Introduction of New TERMINAL and MATERNAL Beef Indexes

Background

The Suckler Beef Value Index and its 5 sub-indexes were launched in 2007. Three of the sub-indexes (Calving Traits, Weanling Export, Beef Slaughter) described the genetic merit of the progeny of a bull whereas the remaining two (Maternal Milk & Fertility, Maternal Calf Quality) described the genetic merit of the bull's replacement daughters and their progeny.

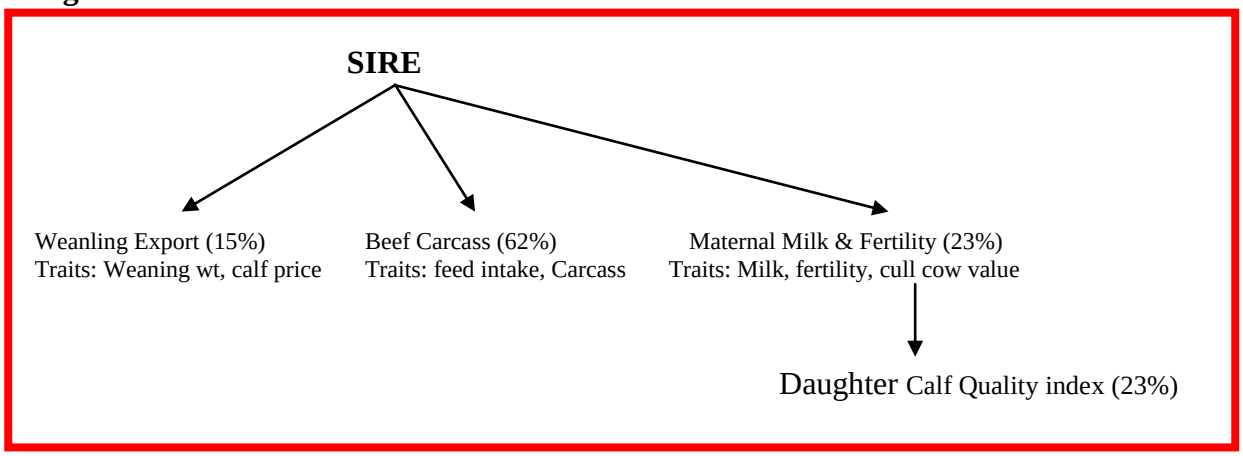
The Suckler Beef Value was constructed based on the expected proportions of calves born which are: Sold at weaning for live export (15%), Retained for slaughter in Ireland (62%), Sold or retained as replacement females (23%). Thus:

SBV = (0.15)*Weanling Export Index + (0.62)*Beef Carcass Index + (0.15 + 0.62)*Calving Traits Index + 0.23*(Milk & Fertility index + Calf Quality index)

Over time there were some revisions to sub-indexes in terms of content and presentation. These included:

1) The dropping of the Calving traits index and from the presentation on the bull search and sales catalogues.
2) The splitting of the Maternal Milk & Fertility index into a Daughter Milk index and a Daughter Fertility index

Figure 1. The SBV index



The SBV was designed as an index for ranking sires for their genetic merit for a range of traits expressed by their progeny and daughter's progeny. This included the fact that when selecting a sire to breed replacements there will also be a by-product of male calves produced which have an economic contribution to the farming enterprise. While there was certain benefits in ranking bulls for the full range of traits there was a strong feeling in the industry for more specialised indexes which separated the genetic merit for progeny beef performance (terminal traits) versus genetic merit for progeny maternal performance (maternal traits). Sires selected for Terminal traits can end up having none or very few daughters returned to the herd as replacements and hence an index which only evaluates the traits relevant to Terminal beef production would be more useful than the SBV.

Alternatively sires used specifically with maternal traits in mind may end up returning a much higher percentage of daughters as replacements than the 23% which is used in the construction of the current SBV. Similarly there was a need for an index to rank females for farmers to use when selecting female replacements.

A full review of beef breeding indexes was carried out which has 3 components:
1) Update of the economic values used for each trait

2) Review of the genetic evaluations which produce the predicted transmitting abilities
3) Exploration of alternative indexes to the SBV which is the product of components 1 and 2

1. Review of economic values used in the indexes

The economic values currently used in the SBV are derived from a model created by Peter Amer and Timothy Byrne (Abacus Bio) consultants hired by ICBF. Each trait is treated on an individual basis when deriving its impact on farm profit. Whilst Peter and Tim have updated these economic values on a yearly basis they have always stressed the need for a full bio-economic model of a typical Irish beef production system to be used for the derivation of economic values. With such a model the impact of a change in one trait can be analysed for its effect on the profitability of the farming enterprise. Paul Crossan from Teagasc Grange Research Centre has recently developed a bio-economic model which can be used for the purpose of deriving economic values among other uses. Following an extensive analysis, feedback and review with the €uro-star review group the following changes to the economic values were recommended.

