

CCA's Terminal Sire Index (TSI)

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The CCA was the first major Canadian breed association to release a multi-trait selection index for public use. Charolais bulls are often sought after as a continental breed component for terminal sire crossbreeding systems. The hallmark index is called the Terminal Sire Index (TSI for short) and has been widely used by commercial cattlemen to make sound breeding and purchase decisions as they incorporate Charolais genetics into their mating systems. As the name implies, TSI is a terminal index designed to rank sire candidates for use in a mating system where all progeny are harvested. TSI doesn't include any maternal trait selection criteria as no replacement females are to be retained in the herd under this selection strategy. Thus, it shouldn't be used in production scenarios where replacements are kept from these matings.

Selection indexes provide a single value that describes differences in expected profit in a specific production and marketing circumstance. The selection index simplifies the ranking of candidates across many available EPDs by placing economic weight on traits that have economic impact on the traits in the prescribed scenario. While the selection index is simple to use, it's construction is not a trivial exercise.

TSI has been updated a number of times in nearly two decades of use. Recently, TSI underwent a major overhaul that featured development utilizing new state-of-the-art selection index construction software and updating of the phenotypic and economic data used to compute the index. The new TSI was developed to model a production scenario and breeding system where Charolais bulls are mated to Angus based cows, 2-years of age and older, and all progeny fed out with harvested carcasses marketed on a value-based grid which includes a premium structure for cattle that are in the upper 2/3 Choice quality grade. These development features are detailed below.

The biggest change in TSI is the development environment in which the economic weights are estimated. Sophisticated bio-economic software models are among the most effective and efficient means to develop a selection index. The software platform utilized to build-out TSI is called iGENDEC (an internet GENetic DECision support tool) hosted by the Beef Improvement Federation and developed by scientists at the University of Nebraska, the US Meat Animal Research Center, Kansas State University and private industry. iGENDEC development was funded through a USDA CARE (Critical Agriculture Research and Extension) grant program. iGENDEC provides a customizable selection index platform where the selection scenario, selection criteria (EPDs), economic assumptions, breeding system and breeds, as well as phenotypic parameters can be modified.

Once parameterized, iGENDEC simulates thousands of progeny under the model assumptions and produces the economic weights for the selection criteria to achieve the optimal selection

index that maximizes progress toward the profit objective. The economic weights place monetary value on a one unit increase in the trait given all other traits held constant. After the weightings are applied to selection criteria EPS, the values are summed together to form the index. The model includes genetic and phenotypic relationships between traits and thereby accounts for correlated responses to selection. iGENDEC also models relevant breed difference and heterotic effects.

In the case of TSI, the selection criteria are the EPDs for hot carcass weight, marbling, ribeye area, fat thickness, post weaning gain and calving ease direct. Animals must have published EPD for CW, REA, Marbling, Fat, WW, YW and CED to receive a TSI value. Dry matter intake (DMI) is included in the economic weightings with a genetic value predicted through the association between DMI and yearling weight (YW) EPD. There's a strong genetic relationship between growth and DMI so animals with high levels of growth are expected to have higher daily DMI.

As presented in Figure 1., DMI accounts for a significant portion of the index and accounts for a large cost component in cattle feeding. Carcass weight, marbling and fat thickness are responsible for the largest value determinants in carcass pricing in a value-based marketing system. The importance of ribeye area in current pricing models is primarily through added carcass weight. The economic weighting in the index then mostly weights the impact REA has on changes in yield grade. Since yield grade changes are substantially less valuable than quality grade changes in the grid pricing model, REA has a smaller relative emphasis.

The second major area of change in TSI is the updated animal performance and economic parameters in the model. In all cases, publicly available data was used to inform the model. A 10-year period was included to capture the average relationships of costs and revenues across an entire cattle cycle. Trends in cattle feed and performance in the most recent 10-year period include extended days on feed in the growing and finishing period, feeding to substantially heavier out weights and the increased cost of feed and value of beef carcasses. Additionally, the industry is realizing substantially higher grading cattle with substantial premiums realized for Prime, Upper 2/3 (program) and Choice grading cattle. All of these trends are represented in the new TSI model parameterizations.

Feedlot parameters are reported in Table 1. The data presented is the 10-year, monthly average cattle performance from the Kansas State University Focus on Feedlot report. The production model includes: 170 days in the finishing phase, delivered feed cost of \$261/ton (\$0.1308/lb.), average daily gain of 3.60 with daily dry matter intake of 22 lb. per day. Combined, these result in a feedlot cost of gain of \$92.69/cwt. Carcass parameters are summarized in Table 2 and represent expected breed of sire means for average Charolais sires from published USDA data. Metrics include expected performance for birth, weaning and yearling growth.

Pricing data included in the model represents a 10-year weekly average of fed cattle prices. Table 3 reports the USDA reported 5 area dressed beef price for steers and heifers with carcasses over

and under 600 lb. Similarly, table 5 includes the USDA 5-area weekly average premium and discount schedule for quality and grades.

