DEVELOPMENTS IN MULTIPLE TRAIT SELECTION PRACTICES CONSIDERING MULTIPLE BREEDS AND AN OPTIMAL PRODUCT

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SUMMARY
A method of selecting beef bulls for commercial use considering their genetic evaluation on a number of traits is described. Two markets leading to 2 separate objectives are considered. Price grids for different markets are implemented, resulting in non-linear relationships between trait means and economic value. An example of this non-linearity is presented. The method incorporates selection across breeds and crosses considering the possibility of an optimal product.
Keywords: beef cattle, non-linear, selection, multiple breeds.

INTRODUCTION

Programs to aid in the selection of beef bulls for commercial use have traditionally focussed on the development of genetic evaluations for traits of importance to breeders. Multiple trait selection has been available for some time as a way to combine these traits to optimize profit potential but until recently has received little attention in beef cattle breeding. However, there is now considerable international interest in multiple trait selection for beef cattle. A commercial software package is available to Australian breeders implementing a customizable selection index as described by Barwick et al. (1994). Considering the heterogeneity of markets, production systems, and crossbreeding systems in beef production, multiple breeding objectives considering multiple breeds may be advantageous.

Objectives are to describe a multiple trait selection procedure for beef bulls using an example of market and production situations in southern Ontario, Canada and the information generated in herd performance tests and central evaluation stations; to describe procedures to incorporate optimal carcass weights and characteristics along with differences in retail markets; to describe procedures for including expected progeny performance across breeds; and to illustrate the changes in emphasis on various traits as a result of the consideration of these various factors. Potential future developments are also discussed.

MATERIALS AND METHODS

Central evaluation stations in Ontario facilitate across breed evaluations on bulls for a number of economically important traits. Before the 112 day test period begins, bulls will have genetic evaluations for Birth Weight (BW), Weaning Gain (WG) and Maternal Weaning Gain (WG-M) from measurements through the herd performance test. The following traits are measured during the central post-weaning performance test, Post Weaning Gain (PWG), Feed Intake (FI), Scrotal Circumference (SC), Back-Fat Thickness (BFT), Rib-Eye Area (REA) and Intra-Muscular Fat (IMF) with the later three traits measured via ultrasound.

Traits measured via multiple trait evaluation can be combined into a net economic value (NEV) by summing the products of the multiple trait EPD's by their respective economic weights. The multiple trait BLUP equations account for the genetic covariances between the traits evaluated and lead to evaluations equivalent to traditional selection index equations. This approach is easily applied to a multiple breed population where multiple breed evaluations allow breeders to compare animals for additive genetic merit despite breed or cross (Miller et al. 1995).

A bio-economic model was developed for a typical production program in southern Ontario. Progeny biological performance was predicted by combining the Across Breed Comparison's (ABC's, across breed EPD's) for the various traits with the appropriate trait means. These biological performance predictions were then substituted into the model for each animal individually to determine the differences in profit potential between bulls. Returns were based on market carcasses and cull cows sold and costs included feed, labour and other variable costs.

Some traits in the bio-economic model were not measured on the bulls directly. However, these could be predicted from the traits available on the bulls. For example, differences in heifer and cow fertility were predicted from a bull's genetic evaluation for SC and differences in calving difficulty were predicted through BW. Carcass weight, days from weaning to slaughter and feed intake from weaning to slaughter were predicted based on predicted performance for progeny end-of-test measurements of weight, BFT and FI using equations of McMorris and Wilton (1986). A constant finish (back-fat thickness) endpoint, which is common in Ontario, was assumed. Intra-muscular fat at end of test was transformed to a fmish constant prediction using an age adjustment and the predicted difference in days from weaning to slaughter. Equations of Jones et al. (1989) were used to predict retail yield based on predicted rib-eye area and carcass weight.

Traits were predicted on a bull progeny basis and transformed to a steer equivalent through a linear adjustment assuming a genetic correlation of unity. Predicted carcass weights were adjusted to a common management program in Ontario by deviating predicted differences in carcass weight from an Ontario average carcass weight. Differences in mature cow weight were predicted through differences in predicted steer weights at a constant finish.

