Decision Support Systems

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The majority of selection indexes available in the U.S. beef industry are generalized. They are generalized in the sense that they use industry-average values for costs and returns, assume industry average levels of performance, and make assumptions about common breeding objectives. Although these tools have been shown to be very robust to differences in values assigned to costs and returns, more advanced tools are available to customize selection index parameters. Breeders can also take advantage of interactive decision support tools to aid with herd-level genetic decisions. Both animal-specific and herd-level decision support tools will be discussed as they relate to systems that are available to the U.S. beef industry

Decision support systems that evaluate herd-level performance are designed to evaluate the herd's overall change in genetic merit and to aid in matching genetic potential to production environments, rather than to evaluate potential individual selection decisions. Animal, most often sire, decision support tools aid in making selection decisions that contemplate genetic potential in an economic framework. In other words, these tools help select sires that will improve net profit through advancing genetic potential.

An example of a system designed to aid in matching genetic potential to production environments is the Angus Optimal Milk Module. This decision aid is a tool designed specifically for producers to decide the appropriate range of milk EPD given the mature weight of their cows, annual cow costs, and variability in feed resources. The system produces recommendations for an optimal range of milk EPD for that specific operation. The remainder of this chapter will discuss animal-specific selection decision support tools.

Why Use a Decision Support Tool?

Bull purchasing decisions need to account for differing marketing goals and environmental constraints to improve profitability and sustainability, but these are unique to each herd as producer-specific production goals and inputs vary considerably. For instance, it is well known that calving ease is more important when considering bulls that will be mated to heifers than it is when selecting bulls to be mated to mature cows. Calving ease is also more important in herds that have high levels of dystocia or that calve in extensive range environments than in herds with infrequent dystocia or readily available labor at calving. Additionally, in low-input environments where forage availability is low, selection for decreased mature size and lower milk production levels is advantageous if heifers are to be produced from within the herd. These are examples where inputs, defined as either labor or feedstuff availability, dictate optimal production levels. The targeted market endpoint also dictates traits and production levels that are economically relevant at the individual farm level. For producers who market all calves towards a quality grid (e.g. Certified Angus Beef target) without retaining replacements, survivability, disease susceptibility, sale weight, and carcass quality are primary economic drivers, and traits such as weaning weight maternal (milk) are irrelevant.

The correct bull choice is conditional on marketing objectives, environmental constraints, and value and number of offspring. Knowledge of the value of individual bulls available and the value differences amongst them would greatly enhance the profitability of commercial cow/calf enterprises. This would allow selection decisions to focus on what is economically important, and what bull price is justified to achieve the subsequent goals for a particular farm given its resource constraints. Many producers do not appear to use all of the relevant information available when making bull purchasing decisions (Weaber et al., 2014; Penton Media, 2010). The Penton Media survey (2010) revealed that producers often incorrectly include an animal's own performance record in selection decisions, and trait emphasis is in conflict with production/marketing goals. Without the aid of a decision support tool, commercial beef cattle producers, often without the technical knowledge required, are forced to attempt to combine several different pieces of information (e.g. current herd performance, EPD of potential seedstock, accuracy of EPD, mean breed differences, projected costs and value of production, production environment constraints, etc.) to decide which bull to buy, and to determine the economic value conditional on their own needs.

Producers face the problem of obtaining the best bulls for their operation in that given setting. Implicit in this exercise is the need to account for the underlying resource base where the sire's progeny will be utilized. It is worth noting here that "best" is a relative concept. When accounting for price differentials across bulls, a "less desirable" bull may become the preferred choice over a "more desirable" bull if his sale price discount is larger than the differential in value between the two bulls. A producer armed with a decision support aid can use the estimates of "value" on different bulls to identify the relative bargains of bulls that are most underpriced relative to their value. Conversely, if the spread in bull prices does not sufficiently reflect the differences in economic value of the bulls offered, having good estimates of value should increase profitability of top seedstock producers.

