FEMALE REPLACEMENT STRATEGIES IN BEEF CROSSBREEDING PROGRAMS

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Summary

A crossbreeding strategy with an objective of phenotypic uniformity was designed to address problems associated with traditional crossbreeding strategies. A distinct component of the strategy was the use of composite bulls. The new "uniformity" strategy was compared by use of simulation to a 3-breed rotational strategy. The rotational strategy had a fixed female replacement rate and used natural service bulls to produce replacement heifers that were selected from within the herd. In contrast, the uniformity strategy employed a flexible female replacement rate, derived for optimal profitability of the replacement heifers and used AI to produce the replacement heifers selected from within the herd. Overall, the uniformity strategy significantly improved phenotypic uniformity of replacement heifers and, over time, of the entire cow-herd. Composite bulls were shown to be effective in contributing to the uniformity of the cow-herd, as well as retained maternal heterosis.

Introduction

The main components of feasible crossbreeding strategies include maximizing heterosis both in cows and calves and complementarity of phenotypes. Complementarity of phenotypes relates to matching breeds or animal types in such a way that the calves produced from the mating of a bull and a cow are superior phenotypically compared to either parent. However, traditional crossbreeding strategies, such as a 3-breed rotation can produce problems, some of which include heifer replacement strategy, phenotypic uniformity of the both production and product, and achieving a desirable level of production. The objective of this research was to compare a 3-breed rotational crossbreeding strategy to a new phenotypic uniformity based crossbreeding strategy. The uniformity crossbreeding strategy was devised to achieve high levels of heterosis, use complementarity, and produced a sustainable female replacement strategy. A distinctive component of the uniformity strategy was the use of composite bulls, which does not require using only purebred sires as with most other crossbreeding strategies. This report deals with the uniformity of female traits in replacement heifers and cows.

Methods

A simulation was constructed utilizing across breed genetic, phenotypic, residual and fixed effect parameters obtained from Beef Improvement Ontario (BIO) and the U.S. Meat Animal Research Center (MARC). Heterosis estimates were multiplicative such that as phenotypic performance changed so did the amount of heterosis. A total of 16 traits were simulated and included: birth weight direct and maternal, weaning weight direct and maternal, post weaning gain, yearling height, slaughter weight, carcass weight, marbling score, rib-eye area, back-fat, mature cow weight, mature cow height, mature cow condition, gestation length, and age at puberty.

Potential herd bulls were simulated as yearling test bulls with average genetic merit. Bull breeds were assigned randomly, producing 750 purebred and 750 composite bulls per yearly crop of test bulls. Ten breeds were used in the simulation such that the percentage of purebred bulls were 10% Hereford, 15% Black Angus, 15% Red Angus, 15% Charolais, 20% Simmental, 10% Limousin, 5% Gelbvieh, 5% Blonde D'Aquitaine, 2.5% South Devon and 2.5% Shorthorn. Composite bulls were simulated such that all breeds in the purebreds were present in the composites and that F1 (2 breed) bulls were 84% of the composites, F2 (4 breed) were 12%, and F3 (8 breed) were 4%. A new crop of test bulls was simulated for each of the 10 production years.

Cows were simulated with an initial breed composition of Hereford, random genetic merit and a random age. Cows were randomly assigned to herds such that each herd had 100 cows. In total 100 herds were simulated containing 10000 cows in the base year. Each herd was assigned a random phenotypic mean in the base year of the simulation. The herds were randomly assigned to either the 3-breed rotational strategy or the uniformity crossbreeding strategy, resulting in 50 herds per strategy.

The rotational strategy herds selected only purebred bulls in a specific rotation. The general form of the rotation was Hereford X Exotic Maternal X Exotic Terminal. Rotational strategy herds had a fixed replacement rate of 20%. The breeding objective for the rotational herds was maximization of total maternal weaning gain. Replacement heifers were selected within herd. Bulls from the test bull crop were selected for natural service and used 1 year and then culled. A 20:1 female to bull ratio was maintained because all bulls were yearlings.

