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447 - Elaboration of strategic and economic recommendations to further develop the breeding programme of Saxonian pig breeding association

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SUMMARY

The aim of this study is to optimize a three way cross breeding plan with Pietrain as the sire, German Landrace and Large White as dam lines in Saxonia by model calculations. Using the gene-flow method, selection index procedures and with inclusion of fix and variable breeding costs, a computer program was used which enables to analyse different breeding strategies for a defined investment period with respect to maximizing annual genetic gain and profit.

This paper considers the comparison of two testing schemes and the contribution of the three breeds to genetic gain and return. Both monetary genetic gain and profit are higher in a scheme with an additonal self performance test of German Landrace boars at station than in a scheme with only progeny test at station. The second scheme is superior in the profit with 2.80 DM, i.e. 24 percent. This indicates that through the additional self performance test of German Landrace boars at the station the return increases considerably whereas the costs increase to a small extent. In that case German Landrace also contributes more to the genetic gain than the other breeds. In both schemes selection in Pietrain leads to the highest return due to its shorter distance to the terminal product and his faster transfer of the genetic gain to it. It is also shown that different standard discounted expressions lead to the result that the economic weight of reproduction traits in Pietrain is negligible whereas that of growth and carcass traits is higher than in the dam lines.

INTRODUCTION

The Saxonian pig breeding scheme consists of different levels in a pyramid, described as nucleus, multiplier and commercial level. The breeding enterprise is interested in an investigation on the optimum allocation of mating, selection and management decisions in the three breeds involved in the three way crossbreeding scheme. Through minor changes of the computer program ZPLAN (Karras et al., 1993) this could be used to give an answer to a part of the problems. The main criteria of evaluating breeding schemes by the program are annual genetic gain and profit. The genetic gain will also be called monetary genetic gain in this paper when it refers to the breeding objective and the profit is the return on investment minus costs. So far the program has not yet been used for a comprehensive model calculation on selecting lines within a crossbreeding scheme.

Although selection takes place in all levels, only selection in the top level influences the rate of annual genetic gain. Selection at the nucleus level for growth and carcass traits is based upon performance test with additional sib information. A substantial part of selection takes place under special conditions of a central test station, which deviate from the conditions of commercial production. Ad libitum feeding and group housing is applied in the central test station. This enables to reduce genotype by environment interactions as it leads to genetic correlations close to 1 between performances in the field and at the testing station (van Oijen and Merks, 1995).

The aim of this paper is to report on some preliminary model calculations about the breeding scheme. These concern different testing schemes in the field as well as at the station and the contribution of the breeds involved to both genetic gain and return. The implication of the present knowledge for the actual breeding programme will be discussed.

MATERIAL AND METHODS

The ZPLAN program uses the gene-flow method described by Mc Clintock and Cunningham (1974), Hill (1974) and Elsen and Mocquot (1974). Figure 1 shows the selection groups in the transmission matrix. For this study, the three parental lines, the F1 sows and the terminal products are considered and, for simplicity, the multiplier level is ignored.

	BB_GL	BS_GL	BB_LW	BS_LW	BB_Pi	BS_Pi	PS_F1
BB_GL	1	2					
BS_GL	3	4					
BB_LW			5	6			
BS_LW			7	8			
BB_Pi					9	10	
BS_Pi					11	12	
PS_F1		13	14				
TP					15		16

BB	- breeding boars	GL	- German Landrace
BS	- breeding sows	LW	- Large White
PS	- production sows	Pi	- Pietrain
		F1	- F1-generation (LW x GL)
>	- produce	TP	- terminal products (Pi (LW x GL))
1, 5, 9	- breeding boars > breeding boars	13	- breeding sows > production sows
2, 6, 10	- breeding sows > breeding boars	14	- breeding boars > production sows
3, 7, 11	- breeding boars > breeding sows	15	- breeding boars > terminal products
4, 8, 12	- breeding sows > breeding sows	16	- production sows > terminal products

Figure 1: Transmission matrix of the three way cross with 16 selection groups. Origin of parents (gene donors) in columns, offspring (gene recipients) in rows

Through weighting the economic values with the number of standardized discounted expressions (SDE-values) the different breeding goals in the breeds involved are taken into account. Using selection index procedures and including fix and variable breeding costs, the program enables to analyse different breeding schemes for a defined investment period with respect to maximizing monetary genetic gain and profit. Simulating selection strategies using different herd and population structures, testing capacities and selection intensities for performance traits, the program realizes a multitrait genetic and economic optimization of breeding schemes.

