Chapter 3

BEEF CATTLE SELECTION

The goal of beef cattle production is to provide highly desirable beef for consumption in the most efficient manner. Knowledge of breeding, feeding, management, disease control and the beef market is fundamental to the economical production of desirable beef.

The beef cattle industry is composed of six basic segments: (1) the purebred breeder, (2) the commercial producer, (3) stocker or backgrounding operations, (4) the cattle feeder, (5) the beef packer and (6) the retailer. The purebred breeder maintains seed stock to provide bulls and, occasionally, females for the commercial producer. The commercial producer provides feeder calves and yearlings to the stocker operator who, in turn, furnishes the cattle feeder who provides the packer with finished cattle ready for slaughter. The packer slaughters the cattle and provides the retailer with either dressed carcasses or wholesale cuts from these carcasses. The retailer cuts, trims and packages the beef for the consumer. Interdependence exists among these segments because each affects cost of production or desirability of product or both. The profits that accrue to all segments of the beef cattle industry depend on continued improvement in productive efficiency and carcass merit.

Major Performance Traits

All traits of economic value should be considered when selecting beef cattle. The major traits influencing productive efficiency of desirable beef are:

- reproductive performance or fertility
- maternal ability
- growth rate
- feed efficiency
- body measurements
- longevity
- carcass merit, and
- conformation or structural soundness

Maximum production efficiency is not necessarily related to maximum performance levels in all of these traits due to unfavorable genetic associations between certain traits. For example, high levels of milk production and large cow size are associated with rapid growth rate in the calf but are not desirable when feed supplies are limited because reproduction in the cow is adversely affected.

Fertility

A high level of fertility, or reproductive performance, is fundamental to an efficient beef cattle enterprise. Fertility is commonly measured in terms of calf crop percentage, and no single factor in commercial cow-calf operations has greater bearing on production efficiency than the number of calves weaned per cow in the herd. The percentage calf crop can easily range from 70 to 95 percent. However, as noted in Table 5 on page 15, the heritability of calving interval or fertility is low (10 percent). Therefore, most of the variation in calving percentage results from environmental factors such as feeding, management or herd health.

Fertility is a complex trait. Many environmental and genetic factors affect fertility from the time a cow is turned with a bull until her calf is weaned. Basic cow herd records should report calf crop percentage to determine if a problem exists. Where fertility or calf crop percentage is low, very detailed records should be kept on reproductive traits to identify management, nutrition, herd health or genetic problems that can be modified to improve reproductive performance in the herd.

The association between fertility and other performance traits, both positive and negative, should be recognized. For example, selection for heavy weaning weight can result in increased milk production or larger cow size in the herd or both and necessitate a higher nutritional level for the cow herd to maintain a satisfactory fertility level. On the other hand, culling open cows or problem breeders to improve reproductive performance in the herd with no regard for the specific cause for low reproductive performance will decrease the average milk production and cow size in the herd. Also, increased birth weight is associated with increased rate of gain and mature size. Calving difficulty as a result of heavy birth weights can cut deeply into calf crop weaned by reducing calf survival at birth and conception rate in the cow the following breeding season.

Maternal Ability

The ability of a cow to wean a healthy, vigorous calf is vital to efficient beef production. Increased milk production increases weaning weight per calf, and heavier weaning weights can increase efficiency of production in relation to fixed costs for the total herd. However, feed requirements and costs per cow are closely related to cow size and level of milk production. Thus, milk production must be matched with feed resources to maximize efficiency of production. Optimum milk production is neither maximum nor minimum milk production in most situations. Increased weaning weight per calf from

milk production can be detrimental if weaning weight per cow is reduced as a result of poor rebreeding performance or market value is diminished by a wasty condition.

Growth Rate

Growth rate is important because of its high association with economy of gain in relation to fixed costs. Growth rate has usually been measured in time constant, post-weaning feeding tests. A reasonably high level of feeding for at least 112 days is desirable to appraise differences in growth rate most accurately.

