Understanding and Utilizing EPDs to Select Bulls

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Beef sire selection decisions have a major impact on future calf crops and ultimately on profitability. Using available selection tools can help make better bull buying choices. A critical place to start when beginning the herd sire selection decision process is to evaluate the cow herd(s) that the sires will service. From these herd assessments, profiles of desirable herd sires can be developed. Then expected progeny differences (EPDs) and other selection tools can be used to make informed sire selection decisions.

Define Selection Goals

Different cow-calf operations 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, then growth performance is a priority in the selection process. Does calf crop color uniformity need improvement? If so, then 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, then 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, then attention needs to focus on yearling weights and carcass traits in selecting breeding animals.

Other factors to consider in bull 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 will impact the emphasis that needs to be placed on maternal traits. Table 1 provides examples of sire selection considerations for various production scenarios.

Evaluate Herd Genetics

With the extensive amounts of information available on prospective beef sires today, sire selection can be almost intimidating. In fact, the National Beef Cattle Evaluation Consortium published an entire manual on beef sire selection. Identifying the strengths and weaknesses of the cow herd is a critical first step in sire selection, whether matching artificial insemination or natural service sires to the herd. Instead of sifting through sale catalogs in search of the "perfect" bull, it is first essential to sort through the cow herd to see what traits need the most improvement and what traits need to be maintained at current levels or simply fine-tuned.

Begin by asking the following questions:

- What are the shortcomings or weaknesses in the herd?
- For what traits is the herd excelling?
- What traits am I currently getting paid for?
- Based on my marketing plans, what traits do I anticipate being economically important in the future?
- How consistent is the herd for traits of interest?

First priority in a cow-calf operation must be given to reproductive efficiency because of its significant impact on herd profitability. Complete breeding and calving records along with pregnancy check results allow producers to determine the current reproductive status as well as lifetime reproductive performance of herd females. Look at the herd as a whole and by age group to see if any trends are revealed. If problems are apparent, then look for underlying causes. For

Table 1. Example beef cattle production scenarios and associated sire selection considerations.

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

[1]EPD = expected progeny difference.

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

	Expected Progeny Difference (EPD)[1]																						
	Production							Maternal									Carcass[2]						
Breed	CE	BW	WW	YW	YH	SC	DOC	CEM	MILK	MG	MW	MH	ME	ST	HPG	GL	CWT	IMF	REA	FAT	YG	RP	TEND
Angus[3]	•	•	•	•	•	•	•	•	•	•	•	•	•		•		•	•	•	•			
Beefmaster		•	•	•		•			•	•													
Brahman		•	•	•					•								•	•	•	•		•	•
Brangus		•	•	•		•			•	•								•	•	•			
Braunvieh	•	•	•	•				•	•	•							•	•	•				
Charolais	•	•	•	•		•		•	•	•							•	•	•	•			
Chianina		•	•	•					•	•							•	•	•	•		•	
Gelbvieh	•	•	•	•		•		•	•	•				•		•	•	•	•	•			
Hereford	•	•	•	•		•		•	•	•								•	•	•			
Limousin[4]	•	•	•	•		•	•	•	•					•			•	•	•		•		
Maine-Anjou		•	•	•					•	•							•	•	•	•		•	
Red Angus	•	•	•	•				•	•	•			•	•	•			•	•	•			
Salers		•	•	•		•	•		•	•				•			•	•	•	•		•	
Santa Gertrudis		•	•	•					•	•							•	•	•	•			
Shorthorn	•	•	•	•				•	•								•	•	•	•		•	
Simmental[5]	•	•	•	•				•	•	•				•			•	•	•	•	•		•
South Devon		•	•	•		•			•	•							•	•	•	•			
Tarentaise	•	•	•	•					•	•													

[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; HPG = heifer pregnancy; GL = gestation length; 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. Angus currently reports both carcass- and ultrasound-based EPDs. Starting with the Fall 2008 National Cattle Evaluation, Angus carcass and ultrasound data will be combined into single carcass weight, marbling, ribeye area, and fat thickness EPDs.

