Increasing Profits per Acre with Appropriate Genetics

Steven Lukefahr
Lukefahr Ranch
Kingsville, Texas

Star cattle – A composite of Red Angus, Senepol, and Tuli breeds
Part II – Characterizing the Composite: Estimates of Across-Breed EPDs and Heterosis and Predicted Performance
Three-Breed Rotational Crossbreeding System:

This system was initiated in 2003 and allowed for the use of several purebred bulls (mostly by AI) of each of three foundation breeds. It also maintained high levels of heterosis in calves and cows. In addition, the best heifers were retained for breeding (even some outstanding bull calves). Another important point is that the three foundation breeds were compatible with respect to mature size and other characters and purebred bulls were generally chosen that were more representative (as opposed to being extreme) of their respective breeds.
The Star Composite was initiated using a Three-Breed Rotational Crossbreeding System:

- Senepol bull (WC 950K)
- Tuli bull (Honey Bear)
- Red Angus bull (PCC R2R Simon)

Crossbred Cows

Tuli bull (Honey Bear)

Senepol bull (WC 950K)
Three-Breed Rotational Crossbreeding:

- Red Angus-sired cow with her Senepol-sired AI calf
- Senepol-sired calf as a cow with her Tuli-sired AI calf
- Tuli-sired calf as a cow with her Red Angus-sired AI calf
- Red Angus-sired calf as a cow with her Senepol-sired AI calf
### Across-Breed EPDs and Heterosis for WW (lbs) in Star Cattle:

<table>
<thead>
<tr>
<th>Breed</th>
<th>Direct (Calf) EPD</th>
<th>Maternal (Cows) EPD</th>
<th>Cross Heterosis in Calves</th>
<th>Cross Heterosis in Cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Angus (R)</td>
<td>0</td>
<td>0</td>
<td>72.1</td>
<td>8.1</td>
</tr>
<tr>
<td>Senepol (S)</td>
<td>-21.9</td>
<td>28.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuli (T)</td>
<td>7.9</td>
<td>18.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N.B. Published data from Star cattle (Lukefahr, 2017).
Basic Genetic Term Definitions:

- **Direct EPD** – The effect of one-half the genes (breeding value) of the parent or parental breed on performance of the offspring. For weaning weight the direct EPD is described as “genes for growth” as expressed by the calf.

- **Maternal EPD** – The effect of one-half the genes (breeding value) of the parent or parental breed on performance of the daughter. For weaning weight the maternal EPD is described as “genes for milk” as expressed by the dam.

For convenience, the direct and maternal EPDs were set to zero for Red Angus. The EPDs for Senepol and Tuli are expressed as differences from Red Angus.

- **Direct heterosis** – The difference in average performance between crossbred (F₁) compared to purebred offspring, which generally causes an increase in performance due to increased heterozygosity (prevents the expression of harmful recessive genes due to “dominance” by a favorable dominant gene).

- **Maternal heterosis** – The difference in average performance between crossbred (F₁) compared to purebred dams, which generally causes an increase in performance due to increased heterozygosity.

**N.B.** Numeric values for WW presented on the previous slide (as well as for other traits) reflect performance **under south Texas conditions and the low-input production management system.** This is an important point because, for example, heterosis is higher in more adverse environments.
Predicted WW performance by breed-type:

The following breed-type examples will be provided to show how across-breed EPDs and heterosis values and the effect of hairy or slick genes can predict weaning weight performance. Of course, there are many traits of economic importance and this is only one trait example.

- Red Angus purebred
- Senepol X Red Angus
- Tuli sire X Senepol-Red Angus crossbred dam
- Star Calves with the Slick Gene
### Predicted WW performance for Red Angus purebred (RA):

<table>
<thead>
<tr>
<th>Direct EPD</th>
<th>Maternal EPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA 0</td>
<td>0</td>
</tr>
</tbody>
</table>

= $536.5 + [0]$

= **536.5 pounds**

The value of 536.5 pounds is the benchmark, predicted average weaning weight (WW) for purebred Red Angus, based on data from Star cattle analyses. Across-breed EPDs and the effect of the hairy genotype (as opposed to slick) are factored into this 536.5 pound figure. Also, the figure excludes heterosis because a purebred is involved.
Predicted WW performance for Senepol sire X Red Angus dam:

<table>
<thead>
<tr>
<th></th>
<th>Direct</th>
<th>Maternal</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Senepol</td>
<td>-21.9</td>
<td>28.4</td>
</tr>
</tbody>
</table>

Heterosis (Calf) = +72.1

Effect of Slick gene = +35

= 536.5 + [0 + -21.9 + 72.1 + 35] = 621.7 pounds (vs. 536.5 pounds)
**WW performance for Senepol sire X Red Angus dam:**

