A REVIEW OF THE NATIONAL BREEDING OBJECTIVE AND SELECTION INDEXES FOR THE AUSTRALIAN DAIRY INDUSTRY

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SUMMARY

We applied a pairwise comparison method using the 1000Minds® software to assess farmers' preferences for cow trait improvements. A Principal Component Analysis (PCA) followed by a Cluster Analysis (CA) of the principal components led to the identification of three farmer clusters (farmer types in the rest of this document) according to the trait improvements to which the farmers had the highest preference. This way, Australian dairy farmers can be classified into production-focused (n = 192), functionality-focused (n = 187), and type-focused (n = 172) farmers. As a result of this study, and bio-economic modelling, three indexes were released to the Australian dairy industry. The Balanced Performance Index aligns with the average preferences, while the Health Weighted and Type Weighted indexes reflect the preferences identified for functionally-focused and type-focused farmer types, respectively. These three indexes include new traits and offer a range of options to choose from when selecting bulls, while all driving gain towards the National Breeding Objective (NBO).

INTRODUCTION

Breeding objectives can play an important, but not exclusive, role in determining the optimal size and direction of genetic changes in traits. Economically efficient multiple-trait selection is normally achieved through the definition of breeding objectives and the development of appropriate selection indexes for specific production systems (James 1981). In nations with industrialised dairy industries a breeding objective is often controlled at the national level (e.g. Harris *et al.* 1996). The NBO underpins the selection index for the ranking of dairy cattle for profitable genetic merit in Australia (Pryce *et al.* 2010). The aim of this study was to update the NBO by calculating economic weights for a range of traits that impact profitability of Australian dairy farms. The final choice of selection indexes was informed by analysing the heterogeneity of farmers' preferences (from surveys) for improvements in dairy cow traits using farmer typologies.

This paper broadly describes the methodology used to analyse heterogeneity of farmers' preferences and how the outcomes of this were used, along with economic analysis underpinning the breeding objective, to develop selection indexes.

METHODS

Survey questionnaire and analysis. We applied a pairwise comparison method to assess farmers' preferences for trait improvements, using the 1000Minds® software. This software is simple to implement and reduces the level of burden on respondents compared to other more complex methods (Hansen and Ombler 2009). The software asks a series of questions to respondents, who are asked to choose, repeatedly, between pairs of alternatives until all possible pairs of alternatives are evaluated. A ranking of the presented alternatives is derived from these choices. We considered most of the traits included in the Australian Profit Ranking (APR), at the time of surveying, as well as other traits that were considered of potential importance for the Australian dairy industry. Survey traits included; protein yield, cow live weight, fertility, longevity, mastitis resistance, milking speed, temperament, calving difficulty, feed efficiency, lactation persistency, lameness, mammary system, and overall type. The magnitude of the suggested improvement in each trait was such that our estimate of the economic impact on farm would be as similar as possible across traits (Martin-Collado et al. 2015). Farmer attitudes towards genetic evaluation tools were assessed by asking farmers to rate, in a five-level Likert scale (Likert 1932), their level of agreement with specific statements. Farmers were also asked a set of farmer and farm descriptors that were thought to have a potential influence on farmers' preferences for improvements in traits. These included farmer age, role on farm, farm location, herd size, total milk production, cow breed distribution, cows registered with breed society, replacements sired by AI or herd bulls, labour profile, calving system, and feeding system. Farmers of all 6314 Australian dairy farms were sent the survey. In addition, 200 levy-paying farmers were randomly selected from the list of all Dairy Australia farmers. The survey produced 618 responses, of which 551 were fully completed and were used for this study.

A Principal Component Analysis (PCA) followed by a Cluster Analysis (CA) of the principal components was used to investigate the patterns of relationships between farmers' preferences for the different trait improvements. We determined the principal components (PCs) of the trait preferences and implemented a Ward's Hierarchical CA of the first five principal components. The selection of the number of clusters was based on the loss of inertia (within cluster sum of squares) at each partitioning of clusters (Ward 1963). We described the farmer types according to their preferences for animal trait improvements. We analysed the relationship between farmer types and farmer attitudes, criteria used for selecting bulls (results not shown) and other farm and farmer descriptors (as reported above). Differences for the normally distributed variables were analysed with the ANOVA test followed by Duncan's multiple comparisons test to analyse pairwise differences. The non-normally distributed variables were analysed with the Kruskal-Wallis test and multiple comparisons were tested with the Wilcoxon's procedure. Finally, the Fisher's exact test was used to analyse pairwise differences between discrete variables among farmer types.