Genetic correlations among measures of growth or size at different ages usually are high. Selection for rapid rate of gain in post-weaning feeding tests usually increases both birth weight and mature size. Increases in birth weight contribute to increased calving difficulty. Increased mature size decreases carcass quality when slaughtered at normal market weights and increases the nutrient requirements for maintenance of the cow herd.

Ideally, the beef animal should be of moderate weight at birth, grow rapidly, but mature and finish for slaughter early. But, the selection criterion to obtain such a growth curve is complex.

Feed Efficiency

Feed efficiency is a trait of great economic importance in beef cattle. Feed efficiency is difficult to evaluate because individual feeding and adjustments for differences in weight are required. Increased weight is associated with higher feed requirements per unit of gain. To be meaningful, feed efficiency should be measured in feeding tests designed within the framework of present-day cattle feeding and marketing practices.

Breeders largely depend on differences in rate of gain as an indicator of feed efficiency rather than incur the added expense of individual feeding. Some bull testing stations obtain individual feed consumption information to measure the pounds of feed required per pound of animal gain.

Body Measurements

Objective body measurements can be useful selection aids. Some common measurements of cattle include backfat, height at the shoulder, height at the hips, length of body, depth of body, scrotal circumference and pelvic size.

Linear body measurements are helpful in matching mature animal size to production resources. Body measurements were never intended to be used only for the purpose of selecting for a larger size. These measurements should also never be interpreted as a replacement for the weight of a beef animal at a given age. No one specific size for an animal will be ideal for all feed and management resources, breeding systems and feed costs. Reproductive rate and market weight ultimately determine the optimum range in size for a given set of feed and management resources, breeding systems and production costs.

Hip height measurement is the most commonly used body measurement in selection programs. The recommended point for measurement of height is directly over the hip bones, or hooks (Figure 9). These measurements may be converted to frame scores using the bull and heifer hip height tables in the Appendix.

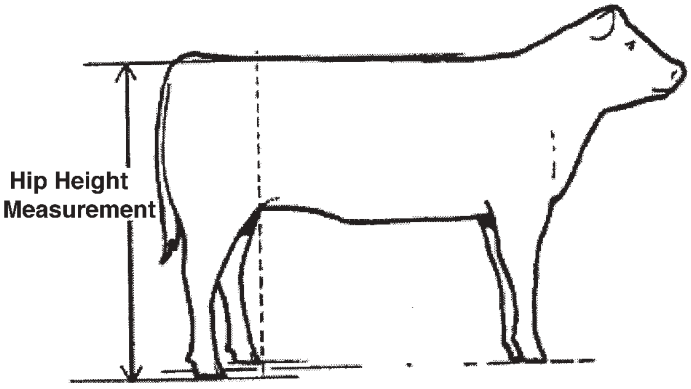

FIGURE 9. Hip height measurement.

Longevity

The longer animals remain productive in a herd, the fewer replacements will be needed. Thus, the cost of growing replacements to productive age is reduced. Longevity is especially important in the commercial cattle herd.

The major factors affecting longevity of cows are infertility, unsoundness of feet and legs, udder troubles and unsound mouth.

Purebred breeders should be concerned with making genetic improvement in longevity for the benefit of the commercial beef cattle population. However, animals retained in purebred herds to an old age increase the generation interval which reduces the possible rate of genetic improvement from selection. Selection for longevity should be confined primarily to such indicators as structural soundness.

Carcass Merit

Carcass merit is of basic importance to the beef cattle industry. The desirability of the beef product determines the price consumers are willing to pay and the amount they are willing to purchase at that price.

Consumers desire beef with a high percentage of lean as compared to fat and bone, and the lean must be tender, flavorful and juicy. The difference in the percentage of lean, often called cutability, is a major factor influencing differences in carcass value. It is not uncommon for carcasses of the same quality to range from 10 to 30 percent fat trim. However, such differences in composition are due to both environmental and genetic variations.

Beef quality, which includes such characteristics as tenderness, flavor and juiciness, can have an important influence on consumer acceptance and value. Beef quality is determined by marbling, texture, color, firmness and maturity.

