WAGYU BREEDOBJECT $INDEXES – TECHNICAL UPDATE

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BreedObject $Indexes are now available that allow selection of Wagyu seedstock based on profitability for different commercial production systems. BreedObject $Indexes are based on Wagyu BREEDPLAN EBVs. Three Wagyu BreedObject $Indexes have been developed to date, these being a

- Self-replacing Breed $Index
- Fullblood Terminal $Index
- F1 Terminal $Index

BreedObject $Indexes are aimed at maximising profit outcomes for commercial producers and will allow producers to achieve faster rates of genetic gain through selection for a range of traits that have important impacts on profitability for each production system.

EXECUTIVE SUMMARY

The development of Single-step Wagyu BREEDPLAN has enabled the full suite of EBVs to be calculated that are needed for development of BreedObject Indexes. The Wagyu BreedObject $Indexes are targeted at Wagyu breeding programs – commercial self-replacing, F1 and Fullblood terminal. The Indexes utilise economic and production data relevant to each enterprise to determine the optimum mix of EBVs for maximising profitability.

Major outcomes from implementation of Single-Step Wagyu BREEDPLAN, in addition to inclusion of genomic information within EBV calculations, were:

- The implementation of breed-specific parameters for Wagyu cattle, which improved the ability of EBVs to represent the genetic range available within each of the reported traits; and
- The implementation of the full EBV set within version six of BREEDPLAN software hosted at ABRI to enable BreedObject indexes to be calculated.

BreedObject Indexes target economic breeding objectives based on average herd and market conditions and have generally targeted the main markets within the main production systems, combining genetic information within BREEDPLAN into one EBV for each $Index that considers production costs and realised value.

Three Wagyu BreedObject $Indexes have been developed to date, these being a Self-Replacing Breeding Index (SRI), Fullblood Terminal (FTI) and F1 Terminal (F1 Index) indexes.
SELF-REPLACING BREEDING INDEX (SRI)
The new Self-Replacing Index can be used to select Fullblood bulls that will produce more profitable females when these are retained in Fullblood or Purebred herds, in addition to profitable slaughter progeny.

The SRI estimates the genetic differences between animals in terms of net profitability per cow joined for production of replacement females and slaughter steers to a carcase weight of 435kg at 32 months of age and a 385kg carcase from surplus heifers at 29 months of age. In terms of relative economic importance, the SRI places the following emphasis on these main traits: 38.5% on MS; 13% on Residual Feed Intake (RFI) feedlot; 11% on sale liveweight; 8% on meat yield; 6% on dressing percentage and 23.5% placed on other cow and calf traits.

Selecting animals based on the SRI places high genetic selection pressure on all live animal growth traits and carcase weight (cwt), with moderate pressure on eye muscle area (EMA), retail beef yield (RBY) and marble Score (MS) EBVs. When compared to the TCI, there is a relatively poor relationship between the SRI and the TCI ($R^2 = 0.57$) meaning that although animals with high SRI will tend to have above average TCI, in general animals will not rank similarly on both indexes.

The total value range of the SRI ($-$36 to $+$278) is approximately half of the value calculated for the TCI, with the average of the Wagyu published Sire list being $+$117. It is important to note that the TCI only uses the carcase weight and Marble Score EBVs to determine the genetic merit of progeny for slaughter value. The TCI does not consider the costs of production, so it is not a profitability index.

FULLBLOOD TERMINAL INDEX (FTI)
The Fullblood Terminal Index has an increased weighting on the Marble Score EBV and can be used to select bulls for the production of profitable slaughter progeny where none are retained for breeding.

The FTI estimates the genetic differences between animals in terms of net profitability per cow joined based on production of slaughter stock only, with a 435kg carcase from steers at 32 months of age and a 385kg carcase from heifers at 29 months of age. In terms of relative economic importance, the FTI places the following emphasis on these main traits: 64% on MS; 11% on Residual Feed Intake (RFI) feedlot; 9% on sale liveweight; 7% on meat yield; 5% on dressing percentage and 3% placed on other young animal traits and 0% on maternal traits.

Selecting animals based on the FTI achieves well balanced genetic selection with pressure placed on all live animal growth, and Marble Score EBVs. When compared to the SRI, the FTI places higher pressure on cwt and MS, with less pressure on RBY and EMA. There is also a strong relationship between FTI and SRI, meaning that animals with a high FTI, will tend to have high SRI values, although there is considerable re-ranking between FTI and SRI indexes. The total value range of the FTI ($-$38 to $+$240) is slightly less than that of the SRI, with the average of the Wagyu Published Sire list at $97.