Formulation of breeding objectives and selection indexes. Economic weights in the breeding objective were calculated as the economic effect on profit per unit change in each of the traits independently, allowing for the Australian dairy production system diversity of feeding systems and calving patterns. These economic weights are reported elsewhere (Byrne *et al.* in preparation). Selection indexes were defined using a combination of economic principles and desired gains approaches, such that indexes remained relevant for improving on-farm profit based on strong scientific principles which were also consistent with farmers' preferences.

RESULTS AND DISCUSSION

In the overall ranking of preferences for trait improvements at population level we could distinguish the most preferred and the least preferred trait improvements, as well as a large number of trait improvements with medium preference. Mastitis (average rank 4.3) was the most preferred trait followed by longevity (5.1) and fertility (5.4) whereas the least preferred traits were milking speed (8.2), lactation persistency (8.3), and cow live weight (10.4). These preferences are relative to crude calculations that equalise the economic effects of each offered trait difference; thus the preferences are more likely to be driven by perception than by economics.

Principal Component Analysis of Farmers' Preferences for Trait Improvements. The scores of farmers' preferences for trait improvements in the first two PCs are described in Figure 1. These first two PC accounted for 26.6% of the total variability of the farmers' trait improvement preferences, and five PCs were needed to explain 55.5% of the initial variability.

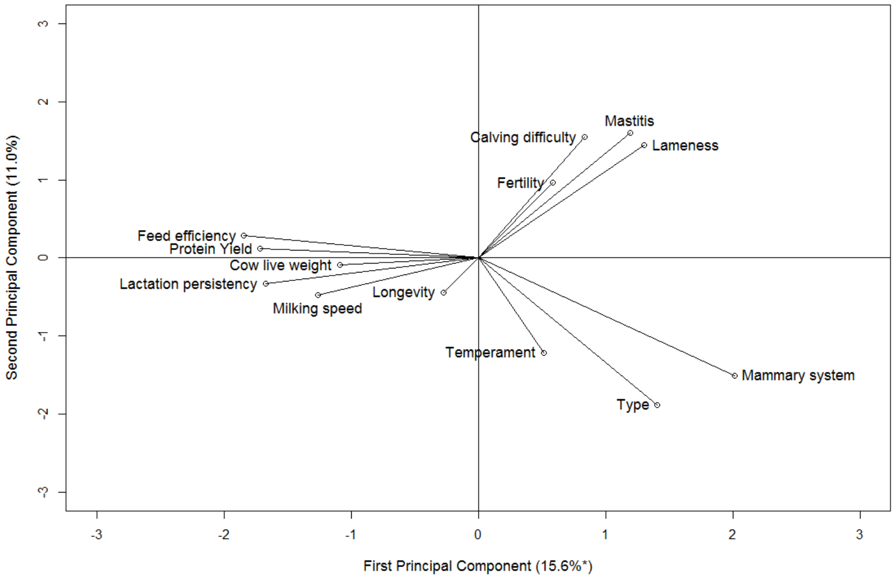

Figure 1. Scores of the preferences for improvements on cow traits on the first two principal components.

Cluster Analysis of the principal component. While the data indicates a continuum of preference, the cluster analysis of the first five PCs determined the existence of three farmer types of very similar sizes, named according to the trait improvements to which the farmers had the highest preference. This way, Australian dairy farmers can be classified into production-focused (n = 192), functionality-focused (n = 187), and type-focused (n = 172) farmers.

