SELECTION FOR BODY WEIGHT IN DAIRY CATTLE IN THE NETHERLANDS

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INTRODUCTION

To facilitate efficient selection of breeding animals, breeding organisations estimate and publish estimated breeding values (EBVs) for traits that are of (economic) importance such as milk production and conformation. Several studies (Dempfle, 1986 ; Steverink *et al.*, 1993 ; Spelman and Garrick, 1997) suggested that the use of EBVs for body weight (BW) when making selection decisions may be a potential tool to increase the economic response of selection. These studies indicated that the combined use of EBVs for milk production and BW may increase the economic response of selection up to 4 %.

Although some countries such as New Zealand (Ahlborn and Dempfle, 1992) and Finland (Hietanen and Ojala, 1995) already provide breeders with EBVs for BW, knowledge on the possibilities and relevance of selection for BW under Dutch circumstances is limited. To decide on a selection strategy including BW, the Dutch breeding industry initiated studies on the genetic and economic aspects of selection for BW. First, the possibilities of easy and efficient systems for large-scale data recording and genetic evaluation were studied. Secondly, economic value (EVs) for BW were estimated to quantify the effects of genetic changes of BW on the economic efficiency. Finally, alternative selection strategies including EBVs for BW were compared. This paper summarises these studies to outline the possibilities and relevance of a combined selection strategy for BW in dairy cattle in the Netherlands.

DATA RECORDING AND GENETIC EVALUATION

In the first study genetic and non-genetic parameters of BW were analysed from field data. In an experiment, 7344 Holstein-Friesian heifers from 560 herds were weighed and measured (heart girth, hip height) at conformation scoring (Koenen and Groen, 1998). Unadjusted BW of these heifers was 546 kg (SD 57). The estimated genetic standard deviation and heritability were 29 kg and 0.33, respectively.

For practical reasons, the implementation of a large-scale genetic evaluation for BW based on weighings is an unrealistic option. Therefore, in the same experiment also the possibilities of a genetic evaluation for BW based on observations for body measurements and conformation traits were studied. Heart girth had the highest genetic correlation with BW (r = 0.77). Genetic correlations of BW with hip height, body depth, rump width, muscularity and size were 0.50, 0.48, 0.43, 0.48 and 0.59, respectively. The efficiency of an indirect selection for BW was studied by selection index calculations. The accuracy of a selection index based on 50 effective daughters was 0.90 for direct BW measurements (weighings) and 0.83 when observations on heart girth, hip height, body depth, rump width and muscularity were used.

From this study it was concluded that field data for BW have a considerable genetic variation indicating that the use of routinely scored conformation traits is an attractive alternative when a large-scale genetic evaluation for BW is considered.

ECONOMIC VALUE OF BW

The EV of BW expresses the extent that economic efficiency of production is improved by an increase at the moment of expression. The EV of BW largely relates to feed costs for maintenance and returns from beef production. A review of previous studies from various countries (Koenen *et al.*, 2001) indicated that the EV of BW is highly sensitive to prices of inputs and outputs and production circumstances. Therefore, the EVs for BW were estimated for three possible future production circumstances (Koenen *et al.*, 2001). The first scenario is based on an extrapolation of current trends in production circumstances. The second scenario included a full market liberalisation. The third scenario included very extreme environmental restrictions.

For all these different production circumstances, the relation between BW and economic productivity at farm level was studied using the bio-economic model of Berentsen and Giessen (1995). Within this model, linear programming was used to maximise labour income before and after genetic changes in BW. The EV for BW was then defined as the marginal revenues after increasing the genetic merit for BW by one unit, while keeping all other traits constant. The estimated EVs for BW in the first, second and third scenario were –0.22, –0.29 and –0.19 €/kg/cow/year, respectively.

Sensitivity analyses within each situation showed that EVs for BW were highly sensitive to assumed levels of dry-matter intake capacity (DMIC) and production : the EV is more negative when DMIC is more restricting and at higher production levels. Extrapolation of current trends suggested that the EV of BW may become more negative in future.

COMBINED SELECTION

The effects of adding BW to the present breeding objective and selection index were studied by comparing the different alternatives (table 1). The expected genetic and economic responses of index selection were derived assuming a selection intensity of 1 and a reliability of 100 % for the available EBVs.

Index 1 (including production traits and durability) will result in a higher milk production, durability and BW. The overall economic response is € 70.94. When the selection index also includes EBVs for BW (Index 2), the positive trend in BW will decrease largely (-78 %) and the positive trends for milk production traits will decrease slightly (-3 %). As a result of small negative correlation between BW and durability (-0.14), the positive trend in durability will increase by about 4 %. The economic response increased slightly to 71.22 € (+0.4 %).

