Usage and Interpretation of Current and Future Production and Carcass EPDs

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Introduction

Ever since farm animals were first domesticated, producers have striven to identify and utilize genetically superior animals in their breeding programs. But, how can we identify those that are genetically superior? Selection, for many years, was based strictly upon visual observation. Still today, it is the method of choice used by many producers. In fact, the show ring was developed as an entity where superior breeding animals could be identified and modeled for the industry (Zollinger, 1998). However, there have been many cases where the pendulum of desired phenotypic selection, based on the judge's opinion, swung beyond that which was acceptable to commercial cattle producers. In the 1950s, cattle were too small; so in the 1970s, frame was emphasized. The cattle were large and grew fast, but encountered problems with carcass quality and female longevity. Today, "moderately sized, functional" cattle are being selected; but throughout history, producers have always strived to select "functional" cattle, only the parameters have changed.

Recognizing the economic value of various production traits, producers have attempted to quantify those traits by weighing the cattle and calculating performance. The actual weights provide additional information, but they still represent a phenotypic evaluation and are greatly influenced by the environment. Given that a trait such as weaning weight may only be 25% heritable, 75% of the phenotypic variation observed in the population is due to the environment. Table 1 provides a listing of heritability estimates for many economically important beef cattle traits. Certainly, this variation, which to a large degree is uncontrollable, has great implications for making genetic improvements through selection.

Advances in computer technology, however, have allowed large databases of production information to be analyzed and the genetic potential of an animal to be extracted based on that individual's performance information and that of related animals (such as the sire, dam, and other relatives). The resulting expected progeny difference (EPD) is expressed as a plus or minus value, and reflects the genetic transmitting ability of the sire or dam (Taylor, 1994). Initially, EPDs were developed for basic traits including birth weight, weaning weight, yearling weight, and milk production. Today, however, many breed associations have either developed or are in the process of developing EPDs for temperament, reproduction, and carcass merit. There is literally a plethora of genetic information available, and sometimes, it may be overwhelming.

EPDs and their Proper Usage

Quantitative traits such as growth rates and reproduction are controlled by a large number of gene pairs. This literally results in an infinite number of genotypic possibilities in the offspring from the mating of two parents where each parent is responsible for transmission of one-half of the genes. Those genes represent a random sampling from the parent (Northcutt and Buchanan, 1998a), and consequently, quantitative traits exhibit continuous variation. Desiring to make genetic improvement through selection, individuals that excel for a designated trait are selected and used for propagation of offspring. Granted, 60 to 90% of the phenotypic variation may be associated with environmental factors, but that selected individual should also possess a genetic superiority for the given trait, and through selective reproduction, change will occur. An animal's genetic superiority or inferiority compared to the average of the population is known as a breeding value. Since each parent will contribute only one-half of the genes inherited by an individual, an EPD represents one-half of the estimated breeding value of that individual.

Most EPDs are reported as plus or minus values in the units of measurement for the trait. For example, birth, weaning, and yearling weight EPDs are measured in pounds of calf where the theoretical average is zero. However, a few breeds report certain EPDs as a ratio (Gelbvieh calving ease) where 100 represents the theoretical average. Regardless of expression, values should be used to compare or rank the genetic superiority of individual animals because they provide a prediction of how future progeny of one individual should perform compared to the progeny of another individual within a specific breed for a specific trait (Northcutt and Buchanan, 1998a). For example, assume that Sire A has a weaning weight EPD of +30 and Sire B has a weaning weight EPD of +20. If bred to cows of similar genetics, the offspring of Sire A would average 10 lbs heavier (30 - 20 = 10) at weaning than the offspring of Sire B. Again, continuous variation for the trait will be exhibited by the offspring of both sires, but the average will be 10 lbs greater for Sire A than Sire B.

Additionally, it is common for EPD values of young sires to change over time. Obviously, the true genetic value of that sire does not change, but as more information becomes available regarding the performance of his offspring, estimates of his genetic worth (expressed as an EPD) become more accurate. Accuracy values that range from 0.0 to 1.0 accompany EPDs to provide a measure of reliability and prediction of the average change that might occur due to sampling errors. Most sire summaries will include a table that shows the accuracy level and associated possible change. The more data used in the calculation of an EPD, the more accurate the estimate, and the less likely that change will occur. For example, in the Angus breed (American Angus Assoc., 1999), an accuracy of .10 for the yearling weight EPD has an associated standard error of ±16.0 lbs, whereas the standard error associated with an accuracy of .90 is only ± 7.3 lbs. If a young sire has a reported yearling weight EPD of +50 and an accuracy of .10, the actual EPD could statistically vary from +34 to +66 lbs. If the accuracy was .90, the range would be from +43 to +57. In reality, the predictions are relatively stable, but change is inevitable as progeny data become available. Minimal changes are expected for EPDs that possess an associated accuracy of .70 or greater. These values may be used for comparative purposes with confidence.

