Economic weights of traits in the breeding objective for Czech Holstein cattle

Z. Krupová, M. Wolfová, E. Krupa, L. Zavadilová, & J. Přibyl

Institute of Animal Science, Přátelství 815, 10400 Prague – Uhříněves, Czech Republic
krupova.zuzana@vuzv.cz (Corresponding Author)

Summary

Economic weights (EWs) of claw disease incidence (CLD), residual feed intake (RFI) and of further 10 production and functional traits currently included in the breeding objective for Czech Holstein cattle were estimated. In total, marginal and relative EWs of 14 traits were calculated under the actual production and economic conditions using the bioeconomic approach. Marginal EWs for the new traits were -100.1 € per case of CLD and -79.37, -37.05 and -6.33 € per kg daily DM intake for cows, heifers, and fattened animals, respectively. Marginal EW for the actual breeding objective traits ranked from -115.4 € (per case of clinical mastitis) to 406.0 € (per % of milk protein). The relative EWs for the new health trait and for RFI across all cattle categories were 1% and 7%, respectively. The highest relative EWs were found for milk yield (25%) and milk components (28%), for productive lifetime of cows (15%), and cow conception rate (14%). These traits remain highly important in the breeding objective, but actual EWs and genetic parameters should be applied to construct an actualised selection index. Taken into account welfare and environmental aspects of animal production, a new health trait along with RFI should also be considered.

Keywords: dairy cattle, breeding objective, claw disease, residual feed intake

Introduction

Economic weights (EWs; economic importance) along with genetic parameters of traits are essential when defining the economic breeding objective and constructing selection indices. Next to production and reproduction traits, health and feed efficiency traits (such as claw diseases and RFI) have been included in breeding objectives to enhance effective utilization of inputs in dairy sector, to reach higher safety and quality of products (Kargo et al., 2014; Gonzalez-Recio et al., 2014) and to lower pollution of the environment (Connor, 2015). Genetic parameters of these traits have been evaluated and applied for selection in dairy cattle (van der Linde et al., 2010; Williams et al., 2011).

Czech Holstein is the most numerous local dairy cattle population in the Czech Republic accounting for 60% of all cows in the performance testing. Since the last estimate of trait EWs (Wolfová et al., 2007), production and economic conditions of the breed changed significantly (e.g. milk yield per cow increased by 33%, longevity by 8%, costs for feeding by 40%; own investigation). In the current breeding objective, 10 traits characterising milk, fertility, growth, udder health and longevity are included. Routine monitoring and genetic evaluation of health traits (along with CLD) has already started (Kašná et al., 2017) and the objective of this study was to calculate EWs for the new traits (CLD and RFI) and for the current breeding objective traits in the Czech Holstein cattle under the actual production and economic conditions to allow a construction of a more comprehensive selection index.

Material and methods

Economic weights (EWs) of claw disease incidence (CLD), residual feed intake (RFI) for cows, heifers and fattened animals and 10 production and functional traits currently included into the breeding objective for the Czech Holstein cattle (see Table 1) were calculated using a bioeconomic model implemented in the program package ECOWEIGHT (Wolf et al., 2013). A closed production system with integrated fattening of bulls (as described by Wolfová et al., 2007) under the actual production end economic conditions in the Czech Republic (Krupová et al., 2017) was considered. EW of a trait was defined as the partial derivative of the profit function (for details see Wolfová et al., 2007). The main parameters for the calculation of trait EWs and the trait means are given in Table 1 and 2, respectively. The input data for the Czech Holstein were taken from the Czech Holstein Cattle Breeders Association or were obtained through own investigation on farms. Altogether, about 800 of input parameter were calculated.

To compare the economic importance of the evaluated traits measured in different units, relative EWs of traits (in %) were calculated that expressed the percentage of the standardised EW of a trait (calculated as marginal EW x genetic standard deviation) from the sum of standardized EWs of all traits. Trait genetic standard deviations (see Table 1) were estimated from the database of the Czech-Moravian Breeders Corporation, or were taken from the literature (van der Linde et al., 2010, Williams et al., 2011) when relevant data were not available.

Results and discussion

Marginal EWs of the evaluated traits for the Czech Holstein cattle are given in Table 2. Marginal EWs for the new traits were -100.1 € per case of CLD and -79.37, -37.05 and -6.33 € per kg daily DM for cows, breeding heifers, and fattened animals, respectively. Regarding the CLD, higher EWs (ranging from 155 to 188 € per case) than in our study were calculated for Holstein and Red dairy cattle farmed in Nordic countries (Kargo et al., 2014). The higher veterinary costs (75 to 90 € per case) and longer veterinarian time (1.43 to 1.87 hours) spent per case compared with the Czech Republic was found there.

Looking at the feed efficiency, the EW of RFI in Czech Holstein cows, -79.4 € per kg DM intake per day, was slightly higher than those found for Slovak Pinzgau by Krupová et al. (2016), namely -55.2 €, or for Finnish dairy cattle by Hietala et al. (2014), namely -55.8 €. The reason for this difference could be the higher price of feed, 0.103 €/kg in the Czech Republic vs. 0.055 and 0.060 €/kg in the Slovak Republic and in Finland, respectively. On the other hand, the difference in the marginal EW of RFI for fattened animals (-6.33 € in our study vs. -29.5 € by Hietala et al., 2014) was caused by the differences in the number of fattened animals per year in these studies (6 animals vs. 55 animals per 100 cows).

