Genetic and economic response of breeding policy in dairy herds

P. Šafus[*], J. Přibyl and Z. Veselá, Research Institute of Animal Production, P.O. Box 1, 104 01 Prague-Uhříněves, Czech Republic

ABSTRACT

The objective of the present study was to compare the genetic and economic response of some breeding measures in a commercial dairy herd within an agricultural enterprise. Simulations for use of breeding arrangements and their consequences over a fifty-year period were carried out for the above models using the gene flow method.

Genetic and economic responses to genetic gain were evaluated for combination the breeding arrangements: single use of bulls under testing and negative selection of cows in the herd (30% of animals are discarded from reproduction and the animals are left in the herd and used for breeding by beef bulls); single use of bulls under testing and negative selection of first-calvers in the herd (25% of animals are discarded for slaughter); single use of proved bulls (selection intensity 1% of the best bulls) and negative selection of cows in the herd; single use of proved bulls and negative selection of first-calvers in the herd.

Only minimum changes will occur since the 25th year of observation. A comparison of the particular models showed the highest gain on average per cow for the whole observed period for single use proved bulls and negative selection of cows in the herd. Single use of bulls under testing and selection of cows in the herd resulted in the second highest cumulative genetic gain.

Keywords: dairy cattle; breeding policy; selection; genetic contribution; economic contribution; gene flow method

INTRODUCTION

Simulation calculations are a suitable tool to test the impact of breeding policy in the framework of selection programmes. Based on simulations it is possible to construct a mathematical model of the population included in the process of breeding and to test the influence of breeding arrangements. It is also important to test the estimated breeding effect when conclusions can be drawn from a potential inconsistency of expected values with the actual state achieved in practice during implementation of breeding programmes that will be aimed at higher effectiveness of breeding work. An important breeding policy is the dimension of the use of tested and proved bulls in a herd.

A gene flow method is regularly used to study genetic and economic gain. Applying the gene flow method it is possible to analyze how the genes of individuals of a selection round are conferred to direct descendants in the whole population. This principle is used to simulate gene transfer from generation to generation. Many authors applied this method (Hill, 1974; Brascamp, 1975, 1978). Jalvingh et al. (1993) simulated dairy herd management using the Markov chain method. The analysis of selection programme usually consists of four paths (selection programmes may be divided into more paths in relation to their structure) through which genes pass from generation to generation. For selection purposes it is advisable to study not only these separate paths but also the age classes within these paths. Transition matrix (T) describes reproduction process and aging course in a summary way. The expected proportion of genes from

particular animals and its influence on gene flow and genetic gain were investigated by Woolliams et al. (1999). Bijma and Woolliams (2000) studied the relation between the theory of gene flow method and genetic gain. The authors stated that in the general theory of gene flow the genetic gain is determined from selection differences and asymptotic proportions of genes in the age categories. Previous studies reported that asymptotic gene proportions might differ considerably from actual proportions. Bijma and Woolliams proved that it was possible to determine genetic gain in spite of these differences. Reinsch and Kalm (1995) applied the gene flow method to examine relative importance of maternal, paternal and direct effect in dairy cattle for reproductive traits. Kennedy and Trus (1993) evaluated genetic relations between herds or regions applying the gene flow method to reveal mutual exchange of genes. Hill (1974) demonstrated a possibility of using the gene flow method for modelling a crossing scheme and for the use of reproduction and production herds. The gene flow method can also be applied to the construction of selection indexes; it was reported by Philipsson et al. (1994), who worked out a simulation study of the effectiveness of total selection index. Kadlečík et al. (2004) analyzed alternatives of breeding program for Pinzgau cattle. The objective of the paper is to evaluate genetic and economic responses of different variants of breeding work in a commercial dairy herd without production of sires, particularly the use of mating bulls and cow selection.

MATERIAL AND METHOD

The long-term selection response during fifty years was examined for single use of breeding arrangements. These breeding policies were used to compare genetic and economic responses:

Model 1 – single use of young bulls under testing and negative selection of cows in the herd (selection intensity 30%);

Model 2 – single use of young bulls under testing and negative selection of first-calvers in the herd (selection intensity 25%);

Model 3 – single use of proved bulls (selection intensity 1% of the best bulls) and negative selection of cows in the herd (selection intensity 30%);

Model 4 – single use of proved bulls (selection intensity 1% of the best bulls) and negative selection of first-calvers in the herd (selection intensity 25%).

