

Impact of Planning Horizon Length on Breeding Objectives and Resulting Selection Decisions

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Summary with Implications

The weighting of traits in a selection index depends on varying circumstances that can differ among beef producers (e.g. economic factors, breeding systems). The determination of planning horizon is an additional variable that can differ among producers that represents the impact of genetic selection decisions over a gradient of time. A web-based economic index construction platform (iGENDEC) was used in the current study to investigate the implications of planning horizon on relative emphasis values of traits within the breeding goal and potential differences in sire selection decisions. General-purpose indexes were created for three breeding systems under six different planning horizons (2–50 yrs.). Relative emphasis for weight (weaning or hot carcass) at point of sale decreased while stayability increased as length of the planning horizon increased. The ranking of selection candidates varied as planning horizon and the point of sale changed. The results are indicative of the importance for determining the correct planning horizon when developing selection indexes.

Introduction

Economic selection indexes serve as tools for multiple trait selection to drive genetic selection decisions based on specified breeding objectives with the aim of increasing commercial-level net profit. The development of selection indexes requires defining a breeding objective, determining the economic parameters associated with costs/revenues, assuming a breeding system, and assuming current population (herd) phenotypic means. Generalized

indexes (i.e., those published by U.S. beef breed associations) make the above assumptions relying on national averages, and although these tools are the preferred method of practicing sire selection, unique differences exist among beef cattle producers that may deviate from these assumptions. This is particularly true with respect to current phenotypic performance and the length of time that the economic impacts of sire selection decisions should be considered (planning horizon; PH).

Selecting a PH is a complex decision that can often be overlooked when constructing economic selection indexes. Philosophically, planning horizon can be thought of as the length of time (years) that the user wants to consider in determining the economic impact of a genetic selection decision. Using simulation to create a large cowherd that expresses the traits in the breeding objective, as is commonly done in developing selection indexes, PH represents the number of years simulated with the improved genetic merit of bulls. Consequently, PH impacts the number of expressions of traits and thus their economic impact. Additionally, PH interacts with discounted gene flow and discounted expression rates. Discounted gene flow accounts for the fact that sire selection decisions impact future calf crops through the retention of daughters. Discounted expression rates account for the fact that some traits are expressed later in life than others.

Thus, the current study investigated the impacts of varying PH on the relative emphasis values of traits and the ranking of selection candidates based on indexes developed for different market endpoints and for different breeding systems.

Procedure

The economic selection indexes evaluated were created using iGENDEC, a web-based decision support platform that allows for the construction of economic selection indexes for U.S. beef production systems.

The general-purpose indexes were created under the assumptions that replacement females were retained. Given this, one index assumed calves would be marketed at weaning and the other assumed retained ownership on all non-replacement animals through the finishing phase. The traits in the indexes for the weaning point of sale included weaning weight-direct (WW-D), weaning weight-maternal (WW-M), mature cow weight (MW), stayability (STAY), heifer pregnancy (HP), calving ease-direct (CE-D), and calving ease-maternal (CE-M). For the finish endpoint index, the traits of hot carcass weight (HCW), ribeye area (REA), fat depth (FAT), marbling score (MS), yearling weight (YW), and feed intake (FI) were included in addition to those in the weaning endpoint index.

Within each index, three breeding systems were assessed: Angus bulls mated to Angus cows, half Simmental and half Angus bulls mated to cows of the same composition, and Simmental bulls mated to half Hereford and half Angus cows. These three breeding systems were chosen to compare the impacts of direct and maternal heterosis as well as reflect a sampling of real-world breeding systems. Six PH (2, 5, 10, 20, 30, and 50 yrs.) were assessed. In total, 36 indexes were developed. In each scenario, the economic parameters (e.g., variable cow costs, value of calves sold, etc.) and the base phenotypic means were the same. Resulting output included marginal economic values (MEV) for each trait in the breeding objective where the MEV is the economic value of changing the trait by one unit while all other traits are held constant. Relative emphasis values were then calculated as the absolute value of the MEV multiplied by the genetic standard deviation for the trait and then divided by the sum of these products for all the traits. The relative emphasis values for each trait are bounded by 0 and 1, and the sum of all relative emphasis values is equal to 1. The relative emphasis values can be interpreted as the relative importance, proportionally, of a trait in the breeding objective.

The indexes were then applied to a group of selection candidates (n=27,123). Spearman rank correlation coefficients were then calculated for all pairwise combinations of indexes to compare the effects of planning horizon, breeding system, and point of sale.

Finally, an evaluation of HCW was conducted to assess the change in relative emphasis as average hot carcass weight increased from 650 lbs. to 1150 lbs. in 100 lb increments when a discount threshold of 1,050 lbs. existed. This was conducted under the purebred Angus system for 2-, 20-, and 50-year planning horizons. This threshold was chosen to represent discounts that exist in U.S. beef production systems.

Results

Relative emphasis values for the primary revenue traits (WW-D and HCW) and STAY were averaged over all breeding systems and are reported in Table 1. As planning horizon increased in indexes that assumed a weaning point of sale, the relative emphasis shifted from WW-D to STAY with the largest change observed between 2- and 5-year PH followed by more gradual changes beyond 5 yrs. Likewise, given the finishing point of sale, the relative emphasis of HCW steadily declined and STAY increased as PH increased. At the longer PH (30 or 50 yr.), the changes in relative emphasis for these traits became smaller and began to plateau.

The Spearman's rank correlation coefficients suggested little re-ranking of the selection candidates based on differences in assumed breeding systems if the point of

Table 1. Comparison of relative emphasis values for weaning weight direct (WW-D), hot carcass weight (HCW), and stayability (STAY) for different lengths of planning horizon from indexes that assumed a weaning (Weaning) or finish (Carcass) point of sale.

Planning Horizon, yrs.	Weaning		Carcass	
	WW-D	STAY	HCW	STAY
2	0.859	0.000	0.449	0.002
5	0.586	0.183	0.444	0.016
10	0.434	0.231	0.407	0.062
20	0.324	0.321	0.363	0.160
30	0.282	0.362	0.348	0.190
50	0.259	0.375	0.334	0.219

sale and PH were the same ($r=0.96 \pm 0.04$). The average rank correlation coefficients between indexes with different endpoints was $r=0.71 \pm 0.12$ when averaged over breeding system and PH lengths. When indexes assumed a finish endpoint, substantial re-ranking ($r=0.78 \pm 0.09$) was observed between the short PH (2, 5, and 10 yrs.) and the longer PH (20, 30, and 50 yrs.). However, given a weaning point of sale, changes in rank correlations were less extreme.

For all PH, as the herd average HCW approached the discount threshold, the relative emphasis of HCW decreased. As planning horizon increased, the relative emphasis of HCW also decreased.

Conclusions

Results from the current study illustrate that situational differences among cattle enterprises can manifest in differences in appropriate selection indexes. The relative emphasis values provide a sense for which traits are economic drivers of a breeding

objective. The changes in relative emphasis values reported herein demonstrate the potential sensitivity to assumptions of planning horizon length. Such changes in planning horizon length might be determined by short-term needs for revenue. The current study also illustrated that differences in planning horizon length and sale point of calves can lead to differences in the ranking of bulls. Producers who make changes to their operational goals also need to update the criteria they use to select bulls, including the relative emphasis that they place on those criteria. Differences in current levels of phenotypic performance can also impact the importance of traits in breeding objectives and ultimately selection indexes as illustrated by changes in average hot carcass weight.

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