GENETIC IMPROVEMENT OF PINZGAU CATTLE IN SLOVAKIA

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INTRODUCTION

Pinzgau cattle belong to the endangered populations of domestic animals registered by FAO. Slovakia is maintaining one of the largest registered populations of Pinzgau cattle in Europe. Pinzgau is a traditional dual-purpose mountain cattle breed oriented at milk and meat production, in the past also for traction (Pšenica, 1990). Pšenica (1996), Kadlečík *et al.* (1999) and Mildner *et al.* (1999) mentioned that decreasing population size and current structure and production ability require developing a strategy for rescue and genetic improvement of this breed. The objective of this study was to evaluate the present and alternative breeding programmes using selection index theory, with emphasis on genetic response, accuracy of selection, generation interval and rate of inbreeding.

MATERIAL AND METHODS

The present breeding programme of Pinzgau cattle in Slovakia consist of 15,000 cows, from which the 150 best cows are selected annually as bull dams and mated with the two best bull sires resulting from progeny testing. Young bulls undergoing progeny testing (about 10) are mated to 20% of the cow population. Annually six young bulls are selected to become sires of cows. It is assumed that there are 8 age classes of dams and 11 age classes of bulls. Replacement rate in cows is 30% per year. Alternatives considered are:
P(roven): Using only proven bulls with information from progeny testing; this means that bulls are selected only from age class 6 trough 11;
Y(oung): Using only young bulls without information from progeny testing; bulls are used from age classes 2 and 3 only, to increase response by decreasing generation interval.
M(OET): Use of young bulls with *MOET* in dams to increase intensity of selection and provide full-sib information for young bulls.
An increase of number sires to breed sires is considered; all alternatives are designed with 2, 5, 10 and 20 sires. Results from milk recording realised by the Slovak Breeding Institute (2001) and from actual genetic evaluation are used as input parameters (Table 1). Selection index theory (Hazel, 1943) is used, to evaluate the alternative breeding schemes, accounting for reduction of variance due to the "Bulmer" effect (Bulmer, 1971). To model the present breeding scheme, a situation with overlapping generations with a fixed proportion of animals selected from each age class in both sexes is used. Comparison to the situation with overlapping generation with truncation selection on EBV across age classes (Ducrocq and Quaas, 1988) is made. In all other cases overlapping generations with truncation selection is used for evaluating alternative breeding schemes. No software is available to predict the rate of inbreeding for multitrait selection in overlapping generations. Therefore, the rate of inbreeding

is approximated using a population with discrete generations that has the same number of sires and dams per generation and the index of the age class where the majority of parents is selected. For all alternatives, the computer program Sel*A*ction (Bijma and Rutten, 2002) is used to calculate ΔG.

Young animals (both sexes) were selected first in age class two (two years old by birth of progeny) on pedigree information. In age class three, own performance information on females, and information on 20 half-sibs becomes available for both sexes. In age class six information on 192 progeny becomes available for males. For alternatives when only young animals are used *(Y, M)*, information on progeny is not available. For the alternative with MOET *(M)* additional information on 20 full-sibs is considered in age class three both for sires and dams.

Table 1. Parameters used in the model

Trait	[kg]	σ^2_P [kg]	h^2	EV [A]
Milk	2646.08	783.33	0.27	0.08
Fat	105.93	33.79	0.20	42.24
Protein	87.05	26.44	0.24	128.92

[A] Economic values of milk traits in Slovak currency (Huba *et al., 2001*) (1€ = 42.46Sk)

RESULTS AND DISCUSSION

Response in milk, fat and protein yields of the present scheme are shown in Table 2. for overlapping generations with fixed proportions and for truncation selection for either 2, 5, 10 or 20 sires selected. With truncation selection response is higher than with selection on fixed proportions. Generation interval does not change with selection on fixed proportions, whereas with truncation selection, generation interval decreases with increasing number of sires selected. Highest response is observed in alternative *M* with 2 sires selected (66.86, 2.4and 2.4 kg milk, fat and protein). Alternative *Y* with 2 and 5 sires selected results in lower response than in alternative *P*. Selection of 10 or 20 bulls in alternative *Y* results in same or higher response than in *P*. Kadlečík *et al.* (1999) concluded that increasing response to selection is obtained if young sires are used in a larger number, for situations with discrete generations. Highest response is observed in alternative *M*. Gesser (1992) obtained similar conclusions, which resulted in the design of a MOET breeding scheme in Austrian Pinzgau cattle. In general, total response in economic units and response to selection in all traits is decreasing with increasing number of sires selected. On the other hand generation interval is increasing in all alternatives with increased number of sires due to higher proportion sires selected in age classes 6–11 *P*, 2 and 3 *Y, M* respectively. With truncation selection a higher proportion of older animals is selected, with higher accuracy compared to selection on fixed proportions. Lowest generation intervals are observed in alternative *M* if 2 or 5 bulls are selected. If 10 or 20 bulls are selected, generation interval in alternative *Y* becomes lower. Truncation selection results in higher rates of inbreeding per generation (1.92–0.46%) than selection on fixed proportions (1.56–0.18%). With an increased number of sires, the rate of inbreeding decreases per generation interval. That is comparable with Kasarda *et al.* (2000), who observed rate of inbreeding for discrete generations in Pinzgau population and concluded same tendency but in general with higher values observed if variable costs of breeding were the criteria for optimisation. Highest rate of inbreeding is observed in alternative *M* 5.99% if 2 bulls are selected to 0.79% with 20 bulls. MOET gives more inbreeding because EBV are largely based on information coming from full-sibs which increases of co-selection of relatives.