Because each breed association that publishes EPDs must utilize a reference population or base year to generate their EPDs, current values are not comparable across breeds and should not be used as absolute values of genetic worth (Zollinger, 1998). The reference population year and corresponding EPDs are different for each breed and may change from year to year. Consequently, the actual average EPD value rarely equals zero. In fact, if the breed association uses a standard base year from which to develop and compare EPDs, the average EPD value for any given trait will change over time because of genetic progress. Assume that a superior sire exhibited a yearling weight EPD of +30 in 1980, and that there has been the equivalency of 40 lbs of genetic progress (yearling weight EPD) within the breed since that time. If the breed average equaled zero in 1980, the breed average today using the same base year would be +40. Obviously, genetics of that superior sire in 1980 did not change, but genetic progress of the breed surpassed him. If used today, that sire would be of inferior genetic worth for the trait in question compared to other sires available.

Debate exists regarding the usefulness of EPD averages in a selection program. True, EPDs should be used to simply compare the genetic value of two individuals within a breed for a given trait. However, breed averages and percentile rankings that are supplied by most breed associations allow the producer to more accurately assess both genetic and economic worth of a sire compared to all sires within the breed available for purchase or use (through artificial insemination). For example, assume that you wish to select a calving ease Gelbvieh sire to be used on first-calf heifers and that the birth weight EPDs of Sire A and Sire B are +4.0 and +6.0, respectively. Using a direct comparison, and assuming that the bulls would be bred to comparable females, calves of Sire A should average 2 lbs lighter at birth, on average, than those of Sire B. However, evaluation of the 1999 Gelbvieh Sire Summary would indicate that the average birth weight EPD for the breed is only +1.9 lbs, and the EPD values of both Sire A and B would be among the heaviest 10% within the breed. Neither sire is acceptable for the given criteria.

Furthermore, caution must be exercised in realizing that positive or negative EPDs do not necessarily reflect absolute changes in the offspring. In other words, Sire A (birth weight EPD of +4) will sire calves that are 3 lbs heavier, on average, than those of Sire B (birth weight EPD of +1). However, Sire A would not be expected to add 4 lbs of birth weight to your calves unless your current sire has a birth weight EPD of 0. Although many EPD values are measured in lbs of calf, they do not represent additive values. They should be used only to compare the genetic merit of sires within a given breed.

Maternal EPDs

Table 2 provides a listing of maternally oriented EPDs that are either currently offered or being developed by each of the major breeds of cattle commonly used throughout Florida.

Producers have long realized the economic impact of dystocia. A review of the literature by Bellows and Short (1994) revealed that neonatal losses at the time of birth represent a 5.9% reduction in the average calf crop. Given that birth weight is the single most important factor associated with dystocia (Rice and Wiltbank, 1972), producers often select for low birth weights in the hopes that calving difficulty will be minimized. However, actual birth weight is not a good predictor of an individual's genetics for calving ease when compared to other traits available for evaluation (Weaber and Gibb, 1996). Nearly all breed associations publish birth weight EPDs, which allow for more accurate selection of calving ease sires.

