# Genetic Selection Tools for Foundation Traits in Beef Cows

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Long-lived cows are the foundation of a profitable commercial cowherd. A commercial cow does not become profitable until approximately six years of age (Sánchez-Castro et al. 2019; Boyer et al. 2020). This six-year mark is the age at which the revenue generated by a cow eclipses the cumulative costs of its development as a heifer and annual maintenance costs. Despite the clear costs associated with replacement heifer development or purchase, cow longevity and the traits that influence it are often overlooked or under-prioritized in the selection process. While some cows are culled only when their production begins to lag at an old age, the most common reasons that cows are culled from commercial herds before becoming profitable include the following:

- Infertility
- Poor structural soundness
- Poor udder quality
- Aggressive disposition
- Calving difficulties



These traits are often called "convenience traits," but their impact on cowherds reaches far beyond making a producer's life easier. Many of these traits have direct costs that impact the bottom line, while others add labor. This additional labor often is confused with convenience, but its actual financial cost is often undervalued or completely ignored. **A producer's time is worth something!** Depending upon a producer's breeding and calving seasons, the cost of spending additional time or incurring additional variable costs affects the operation's profitability and efficiency.

Due to the influence of these traits on the profitability and sustainability of commercial cowherds, we refer to them as foundation traits. Maternal selection and all-purpose indexes for most breeds are comprised of these traits, and they account for approximately 50 percent of the calculations. Health and fertility traits make up more than 90 percent of the relative weights in modern dairy indexes. For most commercial operations, maximizing cow health and fertility and minimizing development and maintenance costs has a more significant impact on profit than selecting for performance (which yields marginal improvements, whether milk in dairy or weaning lbs. in beef). Despite the clear importance of cowherd foundation traits, operations often make selection decisions that prioritize extra growth and a slightly larger check at the end of the year.

Foundation traits tend to be lowly heritable (a small proportion of differences controlled by genetics), meaning that an animal's production environment is also important for expression. In addition to being lowly heritable, problems with these traits are often not revealed until years after selection decisions are made. Taken together, the development of selection tools based on expected progeny differences (EPD) is especially important for making rapid genetic progress on these traits. Here, we discuss each of these foundation traits, how they impact cow herds, and the selection tools that enable producers to accurately select for long-lived, low-maintenance cows.

## STAYABILITY

As mentioned above, a cow's ability to remain in the herd past its "break-even" point is determined by multiple traits. The all-encompassing phenotype that is recorded by many breed associations is called **stayability**. Stayability measures how likely a bull's daughters are to remain in the herd long enough to recoup their development and maintenance costs (6 years old). Stayability provides a full picture of cow longevity on which producers can base selection decisions. Stayability (STAY) EPDs are reported by the Simmental, Limousin, Gelbvieh, Red Angus, Shorthorn, Brangus, Beefmaster and Chianina associations. Accurate STAY EPDs rely on total herd reporting, where each cow has their calf records reported each year, regardless of whether its offspring are registered. This unbiased reporting also increases the accuracy of other performance EPDs. The low heritability of STAY (around 0.10) means that management and environment account for much of the variation in a cow's longevity, making it difficult to make genetic progress through phenotypic selection. In the American Simmental breed, daughters of bulls with top 25th percentile STAY EPDs produce an average of two more calves in their lifetime than those from bulls in the bottom 25th percentile.

## FERTILITY

Failing to rebreed is the most common reason cows are culled from herds. That said, a surprising number of cows get a second chance when open. The extra feed and variable costs required to maintain that cow will hinder the profitability of that individual if it stays in the herd. When a cow misses a calf, it does not become profitable until year 7 or 8, depending upon calf prices (Boyer et al. 2020). If a cow misses twice, it does not become profitable until year 11 (Boyer et al. 2020). Thus, while it is possible for cows that miss a calf to be profitable, it takes more years to realize that profit, which makes fertility a critical financial driver.

Fertility, like stayability, is lowly heritable and largely dependent on an animal's environment, making EPD-based selection important. Multiple breeds (Angus, Brangus, Gelbvieh, Red Angus, Santa Gertrudis) report heifer fertility EPDs, which represent the probability that a sire's daughters will become pregnant as virgin heifers during a typical breeding season. For herds that keep replacement heifers, identifying sires that will produce progeny with an increased probability of getting bred as heifers can help avoid losing the investment associated with developing females that fail to become pregnant. In addition to heifer fertility, the American Gelbvieh Association reports an EPD focused on selecting for animals that will rebreed as second calf heifers. This EPD (called PG30) reflects the

probability that a sire's daughter will conceive as a first calf heifer and again after its first calf. Additionally, the American Hereford Association calculates a sustained cow fertility EPD which predicts a cow's ability to calve from 3 years of age to 12. Like stayability, accurately measuring and predicting fertility requires unbiased reporting of cow inventory and calving records. Estimating actual fertility is more difficult because reporting the number of services per conception and whether the pregnancy resulted from natural service or AI is not feasible.

