Expected Progeny Differences and Selection Indices for Beef Cattle Selection

MISSISSIPPI STATE UNIVERSITY™ EXTENSION

Beef sire selection decisions have a major impact on future calf crops and ultimately on profitability. Using selection tools can help producers make better live cattle, semen, and embryo selection decisions. Widely available beef cattle selection tools include performance data, expected progeny differences (EPDs), and selection indices.

Beef Cattle Selection Tools

Adjusted Performance Records

Many individual trait measurements are adjusted for age of the animal and of its dam. This allows for more fair comparisons of cattle. For example, weaning weight is commonly adjusted to 205 days of age, and yearling measurements (weight, hip height, scrotal circumference) are typically adjusted to 365 days of age. When evaluating bulls for individual performance traits, be sure adjusted performance levels are truly adjusted measurements and not actual performance values.

Performance Ratios and Contemporary Groups

Individual performance ratios rank bulls within their contemporary groups. A contemporary group of bulls would be born within the same birth management group (same management system, calf age group, and age of dam group), managed together, and performance data collected on the same dates (see **Table 1**). The average performance ratio for a contemporary group is 100. The difference between a ratio and 100 is the percent an animal is higher or lower than the average of its contemporary group for the trait measured. For example, an adjusted yearling weight ratio of 115 indicates the animal's adjusted yearling weight was 15 percent higher than the average of its contemporary group. Likewise, an adjusted yearling weight ratio of 93 indicates the animal's adjusted yearling weight was 7 percent lower than the average of its contemporary group.

Not reporting performance data from low-performing (often cull) cattle biases a contemporary group and performance results. Consider the following example. If performance data from lower-performing calves (culls) are not included in performance ratio calculations, then high-performing calves receive lower performance ratios. This results in incomplete contemporary group information and biased performance comparisons of individual calves within the contemporary group.

Table 1. Contemporary group effect on performance ratios.

	Performance Data and Ratios		
Contemporary Group	Adjusted weaning weight (lb)	Adjusted weaning weight ratio including all calves	Adjusted weaning weight ratio without culls
Calf 1	720	119.6	108.8
Calf 2	695	115.5	105.0
Calf 3	648	107.7	97.9
Calf 4	633	105.2	95.7
Calf 5	612	101.7	92.5
Calf 6 (cull)	574	95.4	–
Calf 7 (cull)	559	92.9	–
Calf 8 (cull)	557	92.5	–
Calf 9 (cull)	523	86.9	–
Calf 10 (cull)	498	82.7	–
Group Average	**601.9**	**100**	**100**

Table 2. Expected progeny differences currently available by beef cattle breed.

Breed	Expected Progeny Difference (EPD)[1]																														
	Production									Maternal											Management				Carcass[2]						
	CE	BW	WW	YW	YH	RADG	SC	FS	DMI	CEM	MILK	MG	MW	MH	ME	ST	HP	UQ	GL	$EN	DOC	Claw	Angle	PAP	CWT	MRB	REA	FAT	YG	RP	TEND
Angus[3]	×	×	×	×	×	×	×		×	×	×		×	×			×			×	×	×	×	×	×	×	×	×			
Beefmaster	×	×	×	×			×			×	×	×				×										×	×	×			
Brahman	×	×	×	×			×	×		×	×										×				×	×	×	×		×	×
Brangus	×	×	×	×			×			×	×	×	×			×	×									×	×	×			
Charolais	×	×	×	×			×			×	×	×													×	×	×	×			
Gelbvieh	×	×	×	×		×	×		×	×	×	×				×	×		×		×				×	×	×	×	×		
Hereford	×	×	×	×			×		×	×	×	×						×							×	×	×	×			
Limousin[4]	×	×	×	×			×			×	×					×					×				×	×	×		×		
Red Angus	×	×	×	×		×				×	×					×	×								×	×	×	×	×		
Santa Gertrudis		×	×	×			×				×	×													×	×	×	×			
Shorthorn	×	×	×	×						×	×														×	×	×	×		×	
Simmental[5]	×	×	×	×		×				×	×	×	×			×					×				×	×	×	×	×		×

[1]CE = calving ease direct, direct calving ease, calving ease; BW = birth weight; WW = weaning weight; YW = yearling weight; YH = yearling height; SC = scrotal circumference; DOC = docility; CEM = calving ease maternal, maternal calving ease, calving ease daughters; MILK = milk, maternal, maternal traits, maternal milk; MG = milk and growth, maternal milk and growth, total maternal, maternal weaning weight; MW = mature weight; MH = mature height; ME = cow energy value, mature cow maintenance energy; ST = stayability; HP = heifer pregnancy; 30 month pregnancy (PG30), sustained cow fertility; GL = gestation length; UQ (udder quality) = udder suspension, teat size; CWT = carcass weight, hot carcass weight; IMF = intramuscular fat, percent intramuscular fat, marbling, marbling score; REA = ribeye area; FAT = fat thickness, backfat thickness, days to finish; YG = yield grade; RP = retail product, percent retail product, percent retail yield, percent retail cuts; TEND = tenderness, Warner-Bratzler shear force.

[2]Carcass traits are based on carcass measurements, ultrasound body composition scan data, or both data sources. Consult the respective breed association for details on carcass EPD calculations. Gelbvieh has a days-to-finish EPD in place of a fat thickness EPD.