However, birth weight is not the only factor associated with calving ease. Birth weight and dam pelvic area combined explain only 25% of the variability associated with dystocia (Rice and Wiltbank, 1972). Thus, two breed associations (Gelbvieh and Simmental) report calving ease EPDs in addition to the standard birth weight EPD. For the Simmental breed, the calving ease EPD represents the ease with which a bull's calves are born to first-calf heifers and are reported as a deviation in the percentage of unassisted births. When comparing the EPDs of two animals, a larger EPD indicates a higher percentage of unassisted births (easier calving). If Sires A and B had calving ease EPDs of +3.0 and +1.0, respectively, then calves produced from Sire A and born to first-calf heifers should average 2% fewer assisted births than those fathered by Sire B. The Gelbvieh breed expresses their calving ease EPD as a ratio, with a higher ratio representing easier calving. Values greater than the theoretical average of 100 indicate above average calving ease (fewer difficult births) and ratios below 100 indicate below average calving ease (more difficult births). In a study that used a 100-lb birth weight as a selection benchmark, 33% of bulls with an actual birth weight less than 100 lbs were below average for calving ease. Likewise, trait leaders for birth weight within the Simmental breed are not necessarily trait leaders for calving ease. Whenever both birth weight and calving ease EPD values are available, the calving ease EPD will provide a more accurate assessment of potential calving difficulty. Additionally, both breeds also report maternal calving ease (Simmental) or the calving ease of daughters (Gelbvieh). These values represent the calving ease (as previously defined) that a sire transmits to his daughters.

Milking ability is also an important maternal trait. Certainly, adequate milk production is required to achieve high weaning weights, but at the same time, heavy-milking cows have increased nutritional requirements. Often, weaning weight may be used as an indicator of maternal ability, however, weaning weight is a poor measure of a dam's milk yield because of the confounding influence of the calf's growth potential (Mallinckrodt et. al., 1993). Therefore, weaning weight EPDs simply evaluate differences in genetic potential for growth from birth to weaning. The maternal milk EPD, however, can be difficult to comprehend because it does not represent actual milk production. Instead, it predicts differences in the weaning weight of calves from daughters of various sires, due to differences in milk production or mothering ability (Northcutt and Buchanan, 1998b). If the maternal milk EPDs of Sires A and B were +10 and -5, respectively, the difference is 15 lbs. Thus, the expected difference in weaning weight, due to milk production differences alone, in calves from the daughters of the two sires would be 15 lbs. The units are expressed in pounds of calf, not pounds of milk. Most breed associations also report a combined maternal index or total maternal value. This EPD simply reflects both the milking ability transmitted to the daughters combined with the direct growth from birth to weaning that is transmitted through daughters to the calves. Thus, total maternal values may be calculated as the maternal milk EPD plus ½ of the weaning weight EPD. Only one-half of the weaning weight EPD is included because only one-half of the genes to any given offspring will be transmitted through the dam (daughter of the original sire).

Reproduction EPDs

Most reproductive traits are lowly heritable and largely influenced by environmental factors. Still, sound reproduction is economically critical to the beef cattle enterprise so there has been a major emphasis among certain breed associations to develop reproduction EPDs. The most commonly reported reproductive EPD available is for scrotal circumference. The data is relatively easy to collect and the measurements are highly repeatable. Furthermore, use of yearling scrotal circumference in the selection of bulls is highly recommended because of its relationship to age of puberty and overall fertility in the bull and subsequent replacement offspring. Currently, five breed associations (Table 3) publish scrotal circumference EPDs and at least four others are in the process of having them developed. These EPDs are expressed in centimeters (cm), and higher values indicate that sons of particular sires should have greater testicular development at 12 months of age. Since yearling scrotal circumference in bulls and age at first cycling (puberty) in heifers are similar traits, it would also be expected that daughters of a particular sire should be expected to reach puberty earlier. Remember, however, that scrotal circumference is simply being used as a predictor of other, more important reproductive traits, and it should not be used as a substitute for a breeding soundness examination. The Simmental and Simbrah breeds are currently working on projects (Dr. Jerry Lipsey, personal communication) to develop a sexual maturity EPD.

Another reproductive EPD that has been developed and may be used as an indicator of overall herd fertility is stayability. This EPD is published for both the Limousin and Red Angus breeds. Stayability predicts the probability that a cow (sire's daughters) will remain in the herd for at least six years. Obviously, the stayability of any cow is contingent on the breeders' culling criteria, but given that most producers cull heavily because of reproductive failure, it is thought to indicate genetic differences in sustained reproduction. These values are reported as a percentage or probability. For example, Sire A and B have stayability EPDs of +15 and +5, respectively. If sires A and B were bred to comparable cows, 10% more of daughters from Sire A would be expected to remain in production until the age of six years compared to daughters of Sire B. It may also be said that each daughter of Sire A would be expected to have a 10% greater likelihood of staying in production to at least six years of age.