The German Landrace (GL) with 3600 sows (800 sows in the nucleus, 2800 sows for multiplying crossbred sows) and the Large White breed (LW) with 75 sows are used as dam lines and Pietrain (Pi) with 125 sows as the sire line. The F1-generation (LW x GL) consists of 46200 sows. Animals are tested either in a field testing programme or at the central test at station. Table 1 lists the traits used for selection.

Table 1: Description of the recorded traits in the testing schemes

Trait	Self performance test			Progeny test	
	boars field	boars station	sows field	field	station
DG		X			X
MP		X		X	X
FE		X			X
pH1				X	X
NBA			X		
ADG	X	X	X	X	
US	X	X	X		

DG daily gain (test time); MP meat percentage; FE feed efficiency; pH1 pH-value; NBA number piglets born alive; US ultrasonic sidefat thickness; ADG average daily gain (life time)

At the station a tested group consist of 2 piglets per sow of the same sex (male in GL, females in LW and Pi). For tests under field conditions the group size is assumed to consist of 7 slaughtered animals per successful mating. Heritabilities, phenotypic standard deviations and economic values for the traits considered are presented in Table 2. Different standard deviations are assumed for the traits between dam and sire lines corresponding to recent findings in Saxonia.

Table 2: Heritabilities (h^2), phenotypic standard deviations (δ_P) and economic values (v) for the traits in the breeding goal and index

Trait	Unit	h^2	δ_P GL, LW	δ_P Pi	v DM
DG	g/d	.35	95	85	.12
MP	%	.55	2.2	2.3	5.0
FE	kg/kg	.35	.24	.16	- 36
pH1	.1	.20	.20	.18	2.0
NBA	number	.10	2.0	1.7	7.5
ADG	g/d	.20	45	50	-
US	mm	.25	.15	.12	-

The criteria of evaluating breeding schemes were the monetary genetic gain and profit per dam in the total population. Usual lengths of productive lifetime and for generation interval were assumed.
The breeding scheme 1 is based on self performance test for all breeding animals as well as progeny tests for LW boars mated to produce the F1-generation and Pi boars mated to produce terminal crossbreds in the field. For boars mated to produce purebreds, progeny test is carried out in the station. In breeding scheme 2 an additional self performance test at the station is assumed for GL boars. In a first step the optimal relationship between self performance test and progeny test at station was investigated under inclusion of different traits in the selection decision.

RESULTS and DISCUSSION

By simulating the number of tested boars per line and tested sib groups per boar it is intended to find out the combination with the maximum monetary genetic gain or profit for a determined station size. Results are shown in Table 3. Both monetary genetic gain and profit are higher in scheme 2. The superiority in profit is 2.80 DM, i.e. 24 percent.

Table 3: Comparison of scheme 1 and scheme 2 with respect to the monetary genetic gain per year, return, costs and profit

Criteria	Unit	Scheme 1	Scheme 2
Monetary genetic gain	DM	4.64	6.88
Return / unit	DM	23.91	26.88
Costs / unit	DM	12.44	12.62
Profit / unit	DM	11.47	14.26

For traits in the breeding objective, Table 4 shows the mean economic weights (economic values weighted with their standard discounted expressions) over selection groups within the three breeds. These show clearly that the sire line gets a negligible weight for the reproduction trait (NBA), but higher weights than dam lines for growth and carcass traits. The latter deviates considerably from the equal weighting often applied in practical breeding programmes.

