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# Economic Indexes for Beef Sire Selection

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Selecting a beef sire can be made easier with economic indexes. This NebGuide illustrates the various beef sire selection indexes available.

Indexes have been around for decades and have been adopted by both the swine and dairy industries for some time. Recently several beef breed associations have developed and released economic indexes to aid producers in making selection decisions.

Economic indexes allow for multiple-trait selection, or simultaneous selection for more than one trait. They do so by combining multiple Expected Progeny Differences (EPD), each weighted by an economic value, into one numeric value often expressed in dollars per animal.

Just like EPDs, indexes are to be used across herds within a particular breed. Although accuracy values are not published for indexes, use caution when making selection or mating decisions based on the index value of a young sire. As progeny information is added, indexes will change. Accuracy values associated with the EPDs in an index are good indicators of how accurate the index will be. The various indexes described below are intended for use within specific production goals. Adverse effects could be realized if indexes designed for terminal scenarios (terminal indexes) are utilized as the primary selection tool in a herd that retains replacement females.

## Economic Indexes Defined

An economic index is a collection of EPDs weighted by their economic value such that traits with greater impacts on production goals have a larger economic weight associated with them. The basic equation of an economic index is:

$$I = EPD_1 x\ a_1 + EPD_2 x\ a_2 + EPD_3 x\ a_3 \ldots EPD_n x\ a_n$$

Where: $I$ is the index value; $EPD_n$ is the EPD for trait $n$; and $a_n$ is the economic weight associated with trait $n$.

## Angus Economic Indexes *(www.angus.org)*

### *Weaned Calf Value ($W)*

The weaned calf value is designed for producers who primarily sell calves at weaning and is interpreted in dollars per head of added profit. This index incorporates EPDs for birth weight, weaning weight, milk (mm) and mature cow size. Milk is weighted both positively and negatively as it directly influences the pre-weaning growth of the calf (the source of revenue), but also increases lactation energy requirements (a source of expense). Mature cow size is weighted negatively as larger cows require more energy for maintenance and thus add to the annual cost of maintaining the cow. The $W index makes certain economic assumptions regarding the price per cwt of calves, price of energy fed to cows, average mature cow size, and the proportion of heifers in the herd.

### *Cow Energy Value ($EN)*

This is a component of $W and is measured in dollars of savings per cow per year. It takes into account energy requirements due to mature size and milking ability. As both mature size and milking ability increase additional protein and energy are required *(Table I)*. Females with high genetic potential for milk production require additional nutrients, even when they are not in production, due to the increased size of their visceral organs.

Example: Bull A +10
Bull B +5

The daughters of Bull A should require less energy (feed costs) due to lactation energy requirements and/or differences in mature size. In this example, daughters from Bull A would save $5/hd./yr., on average than those from Bull B. In limited feed and high-stress environments, it can be particularly useful to select animals from within an acceptable window for $EN in order to improve production traits while avoiding high maintenance females.

**Table I. Effect of Mature Size and Milk Production on Nutrient Requirements**

| *Cow Size/lbs* | *Milking Level* | *Milk/day, lbs* | *TDN Needed, lbs* | *CP Needed, lbs* |
|---|---|---|---|---|
| 1,000 | Avg. | 10 | 12.4 | 1.9 |
| 1,000 | Above Avg. | 20 | 14.8 | 2.6 |
| 1,000 | Superior | 30 | 17.2 | 3.5 |
| 1,200 | Avg. | 10 | 13.8 | 2.1 |
| 1,200 | Above Avg. | 20 | 16.2 | 2.8 |
| 1,200 | Superior | 30 | 18.7 | 3.5 |
| 1,400 | Avg. | 10 | 15.2 | 2.3 |
| 1,400 | Above Avg. | 20 | 17.6 | 3.0 |
| 1,400 | Superior | 30 | 20.1 | 3.7 |

NRC, 1996.

### *Feedlot Value ($F)*

This index focuses on post-weaning merit and includes EPDs for both weaning weight (ww) and yearling weight (yw) where yearling weight is the driving factor behind the index. Assumptions are made concerning the number of days on feed, feedlot ration costs, and the live price of fed cattle. This index would be useful in a commodity based terminal scenario.

### *Grid Value ($G)*

This index places emphasis on carcass traits and is calculated for animals with carcass and/or ultrasound EPDs. (In July 2008, Angus will combine carcass and ultrasound data and report them on a carcass basis.) Assumptions made include three-year rolling averages for premiums and discounts for different quality and yield grades as well as overweight carcasses. This index is beneficial in identifying animals that would enhance both quality and yield grade. Two separate components of this index include Quality Grade Value ($QG) and Yield Grade Value ($YG). The Grid Value index is the exact sum of $QG and $YG. Producers with an interest in placing selection pressure on one component and not both could use either $QG or $YG separately.

