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# Stochastic Modeling of Genetic Improvement of Pinzgau Cattle using Complex Selection Index.

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Selection on complex selection index is essential because covering all desirable traits for dual purpose cattle. In Slovakia cattle is selected only on milk production index. Especially for endangered Pinzgau cattle breed, while it can not be competitive to other cattle breeds in milk production only, selection on complex index is important, giving more possibilities in future breeding. Aim was to model possible impact of selection on complex selection index including live weight in age of 210 days, milk production and functional length of production life on genetic improvement of estimated breeding values. Alternative breeding scheme with increased use of young bulls was used to estimate possible genetic improvement of Pinzgau cattle. Stochastic simulation was used to model breeding process: selection of animals as parents of next generation, production of offspring, testing and estimation of breeding values. Decrease of variance components: heritability, correlations and variance due to Bulmer equilibrium in population per year and genetic trends of breeding values per generation for future 10 generations were estimated.

**Key words:** simulation, genetic improvement, total merit index, Bulmer equilibrium

## Introduction

Pinzgau cattle is traditional dual purpose breed used in mountain areas of Slovakia. For last decades selected only on results of milk recording. Such a narrow breeding goal does not correctly emphasize on the on dual purpose character and state of endangerment of this population. To propose future development simultaneous selection on complex selection index has been proposed. Mildner et al. (1999), Kadlečík, Swalve, Lederer and Grosu (2004) advised change of breeding program of Pinzgau cattle and breeding goal to save original dual purpose character of breed. In breeding goal have to be included milk production traits with share of 36 %, beef production 14.3 % and fitness traits with share of 46.3 %. Based on described groups of traits a total merit index should be established – regarding dual purpose character with increased accent on fitness of animals.

Last knows results from beef recording in Slovakia are those presented by Pšenica, Kadlečík et al. (1989). From 1990 beef recording in Slovakia doesn't exist in its previous form and cattle is selected only on results of their milk production results. In year 1994 become Pinzgau cattle endangered. As mentioned by Kasarda (2003), decrease of Pinzgau cattle under milk recording is more than 10 % annually.

Change of breeding program regards results of Kasarda, Bijma, Groen, et al. (2002 a, b), Kasarda (2003) and Kasarda, Kadlečík, Hetényi (2004), who's advised breeding program with use of

70 % of young bulls in mating. Peškovičová, Krupa, Huba (2004) advised as most important trait for evaluation of beef performance live weight at 210 days of age. Krupa, Polák, Oravcová et al. (2005) estimated economic weights of beef cattle in defined production system (Table 1). Huba, Daňo, Kica et al. (2004) estimated economic weights of milk production and its components (Table 1). Mészáros, Kadlečík, Kasarda et al. (2007) analyzed length of production life of Pinzgau cattle cows in Slovakia.

Aim of the paper was simulation of selection under total merit index on three groups of traits: milk production, live weight and length of production life, estimate genetic improvement of selected traits, build selection index and propose of trends in estimated breeding values and production ability of population.

**Material and Methods**

Basic statistical information on beef performance of Pinzgau cattle in Slovakia was taken from results of growth recording system (Peškovičová, Huba, Krupa, 2004). Information on milk production and length of production life were taken from milk recording system of State breeding institute (2007). Input information is in table 1.

Table 1 Basic characteristic of selected traits in population

| *Trait* | $\bar{x}$ | $\sigma_P$ | *E.V. [Sk]* [3] |
|---|---|---|---|
| Milk [kg] | 3558,00 | 590,40 | 0,623 † |
| LW 210 [1] [kg] | 162,30 | 28,45 | 60,660 ‡ |
| LPL [2] [year] | 3,43 | 2,33 | 2675,500 ‡ |