[3]The Angus Optimal Milk Module allows custom inputs to determine the Angus optimal milk EPD range for an operation. Docility and 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.

instance, if the second-calf heifers have low rebreeding rates as a group, then look for potential causes such as less than optimum nutrition or a fertility or breeding problem with clean-up bulls. Forage test results, heat detection records, and breeding soundness examination results are additional records that can make this evaluation process more valuable. After looking at the herd in groups, evaluate individual herd females. The herd may be performing well for conception to first service or calf adjusted weaning weight, for example, but individuals within the herd may be underperforming in these areas. Identifying these individuals enables producers to make better culling, grouping, and related management decisions.

With seedstock herds, assessing EPDs for economically important traits is a logical place to start in evaluating herd genetics. This can then be coupled with other factors such as reproductive performance, temperament, muscling, frame size, structural soundness, and udder quality in the overall herd analysis. For commercial producers, identifying production strengths and weaknesses within the cow herd involves analyzing performance ratios and records. Adjusted calf weaning and yearling weights account for age of dam, calf sex, and calf age. Proper contemporary grouping and ratio calculation are a must if meaningful comparisons are to be made among herd mates. The latest edition of the *Uniform Guidelines for Beef Improvement* is posted on the Beef Improvement Federation website and provides detailed information on performance record measurement, calculation, and interpretation: *http://www.beefimprovement.org*.

Table 3. Across-breed expected progeny difference adjustment factors.[1]

	Trait			
Breed	Birth weight	Weaning weight	Yearling weight	Maternal milk
Angus	0.0	0.0	0.0	0.0
Beefmaster	9.0	42.2	43.7	-4.1
Brahman	12.1	38.5	2.6	26.7
Brangus	5.0	24.3	26.5	-3.1
Braunvieh	6.3	30.3	17.4	24.5
Charolais	9.6	40.9	48.7	3.5
Gelbvieh	4.4	7.0	-21.2	6.2
Hereford	2.7	-3.1	-12.7	-15.7
Limousin	4.0	-1.3	-24.0	-12.6
Maine-Anjou	7.1	-2.9	-31.9	-6.2
Red Angus	2.5	-4.7	-0.7	-5.1
Salers	4.2	30.7	43.5	12.8
Shorthorn	7.0	32.5	46.1	16.6
Simmental	5.7	24.4	17.0	13.7
South Devon	5.8	23.1	41.7	8.0
Tarentaise	3.0	31.9	18.3	20.0

[1]Adapted from Keuhn et al., 2007.

Selection Tools

Adjusted performance records

Many individual trait levels are adjusted for age of the animal and age of its dam. This allows for more fair comparisons of cattle for these traits. 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 that adjusted performance levels are truly adjusted levels and not, instead, actual performance levels.

Performance ratios

Individual performance ratios rank bulls compared to other bulls within their contemporary groups. A contemporary group of bulls would be bulls that were born within the same birth management group (same management system, calf age group, and age of dam group), managed together, and had performance data collected on the same dates. 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 that the animal's adjusted yearling weight was 15% higher than the average of its contemporary group. Likewise, an adjusted yearling weight ratio of 93 indicates that the animal's adjusted yearling weight was 7% lower than the average of its contemporary group

Consider the size of the contemporary group when evaluating performance ratios. A contemporary group of three does not provide information as useful as a contemporary group of 30, for example. Generally, larger contemporary groups give better indications of cattle performance compared to other cattle than smaller contemporary groups. In fact, many breed associations will not accept performance data for use in national cattle evaluations to produce expected progeny differences 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 (Table 2). Expected progeny differences provide predictions of the expected performance for specific traits of the calves (progeny) sired by a particular bull compared to the expected performance of calves sired by another bull or group of bulls. They are based on the performance records of an individual, its relatives, and its progeny.

Expected progeny differences are currently the best predictors of the genetic performance of an individual animal. They are available for a growing number of economically relevant traits. Different breeds will 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 run multiple times per year. This varies by breed, but the important point here is to make sure that EPDs being used are current. For instance, bull sale catalogs may be published before an upcoming national cattle evaluation is released. The EPDs reported in the catalog would then be dated soon after its distribution.

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 different beef cattle breeds to estimate across-breed EPDs. The most recent update appears in Table 3. 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.