[3]The Angus Optimal Milk Module allows custom inputs to determine the Angus optimal milk EPD range for an operation. Heifer pregnancy EPDs are available on Angus sires meeting certain criteria and are published in the Angus Sire Evaluation Report.

[4]Limousin and Lim-Flex.

[5]Purebred Simmental, Simbrah, and hybrid Simmental.

Consider the size of the contemporary group when evaluating performance ratios. For example, a contemporary group of three does not provide information as useful as a contemporary group of 30. Generally, larger contemporary groups give better indications of cattle performance and associated performance comparisons than smaller contemporary groups. In fact, many breed associations will not accept performance data for use in national cattle evaluations to produce EPDs if a minimum contemporary group size is not met.

Expected Progeny Differences

Expected progeny differences are useful genetic selection tools available for a wide variety of beef cattle traits (see **Table 2**). Expected progeny differences predict the expected performance for specific traits of the calves (progeny) sired by a particular bull (or out of a particular dam) compared to the expected performance of calves sired by another bull (or dam) or group of bulls (or dams). The differences are based on the performance records of an individual, its relatives, and its progeny.

Expected progeny differences are easily interpreted. They are expressed in various units, depending on the specific trait. For example, units for birth weight, weaning weight, yearling weight, and milk EPDs are pounds of calf. Units for scrotal circumference EPDs are centimeters. Contact the respective breed association for specific EPD definitions and units.

Expected progeny differences can be compared between animals or to a breed average. In **Table 3**, calves sired by Bull A (yearling weight EPD = 82) are expected to be on average 18 pounds lighter at yearling age than calves sired by Bull B (yearling weight EPD = 100) when mated to similar females. This is determined by calculating the difference between the two EPD values: 82 – 100 = -18. Similarly, calves sired by Bull A can be expected to be on average 7 pounds heavier at yearling age than calves sired by all other bulls in that same breed when mated to similar females (breed average yearling weight EPD = 75): 82 – 75 = 7.

Expected progeny differences are currently the best predictors of the genetic performance of an individual animal and are available for a growing number of economically relevant traits. Different breeds have EPDs available for different traits. However, most breeds have basic EPDs, such as birth weight, weaning weight, yearling weight, and milk. Expected progeny differences can be used to make herd genetic improvement in both commercial and seedstock operations. National cattle evaluations, in which EPDs are reported, are typically calculated multiple times per year. This varies by breed, but it is important to make sure decisions are made using current EPD calculations. For instance, a bull sale catalog may be published before an upcoming national cattle evaluation is released, and the EPDs reported in that catalog could be outdated relatively soon after its distribution.

Across-Breed EPDs

Expected progeny differences are breed specific. The EPDs of bulls from different breeds cannot normally be compared because they are calculated in separate analyses, and each breed has different base points for various EPDs. Therefore, direct comparisons of EPDs across breeds should not be made unless across-breed EPD adjustment factors are used. The USDA Meat Animal Research Center publishes annual updates of adjustment factors to add to EPDs of 16 beef cattle breeds to estimate across-breed EPDs. The 2010 update appears in **Table 4**. As a general rule, unless updated breed-specific adjustment factors are added to current EPDs, compare the EPDs of a particular animal to animals within the same breed.

Table 3. Expected progeny difference (EPD) comparisons.

EPDs	EPD Values			EPD Comparisons		
	Bull A	Bull B	Breed Average	Bull A Versus Bull B	Bull A Versus Breed Average	Bull B Versus Breed Average
Calving ease direct, %	7	1	5	+6	+2	-4
Birth weight, pounds	1.2	4.2	2.2	-3.0	-1.0	+2.0
Weaning weight, pounds	35	49	40	-14	-5	+9
Yearling weight, pounds	82	100	75	-18	+7	+25
Milk, pounds	22	15	20	+7	+2	-5
Scrotal circumference, cm	.50	-.05	.33	+.55	+.17	-.38
Calving ease maternal, %	0	8	6	-8	-6	+2
Intramuscular fat, %	.25	.05	.12	+.20	+.13	-.07
Ribeye area, square inches	-.01	.63	.23	-.64	-.24	+.40
Fat thickness, inches	.021	.005	.005	+.016	+.016	0

Table 4. Across-breed expected progeny difference adjustment factors.[1]

