Breeding for profit in the Netherlands

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1. Introduction

In general terms, the breeding goal for dairy cattle is straightforward: a cow that produces a lot of milk of proper composition, and that can sustain a high production level without problems. Predicted breeding values for many traits have been developed to facilitate efficient breeding for this aim. In the Netherlands, more than 30 different predicted breeding values are available. To make optimal use of this information, the various predicted breeding values should be put into the proper economic perspective. This paper summarises the economic values for the traits, and addresses the question how to combine the predicted breeding value information into a total economic value.

2. Economic values per trait

Milk production

Wilmink (1988) described a farm-income model to derive economic values for milk production traits. In this model, income was due to milk production and selling cows and calves, and costs due to feed costs, rearing costs, housing costs and a fixed *per cow* cost. Maintenance and the level of milk production determined feed costs. Weight per cow was considered constant and not related to the level of milk production. Most costs, such as costs of housing, were considered to vary with the number of cows. When this model is used to compute economic values under free market conditions, the economic value of a milk production trait reduces to extra milk income minus extra feed costs. Under the EU quota system, increasing milk or fat production per cow results in a reduced number of cows and a reduced protein production. For fat, the quota system is such that increasing the fat production per cow with 1 kg results in a milk quota that is reduced by 18 KGs of milk. The economic value for fat is therefore equal to the price per kg of fat, minus the feed costs per kg of fat, minus 18 times the margin per kg of milk.

In the Netherlands, the margin per kg of milk is the issue of many debates. The question is if on a dairy farm the labour and building costs are fixed or do they vary with the number of cows. Since breeding is a long-term business, in the farm-income model most costs are considered to vary with the number of cows.

The farm-income model was used in a scenario-study in 1989. Based on this study, the economic values of milk, fat and protein were set to be -0.15 for a kg of milk, +2 for a kg of fat, and + 12 for a kg of protein. The negative value for a kg of milk is a result of the Dutch system in which farmers are paid for delivering fat and protein, but have to pay for each kg of milk volume they produce. Milk, fat and protein are combined in a production index: INET = -0.15 $\times$ milk + 2 $\times$ fat + 12 $\times$ protein.

Durability (DU)

Van der Beek (1999) computed the economic value for durability using the model of Van Arendonk and Dijkhuizen (1985). This model optimises the replacement policy on a dairy farm. In the model each cow has a probability of being involuntary culled. This probability depends on parity and stage of lactation. One of the parameters in the model is the relative probability of involuntary culling. Changing this parameter gives a fractional change in all involuntary culling probabilities. This way of modelling variation in culling is similar to the way survival is modelled in the survival analysis used to compute breeding values for durability.

Economic values for durability were computed by varying the relative probability of involuntary culling. For scenarios that varied in the rearing costs of a replacement heifer, and the level of production, economic values varied from 61 till 74 Dfl per genetic standard deviation unit. Based on this, the economic value of durability was set to be 67.5 Dfl per genetic standard deviation unit, which corresponds to 15 Dfl per breeding value point.

Mastitis resistance

A case of mastitis results in economic loss due to loss of production, culling of a cow, treatment costs, and milk that cannot be delivered to the milk factory. The loss due to a decrease in production is part of the breeding value for milk production, and the loss due to culling is part of the breeding value for durability. The remaining costs are on average 180 Dfl per case of mastitis (De Vos, 1998). Assuming a heritability of 0.03 on the observed scale, and given an incidence of 0.26 cases per cow per year, one genetic standard deviation unit corresponds to a change of 0.0685 cases per cow per year. This means that value of one genetic standard deviation unit is 12.33 Dfl.

Somatic cell count

The price per kg of milk is reduced by 2 cents if the bulk somatic cell count is above 400,000, and by 4 cents if the bulk somatic cell count is above 500,000. The probability that the bulk somatic cell count is above 400,000 depends on the farm average, and on the number of cows on a farm. For a farm level of 200,000 and less, the probability of a bulk somatic cell count of above 400,000 is zero, and the economic value of improving somatic cell count is zero. For a farm level of 300,000 and 40 cows, the probability of a bulk somatic cell count of above 400,000 is 0.16, and the economic value per cow per year of improving somatic cell count with one genetic standard deviation unit is 28 Dfl. For a farm level of 400,000, the economic value per cow per year of improving somatic cell count with one genetic standard deviation unit is 80 Dfl per cow per year. Thus, the economic value of somatic cell count is very much farm-dependent. In 1998, the average bulk somatic cell count for one the large Dutch dairy factories was 206,000, which shows that for most farmers improving somatic cell count is of no direct economic importance.

