

Influence of Maximum Inbreeding Avoidance under BLUP EBV Selection on Pinzgau Population Diversity

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Abstract

Evaluated was effect of mating (random vs. maximum avoidance of inbreeding) under BLUP EBV selection strategy. Existing population structure was under Monte Carlo stochastic simulation analyzed from the point to minimize increase of inbreeding. Maximum avoidance of inbreeding under BLUP selection resulted into comparable increase of inbreeding then random mating in average of 10 generation development. After 10 generations of simulation of mating strategy was observed $\Delta F = 6,51\%$ (2 sires), $5,20\%$ (3 sires), $3,22\%$ (4 sires) resp. $2,94\%$ (5 sires). With increased number of sires selected, decrease of inbreeding was observed. With use of 4, resp. 5 sires increase of inbreeding was comparable to random mating with phenotypic selection. For saving of genetic diversity and prevention of population loss is important to minimize increase of inbreeding in small populations. Classical approach was based on balancing ratio of sires and dams in mating program. Contrariwise in the most of commercial populations small number of sires was used with high mating ratio.

Keywords: Inbreeding, mating strategy, Pinzgau breed.

1. Introduction

Impact of inbreeding as important factor affecting breeding program efficiency was analysed by Kasarda and Kadlečík [1, 2], Kadlečík et al. [3], Kasarda et al. [4, 5, 6]. Kasarda and Kadlečík [2], Kasarda and Kadlečík [7,8, 9] proposed increasing of annually selected proven sires to manage level of inbreeding under 1 % per generation, according to global strategy of FAO [10], and sustainable genetic gain.

Random mating is system where every individual has equal chance to mate each other in population [11]. Kremer et al. [12,13] developed software which allow stochastic simulation of selection and different mating strategies for development of sustainable breeding programs. To save genetic diversity and prevention of loss is essential to

minimize increase of inbreeding in small populations as endangered breeds [14].

The Aim of the work was to analyze influence of mating strategy on development of inbreeding in population of Pinzgau cattle in Slovakia.

2. Materials and methods

Direct effect of population structure was evaluated as well as intensity of selection on development of parameters of inbreeding per generation: coefficient of inbreeding (F_X), increase of inbreeding (ΔF) nad relationship coefficient (R_{XY}) by use of stochastic simulation Monte Carlo [12,13].

Mating strategies:

Alternative 1: random mating with phenotypic selection

Alternative 2: factorial mating with BLUP breeding values selection

Truncation selection with restriction on mating of relatives algorithm was used [15, 16]. Fixed number of matings per parent was used,

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insemination and preposition that individuals of generation 0 are founders.

Input parameters of population structure for alternatives 1, 2:

Numbers of selected sires of sires: 2, 3, 4, 5

Number of selected dams of sires: 40

Coefficient of heritability

of selection index (h^2): 0,091

Sex ratio: 50: 50

Number of generations: 10

Directional selection of sires of sires and dams of sires with truncation selection and restriction on mating of relatives

According to breeding goal definition [17] was build complex selection index, which included milk production, growth [18] and fitness [19] traits [20]. Economic weights were used according to [21, 22].

3. Results and discussion

According to results in Table 1 its shown development of pedigree structure in population. In alternative with 2 sires of sires was observed

highest increase of inbreeding in average of 10 generations $\Delta F = 4.25\%$. With higher number of sires selected average increase of inbreeding decreased to 3.14 %, 2.42 %, resp. 2.17 % by ue of 3, 4 or 5 sires.

In Table 2 are results of factorial mating and BLUP selection on development of pedigree structure. In alternative with 2 sires of sires was observed highest increase of inbreeding per generation, with average value 6.92 %. With higher number of sires selected inbreeding decreased to na 4.77 %, 4.30 %, resp. 3.856 % by 3, 4 or 5 sires.

Between alternatives compared was observed high significant difference in average increase of inbreeding per 10 generations for phenotypic selection and random mating (Table 1, 2), with 0.24**, 0.93**, 0.53**, 1.54** by 5, 4, 3 resp. 2 sires of sires.

Selection based on BLUP breeding values leded to higher inbreeding. In case of random mating and BLUP selection, factorial mating s leading to lower level of inbreeding [23].

Table 1. Simulation results of random mating and BLUP EBV selection on increase of inbreeding in population according to number of sires of sires (alternative 1)

Generation	1	2	3	4	5	6	7	8	9	10
2										
F_x [%]	0	5.469	15.51	20.53	26.53	32.54	38.02	42.45	46.19	50.78
R_{xy} [%]	13.13	27.98	42.4	52.29	64.12	73.95	84.53	92.93	99.67	109.7
ΔF [%]	0	2.879	5.525	6.128	6.511	6.827	7.069	7.184	7.204	7.279
3										
F_x [%]	0	4.271	7.422	13.07	18.86	21.1	27.46	31.41	35.05	40.58
R_{xy} [%]	8.75	16.11	28.77	34.98	43.43	51.99	62.94	67.69	79.25	87.18
ΔF [%]	0	2.255	2.849	3.569	4.229	4.315	4.668	4.884	5.024	5.252
4										
F_x [%]	0	3.281	9.844	12	18.43	23.82	27.83	30.86	34.38	38.16
R_{xy} [%]	0.563	16.08	25.4	32.77	45.71	54.28	60.85	68.21	75.27	81.42
ΔF [%]	0	1.744	2.444	3.578	4.151	4.62	4.871	4.947	4.991	5.05
5										
F_x [%]	0	2.625	6.938	11.47	15.59	19.71	22.45	24.18	27.93	32.22
R_{xy} [%]	5.25	12	19.46	29.47	37.39	44.59	49.41	57.26	62.18	68.11
ΔF [%]	0	1.397	2.457	3.155	3.566	3.65	3.935	3.867	3.886	3.99

