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Conference paper

OPTIMAL SELECTION STRATEGY FOR CROSSBRED PERFORMANCE IN COMMERCIAL PIG BREEDING PROGRAMMES

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Summary

To choose the optimal selection strategy for genetic improvement of both purebred and crossbred performance, in the Stamboek breeding programme, data of purebred Great Yorkshire-sire (GY-s) animals and their crossbreds with Duroc and Pietrain were analysed. The genetic correlation (r_{pc}) between purebred and crossbred performance ranged from 0.9-1.0 for weight at 180 days and from 0.61-0.95 for backfat thickness. The heritabilities estimated (h^2_c) for the crossbred animals were in general higher than for the purebred animals. It is concluded that next to r_{pc} and h^2_c, the design of the breeding programme is the important factor to decide on the optimal selection strategy to maximize genetic response in crossbreds.

Keywords: crossbreeding, recurrent selection, pig breeding.

Introduction

Most current pig breeding programmes apply purebred performance with pure-line selection (PLS) to improve their pigs within lines or breeds. However, in commercial pig breeding programmes different breeds/lines are maintained and selected to improve the performance of crossbred pigs. In such a system, the breeding goal should be defined at the crossbred level and selection criteria should be adapted to that. A combined crossbred and purebred selection (CCPS) method might be applied in such a situation (Wei and Van der Steen, 1992, Wei 1992, Van der Werf et al. 1994).

In order to apply CCPS successively, the genetic correlation between purebred and crossbred performance (r_{pc}) and the crossbred heritability (h^2_c) are

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crucial factors (Van der Werf et al. 1994). This study presents a) the results of the estimation of r_{pc} and h^2_c in the Stamboek breeding programme for Great Yorkshire sire (GY-s) line performance compared to the performance of Duroc x GY-s- and Pietrain x GY-s s crossbreds and b) the consequences of these estimates for optimal selection strategy.

To choose the optimal selection strategy, the Stamboek situation is considered: the GY-s breed is selected both for production of purebred GY-s as well as for crossbred terminal boars while Duroc is selected only for production of crossbred boars.

Materials and methods

Production data were used from pure line and crossbred populations of the Stamboek sire lines Great Yorkshire (GY-s), Duroc (D), Pietrain (P) and their crosses P*GY-s and D*GY-s. Data were collected for the traits weight at 180 days (kg), backfat-thickness at 110 kg (mm) and daily live weight gain (gr/day from birth to 180 days). For crossbred populations only information of traits measured on boars was available. Data from 72,419 animals, recorded between june 1992 to may 1997 were used in the analysis (P*GY-s data since march 1993).

The traits weight and backfat were analized by two different mixed-models: univariate (considering one trait at one breed) and bivariate (recognizing purebred and crossbred performance as two different traits with a genetic correlation between them). The model was as follows:

$$y_{ijkl} = \mu + sexe_i + c_j + s_k + a_l + e_{ijkl}$$

Where y_{ijkl} = the performance of r_{ijkl}, animals, μ = the general mean, sexe = the i^{th} sexe effect (fixed, only used in purebred analyses), c_j = the j^{th} litter effect (random), s_k = the k^{th} herd-year-season effect (random), a_l = the random effect of the l^{th} animal, e_{ijkl} = the random residual effect. The variances and covariances were determined by a PEST/VCE procedure (Groeneweld, 1994) and pedigree information of 3 generations.

For the comparison of the effectiveness of using only crossbred (RRS) versus only purebred (PLS) information for crossbred selection response, the formula described by Sellier (1982) are used:

For the situation of the Stamboek breeding programme the use of PLS and RRS may be plied in two ways

a) Half sib RRS scheme (HS-RRS): selected pure-line animals produce the next purebred generation and the crossbred progeny simultaneously.

b) Two-stage RRS scheme (TS-RRS): two-stage selection with independent culling levels for purebred and crossbred progeny performance. The purebred selection precedes each cycle of crossbred selection.

Results

In table 1 the number of animals for each genotype and the means and standard deviations for the traits measured are indicated. In table 2, the genetic parameters estimated by univariate analysis are tabulated.

Table 1. - NUMBER OF RECORDS, FOR EACH GENOTYPE AND THE MEANS AND STANDARD DEVIATIONS (BETWEEN BRACKETS) FOR THE TRAITS MEASURED

Breed / Traits	GY-s⁺	D	D*GY-s	P*GY-s
	44,529	5,341	18,785	3,764
Weight at 180 days (kg)	115.6 (12.9)	106.0 (10.4)	128.9 (13.3)	120.0 (12.9)
Backfat thickness at 110 kg	10,02 (1.30)	12.60 (1.77)	10.77 (1.39)	9.29 (1.26)

+ Backfat thiskness of 1,181 Y-animals were not recorded

Estimates of heritability for weight under a univariate model varied from .20 for Y to .45 for DY (table 2). Estimates of heritability for backfat were higher and varied from .37 for Y to .62 for D.