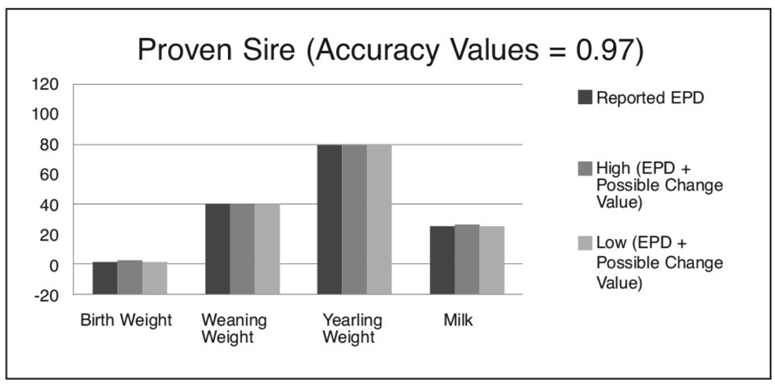
Breed	Trait						
	Birth Weight	Weaning Weight	Yearling Weight	Maternal Milk	Marbling Score[2]	Ribeye Area	Fat Thickness
Angus	0.0	0.0	0.0	0.0	0.00	0.00	0.000
Beefmaster	7.3	41.0	42.9	3.2			
Brahman	12.5	42.0	2.6	24.4			
Brangus	4.9	20.9	20.6	3.6			
Braunvieh	7.3	25.6	26.8	30.9	-0.31	0.89	-0.165
Charolais	9.3	41.9	50.8	3.1	-0.42	0.75	-0.233
Gelbvieh	4.3	5.7	-10.2	8.3			
Hereford	3.4	0.5	-15.5	-17.6	-0.33	-0.14	-0.050
Limousin	4.2	1.4	-29.1	-15.5	-0.75	1.05	
Maine-Anjou	4.8	-9.2	-25.0	-2.3	-0.88	1.06	-0.208
Red Angus	2.6	-2.3	-5.5	-4.2	-0.06	-0.06	-0.051
Salers	2.6	2.2	-5.5	-0.1	-0.20	0.80	-0.214
Shorthorn	6.4	20.6	47.4	22.4	-0.10	0.20	-0.158
Simmental	5.2	28.4	28.3	11.8	-0.55	0.94	-0.224
South Devon	4.8	4.6	-4.0	-8.0	-0.03	0.11	-0.118
Tarentaise	2.2	34.2	23.4	22.7			

[1]Adapted from Keuhn et al., 2010.
[2]Marbling score units: 4.00 = Sl00; 5.00 = Sm00.

Across-breed EPDs have the most application for commercial cow-calf producers, considering use of bulls of more than one breed in crossbreeding programs. Uniformity between generations may be improved by selection for similar across-breed EPDs. Many breed associations publish EPDs on individual animals in sire summaries and searchable Internet databases. Breed associations also publish tables that show where individual animals rank within the breed for specific traits such as weaning weight or ribeye area.

Accuracy Values

Expected progeny differences can change over time as additional performance information is collected. Therefore, EPDs come with accuracy values that indicate the reliability of the EPD. Accuracies range from 0 to 1, with values closer to 1 signifying higher accuracies. As more usable performance information becomes available for an animal and its relatives and progeny, its EPDS will become more accurate or reliable. Thus, a young, unproven bull with no calves will have lower accuracy EPDs than a proven sire with hundreds of calf records. Expected change tables are published by breed associations as part of national cattle evaluations to show how much variation can be expected for EPDs at specific accuracy levels.



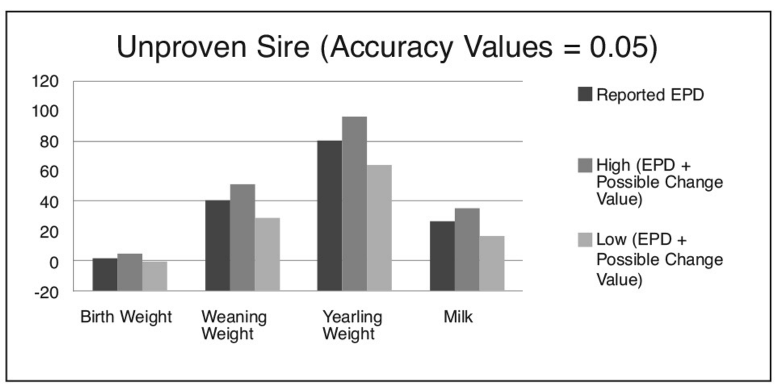


Figure 1. Accuracy and possible EPD change example of expected progeny differences for two bulls.

For an illustration of accuracy values and their role in EPD interpretation, consider the following two bulls (**Figure 1**). The "Proven Sire" has high EPD accuracy values (ACC = 0.97) for birth weight, weaning weight, yearling weight, and milk EPDs, while the "Unproven Sire" has low EPD accuracy values (ACC = 0.05) for the same EPDs. Yet both bulls have the same EPD values reported for these four EPDs in the current national cattle evaluation.

The chart of the "Proven Sire" shows little change in EPD values is expected in the future as additional performance data are reported to the breed association. The low accuracy values of the "Unproven Sire" indicate the reported EPDs are less reliable and subject to more possible change as additional performance data are reported to the breed association. While the "Unproven Sire" may currently display EPD levels that meet selection goals, the variability in these values may move its reported EPDs to levels in the future that may or may not meet selection goals. Low accuracy values simply mean more risk is involved in EPD use. However, even low accuracy EPDs might still be the best genetic prediction available for use in selection decisions.

Marker-Assisted EPDs

Marker-assisted EPDs are a relatively new selection tool. They also are referred to as genomically enhanced EPDs. They incorporate genetic information from specific DNA segments of interest into traditional EPD calculations. Incorporation of genetic marker data into EPD calculations can improve EPD accuracy values. Use of marker data alone in selection decisions ignores the genetic contributions of other genes and may not explain much of the variation in a particular trait that is genetic. This is a rapidly expanding field of study that promises more application for practical beef cattle production situations in the future. Until sufficient marker data are known to explain much of the genetic variation in traits of interest, marker data should not be used in place of EPDs. Instead, marker data should currently be used only with EPDs in selection decisions.