Selection on BW is expected to affect also genetic levels of important traits that are not in the breeding objective such as DMIC, body condition score (BCS) and calving interval (CI). These three traits have a genetic correlation with BW of 0.35, 0.75 and –0.42, respectively. When the correlated effects of selection were also considered for Index 1 the genetic trend in DMIC is positive whereas trends in BCS and CI are unfavourable. Table 1 shows that an index with a negative weighting on BW (Index 2) results in larger unfavourable responses than an index excluding BW. When the EV of BW is doubled (Index 3), positive trends in production traits are about 5 % lower, whereas the trend in BW becomes even negative (-1.9 kg). At the same time the unfavourable response in DMIC, BCS and CI are increasing. The additional effect of including EBVs for BW in the selection index on the economic response is 0.4 % and 1.6 % for Index 2 and Index 3, respectively.

Table 1. Effect of selection on milk production, durability (DU), body weight (BW), total economic response, dry-matter intake capacity (DMIC), body condition score (BCS) and calving interval (CI) (Koenen, 2001)

	Index 1	Index 2	Index 3	Index 4
Response in breeding objective traits				
Milk (kg)	265	258	250	300
Fat (kg)	14.3	14.0	13.7	15.1
Protein (kg)	11.7	11.5	11.2	12.0
DU (points)	1.92	1.99	2.04	1.84
BW (kg)	3.2	0.7	-1.9	4.6
DMIC (kg/day)	-	-	-	0.588
Response (€)	70.94	71.22	71.35	91.74
Response in correlated traits				
DMIC (kg/day)	0.539	0.511	0.479	-
BCS	-0.20	-0.27	-0.33	-0.20
CI (days)	2.8	3.2	3.6	3.1

Index 1 : = -0.068 EBV_{milk} + 0.91 EBV_{fat} + 5.45 $EBV_{protein}$ + 6.81 EBV_{DU}.
Index 2 : = -0.068 EBV_{milk} + 0.91 EBV_{fat} + 5.45 $EBV_{protein}$ + 6.81 EBV_{DU} -0.22 EBV_{BW}.
Index 3 : = -0.068 EBV_{milk} + 0.91 EBV_{fat} + 5.45 $EBV_{protein}$ + 6.81 EBV_{DU} -0.44 EBV_{BW}.
Index 4 : = -0.039 EBV_{milk} + 1.56 EBV_{fat} + 5.35 $EBV_{protein}$ + 8.41 EBV_{DU} + 0.10 EBV_{BW}.

To reduce the unfavourable effects of selection on BW the inclusion of DMIC in the breeding objective may be considered as well. When the original weighting factors of Index 2 were optimised for such a breeding objective, the weighting of EBVs for BW in the index became even positive (Index 4). Selection on Index 4 will result in larger trends for production and DMIC, but it will also result in more unfavourable trends in BW and CI.

The effect of using the discussed selection strategies on expected re-ranking of breeding animals was quantified by estimating the correlation between the indices. The high estimated correlations (> 0.99), imply that re-ranking will be small as milk production traits and durability are likely to dominate the selection index.

IMPLEMENTATION IN THE DUTCH BREEDING PROGRAM

To provide breeders with an adequate tool to select on BW a routine genetic evaluation for BW was introduced in the Netherlands in August 2001. The EBVs for BW are derived from EBVs for hip height (HH), chest width (CW), body depth (BD), angularity (AL) and rump width (RW). The weighting of individual EBVs for conformation depends on their reliabilities. For proven sires with very reliable EBVs for conformation the EBV for BW is derived as EBV_{BW} = 100 + 0.41(EBV_{HH} - 100) + 0.25(EBV_{CW} - 100) + 0.29(EBV_{BD} - 100) - 0.55(EBV_{AL} - 100) + 0.25 (EBV_{RW} - 100). The reliabilities of the conformations EBVs also determine the reliability of the EBV for BW. The reliability of EBVs for BW of proven and young sires (60 scored daughters) is about 90 % and 60 %, respectively.

The EBV for BW is published on a relative scale (low - high) with a mean of 100. 4.5. Points on the publication scale represent one genetic standard deviation on the original scale which means that one point of EBVs for BW represents a genetic difference of about 6 kg.

The EBVs for BW can easily be used by breeders to breed for a lower or higher BW depending on the personal breeding objective. However, the use of EBVs for BW within a combined selection strategy is complicated. In the present Dutch breeding program, animals are ranked on the Durable Performance Sum (DPS) index (De Jong and Harbers, 2001). The main traits in this index are 305-day milk, fat and protein production and durability. It is not yet clear how EBVs for BW can be optimally combined within the DPS index. On the one hand, a negative weighting on BW (Index 2) results in an increase in the total economic response by selection. It also results in a lower favourable trend in milk production and DMIC and in higher unfavourable trends in BCS and CI. On the other hand, a positive weighting of BW in the DPS index in combination with DMIC in the breeding objective (Index 4) may confuse practical breeders as EBVs for BW are then used to increase DMIC (positive EV) rather than to decrease BW (negative EV). Another disadvantage of Index 4 is that, compared to the present DPS-index, it will also result in more unfavourable trends for durability and CI which may be undesirable from a welfare point of view. The combined selection on a higher DMIC and lower BW can only be achieved when also reliable EBVs for DMIC are used which are not available in most practical breeding programs. Based on these results, the breeding industry decided to not include EBVs for BW in the current DPS index as long as reliable EBVs for DMIC are not available.

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