Table 1. The change in economic values resulting from the switch to using the Grange bio-economic model.

Trait	Economic Value		change	% change	direction of change
	Old	New			
Direct calving difficulty (€/% change)	-€2.96	-€5.31	€2.35	79.4%	Increase
Gestation length	-€2.12	-€1.72	-€0.40	18.9%	Decrease
Progeny feed intake (€/kg DM)	-€0.13	-€0.16	€0.03	23.1%	Increase
Carcass weight (€/kg carcass)	€3.20	€3.78	-€0.58	18.1%	Increase
Replacement heifer feed intake (€/kg carcass)	-€1.22	-€2.28	€1.06	86.9%	Increase
Age 1st Calving (€/day)	-€0.96	-€1.65	€0.69	71.9%	Increase
Maternal calving difficulty (€/% change)	-€1.81	-€2.29	€0.48	26.5%	Increase
Maternal milk (€/kg weaning wt)	€1.80	€1.81	-€0.01	0.6%	Increase
Calving interval (€/day)	-€1.37	-€2.20	€0.83	60.6%	Increase
Survival (€/% decrease)	€2.94	€4.00	-€1.06	36.1%	Increase
Cow feed intake (€/kg carcass)	-€0.41	-€0.57	€0.16	39.0%	Increase
Cull cow weight (€/kg carcass)	€2.80	€3.04	-€0.24	8.6%	Increase

The switch to the Grange bio-economic model has resulted in a significant increase in the importance of cost of production traits such as direct and maternal calving difficulty, age at first calving, calving interval and survival, and both weanling and cow feeding costs. There is a moderate increase in the economic value of carcass weight.

2) Review of the genetic evaluations which produce the predicted transmitting abilities

The €urostar review group raised concerns regarding the genetic evaluation of certain traits. The evaluations identified for initial investigation are the calving difficulty evaluation, maternal weaning weight evaluation and the fertility evaluation. The trait age at first calving was identified as the fertility most in need of investigation. A review has been underway for both the beef performance evaluation (commenced in Spring 2012) and the calving evaluation (commenced in June 2012) with results expected to be communicated to the industry ahead of the December 2012 routine evaluation update. A decision will be made at that stage as to what changes to implement. A commitment by ICBF has also been given to look at the age at first calving trait ahead of the December run.

3) Exploration of alternative indexes to the SBV

The €urostar review group recommended the replacement of the SBV with 3 new indexes:
A) a Terminal index, B) a Maternal index and C) a Dairy-Beef index

1) A Terminal index for selecting sires to breed calves which are destined for slaughter. This index is composed of eight traits of which three are calving traits (calving difficulty, gestation and mortality) and five are beef production related traits (docility, feed intake, carcass weight, carcass conformation and carcass fat). The economic values, discounted genetic expressions, economic weights and the relative weighting of each of the traits in the Terminal index is shown in Table 2.

Table 2. The weighting given to each of the traits in the new Terminal index.

Traits	Economic value of the trait	Discounted genetic expression	Economic weights	Relative emphasis %
Calving difficulty	-€5.27	1.0	-€5.27	22.1%
Gestation	-€1.72	1.0	-€1.72	3.7%
Mortality	-€5.34	1.0	-€5.34	3.6%
docility	€18.40	0.86	€15.82	2.4%
Feed intake	-€0.16	0.78	-€0.12	18.4%
Carcass wt	€3.78	0.78	€2.95	35.1%
Carcass conf	€18.93	0.78	€14.77	9.3%
Carcass fat	-€10.08	0.78	-€7.86	5.5%

