J. Dairy Sci. 101:1–7
https://doi.org/10.3168/jds.2017-14012

Estimation of relative economic weights and the marginal willingness to pay for breeding traits of Brown Swiss cattle using discrete choice experiments

A. Just,[1] R. Wellmann, and J. Bennewitz
Institute of Animal Science, University of Hohenheim, Stuttgart 70599, Germany

ABSTRACT

Breeding traits are usually combined in a total merit index according to their economic weights to maximize genetic gain based on economic merit. However, this maximization may not always be the aim of the selection decisions by farm managers. A discrete choice experiment was used to evaluate the importance of traits in terms of the selection decisions of farm managers operating in different environments. Six trait complexes, the semen price, the interactions between these traits, and significant characteristics of the farms were included in a conditional logit model to estimate relative economic weights and the marginal willingness to pay for all traits. Milk value, conformation/udder, and fitness were the most important traits for the farmers, and significant interactions indicated that fitness is of greater importance on organically managed farms than on conventional farms. Farm managers with an advanced education placed more weight on the milk value trait than farm managers without advanced education. On conventional farms, managers weighted the traits milk value and conformation/udder highly. The conformation/udder and fitness trait complexes were important on organic farms. A new trait called perinatal sucking behavior of newborn calves should be included in the total merit index.
Key words: economic weight, discrete choice experiment, Brown Swiss cattle

INTRODUCTION

The definition of breeding goals is one of the most important steps in the development of efficient breeding programs. Trait selection for inclusion in a breeding goal depends on trait heritability and genetic correlations with other traits as well as the costs and labor required to record phenotypic data and the economic importance of the trait. For many breeds, a total merit index (**TMI**) is established that includes both the traits and their relative economic weights (**REW**). Several methods are available to estimate REW, the most common of which are strictly economic in nature and include objective and profit-oriented methods, such as the herd model (Amer et al., 1996; Fuerst-Waltl et al., 2010), or direct costing and profit functions, which are based on the costs and profits of a production system (Brascamp et al., 1985; Nielsen and Amer, 2007). Critical aspects of these methods are the lack of information on some traits, especially functional traits and new traits that have not been validated monetarily, and the assumption that the sole objective of breeders and farmers is profit maximization. However, the choices of farmers may not be affected only by economic factors, especially on organic farms, where particular importance may be attached to noneconomic aspects such as animal welfare, environmental impacts, and other individual operational characteristics (Nielsen and Amer, 2007).

Alternatively, REW may be derived via nonobjective methods that are based on the subjective assessments and empirical values of experts, breeders, farmers, or consumers. Teegen et al. (2008) and von Rohr et al. (1999) applied the contingent valuation method to estimate REW in horse and pig breeding, respectively. A simple and intuitive approach is to analyze the frequency of the use of sires for AI and link it to the EBV of their traits, which would yield some realized REW (i.e., the relative importance of trait EBV in the past selection of the sires). However, such an approach would fail for new traits, and more sophisticated methods have to be used. Choice experiments are frequently applied to study farmers' preferences for traits. For example, Martin-Collado et al. (2015) applied pairwise comparisons of traits in an online survey to study Australian dairy farmers' preferences for 13 traits. The authors showed that the preferences are heterogeneous with respect to farmer characteristics—that is, they differed for production-focused, functionality-focused, and type-focused farmers. The farmer characteristics were identified by using principal component analysis followed by

Received October 18, 2017.
Accepted January 23, 2018.
[1]Corresponding author: Annik_Just@uni-hohenheim.de

hierarchical cluster analysis. A similar approach was used by Slagboom et al. (2016a,b) to identify farmers' characteristics. An interesting result of Martin-Collado et al. (2015) was that the heterogeneity was intrinsic to farmers and not to production systems or breeds. The results of the study were used in the design of new breeding objectives and selection indices tailored for these 3 farmer types in Australia (Byrne et al., 2016). Choice experiments have also been applied in other species, such as sheep (Byrne et al., 2012; Ragkos and Abas, 2015), pigs (Roessler et al., 2012), and chickens (Bett et al., 2011) and frequently to study farmers' preferences in developing countries (Duguma et al., 2011). Ahlman et al. (2014) and Slagboom et al. (2016a,b) used choice experiments to study Swedish and Danish dairy farmers' preferences for breeding traits, respectively, considering heterogeneous preferences among farmers (i.e., organic and conventional farmers).