† *Huba, Daňo, Kica et al. (2004);* ‡ *Krupa, Polák, Oravcová et al. (2005)*

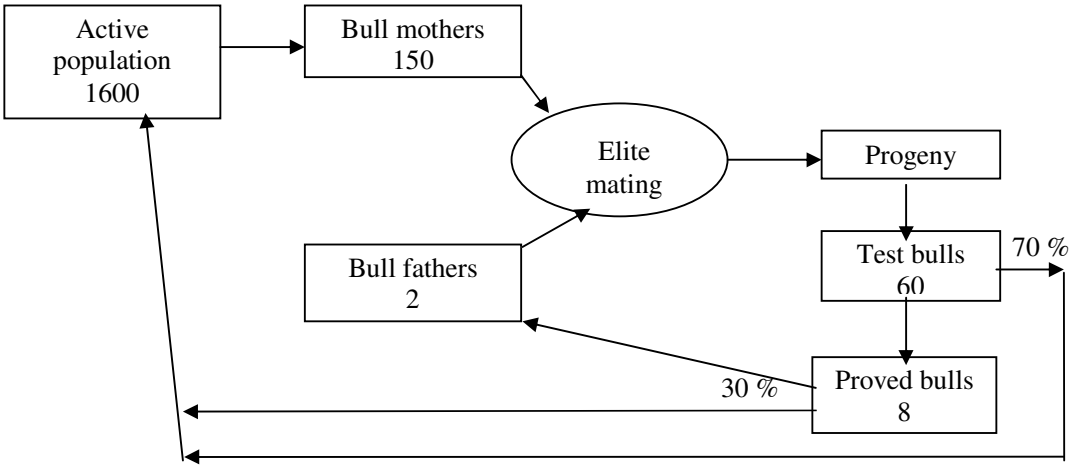
[1] *live weight in age of 210 days,* [2] *Length of production life,* [3] *Economic value: 1€ = 34,26 Sk*

For estimation of expected genetic gain flexible breeding scheme (Kasarda, Kadlečík, Hetényi, 2004 – picture 1) was used. Animals were selected based on TMI selection index. Decrease of variability of selection index due to Bulmer equilibrium (Bulmer, 1971) was taken under consideration. Genetic improvement after reaching Bulmer equilibrium was estimated under stochastic Monte Carlo simulation for parents and for generations of progeny using software R 2.0 plus.

In each selection round 60 young bulls were selected from population of normal distribution due to broader use of natural insemination. Intensity of selection was low (i = 0.35). Eight proven bulls were used in artificial insemination (i = 1.227), from which 2 best bulls were used for elite mating (i = 1.839). Elite cows (n = 150) were selected from purebred population (n = 1600; i = 1.311). Intensity of selection in selection pad mother dams was i = 0.07. Genetic improvement of estimated breeding

values of traits of TMI was estimated. This process was repeated 1000 times in 10 generations. Purebred cows under recording and artificial insemination present active population.

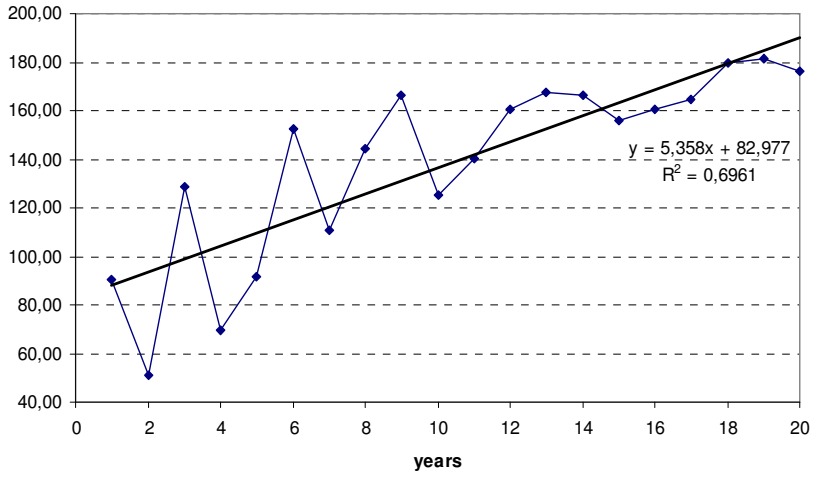
Picture 1: Proposed design of breeding scheme of Pinzgau cattle in Slovakia used for simulation