Simulation calculations for single use of combinations breeding measures and their consequences over a fifty-year period were carried out for the above models using the gene flow method.

This methodical procedure was applied to calculate genetic and economic responses of breeding measures (Šafus and Přibyl, 2005):

1) Construction of transition matrix (T)
2) Construction of vector (S) to examine the expression of breeding policy
3) Calculation of average proportion of genes in animals that in the given year exhibit performance coming from the given path of selection
4) Determination of the expression of discounted value of breeding policy
5) Determination of breeding value expression – genetic contribution of breeding arrangements in the herd
6) Calculation of economic contribution

RESULTS

Only minimum changes will occur since the 25th year of observation. Genetic and economic contribution of breeding policy is influenced by the above-mentioned proportions of conferred genes, breeding values of selected animals, interest rate and economic weight.

Table 1 shows cumulative genetic and economic contributions of breeding policies.

Table 1   Cumulative genetic and economic contribution (interest rate 5%)

Breeding policy	Genetic contribution (kg of milk proteins)	Economic contribution (CZK)
Model 1	48,83	3 154,89
Model 2	45,53	2 989,94
Model 3	55,06	3 555,06
Model 4	51,76	3 390,11

CONCLUSION

Based on the results of this study, we can recommend the use of bulls that provide the highest genetic and economic contribution in the herd in relation to their breeding value as the best breeding policy.

The quality of cow herd should be taken into account when different selection intensity is to be used. Calving interval and fruitfulness rearing of young animals until the first calving are limiting factors from the aspect of selection intensity. If e.g. 10% of cows are discarded, the calving interval should be 365 days and fruitfulness rearing of animals 75% to ensure the relevant number of animals for herd replacement. In case the calving interval is longer, the improvement of the herd quality – a possibility of cow culling – requires increasing the fruitfulness rearing of animals. Therefore a conclusion can be drawn that in the present state (calving interval longer than 400 days) higher selection intensity may endanger the herd replacement. Another possibility of coping with the given state is to increase longevity and survivability, which would lead to changes in the age structure of the population. Model calculations were performed only for the main selection criterion – amount of milk proteins in kg. If we used combined selection indices for a complex of traits, selection intensity, transition of genes and the other calculations would be the same. Results would only be expressed by different values.

Applying the gene flow method it is possible to describe the influence of breeding policy within subsequent generations and to acquire information for decisions on the choice of appropriate strategy of breeding work in the herd.

REFERENCES

BIJMA P., WOOLLIAMS J.A. (2000): On the relation between gene flow theory and genetic gain. Genet. Sel. Evol., 32, 99–104.

BRASCAMP E.W. (1975): Thesis Wageningen. Agr. Res. Rep., 846.

BRASCAMP E.W. (1978): Methods of economic optimization of animal breeding plans. Res. Inst. Anim. Husb., Schoonoord, Zeist, Rapport B-134.

HILL W.G. (1974): Prediction and evaluation of response to selection with overlapping generations. Anim. Prod., 18, 117–139.

JALWINGH A.W., VAN ARENDONK J.A.M., DIJKHUIZEN A.A., RENKEMA J.A. (1993): Dynamic probabilistic simulation of dairy-herd management practices. 2. Comparison of strategies in order to change a herds calving pattern. Livest. Prod. Sci., 37, 133–152.

KADLEČÍK O., KASARDA R., HETÉNYI L. (2004): Genetic gain increase in inbreeding rate and generation interval in alternatives of Pinzgau breeding program. Czech J. Anim. Sci., 49, 524–531.

KENNEDY B.W., TRUS D. (1993): Consideration on genetic connectedness between management units under an animal model. J. Anim. Sci., 71, 2341–2352.

PHILIPSSON J., BANOS G., ARNASON T. (1994): Present and future uses of selection index methodology in dairy cattle. J. Dairy Sci., 77, 3252–3261.

ŠAFUS P., PŘIBYL J. (2005): Comparison of long-term selection responses of breeding policy in dairy herds. Czech J. Anim. Sci., 50, 439-449.

WOOLLIAMS J.A., BIJMA P., VILLANUEVA B. (1999): Expected genetic contribution and their impact on gene flow and genetic gain. Genetics, 153, 1009–1020.