### *Beef Value ($B)*

This is a combination of $F and $G, although it is not as simple as the sum of the two. It includes EPDs for YW, carcass weight and carcass and/or ultrasound traits. Producers wishing to enhance growth and simultaneously select for quality and yield grade should use this index. Similarly to $F and $G, $B is a terminal index and caution should be used if replacement females are retained under a program that applies significant pressure to $B to avoid increasing mature weights of females.

Example: Bull A +45.60
Bull B +32.50

We would expect that the calves from Bull A would be worth $13.10/hd. more on average than those from Bull B if retained through a feedlot and sold on a grid-based system.

Outside of the structured economic indexes for Angus listed above, the Angus association allows producers to customize indexes based on individual economic and production scenarios.

## Charolais Economic Indexes *(www.charolaisusa.com)*

Charolais calculates one index called the Terminal Sire Profitability Index, designed to aid producers when selecting Charolais bulls for use as terminal sires on cows of a different breed. This index is unique in that economic and herd-based assumptions are provided by the producer searching for candidate sires on the breed association's Web-based sire search. Producers enter historical information about their herd such as average cow weight, length of the backgrounding phase, calf price, fed cattle price, and other performance information and the American International Charolais Association (AICA) database returns a list of sires that best suits the needs of the commercial producer.

## Gelbvieh Economic Indexes *(www.Gelbvieh.org)*

Gelbvieh calculates two terminal indexes: Feedlot Merit (FM) and Carcass Value (CV). The FM index focuses on feedlot gain and efficiency as measured by Gelbvieh's Days to Finish EPD. The Days to Finish EPD is measured in the number of days it takes to reach a constant fat endpoint. The CV index takes into account both quality and yield grade as well as carcass weight.

## Hereford Economic Indexes *(www.hereford.org)*

### *Baldy Maternal Index (BMI$)*

This index is designed to select bulls for use on Angus-cross cows and heifers where some replacements are kept and all other offspring are sold on a grid-based system. These cattle could potentially qualify for either Certified Hereford Beef (CHB) or Certified Angus Beef (CAB) programs. Both calving ease (CE) and fertility (as measured by scrotal circumference) are emphasized. WW is weighted positively, while YW is weighted slightly negatively in an attempt to promote pre-weaning gain, but minimize mature cow size. Intramuscular fat (IMF) is emphasized more than ribeye area (REA) in order to enhance quality grade while maintaining an acceptable (3 or lower) yield grade.

### *Brahman Influenced Index (BII$)*

This index is similar to the BMI$ except that Calving Ease (CE) is not emphasized as much and it is assumed that all cull offspring are marketed on a commodity (weight) basis, since most grids do not accept Brahman influenced cattle. Fertility is strongly emphasized.

### *Calving EZ Index (CEZ$)*

This index is designed for selecting bulls to be used on heifers and thus emphasizes both CE and maternal CE. Although less emphasis is placed on growth and carcass traits, it still assumes that all cull offspring will be sold on a CHB grid.

### *Certified Hereford Beef Index (CHB$)*

This is a terminal index that places emphasis on WW and YW, CE and carcass traits. Fertility and milk are not index components, since all offspring are expected to be sold on a CHB grid. CE is included in an attempt to avoid extreme calving problems. Although fertility is not included in the index, it can be expected that scrotal circumference (SC) would increase due to its genetic correlation with growth traits.

Milk is obviously ignored in the CHB$ index. It is included in the other indexes, but is weighted slightly negatively due to the fact that milk production in excess of the calf's needs becomes an added expense because of the influence milk production has on the maintenance requirements of the cow.

*Table II* illustrates correlations between the Hereford Economic Indexes and different Hereford EPDs. From this table it is clear that CHB$ will have the greatest impact on Weaning Weight (WW), Yearling Weight (YW), Ribeye Area (REA) and Intramuscular Fat (INF) while CEZ$ will have the greatest impact on Calving Ease Direct (CED) and Calving Ease Maternal (CEM). These two breeding objectives (CHB$ and CEZ$) represent opposite production goals as evidenced by their low correlation *(Table III)*.

**Table II. Correlations between Hereford Economic Indexes and Other Traits**

| | CED | WW | YW | MM | CEM | SC | FAT | REA | IMF |
|---|---|---|---|---|---|---|---|---|---|
| BII$ | -0.17 | 0.43 | 0.46 | -0.14 | 0.16 | 0.87 | 0.06 | 0.28 | 0.21 |
| BMI$ | 0.02 | 0.54 | 0.57 | -0.02 | 0.36 | 0.87 | 0.06 | 0.31 | 0.26 |
| CHB$ | -0.13 | 0.89 | 0.88 | 0.25 | 0.18 | 0.68 | 0.06 | 0.40 | 0.35 |
| CEZ$ | 0.91 | -0.27 | -0.23 | 0.09 | 0.58 | 0.00 | 0.17 | -0.16 | 0.23 |

*Hereford World,* 2005.