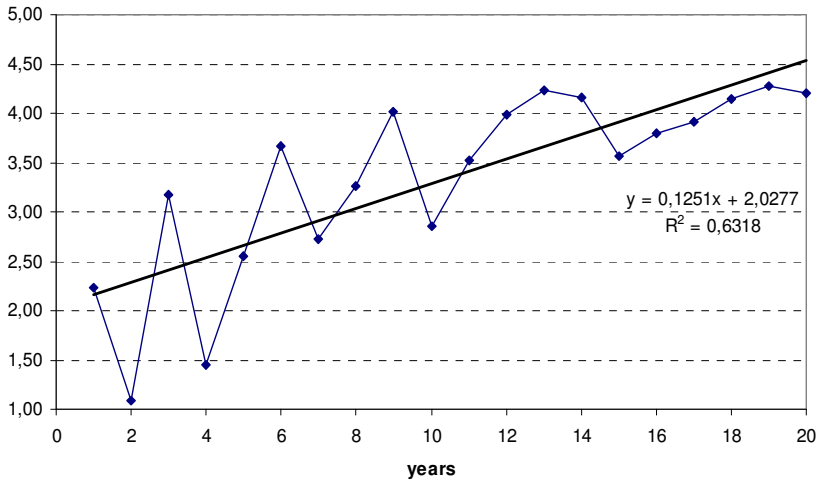

**Results and Discussion**

Average value of milk genetic gain was 139.24±37.99 kg (Picture 2). This trend respond to linear tendency with reliability of 69.61 %. Variability of the milk production EBV's was 16.59 %. Following design of breeding program in 10 generations, was observed curvilinear trend ($R^2$ = 0.999) with increase of average production in population from 3558 kg to 4571.25 kg of milk (Picture 6).

Picture 2 Genetic improvement of milk production in kg during 20 years of breeding program

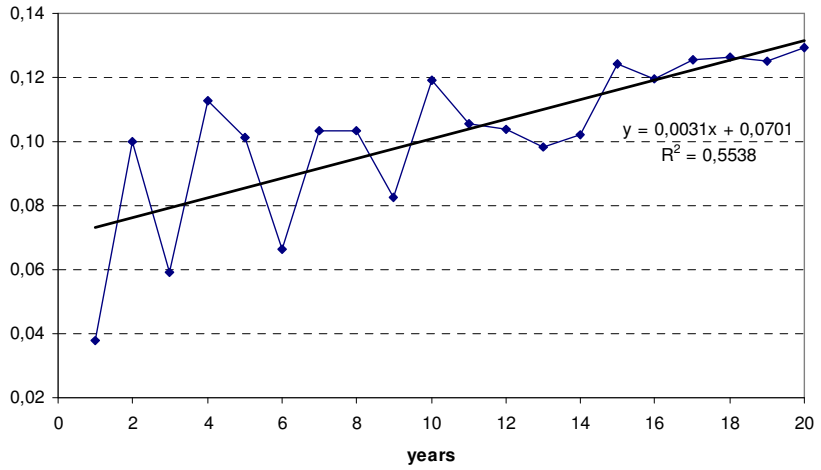



Picture 3 Genetic improvement of live weight (LV) in age of 210 days during 20 years of breeding program




Average increase of EBV of live weight at age of 210 days was 3.43±0.93 kg (Picture 3). Variability of live weight was 17.56 %. Reliability of proposed overall trend is 63.18 %. Following design of breeding program in 10 generation was observed curvilinear trend ($R^2$ = 0.997) with positive change of life weight from 162 kg to 185 kg (Picture 7). Non – linear trend with tendency to achieve asymptotic values is result of so called Bulmer effect - tendency of population to achieve equilibrium state of genetic linkage.