Selection Indices

Selection indices are based on multiple traits weighted for economic importance, heritability (the proportion of the differences among cattle that is transmitted to their offspring), and genetic associations among traits. In other words, a selection index is a

Table 5. Selection indices currently available by beef cattle breed.

Breed	Selection Index	Abbreviation
Angus	Cow Energy Value	$EN
	Weaned Calf Value	$W
	Feedlot Value	$F
	Grid Value	$G
	Quality Grade	$QG
	Yield Grade	$YG
	Beef Value	$B
Charolais	Terminal Sire Profitability Index[1]	—
Gelbvieh	Feedlot Merit	FM
	Carcass Value	CV
Hereford	Baldy Maternal Index	BMI$
	Calving EZ Index	CEZ$
	Brahman Influence Index	BII$
	Certified Hereford Beef Index	CHB$
Limousin	Mainstream Terminal Index	$MTI
Simmental	All-Purpose Index	API
	Terminal Index	TI

[1]Allows operation-specific production and economic input values for calculating the index.

selection tool that accounts for both biological production levels and economics. That is why selection indices are sometimes called bioeconomic values.

Selection indices are expressed in dollars per head. A selection index may provide a balanced selection approach when selecting for more than one trait at a time. Yet, when using a selection index, it is valuable to know the traits included in it and the relative emphasis placed on these traits within the index calculation. This allows fine tuning of selection index use within a specific herd. Definitions of specific selection indices are available from the respective breed associations.

Customizable selection indices let breeders rank cattle according to production and economic conditions the user specifies. Several breed associations provide web-based versions of selection indices that allow the user to enter individual ranch values for various inputs such as herd size, average cow weight, nutrition-related costs, and market prices (see **Table 5**). Customizable selection indices can rank cattle for the specific production and economic environment in which they are to be used. The end result is a simulation of ranch-specific production and marketing conditions for comparing potential breeding animals.

Ranking Potential Breeding Cattle

Breed associations report EPDs and selection index breed averages and percentile rank tables for active sires, active dams, and non-parent cattle. Current percentile rank tables are readily available on breed association websites or by request from the associations. These tables are straightforward to interpret and let producers see where cattle rank within their breeds for specific EPDs and selection indices.

Prospective sire EPDs and selection indices can be compared to other prospective sires and breed averages. Percentile rankings of a bull within a breed provide a profile of the bull that can be readily assessed and compared to other bulls of that breed. Comparing the percentile rank profiles in **Figure 2**, the bull profile on the left appears to be better suited to breeding to mature cows where no heifers are retained and calves are marketed at weaning or yearling. The bull profile on the right depicts a bull that may be appropriately used to breed to heifers or mature cows where replacement heifers could be retained and calves could best be marketed on value-based grids at harvest. Some breed association websites generate automatic EPD and selection index profiles similar to those shown below. Producers interested in bulls of breeds that do not do this can use the same concept to develop their own percentile rank profiles for comparison and selection.

When evaluating EPD and selection index profiles, do not get caught up in searching for the "perfect" bull. Producers who have severe independent culling levels should not expect to routinely find natural service sires that meet all of their criteria. In situations where producers insist that bulls need to be in the extreme top end of the breed for almost all traits while at the same time having a perfect appearance, gentle temperament, and homozygous polled genetics, it becomes very hard to find cattle that meet all these standards. Be realistic about your breeding goals, and be prepared to make tradeoffs to achieve overall breeding objectives. Also keep in mind that artificial insemination does have the advantage of allowing strategic mating of multiple sires within small seedstock or commercial herds where strategic mating could not be accomplished to the same degree through natural mating.