2) A Maternal index for selecting sires with the intention of keeping all daughters as replacement females in the herd. This index is composed of 25 traits of which eight traits relate to the male progeny produced by a bull which are slaughtered (calving difficulty, gestation, mortality, docility, feed intake, carcass weight, carcass conformation and carcass fat. These are the same traits used in the Terminal index. Nine of the traits in the Maternal Index are traits related to the daughters of the bull who become replacements. (heifer intake, age at first calving, maternal calving difficulty, maternal milk, calving interval, survival, cow docility, cow intake and cull cow weight). The remaining 8 traits are the same as the Terminal index also but they relate to the calves which these daughters produce (calving difficulty, gestation and mortality, docility, feed intake, carcass weight, carcass conformation and carcass fat). So there all the traits in the Terminal index are also in the Maternal index to reflect all the downstream consequences of selecting a Maternal bull (Figure 1). The economic values, discounted genetic expressions, economic weights and the relative weighting of each of the traits in the Maternal index are shown in Table 3. Table 4 shows a simpler version of Table 3 where the emphasis is shown by trait category. Figure 3 shows a breakdown of the construction of the of the Terminal and Maternal index for the AI sire Pacha 08 (PCH). It is important to note that the Terminal index is expressed in terms of profitability per progeny born to a sire whereas the Maternal index is expressed in terms of profitability per replacement heifer from the sire over her lifetime including all of her calves.

Figure 2. The Terminal and Maternal indexes.

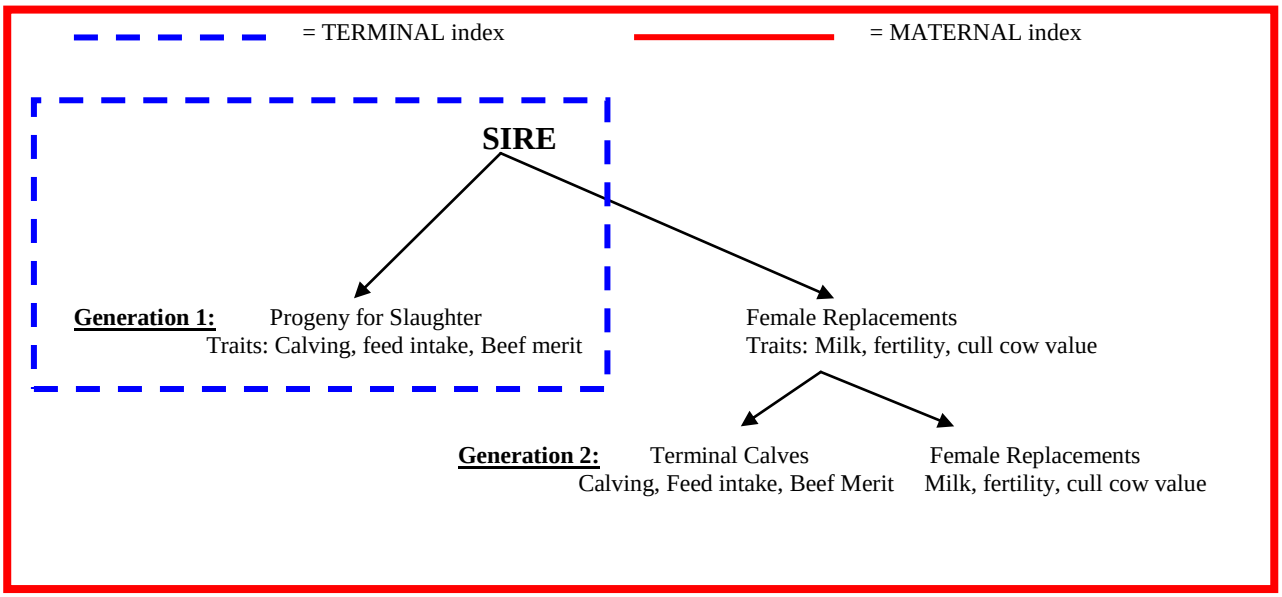


Table 3. The weighting given to each of the traits in the new Maternal index.