The genetic association between cutability and quality is negative. Selection for high quality will usually diminish cutability, and selection for high cutability will often lower beef quality. Also, selection for rate of gain or mature size often will diminish carcass quality.

Conformation and Structural Soundness

Conformation and structural soundness are performance traits to the extent that they contribute to functionality and longevity, feed efficiency and carcass merit. Conformation in live cattle is normally a subjective evaluation of thickness of natural fleshing or muscling. Differences in conformation or muscling can be used to reflect potential differences in carcass cutability without having to obtain carcass data. Also, feed efficiency relates to muscling among cattle of similar growth pattern and mature size. Structural soundness is particularly important for productive grazing and pasture breeding. Sound hips, hocks, shoulders and feet are valuable for longevity in the herd.

Selection Methods

Three approaches to selection are (1) tandem selection, (2) selection based on independent culling levels and (3) selection based on an index of net merit.

Tandem is selection for one trait at a time. When the desired level of performance is reached in this trait, a second trait is given primary emphasis, etc. This is the least effective of the three types of selection. Its major disadvantage is that by selecting for only one trait at a time, some animals extremely poor in other traits will be retained as replacements. This method of single trait selection is not recommended

Selection based on independent culling levels requires that specific levels of performance be obtained in each trait before an animal is kept for replacement. This is the second most effective type of selection. However, selecting for specific levels of performance in all traits does not allow for slightly substandard performance in one trait to be offset by superior performance in another.

Selection based on an index of net merit gives weight to the traits in proportion to their relative economic importance and their heritability and recognizes the genetic association among traits. This can be the most effective type of selection, but the importance of each individual trait in the index should vary depending upon the needs and desires of each individual producer. This balanced selection approach considers multiple economically relevant traits at one time.

Buying a Herd Bull

Purchasing the next herd sire is one of the most important decisions that a cattle producer makes. Because every calf in the herd gets half of its genetic makeup from the sire and half from its dam, the sire is said to be half the herd. In actuality, studies of selection experiments have shown that the sire may be responsible for as much as 90 percent of the change in a trait such as weaning weight. The sire influences the herd in two ways. First, he changes the current calf crop. Secondly, he influences later calf crops through daughters that are retained for use as brood cows. The sire's influence may be either in a positive or negative direction. A commercial cattle producer should consider many questions when buying a bull.

1. Should I buy a performance-tested bull?

Performance testing is nothing more than keeping a record of performance on the traits of interest and using these records to make selection decisions. Performance testing programs provide cattle producers with reliable information for identifying animals with superior genetic potential for the traits of production measured by the test. By using the information as a basis for herd sire selection, a breeder can greatly increase the chances of obtaining a bull that will sire rapid-gaining, more efficient, high-quality calves. Such calves can increase profits for both the breeder and the feeder.

2. Do I buy a young bull or an older proven bull?

Usually more weanling and yearling bulls are available to select from than older, proven bulls. Obviously, more performance information is available on an older bull; but in some cases, the older bull is for sale because of poor performance. Occasionally, an outstanding older bull is for sale by a breeder that has retained replacement heifers

from him. Usually, buying yearling bulls will offer the greatest number of bulls with the most complete records from which to select. Use of virgin bulls is helpful in limiting the introduction of diseases into the breeding herd.

3. What performance information should I expect?

The records maintained by purebred breeders range from none to very elaborate record keeping systems. Basic performance information should include birth date, birth weight, weaning weight, yearling weight and number in the contemporary group on all bulls. Sufficient records to evaluate the bull's sire and dam are preferred. Expected progeny differences (EPDs) are a valuable selection tool that should be used when available. Structural soundness, type and conformation can be evaluated visually. Always conduct a breeding soundness evaluation on yearling or older bulls.

4. What performance levels should I require in the bull?

When selecting a herd sire, buy bulls that are above average of the source herd in the traits of interest. Individual records are meaningful but may be greatly influenced by the environment in which the bull was tested. Comparison to other animals tested in the same environment provides some indication of genetic difference. EPDs give estimations of genetic merit for many economically relevant traits and allow comparisons to be made between bulls within the same breed or with breed averages.