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.

Expected progeny differences can change over time as additional performance information is collected. Expected progeny differences come with accuracy values that give an indication of 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, the more accurate or reliable its EPDs become. 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.

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 BW, WW, YW, and Milk EPDs, while the "Unproven Sire" has low EPD accuracy values (ACC = 0.05) for the same

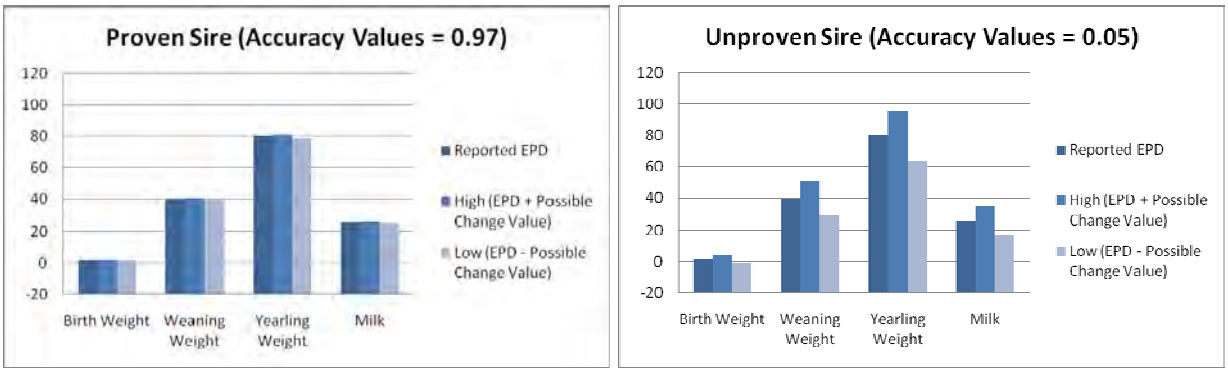


Figure 1. Accuracy and possible EPD change example of expected progeny differences for two Angus bulls.

Table 4. Selection indices currently available by beef cattle breed.

Breed	Selection Index	Abbreviation
Angus	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.

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 that little change in EPD values is expected in the future as additional performance data is reported to the breed association. The low accuracy values of the "Unproven Sire" indicate that the reported EPDs are less reliable and subject to more possible change as additional performance data is 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 his 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 may still be the best genetic prediction available on an animal for use in selection decisions.

Marker-assisted EPDs are a relatively new selection tool. Marker-assisted EPDs 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 due to genetics. 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 is 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 only be used 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 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 comprising the selection index and the relative emphasis placed on these traits within the index calculation. This allows fine-tuning of selection index use within a specific herd. Selection indices currently available from beef cattle breed associations are listed in Table 4. Definitions of specific selection indices are available from the respective breed associations.

Customizable selection indices provide breeders with the option to rank cattle according to production and economic conditions specified by the user. Several

breed associations provide web-based versions of selection indices that allow the user to enter their own values for various inputs such as herd size, average cow weight, nutrition-related costs, and market prices. Customizable selection indices can be used to rank bulls for the specific production and economic environment in which they intended to be used. The end result is a simulation of ranch-specific production and marketing conditions in which potential herd sires can be compared.

Common EPD Myths and Selection Pitfalls

Actual birth weight versus birth weight EPD

Birth weight EPDs are selection tools that give an indication of expected calf birth weights relative to calves out of other cattle within a breed. Unlike actual birth weight data, which is for an individual animal, birth weight EPDs combine information from the individual animal and its relatives. Breed associations publish sire summaries that contain breed average EPDs and percentile rankings within the breed that can be useful benchmarks for comparison purposes.

