A COMPARISON OF BEEF CATTLE CROSSBREEDING SYSTEMS
ASSUMING VALUE-BASED MARKETING


University of Nebraska, Lincoln, Nebraska USA 68583-0908

INTRODUCTION

For evaluation of breeds and crosses, the US beef cattle industry should not simply base decisions on carcass value per kilogram of fed calves. Rather, total life-cycle expenses and income need to be considered. Breeds or crosses that have the highest carcass value might also have higher production costs due to poorer reproduction and/or higher maintenance feed costs. Evaluation should also consider a totally contained, sustainable, crossing system. The purpose of this study was to simulate biological and then economic outcomes under value-based marketing for crossbreeding systems assuming equal backfat at slaughter of calves.

MATERIALS AND METHODS

Fourteen breeds and their crosses were simulated using biological performance derived using data reports from the Germ Plasm Utilization and the Germ Plasm Evaluation projects, conducted at the USDA Meat Animal Research Center, Clay Center, NE, USA. The 14 breeds were: Hereford, Angus, Simmental, Limousin, Charolais, Brahman, Red Poll, Gelbvieh, Maine Anjou, Braunvieh, Chianina, Brangus, Pinzgauer, and Tarentaise. In addition, other literature data were incorporated to set levels of individual and maternal heterosis for the simulation and to predict heifer performance from steers (see Tomsen, 1998 for the sources of data).

Simulations were done using a deterministic model (i.e., performance was based on averages within a breed or cross with no animal variation). All systems were simulated using an equal pasture resource base. For the 14 pure breeds, the amounts of pasture used by 1000-cow herds were simulated. The average of these 14 purebred systems (1000 females) became the standard pasture usage. After establishing the standard base, the total number of cows in each system, including all purebred systems, varied to equalize use of the standard pasture resource.

Purebred, two-breed rotation, three-breed rotation, rota-terminal, and four-breed composite systems, using the 14 breeds, were simulated. The rotational and rota-terminal systems were totally contained beef breeding systems. Separate breeding groups were part of the total rotational systems and were assumed to produce purebred breeding animals (bulls) needed for the rest of the system. The rota-terminal system assumed a two-breed rotation to generate replacement females plus terminal crossing to a third breed of sire to produce only slaughter animals. The four-breed composite was assumed already created, thus only one breeding group was simulated.

Systems simulated conception through slaughter under Nebraska conditions. Calving was in spring, weaning was at 205 d, and calves immediately entered the feedlot for feeding until slaughter. Average days fed for the biological data from the Meat Animal Research Center
were 235 d with slaughter at 440 d of age. Output was initially generated under equal age at
slaughter. Purebred groups varied widely in backfat and yield grade when slaughtered at an
equal age. Another management scenario was thus simulated where genetic groups of animals
were fed different numbers of days and then slaughtered at the same backfat. Because this
required extrapolation from the biological data and minimizing amount of extrapolation was
desired, average backfat of purebred groups in the “Equal Age” scenario was used as the
slaughter endpoint in the “Equal Fat” scenario. For steers, this was .60 cm, and for heifers, the
endpoint was .70 cm. Only economic outcomes under the Equal Fat scenario are reported here.

Numbers of steers and heifers fed directly for slaughter varied for each system and were a
function of the total size of the system as determined by the constant pasture resource base, the
reproductive rate, and the number of breeding bulls (purebred and composite systems and
segments of rotational systems) and replacement heifers needed (purebred and composite
systems plus rotational segments of rotational and rota-terminal systems). Input costs and
output values were derived from 10-yr averages for Nebraska.

Fifteen traits were used in the simulations. Many of the traits incorporated differences in 2-yr-
old, 3-yr-old, and mature dams. Age distributions by breed type for the cow herd were
simulated, based on reproductive rate and culling of non-pregnant females at weaning time to
produce income. All cows were culled for salvage at 8.5 yr. Calf losses were simulated at
various times of the production year, and cows not nursing a calf were culled to generate
income.