5. What about performance by the bull's sire and dam?

The herd sire should come from a cow that has been a regular producer, has consistently weaned calves heavier than the herd average and is strong structurally. The sire should be an outstanding individual in the desired performance traits and should have proven ability to transmit his characteristics to his offspring.

6. How much is a bull worth?

Performance information along with EPDs gives an indication of the expected performance of a bull's calves for particular traits such as growth performance relative to the performance of calves sired by another bull or group of bulls. Using this information, educated purchasing decisions can be made regarding the purchase price differences that can be justified when comparing bulls. To illustrate differences in bull value, the following is an actual scenario from the Livestock and Forestry Branch Station in Batesville, Arkansas. Bull A and Bull B were exposed to cows of similar genetic merit. Bull A sired calves that weighed on average 436 pounds at weaning. Calves sired by Bull B weighed 543 pounds on average at weaning.

Weaning weight difference between Bull B and Bull A = 543 pounds - 436 pounds = 107 pounds

Lighter weight calves typically sell at a higher price per pound than heavier weight calves. If calves sired by Bull A could be sold for $0.92 per pound and calves sired by Bull B could be sold for $0.78 per pound, then gross returns from each bull would be as follows:

Bull A: 436 pounds x $0.92 per pound = $401 per calf sold

Bull B: 543 pounds x $0.78 per pound = $424 per calf sold

The difference in gross returns per calf would then be:

$424 (Bull B) - $401 (Bull A) = $23 per calf

If each bull can be expected to sire 25 calves per year, then the difference in gross returns per year between the two bulls would be:

$23 per calf x 25 calves per year = $575 per year

Over 5 years, the difference in gross returns between the two bulls would be:

$575 per year x 5 years = $2,875

If Bull B costs $1,000 more than Bull A, then it would take 20.9 months to capture the difference in purchase price with added returns from calf sales:

$1,000 ÷ $575 per year = 1.74 years or 20.9 months

By using Bull B as a herd sire beyond 20.9 months, a producer can more than justify paying the $1,000 premium for him over Bull A. This ignores interest and depreciation costs and assumes that there are only weaning weight differences in the calves sired by the two bulls. If Bull B is also superior to Bull A in his ability to transmit heavier muscling, enhanced carcass characteristics or other economically important traits to his calves, then an even higher premium may be justified over the same payback period. This illustrates the financial importance of making bull-purchasing decisions based on as much useful and reliable information as is available.

7. What is the reputation of the herd from which selection is made?

The honesty and integrity of the owner and manager, the overall performance of the herd and the management practices under which the bull has been developed are extremely important to the prospective bull buyer.

Selecting Replacement Heifers

These traits should be considered when selecting heifers from the herd for brood cow replacements: (1) reproductive performance in the heifer's dam, (2) maternal ability of the heifer's dam, (3) weaning weight and yearling weight of the heifer, (4) conformation and (5) soundness.

When the heaviest heifers are selected at weaning, the results are improved maternal ability and growthiness in the herd. Heifers which fail to grow and develop after weaning should be culled at breeding time. Conformation is best evaluated after the heifer has reached yearling age. The third selection can be made after the heifers wean their first calves. Remove heifers that either fail to calve or produce poor calves. Generally, the first calf is a good indication of a cow's production in succeeding years.

For a 100-cow herd, about 16 heifers will usually be needed for replacements each year to maintain numbers. More than 16 may be needed if considerable culling is done at breeding time and after the first calf.

Performance Records

The Extension Service can assist beef cattle breeders with developing a systematic set of performance records. It also can help in utilizing these records in decisions relative to individually defined objectives within their breeding programs. Defined objectives and a planned breeding program are fundamental to attaining the maximum rate of genetic improvement in economically important traits in beef cattle. An organized improvement program with selection based on differences in records is basic to any planned breeding program.