The uniformity strategy was designed with an overall objective of maximizing heterosis in the calves equally with performance criteria. Composite or purebred bulls could be selected and used. The performance criterion was established for each cow each year such that the overall objective of selection was for the herd mean performance to be equal to the performance targets (Table 1) for each trait. To produce heifers suitable as replacements, a group of cows from each herd were identified that produced calves closest to the desired performance targets. This group of cows, called the replacement female nucleus, was then assigned to be bred by AI and the resulting heifers considered for replacements.

The number of cows in the female replacement nucleus changed over time. The size of the female replacement nucleus was established as a function of the ages of the cows identified to be culled and the average age of the cow-herd. The average age required for a replacement female to return a profit on her development investment was assumed to be when she is 6 years old (or fifth consecutive calf weaned). The uniformity strategy maintained an average age in the cow-herd of 6 years implying that the average replacement female achieved the age of profit. Approximately 40 cows per uniformity strategy herd were assigned to the female replacement nucleus to be bred by AI. The remaining 60 cows were bred by natural service for terminal calves (i.e. heifers were not considered for replacements).

The female replacement nucleus cows were individually mated to AI bulls, selected from the test bulls, in order to produce optimum replacement heifers and maximize retained maternal heterosis. The actual performance targets for the cow traits that were used to define optimum replacement heifers are reported in Table 1. Yearling weight and height have been included with cow traits because they are highly related to mature cow weight and height. The yearling weight target was estimated as 65% of the mature cow weight target. Mature cow condition was scored on a 10 point scale where 1 is emaciated, 10 is obese, and optimum is between 5 and 6 depending on season of scoring.

Results and Discussion

Although many traits were studied, this paper deals only with replacement heifer and cow traits. These traits are yearling weight and height, mature cow weight and height, and mature cow condition. Replacement heifer strategies are discussed because uniformity of the cow-herd based traits is dependent on replacement rate as well as breeding strategy.

The female replacement rates did differ between strategies. The 3-breed rotational strategy had a fixed replacement rate of 20%. In contrast, the uniformity strategy had an average replacement rate of 16%. In terms of average age of the cows, the uniformity strategy achieved 6.0 years of age compared to 5.3 from the rotational strategy. Therefore, the uniformity strategy herds were very close to optimal.

Uniformity was measured as the amount of phenotypic variation present each year. The unit of measurement for variation was the phenotypic standard deviation. Yearling weight (Fig. 1) and height (Fig. 2) illustrates a significant improvement in uniformity through a large reduction in variation compared to the rotational strategy.

Cow size is related to maintenance costs, such that as cow size increases, so do the costs of maintaining weight and condition of that cow. Mature cow height and weight variation over time is plotted in Figs 3 and 4 and shows a significant reduction in variation in favour of the uniformity strategy. Mature cow condition results (Fig. 5) illustrate that little differences in variation exist between strategies, indicating weight variation could be reduced without changes in the average or the range in condition.

Conclusions

The uniformity crossbreeding strategy improved uniformity, both in replacement heifers and mature cows compared with a 3-breed rotational crossbreeding strategy. The heifer replacement system in the uniformity herds resulted in an average age to cover the average costs of producing replacement heifers. Composite bulls used in the uniformity strategy were effective in contributing to improved uniformity of replacement heifers and cow-herds.

Significance to the Industry

Crossbreeding strategies can be developed to improve uniformity of replacement heifers and cow-herds over time. A replacement system based on AI breeding, with a replacement rate tied to a profitable heifer replacement system can contribute to uniformity. Composite bulls can be used to improve uniformity of production.

Acknowledgements

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Table 1: Performance Targets

Traits	Performance Goal
Yearling Weight (kg)[a]	385
Yearling Height (cm)[b]	120
Mature Cow Height (cm)[c]	132
Mature Cow Weight (kg)[d]	567
Mature Cow Condition (units)[e]	5.5

[a] Yearling weight required to produce optimum sized yearling heifer for target cow weight.
[b] Yearling height target.
[d] Mature cow height target.
[c] Mature cow weight target.
[e] Mature cow condition was targeted for optimal score.