Production-focused farmers gave the highest preference to improving longevity (mean rank±SE: 4.4±0.23), feed efficiency (5.2±0.22), and protein yield (5.3±0.23). Compared to the other farmer types production-focused farmers gave the highest importance of all to protein yield, lactation persistency (6.3±0.25), feed efficiency, cow live weight (9.0±0.25), and milking speed (6.9±0.26). Conversely, they gave lowest importance of all the farmer types to improving mastitis (5.8±0.27), lameness (8.1±0.23), and mammary system (8.4±0.21).

Functionality-focused farmers gave the highest preference to mastitis (2.8±0.17), followed by lameness (4.6±0.26), calving difficulty (5.2±0.22), and fertility (5.4±0.25). Compared to the other farmer types, functionality-focused farmers gave the highest preference of all to mastitis, lameness, and calving difficulty.

Type-focused farmers preferred improvements in mammary system (3.7±0.15), longevity (4.0±0.19) and mastitis (4.1±0.20) the most. Compared to the other farmer types, type-focused farmers gave the highest preference of all to mammary system, and type (4.9±0.19). On the contrary, type-focused farmers gave the lowest importance of all to protein yield (8.5±0.22).

There was an expectation that factors such as farm size and calving or feeding system would explain some of the variability in farmers' preferences for trait improvements, but we did not find significant differences between farmer types for any of the farm descriptors. However, in a univariate analysis of the survey results, we observed that the importance given to specific traits was related to some of the farm features. Seasonal calving farmers gave higher preference (ANOVA p-value < 0.05), average rank 4.9, to an improvement in cow fertility compared to farmers of split-calving herds (5.5) and all-year-round herds (5.8) and to not increasing live weight (ANOVA p-value < 0.001), average rank 9.6, compared to the other calving systems (pooled average of 10.7). There was also no clear relationship between farmers' preferences and breed when analysing the PC clusters. The results could imply that farmers' preferences are intrinsic to the farmer, rather than being strongly linked to external system factors.

Formulation of selection indexes informed by farmers' preferences. Australian dairy farmers can be divided into three types according to the pattern of their preferences for trait improvements. As a result of detailed bio-economic modelling, and this study, three indexes were released to Australian dairy farmers (Figure 2) in September 2014. These three indexes include new traits, informed by trait preference data, and offer a range of options to choose from when selecting bulls. The Balanced Performance Index aligns with the average preferences, while the Health Weighted and Type Weighted Indexes reflect the preferences identified for Functionally-focused and Type-focused farmer types, respectively. The economic weights for all traits were calculated based on economic principles, with the exception of a number of trait weightings in the Type-weighted index, which were calculated using a desired gains approach informed by trait preference data.

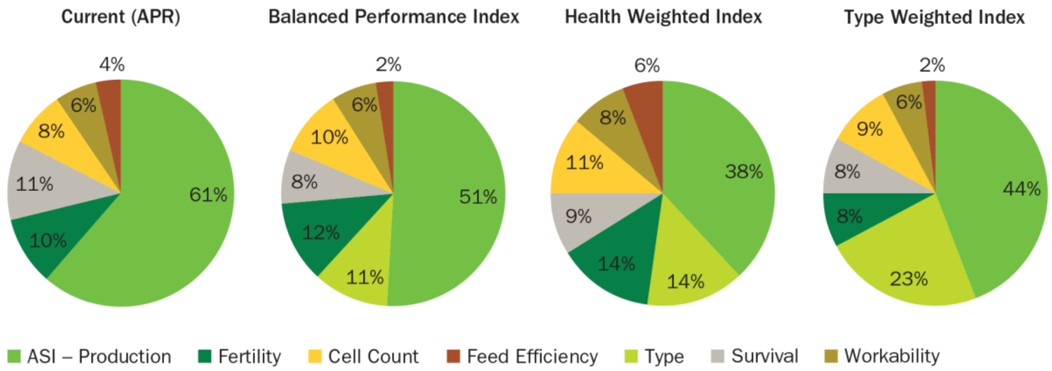

Figure 2. Relative emphasis in the three new indexes and the APR.

CONCLUSION

There are different groups of Australian dairy farmers with specific needs. This has led to the three indexes including new traits and offers a range of options when selecting bulls.

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