Marginal EWs for the 10 actual breeding objective traits ranked from -115.4 € (per case of clinical mastitis (CM)) to 406.0 € (per % of milk protein). Compared to the EWs of these traits calculated previously (Wolfová et al., 2007; Table 1), EW of the CM incidence increased by 43 € per case per cow and year and EW of cow longevity decreased by 26 € per year. The higher actual EW of mastitis reflects the increase in costs for drugs and veterinary care and the higher milk losses due to the higher milk yield per cow in the past several years in the Czech Republic (see Tables 1 and 2). EW for longevity is generally strongly influenced by the cost to revenue ratio. The

total costs on livestock farms in the last ten years period increased more than revenues (by 29% vs. 19%). Next to the lower production efficiency (profitability decreased from 8.4% to 0.4%), a slightly higher longevity of cows (+0.21 years, see Table 2) was found in the given time period. These circumstances were the main reasons for the lower actual value of EW for cow longevity.
The relative EWs of the traits are given in Table 2. Comparing the values estimated in 2005 with the current estimates in 2017, different number of traits simultaneously evaluated in both years should be considered. Nevertheless, the four most important traits remained the same in both years, namely milk yield, milk fat and protein contents and cow productive lifetime (longevity). The relative EW of CLD seems to be low (1%), nevertheless, some authors (van der Linde et al., 2010; Krupová et al., 2017) recommended including this trait into breeding objectives to improve claw health. Summing the relative EWs of RFI across all animal categories, the relative importance of RFI reached 7% which is similar to the values of 6% to 8% estimated by Hietala et al. (2014) for Finnish dairy cattle.

Conclusions

Economic importance (economic weights) of the actual breeding objective traits changed slightly under the actual economic situation in cattle production systems comparing with former estimates. Currently, clinical mastitis is the only health trait in the breeding objective for the Czech Holstein cattle. Including claw diseases in the breeding objective could contribute to further improvement of the health status of cow herds. Moreover, feed efficiency traits should be considered in animal selection to follow the general trend in the elimination of the negative impact of livestock on environment and in the reduction of greenhouse emissions. Following our study, selection response for each trait in a comprehensive selection index should be calculated taking into account the estimated trait economic weights and the genetic correlations among the new traits and the traits in the actual breeding objective.

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Table 1. Some input parameters for the calculation of revenues and costs[1]

Variable	2005	2017
Basic price for milk volume (cent[2]/kg)	26.79	27.89
Price for carcass weight of cows in the quality class S1 (€[2]/kg)	2.60	1.92
Price for pregnant breeding heifer (€)	1 071	1 296
Price of AI doses (€/dose)	17.86	18.52
Maximal number of inseminations per cow / heifer	4/4	4/4
Costs for removing dead animal (€/mature animal)	140	185
Costs for veterinary treatment of cows (€/animal per lactation)	42.86	87.04
Fixed costs for cows[3] (€/day)	2.32	2.70
Average charge for veterinary service (€/hour)	10.71	12.96
Average cost of drugs for CM (€/case)	11.43	14.07
Average cost of drugs for CLD treated with antibiotics (€/case)	-	14.81
Annual discount rate	0.05	0.02

[1] Values relevant for the year 2005 were taken from Wolfová et al. (2007). [2] 100 cents = 1 € = 27 CZK. [3] Fixed costs include labour, energy, fuels, reparations, insurance, interest of investments and overhead costs.

Table 2. Means, genetic standard deviations (GSD) and economic weights (EW) of traits[1]

	Mean		GSD		Marginal EW		Relative EW	
Trait (unit)	2005	2017	2005	2017	2005	2017	2005	2017
Milk yield/lactation (kg)	7200	9546	605.1	741.6	0.155	0.132	30	25
Milk fat content (%)	3.85	3.80	0.28	0.270	110	196	10	13
Milk protein content (%)	3.26	3.34	0.143	0.145	348	406	16	15
Conception rate of cows (%)	91	91	7.54	7.54	4.64	7.40	11	14
Service period (days)	134	127	5.00	5.00	-0.01	-0.02	0	0
Losses of calves in rearing (%)	6.0	5.4	2.00	2.00	-1.48	-1.61	1	1
Age at first calving (days)	804	765	10.00	10.00	-0.05	-0.10	0	0
Mature weight of cows (kg)	615	635	25.00	25.00	-0.73	-0.89	6	6
Productive lifetime of cows (years)	2.74	2.95	0.74	0.74	104	77.5	24	15
CM incidence (cases/year of risk)	0.98	0.98	0.10	0.10	-72.4	-115	2	3
CLD (cases/year of risk)	-	1.00	-	0.054	-	-100	-	1
RFI of cows (kg DM/d)	-	0	-	0.280	-	-79.4	-	6
RFI of breeding heifers (kg DM/d)	-	0	-	0.120	-	-37.1	-	1

RFI of fattened animals (kg DM/d)	-	0	-	0.100	-	-6.33	-	0

[1] Values relevant for the year 2005 were taken from Wolfová et al. (2007). Marginal EWs in €/unit of trait and per cow and year; relative EWs are in %.