bulls that were produced at Lukefahr Ranch. Of note, these bulls tend to have even larger negative EPDs for birth weight than most of the influential purebred AI bulls initially used. These Star bulls are related to two or more of the featured and other AI purebred bulls. Through the simple process of gene recombination in producing sperm and egg cells, these and other composite-bred bulls inherited genes from both parents for decreased birth weight that were from their AI-sire ancestors of all three breeds. It took several generations to make this improvement. For example, LR Dagha's pedigree has PCC R2R Simon as his paternal grand sire, while Honey Bear appears on both sides of his pedigree. This represents 56.25% of his breeding. Dagha was first used for breeding last year at Lukefahr Ranch at 14 to 15 months of age. His breed composition is 43.8% Red Angus, 18.8% Senepol, and 37.5% Tuli. Presently, his birth weight EPD is -3.71 (0.78 ACC). The average birth weight of his calves born in 2018 was 69.1 pounds. A 2017 bull that will be used for breeding this summer has a birth weight EPD of -5.44. His paternal grand dam is a daughter of Blondie, his maternal grand sire is Simon, and Honey Bear appears three time in his pedigree, yet his inbreeding coefficient is only 3%.

A final comment about the figure, the observed straight line passes just above or below the data points in such a way that the average distance between the line and all the data points is minimized. This linear function reveals that the average EPD tended to decrease at a rate of about 0.175 pounds per year (or approximately one pound every six years). However, this rate of genetic response is by no means dramatic. To reiterate, while genetic progress is both cumulative and permanent, it takes both time and patience.

At some point in time the decision will be made to no longer select for decreased average birth weights. This decision relates to the concept of stabilized selection which involve selection limits. No breeder should want 100-pound calves at birth; likewise, no breeder should want 30-pound calves. Instead, the average between these extreme values of 65 pounds would certainly be considered more acceptable. This simple illustration too reflects the concept of stabilized selection. Once this point is reached then the breeder should reset their breeding objective on selection for other traits of importance to further improve the herd.

In conclusion, progressive breeders of purebred stock could develop genetic trend figures for their own herds using trait EPDs that are furnished by their respective breed association. This way, breeders can monitor genetic progress over time in their own herds.

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