

## **Stayability till second lactation as a component of selection criterion for dairy cattle\***

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The purpose of the study was to propose economic weights for three traits of selection criterion in dairy cattle. Besides fat and protein yields, which have earlier been accepted as a routine criterion, "stayability to lactation II" is additionally proposed, so that in breeding work the fitness of cows can be considered. Data used were obtained from 5 herds with a high dairy productivity. The economic weights were computed as linear regression coefficients of phenotypic life income on the breeding values for fat and protein yields and on breeding value for stayability to lactation II. Approximation of life income was calculated using data on 1906 cows which have recently been culled from herds. Economic weights for fat and protein yields and for stayability were as 8 : 18.3 : 4940 (1 : 2.3 : 617.5). Breeding values of traits in the selection criterion explained 47% of the phenotypic life income.

**KEY WORDS:** dairy cattle / economic weights / selection criterion / stayability

The profit obtained from the management of dairy cattle herds is a difference between the proceeds from the sale of milk, culled cows, calves and breeding heifers and the costs incurred, among which the most important are the costs of nutrition, labour, buildings, veterinary treatment, reproduction as well as the purchase of equipment and animals. Hitherto, the principal factor affecting the income and considered in breeding work was the increase in dairy production.

Recently the priorities in agricultural policy have changed. The utilization of animals is subjected to the policy of consumer and environment protection. Irrespectively

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of that, a one-sided selection for the improvement of dairy traits has a negative effect on the health status, stayability and other functional traits of animals. Another important factor inducing breeders to modify the breeding goal and aim at lowering production costs was the introduction of milk quotas. Improving the animals' fitness and thus their stayability and health condition may be a method of lowering milk production costs. Moreover, an improved health status should have a positive effect on milk quality.

The problem of the stayability of cows, treated as an indicator of the animal's fitness was studied on data obtained from herds of a high dairy production [Reklewski *et al.* 2004]. The mean stayability of cows was found to amount to 2.85 lactations and the involuntary culling proved high. Stayability till lactation II, treated as an indicator of potential longevity (genetic correlations with the length of production life and overall longevity amounted to 0.40 and 0.47, respectively), determined at an early stage of life, may be a reliable selection criterion. The heritability of a cow's stayability in a herd until lactation II proved to exceed 0.1. Similar coefficients of heritability were reported by Boichard *et al.* [1996], Rogers *et al.* [1989] and Haile-Mariam *et al.* [2003]. Moreover, a positive relation was observed between stayability and the length of the calving interval:  $r_G = -0,18$  [Reklewski *et al.* 2004] thus, stayability may also be an indicator of reproduction.

Swedish investigations showed significant genetic correlations between the functional traits of cows and fertility (0.20) and the incidence of mastitis (0.24) – Philipsson and Lindhé [2003]. Thus, the animals remain in herd because they are of a better health status and show a higher reproduction.

Thus, it seems justified to introduce into selection the trait “stayability till lactation II”, as it has got attributes of an indicator showing genetic relations with important functional traits [Boettcher *et al.* 1999, Łukaszewicz *et al.* 1995]. On the other hand, protein and fat yields, as the principal components determining milk price, should also be accounted for in selection.

The purpose of the work presented was to calculate economic weights for the components of the above criterion.

### **Material and methods**

Detailed information about the animal material are included in the paper by Reklewski *et al.* [2004]. On the basis of the life production of 1906 cows from herds of high dairy production an approximate income per cow was calculated basing on the following assumptions:

- value of a culled cow – 750 PLN;
- value of each born and reared heifer – 400 PLN;
- value of each born and reared bull – 200 PLN.

Computation of the life income from milk production, fat and protein yield, was related to the milk fat content:

- fat content  $\leq 4.5\%$  – the total income equalled the life fat production multiplied by 4 PLN and increased by the life protein production multiplied by 8 PLN;
- fat content  $> 4.5\%$  – 0.18 PLN was paid for each kg milk increased by  $0.08 \times$  protein content (%).

The payment method accepted corresponds with that used by the Agricultural Daily Cooperative “ROLMLECZ”, Radom.

Weights for components of the selection criterion were calculated using the multiple regression of the cow’s life income on the cow’s breeding values of protein and fat yields, and stayability till lactation II. The prediction of the breeding values for protein and fat yield per lactation was performed according to the BLUP method on 2670 cows and 6739 lactations, using the following two-trait model:

$$y_{ijkl} = \alpha + HYS_i + L_j + a_k + p_k + \beta_1 \times (\text{days in milk}_{ijkl}) + \beta_2 \times (\text{days in milk}_{ijkl})^2 + e_{ijkl}$$

where:

- $\alpha$  – vector of intercepts;
- $y$  – vector of traits evaluated;
- $HYS$  – vector of environmental effects of herd, year and season of calving;
- $L$  – vector of the effects of subsequent lactations;
- $a$  – vector of the animal’s additive effects;
- $p$  – vector of the effects of the cow’s specific environment;
- $\beta_1, \beta_2$  – vectors of the coefficients of linear and quadratic regressions for the number of days in milk per lactation;
- $e$  – vector of random errors.

The evaluation model for the breeding value of stayability till lactation II (1897 cows), beside the additive value of the cow, accounted also the effect of the environment at first calving (herd-year-season – HYS). The BLUP predictions were computed using the BLUPF90 package of Misztal [1998].

The first calving environment (HYS) was also fitted upon determining the relation between the life income and the lactation breeding values.

## **Results and discussion**

Table 1 shows the mean breeding values for the traits analysed and their standard deviations. The mean breeding value of cows as regards “fat yield” amounted to 55.9 kg, while for “protein yield” – 29.5 kg. The mean breeding value for “stayability till lactation II” amounted to 0.38.