Just because a bull has a higher actual birth weight than another bull, it does not mean that 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. An example from a recent bull sale illustrates this point. Actual birth weights and birth weight EPDs from a two bull calves born four days apart in the same cattle herd and sold through the sale are as follows:

Bull A
Born September 6, 2007
Actual birth weight = 76 pounds
Birth weight EPD = 3.4

Bull B
Born September 10, 2007
Actual birth weight = 83 pounds
Birth weight EPD = 1.7

These bulls were of the same breed and managed the same in one contemporary group. Bull A weighed seven 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 heavier 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

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 several of the other factors impacting calf birth weights are components of calving ease EPDs published by a growing number of breed associations. Birth weight is accounted for in the 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 calving ease scores that assess observed calving ease 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 a particular animal that are expected to require assistance at calving out of two-year-old heifers. For example, a bull with a calving ease direct EPD of +10% compared to a bull within the same breed with a calving ease direct EPD of +2% is expected to sire, on average, 8% (10 – 2) more calves that can be born unassisted.

Calving ease maternal EPDs, on the other hand, give an indication about the expected assistance required at calving for calves out of an animal's two-

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 daughter's calving ease and is the ease with which an animal's daughters calve as first-calf heifers.

Selection for calving ease

It is important to approach sire selection with the needs of the cow herd in mind. Calving ease may be an essential consideration in the selection process, particularly when first-calf heifers are to be bred. First, decide what level of calving difficulty is acceptable in the herd. Mature cows may be expected to calve unassisted, while assistance may be acceptable for a few of the heifers. Labor availability may also influence how a calving ease bull is valued. Sire selection is a balancing act where a little may have to be given up in one trait to make gains in another trait. By prioritizing the needs of the cow herd and comparing sires using available information on breeding and genetic potentials, bulls can be found that fit each unique cow-calf operation.

EPDs for maternal traits

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 due to the milk production of the dam.

In addition to milk EPDs, some breed associations report EPDs that combine the effects on calf weaning weights of a dam's milk production and the growth potential she transmits to her calves. 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 traits such as carcass traits.

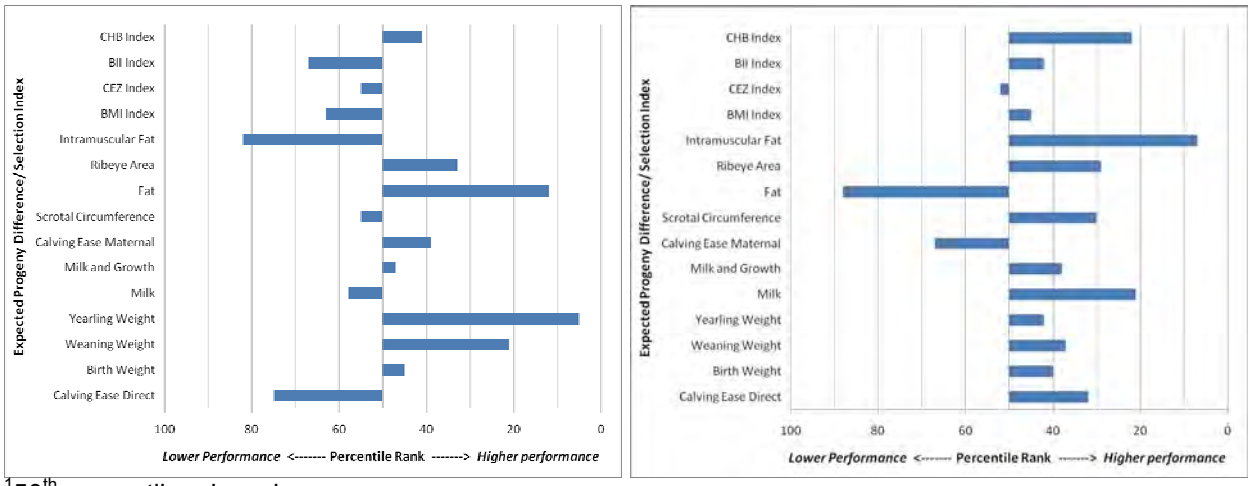
Intermediate EPD optima

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 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 that nutrient requirements of lactating cattle are met and rebreeding is not hindered by inadequate nutrition.

Nutritional and other environmental factors will 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 that 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, high 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 has been shown to increase both weaning weights and efficiency to weaning in the cow-calf sector, with mixed results on efficiency to slaughter. 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



[1]50th percentile = breed average.