Traits simulated were body weights, energy requirements, milk production, reproduction, and
carcass characteristics. Value per kilogram of carcass for slaughter steers and heifers was based
on yield grade, marbling and breed type using regression equations developed in research work
at Texas A&M University (Griffin et al., 1989). For the crossbreeding systems, individual and
maternal heterosis increments were simulated for the fifteen traits.

RESULTS AND DISCUSSION
Table 1 contains the average net returns of the 14 purebreds, 91 possible two-breed rotations,
364 possible three-breed rotations, 1092 possible rota-terminals, and 1001 possible composites.
Overall, three-breed rotations and composites were the most profitable systems. These systems
capitalize on appreciable amounts of heterosis, with substantial benefits coming through
increased reproductive performance and increased rate of growth. Purebreeding was the least
profitable system, losing out on the desirable benefits from heterosis.

Table 1 also contains the average for net returns of top and bottom ten in each crossing system
plus averages for top and bottom three purebreds. Averages of all three-breed rotations and all
composites were slightly higher than for all rota-terminals. But for the top-ten average, rota-
terminal systems fared better than three-breed rotations and composites. Being able to
capitalize on terminal crossing, gaining the benefit of larger calf size relative to cow size in
some systems, was beneficial. Four-breed composite and three-breed rotation were the least
risky systems in choices of breeds because these systems were more profitable among their
least profitable crosses. Two-breed rotation systems were more profitable than purebreeding.
Table 1. Average net returns (US$) for all crosses and selected crosses in each system

<table>
<thead>
<tr>
<th>System</th>
<th>Average of all</th>
<th>Average of top 10</th>
<th>Average of bottom 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purebred</td>
<td>36,077</td>
<td>45,662</td>
<td>20,703</td>
</tr>
<tr>
<td>Two-breed rotation</td>
<td>49,121</td>
<td>60,459</td>
<td>36,411</td>
</tr>
<tr>
<td>Three-breed rotation</td>
<td>55,404</td>
<td>69,711</td>
<td>38,622</td>
</tr>
<tr>
<td>Rota-terminal</td>
<td>51,771</td>
<td>70,757</td>
<td>32,992</td>
</tr>
<tr>
<td>Composite</td>
<td>53,971</td>
<td>68,757</td>
<td>38,783</td>
</tr>
</tbody>
</table>

*AAll crossing systems are totally sustaining, including all necessary purebred groups.  
**Top 3 for purebred.  
^Bottom 3 for purebred.

Table 2 contains the top ten crosses for each of the crossbreeding systems for the Equal Fat slaughter scenario. Differences in net returns among the top ten crosses within a system were not as large in the composites as in the systems that used rotational crossing. The top ten rotational terminals had six different breeds of terminal sire represented. Breeds that were included in many of the top crossing systems were: Angus, Charolais, and Gelbvieh. On purebred carcass value per kilogram when slaughtered at equal backfat, these three breeds averaged slightly less value per kilogram than the other eleven breeds.

Table 2. Top ten crosses\(^{A}\) in each system\(^{B}\) on the basis of net returns (US$)

<table>
<thead>
<tr>
<th>Two-breed rotation</th>
<th>Three-breed rotation</th>
<th>Rota-terminal</th>
<th>Composite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross</td>
<td>Returns</td>
<td>Cross</td>
<td>Returns</td>
</tr>
<tr>
<td>AN*CA</td>
<td>64,906</td>
<td>AN<em>CA</em>GV</td>
<td>74,250</td>
</tr>
<tr>
<td>AN*GV</td>
<td>63,872</td>
<td>HE<em>CA</em>GV</td>
<td>72,366</td>
</tr>
<tr>
<td>HE*CA</td>
<td>62,598</td>
<td>AN<em>LM</em>CA</td>
<td>70,352</td>
</tr>
<tr>
<td>HE*GV</td>
<td>61,613</td>
<td>AN<em>LM</em>GV</td>
<td>69,961</td>
</tr>
<tr>
<td>CA*MA</td>
<td>60,345</td>
<td>AN<em>SM</em>CA</td>
<td>69,291</td>
</tr>
<tr>
<td>CA*TA</td>
<td>59,589</td>
<td>AN<em>SM</em>GV</td>
<td>68,759</td>
</tr>
<tr>
<td>GV*MA</td>
<td>58,784</td>
<td>CA<em>GV</em>MA</td>
<td>68,596</td>
</tr>
<tr>
<td>GV*TA</td>
<td>57,897</td>
<td>HE<em>LM</em>CA</td>
<td>67,956</td>
</tr>
<tr>
<td>AN*LM</td>
<td>57,729</td>
<td>CA<em>GV</em>TA</td>
<td>67,855</td>
</tr>
<tr>
<td>AN*SM</td>
<td>57,261</td>
<td>AN<em>CA</em>PG</td>
<td>67,724</td>
</tr>
</tbody>
</table>