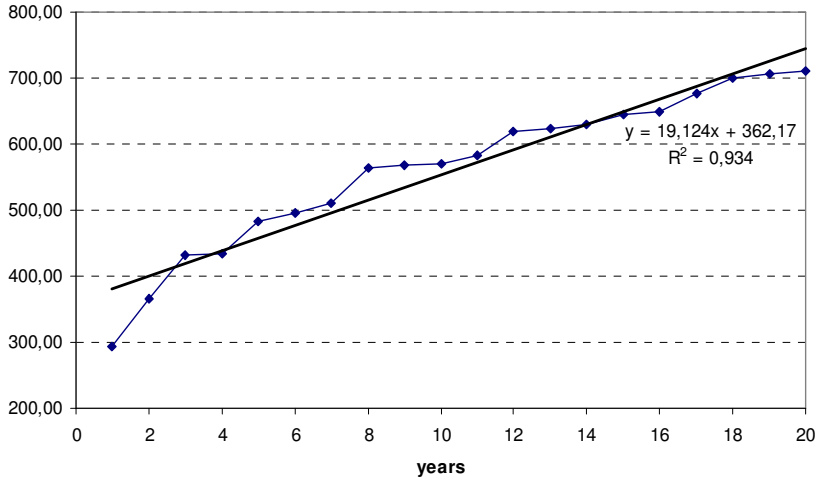
Picture 4 Genetic improvement of length of productive (LPL) life during 20 years of breeding program




Estimated was average genetic improvement 0.1±0.024 year of length of production life (Picture 4). Length of production life was observed to be trait with relatively high variability (v = 67.93 %) with average value 3.43 year ± 2.33 year. Following design of breeding program in 10 generation was observed curvilinear trend ($R^2$ = 0.985). Length of production life or any other trait of longevity resp. survival is missing today in breeding goal of Pinzgau cattle in Slovakia. Selection on

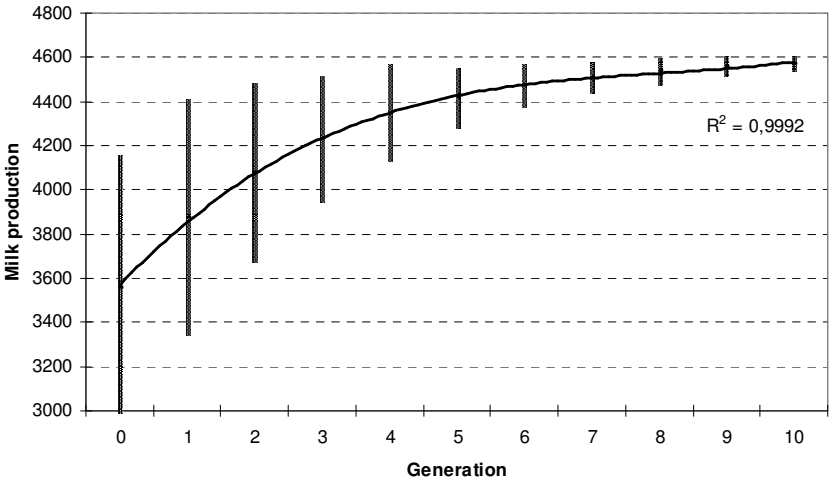
functional length of production life could lead after 10 generations to average value of 5.5 ± 0.6 years (Picture 8).

Picture 5 Genetic improvement of Total Merit Index (TMI) during 20 years of breeding program