Figure 2. Percentile rank profile example of expected progeny differences and selection indices for two Hereford bulls.[1]

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 be applicable 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

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, sire selection should not be based solely on one trait such as birth weight or calving ease. There are performance tradeoffs that must be considered. 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 too much ground is given up 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 commonly encountered 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, but also increases the dam's nutrient requirements. If these increased nutritional needs are not met, then 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 that is 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

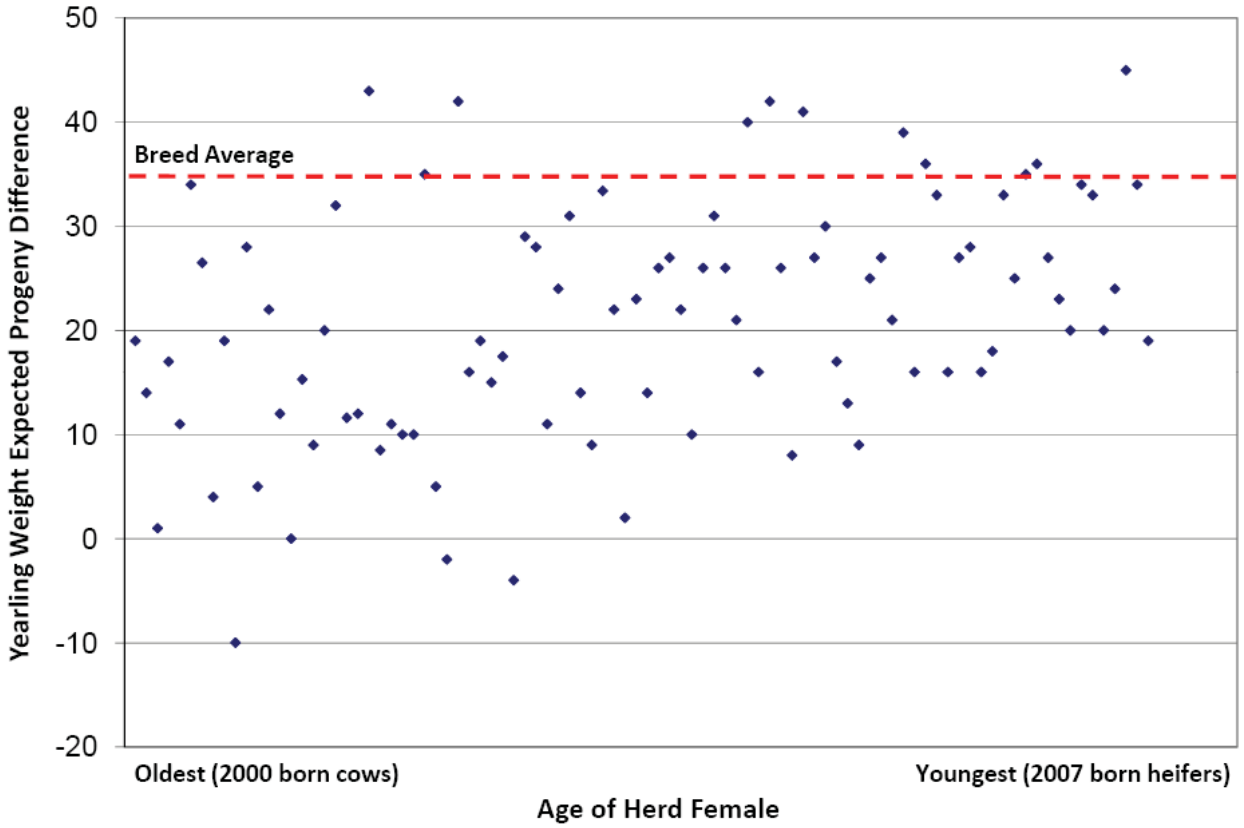


Figure 3. Example of yearling weight expected progeny differences for a beef cow herd.

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.

Ranking Potential Herd Sires

Breed associations report EPD 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 allow producers to see where cattle rank within their breed 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 (Figure 1). 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 depicted in Figure 2. 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 purposes.

In assessing EPD and selection index profiles, do not get caught up in searching for the "perfect" bull. Dr. Daryl Strohbehn, with Iowa State University, once referred to producers who have severe independent culling levels as living in a "dream world" if they planned to routinely find natural service sires

who met all of their criteria. He was referring to 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, homozygous polled genetics, etc. The take home message is to be realistic about breeding goals, and be prepared to make trade-offs 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 through natural mating.