A challenge is the proper design of the choice sets. The discrete choice experiment (**DCE**) has a well-defined theoretical basis in random utility theory (Louviere et al., 2010) and is closely related to natural decision processes. Respondents are given a questionnaire consisting of multiple questions called choice sets, and they are required to choose one alternative from each set, which enables researchers to examine comprehensive decisions. In animal breeding, this method can be used to study farmers' preferences for breeding traits and, based on this, to derive REW by allowing breeders to choose among hypothetical sires with different EBV and semen prices. The assumption is that the sire chosen from the questionnaire will represent the greatest utility for the breeder. This utility is affected by the levels of the attributes of the sires (i.e., hypothetical EBV and semen prices) and by operational characteristics of the farm (e.g., conventional or organic systems). The latter allows for the consideration of heterogeneous preferences among farmers. Naturally, the utility comprises economic aspects but also values the experience, informal background, or future orientation of the farmers. Interactions between the trait EBV of the sires and the characteristics of farms or farmers can be used to determine heterogeneous REW, which is termed "environment-specific REW" throughout this article. These can be used to define environment-specific breeding goals.

The DCE can also be used to calculate the marginal willingness to pay (**MWTP**), which describes the amount of money a respondent is willing to pay to obtain an additional nonmonetary attribute (Aizaki et al., 2015)—in this case an improvement in a certain trait by 1 genetic standard deviation. This broadens the assessment of trait importance to include a monetary perspective.

The Brown Swiss cattle breed is a milk-type, dual-purpose breed that is commonly used in southern Germany, and it is reared in conventional as well as organic farming systems, which have their own TMI with different REW. The aim of the present study was to estimate REW and the MWTP using a DCE for Brown Swiss cattle in the state of Baden-Wuerttemberg in southern Germany. The REW were subsequently used to establish an environment-specific TMI and were compared with the REW used in the current TMI for this breed.

MATERIALS AND METHODS

Survey Design and Data

A choice experimental design was created with 18 choice sets consisting of 3 hypothetical sires each; 1 sire had to be chosen by the breeder to serve as an average cow in the herd. Seven attributes were defined for the sires, namely the price for 1 portion of semen (monetary element in euros) and breeding values for the following 6 trait complexes. The milk production value trait complex represented milk, protein, and fat yield. The general beef production value represented daily gain, carcass quality, and slaughter yield. The conformation/udder trait complex consisted of exterior and health of claw, leg, and udder. The fitness trait complex comprised the remaining functional traits (i.e., calving ease, stillbirth, functional longevity, persistency, fertility). The show type trait denoted all exterior traits except udder, claw, and leg exterior. The final trait, perinatal sucking behavior (**PSB**), was included because insufficient PSB is a serious problem in this breed and shows significant heritability (Maltecca et al., 2007). According to a survey, approximately 7% of newborn Brown Swiss calves exhibit insufficient PSB in Germany, and the heritability is about 0.15 (C. Dreher and J. Bennewitz, Institute of Animal Science, University Hohenheim, Germany, personal communication). This trait is a putative novel breeding trait. The admissible levels of the breeding values were 100 (mean breeding value), 112 (1 SD above the mean), and 124 (2 SD above the mean), and no breeding value was assumed to be below the mean. The prices for 1 portion of semen were set at €6 (low cost), €12 (moderate cost), and €18 (higher cost). The analytical design was created with the R package "support.CEs" (Aizaki, 2012). Seven orthogonal main effects arrays (1 for each trait and 1 for the semen price) were used to define the first alternative of each choice set, and the same was done for the second and third alternatives. Assignments were performed randomly with different seeds. For each of the 1,000 designs resulting from the different seeds, 500 DCE were simulated, and the average standard errors