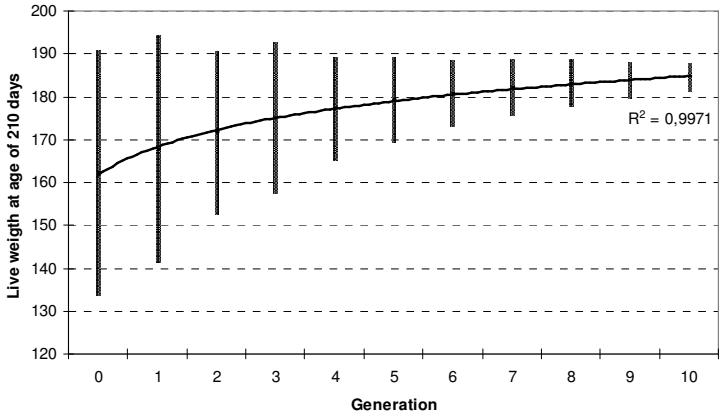



Total trend of TMI was positive with differences of effect of year. Trend of TMI in monetary units was positive in average 592.98±117.07 SK per year, TMI with linear ($R^2$ = 0.934) trend (Picture 5). Proportion of traits in TMI follows recommendations made by Kadlečík, Swalve, Lederer and Grosu (2004). From long term view selection on TMI will increase average production in population from 3558 kg to 4571.25 kg of milk, whereas trend was observed curvilinear ($R^2$ = 0.999, picture 9). Result of selection on TMI after 6 to 10 generations gaining asymptotic result was confirmed by Meuwissen (1990) and Bijma (2000).

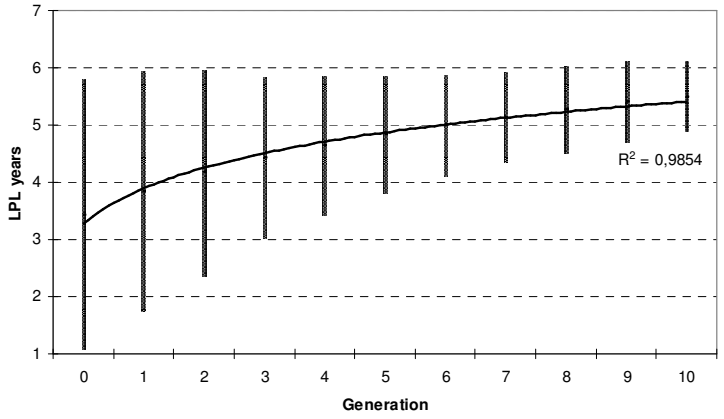
Picture 6 Long – term trend of milk production in population of Pinzgau cattle in Slovakia



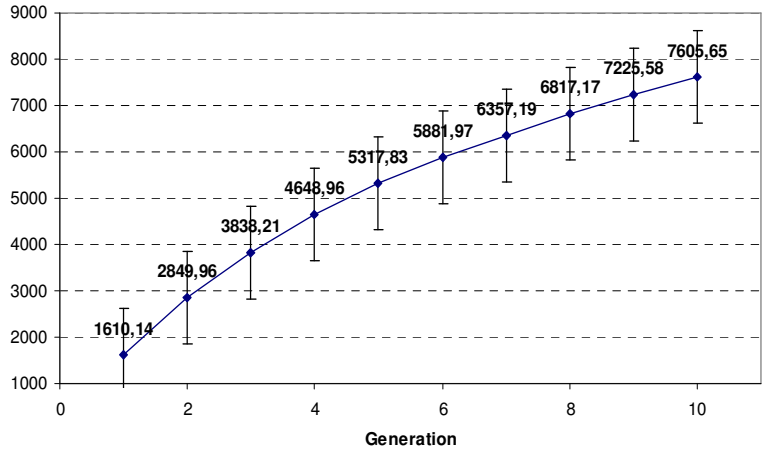
Picture 7 Long – term trend of live weigth at afe of 210 days in population of Pinzgau cattle in Slovakia




Picture 8 Long – term trend of length of productive life in population of Pinzgau cattle in Slovakia




Picture 9 Long – term trend of TMI in population of Pinzgau cattle in Slovakia



Long term development of TMI is in Picture 9. After first generation will be effect of selection 1610 SK, after 10 generations could this value increase to 7606 SK. TMI represent total value of animal in population – effect for farmer.

**Conclusions**

Short term results of selection on TMI in breeding program showed suitable genetic gain, which will be present as positive trend of estimated breeding values: in average 139.24 kg of milk, 3.43 kg of life weight at 210 days of age and 0.1 year of length of production life. Increase of genetic gain between years of breeding programs decreases as decreases variability of breeding values in selection index. From long term view could been proposed increase of production ability of population as result of positive trend of estimated breeding values, which will be nonlinear. Within $6^{th}$ to $10^{th}$ generations, due Bulmer effect, trend will be resulting to asymptotic vaalues. Future research will be harmonization of TMI with Austrian model.

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