Assessing Traits of Interest

Seedstock herds

For seedstock herds, EPDs and selection indices of the cow herds can be utilized in establishing herd benchmarks for individual traits and determining variability within herds for these traits. Sire selection becomes more challenging when it is discovered that 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. For example, Figure 3 shows yearling weight (YW) EPDs for an actual herd. Notice that the older herd females are more variable in terms of YW EPD than the younger females. It also appears that there is a genetic trend within the herd for increased YW EPD in the younger generations. In fact, the average YW EPD of the 2007 born heifers is approaching breed average, while the average YW EPD of the 2000 and 2001 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 can be used to evaluate many economically important traits. In the yearling weight example above, the data indicates that use of high YW EPD sires should be a priority for this herd. Consider the following scenario. After artificial insemination to a performance sire offering high yearling growth, the operation has two bulls available for use as clean-up bulls. One is in the top 25% of the breed for YW EPD, while the other one is in the top 50% 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 EPD that is very acceptable for breeding heifers. The herd analysis for YW EPD shows that herd females can be grouped into older herd females well below breed average for YW EPD and younger herd females plus older herd females closer to breed average for YW EPD.

This strategic mating plan should improve yearling growth genetics throughout the herd while improving consistency for this trait as well. The females that are lagging further behind for this economically important trait are mated such that 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. A balanced selection approach for several traits of interest should be undertaken.

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 other less obvious traits may be more difficult for which to define desirable herd sire EPD ranges. When selecting herd sires for a commercial herd, do not assume that because a prospective sire is above breed average for traits of interest he will improve the calf crop for those traits when mated to that commercial herd. 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 herd 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 to approaching 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.

Table 5. Beef cattle breed performance levels for selected traits.[1,2]

	Trait						
	---------- Production ---------		------- Maternal ------		---------- Carcass ----------		
Breed	Growth Rate and Mature Size	Tropical Adaptability	Age at Puberty	Milk Production	Lean to Fat Ratio	Marbling (Intramuscular Fat)	Tenderness
Angus	XXXX	X	XX	XXX	XX	XXXX	XXX
Beefmaster	XXXX	XXX	XXX	XXX	XXX	XX	XX
Brahman	XXXX	XXXX	XXXXX	XXXX	XXXX	XX	X
Brangus	XXXX	XXX	XXX	XXX	XXX	XXX	XX
Braunvieh	XXX	XX	XX	XXXX	XXXX	XXX	XX
Charolais	XXXXX	X	XXXX	XX	XXXXX	XX	XX
Chianina	XXXXX	XX	XXXX	X	XXXXX	XX	XX
Gelbvieh	XXXX	X	XX	XXXX	XXXX	X	XX
Hereford	XXXX	X	XXX	XX	XX	XXX	XXX
Limousin	XXX	X	XXXX	X	XXXXX	X	XX
Maine-Anjou	XXXXX	X	XXX	XXX	XXXX	XX	XX
Red Angus	XXXX	X	XX	XXX	XX	XXXX	XXX
Salers	XXXX	X	XXX	XXX	XXXX	XX	XX
Shorthorn	XXXX	X	XX	XXX	XX	XXXX	XXX
Simmental	XXXXX	X	XXX	XXXX	XXXX	XX	XX
South Devon	XXX	X	XX	XXX	XXX	XXXX	XXX
Tarentaise	XXX	X	XX	XXX	XXX	XX	XX

[1]Adapted from Cundiff, 2003.
[2]Increasing numbers of Xs indicate relatively higher value.

Advance Planning for Sire Selection

No matter what the source, knowledgeable herd sire selection and bull or semen procurement requires prior planning. Stay informed of upcoming sale dates, times, and locations by monitoring industry publications and websites. Keep up with semen offerings through bull studs and individual breeders. Make sure that catalog and mailing list addition requests are made in a timely manner. Take time to scan through bull sale catalogs in advance of sales where potential herd sires will be purchased.