\(^A^\)Breed codes: AN=Angus, BV=Braunvieh, CA=Charolais, HE=Hereford, GV=Gelbvieh, LM=Limousin, MA=Maine Anjou, PG=Pinzgauer, SM=Simmental, and TA=Tarentaise. 
\(^B^\)All crossing systems are totally sustaining, including all necessary purebred groups. 
\(^C^\)Terminal sire breed and two-breed rotation dam breeds.

In rota-terminal systems, there were 78 combinations of crossbred dams for each terminal sire. Top five terminal sire breeds, in order, were: Simmental, Gelbvieh, Charolais, Braunvieh, and Limousin. There were 12 different terminal sire breeds for each two-breed rotation of dams. Top five two-breed rotations for dams, in order, were: Angus*Gelbvieh, Angus*Charolais, Hereford*Gelbvieh, Hereford*Charolais, and Charolais*Maine Anjou. Angus was included as part of the dam-breedom rotation in all of the top ten unique rota-terminal systems.
Systems simulated here all had a constant amount of pasture usage for the cow-calf herd. This resulted in widely varying numbers of cows for the different crossbred and purebred groups. Number of breeding females including replacement heifers ranged in the purebreeding systems from 915 for Chianina to 1216 for Hereford. Likewise, numbers of animals sold for income (cull females from the reproducing herd and fed steers and heifers) ranged widely too.

Several slaughter endpoints are possible. Equal Fat at slaughter is more realistic and provides a much better basis for comparison than Equal Age at slaughter. Part of the differences between breeds and crossing systems in carcass value per kilogram is diminished when carcasses have the same outside fat. A possible weakness of the simulations under the Equal Fat scenario is that linear adjustments, unique for each breed, were used to derive the carcass characteristics. Because there were wide differences in backfat when slaughtered at 440 d of age, large differences then had to be simulated in days on feed to attain the target Equal Fat endpoint.

Variation in value of slaughter animals from the feedlot was important. The correlation between average net returns for terminal sire breeds in rota-terminal systems and the value per steer was .94 in the Equal Age scenario and .96 in the Equal Fat scenario. But, the correlation between the average net returns of terminal sire breeds in rota-terminal systems and the price per kilogram of carcass was .85 in the Equal Age scenario and only .31 in the Equal Fat scenario. Thus under an Equal Fat scenario, price per kilogram of carcass had much less influence on net returns for the system.

Breeds with high maintenance energy requirements per unit size generally did not surface as top maternal-use breeds. Cow size was not an important determiner of net returns for maternal use. Likewise, breeds with higher milk production levels did not rank well for maternal use. Breeds with heavier slaughter weights at the target backfat ranked as the top sire breeds in terminal crossing.

CONCLUSION
This study simulated total life-cycle expenses and income under value-based marketing at equal fat. Unique rota-terminal systems had the greatest net returns, but four-breed composites and three-breed rotations had the least risk of selecting a poorer set of breeds for crossing. Breeds with high maintenance energy requirements per unit size generally were not the top maternal-use breeds. Cow size was not an important determiner of net returns for maternal use. Breeds with higher milk production levels did not rank highly for maternal use. Breeds with heavier slaughter weights at the target backfat ranked as the top terminal-sire breeds.

REFERENCES

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