#### STRUCTURAL SOUNDNESS

Cattle must have good feet and leg structure to graze, travel, and breed, and the discomfort of poor feet and leg structure reduces the time they spend grazing or drinking. Besides directly impacting performance, it creates animal welfare issues. Hoof trimming and other management interventions may prolong an unsound cow's productive life, but these are likely to incur costs and significant additional labor. Concerted efforts to collect foot and leg scores have increased in recent years. The American Angus Association is calculating EPDs for two hoof phenotypes: claw set and foot angle. In both cases, cows are scored on a scale of 1-9, where the intermediate score of 5 is ideal (Figure 1). The American Simmental and Red Angus Associations also collect foot scores, but EPDs are not yet available for those breeds at the time of writing this publication. These breed registries also collect rear leg side-view scores to select for hock angle. While EPD-based selection tools are important, any cowherd can benefit from yearly foot and leg structure evaluation. Foot and leg structure are also essential for identifying bulls that will work consistently throughout the breeding season.



**Figure 1.** Phenotype scoring scales for foot angle (top), claw set (middle), and side leg profile (bottom). Image courtesy American Simmental Association.

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#### UDDER QUALITY

Poorly structured udders can create additional labor and management challenges during the calving season. Manually milking out a problem quarter is a chore that adds substantial labor and additional time. Beyond extra work, problem udders can result in mastitis, reduced calf performance and increased calf sickness. Compared to fertility, teat and udder structure is more highly heritable (around 0.2-0.3), meaning that keeping daughters from cows with better udders can result in reasonable genetic progress. The Hereford and Charolais Associations both report Udder Suspension and Teat Size EPDs. Udders are scored within the first 48 hours of calving on a 1-9 scale where higher scores are preferable (tighter udder suspension and smaller teat size). Both breeds have made considerable genetic improvement in udder quality since the introduction of these predictions. Even without udder EPDs, annual scoring in commercial herds can help identify cows with problem udders or udders that have begun to decline.





Figure 2. Phenotype scoring guide for udder suspension (top) and teat size (bottom). Image courtesy Rick Rasby, University of Nebraska Extension.

#### DISPOSITION

The economic value of docility is difficult to capture, but it directly impacts the safety of an operation. An injury caused by a problem cow can quickly erase every cent of revenue it has produced and more. Beyond safety, cows and heifers with poor docility have longer calving intervals than their more docile contemporaries, and aggressive feeder cattle gain at a slower rate and with less efficiency. Depending upon the location of the herd, an intermediate docility phenotype may be preferable. Cows that have a protective instinct towards their newborns may be necessary for areas where predators are common. Furthermore, overly docile cows can be difficult to work in some contexts. That said, cows that are aggressive without being provoked should be quickly culled. Since docility is moderately heritable (around 0.4), keeping daughters from aggressive cows is not advisable. Preventing docility issues can also be accomplished through breeding, as most breed associations report Docility EPDs.

## CALVING DIFFICULTIES

Calving difficulties in heifers can add substantial labor to an operation during an already busy time. Beyond the increased workload, the greater number of calf losses results in a direct loss of revenue. Furthermore, heifers that experience calving difficulty rebreed later, if they rebreed at all, further reducing their profitability. This could lead to some females not fitting into the operation's breeding season. Genetic predictions for calving ease are available for every major beef breed in the form of calving ease direct (CED) or birth weight (BW) EPDs. It is important to remember that a low BW EPD might not directly contribute to easy calving, so using a CED to evaluate calving ease is preferable. If heifers are retained from a bull, paying attention to that bull's calving ease maternal (CEM) EPD allows us to gauge how easy calving a bull's daughters will be.

## ADAPTABILITY AND MAINTENANCE

One underappreciated class of foundation traits deals with a cow's ability to adapt to its environment. A cow's environment could mean many things, including the weather, biotic and abiotic stressors, or its management level. Identifying cows that fit their production environment is essential for sustaining a profitable herd. One of the biggest challenges when breeding high-performance cattle is ensuring that cow maintenance costs do not erode calf profitability. For example, selecting for high weighing weight potential also increases mature cow weights, resulting in increased maintenance costs. Using EPDs like mature weight (MW) can help balance calf performance and cow efficiency. High genetic potential for milk production (weaned calf weight) can incur additional costs without delivering additional revenue for cows with somewhat limited resources. Thus, being mindful of these traits is essential.

Breeding cattle adapted to their local climate and stressors allows them to partition energy towards raising a calf, as opposed to thermoregulating. We would also expect that better-adapted cattle have higher reproductive performance. Measuring adaptive phenotypes can allow producers to identify cattle that are better suited for their environment. For example, identifying cattle that tolerate toxic fescue conditions or cattle that shed hair early allows them to handle heat stress better. The American Angus Association has published a research EPD for hair shedding and reports predictions for pulmonary arterial pressure (PAP), an adaptive trait for cattle raised at high elevations.

## INDEX-SELECTION FOR PROFITABLE COWS

Breeding profitable cattle is a multi-faceted task that requires balancing many component traits that are often correlated. It is also essential to keep in mind that cow traits are not the only concern for an operation that still needs to produce direct revenue streams (e.g., weaned calf pounds). To make selection decisions more straightforward, breed associations have developed a variety of economic selection indexes tailored to specific production contexts. These indexes account for correlated traits and attach relative economic values to the EPDs, resulting in genetic predictions for profitability. Many associations report maternal indexes focused on situations where replacement females are kept. These indexes (e.g., \$M & \$W in Angus, API in Simmental, HerdBuilder in Red Angus) emphasize the foundation traits discussed throughout this publication. Using an index that reflects the breeding goals of an operation can allow simultaneous selection for the optimal combination of these foundation traits, which will result in the maximum profit potential when combined with the appropriate level of management.

#### REFERENCES

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