Table 4: Mean economic weights (DM) over selection groups within the three breeds for traits in the breeding goal

Trait	Unit	GL	LW	Pi
DG	g/d	.009	.005	.017
MP	%	.36	.21	.71
FE	kg/kg	-2.64	-1.53	-5.17
pH1	.1	.14	.08	.28
NBA	piglets	.925	.730	.006

Estimated genetic gains for the different populations are shown in Table 5. Generally speaking, in both schemes the genetic gain per year for NBA is much (more than ten times) higher in the dam lines whereas there is no substantial difference between sire and dam lines concerning the genetic gain for growth and carcass traits. This is due to different breeding objectives according to the different economic weigts as shown above. In scheme 1 the monetary genetic gain is rather similar for the three lines. In scheme 2 there is a considerable superiority of GL in the genetic gain for DG, MP and FE. This indicates the importance from the shift of the self performance test from the field to the station. The differences in the genetic gain between LW and Pi are only slight.

Table 5: Annual genetic gain for single traits and for the breeding objective of the different breeds

Trait	Unit	Scheme 1			Scheme 2		
		GL	LW	Pi	GL	LW	Pi
DG	g	3.86	4.05	3.93	6.33	3.85	3.73
MP	%	.090	.105	.143	.176	.097	.136
FE	kg/kg	-.012	-.013	-.010	-.022	-.013	-.010
pH1	.1	-.004	-.005	-.004	-.007	-.004	-.005
NBA	piglets	.017	.016	-.001	.019	.018	-.001
Breeding objective	DM	4.44	4.83	4.63	7.67	4.56	4.41

Table 6 shows the dominant influence of the sire line in the return for both single traits and total. The main reason is the shorter genetic distance to the terminal product and the faster transfer of genetic superiority to it. A major role plays the high importance of MP which is the dominant trait in the sire line and has the highest influence in the breeding objective.

Table 6: Distribution of the returns (DM) for the single traits and for the lines

Trait	Scheme 1			Scheme 2		
	GL	LW	Pi	GL	LW	Pi
DG	1.42	1.62	3.94	2.33	1.59	3.81
MP	1.37	1.61	6.77	2.69	1.57	6.68
FE	1.36	1.56	3.22	2.40	1.54	3.14
pH1	-.02	-.03	-.09	-.04	-.03	-.09
NBA	.56	.63	-.01	.62	.68	-.01
Total	4.69	5.39	13.83	8.00	5.35	13.53
Percent	19.6	22.6	57.8	29.8	19.9	50.3

The distribution of the limited testing capacity between the breeds is shown in Table 7 and Table 8. The figures are received by varying the number of tested boars and tested groups per boar with respect to maximize the profit. For evaluating young boars in the self performance test, information from tested full- and halfsibs at station are taken into account. In scheme 1 (Table 7) the small number of tested animals in LW is also caused by the decreased selection intensity in sow selection, because female piglets tested on station are lost for breeding.

Table 7: Distribution of the limited testing capacity between the breeds and number of matings necassary per year for field test (scheme 1)

	GL	LW	Pi	LW	Pi
	Purebred mating, station			Crossbred mating, field	
Number of boars	18	11	15	26	72
Groups per boar	7	7	9	7	5
Tested animals (no.)	252	144	270		
Tested animals (%)	37	23	40		

Compared with the results of scheme 1, the additional self performance test of GL boars in scheme 2 (Table 8) absorbs a substancial part of the capacity of the test station. The number of boars needed for progeny test and the number of groups per boar decreased slightly. An exception is the number of groups per GL boar which dropped considerably. This is due to the degree of relationship of animals in the self performance and progeny test. With respect to progeny test in the field there are negligible differences between both schemes.

Table 8: Distribution of the limited testing capacity between the breeds and number of matings necassary per year for field test (scheme 2)

	GL*	GL	LW	Pi	LW	Pi
		Purebred mating, station			Crossbred mating, field	
Number of boars	330	14	8	12	28	73
Groups per boar		3	6	7	7	5
Tested animals (no.)	330	84	96	168		
Tested animals (%)	49	12	14	25		

* Self performance testing at station

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