Success in breeding superior beef cattle depends on the ability of the breeder to make accurate decisions while working toward his objectives. The more a breeder knows about the individuals in his herd and the more clearly he understands his objectives, the more likely he is to make correct decisions. Records from a complete improvement program provide the basis for making accurate decisions. A breeder's objectives for improvement can be reached only through a planned breeding program based on the use of performance data in selection.

Performance records should have flexibility and be helpful to both purebred and commercial cattle producers for comparing cattle within the same herd, breed, sex, age group and management group (Figure 10). Performance records are not designed for estimating differences between herds or between groups managed differently within a herd, because environmental differences are likely to exist.

FIGURE 10. Weighing calves and measuring hip height for performance testing.

Two types of performance testing programs are available to beef cattle breeders who may use them collectively to monitor each animal's performance from birth. The two types that should receive emphasis by cattle breeders are (1) cow herd performance testing and (2) on-farm bull testing.

When performance data are maintained, they can be a valuable aid in (1) measuring progress in herd improvement, (2) evaluating performance of herd sires, (3) culling poor-producing cows, (4) selecting replacement females, (5) selecting bull calves for testing, (6) selecting future herd sires and (7) determining structural soundness under standardized conditions.

Contact your county Extension office for more information about performance testing.

Genetic Evaluation

Beef cattle producers have at their disposal the most informative, accurate selection tools ever available. These tools, performance pedigrees and sire summaries, supply objective information to help both purebred and commercial cattle producers make more informed selection decisions. Both performance pedigrees and sire summaries are available to participants in record programs of most breed associations. Purebred cattle producers should contact their breed association to enroll.

Sire summaries are generally available from breed associations to both purebred and commercial cattle producers upon request. Performance pedigrees and sire summaries contain EPDs for many traits.

What Are EPDs?

Expected progeny differences or EPDs are exactly what they sound like: the **difference** in performance that you **expect** in calves (**progeny**) from one animal when compared to calves from another animal or group of animals. Expected progeny differences are based on the performance records of an individual, its relatives and its progeny. Many breed associations publish EPDs on individual animals in sire summaries and in 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.

How Can Beef Cattle Producers Use EPDs?

Expected progeny differences are a cattle selection tool. They are the best predictors of the genetic performance of an individual animal currently available, and they are available for a growing number of economically relevant cattle traits. Expected progeny differences can be used to make herd genetic improvement in both commercial and seedstock operations. Genetic improvement can increase weaning weights and growth performance, improve reproductive performance and better performance on the rail (carcass quality), all of which can enhance the profitability and viability of a cattle operation.

What Are Some Things to Consider When Using EPDs as a Selection Tool?

Accuracy – Accuracy (ACC) may range from 0.00-0.99 and is a measure of the reliability of the EPD. As ACC approaches 1.00, the EPD becomes a more reliable estimate of true breeding value (Table 3). Accuracy is primarily influenced by (1) amount of information, (2) source of information and (3) heritability of the trait.

When selecting sires, the procedure used depends on whether the producer wishes to obtain maximum progress in a single trait or improve two or more traits simultaneously. When more traits are considered in selection, improvement in any one trait is slower. When net profit is considered, maximization of a single trait without concern for others may be costly. In most cases, producers should use a balanced approach to EPDs in selection. The first priority in selecting young, unproven bulls for natural service is to identify breeders with objectives similar to those of the herd for which selection is practiced. Both commercial and purebred cattle producers can use sire summary information to evaluate the programs of breeders. After locating qualified breeders, the next step is to identify bulls that meet your established criteria. Then, eliminate from consideration all bulls with structural and/or reproductive unsoundness. Identify the frame size range and scrotal circumference that is acceptable. Lastly, sort bulls for acceptability using EPDs.

TABLE 3. General Guidelines for Determining Reliability Based on Accuracy

Reliability Level	EPD
Low	Less than 0.60
Medium	0.60 to 0.80
High	Greater than 0.80

Balance of traits – How can I improve certain traits without sacrificing performance in other traits? Performance tradeoffs are often made when selection focuses heavily on particular traits without the big picture in mind. For example, selecting for increased weaning and yearling weights alone may simultaneously increase birth weights and calving difficulty. Try to strike a balance among several economically relevant traits and avoid selecting for extremes.