F1 TERMINAL INDEX (F1 INDEX)
The F1 Terminal Index has an increased weighting on the Marble Score EBV and can be used to select bulls for the production of profitable F1 slaughter progeny where none are retained for breeding.

The F1 Index estimates the genetic differences between animals in terms of net profitability cow joined based on production of a 420kg carcase from steers and a 375kg carcase from heifers at 28 months of age. In terms of relative economic importance, the F1 Index places the following emphasis on these main traits: 68% on MS; 9% on Residual Feed Intake (RFI) feedlot; 4% on sale liveweight; 6% on meat yield; 4% on dressing percentage and 9% placed on other young animal traits and 0% on maternal traits.
Selecting animals based on the F1 Index placed a high relative degree of selection pressure on the Marble Score EBV compared to all other traits, with moderate pressure on EMA and Rump fat (correlated with Marble Score). The F1 index is relatively neutral for cwt, but negative for RBY, Milk and slightly negative for growth traits. When compared to the TCI, the F1 Index has the strongest relationship of the Wagyu BreedObject indexes (R2 0.83), meaning that animals with high F1 Index will have high TCI values. Like the TCI, there is relatively weak relationship between F1 Index and SRI (R2 0.58). The total value range of the F1 Index is -$64 to +$234, with an average of the Wagyu Published Sire list at +$87.

TESTING FOR CONFLICT BETWEEN INDEXES

The potential for conflict between the indexes, that is, whether selection for one index will be detrimental to performance with an alternate index has been tested by comparing top-ranking animals in each index and considering if they are above average for the other indexes (see the final section of this paper). Selecting sires within the top 10% of the breed for any one index will select for animals above breed-average in any of the other indexes.

BACKGROUND

BreedObject is in itself, a commercial production system model that considers input cost and value generation across the supply chain from breeding the cow to carcase endpoint (carcase value post grading) which includes the contribution of both the progeny and cow carcase. As such, it considers within its model, the costs of the cow-calf operation and sale weight of calves, grow-out production costs and 600 day weight, feedlot costs and final carcase value of both the progeny and cow as represented in Figure 1.

The previous Wagyu Terminal Carcase Index (TCI) was put in place in 2015 as an interim Index prior to the availability of BreedObject derived Indexes. BreedObject allows for more robust development of indexes for multiple purposes and assists the targeting of beef breeding programs by calculating the optimum mix of EBVs. BreedObject places appropriate emphasis on the growth, fertility and carcase EBVs depending on the economic value of the trait within different commercial production systems and the available genetic variation.

BreedObject Indexes help to establish economic breeding objectives based on an average cow in the herd, average market and environmental conditions, targeting the specified production and market system. BreedObject Indexes combine the genetic information contained in BREEDPLAN EBVs into a single $Index for potential profitability of progeny performance which describes how breeding from a particular animal is expected to impact profitability. This $Index figure considers costs and returns across the whole commercial production system.
WAGYU $INDEX DEVELOPMENT SUMMARY

Development of Indexes for Wagyu commenced in June 2018. It is important to note that the full financial model within BreedObject has a structure representative of the commercial industry and that the parameters specifically aimed at Wagyu within the model are appropriate to Wagyu production system outcomes.

The main parameters are summarised in Table 1. for the Wagyu BreedObject Index models.

TABLE 1  Principle Wagyu BreedObject $Index Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Self-Replacing</th>
<th>FB Terminal</th>
<th>F1 Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaning Rate (%)</td>
<td>85%</td>
<td>85%</td>
<td>95%</td>
</tr>
<tr>
<td>Age at Weaning (months)</td>
<td>7</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Feedlot Entry Weight – Steers (kg)</td>
<td>330</td>
<td>330</td>
<td>370</td>
</tr>
<tr>
<td>– Heifers (kg)</td>
<td>270</td>
<td>270</td>
<td>350</td>
</tr>
<tr>
<td>Days on Feed – Steers (days)</td>
<td>550</td>
<td>550</td>
<td>370</td>
</tr>
<tr>
<td>– Heifers (days)</td>
<td>450</td>
<td>450</td>
<td>370</td>
</tr>
<tr>
<td>Sale Age – Steers (months)</td>
<td>32</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td>– Heifers (months)</td>
<td>29</td>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>Carcass Weight – Steers (kg)</td>
<td>435</td>
<td>435</td>
<td>420</td>
</tr>
<tr>
<td>– Heifers (kg)</td>
<td>385</td>
<td>385</td>
<td>387</td>
</tr>
<tr>
<td>Carcass Price – Steers ($/kg)</td>
<td>8.25</td>
<td>8.25</td>
<td>6.25</td>
</tr>
<tr>
<td>– Heifers ($/kg)</td>
<td>8.25</td>
<td>8.25</td>
<td>6.25</td>
</tr>
<tr>
<td>Marbling premium ($/MS)</td>
<td>~1.00</td>
<td>~1.00</td>
<td>~1.00</td>
</tr>
</tbody>
</table>