Figure 1.

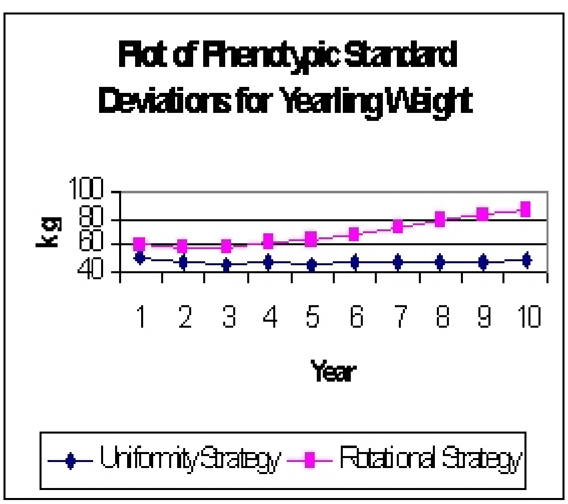
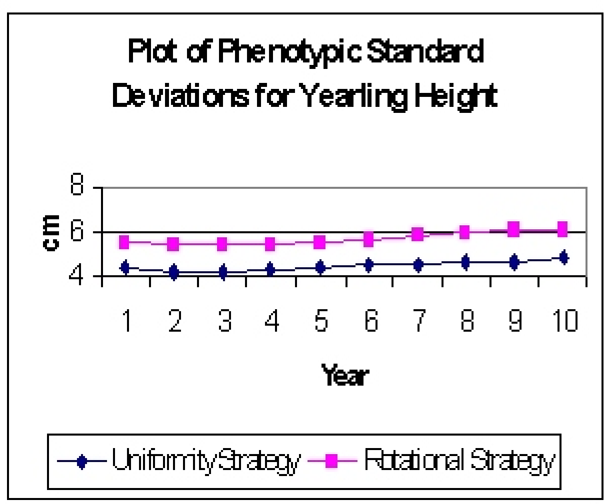


Figure 2.



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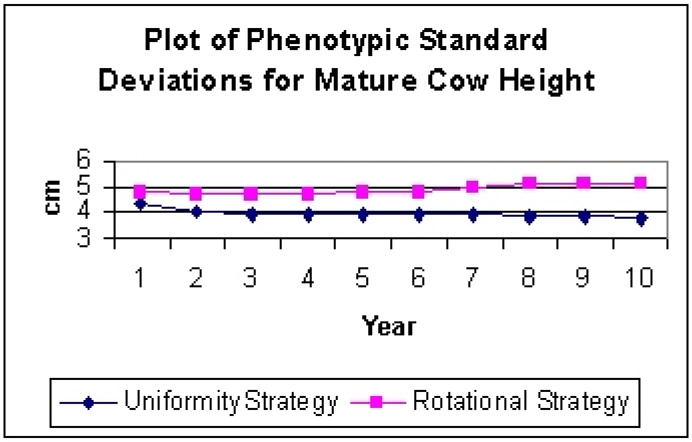

Figure 4.

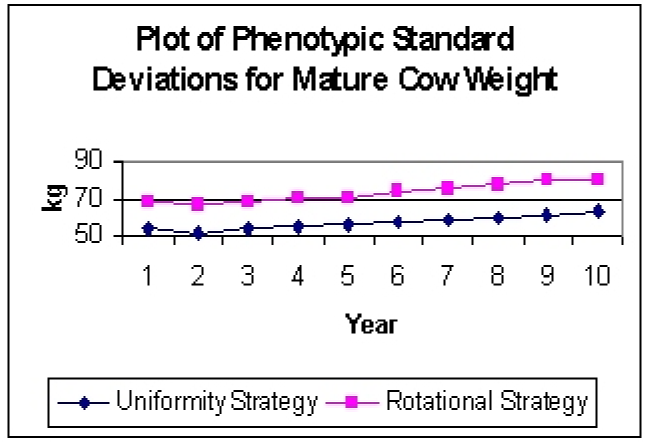

Figure 5.