Past and Current Tools

Decision support tools that address these various scenarios have been proposed before (e.g., Decision Evaluator for the Cattle Industry; DECI; Williams and Jenkins, 1998; Colorado Beef Cow Production Model; CBCPM; Shafer et al., 2005) but were not widely adopted due to the level of complexity and detail relative to firm-level inputs required to parameterize the underlying model. The American International Charolais Association offers a terminal sire index that is designed to evaluate decisions for selection of sires in the database based on their relative impact on profitability in a terminal sire mating system. By definition, no replacements are kept from within a terminal mating system. The tool allows input of current herd production characteristics and sources of income by the producer including options for weaned calves, backgrounded calves, and grid pricing models. Sires are then

ranked by their index values given the producer's production values. This system offers increased flexibility over selection indexes by allowing producers to select animals based on their specific production system. The terminal system accounts for increased feed requirements for animals sired by bulls with greater levels of growth, but does not account for differences in costs of production. The tool assumes that all calves are marketed on a carcass value basis.

It is clear that to achieve widespread use, a decision support tool that allows a tiered level of input information, with default values that are customizable from each specific user, is required. The decision process, which includes input from the user, is outlined below.

Breeding objective. This identifies which traits are economically relevant, and thus the traits that are included in the index. Critical information includes if the herd is self-replacing, at what age calves are marketed, and how value is assigned to sale animals (e.g., live weight, carcass weight).

Phenotypic values. These are the current herd averages for traits that are economically relevant. For example, average weight at time of sale, cow herd age distribution, pregnancy rates, mature cow weight, and carcass metrics could be important depending on the breeding objective. This information allows the system to establish a baseline or starting place from which to assign economic values when changing each particular trait by one unit while holding all other traits constant. A generalized index assumes that every producer has the same level of performance. A customizable index allows these values to differ. This can be important for traits whereby a threshold in costs/pricing exists. For example, a herd that has carcass weights that routinely exceed plant limits has a different economic value assigned to carcass weight than a herd that has carcass weights that fall within an acceptable window.

Values for costs and returns. In general, the relationship between costs and revenue are similar across an intermediate time span (i.e., cattle cycle). However, differences do exist between producers. These differences might exist due to differences in production environments (i.e., cost of feed). For producers with detailed economic knowledge of their herd, such as unit cost of production, being able to customize underlying economic assumptions of an index can be helpful. However, the majority of beef cattle producers can utilize industry averages and feel comfortable in constructing an accurate index.

Cow herd breed composition. Genetic decisions relative to sire selection should be based on additive genetic effects (EPD) and non-additive genetic effects (heterosis from crossbreeding). The latter can only be determined when the breed composition of the cow herd is known to some degree. For example, if the cow herd is predominately Angus and the additive genetic merit of two bulls, Hereford and Angus, are equal, the better decision is to choose the Hereford bull given that this will lead to increased heterosis in the corresponding calf crop.

Planning horizon. This is the length of time that a producer considers for their current plan or breeding objective. For example, a terminal producer could easily change breeding objectives rapidly given no females are retained. Once females are retained, the planning horizon naturally becomes longer. Even so, some producers may think in 5-year time spans while other might consider the impact of their decisions over 10 years. This impacts the relative importance of traits that might be measured later in life (i.e., reproductive longevity).

A web-based animal selection support tool, iGenDec, has been developed by a group of researchers from the University of Nebraska-Lincoln, US MARC, Kansas State University, and Theta Solutions, LLC. This effort is funded by USDA-AFRI-CARE award number 2018-68008-27888. The iGenDec tool is designed to aid producers in combining many sources of information (EPD, herd-level data, heterosis, breed differences) toward improving net profit. This tool employs user-defined input or default values to develop a selection index that can be applied to a list of animals that are either uploaded by the user or contained in a database of participating organizations. The index is then user-specific, and accounts for differences in heterosis (if applicable).

Conclusion

The impetus for selection decision aids is not the belief that generalized selection indices are flawed but rather that improvements can be made to more closely match the selection tool with its intended use. Given that commercial producers have to make a plethora of farm-level decisions, utilizing a decisions support aid to reduce the complexity of sire selection could make this process more efficient and accurate. Producers who have greater degrees of herd-level data (past performance and costs of production) will be able to populate decision support tools with ranch-specific data rather than default values, and will derive the most benefit from these tools.

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