THREE WAY CROSS BREEDING IN PIGS: EVALUATION OF ECONOMIC VALUES AND DIFFERENT BOAR TESTING SCHEMES

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SUMMARY

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

This paper shows that due to different standard discounted expressions for each breed the economic weight for litter size in Pietrain is negligible, whereas economic weights for growth and carcass traits are higher than in dam lines. Four testing schemes are compared and the contribution of the three breeds to the return is evaluated. Both, monetary genetic gain and profit, are higher in schemes with self performance testing of boars at station in comparison to a scheme with only progeny testing at station. Due to a reduced generation interval, using boars to produce breeding boars straight after their self performance test leads to a further increase of monetary genetic gain and profit. In all schemes, selection in Pietrain leads to the highest return due to its shorter distance to the terminal product and the faster transfer of genetic gain.
Keywords: pig, breeding programmes, crossbreeding, performance testing

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 for the three breeds used in the three way cross breeding scheme. Through minor changes of the computer program ZPLAN (Karras *et al.*, 1993) it is possible to investigate some of these problems. The main criteria for evaluating breeding schemes 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. Until this study the program had not been used for a comprehensive model calculation on selection in lines within a crossbreeding scheme.

The aim of this paper is to report on the results of model calculations for the breeding scheme. These concern the economic value of traits in the three breeds involved, different testing schemes in the field as well as at the station and the contribution of the breeds to both monetary

genetic gain and return. Implications of the present results for the actual breeding programme will be discussed.

MATERIAL AND METHODS

The ZPLAN program uses the gene-flow method described by McClintock and Cunningham (1974), Hill (1974) and Elsen and Mocquot (1974). For this study, the three parental lines, the F_1-sows and the terminal products are considered. Through weighting the economic values with the number of standardised discounted expressions (SDE-values) the different breeding goals for each breed involved are taken into account. Using selection index procedures and including fixed and variable breeding costs, the program enables the analysis of different breeding schemes for a defined investment period with respect to maximising monetary genetic gain and profit. Simulating selection strategies using different herd and population structures, testing capacities and selection intensities for performance traits, the program realises a multitrait genetic and economic optimisation of breeding schemes.

The German Landrace (GL) with 4000 sows (800 sows in the nucleus, 3200 sows for multiplying crossbred sows) and the Large White breed (LW) with 100 sows are used as dam lines and Pietrain (Pi) with 125 sows as the sire line. The F_1-generation (LW x GL) consists of 46000 sows. Animals are tested either in a field testing programme or at a central station test. Table 1 shows 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
Daily gain (test period) (DG)		X			X
Meat percentage (MP)		X		X	X
Feed efficiency (FE)		X			X
pH-value at 45 minutes p.m. (pH_1)				X	X
Number of piglets born alive (NBA)			X		
Average daily gain (life time) (ADG)	X	X	X	X	
Ultrasonic side-fat thickness (US)	X	X	X		

The criteria for evaluating breeding schemes were the monetary genetic gain and profit per dam in the total population. Input parameters are shown by Wuensch *et al.* (1996). All breeding schemes are based on self performance tests of sows, progeny tests for LW boars mated to produce the F_1-generation and Pi boars mated to produce terminal crossbreds in the field. For boars mated to produce purebreds, a progeny test is carried out at the station. Four breeding schemes were defined according to testing and selecting boars (Table 2).

Table 2. Characterisation of breeding schemes 1 to 4 according to testing and selecting boars in the three breeds. BB = Boars to breed boars in all lines

Characteristic	1	2	3	4
Self performance test in the field	all	LW, Pi	---	---
Self performance test at the station	---	GL	all	all
BB selection after self performance test	---	---	---	X
BB selection after progeny test	X	X	X	---

RESULTS AND DISCUSSION

Table 3 shows for traits in the breeding objective the non-discounted economic values, expressed on a per sow basis. These have been calculated as the difference between the additional revenue and additional costs from increasing the trait by one unit. Furthermore, economic values weighted with their SDE-values, called absolute economic weights, are presented. These show clearly that the sire line is characterised by a negligible weight for number of piglets born alive (NBA), and has higher weights than dam lines for growth and carcass traits. The relative economic weight of meat percentage (MP), expressed as within line percentages after weighting the absolute economic weight with the genetic standard deviation, is higher in the sire line than in the dam lines whereas the value of NBA in the dam lines is quite high.

Table 3. Absolute and relative economic weights of traits in the breeding goal for the three breeds

Trait [1)]	Economic value [2)]	Absolute (DM/Unit)			Relative (%)		
	(DM/Unit)	GL	LW	Pi	GL	LW	Pi
DG (g/d)	.11	.11	.05	.15	29.25	26.55	34.14
MP (%)	4.5	3.64	1.91	5.28	31.71	29.66	44.62
FE (kg/kg)	-36	-33.14	-17.85	-47.09	21.33	20.34	21.22
pH_1 (.1)	2.0	1.84	1.08	2.60	.01	.01	.01
NBA (piglets)	7.5	11.13	8.26	.09	17.70	23.44	.01

[1)] for abbreviations of traits see Table 1 [2)] on a per sow basis, not discounted

Different combinations of the number of tested boars per line and tested sib groups per boar were simulated in order to find the combination which maximised profit for a determined station size of each breeding scheme (Table 4). Both monetary genetic gain and profit are higher in scheme 2 and 3 than in scheme 1. The latter indicates that through self performance testing of boars at the station the return increases considerably whereas the costs increase to a

small extent. The second scheme is superior in profit with 3.10 DM (26 %). It is quite attractive for the Saxonian breeding association, because in this crossbreeding scheme Landrace breeders are mainly interested in selling sows. Profit of scheme 3 is 8.19 DM (68 %) higher than in scheme 1 and 5.09 DM (34 %) higher than in scheme 2. The implementation of this scheme is only realistic if breeders and the breeding association collaborate closely together. Breeders have to be willing to submit their piglets to the station. If boars are used to produce breeding boars already after the self performance test, the profit raised again by 2.67 DM (13 %). The positive effect of the shorter generation interval is higher than that of losing information for the breeding value due to the lack of progeny records.

Table 4. The efficiency of the breeding schemes each optimised for maximum profit (all criteria in DM)

Criteria	Scheme 1	Scheme 2	Scheme 3	Scheme 4
Monetary genetic gain	4.45	5.29	6.03	6.36
Contributions to the total returns				
DL	5.53	9.21	8.54	9.72
DE	5.89	5.80	7.54	8.16
Pi	13.43	13.08	17.07	17.94
Return per sow	24.85	28.09	33.15	35.82
Costs per sow	12.77	12.91	12.88	12.88
Profit per sow	12.08	15.18	20.27	22.94

In all schemes selection in Pietrain contributes higher returns than in the other two breeds. The main reason for this is the shorter genetic distance to the terminal product and the faster transfer of genetic superiority to it. Meat percentage was the dominant trait in the sire line, and had the highest influence in the breeding objective for all breeds.

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