**Table 1.** Mean estimated breeding values (EBV) for the traits analysed and the life income

Trait	EBV	Standard deviation
Fat yield (kg)	55.9	48.8
Protein yield (kg)	29.5	37.9
Stayability to lactation II	0.38	0.35
Life income (PLN)	11551	6015

The life production income (11,551 PLN) is approximate and underestimated. If the differentiated live body weights of the cows were considered it could additionally have varied the life income. To an even greater degree this variation could be reached by accounting for the level of somatic cells as this would have increased milk unit price. However, the lack of data made it impossible to include the somatic cell count in the analysis. Moreover, the value of our cows increased after Poland's accession to the European Union about three times but, as it proved impossible to differentiate the price obtained for individual cows, such an increase would have resulted in an increase of the intercept, common for all cows, in the regression equation. Also the accepted differentiation in calf value, related to its sex, corresponds to the situation existing before Poland's accession to the EU. The considerable increase in the price of bulls, which took place after Poland's accession to a value similar to that for heifers, would have probably resulted in an increase of the weight for "stayability till lactation II", as the number of calves from a cow is to a considerable extent a function of the time she remains in the herd. However, the current equalization between the prices for bulls and heifers should be treated as transitory.

**Table 2.** Regression coefficients of life income (PLN) on the breeding values of selection criterion traits (weights in parentheses relative to the weight for kg fat)

Trait	Coefficient of regression (weight)
Fat yield (kg)	8.0** (1)
Protein yield (kg)	18.3** (2.3)
Stayability to lactation II	4940** (617.5)
Intercept (PLN)	2549** (318.6)

\*\* $P \leq 0.01$ .

The values obtained for the coefficients of regression of life income on the breeding values of selected traits are presented in Table 2. Hence, the selection criterion, ranking cows as regards their predicted life income, takes the following form:

$$8.00 \times \text{EBV kg fat} + 18.3 \times \text{EBV kg protein} + 4940 \times \text{EBV stayability till lactation II}$$

The ratio between weights for fat and protein yield (1:2.3) does not differ much from that accepted officially in the breeding goal, on the basis of which animals in Poland are ranked (1:2). On the other hand, the value of the weight estimated for stayability till lactation II may seem shocking. However, one should bear in mind that the selection criterion analysed shifts the evaluation of the animal from the level of one lactation to that of several lactations. Thus, it favours animals, which are not only genetically determined for high production but are also able to express it repeatedly.

If in the criterion proposed the mean breeding values (Tab. 1) estimated for the population examined are incorporated, the value obtained will reach about 2863 PLN. Together with the value of the intercept (2549 PLN) the genetic determination for fat and protein yields, as well as for stayability till lactation II, explains about 47% (5412 PLN) of the phenotypic life income. Analysed separately for production traits (fat and protein) and stayability, the former are on average responsible for 34% (986 PLN), while the latter for 66% (1877 PLN) of the income explained by the genetic variability of those traits.

As shown in Table 3, the genetic correlation between stayability till lactation II and the lactation yields amount to zero although there is an indication that cows producing milk with a higher per cent of fat and protein tend to remain in the herd for a shorter time. However, in the population examined the cows remained in the herd or were culled irrespectively of their productivity – only about 5% of culling resulted from a low productivity [Reklewski *et al.* 2004]. Thus the presence of stayability till lactation II in the selection criterion is a measurement of the repeatability of lactation yields along the cow's life. This is the production aspect of stayability.

**Table 3.** Genetic correlations ( $r_G$ ) between stayability to lactation II and lactation production and reproduction traits

Parametre	Milk yield	Fat yield	Protein yield	Fat (%)	Protein (%)	Calving interval
$r_G$	0.01	-0.00	0.00	-0.05	-0.04	-0.18
p	0.62	0.88	0.84	0.06	0.06	0.00

Among the traits presented in Table 3 in fact only the calving interval is not present in the selection criterion proposed. However, in the presence of a significant though moderate genetic correlation with stayability till lactation II, stayability also becomes an index trait, representing reproduction in the selection criterion while infertility was responsible for over 41% of culling [Reklewski *et al.* 2004]. Disregarding accidents, diseases of the udder were the next in size (14%) reason for culling. Thus, stayability till lactation II has also a fitness dimension. In the population examined 89% of culling was qualified as involuntary!

As long as a direct inclusion of fitness traits into breeding programmes will not be possible in Poland, the use of an easily measurable trait, such as the stayability till lactation II, may accelerate a more comprehensive estimation of the breeding value of bulls.

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## Przeżywalność do drugiej laktacji jako komponent kryterium selekcyjnego bydła mlecznego

### Streszczenie

Celem badań było wyznaczenie wag ekonomicznych trzech składowych kryterium selekcyjnego bydła mlecznego. Obok wydajności tłuszczu i białka, wykorzystywanych dotychczas jako samodzielne kryterium, zaproponowano uwzględnienie cechy “przeżywalność do II laktacji” tak, aby w pracy hodowlanej uwzględnić również cechy adaptacyjne. Analizy przeprowadzono na materiale pochodzącym z 5 stad o wysokiej mleczności. Wagi ekonomiczne cech tworzących kryterium selekcyjne obliczono jako współczynniki regresji liniowej fenotypowego przychodu życiowego uzyskanego od krowy na wartości hodowlane wydajności tłuszczu i białka oraz przeżywalności do II laktacji. Przybliżenie dochodu życiowego uzyskano na podstawie danych o 1906 krowach wybrakowanych ostatnio w tych stadach. Wagi ekonomiczne kilogramów tłuszczu i białka oraz przeżywalności do II laktacji miały się jak 8 : 18,3 : 4940 (1 : 2,3 : 617,5). Wartości hodowlane tych trzech cech tłumaczyły 47% przychodu fenotypowego.