Table 2. Response in milk, fat and protein yields, rate of inbreeding and generation interval in the present breeding scheme of Pinzgau cattle

No. of sires	2	5	10	20
Trait	Truncation selection			
Milk [kg]	62.64	54.56	48.47	42.01
Fat [kg]	2.82	1.98	1.74	1.5
Protein [kg]	2.26	1.97	1.74	1.51
L^A [year]	4.53	4.19	3.96	3.78
ΔF^B [%]	1.919	0.907	0.474	0.460
	Fixed proportions			
Milk [kg]	59.52	50.73	43.93	38.19
Fat [kg]	2.16	1.83	1.58	1.37
Protein [kg]	2.14	1.83	1.58	1.37
L^A [year]	5.01	5.01	5.01	5.01
ΔF^B [%]	1.562	0.663	0.343	0.181

[A] Generation interval, [B] observation per generation interval

Table 3. Response in milk, fat and protein yields, generation interval and level of inbreeding in alternative breeding schemes

No. of sires	2			5			10			20		
Alternative	*P*	*Y*	*M*	*P*	*Y*	*M*	*P*	*Y*	*M*	*P*	*Y*	*M*
Milk [kg]	59.8	50.8	66.9	48.2	45.3	56.7	38.2	38.2	48.9	26.3	32.3	40.7
Fat [kg]	2.18	1.75	2.4	1.76	1.59	2.03	1.39	1.3	1.74	0.95	1.1	1.45
Protein [kg]	2.16	1.82	2.4	1.74	1.61	2.04	1.38	1.36	1.76	0.95	1.15	1.46
L^A[year]	5.02	3.15	3.12	5.16	3.09	3.13	5.29	3.06	3.08	5.47	3.02	3.03
ΔF^B [%]	1.5	2.93	5.99	0.61	1.15	3.04	0.31	0.57	1.9	0.16	0.31	0.79

[A] generation interval, [B] observation per generation interval

Accuracy of pedigree EBV was higher in the situation with a fixed proportion animals selected on pedigree information (0.35 with two sires to 0.46 with 20 sires selected) in comparison to truncation (0.25–0.23). Accuracy in sires increased when including information on half-sibs in age class 3 (0.39–0.49 fixed proportions; 0.28–0.35 truncation) and in age class 6, when information from progeny becomes available (0.95–0.95 truncation; 0.95–0.96 fixed). Accuracy in dams increases in age class 3, when information on own performance and information on half sibs is included in the selection index (0.49–0.53 truncation; 0.55–0.62 fixed). Accuracy of selection increases with number of sires selected. Because with lower selection intensity the genetic variance is less reduced by the Bulmer effect. These trends correspond to conclusions by Kasarda and Kadlečík (1998) observed on Slovak spotted cattle for discrete generations. The highest accuracy of sires is observed in alternative *P* when selection is only made on the information of progeny (0.945–0.948). In this alternative accuracy in sires and dams increases with increasing number of sires. In alternatives *Y* and *M* accuracy in sires goes slightly up with increased number of sires selected (from 0.38 to 0.39 *Y*; 0.54 to 0.56 *M*). The highest accuracy in dams is observed in alternative *M* (0.63–0.65) when the information on full-sibs becomes available, following *Y* (0.55–0.56) and *P* (0.48–0.51). The reason that selection using fixed proportions gives higher accuracy is due to the Bulmer effect. With fixed proportions the difference in the mean breeding value of animals selected from different age class contributes more to the genetic variance that with truncation selection.

CONCLUSION

It has been shown that increasing the number of sires to breed sires results in decreased response to selection in all alternatives presented. At the same number of sires a *MOET* scheme yields the highest gain but also highest inbreeding. When restricting the rate of inbreeding to a value between 0.5-1% per generation the highest gain is obtained by using five progeny tested sires per year.

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