Traits influencing profitability in the Decendants of a bull	Traits	Economic value of the trait	Discounted genetic expression	Economic weights	Relative emphasis %
Traits affecting the profitability of a bulls progeny when they are destined for slaughter	Calving difficulty	-€5.27	1.0	-€5.27	2.6%
	Gestation	-€1.72	1.0	-€1.72	0.4%
	Mortality	-€5.34	1.0	-€5.34	0.4%
	docility	€18.40	0.86	€15.82	0.3%
	Feed intake	-€0.16	0.78	-€0.12	2.2%
	Carcass wt	€3.78	0.78	€2.95	4.1%
	Carcass conf	€18.93	0.78	€14.77	1.1%
	Carcass fat	-€10.08	0.78	-€7.86	0.6%
Traits affecting the profitability of a bulls daughters when they are destined for replacements	Age 1st Calving	-€1.65	1.4	-€2.38	5.0%
	Maternal cdiff	-€2.29	5.5	-€12.60	4.4%
	Materal wean wt	€1.81	5.5	€9.96	9.1%
	Calving interval	-€2.20	5.5	-€12.10	7.0%
	Survival	€4.00	5.5	€22.00	5.0%
	Mature wt heifer intake	-€2.28	1.4	-€3.28	7.8%
	Mature wt cow intake	-€0.57	5.5	-€3.14	7.4%
	Cow docility	€34.40	5.5	€189.20	2.9%
	Cull cow wt	€3.04	0.8	€2.31	5.5%
Traits affecting the profitability of a bulls grand-progeny through his daughters	Calving difficulty	-€5.27	3.7	-€19.71	9.7%
	Gestation	-€1.72	3.7	-€6.43	1.6%
	Mortality	-€5.34	3.7	-€19.97	1.6%
	docility	€18.40	3.5	€64.40	1.0%
	Feed intake	-€0.16	1.9	-€0.31	5.7%
	Carcass wt	€3.78	1.9	€7.26	10.2%
	Carcass conf	€18.93	1.9	€36.35	2.7%
	Carcass fat	-€10.08	1.9	-€19.35	1.6%

Table 4. The weighting given to each trait type in the new Maternal index.

Trait type	Trait	Relative emphasis %
Calving traits	Calving difficulty (direct and maternal), gestation, mortality	**21%**
Docility	Weanling and cow docility	**4%**
Beef	Carcass weight, conformation and fat, cull cow wt	**26%**
Milk	Daughter Milkability	**9%**
Fertility	Age 1st Calving, calving interval, survival	**17%**
Feed intake	Weanling, replacement heifer and cow intake	**23%**

Figure 3. Example of the construction of the Terminal and Maternal index for an AI sire

Example: Limousine AI bull Pacha 08 (PCH)

	Traits	Economic value of the trait	Discounted genetic expression	Economic weights	PTAs	€ contribution	Terminal Index Value	€ contribution	Maternal Index Value
(A) TERMINAL: Male and female Progeny of a bull destined for slaughter	Calving difficulty	-€5.27	1.0	-€5.27	4.20	€9		€5	
	Gestation	-€1.72	1.0	-€1.72	3.27	-€6		-€3	
	Mortality	-€5.34	1.0	-€5.34	0.36	-€2		-€1	
	docility	€18.40	0.86	€15.82	-0.05	-€1	€121	€0	
	Feed intake	-€0.16	0.78	-€0.12	-0.46	€22		€11	
	Carcass weight	€3.78	0.78	€2.95	22.93	€68		€34	
	Carcass conformation	€18.93	0.78	€14.77	1.67	€25		€12	
	Carcass fat	-€10.08	0.78	-€7.86	-0.69	€5		€3	
(B) Female Progeny of bull who become cows	Age 1st Calving	-€1.65	1.4	-€2.38	-13.87			€16	
	Maternal calving difficulty	-€2.29	5.5	-€12.60	4.62			€9	
	Materal weaning weight	€1.81	5.5	€9.96	21.00			€105	
	Calving interval	-€2.20	5.5	-€12.10	-0.04			€0	
	Survival	€4.00	5.5	€22.00	1.03			€11	€282
	Heifer feed intake	-€2.28	1.4	-€3.28	31.22			-€51	
	Cow feed intake	-€0.57	5.5	-€3.14	31.22			-€49	
	Cow docility	€34.40	5.5	€189.20	-0.05			-€5	
	Cull cow weight	€3.04	0.8	€2.31	31.22			€36	
(C) grandprogeny of bulls through his daughters	Calving difficulty	-€5.27	3.7	-€19.71	4.20			€18	
	Gestation	-€1.72	3.7	-€6.43	3.27			-€11	
	Mortality	-€5.34	3.7	-€19.97	0.36			-€4	
	docility	€18.40	3.5	€64.40	-0.05			-€2	
	Feed intake	-€0.16	1.9	-€0.31	-0.46			€27	
	Carcass weight	€3.78	1.9	€7.26	22.93			€83	
	Carcass conformation	€18.93	1.9	€36.35	1.67			€30	
	Carcass fat	-€10.08	1.9	-€19.35	-0.69			€7	

MATERNAL: Includes (A) the male progeny of a bull who are slaughtered, (B) the females who end up as cows and (C) their progeny

3) A Dairy Beef index for selecting sires to use on dairy cows. This index will focus on the traits relevant to a dairy farmer when selecting a bull for use on dairy cows. The index will focus on cost of production traits such as calving difficulty, gestation and mortality and the revenue trait will be mart calf price to reflect the growing trend of selling surplus calves at young age. This index is still under construction.