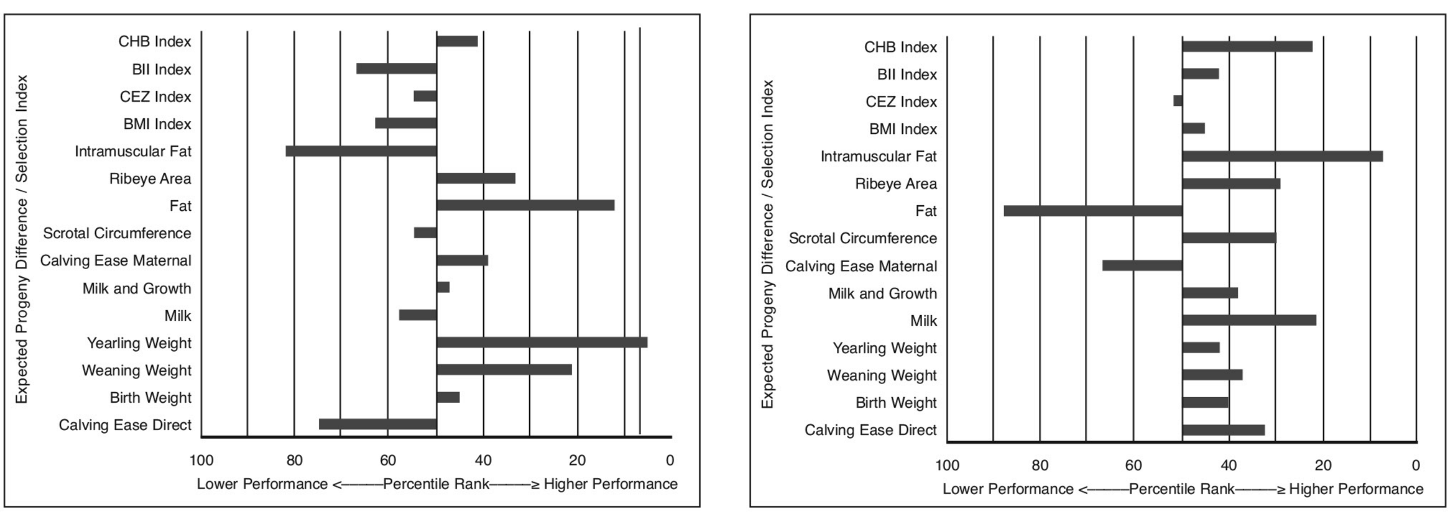


Figure 2. Percentile rank profile example of expected progeny differences and selection indices for two bulls (50th percentile = breed average).

Common EPD Myths and Selection Pitfalls

Actual Birth Weight versus Birth Weight EPD

Birth weight EPDs are selection tools that indicate expected calf birth weight differences relative to calves out of other cattle within a breed. Unlike actual birth weight data, which are for an individual animal, birth weight EPDs combine information from the individual animal as well as its relatives. Just because a bull has a higher actual birth weight than another bull, it does not mean his calves will have higher average birth weights than the other bull's calves. Actual birth weights do not always follow the same trends as birth weight EPDs within a contemporary group. **Table 6** makes this point.

Table 6. Actual birth weights and birth weight EPDs from two bull calves born 4 days apart in the same cattle herd.

Bull A	Bull B
Born September 6, 2007	Born September 10, 2007
Actual birth weight = 76 lb.	Actual birth weight = 83 lb.
Birth weight EPD = 3.4	Birth weight EPD = 1.7

The bulls in this example were of the same breed and managed the same in one contemporary group. Bull A weighed 7 pounds less at birth than Bull B. Yet based on EPDs, calves sired by Bull A are expected to weigh on average 1.7 pounds more at birth (3.4 – 1.7 = 1.7) than calves out of Bull B if bred to the same type of females. Because many factors can influence actual birth weight, such as gestation length and calving season, birth weight EPDs tend to give a better indication of expected calf birth weights and calving ease than actual birth weights.

Calving Ease EPDs versus Birth Weight EPDs

When possible, emphasizing calving ease in selection rather than birth weight may make it easier to select for calving ease and growth performance at the same time. Birth weight and other factors impacting calving ease are components of calving ease EPDs published by a growing number of breed associations. Birth weight is accounted for in calving ease EPDs, so selection based on both calving ease and birth weight EPDs is discouraged because it may put too much selection emphasis on birth weight. Birth weight is actually only an indicator of calving ease and not an actual measurement of calving ease. Calving ease EPDs take into account observed calving ease scores along with other relevant data in predicting calving ease.

Two types of calving ease EPDs are calving ease direct and calving ease maternal EPDs. Calving ease direct EPDs provide information about the expected assistance required at birth for an animal's calves and predict the ease with which an animal's calves will be born to first-calf heifers. Calving ease direct indicates the percent more or less of calves out of or by a particular animal that are expected to require assistance at calving out of 2-year-old heifers. For example, a bull with a calving ease direct EPD of +10 percent compared to a bull within the same breed with a calving ease direct EPD of +2 percent is expected to sire, on average, 8 percent (10 – 2 = 8) more calves that can be born unassisted.

Calving ease maternal EPDs, on the other hand, indicate the expected assistance required at calving for calves out of or by an animal's 2-year-old daughters. In this case, a bull on which the EPD is evaluated would be the grandsire of the calf for which the necessary assistance at birth is being predicted. Calving ease maternal is also referred to as daughters' calving ease and is the ease with which an animal's daughters calve as first-calf heifers.

Milk EPD Interpretation

Milk production is an important maternal trait that directly affects calf weaning weights, and milk EPDs are one of the more common EPDs available from beef cattle breed associations. A common misconception is that milk EPDs refer to pounds of milk produced. This is not the case. Instead, milk EPDs are expressed as pounds of calf weaned because of the milk production of the dam.

In addition to milk EPDs, some breed associations report EPDs that combine the effects of a dam's milk production and the growth potential she transmits to her calves on calf weaning weights. These combined maternal EPDs are equal to one-half of the weaning weight EPD plus the milk EPD. Various breed associations have different names for combined maternal EPDs, including maternal milk and growth, maternal weaning weight, and total maternal EPDs.

Other EPDs available for maternal traits include heifer pregnancy, gestation length, and stayability. The availability of these EPDs varies by breed. Reproductive traits typically have a low heritability, so selection for improved reproductive performance may be slower than selection for more heritable qualities, such as carcass traits.

Assessing Traits of Interest

Optimal EPD Levels

One of the challenges in beef cattle selection and culling involves finding optimum levels of individual traits for the herd. Optimum does not necessarily mean maximum. With many evaluated traits in beef cattle production, it is advisable to avoid extremes. For illustration, too much milk production in a herd can have some negative consequences. Likewise, too little milk production in a beef herd can result in lighter weaning calves. The level of milk production in a cow-calf herd must fit the forage and feed environment to ensure nutrient requirements of lactating cattle are met and rebreeding is not hindered by inadequate nutrition.