How to Use TSI:

Implementation of TSI into a terminal sire selection decision is simple and straight forward. TSI is reported in dollars and represents the differences of sires' progeny values when harvested on a value-based pricing grid after feeding. The TSI values reported are on a per conceived calve basis. It is expected that users of the TSI index generally conform to this production circumstance. In the example below, we would expect Sire A to produce progeny that average \$50 per head more net return than those of sire B.

Sire A:	TSI \$300
Sire B:	TSI \$250
Difference:	\$50 per head

TSI is **not** a suitable selection criterion for evaluation of sires where replacement females will be retained. The terminal model used doesn't contemplate replacement female retention and therefore, doesn't include any maternal trait weightings. In fact, misuse of the index may induce a set of genetic antagonisms. The extra emphasis placed on growth and carcass weight would be expected to have a correlated genetic effect of making larger sized mature females with increased maintenance requirements which may be counterproductive in a replacement scenario.

To search AICA EPDs and TSI values visit: WWW.charolais.com

**FIGURE 1. CCA TERMINAL SIRE INDEX SELECTION
CRITERIA RELATIVE EMPHASIS**

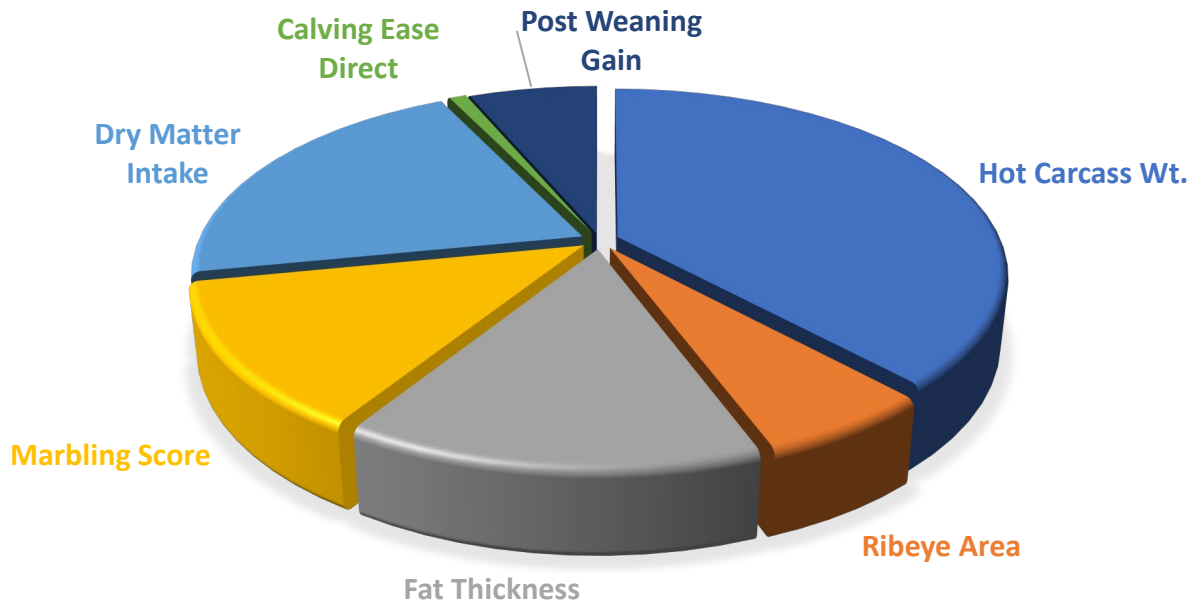


Table 1. Feedlot Performance Phenotypic Means

Parameter	Units	Value
Background Days	Days	150
Days on Feed (feedlot)	Days	170
Feedlot Feed Cost	\$/lb DM	\$ 0.1308
ADG	lb/day	3.60
FCR	lb feed/lb gain	6.128
DMIp	lb intake/day	22.03
CoG	\$/cwt gain	\$ 92.69
FE		0.1632

Table 2. Animal Phenotypic Growth and Carcass Parameters

Parameter	Units	Value
Hot Carcass Weight	lb	902
Ribeye Area	square inches	14.58
12 th Rib Fat Thickness	inches	0.472
Marbling Score	Marb (SM00=5.00)	5.32
Birth Weight	lb	89.4
Weaning Weight	lb	542
Yearling Weight	lb	842

Table 3. USDA Average Weekly Weighted 5 Area Dressed Beef Prices July 2013-June 2023

Class	Weight	\$/cwt
Steers	<600 lb.	\$186.62
Steers	>600 lb.	\$206.62
Heifers	<600 lb.	\$186.63
Heifers	>600 lb.	\$206.63

Table 4. Fed Cattle Carcass Pricing Grid

Quality Grade	Yield Grade				
	1	2	3	4	5
Prime	\$ 21.74	\$ 18.98	\$ 16.47	\$ 6.83	\$ 2.11
Program (Upper 2/3 Choice)	\$ 9.67	\$ 6.91	\$ 4.39	\$ (5.25)	\$ (9.97)
Choice	\$ 5.27	\$ 2.52	\$ -	\$ (9.64)	\$ (14.36)
Select	\$ (7.70)	\$ (10.46)	\$ (12.98)	\$ (22.61)	\$ (27.34)
Standard	\$ (21.36)	\$ (24.12)	\$ (26.64)	\$ (36.28)	\$ (41.00)