Docility, Polledness and Breed specific Quality schemes

These 3 new traits have been added to the new Terminal and Maternal indexes (the Dairy-Beef index will also incorporate these indexes.

Docility has been evaluated for a number of years now and was presented as a stand alone trait outside of the SBV index previously. An economic value has now been developed for both weanling and cow docility. The weanling docility economic value is €18.40 per unit change in weanling docility on the animal welfare recording scale of 1 to 5. Similarly an economic value of €18.40 per unit change in cow docility of €34.40 has also been developed and both these values are now integrated into the new Terminal and Maternal indexes.

Polledness at the moment is incorporated for all Angus sires with an economic value of €7.95 per calf born. Sires from other breeds will also receive this additional economic benefit when suitable evidence of polledness has been supplied to ICBF (polledness genetic test evidence).

Similarly there is a quality bonus integrated into the Terminal index for Angus and Hereford to reflect the Angus and Hereford schemes which reward animals sired by bulls from these breeds. The bonus equates to €6.60 which is added to the Terminal index of Angus and Hereford. The bonus is calculated as the product of the average bonus received for animals which qualify multiplied by the proportion of animals which received the bonus in the recent past.

Re-ranking of sires compared to old SBV index

The introduction of new economic values will affect the ranking of sires aside from any change in index. Figure 4 shows the comparison between SBV (April 2012 evaluation) versus a run with the new economic values for beef AI sires with 50% reliability or greater on SBV in the April 2012 run. The correlation between the indexes was 0.80 which indicates quite a significant re-ranking for bulls.

Figure 5 shows the comparison between SBV (April 2012 evaluation) versus the new Terminal index for the same group of beef AI sires from the April 2012 run. The correlation between these indexes was 0.68. Similarly Figure 6 shows the comparison between SBV (April 2012 evaluation) versus the new Maternal index. The correlation in this comparison was 0.45. This indicates that the SBV was selecting an animal which was more heavily influenced by Terminal type traits that maternal traits. Hence the Maternal index will rank animals very differently to the old SBV. Finally Figure 7 shows the comparison between the new Terminal and the new Maternal index. The correlation in this comparison was 0.18 indicating that these indexes will rank sires in a completely different way. Table 5 shows the average pta of the top 100 AI bulls of 50% reliability or more (on the SBV reliability) ranked on the SBV, Terminal and Maternal indexes. Relative to the SBV the Terminal index will lead to an increased tendency for calving difficulty (7.2% v 6.6%), lower feed intake (-0.39 v +0.04), similar carcass weight (+27 v +28kg) and better carcass conformation (+2.18 v +1.67).

Similarly comparing the SBV to the Maternal index will rank lead to much better selection pressure on the cow maternal traits such as age 1st calving, milkability, calving interval and survival but also a decreased tendency for calving difficulty (4.3% v 6.6%) . However gains in the Terminal beef traits like carcass weight and carcass conformation will not be as high as with the old SBV. Comparing the Terminal and the Maternal again reaffirms the distinctly different selection likely with these two indexes which is shown in the scatter plot of Figure 7 where the correlation for those 1006 AI sires was only 0.18.

Presentation of indexes

Figure 8 shows an example of the new bull search showing the new Terminal and Maternal indexes and key profit component traits for the Limousine bull Pacha 08 (PCH) . Similar changes will be made to all areas where the old SBV was shown including sales catalogues, online herdbook screens and ICBF herdplus screens.