Table 2. - ESTIMATES OF VARIANCE COMPONENTS AND HERITABILITY FOR WEIGTH AND BACKFAT THICKNESS FROM UNIVARIATE ANALYSIS

Trait	Breed	σ^2_P	σ^2_A	σ^2_C	σ^2_S	h^2 (±s.e.)	c^2	s^2
Weight	GY-s	155.8	31.6	23.6	44.4	.33±.01	.15	.29
	D	103.6	26.4	9.7	22.5	.26±.02	.09	.22
	D*GY-s	180.9	81.9	23.6	43.8	.45±.03	.13	.24
	P*GY-s	165.5	41.0	29.1	38.9	.24±.05	.18	.24
Backfat	GY-s	1.71	0.62	0.11	0.25	.37±.01	.07	.15
	D	3.15	1.77	0.14	0.15	.56±.03	.04	.05
	D*GY-s	2.06	1.05	0.18	0.31	.51±.03	.09	.15
	P*GY-s	1.64	1.01	0.12	0.17	.62±.05	.07	.11

Genetic correlations between purebred and crossbred populations are given in table 3. Genetic correlations were highest for weight and did not significantly differ from 1. Genetic correlacions for backfat thickness varied from .61 between D and D *GY-s to .95 between GY S D*GY-s.

Table 3. - ESTIMATES OF HERITABILITY AND GENETIC CORRELATIONS FOR WEIGHT AND BACKFAT BETWEEN PUREBRED (PB) AND CROSSBRED (CB) POPULATIONS

Trait	PB	CB	h^2_p	h^2_c	r_{PC}(±s.e.)
Weigt	GY-s	D*GY-s	.20	.46	.90±.03
	D	D*GY-s	.27	.43	1.00±*
	GY-s	P*GY-s	.22	.42	1.00±*
Backfat	GY-s	D*GY-s	.42	.58	.95±.02
	D	D*GY-s	.57	.51	.61±.11
	GY-s	P*GY-s	.41	.66	.74±.05

The results of the effectiveness for crossbred selection response of using only crossbred (RRS) versus only purebred (PLS) information for HR-RRS and TS-RRS is indicated in table 4. For each sire 15 (half sibs) crossbred progeny are assumed.

Table 4. - THE EFFECTIVENESS OF USING ONLY PUREBRED VERSUS ONLY CROSSBRED INFORMATION (PLS/RRS) FOR RELATIVE CROSSBRED SELECTION RESPONSE IN THE SYSTEM OF HALF-SIB RRS (HS-RRS) AND TWO-STAGE RRS (TS-RRS)

		Weight		Backfat	
PB	CB	HS-RRS	TS-RRS	HS-RRS	TS-RRS
GY-s	D*GY-s	0.64	1.02	0.73	1.17
D	D*GY-s	0.65	1.04	0.56	0.90
GY-s	P*GY-s	0.59	0.94	0.55	0.88

Discussion

The estimated genetic parameters for weight and backfat thickness are in agreement with literature (among others Hovenier, 1992). The estimates of r_{pc} are within the range of estimates reviewed by Wei and Van der Steen (1991). The high estimates of r_{pc} for weight (0.9-1.0) are in agreement with the theoretical findings of Wei (1992) from the locus model: differences in sire variance components are small. Wei (1992) showed that a greater difference of sire components or heritabilities in purebreds and crossbreds is associated with larger dominance gene effects and larger gene frequency differences in parental populations. For backfat thickness differences in sire variance components are large between Duroc and D*GY-s and between GY-s and Pi *GY-s, both associated with r_{pc} of 0.6 - 0.7. Combining both purebred and crosbred information (CCPS) in selection has been tested by Mei and Van der Werf (1994, 1995) and further optimised by Van der Werf et al. (1994) for different situations. For the particular Stamboek situation optimal use of PLS and RRS or CCPS seems to be dependent on the breed and breeding structure. The results in table 4 show the high effectiveness of RRS versus PLS in the situation that sires produce purebred and crossbred progeny at the same time. This is also shown in the study of Van der Werf et al. 1994. However, in the situation of two-stage selection, the effectiveness of RRS versus PLS is very much dependent on r_{pc} and the difference in heritability between purebred and crossbred information. Improvement of Duroc x GY-s is for two stage selection more effective done by using only purebred information. But selection of GY-S to produce Pietrain x GY-s crossbreds is more effective by selection on crossbreds even for weight where $r_{pc} = 1$.

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STRATEGIJA OPTIMALNE SELEKCIJE ZA PERFORMANCU KRIŽANACA U PROGRAMIMA KOMERCIJALNOG UZGOJA SVINJA

Sažetak

Radi izabiranja strategije optimalne selekcije za genetsko poboljšanje performance čistokrvnih životinja i križanaca, u uzgojnom programu Stamboek analizirani su podaci o čistokrvnim životinjama rasplodnjaka Velikog Yorkshira (GY-s) i njihovih križanaca s Durocom i Pietrainom. Genetska korelacija (r_{pc}) između performance čistokrvnih i križanaca kretala se od 0.9-1.0 za težinu od 180 dana i od 0.61-0.95 za debljinu leđne slanine. Procijenjene nasljednosti (h^2_c) za križane životinje bile su općenito više nego za čistokrvne životinje. Zaključak je da je osim r_{pc} i h^2_c, plan uzgojnog programa važan čimbenik kod odlučivanja o strategiji optimalne selekcije za maksimalno povećanje genetske reakcije.

Ključne riječi: križanje, povratna selekcija, uzgoj svinja

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