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Economic basis for the Nordic Total Merit Index

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ABSTRACT

Within a group of cooperating countries, all breeding animals are judged according to the same criteria if a joint breeding goal is applied in these countries. This makes it easier for dairy farmers to compare national and foreign elite bulls and may lead to more selection across borders. However, a joint breeding goal is only an advantage if the countries share the same production environment. In this study, we investigated whether the development of a joint breeding goal for each of the major dairy cattle breeds across Denmark, Finland, and Sweden would be an advantage compared with national breeding goals. For that purpose, economic values for all breeding goal traits in the 3 countries were derived, and estimated rank correlations between bulls selected for a national breeding goal and a joint breeding goal were compared. The economic values within country were derived by means of an objective bio-economic model, and the basic situation in each of the 3 production environments was based on an average dairy cattle herd with regard to production system, production level, and management strategy. The common Nordic economic values for each trait were calculated as the average of that specific trait in each of the 3 production environments. Balanced breeding goals were obtained in all situations because the derived economic values for traits related to health, fertility, milk production, and longevity were sizeable. For both Nordic Red Dairy Cattle and Nordic Holstein, the estimated rank correlations between bulls selected for a national breeding goal and a joint breeding goal were very high. Thus, a joint breeding goal within breed is feasible for Denmark, Finland, and Sweden.

Key words: economic value, breeding goal, dairy production, phenotypic level

INTRODUCTION

Four major factors contribute to the usefulness of selection indices across lines of the same breed in different countries: difference in breeding goals, genotype-by-environment interaction (**G×E**), difference in trait definition, and difference in genetic evaluation. The breeding goal defines which traits are to be improved and how much weight is given to each trait. In dairy cattle breeding, the weighting factors are usually economic values (Groen et al., 1997). Economic values are functions of the production circumstances. Breeding goals might differ because of different production circumstances, but they are ultimately something to be decided upon by the breeding organizations, and hence may ignore some variation in production circumstances between herds. If G×E exists, genes and their effects behave differently across environments (Lynch and Walsh, 1998). Therefore, phenotypes recorded in a different environment have lower information value. Similarly, differences in trait definitions and differences in genetic evaluations cause reduced efficiency of selection across populations and lower the value of information.

The establishment of Nordic Cattle Genetic Evaluation (**NCGE**) in 2002 and the establishment of a Danish–Finnish–Swedish AI organization have nullified the previous differences in trait definitions and genetic evaluations. Attempts to find G×E in and across the Nordic countries have resulted in small differences (e.g., Kolmodin, 2003), which suggests that the major part of the genes have the same effect within breed across all countries. The remaining question is whether a joint breeding goal within breed is feasible for the entire region.

In countries with the same production environment, the main advantage of a joint breeding goal is higher genetic gain as a result of higher selection intensity due to a larger population size. Using the same methodology across countries, Kulak et al. (2004) derived economic values for some of the breeding goal traits and some of the breeds in Denmark, Finland, Norway, and Sweden. On the basis of their results, they concluded

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Table 1. Assumed feed prices (€/kg) for the 3 production environments

Feed	Denmark	Finland	Sweden
Grain	0.17	0.19	0.17
Soy	0.23	0.25	0.25
Calf mixture	0.20	0.22	0.20

that the differences in the economic values were not an impediment to a closer co-operation between the Nordic countries.

Based on this background information, we reasoned that the development of a joint breeding goal for each of the major dairy cattle breeds across Denmark, Finland, and Sweden would be an advantage. We tested this hypothesis by comparing estimated rank correlations between bulls selected for a national breeding goal and a joint breeding goal. To do so, we derived economic values for all breeding goal traits in the 3 countries.

MATERIALS AND METHODS

Model

The economic values were derived by means of a static, deterministic bio-economic model of dairy farming. The model is described in details in Pedersen et al. (2008) and is accessible to the public (NAV, 2014). The input parameters included average phenotypic levels for all traits and basic prices of all input and output factors for 2 breeds [Red Dairy Cattle (**RDC**) and Holstein] in 3 production environments (Denmark, Finland, and Sweden). Assumptions on the phenotypic levels for a given combination of breed and production environment are averages of phenotypic records from all cows falling into this particular combination of breed and country that have EBV in 2007. The averages of the phenotypic records come from national cattle databases and statistical publications as given in Pedersen et al. (2008). Basic prices of all input and output factors were national market prices from 2007 as described in Pedersen et al. (2008). The pricing system in northern Finland differs substantially from that in central and southern Finland. The differences are mainly due to higher milk prices and higher feed costs in northern Finland. We chose to use prices from central and southern Finland.

Production System, Production Level, and Feeding of Cows

An average dairy cattle herd with regard to production system, production level, and management strategy formed the background for the basic situation in each of the 3 production environments. Beef production was evaluated as an integrated part of the dairy cattle production system. The economic values were derived at the herd level; that is, only factors directly connected to the animals were considered. All groups of animals were fed according to requirements, for example, maintenance, growth, milk production, and fetal development. The energy requirements for milk, fat, and protein production were based on the study by Sjaunja et al. (1990) and adjusted for the marginal feed utilization that results from a genetically improved yield capacity. The marginal feed utilization was assumed to be 70% based on the considerations of Østergaard and Neimann-Sørensen (1989) and Veerkamp et al. (1995). The assumed feed prices are shown in Table 1.

Females were inseminated until pregnancy or until 168 d after first insemination (8 estrus periods). Pregnant heifers were sold internally or externally at the assumed price of springing heifers (Table 2). Barren females were slaughtered.

Heifers were purchased if there was a deficit of pregnant heifers born within the herd; thus, there were always enough heifers available for replacement. Therefore, cow replacement rate was independent of the number of heifers born within the herd. We assumed that 3% of the liveborn heifer calves died, 5% of the live born bull calves died, and 4% of the cows died each year. For all dead animals, the costs of disposal were taken into account.

Traits and Price Assumptions

Economic values were derived for 27 breeding goal traits. The derivations were based on average market prices from spring 2007. The herds generated revenues

Table 2. Assumed prices of springing heifers (€/head) and slaughtered females (€/kg of carcass) for the 3 production environments

Item[1]	Denmark	Finland	Sweden
Springing heifer, RDC	1,160	1,220	1,160
Springing heifer, HOL	1,160	1,350	1,160
Slaughtered heifer	2.32	3.12	2.90
Slaughtered cow	1.86	1.64	2.30

[1]RDC = Red Dairy Cattle; HOL = Holstein.