Figure 4. SBV versus SBV with the new economic values

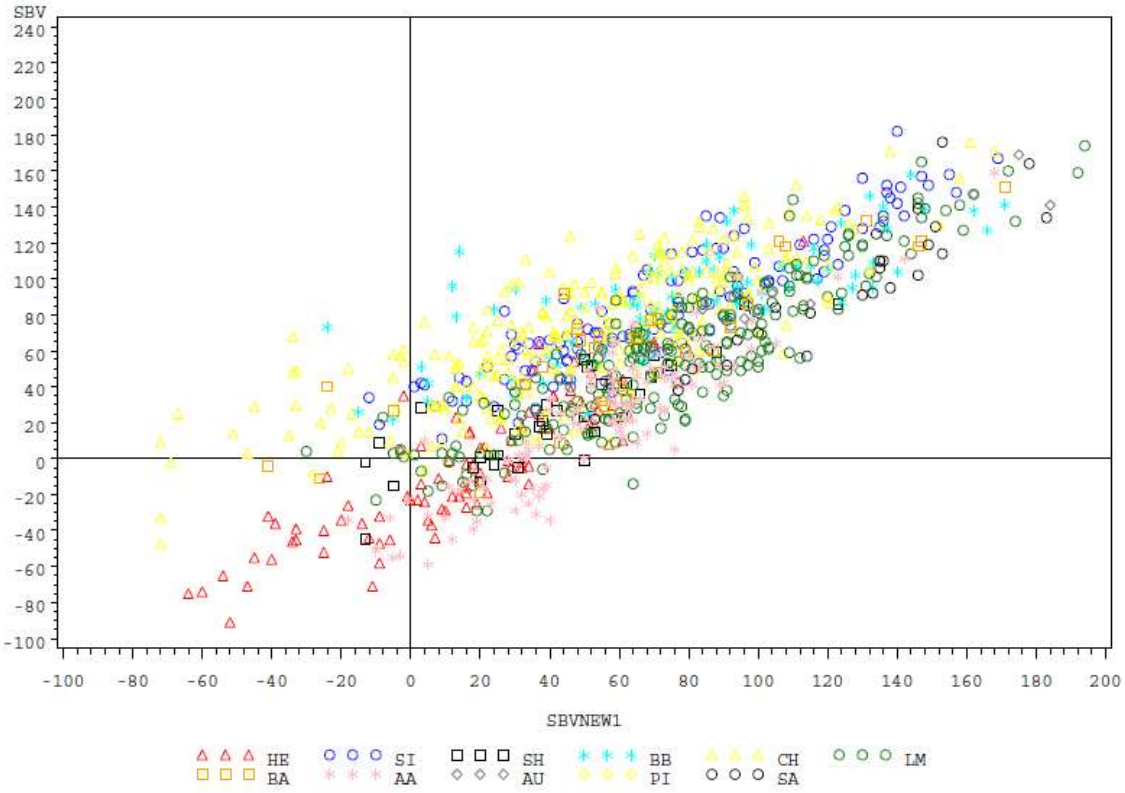


Figure 5. Old SBV versus Terminal index for sires >50% reliability on old SBV

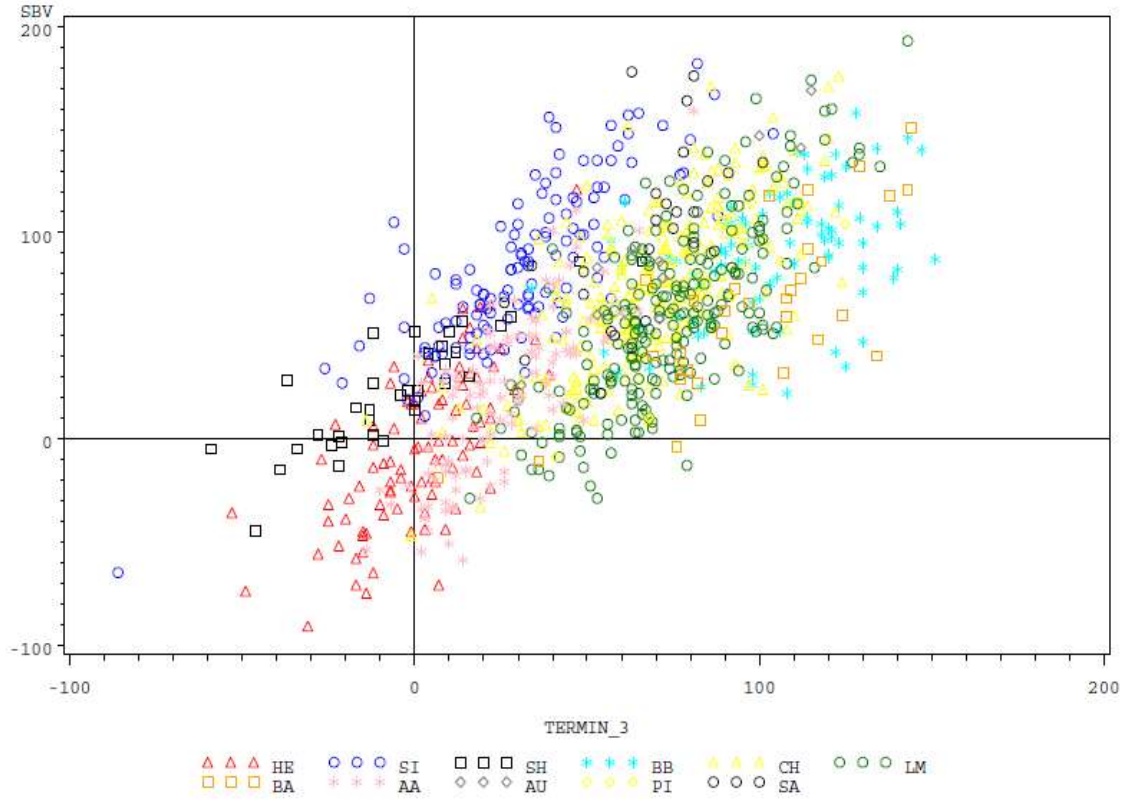


Figure 6. SBV versus Maternal index for sires >50% reliability on old SBV

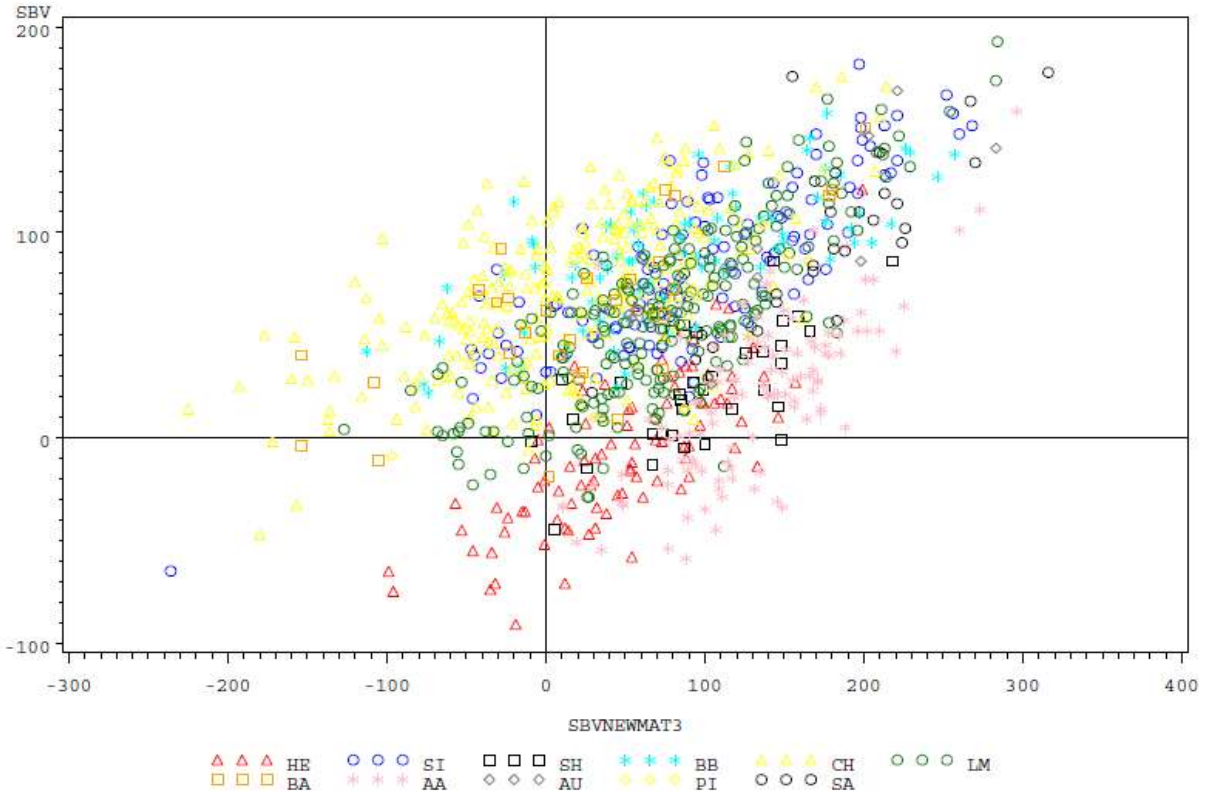


Figure 7. Terminal versus Maternal index for sires >50% reliability on old SBV

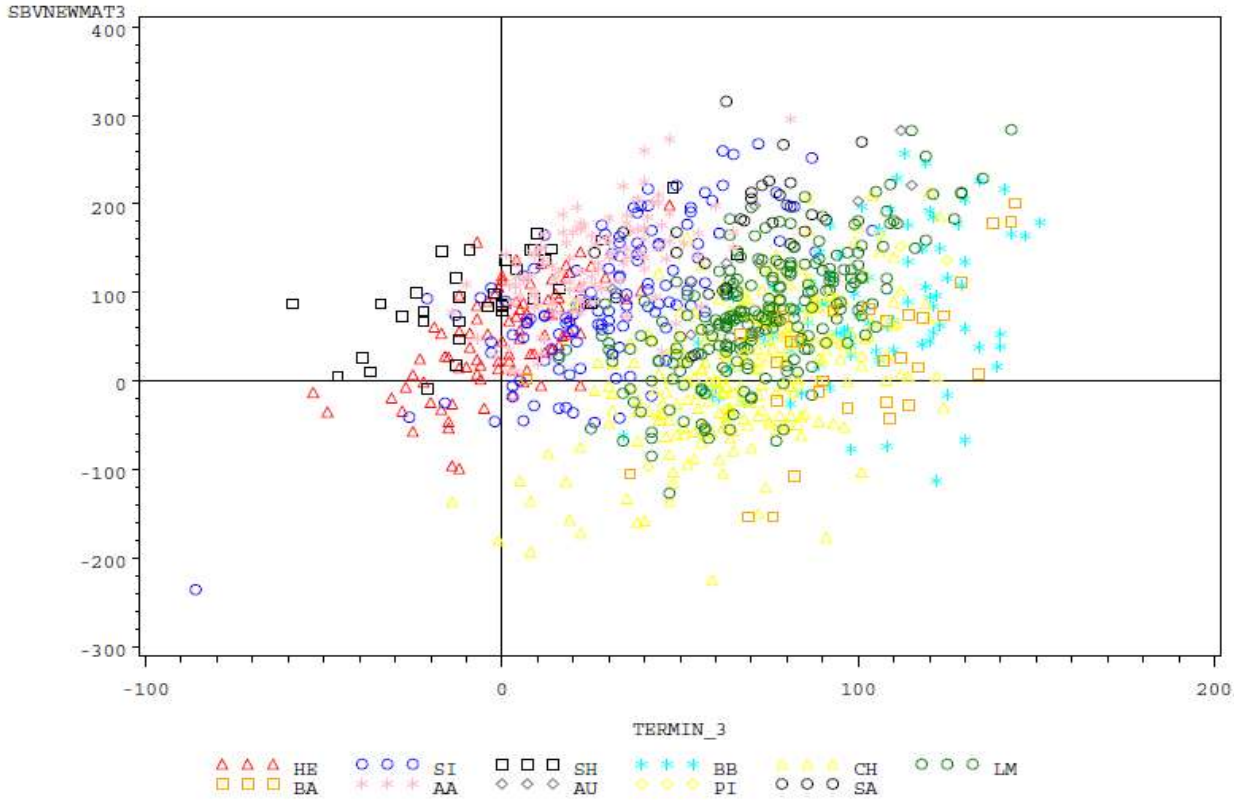


Table 5. The average pta of the top 100 AI bulls of 50% reliability or more (on the SBV reliability) ranked on the SBV, Terminal and Maternal indexes.

Trait	Index option SBV	TERMINAL	MATERNAL
direct calving difficulty (%)	6.6	7.2	4.3
Gestation Length (days)	2.2	1.7	1.5
Mortality (dead 0 to 28 days)	0.57	0.72	0.27
Feed intake (kg DM per day)	0.04	-0.39	-0.01
Carcass weight (kg)	28	27	19
Carcass conformation (scale 1 to 15)	1.67	2.18	1.42
Carcass fat (scale 1 to 15)	-0.62	-1.01	-0.31
Docility (scale 1 to 5)	0.04	0.07	0.02
Age at first calving (days)	-19	-11	-21
Maternal calving difficulty (%)	6.7	9.3	7.5
Maternal Milk (kg)	5.3	0.1	8.5
Calving Interval (days)	-0.42	2.99	-2.61
Daughter survival (%)	1.16	-0.31	1.31
Cull cow weight (kg)	29	36	17

Figure 8. An example of the new bull search showing the new Terminal and Maternal indexes and key profit component traits