Based on the above parameters, post-weaning average daily gain for Fullbloods is 0.8kg/day and 0.6kg/day for steers and heifers respectively. Cost of supplementary feed prior to feedlot entry is based on a long-term average of $250 per tonne, with feedlot feed cost at $350 per tonne. Feed costs are based on typical long-term feed costs and do not reflect variation due to seasonal pricing and availability.

An evaluation of the Australian Wagyu Association (AWA) carcase database for cwt averages shows that the average cwt value for recorded Wagyu carcasses is 420kg. During 2016 and 2017, the average cwt recorded in the AWA database was 435kg.

A summary of the emphasis placed on traits for the Terminal indexes relative to the Self-replacing index is shown in Table 2. Of note in comparing Indexes shown in Table 2, parameters associated with the cow component of the production system are not included within Terminal index models.

TABLE 2  Relative emphasis placed on main objective traits within the Wagyu Self-replacing Herd, Fullblood Terminal and F1 Terminal BreedObject $Indexes.

<table>
<thead>
<tr>
<th>Objective traits</th>
<th>Self-Replacing</th>
<th>FB Terminal</th>
<th>F1 Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale Liveweight</td>
<td>kg</td>
<td>10.83</td>
<td>9.23</td>
</tr>
<tr>
<td>Dressing Percentage</td>
<td>%</td>
<td>5.90</td>
<td>4.93</td>
</tr>
<tr>
<td>Saleable Meat Percentage</td>
<td>%</td>
<td>8.01</td>
<td>6.68</td>
</tr>
<tr>
<td>Fat Depth (rump)</td>
<td>mm</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Entry Weight</td>
<td>kg</td>
<td>0.65</td>
<td>0.11</td>
</tr>
<tr>
<td>Marbling Score</td>
<td></td>
<td>38.48</td>
<td>64.01</td>
</tr>
<tr>
<td>Weaning Weight - Dir.</td>
<td>kg</td>
<td>0.47</td>
<td>0.25</td>
</tr>
<tr>
<td>Weaning Weight - Mat.</td>
<td>kg</td>
<td>3.61</td>
<td>-</td>
</tr>
<tr>
<td>Resid. Feed Intake-pasture</td>
<td>kg/d</td>
<td>3.00</td>
<td>3.26</td>
</tr>
<tr>
<td>Resid. Feed Intake-feedlot</td>
<td>kg/d</td>
<td>13.14</td>
<td>10.82</td>
</tr>
<tr>
<td>Cow Weight</td>
<td>kg</td>
<td>3.45</td>
<td>-</td>
</tr>
<tr>
<td>Cow Weaning Rate</td>
<td>%</td>
<td>10.33</td>
<td>-</td>
</tr>
<tr>
<td>Cow Body Condition</td>
<td>Score</td>
<td>1.49</td>
<td>-</td>
</tr>
<tr>
<td>Calving Ease - Dir.</td>
<td>%</td>
<td>0.48</td>
<td>0.71</td>
</tr>
<tr>
<td>Calving ease – Mat.</td>
<td>%</td>
<td>0.16</td>
<td>-</td>
</tr>
</tbody>
</table>
BREEDOBJECT INDEX MODELS

WAGYU SELF-REPLACING BREEDING INDEX (SRI)

The Wagyu SRI estimates the genetic differences between animals in terms of net profitability per cow joined for production of replacement females and slaughter steers, along with excess heifers finished to a carcase weight of 435kg and 385kg respectively.

The new Self-Replacing Breeding Index can be used to select Fullblood bulls that will produce more profitable females when these are retained in Fullblood or Purebred herds, in addition to profitable slaughter progeny.

Figure 2 demonstrates the key economic traits that are important to SRI within the blue bar graph (also shown in Table 2). The different trait emphases reflect the underlying profit drivers in a typical self-replacing commercial operation. The red bar graph shows the subsequent emphasis that BreedObject places on Wagyu BREEDPLAN EBVs in ranking animals within the SRI.