Nutritional and other environmental factors affect the degree to which the genetic potential for milk production is expressed. Even when the genetic potential for a particular level of milk production is present within an individual or herd, it does not mean this level of milk production will be achieved. Both genetic and environmental influences on milk production can ultimately affect calf weaning weights and cow reproductive rates.

As nutrient costs increase, heavy milking or larger cattle may be less desirable in a cow-calf operation. In contrast, reasonably priced feed favors heavier calves from higher milking dams in cow-calf production and lighter weight calves fed over a longer period in the feedlot. Increasing milk yield increases both weaning weights and efficiency to weaning in the cow-calf sector, with mixed results on efficiency to harvest. Therefore, for strictly cow-calf producers, increasing milk and size may be practical for increasing weaning weights and optimizing production when feed prices are reasonable. However, for producers retaining ownership of calves through post-weaning phases, maximizing profit by increasing weaning weights via milk production works in some cases and not in others.

Genetic potential for milk production can vary widely among cattle. An efficient level of milk production and mature body size for the herd may vary from one farm to the next. A moderate level of milk production is generally most appropriate. However, low to high milk production levels can apply, depending on production and market conditions. In general, larger body size is more suitable with larger quantities of forage, and high milk production fits better with adequate levels of high-quality forage.

Performance Tradeoffs among Economically Relevant Traits

In addition to considering optimum levels of individual traits, be aware of performance tradeoffs among traits. There are genetic antagonisms in beef production where improvement for one trait tends to decrease the level of performance for another trait. Single-trait selection puts the herd at risk for negative production consequences from genetic antagonisms. Common performance tradeoffs include birth weight/calving ease versus retail product yield, milk production/cow body size versus mature cow maintenance energy, and retail product yield versus marbling.

For genetic progress to be made within the herd, do not base animal selection solely on one trait, such as birth weight or calving ease. Consider performance tradeoffs. Birth weight is highly, positively correlated to weaning and yearling weights. Selection for increased growth rate may increase weight at all ages, including birth, while selection for low birth weight alone may decrease weaning and yearling weights. Make sure that, by selecting a calving ease bull, not to give up too much ground in these other economically relevant traits. Easy-calving, high-growth sires are available that break the rules for the genetic antagonism between birth weight and growth. Try to strike a balance among several economically relevant traits, and avoid selecting for extremes.

Evaluating milk production versus mature cow maintenance energy is a common selection decision where performance tradeoffs are considered. As milk production increases, more energy, protein, and other nutrients are leaving the beef female and being transferred to the suckling calf through the milk. This benefits the calf and increases the dam's nutrient requirements. If these increased nutritional needs are not met, the lactating cow or heifer may lose body condition. In turn, reproductive rates can be negatively impacted if body condition drops below moderate levels.

As cow body size increases, larger quantities of nutrients are required. A higher milking cow, on the other hand, requires a diet higher in both quantity and quality. Because high-milking beef females often cannot consume enough extra low-quality forage and feed to meet added nutrient demands, high genetic milking potential may not match up well to a low-quality diet. Of course, increased nutritional demands resulting from high milk production or larger body size can be met with a proper feeding program, but expenditures for forages and supplemental feedstuffs often increase to meet these demands. Optimizing milk production levels with nutritional program costs is a balancing act.

Genetic Evaluation of Breeding Herds

Define Selection Goals

Cow-calf operations across the state have different goals and different resources. Yet sire selection goals for any cow-calf herd should target an acceptable combination of traits that complement the strengths and weaknesses of the cow herd and match target markets. When selecting a bull, consider the needs of the cow herd. Ask questions that will help match a bull to the cow herd. Do weaning weights need to be improved? If so, growth performance is a priority in the selection process. Does calf crop

Table 7. Example beef cattle production scenarios and associated sire selection considerations.

Production Scenario	Sire Selection Considerations[1]
Producer #1	**Growth and carcass sire**
Herd size: 250 cows	Superior yearling weight EPDs (rapid growth)
Breeding mature cows only	Heavy muscling, natural thickness
Will not retain heifers as replacements	High terminal selection indices
Sires used to complement the cows in terminal cross	Moderately low calving ease EPD (or moderately high birth weight EPD in cases where calving ease EPD is not available) is acceptable (only breeding to mature cows, labor available)
Focus on uniform calf crop	Sensible frame size to maintain acceptable carcass weights
Emphasis on rapid growth and carcass traits	Milk not important (no daughters retained)
Hired labor on hand	Consider carcass EPDs
High level of management	Complement the cow herd and match the market
Marketing after stocker phase or retaining ownership through finishing depending on market conditions	Structurally sound and healthy
Utilizes value-based marketing and high level of information transfer to buyers	
Producer #2	**Maternal "all-purpose" sire**
Herd size: 100 cows	Optimal calving ease, milk, growth, mature size, and carcass traits (balanced trait selection)
Seedstock producer	Close attention to all traits, EPDs, selection indices, and pedigree (important for seedstock marketing)
Will retain heifers as replacements	Large scrotal size and EPD (negative correlation with daughters' time to first estrus)
Desires "all-purpose" sire	Optimal milk EPD (avoid extremes)
Hired labor on hand	Disposition
Marketing registered bulls as long yearlings and selected females after breeding	Adaptability
	Muscularity
	Structurally sound and healthy
Producer #3	**Calving ease sire or "heifer bull"**
Herd size: 25 cows	Most calving difficulty and associated losses occur in first-calf heifers
Breeding many first-calf heifers	Desirable calving ease EPD (or low birth weight EPD in cases where calving ease EPDs are unavailable)
Will retain heifers as replacements	Good calving ease and maternal selection indices
No hired labor	Large scrotal size and EPD (negative correlation with daughters' time to first estrus)
Producer works full-time off farm	Optimal milk EPD (avoid extremes)
Limited cattle handling facilities	Seek relatively high weaning weight EPD (curve bender bull with both calving ease and growth advantages)
Marketing steers at weaning on commodity markets	Reasonable muscling
	Manageable disposition
	Structurally sound and healthy