Calving Interval

The economically optimal calving interval under Dutch circumstances is around 11-12 months (Dijkhuizen, 1996). The economic loss per day prolonged calving interval increases with the calving interval. For a calving interval of 11 months, the cost of a one day longer calving interval is zero, whereas it increases to almost 3 Dfl per day for a calving interval of 17 months. Based on the observed distribution of calving interval, the weighted average costs per day prolonged calving interval are 1.58 Dfl per cow per day.

Calving Ease

Groen *et al.* (1995) estimated the economic value of calving ease to be 1.33 Dfl per percent of calving difficulties. Veterinary costs, increased labour, and loss of calves were accounted for. Calving ease is genetically determined by the direct effect of the calf itself, and by the maternal effect of the dam of the calf. The incidence of calving difficulties depends on parity.

Averaged over parities, one genetic standard deviation corresponds to 7.9% calving difficulties for the direct effect, and to 5.8% for the maternal effect of calving difficulties.

Milking speed

Labour costs and the numbers of spaces in the milking parlour mainly determine the economic value of milking speed. The economic value of milking speed varies from 25-65 Dfl per minute per cow per year (Stegink, 1994).

3. Durable Performance Sum

A total economic value weights economic traits with their economic value. The impact of each trait on the total economic value depends on the economic value of the trait, and on the genetic standard deviation of the trait. In Table 1, the economic values per breeding value unit and per genetic and phenotypic standard deviation are given.

Table 1. **Economic values of economic traits in Dfl**

Trait	Unit	Genetic standard deviation	Economic value per breeding value unit	Economic value per genetic standard deviation	Economic value per phenotypic standard deviation
Milk	Kg	447	-0.15	-67.05	113.3
Fat	Kg	18.9	2	37.8	63.9
Protein	Kg	13.7	12	164.4	277.9
INET	Dfl	140	140	140	236.7
DU	Breeding value point	4.5	15	67.5	203.5
Mastitis index	Breeding value point	4.5	2.74	12.33	71.2
Somatic cell count	Multiplicative scale			4.72	
Calving interval	Days	7.5	1.58	11.85	59.3
NR56	%	6.55	0.45	2.95	20.9
Direct calving ease	%	7.9	1.33	10.5	29.1
Maternal calving ease	%	5.8	1.33	7.7	29.1
Milking speed	kg/min	0.75	25-65	18.75-48.75	34.2-89.0

INET has a standard deviation of 140 Dfl. As can be seen from Table 1, several traits can be included in a total economic value. In August 1999, two of the traits of Table 1 were combined into an index called Durable Performance Sum (DPS). DPS is a combination of INET and durability (DU), which is the trait with the second largest economic value per genetic standard deviation unit. DPS is computed as:

$$\text{DPS} = \text{INET} + 15\ (\text{DU-100}) = -0.15\times\text{milk} + 2\times\text{fat} + 12\times\text{protein} + 15\times(\text{DU-100})$$

The correlation between INET and DU is zero, and thus the standard deviation of DPS is $(140^2+67.5^2)^{0.5}$ = 155.4 Dfl. To improve DPS one %, the standard deviation of DPS has to increase to 156.95. To realise this, one has to add a trait with an economic value per genetic standard deviation of $(156.95^2-155.4^2)^{0.5}$ = 22 Dfl. From Table 1 it follows that of the candidates to be added to DPS, only milking speed has a value above 22 Dfl. The perception of milking speed, however, is that it is a trait with an optimum value. Therefore, before adding milking speed to DPS, acceptance by the farmers of linearly including milking speed should be investigated. Adding mastitis, calving interval, NR56 and direct and maternal calving ease to DPS results into an increase of the standard deviation of DPS by 1%.

4. Discussion

DPS is currently the best tool to breed for profit in the Netherlands. Adding remaining available traits to DPS will only marginally increase the economic variance of DPS. The reason why it is difficult to improve upon an index including milk production and durability is that for many traits the benefits of improving that trait are increased milk production and reduced culling. Those benefits are covered by the breeding values for milk production and durability and thus already part of DPS. Including traits like mastitis resistance to DPS might however still be important to show explicitly that DPS takes into account the effects of those traits.

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