Bull registration numbers are typically listed in sale catalogs. They can be obtained directly from breeders as well. Registration numbers allow bull buyers to "do their homework" behind the scenes. Breed association websites have search tools that not only allow for individual bulls to be researched, but also relatives including calves out of the bulls or out of the bulls' parents. Calving intervals of dams, performance ratios, current EPDs, pedigrees, and birth dates are some examples of data that are easily accessible on the Internet for many breeds. Sometimes after sale catalogs are printed, EPDs are updated prior to the sale. Looking up current EPDs on sale lots of interest can provide more reliable information about the sale offering in this case.

An easy step when sorting through sale lots is to eliminate bulls that obviously do not match selection goals. Then effort should be put into ranking the remaining herd sire candidates. A "short list" that ranks the bulls on paper and lists all bulls that should be evaluated at the sale site should be prepared before the sale. In the case of production sales and even consignment sales, the ranches of origin can be visited ahead of time to view the sale offering. The short list of prospective bulls for purchase can then be refined.

Farm visits are ideal times to evaluate cattle type and structural soundness and to ask questions about herd health specifics, bull nutritional programs, and herd performance records. Viewing in-herd relatives of bulls being considered for purchase is another reason to schedule a farm visit. Dams, sires, full siblings, and half siblings may be available for evaluation. Breeders may even recommend that prospective buyers visit with past satisfied customers about their bull purchases and resulting calf crops.

Table 6. United States beef cattle breed registrations.

Breed	2007 Registrations	Percentage of 2007 Total	1997 Registrations	Change from 1997-2007
Angus	347,572	43.5	239,476	+45%
Beefmaster	18,202	2.3	47,349	-62%
Brahman	8,300	1.1	16,000	-48%
Brangus	25,097	3.1	27,727	-9%
Charolais	74,569	9.3	49,223	+51%
Chianina	9,270	1.2	7,864	+18%
Gelbvieh	36,222	4.5	30,178	+20%
Hereford[1]	69,344	8.7	106,608	-35%
Limousin	37,742	4.7	61,462	-39%
Maine-Anjou	12,316	1.5	12,300	+0%
Red Angus	47,064	5.9	33,875	+39%
Salers	14,399	1.8	10,809	+33%
Santa Gertrudis	7,500	0.9	11,000	-32%
Shorthorn	19,700	2.5	15,474	+27%
Simmental[2]	52,258	6.7	51,390	+2%
Total	779,555	100.0	738,629	+6%

[1]Horned and polled.
[2]Includes Simbrah.
Source: National Pedigreed Livestock Council 2007-2008 Annual Report.

Breed considerations and resources

Breed is an important consideration in ranking herd sires. An organized crossbreeding program can capitalize on hybrid vigor while producing calves with a desirable combination of characteristics from multiple breeds. Hybrid vigor or heterosis is the amount by which the average performance for a trait in crossbred calves exceeds the average performance of the two or more purebreds that were mated in that particular cross. In addition, different breeds tend to excel for different traits (Table 5). A well-designed crossbreeding program can combine the performance strengths among several breeds. Considerations for designing a crossbreeding program may include the current breed composition of the herd, whether or not replacement heifers will be kept, market targets, environmental conditions, and forage and feed resources.

In selecting herd sires, it is useful to have a sense of the pool from which bulls are available. The National Pedigreed Livestock Council recently released data from their member organizations showing the 15 largest beef cattle registries recorded at least 7,500 animals. Registrations of those 15 largest associations, and comparative numbers from 10 years ago, are shown in Table 6. Contact information for these breed associations appears in Table 7. These breed associations can serve as a valuable resource for EPD specifics and other genetic improvement information.

Angus and Red Angus together had almost 50% of registrations. Breeds with the highest percentage increases from 1997 to 2007 were Charolais, Angus, Red Angus, Salers, and Shorthorn. Breeds with the highest percentage decreases were Beefmaster, Brahman, Limousin, Hereford, and Santa Gertrudis. By functional type for the fifteen largest beef cattle breeds, the four British breeds made up 62%, the seven Continental breeds 30%, and the four Brahman/American breeds 8%. Those respective figures in 1987 were 53, 32, and 15% and in 1997 were 55, 31, and 14%.