**Table III. Correlations between Hereford Economic Indexes**

| | *BMI$* | *CHB$* | *CEZS* |
|---|---|---|---|
| BII$ | 0.94 | 0.50 | 0.15 |
| BMI$ | | 0.66 | 0.35 |
| CHB$ | | | 0.01 |

*Hereford World,* 2005.

### Limousin Economic Indexes *(www.nalf.org)*

Mainstream Terminal Index ($MTI) is used when selecting Limousin bulls for use on Angus x Hereford females for the production of terminal offspring. It is measured in terms of expected profit per carcass and places emphasis on post-weaning growth and both quality and yield grade.

### Simmental Economic Indexes *(www.Simmental.org)*

The American Simmental Association currently publishes two indexes to be used for selecting bulls for use on Angus cows.

#### *All-purpose Index (API)*

This index assumes that the sire will be used on both cows and heifers and that heifers will be retained as replacements while all other offspring will be sold grade and yield. This index is targeted at a producer that is looking to optimize revenue from fed cattle and maternal characteristics of replacement heifers.

Example: Bull A 118
Bull B 98

We would expect that the calves from Bull A would be worth $20/hd. more than those from Bull B. Over a span of four years Bull A could generate $2,400 more revenue than Bull B if mated to 30 females/yr. ($20/hd x 30/hd x 4 yrs.).

#### *Terminal Index (TI)*

As the name would imply, this is a terminal index that assumes all progeny will be sold grade and yield. It is to select bulls to be used on cows only.

## Choosing an Index to Use

When making selection and breeding decisions based on economic indexes, it's important to consider your particular breeding objective and which genotype will achieve desired production goals. For instance, if your production goals included retaining replacements and selling cull heifers and steer progeny at weaning, then an index that assumes all offspring are sold on a grid-based system is inappropriate to help you attain your production goals. If a large component of an index is yearling weight, and your goal is to moderate the mature size of replacement females, then using a growth-oriented index would be counter-productive. Different indexes include different traits, and associate different economic values with them. Consequently, you must understand what traits to emphasize in your herd and what indexes to use in particular circumstances. As with any selection or breeding decision, your particular production environment will dictate what production goals are feasible.

## Other Methods of Multiple Trait Selection

### Tandem Selection

This is the process of placing selection pressure on one trait and once the desired level of the trait under selection has been reached, selection for a new trait would begin. This is the simplest form of multiple trait selection and the most inefficient. The two (or more) traits involved are selected for independently. This means that progress made in one trait could be eroded once selection for another trait becomes the focus of the breeding scheme.

### Independent Culling Levels (ICLs)

In this process, threshold criteria for multiple traits are set and any animal not meeting all criteria (threshold levels for all traits) is excluded as a candidate for selection. Although this ensures a certain level of superiority across multiple traits, it may cull a particular animal just below the threshold level for one trait.

Economic indexes allow for simultaneous multiple-trait selection and allow for the superiority of one trait to compensate for average or even below-average levels of component traits. *Table IV* illustrates the potential differences between using ICLs and economic indexes, assuming that the breeding objective is to mate Hereford bulls to Angus cows and heifers, keep some replacements and sell all others on a CHB grid.

Assume the following ICLs have been set: CED = 2.0, WW= 43, Maternal Milk (MM) = 17, Scrotal Circumference (SC) = 0.9 and IMF = 0.04. If we only select bulls that meet or exceed the ICLs established then Bull 2 would not be chosen because his IMF value is below 0.04 and Bull 4 would not be chosen because his CED value is below 2.0. Unfortunately Bull 4 has the highest BMI$. This occurs because although he is slightly below the other bulls for CED, he is similar or decidedly better in all other categories. So although Bull 4 would not make the most genetic improvement in calving ease, he would contribute the most to the overall breeding objective.

**Table IV. Comparison Between Independent Culling Levels and Index Selection**

| Bull | CED | WW | MM | SC | IMF | BMI$ |
|---|---|---|---|---|---|---|
| 1 | 2.5 | 55 | 20 | 1.0 | 0.10 | 20.16 |
| 2 | 5.0 | 50 | 25 | 1.2 | -0.10 | 19.55 |
| 3 | 4.0 | 45 | 20 | 1.0 | 0.25 | 20.35 |
| 4 | 1.6 | 62 | 19 | 1.0 | 0.20 | 21.64 |

*Hereford World,* 2005.

## Challenges

It is critical that producers understand the traits included in a particular index. Understanding individual traits included in an index, along with their economic value, will help producers avoid unwanted phenotypic changes after long-term selection. It is also important to realize that economic indexes allow for superiority in one trait to offset average or below-average performance in other traits. Consequently, a sire with an above-average index value may not be above-average for all of the component EPDs, but rather superior in one that is weighted heavily. It is important to know the breed average values for particular indexes and to use percentile ranks to determine how far above or below average a particular animal is compared to the rest of a breed.

## Summary

Economic indexes are a valuable tool in a very extensive toolbox from which producers can make genetic change. Understanding the components of an index and the production scenario it is designed for is critical in order to avoid unwanted or unexpected results.

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