[1]EPD = expected progeny difference.

color uniformity need improvement? If so, color pattern inheritance is an important consideration in sire selection. Will the bull be bred to heifers, and is limited labor available to assist with calving? If either is the case, calving ease is a priority. Are there plans to retain ownership of calves beyond the feedlot and market them on a value-based pricing grid? If so, focus on yearling weights and carcass traits in selecting breeding animals.

Other factors to consider in sire selection include structural soundness, conformation, libido, disposition, scrotal circumference, sheath, frame size, muscling, breed, and horn presence or absence. Try to strike a balance among economically relevant traits and avoid extremes. The type of bull selected also needs to be based on the purpose of the bull in the breeding herd. Will the bull be used as a terminal sire on mature cows, will he be bred to heifers, or will he be used to sire replacement heifers? The answers to these questions impact the emphasis on maternal traits. **Table 7** provides examples of sire selection considerations for various production scenarios.

Seedstock Herds

For seedstock herds, EPDs and selection indices of the cow herds can be used in establishing herd benchmarks for individual traits and determining variability within herds for these traits. Sire selection becomes more challenging when there is little consistency in the cow herd. It may be difficult to achieve breeding goals with one type of bull in herds with wide ranges in the cow herd for specific EPDs. **Figure 3** shows yearling weight (YW) EPDs for an actual herd. Notice the older females are more variable in terms of YW EPD than the younger females. It also appears there is a genetic trend within the herd for increased YW EPD in the younger generations. In fact, the average YW EPD of the 2010-born heifers is approaching breed average, while the average YW EPD of the 2003- and 2004-born cows is well below breed average. Yearling weight is an obvious weakness of the entire herd and particularly of the older herd females.

This approach evaluates many economically important traits. In the yearling weight example above, the data indicate that use of high YW EPD sires should be a priority. Consider the following scenario. After artificial insemination to a sire offering high yearling growth, the operation has two bulls available for cleanup breeding. One is in the top 25 percent of the breed for YW EPD, while the other one is in the top 50 percent of the breed for YW EPD. Otherwise, the only other major difference between the bulls is that the lower YW EPD bull also has a higher calving ease direct (CED) EPD that is very acceptable for breeding heifers. The herd analysis for YW EPD shows herd females can be grouped for breeding, as older females