Cows are expected to produce a calf every 365 days, and average gestation lengths vary from 283 to 295 days dependent upon the breed type, genetic selection, and environmental/seasonal factors. Cattle genetically selected for shorter gestation lengths should more time to recuperate from the stresses of calving and to start cycling postpartum. An EPD for gestation length is published for the Gelbvieh and Limousin breeds, and this value is expressed in days. A negative value represents a shorter gestation length compared to the theoretical average whereas a positive value represents longer gestation lengths.

Additional reproductive EPDs being developed by the Limousin breed (Dr. Kent Anderson, NALF Director of Education and Research, personal communication) include an EPD to predict pregnancy. Based on experimental calculations, the heritability of the pregnancy trait is estimated at .20 within the Limousin breed, and the EPD values would likely range from -10 to +10 measured in terms of a percentage. The theoretical average of zero would represent the average pregnancy rate of the breed during the reference year, and positive values would indicate that a greater percentage of females sired by a particular bull would be expected to become pregnant than those sired by the average bull. It's possible that this EPD might be released within a 1-2 years.

Pregnancy and reproductive efficiency is greatly influenced by nutrition. Consequently, the usage of body condition scoring as a tool to subjectively evaluate the adequacy of the nutritional program in meeting the cows' requirements has been encouraged for many years. Optimum reproductive efficiency occurs when cows possess a body condition score of 5 at calving (Rae et al., 1993). In response, the North American Limousin Foundation is conducting study (Dr. Kent Anderson, personal communication) in the development of a body condition score EPD expressed as the probability that a cow (sire's daughters) would maintain a body condition score of 5 or greater. Obviously, body condition is greatly influenced by environmental factors, primarily nutrition. Still, the EPD should be able to accurately rank the genetic ability of daughters to maintain body condition regardless of the environment. On a high plane of nutrition, the cow may possess a body condition score of 7, whereas on a low plane of nutrition, that same cow may possess a body condition score of 4. But in both cases, that cow's ranking for body condition among her contemporaries should not change.

Growth and Mature Size EPDs

Weaning and Yearling weight EPDs have been used extensively by producers because they are relatively easy to comprehend and their economic value is readily ascertained. In commercial beef production, producers are paid for each pound of calf or product sold. If Sire A (weaning weight EPD = +20) and Sire B (weaning weight EPD = +10) were used on the same group of cows, calves from Sire A would be expected to average 10 lbs more weight at weaning than those from Sire B. Given a value of $.60/lb, that represents $6.00 per animal sold at weaning, which is substantial given low margin returns and large inventories of many producers. Likewise, if calves from different sires are exposed to the same environmental conditions and are from cows of similar genetic merit, then the yearling weight EPD can be used to predict differences in salable weight at one year of age. Often, the yearling weight EPD is used as an indicator of feedlot growth performance.

Expected progeny differences that represent body weight or size at a given point in time (birth, weaning, and yearling) are not only important when evaluating the genetic growth potential of salable offspring, but they represent important considerations for those animals retained as breeding stock. As mature body size and weight increases, maintenance requirements also increase (NRC, 1996). The cows consume more feed, and if they are not properly matched to their environment, will ultimately lose body condition and reproductive performance will decline. Consequently, producers of many breeds have emphasized moderation of size. In response, the Angus breed now publishes a yearling height EPD (expressed in inches of height at one year of age) and maturity EPDs for both weight (lbs) and height (inches) of a sire's daughters. These values may be used to increase or decrease mature cow size dependent upon the producer's individual objectives and environmental or marketing considerations. Similar EPDs are currently being developed for the Limousin breed.

Carcass EPDs

As the beef industry strives to more adequately meet consumer demands for a consistent, quality and palatable product that is free of excess fat, value-based marketing will become more important. Already, numerous marketing opportunities exist where producers are paid based on the true value of their product. In response, commercial producers have demanded more carcass information on potential herd sires and replacement breeding stock. However, traditional collection of carcass data is both time and labor intensive. Furthermore, this procedure involves a major time lag. If a potential sire was collected and used at 15 months of age, a minimum two-year time lag would exist between the usage of that bull as a sire and the collection of any carcass data on his progeny. Thus, collection of data and development of carcass EPDs based on actual cutout information is a slow, expensive process. Of all breeds that currently publish carcass EPDs, only Gelbvieh EPDs are based on actual cutout data. Others either use ultrasound or a combination of both ultrasound and cutout data.