¹ generation, ² sires of sires

Table 2. Simulation results of maximum avoidance of inbreeding and selection on BLUP breeding values on increase of inbreeding in population according to number of sires of sires (alternative 2)

Generation	1	2	3	4	5	6	7	8	9	10
2										
F_x [%]	0	5.781	13.09	16.93	23.1	27.61	33.21	37.12	42.65	48.06
R_{xy} [%]	13.13	15.21	29.19	46.04	57.49	64.74	77.29	84.29	93.2	103.3
ΔF [%]	0	3.041	4.819	5.037	5.467	5.65	5.915	6.021	6.237	6.509
3										
F_x [%]	0	4.271	11.64	12.72	20.76	23.42	29.7	30.81	35.59	39.97
R_{xy} [%]	8.75	19.32	33.52	40.06	50.05	59.16	66.91	72.71	79.09	87.05
ΔF [%]	0	2.255	4.188	3.923	4.643	4.745	5.092	5.014	5.082	5.203
4										
F_x [%]	0	0	2.422	5.596	8.439	11.51	14.42	20.78	23.21	26.07
R_{xy} [%]	6.583	11.91	17.25	22.55	29.2	33.91	40.23	48.9	56.71	62.69
ΔF [%]	0	0	0.7354	1.391	1.809	2.124	2.352	2.81	3.054	3.217
5										
F_x [%]	0	0	3.125	8.547	10.73	14.34	16.66	18.38	19.96	24.6
R_{xy} [%]	5.25	12.05	17.86	25.59	30.76	38.17	42.03	45.19	49.82	56.57
ΔF [%]	0	0	0.9479	2.113	2.462	2.757	2.878	2.878	2.827	2.94

¹ generation. ² sires of sires

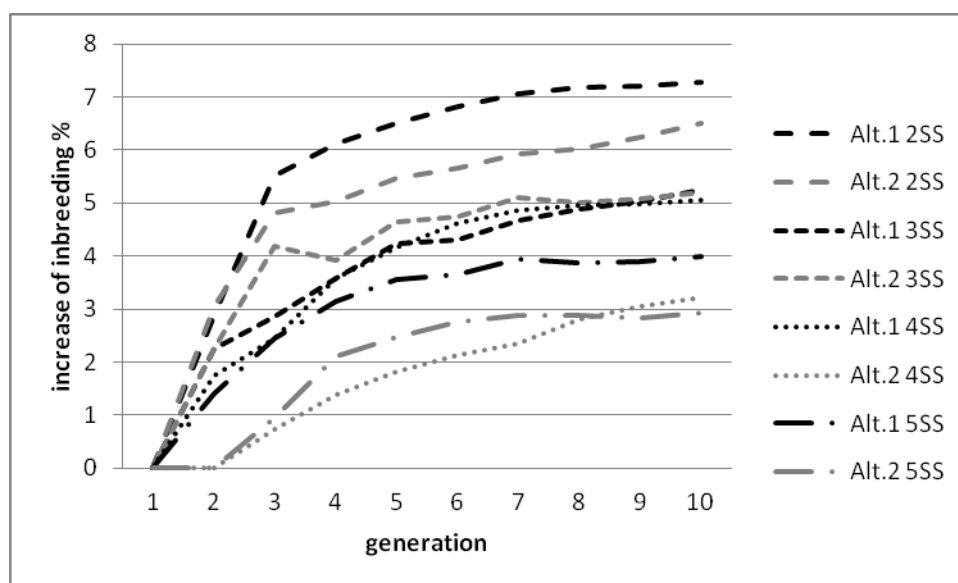


Figure 1. Comparison of increase of inbreeding of alternatives by use of 2, 3, 4 and 5 sires of sires

Selection on BLUP breeding values applied Caballero *et al.* [24], Meuwissen and Sonnensson [16], Fernández *et al.* [25], Windig and Engelsma [26], and proved that there is possibility to lower inbreeding. Increase of inbreeding under phenotypic selection and random mating was lower [11] as by selection on BLUP breeding values. Similar results were observed by Sánchez *et al.* [27], Silvela and Diez-Barra [28], in comparison to maximum avoidance of

inbreeding strategy, resp. Sørensen *et al.* [29], Honda *et al.* (2004), Nomura [31], Caballero *et al.* [24] in comparison to assortative mating, even Sørensen *et al.* [29], Sánchez *et al.* (2003) by factorial mating resp. strategy avoiding mating of half sibs or full sibs Wright [32], Kimura and Crow [33].

4. Conclusions

In population with selection based on estimated breeding values was expected higher increase of inbreeding. Mating according to maximum avoidance of inbreeding scheme is the way how to control inbreeding in selected populations. In population with selection by estimated breeding values were obtained high inbreeding gains. Factorial mating led to higher inbreeding improvement than random mating by phenotypic selection. Differences in inbreeding gains ranged from 0,24 to 1,54 % in average values found after 10 generations. After that inbreeding gain was 6,92 % at factorial mating when 2 bull fathers were used, 4,77 % (3 bulls), resp. 3.86 % when 5 bulls were used in mating.

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