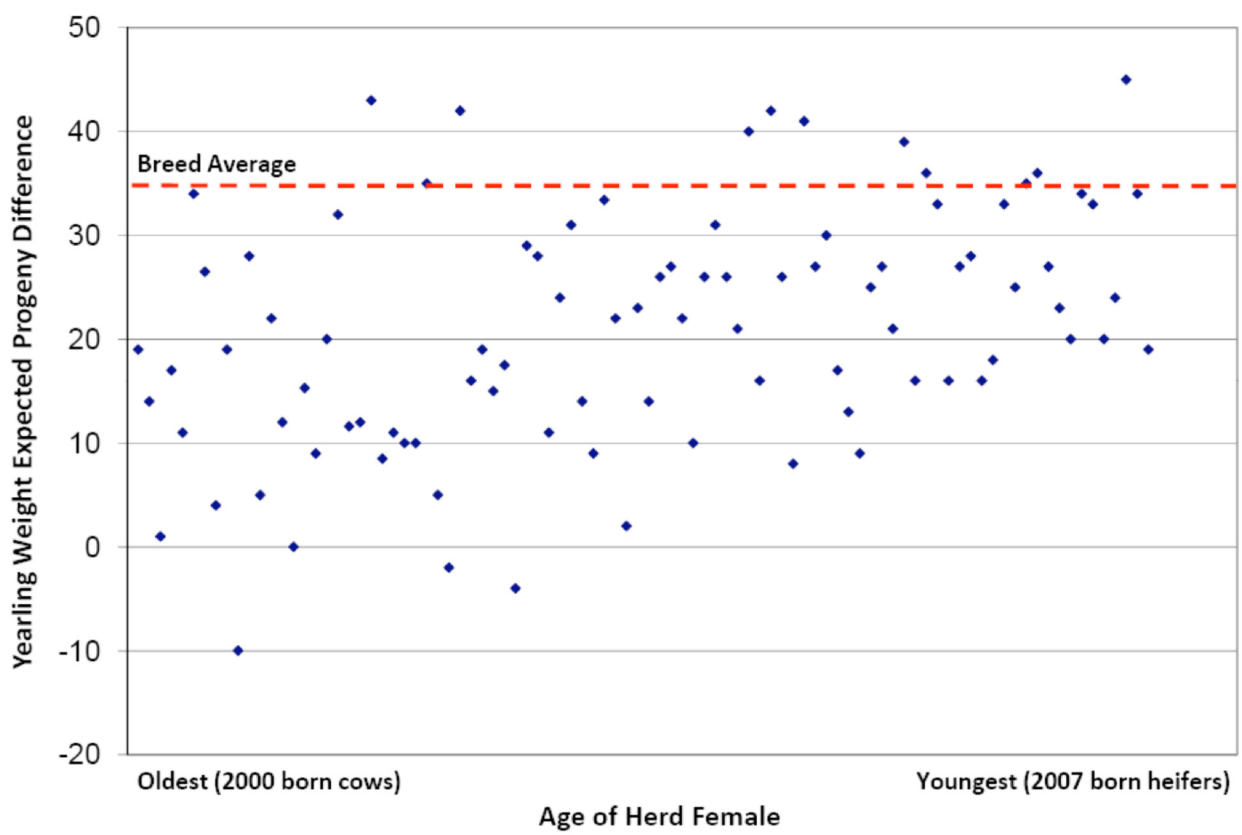


Figure 3. Example of yearling weight expected progeny differences for a beef cow herd.

well below breed average for YW EPD and younger females plus older females closer to breed average for YW EPD. The higher YW EPD and lower CED EPD bull could be mated to the older female group, while the other bull is mated to the younger female group.

This strategic mating plan should improve yearling growth genetics throughout the herd while also improving consistency for this trait. The females lagging further behind for this economically important trait are mated so their calves are more likely to exhibit desired performance levels. Although herd breeding decisions are often not this simple or clear cut, the general concept presented here can be applied to most situations. Adopt a balanced selection approach for several traits of interest.

Commercial Herds

While EPDs and selection indices for seedstock herds can be analyzed in determining the genetic potential of the cow herd, commercial breeders must rely on other means of evaluating herd genetics. Obvious herd performance shortcomings may be relatively easy to address, but it may be more difficult to define desirable herd sire EPD ranges for other less obvious traits. When selecting sires for a commercial herd, do not assume that because a prospective sire is above breed average for traits of interest he will improve those traits in the resulting calf crop. If the commercial herd is already performing at high levels for those traits, then breed average herd sires may actually work against genetic improvement.

It is very important to identify economically relevant traits for the commercial herd and to make a reasonable assessment of its performance levels for those traits. Extensive herd performance records will help in making these judgments. The EPDs of previously used herd sires serve as a rough guide for this assessment but still do not provide a complete picture of the herd's genetic potential. Knowledgeable seedstock providers may be a good resource to assist in matching herd sires to commercial herds.

Future Genetic Selection Tools

With each new national cattle evaluation, breed associations continue to release EPDs and selection indices for new traits or combinations of traits of interest. Current research focuses on expanding national cattle evaluations to include feed efficiency and health traits. In addition, multi-breed cattle evaluations where multiple beef cattle breeds combine data into a unified national cattle evaluation have great potential for expanding EPD use in commercial cattle operations. Preliminary multi-breed evaluations have already been run in cooperation with select beef cattle breed associations. Finally, further development of DNA-based technologies will improve and expand marker-assisted EPDs. This may lead to higher accuracy EPDs for cattle at younger ages.

Balanced and Disciplined Selection Approach

While EPDs and selection indices are invaluable genetic selection tools, cow-calf producers should not rely solely on "selection by numbers." Selecting solely on performance data and genetic predictions may ignore structurally unsound or infertile bulls that will do little for calf crop percentage and herd improvement. Conversely, selection based only on visual appraisal may ignore the genetic potential of a bull.

Producers are often tempted to select an "eye appealing" bull with little regard for his accompanying genetic information. Surveys of Mississippi beef cattle producers revealed that 66.4 percent of small producers and 71.2 percent of large producers considered bull appearance when selecting herd sires. However, only 17.4 percent and 51.2 percent of these small and large producers, respectively, used EPDs in sire selection. The proven effectiveness of using EPDs for genetic improvement in beef cattle herds makes EPDs a "must consider" selection tool. Making informed beef cattle selection decisions necessitates using selection tools that consider both genetic and performance information and functionality as part of a comprehensive evaluation of potential breeding animals.

Once breeding goals are defined based on herd evaluation, farm resources, and marketing plans, stick to them. Genetic improvement takes patience. Significant progress can be made in calf crop genetics when cow herd genetics are well below desired levels. However, when the breeding program brings the cow herd closer to a desired genetic level, the focus becomes fine-tuning certain traits without sacrificing performance in others.

Beef cattle producers (whether seedstock or commercial) should always keep in mind that they are ultimately involved in producing food. The results of breeding decisions made now will not be known for some time, and these decisions will affect calf crops and the food supply for years down the line. It is worthwhile to invest time and effort in studying genetic information for the herd and prospective breeding animals. A well thought-out breeding program is one of the best ways to improve cow-calf profitability, and it contributes to beef product improvement all the way to the final consumer. For more information on beef cattle sire selection, contact your local Mississippi State University Extension Service office.

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