Cow herd needs – What traits need the most improvement? Each cow herd has strengths and weaknesses. Evaluate the herd and choose bulls that will provide an acceptable combination of traits that will complement the strengths and improve the weaknesses.

Expected progeny differences should be used in conjunction with visual appraisal, breeding soundness evaluation information and other selection tools to make selection and culling decisions for the herd. A genetically superior bull with excellent EPDs may not be an effective herd sire if he does not also have the structural soundness and fertility to ensure high reproductive rates in the herd.

How Do Producers Interpret EPDs?

Expected progeny differences may be divided into three categories relative to procedure of calculation and hence their use in breeding programs. These categories are pedigree, interim and analysis.

Pedigree EPDs are calculated as 1/2 (EPD of sire + EPD of dam). Because pedigree EPDs are estimated and no progeny or collateral relative data

are directly involved, pedigree EPDs are the weakest estimate of breeding value. When using pedigree EPDs for birth weight in selection, an actual birth weight and ratio will be helpful. Bull test data can be an excellent supplement to pedigree EPDs for growth. This is particularly true when selecting young bulls (12 to 15 months old) for use in commercial cattle breeding programs.

Interim EPDs are the second most accurate of the EPDs reported. They involve data on the subject animal's performance, data on the sire and dam of subject animal, and data on collateral relatives, but no progeny data is included in their calculation. As progeny data becomes available, EPDs will fluctuate and their accuracy will improve.

The most reliable EPDs are generated through National Cattle Evaluation Procedures (NCE). Simply stated, pedigree EPDs tell the producer what an animal should be, interim EPDs tell the producer what an animal appears to be and NCE EPDs tell the producer what the animal really is in terms of breeding value.

Expected progeny differences given in sire summaries are adjusted for competition, genetic trend, and include progeny and pedigree data. Therefore, EPDs are directly comparable among cattle of the same breed and should be used to compare proven sires listed in sire summaries. Expected progeny differences cannot be compared across breed without using proper adjustment factors.

In practical application, the magnitude of an EPD determines if a cattle producer should use a particular bull, and the accuracy value of the EPD tells a cattle producer how extensively he/she should use that bull in a breeding program. Table 4 illustrates how EPDs are used to compare two bulls for the traits of birth weight, weaning weight, yearling weight and maternal milk.

In the example, calves produced by Sire A are expected to be on the average 4.5 pounds heavier at birth than those produced by Sire B. Calves produced by Sire A are expected to be on the average 15.0 pounds heavier in weaning weight than those produced by Sire B. As can be seen, these values are relative values used in selection and do not identify the absolute values of the birth weight and weaning weight of calves sired by bull A and bull B.

TABLE 4. An Example of How the EPDs of Two Bulls May Be Compared to Estimate the Differences That Can Be Expected in Progeny Performance

	Birth Weight EPD	Weaning Weight EPD	Yearling Weight EPD	Maternal Milk EPD
Sire A	+3.5	+35.0	+60.0	+20.0
Sire B	-1.0	+20.0	+40.0	+10.0
Difference	4.5 lb	15 lb	20 lb	10 lb

These expected progeny difference values are reported in pounds. EPD is an expression of how future progeny sired by the bull can be expected to perform compared to other bulls in that breed and is calculated from progeny data plus information on close relatives. Higher EPDs correspond to more weight. For example, a bull with a weaning weight EPD of +30.0 lb can be expected to sire calves with 205-day adjusted weights that are 30 lb heavier than calves sired by bulls with a weaning weight EPD of 0.0 lb. Maternal milk EPD is an estimate of that portion of daughter progeny weaning weight attributable to the daughter's milk production.

Maternal weaning weight EPD is not a direct estimate of milk production as it represents a combination of factors associated with the cow's influence on her calf's weaning weight, such as growth, milk and maternal ability. It is generally true, however, that daughters of bulls with higher maternal EPDs will likely give more milk. For some breeds, maternal milk and maternal milk plus growth are reported separately.