However, the advent of ultrasound technology has spurred interest and development of carcass EPDs, but producers have questioned the accuracy of ultrasound measurements. A review of the literature indicates that ultrasound fat thickness measured between the 12th and 13th rib has a correlation of .96 with that of the actual carcass data. In fact, some technicians and researchers believe that the ultrasound fat thickness may actually be more accurate than that measured on the carcass due to the potential of excess fat being removed during the hide pulling process. Correlations between ultrasound and carcass ribeye area range from .62 to .94, and reported correlations for ultrasound estimations and actual quantity of intramuscular fat, which can be used as an objective measure of marbling, range from .60 to .80. Provided that technicians are properly trained and equipment is properly maintained, ultrasound technology can provide an accurate assessment of carcass value in the live animal. To provide consistency, ultrasound data on bulls should be collected at approximately one year of age. Measurements taken at this age predict end product traits as accurately as similar measures made immediately prior to slaughter (Hassen, et al., 1999).

A listing of various carcass EPDs are shown in Table 5. Because consumers and retail outlets currently demand greater portion control, carcass weight increasingly become an important value factor. Carcasses that weigh less than 550 or more than 950 lbs are heavily discounted, and the window of carcass weight acceptability is expected to narrow. The "ideal" carcass weight according to National Beef Quality Audits is approximately 750 lbs. Carcass weight EPDs are expressed in lbs of carcass weight. If Sires A and B have carcass weight EPDs of +10 and -5, then offspring of Sire A should produce carcasses that are 15 lbs heavier at an age constant endpoint than those produced by Sire B provided they were bred to genetically similar cows. A negative EPD value for carcass weight does not necessarily imply that absolute carcass weights will be reduced. That depends on the genetic merit of your current sires for carcass weight compared to the proposed sire to be used. Emphasis for selection of increased or decreased carcass weight is both individual and situation-specific. It will depend on your cowherd and your marketing constraints (available premiums and discounts) associated with carcass weight.

Ribeye area EPDs, expressed in units of square inches, offer an objective assessment of genetic differences in muscle. Larger values indicate larger ribeye areas and increased overall muscle mass in the live animal and on the carcass. Sires with larger numeric ribeye area EPDs would be expected to produce offspring that also have greater ribeye areas on an age constant basis. However, bigger is not necessarily better. One of the primary concerns of purveyors, restaurant managers, and retailers is that many steaks are too large. In order to serve a 6, 8, or 12 ounce portion, the steak must be cut so thin that it is difficult to prepare and maintain acceptable palatability.

Excessive external fat represents a major economic loss to the beef industry so some breeds generate fat thickness EPDs expressed in inches of fat measured between the 12th and 13th rib. Although it would appear that producers should simply select cattle that have reduced fat (lower fat thickness EPD) to minimize excessive trim loss, extremely lean cattle represent potential for cold induced shortening (causes toughness) and fleshing ability problems in the cow herd ("hard doers") if heifers are retained (Anderson, 1999). Thus, it may be wise to use the fat thickness EPD to limit usage of both genetically fat or extremely lean breeding stock.

Both muscle and fat are important factors in the determination of yield grades or percentage of retail product that is available from a given carcass. Thus, some breeds have developed and publish a percent retail product (cuts) EPD. For Angus cattle, the percent retail product EPD combines the traditional traits (hot carcass weight, fat thickness, ribeye area, and KPH) into a composite EPD (American Angus Association, 1999). The EPD is expressed as a percentage and is heavily influenced by the fat thickness measurement, which accounts for 42 to 48% of the variation in percent retail product (Hassen et al., 1999). Live and ultrasound traits measured in cattle at one year of age can be used to predict percent retail product with great accuracy. Validation of percent retail product models showed correlations that ranged from .78 to .88 between predicted and actual cutout values (Hassen et al., 1999).

Marbling is a subjective evaluation of the quantity of intramuscular fat and is one of the two major factors used in determination of beef quality grades. Marbling score EPDs are expressed in units of numeric marbling score according to Beef Improvement Federation Guidelines (Table 6). Thus, if Sires A and B have marbling score EPDs of +.25 and -.25, carcasses from the offspring of Sire A would be expected to score .50 units higher than the average of carcasses produced from Sire B, due to genes passed on from the sires for marbling score. This assumes that the cattle from both groups would be fed under identical environmental conditions. Specifically, how would your cattle grade? That depends upon numerous factors including, but not limited to, the current genetic propensity of your cattle to deposit intramuscular fat, the age of cattle when slaughtered, the diet and number of days fed, etc. The EPD provides a comparison of the genetic worth of two sires for a single trait evaluated under similar environmental conditions. The Brangus association (Lauren Jackson, personal communication) reports an intramuscular fat EPD instead of marbling score.

Marbling and intramuscular fat provide juiciness and flavor to the meat, but the major factor associated with acceptable palatability of beef is tenderness. Ultimately, tenderness is extremely important to the consumer, and beef often lacks consistency for the trait. The American Simmental Association is involved with a major study to evaluate tenderness genetics among their most popular Simmental and Simbrah sires. Their hope is to eventually develop and publish a tenderness EPD (Dr. Jerry Lipsey, personal communication) that may be expressed in lbs of shear value. It could also be presented as the probability that offspring would have a shear value of less than some threshold deemed acceptable to the consumer such as 6 lbs.

Summary

National cattle evaluations and computerized technology have made it possible for breed associations to develop and publish EPD values for nearly any trait that is measurable and repeatable. Never before, have beef producers had so much genetic information available from which to make selection decisions. The plethora of EPDs available may seem overwhelming, but it is imperative that producers strive to utilize this information if they are to remain profitable and viable entities within the beef industry. However, each production and marketing situation is different. Each producer must develop their own breeding program and target those genetic changes that allow him/her to be competitive in the market place. Many traits are interrelated and a proper balance of economically production traits is essential. Expected progeny differences represent a powerful tool for making genetic change, but other factors such as structural and reproductive soundness are also important. Remember, EPDs are simply a selection tool that allow you to compare the genetic worth of two individuals within the same breed.

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Table 1. Heritability estimates[a] of economically important traits in beef cattle

Traits	Heritability[b] (%)
Mature cow weight	50
Calving Interval (fertility)	10
Calving ease	10
Calf survival	10
Birth weight	30
Weaning weight	25
Post-weaning gain	30
Efficiency of gain	35
Yearling weight (feedlot)	40
Yearling weight (pasture)	35
Carcass weight	25
Dressing percent	40
Carcass quality grade	40
Marbling	40
Ribeye area	40
Thickness of outside carcass fat	45
Lean percent	55
Tenderness	30

[a]Ensminger and Perry, 1997.
[b]Heritabilities below 20% are considered low, those 20-39% are considered medium, and those over 40% reflect highly heritable traits.

Table 2. Current EPD averages[a] for maternal EPDs offered by breeds commonly used in Florida

			Dystocia		Milking Ability		
Breed	Summary Year	BW[b]	CE[c]	CED[d] MCE[d]	WW[e]	MM[f]	TM[g] CMV M&G MWW
Angus	1999	1.62	—	—	11.59	4.64	10.43
Hereford	1998	4.10	—	—	33.00	9.00	26.00
Red Angus	1998	0.90	—	—	25.80	10.20	22.80
Charolais	1999	2.10	—	—	13.80	6.70	13.60
Gelbvieh	1999	2.20	102	103	33.00	18.00	35.00
Limousin	1999	1.20	—	—	8.30	2.30	6.40
Simmental	1999	4.30	2.20	1.40	37.70	7.30	26.10
Beefmaster	1998	-2.50	—	—	7.20	2.75	—
Braford	1999	DNC[i]	—	—	DNC[i]	DNC[i]	DNC[i]
Brahman	1999	1.60	—	—	11.30	5.40	—
Brangus[h]	1999	1.40	—	—	15.00	0.60	8.00
Santa Gertrudis	1999	0.90	—	—	6.90	1.30	4.70
Simbrah	1999	4.70	UD[j]	UD[j]	23.00	4.30	15.80

[a]Because each breed has a different database and base of year from which averages and genetic progress are measured, **AVERAGES PRESENTED ARE NOT COMPARABLE ACROSS BREEDS**.

[b]BW = Birth Weight; expressed in lbs of calf.

[c]CE = Calving Ease (direct); expressed as a percentage or ratio. This value represents the direct influence of a sire on calving ease. Some breeds express the average as 100 (Gelbvieh) and others express the average as 0 (Simmental). However, in both cases, a larger number represents easier calving.

[d]CED = Calving Ease of the Daughters (Gelbvieh, MCE = Maternal Calving Ease (Simmental); expressed as a percentage or ratio. This value represents the calving ease that a sire transmits to his daughters. Some breeds express the average as 100 (Gelbvieh) and others express the average as 0 (Simmental). However, in both cases, a larger number represents easier calving.

[e]WW = Weaning Weight (direct); expressed in lbs of calf.

[f]MM = Maternal Milk; expressed in lbs of calf. This value represents the genetic ability of a sire's daughters to produce milk expressed in lbs of weaning weight.

[g]TM = Total Maternal; expressed in lbs of calf. This value reflects both the maternal ability of a sire's daughters and the growth potential of their calves. Usually calculated as MM + ½ WW direct. Other breeds term this value differently; CMV = combined maternal value (Angus), M&G = milk and growth (Hereford), MWW = maternal weaning weight (Simmental, Simbrah).

[h]Brangus EPDs include both black and red Brangus (submitted to the International Red Brangus Breeders Association).

[i]DNC = These breeds do not calculate breed averages for their EPDs.

[j]UD = EPDs currently under development.

Table 3. Current EPD averages[a] for reproduction EPDs offered by breeds commonly used in Florida

Breed	Summary Year	SC[b]	SM[c]	GL[d]	Stay[e]	Preg[f]	BCS[g]
Angus	1999	.02	—	—	—	—	—
Hereford	1998	.40	—	—	—	—	—
Red Angus	1998	—	—	—	5.80	—	—
Charolais	1999	UD[i]	—	—	—	—	—
Gelbvieh	1999	.10	—	-0.60	—	—	—
Limousin	1999	.10	—	-0.30	12.00	UD[i]	UD[i]
Simmental	1999	UD[i]	UD[i]	—	—	—	—
Beefmaster	1998	—	—	—	—	—	—
Braford	1999	UD[i]	—	—	UD[i]	—	—
Brahman	1999	—	—	—	—	—	—
Brangus[h]	1999	.30	—	—	UD[i]	—	—
Santa Gertrudis	1999	—	—	—	—	—	—
Simbrah	1999	UD[i]	UD[i]	—	—	—	—

[a]Because each breed has a different database and base of year from which averages and genetic progress are measured, **AVERAGES PRESENTED ARE NOT COMPARABLE ACROSS BREEDS**.

[b]SC = Scrotal Circumference; expressed in cm.

[c]SM = Age at Sexual Maturity.

[d]GL = Gestation Length; expressed in days.

[e]Stay = Stayability; expressed as a percentage. This value predicts genetic differences in the probability that daughters of a sire will remain in production until 6 years of age or beyond.

[f]Preg = Pregnancy; possibly expressed as a percentage. This value under current development will be designed to predict genetic differences in the probability that daughters of a sire will become pregnant.

[g]BCS = Body Condition Score; possibly expressed as a percentage. This value under current development will be designed to predict genetic differences in the probability that daughters of a sire will maintain a body condition score of 5 (moderate condition).

[h]Brangus EPDs include both black and red Brangus (submitted to the International Red Brangus Breeders Association).

[i]UD = EPDs currently under development.

Table 4. Current EPD averages[a] growth and mature size EPDs offered by breeds commonly used in Florida

Breed	Summary Year	BW[b]	WW[c]	WH[d]	YW[e]	YH[f]	MW[g] (Dtrs)	MH[h] (Dtrs)
Angus	1999	1.62	11.59	—	20.48	0.35	10.09	0.78
Hereford	1998	4.10	33.00	—	56.00	—	—	—
Red Angus	1998	0.90	25.80	—	43.20	—	—	—
Charolais	1999	2.10	13.80	—	24.00	—	—	—
Gelbvieh	1999	2.20	33.00	—	59.00	—	—	—
Limousin	1999	1.20	8.30	UD[j]	15.80	UD[j]	UD[j]	UD[j]
Simmental	1999	4.30	37.70	—	51.70	—	—	—
Beefmaster	1998	-2.5	7.20	—	17.00	—	—	—
Braford	1999	DNC[k]	DNC[k]	—	DNC[k]	—	—	—
Brahman	1999	1.60	11.30	—	19.60	—	—	—
Brangus[i]	1999	1.40	15.00	—	27.00	—	—	—
Santa Gertrudis	1999	0.90	6.90	—	8.60	—	—	—
Simbrah	1999	4.70	23.00	—	28.20	—	—	—

[a]Because each breed has a different database and base of year from which averages and genetic progress are measured, **AVERAGES PRESENTED ARE NOT COMPARABLE ACROSS BREEDS**.