**Interpreting the numbers:**

The benchmark average of 536.5 pounds is first increased by the direct EPDs of Red Angus (0) and Senepol (-28.4) parents. The maternal EPD value for the purebred Red Angus dam does not need to be considered since it was set to zero. Because the calf is fully crossbred, the full potential value of 72.1 is added for direct heterosis. However, there is no benefit to the calf from maternal heterosis because the dam is purebred. Otherwise, this effect would further increase WW performance. Crossbred cows express hybrid vigor (heterosis), especially for fertility, health, milking ability, and longevity, which makes crossbreds generally more productive than the average performance of the parental breeds. Lastly, analyses reveal that the effect of the dominant slick genotype is to increase WW by 35 pounds. The 621.7 average WW is predicted based on all of these genetic factors. For a Star sire X Red Angus dam mating, a WW of 605.6 pounds is predicted.
Predicted WW performance for Tuli sire X Senepol X Red Angus crossbred dam:

<table>
<thead>
<tr>
<th></th>
<th>Direct EPD</th>
<th>Maternal EPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Senepol</td>
<td>-21.9</td>
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<tr>
<td>Tuli</td>
<td>7.9</td>
<td>18.6</td>
</tr>
</tbody>
</table>

Heterosis (Calf) = +72.1
Heterosis (Dam) = +8.1

= 536.5 + [7.9 + .5(0) + .5(-21.9) + 0 + 28.4 + 72.1 + 8.1]
= **642.1** pounds (vs. 536.5 pounds)
Interpreting the numbers:

The benchmark average of 536.5 pounds is first increased by the direct EPD of the Tuli sire (7.9). The calf is 25% Red Angus and 25% Senepol so the direct EPDs for these breeds (0 and -21.9) need to multiplied by one-half. Because the dam is 50% Red Angus and 50% Senepol, the maternal EPDs of 0 and 28.4 are simply added to the linear equation. Next, because both the calf and the dam are fully crossbred, the entire values of 72.1 and 8.1 are added for direct and maternal heterosis. The dam is heterozygous for the slick gene, so on average half of her calves will be slick and half will be hairy. When added, the effects of these genes cross-cancel one another. (The Tuli breed does not possess the slick gene.) This cross is predicted to be 20.4 pounds heavier than the previous Senepol sire X Red Angus dam cross, mostly due to the higher direct EPD from the Tuli sire (genes for growth), the higher maternal EPD from the Senepol dam (genes for milk), and favorable maternal heterosis. (Senepol could be classified as a maternal tropical breed). This is despite the fact that only half of the calves benefit from the slick gene.
Predicted WW performance for slick Star calves:

<table>
<thead>
<tr>
<th></th>
<th>Direct EPD</th>
<th>Maternal EPD</th>
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<tbody>
<tr>
<td>RA</td>
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</tr>
</tbody>
</table>

Heterosis (Calf) = +72.1
Heterosis (Dam) = +8.1

Effect of Slick gene = +35

\[
= 536.5 + \frac{(2(0 + -21.9 + 7.9))}{3} + \frac{(2(0 + 28.4 + 18.6))}{3} + 0.67(72.1) + 0.67(8.1) + 35 \\
= 647.0 \text{ pounds (vs. 536.5, a difference of } \sim 110.5 \text{ pounds)}
\]
Interpreting the numbers:

The benchmark average of 536.5 pounds is first increased by the averages of the direct and maternal EPD of all three breeds. The EPDs first have to be doubled to account for all of the genes (breeding value) from each breed, then divided by three to take an average. In addition, for the three-breed composite, 67% of the direct and maternal heterosis level is retained. The values of 72.1 and 8.1 are multiplied by .67, then added to the equation. Despite some heterosis loss, the trade-off is the sustainable breeding system (as opposed to use of terminal sire breeds that produce fully crossbred calves). DNA tests for the slick gene have been done for several years now. The light calf in the previous slide photo tested homozygous for the slick gene (i.e., two copies). Later as a sire all of his calves are expected to be slick. Now that the composite is developed, combined natural and artificial selection will assemble the wide array of desired genes from foundation breeds. Like any breed, the composite will continue to further improve over time.
Predicted WW performance by breed-type:

- **Red Angus (breed control group)**
  - 536.5

- **Senepol X Red Angus**
  - 621.7

- **Tuli sire X Senepol-Red Angus dam**
  - 642.1

- **Star Calves with Slick Gene**
  - 647.0
Summary:

The predicted WW of 647.0 pounds for Star calves requires some explanation. First, Star cattle possess genes for rapid preweaning growth towards maturity. This statement is based on the fact that some heifers and bulls are fertile as early as 6 to 7 months of age. In addition, mature weights of cows generally range between 1,000 and 1,200 pounds. So even by weaning age the calf has reached well over half of its potential mature size. Of relevance, limited to no Bos indicus or large Continental Bos taurus breed (e.g., Charolais and Simmental) influence are involved, which is another reason for early age at puberty and/or maturity. Heterosis is also known to accelerate the maturity process. The direct heterosis figure for WW of 72.1 pounds is substantial. This is due to the wide genetic distance between the foundation breeds. Such a high level of heterosis is similar to reported values for other wide crosses such as Bos indicus X Bos taurus. Lastly, the slick gene boosts the Star calf’s WW by 35 pounds, which is dramatic.