FIGURE 2A AND 2B. The assessed SRI target trait importance for breeding for the commercial production system (blue) and subsequent % emphasis placed on EBVs based on target trait importance (red).

While the graphs in Figure 2a and 2b show the different profit drivers and emphases that have been placed on each EBV within the SRI, they do not illustrate the likely average change that will occur to each individual trait if producers select animals using this selection index. The response to selection will also be influenced by such factors as the genetic relationship between traits and the animals that are available for selection.
Figure 3 provides an indication of the relative change that would be expected in each individual trait if producers select animals using the SRI. The graph reflects the average relative change if producers selected animals within the top 10% of the published sire list within their breeding programs.

**FIGURE 3** SRI Indicative selection response (average EBVs for the top 10% of sires ranked on SRI). Individual EBVs (X-axis), with genetic progress per generation in standard deviations (Y-axis).

Based on Figure 3, it is evident that the SRI is expected to produce higher responses in the growth traits and Marble Score. The significant expected changes in all five growth traits produces a high correlated response in cwt (CW: orange bar). The carcase quality, EMA, RBY and Marble Score all show lower, but positive responses. The slight to small responses in the GL, Milk and Rump fat EBVs are considered to be negligible to zero change.

Average SRI for the Wagyu Published Sire list as at August 2018 is $117, with a range from -$36 to +$278. When compared to the TCI, there is a relatively poor correlation between the SRI values and TCI values within the published Wagyu Sire list (Figure 4).

Although there is a general trend for animals that rank highly for TCI to have high SRI (and visa-versa), there is considerable difference in the ranking of animals for TCI and SRI across the Wagyu Sire list.

For example, around the average SRI value of $117, the range in TCI values is from +$40 to +$340 (see red lines in Figure 4).

**FIGURE 4** The relationship between SRI and TCI for animals within the published Wagyu Sire List.
WAGYU FULLBLOOD TERMINAL $INDEX (FTI)

The Wagyu FTI estimates the genetic differences between animals in terms of net profitability per cow based on production of a 435kg carcase from steers and 385kg carcase from heifers. This index is derived from production cost and value estimates for slaughter production only, assuming no progeny are retained within the herd as replacement females.

The Fullblood Terminal Index has an increased weighting to the Marble Score EBV and can be used to select bulls for the production of profitable slaughter progeny where none are retained for breeding.

Figure 5a and 5b shows the key economic traits that are important in this FTI within the blue bar graph (also shown in Table 2). The different trait emphases reflect the underlying profit drivers in a typical commercial terminal carcase production operation. The red bar graph shows the subsequent emphasis that BreedObject places on Wagyu BREEDPLAN EBVs in ranking animals within the FTI.

FIGURE 5A AND 5B  The assessed FTI target trait importance for breeding for the commercial production system (blue) and subsequent % emphasis placed on EBVs based on target trait importance (red).

The likely change that will occur in each individual trait if producers select animals within the top 10% of the breed for this selection index is shown in Figure 6. It is evident that similar to the SRI, the FTI is expected to produce significant change in all five growth traits, albeit lower for Birth Weight. A similar response is expected for cwt, although increased response is expected in Marble Score compared to the SRI with less change in EMA and no change in RBY.

FIGURE 6  FTI indicative selection response (average EBVs for the top 10% of sires ranked on SRI). Individual EBVs (X-axis), with genetic progress per generation in standard deviations (Y-axis)
Average FTI for the August 2018 Wagyu Sire-list is $97, with a range from -$38 to +$240. Figure 7 shows the relationship between the FTI and the SRI. These show higher relative correlation (R² 0.79), with animals high in FTI also tending to have high SRI. However, there is significant variation in ranking between the SRI and the FTI. For example, around the average FTI value of +$97, the range in SRI values is from approximately +$80, up to +$180 (see red lines in Figure 7).

**WAGYU F1 TERMINAL INDEX (F1 INDEX)**

The Wagyu F1 Index estimates the genetic differences between animals in terms of net profitability perjoinings of non-Wagyu cows (based on Angus female) for production of a 420kg carcase from steers and 375kg carcase from heifers. This index is derived from production cost and value estimates for slaughter production only, assuming no progeny are retained within the herd as replacement females.

The F1 Terminal Index has an increased weighting to the Marble Score EBV and can be used to select bulls for the production of profitable F1 slaughter progeny where none are retained for breeding.

Figure 8a shows the key economic traits that are important in this F1 Index within the blue bar graph (also shown in Table 2). The different trait emphases reflect the underlying profit drivers in a typical F1 terminal commercial operation. The red bar graph (Figure 8b) shows the subsequent emphasis that BreedObject places on Wagyu BREEDPLAN EBVs in ranking animals within the F1 Index.

**FIGURE 8A AND 8B** The assessed F1 Index target trait importance for breeding for the commercial production system (blue) and subsequent % emphasis placed on EBVs based on target trait importance (red).
The likely change that will occur to each individual trait if producers select animals within the top 10% of the breed for this selection index is shown in Figure 9. It is evident that in contrast to the SRI and FTI, the F1 Index is expected to produce negligible change in all the growth traits and slight decreases in birth weight. Significantly less change is expected in cwt compared to the SRI and FTI, with a much larger change in Marble Score within the F1 Index.

**FIGURE 9**  F1 Index indicative selection response (average EBVs for the top 10% of sires ranked on SRI)

The relationship between the F1 Index and prior TCI is shown in Figure 10, which demonstrates that there is a strong correlation (R² 0.83) between these two Indexes. Average F1 Index for the Wagyu Sire-list is $87, with a range from -$64 to +$234. In general, animals with high TCI, have above average F1 Index values, although again, there is significant re-ranking between the F1 Index and the TCI. For example, around the average F1 index value of +$87, the range in SRI values is from approximately +$90, up to +$250 (see red lines in Figure 10), noting that the range in TCI is two-fold of any of the other indexes.

**FIGURE 10**  Correlation between F1 Index and TCI showing the relative similarity in indexes across the Wagyu Sire List.
SELECTION DIFFERENTIAL ACROSS INDEXES – TESTING THE POTENTIAL FOR CONFLICT

To compare potential conflict between indexes, the distribution of sires within the top 10% for each index was compared. Figures 11 to 13 show the distribution of the top 10% of sires in one index against their ranking in the other Wagyu indexes. This demonstrates that selection for animals in the top 10% of one index will not adversely affect an alternate Wagyu index.

Figure 11 shows the distribution of the top 10% of Self-Replacing Index sires within the other Wagyu indexes. This demonstrates that selection with the Self-Replacing Index produces a positive response (selects animals within the top 50%) across all other Wagyu indexes. Of note is that one sire within the Self-Replacing Index is placed within the bottom 50% of F1 Terminal index (Index 4).

![Distribution of sires within the top 10% of SRI across the TCI (Index 1), SRI (Index 2), FTI (Index 3) and F1 Index (Index 4).](image)

FIGURE 11 Distribution of sires within the top 10% of SRI across the TCI (Index 1), SRI (Index 2), FTI (Index 3) and F1 Index (Index 4).
Figure 12 shows the distribution of the top 10% of FTI sires within the other Wagyu indexes. This demonstrates that selection for FTI produces a positive response (selects animals within the top 50%) across all other Wagyu indexes.

FIGURE 12  Distribution of sires within the top 10% of FTI across the TCI (Index 1), SRI (Index 2), FTI (Index 3) and F1 Index (Index 4).
Figure 13 shows the distribution of the top 10% of F1 Index sires within the other Wagyu indexes. This demonstrates that selection with the F1 Index produces a positive response (selects animals within the top 50%) across all other Wagyu indexes. Of note is that one sire within the F1 Index is placed within the bottom 50% of SRI (Index 2).

**CONCLUSION**

The development of the Wagyu BreedObject $Indexes – SRI, FTI and F1 Index – is a positive step forward for the increased profitability and genetic gain for the Australian Wagyu industry. Considerable advantages in profitability and genetic gain can be achieved by using the appropriate Index based on the production system application.

Each $Index is tailored to a specific outcome – for example – with the SRI, balanced pressure is applied on maternal and growth traits in addition to carcase traits for optimal profitability in a self-replacing herd. For the Terminal Indexes, no maternal characteristics are considered in the model as it is assumed all progeny are to be slaughtered for carcase production. The Terminal indexes therefore place significant additional pressure on Marble Score.

In using the new Wagyu BreedObject $Indexxes, the Self-replacing Breeding Index can be used to select Fullblood bulls that will produce more profitable females when these are retained in Fullblood or Purebred herds, in addition to profitable slaughter progeny. The Fullblood Terminal and F1 Terminal Indexes have an increased weighting to the Marble Score EBV and can be used to select bulls for the production of profitable slaughter progeny where none are retained for breeding.