Future Genetic Selection Tools

With each new national cattle evaluation, breeds 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 usefulness and use in commercial cattle operations. Preliminary multi-breed

Table 7. Beef cattle breed association contact information.

Breed	Association[1]	Website	Address	Phone
Angus	American Angus Assoc.	www.angus.org	3201 Frederick Ave. St. Joseph, MO 64506	816.383.5100
Beefmaster	Beefmaster Breeders United	www.beefmasters.org	6800 Park Ten Blvd., Suite 290 West San Antonio, TX 78213	210.732.3132
Brahman	American Brahman Breeders Assoc.	www.brahman.org	3003 South Loop West, Suite 520 Houston, TX 77054	713.349.0854
Brangus	International Brangus Breeders Assoc.	www.int-brangus.org	P. O. Box 696020 San Antonio, TX 78269-6020	210.696.4343
Braunvieh	Braunvieh Assoc. of America	www.braunvieh.org	3815 Touzalin Ave. Suite 103 Lincoln, NE 68507	402.466.3292
Charolais	American-International Charolais Assoc.	www.charolaisusa.com	11700 NW Plaza Circle Kansas City, MO 64153	816.464.5977
Chianina	American Chianina Assoc.	www.chicattle.org	1708 N. Prairie View Rd. P. O. Box 890 Platte City, MO 64079	816.431.5381
Gelbvieh	American Gelbvieh Assoc.	www.gelbvieh.org	10900 Dover St. Westminster, CO 80021	303.465.2333
Hereford	American Hereford Assoc.	www.hereford.org	P. O. Box 014059 Kansas City, MO 64101	816.842.3757
Limousin	North American Limousin Foundation	www.nalf.org	7383 S. Alton Way Suite 100 Centennial, CO 80112	303.220.1693
Maine-Anjou	American Maine-Anjou Assoc.	www.maine-anjou.org	204 Marshall Rd. P. O. Box 1100 Platte City, MO 64079-1100	816.431.9950
Red Angus	Red Angus Assoc. of America	redangus.org	4201 N. Interstate 35 Denton, TX 76207-3415	940.387.3502
Salers	American Salers Assoc.	www.salersusa.org	19590 E. Main St. Suite 202 Parker, CO 80138	303.770.9292
Santa Gertrudis	Santa Gertrudis Breeders International	santagertrudis.com	P. O. Box 1257 Kingsville, TX 78364	361.592.9357
Shorthorn	American Shorthorn Assoc.	www.shorthorn.org	8288 Hascall St. Omaha, NE 68124	402.393.7200
Simmental	American Simmental Assoc.	www.simmental.org	1 Simmental Way Bozeman, MT 59715	406.587.4531
South Devon	North American South Devon Assoc.	www.southdevon.com	19590 E. Main St. Suite 202 Parker, CO 80138	303.770.3130
Tarentaise	American Tarentaise Assoc.	www.americantarentaise.org	9150 North 216th St. Elkhorn, NE 68022	402.639.9808

[1]Beef cattle breed associations among the top 15 in U.S. registrations or U.S. breed associations reporting expected progeny differences.

cattle 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 available. 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 only based 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. The proven effectiveness of utilizing EPDs for genetic improvement in beef cattle herds makes EPDs a "must consider" selection tool. As with performance tradeoffs among individual traits, performance tradeoffs among visual appraisal of soundness and conformation and genetic predictions are warranted for marketability reasons. Making informed sire selection decisions necessitates using selection tools considering both genetic and performance information and functionality as part of a comprehensive evaluation of potential sires.

Once breeding goals are defined based on herd evaluation, farm resources, and marketing plans, producers should stick to them. Genetic improvement takes patience. Significant progress can be made in the genetics of the calf crop when cow herd genetics are well below desired levels. However, when the breeding program brings the cow herd to a level where genetics are closer to desired levels, then the focus becomes fine-tuning certain traits without sacrificing performance in others. The results of breeding decisions made now will not be known for some time, and these decisions will affect calf crops for years down the line. It is worthwhile to invest time and effort in studying the herd. 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 a local Extension Service office.

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Notes: