A MODEL FOR THE DERIVATION OF ECONOMIC VALUES OF PRODUCTION AND FUNCTIONAL TRAITS IN DAIRY CATTLE

H.M. Nielsen[1], A.F. Groen[2], S. Østergaard[1] and P. Berg[1]

[1] Danish Institute of Agricultural Sciences, P.0. Box 50, DK-8830 Tjele, Denmark
[2] WIAS, Wageningen University, P.O. Box 338, 6700 AH Wageningen, The Netherlands

INTRODUCTION

Derivation of economic values for production traits for dairy cattle has been thoroughly discussed in the literature (*e.g*. Gibson, 1989 ; Groen, 1989). However, the trend in dairy cattle production has shifted from increasing milk yield to improving the efficiency of production, *i.e*., reducing costs of input, which necessitates the consideration of functional traits (Groen *et al.,* 1997). Inclusion of functional traits in breeding goals has made the derivation of economic values more complicated, as many of these traits are difficult to define and model in an appropriate way. Adding to the complications is the growing public concern about welfare and ethical issues related to farm animals in recent years (Olesen *et al.,* 2000). In the Scandinavian countries selection for functional traits has been practised for several years. The total merit index used in Denmark includes milk yield and some functional traits such as calving ease, fertility and mastitis (Principles of Danish cattle breeding, 2001). However, economic values applied in the breeding goal are not well documented and methods to derive economic values for some functional traits have not been described in the literature. The aim of this study was to establish and validate a model for a dairy cattle production system and to derive economic values for both production and functional traits under Danish production circumstances.

METHODS

General model. The model presented in this study was based on the stochastic SimHerd model described by Sørensen *et al*. (1992) and Østergaard *et al*. (1994, 2000). This bio-economic model is a dynamic (weekly time-stepping) model, which was developed for simulation of production and health in a dairy herd under Danish production circumstances. An additional module (SimProfit) was added to model additional breeding goal traits and to derive economic values. In SimProfit revenues and costs at the farm level are calculated from herd production parameters obtained from the SimHerd model. Genetic levels for milk production, body weight, feed intake and resistance to diseases are the basis for phenotypic performance for each cow in the model. Traits considered in the model are milk production, beef production of bull calves, health traits, reproduction, calving traits, longevity, feed intake, body weight, milking speed and temperament. Milk production, growth and feed intake were modelled as described by Sørensen *et al*. (1994). Health traits were modelled with a basic disease risk and other risk factors like parity and relationships to other diseases (Østergaard *et al.,* 2000). Genetic changes were modelled by varying the basic disease risk. Revenues of the farm came from milk production and beef production from bull calves and culled cows. Costs were divided into costs variable per cow, costs fixed per cow and costs fixed per farm (Groen *et al*., 1997). Variable costs included costs of feed, diseases, dystocia, milking, temperament, insemination, replacement and costs of producing bull calves. Fixed cow costs included costs of labour, milking parlour, electricity, housing and milk recording. Economic values were derived by comparing farm profit before and after changing the genetic level of each trait from the basic situation separately. In this study, economic values were derived with a fixed number of cows as base of evaluation. Economic values can then be derived as :

$$1/n*(\delta R-\delta C)$$

Where, n is the number of cows, δR change in revenues and δC change in costs respectively.

Input parameters. Prices used to derive economic values are given in Table 1. Only direct costs of diseases were included (farmer labour, veterinary treatment and discarded milk). Data for cow performance were chosen to represent an average Danish Holstein cow and were supplied from the national cattle database. Traits considered in this study were milk production, milk fever, mastitis, retained placenta and laminitis.

Table 1. Applied prices to derive economic values.

Parameter	Value (DKK)
Price per kg of energy corrected milk	2.3
Price per kg of concentrate	1.2
Price per kg of roughage	0.9
Price of replacement heifer	7000
Cost of mastitis per first incidence	902
Cost of retained placenta per first incidence	357
Cost of milk fever per first incidence	1155
Cost of laminitis per first incidence	780

Validation. Cow performance parameters based on an average of 5 years from 50 replicates for the basic situation are given in Table 2.

Table 2. Simulated cow performance (mean and standard deviations) for the basic situation based on 50 replicates.

Trait	Mean	Standard deviation
Number of cows per year	70.8	0.4
Energy corrected milk (kg/cow/year)	8526.4	128.2
Mastitis (incidence/year)	23.5	4.4
Retained placenta (incidence/year)	11.9	3.1
Milk fever (incidence/year)	6.8	2.3
Laminitis (incidence/year)	5.0	2.2
Feed intake (SFU/cow/year)	5561.4	58.8
Weight of slaughter cows (kg/cow)	564.7	16.5
Dead cows per year (%)	3.6	2.3
Herd life (days)	943.7	160.0
Inseminations (cow/year)	1.9	0.1

In the basic situation, milk yield was 8526 kg energy corrected milk per cow per year, feed intake was 5561 Scandinavian feed units (SFU) per cow per year and average body weight of slaughter cows was 565 kg. Number of first incidence of mastitis, retained placenta, milk fever and laminitis in the herd were 23.5, 11.9, 6.8 and 5.0 respectively. The average productive herd life was 944 days.

RESULTS AND DISCUSSION

Table 3 shows cow performance levels after changing genetic levels of energy corrected milk and health traits. After a 1% change in genetic level for milk production, milk yield in the herd was 8629 kg per cow per year. A change in genetic level of diseases results in 19.8 incidences of mastitis and 8.3 incidences of retained placenta. For milk fever and laminitis corresponding numbers are 3.2 and 0.8 incidences per year. Except for milk fever, energy corrected milk per cow were fairly constant when genetic levels for disease traits were changed.

Table 3. Cow performance levels after changing genetic level of energy corrected milk (ECM) and health traits.

Trait	Change in level of				
	ECM	Mastitis	Retained placenta	Milk fever	Laminitis
Number of cows per year	70.8	70.8	70.8	70.8	70.8
Energy corrected milk (kg/cow/year)	8629.4	8530.2	8519.6	8543.6	8522.4
Mastitis (incidence/year)	23.4	19.8	22.5	22.4	22.8
Retained placenta (incidence/year)	12.1	11.5	8.3	11.1	11.2
Milk fever (incidence/year)	7.2	6.7	7.0	3.2	7.0
Laminitis (incidence/year)	4.9	5.3	5.2	5.1	0.8
Feed intake (SFU/cow/year)	5603.2	5562.1	5557.4	5568.7	5559.5
Weight of slaughter cows (kg/cow)	564.6	563.0	565.4	564.6	566.5
Dead cows per year (%)	3.4	3.3	3.4	3.0	3.4
Herd life (days)	956.4	957.6	959.2	965.1	972.0
Inseminations (cow/year)	1.9	1.9	1.9	1.9	1.9

Table 4 gives economic values for energy corrected milk and health traits. The economic value per kg milk was 1.87 DKK per cow per year. For mastitis, retained placenta, milk fever and laminitis economic values were -22.41, -8.91, -45.48 and -19.74 DKK per first incidence per cow per year, respectively.

Table 4. Economic values (EV) for energy corrected milk (ECM) and health traits.

Trait		Diseases (cases per cow/year)			
	ECM	Mastitis	Retained Placenta	Milk fever	Laminitis
Change in farm profit (DKK)	13668.73	5868.71	2269.79	11589.15	5867.81
EV (DKK/unit/cow/year)	1.87	-22.41	-8.91	-45.48	-19.74

The economic value for energy corrected milk is from increased revenue from milk and increased feed cost due to increased feed requirements. An increase in genetic level of milk production results in an increase of 103 kg milk and a change in farm profit corresponding to 13669 DKK. Divided with the number of cows in the basic situation (70.8), farm profit per cow equals 193 DKK per year, which gives an economic value of 1.87 DKK per kg energy corrected milk per cow per year. Mastitis and milk fever were the most economically important health traits. Decreasing the level of milk fever resulted in less cases of mastitis and retained placenta due to environmental correlations.

Discussion. The use of a stochastic simulation model as applied in this study gives random variation within alternatives. Consequently, standard deviations on economic values can be obtained and used to account for uncertainty on economic values when deriving selection index weights as suggested by Amer and Hofer (1994). Additionally, the model contains environmental correlations between traits, which further complicates the derivation of economic values. Therefore, further research will focus on how those correlations influence the economic values. Moreover, sensitivity analysis needs to be performed for further validation of the model and for all traits considered in the model.

CONCLUSIONS

The results of this study show that health traits are economically important traits, which should be included in the breeding goal. It is shown that the stochastic simulation model can be used to derive economic values for both production and functional traits. However, sensitivity analysis needs to be performed for further validation of the model. In the model genetic levels for cow performance together with environmental levels for each trait gives the phenotypic performance. Consequently, environmental correlations between traits exist. The effect of those relationships on the economic value needs to be quantified. Using a stochastic simulation model to derive economic values allows to compute standard deviations on economic values.

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