Two production systems or potential lines of cattle were modeled independently. Both production systems assumed a bull would be used for two years in a herd of 30 cows. Line A modeled popular commercial production practices where producers retain their own replacement heifers and market their steers on the current grid of predicted prices per unit of carcass. Line B was intended to develop specialized replacement females with the steer progeny generated along with cull heifers satisfying a specific market. The market for line B animals was speculated such that there would be demand for a smaller carcass with an optimum weight as it relates to portion size and a high degree of marbling. The different markets for each of the lines A and B were incorporated into the respective NEV calculations through the bio-economic model by substituting the appropriate price grid which relates price per unit of product to carcass weight and percent intra-muscular fat.

Depending on the assumed price grid, a non-linear relationship between traits such as carcass weight and revenue, as a major component of NEV, developed. This was the case for the price grid assumed for both lines A and B. The relative trait emphasis is then different for every animal. The relative trait emphases were determined for a prospective genotype by increasing each of the traits evaluated independently by one tenth of the respective genetic standard deviation.

RESULTS AND DISCUSSION

Bulls completing Beef Improvement Ontario's Bull Evaluation Program in 1997 with evaluations on each of the predescribed traits had an NEV calculated and reported for both lines. The NEV represents the difference in profit expected compared to an average bull (ABC of zero on each trait). A 3-year rolling base was used where the average ABC in the previous three years is set to zero. Results for two sample bulls are reported in Table 1.

Table 1 illustrates the change in trait emphasis with changing genotypes. Generally, due to the non-linearity imposed by the price grids in both lines, as predicted carcass weight increases through a combination of increasing growth and decreasing relative finishing ability (BFT) the emphasis on BFT was increased and growth was decreased. The price grid for Line A essentially decreased the value per unit of product as carcasses got heavier. The price grid of Line B on the other hand favoured an optimal carcass weight with higher marbling. As a result, premiums were paid for heavier marbling for carcasses at the desired weights. As a result, bulls with predicted progeny carcass weights closer to the desired weight had greater emphasis on increased marbling. This is illustrated by comparing bulls 1 and 2 for their emphasis on marbling for line B. Progeny of bull 2 were close to the optimum weight where bull l's progeny were over weight. There was little advantage to increasing growth further on bull 1 as his progeny were already over weight, likewise there was an advantage to increasing back fat thickness (BFT) on this bull where increasing BFT on bull 2 was undesirable as it related to under weight carcasses

Predicted progeny performance was incorporated into the bio-economic model. The assumption was that there was no genotype by environment (GxE) interaction present. If a GxE was likely it could be incorporated using the appropriate relationships which could be derived from appropriate experimental data. The bio-economic model assumed a common level of management. However, a fully customizable bio-economic model would allow management variables and genotype of mate to vary. Ideally genotypes and management would be considered simultaneously with management variables optimized for each sire. Results would then be the most profitable sire under a prescribed level of management. Limitations could be placed on the range in management variables available. For example, some herds may be able to afford calving surveillance where others may not. This restriction could change the predicted NEV of a sire that had a higher level of predicted calving difficulty.

Advancements in the bio-economic model and prediction equations implemented are being developed. The technology implemented thus far has indicated that substitution of predicted progeny performance based on across breed genetic evaluations and prescribed management variables such as feeding program allow bulls to be compared for their potential impact on the profitability of a commercial beef operation. Challenges remaining include quantifying the relationship between changing environment and genotype on performance as well as improving parameters to allow prediction of performance of traits not measured directly through measured traits.

Table 1. Net Economic Value and trait emphasis for two sample bulls in two lines

Item	Bull	NEV[A]		Traits[B]		
		Line A	Line B	PWG	BFT	IMF
ABC[C]	1	3642	693	79	04 .	01 .
	2	1429	4327	13	10 .	07 .
E[D] Line A	1			101	23	
	2			117	-10	
E[D] Line B	1			-28	323	34
	2			185	-106	154

[A] Net Economic Value
[B] Central evaluation Post Weaning Gain, Back Fat Thickness, Irma-Muscular Fat percent
[C] Across Breed Comparison (multi-breed EPD)
[D] Emphasis, change in NEV with 1/10 genetic standard deviation increase in trait

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