[b]BW = Birth Weight; expressed in lbs of calf.
[c]WW = Weaning Weight (direct); expressed in lbs of calf.
[d]WH = Hip Height at Weaning; expressed in inches of height.
[e]YW = Yearling Weight; expressed in lbs of calf.
[f]YH = Hip Height at one year of age; expressed in inches of height.
[g]MW = Mature Weight of Daughters; expressed in lbs of mature weight.
[h]MH = Mature Hip Height of Daughters; expressed in inches of height.
[i]Brangus EPDs include both black and red Brangus (submitted to the International Red Brangus Breeders Association).
[j]UD = EPDs currently under development.
[k]DNC = These breeds do not calculate breed averages for their EPDs.

Table 5. Current EPD averages[a] for carcass EPDs offered by breeds commonly used in Florida

Breed	Summary Year	Docility[b]	CW[c]	REA[d]	FT[e]	PRP[f] PRC	MS[g]	% IM Fat[h]	Tend[i]
Angus	1999	—	6.17	.12	-.002	0.08	.06	—	—
Hereford	1998	—	—	—	—	—	—	—	—
Red Angus	1998	—	—	—	—	—	—	—	—
Charolais	1999	—	UD[k]	UD[k]	UD[k]	UD[k]	UD[k]	—	—
Gelbvieh	1999	—	1.00	.01	.000	—	-.02	—	—
Limousin	1999	5.20	8.70	.13	.000	—	.01	—	—
Simmental	1999	—	0.00	—	—	0.00	.00	—	UD[j]
Beefmaster	1998	—	—	—	—	—	—	—	—
Braford	1999	—	—	—	—	—	—	—	—
Brahman	1999	—	—	—	—	—	—	—	—
Brangus[j]	1999	—	—	.10	-.002	—	—	-.01	—
Santa Gertrudis	1999	—	—	—	—	—	—	—	—
Simbrah	1999	—	UD[k]	—	—	UD[k]	UD[k]	—	UD[k]

[a]Because each breed has a different database and base of year from which averages and genetic progress are measured, **AVERAGES PRESENTED ARE NOT COMPARABLE ACROSS BREEDS**.

[b]Docility is expressed as a percentage. This value may be used to rank bulls according to their temperament and expected temperament of their offspring. Larger values mean that a greater percentage of that sire's offspring would exhibit acceptable rather than nervous or aggressive behavior.

[c]CW = Carcass Weight; expressed in lbs of carcass.

[d]REA = Ribeye Area; expressed in square inches of ribeye area measured between the 12th and 13th rib.

[e]FT = Fat Thickness; expressed in inches of outside fat cover measured between the 12th and 13th rib.

[f]PRP = Percent Retail Product (Angus), PRC = Percent Retail Cuts (Simmental).

[g]MS = Marbling Score; expressed as a "score" of marbling. When comparing sires, higher marbling scores represent greater quality.

[h]% IM fat = Percent Intramuscular Fat, expressed as a percentage of the ribeye weight sampled. Intramuscular fat is the fat located within the ribeye muscle, and it is the fat that graders evaluate as they assign marbling scores and quality grades.

[i]Tend = Tenderness, potentially expressed either as lbs of shear force or as a ratio (probability that sires would shear greater than or less than a certain shear value that would represent the acceptability threshold.

[j]Brangus EPDs include both black and red Brangus (submitted to the International Red Brangus Breeders Association).

[k]UD = EPDs currently under development.

Table 6. Beef quality grades and associated numerical marbling scores.

Quality Grade	Amount of Marbling[a]	Numerical Score[b]
High Prime	Abundant	10.0-10.9
Average Prime	Moderately Abundant	9.0–9.9
Low Prime	Slightly Abundant	8.0-8.9
High Choice	Moderate	7.0-7.9
Average Choice	Modest	6.0-6.9
Low Choice	Small	5.0-5.9
Select	Slight	4.0-4.9
High Standard	Traces	3.0-3.9
Low Standard	Practically Devoid	2.0-2.9
Utility	Devoid	1.0-1.9

[a]USDA marbling classifications.
[b]Beef Improvement Federation numerical marbling scores.

NOTES: