INCLUDING MEAT QUALITY IN PIG BREEDING PROGRAMS

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SUMMARY

Three strategies are evaluated to improve meat quality by breeding: 1) no change of the currently used breeding goal and selection index, and rely on correlated responses of meat quality traits, 2) inclusion of meat quality traits only in the breeding goal, and 3) inclusion of meat quality in both breeding goal and selection index. It is shown that selection for production traits only will probably result in a decrease of meat quality. Inclusion of meat quality in the breeding goal, but not in the index, improves meat quality and is an interesting option because no costs for meat quality measurements are made and the relative loss in production traits is small. The effects of different population means of meat quality traits on economic values of these traits and on the results found are discussed.

INTRODUCTION

Consumers and industry increasingly pay attention to the quality of the meat and meat products they buy. Studies of Hovenier et al. (1992, 1993[b]) showed that there are possibilities to improve meat quality by breeding. Heritabilities were estimated to range from 0.20 for ultimate pH to 0.61 for intramuscular fat content. Phenotypic correlations between production and meat quality traits differed hardly from zero except for intramuscular fat content. Genetic correlations between daily gain and meat quality were favourable but unfavourable between lean meat content and meat quality.

Economic weights are used to combine traits in a breeding goal. In most present applications, the economic values are assumed to be independent of the population mean of the traits. However, various traits, like meat quality traits, show an optimum range resulting in a non-linear relationship between their economic values and the population means. Hovenier et al. (1993[a]) developed a method to derive economic values for this case, based on the knowledge of threshold levels beyond which the product is not acceptable or only acceptable for lower prices.

Because reliable and quick methods to measure meat quality individually in the slaughter line are not available it is not possible to pay producers according to the meat quality of their products. This means that breeding to improve meat quality will be done only when no substantial extra costs are involved or when agreements can be made between different tiers of the pig meat production chain to share costs and profits. This may be possible in a closed pig meat production chain.

In this study, three options, each different in the definition of the breeding goal and the selection index, are evaluated to illustrate the possible effects of implementation of meat quality in a pig breeding program. Furthermore, the effects of different population means for meat quality traits on the results are discussed.

SELECTION PROCEDURES

Three options were evaluated. In Option 1, the breeding goal is defined only for the production traits: daily gain (DG), feed intake (FI), and lean meat content (LMC). Index traits are DG and backfat thickness (BF) measured on the performance tested animal, its full sibs and paternal half sibs, its sire and dam and the full sibs of both the sire and the dam. It is assumed that five animals per litter are tested and that each sire produces twenty litters. This option is supposed to reflect current breeding programs. Changes in meat quality only depend on genetic correlations with breeding goal traits.

Table 1. Breeding goal traits, optimum ranges, standard deviations, economic values (assumed population means for the optimum traits between brackets) and genetic superiorities as a percentage of the phenotypic standard deviation (%σ_p), correlation between index and breeding goal (r_{IH}), total financial superiority (ΔG_{tot}) and financial superiority for production (ΔG_{prod}) and meat quality traits (ΔG_{qual}) after one round of selection (i = 1) for the three different options[1].

Trait	optimum range[2]	stand. dev.	economic values[3]	genetic superiority, %σ_p		
				option 1	option 2	option 3
daily gain, gd^{-1}		100	0.262	19.5	24.9	22.1
feed intake, gd^{-1}		200	-.064	8.8	12.8	11.8
lean meat %		4.0	3.1	9.9	0.1	-.7
ultimate pH	5.5-5.8	0.10	88.76 (5.50)	-.4	1.3	6.5
meat colour[4]	2.0-4.0	0.4	0.00 (3.0)	14.7	14.3	17.0
drip loss, %		2.2	-2.25	-.5	-1.1	-6.3
intramuscular fat content, %	1.5-2.5	0.6	9.90 (1.6)	-2.4	3.0	5.1
maximum shearforce, N	0-35.0	4.0	-2.24 (35.0)	0.4	-1.3	-6.2
r_{IH}				0.35	0.31	0.34
ΔG_{tot}, Dfl				5.03	5.36	5.94
ΔG_{prod}, Dfl				5.21	4.89	4.19
ΔG_{qual}, Dfl				-.18	0.47	1.75

[1] Option 1: only production traits in the breeding goal and the index. Option 2: production and meat quality traits in the breeding goal, only production traits in the index. Option 3: production and meat quality traits in both breeding goal and index.

[2] Not given when value is not of interest for the calculation of the economic value.

[3] Economic values of the optimum traits based on 45 kg lean meat per pig, price difference between meat within and outside the optimum range Dfl 0,50 kg^{-1}.

[4] Meat colour based on Japanese colour scale (1 = pale, 5 = dark).

In Option 2, the same index traits are used but the breeding goal is extended with meat quality traits: ultimate pH (PH), meat colour (COLOR), drip losses (DRIP), intramuscular fat content (INTMF), and maximum shearforce (SHEAR). In contrast to Option 1, in Option 2 there is direct selection emphasis on meat quality, although it is not measured. Extra costs are made only to obtain genetic parameters, but the gain in production traits may decrease somewhat.

In Option 3, the same breeding goal is used as in Option 2, but now one animal from each litter is slaughtered experimentally to measure meat quality traits on. This option is most costly because animals should be slaughtered experimentally and meat quality measurements need to be carried out. Because of the high correlations among PH, COLOR and DRIP and for simplicity of the calculations, only PH, INTMF and SHEAR are considered as meat quality index traits.

Table 2. Heritabilities (bold on diagonal) and genetic (below diagonal) and phenotypic (above diagonal) correlations between production and meat quality traits[1].

	DG	FI	BF	LMC	PH	COLOR	DRIP	INTMF	SHEAR
DG	**0.30**	0.60	0.55	-.35	-.05	0.05	0.00	0.15	-.05
FI	0.55	**0.30**	0.40	-.45	0.05	0.05	-.05	0.10	-.05
BF	0.55	0.40	**0.50**	-.75	0.00	0.00	-.05	0.30	-.10
LMC	-.25	-.55	-.70	**0.50**	-.05	0.00	0.10	-.30	0.10
PH	0.10	0.10	0.15	-.10	**0.30**	0.45	-.45	-.10	-.10
COLOR	0.45	0.10	0.00	0.15	0.70	**0.30**	-.35	-.10	-.20
DRIP	-.05	-.10	-.05	0.10	-.80	-.75	**0.30**	-.05	0.10
INTMF	0.20	0.20	0.35	-.45	-.20	-.35	-.05	**0.60**	-.05
SHEAR	-.10	-.10	-.15	0.15	-.10	-.25	0.15	-.20	**0.30**

[1] Daily gain (gd^{-1}; DG), feed intake (gd^{-1}; FI), backfat thickness (mm; BF), lean meat content (%; LMC), ultimate pH (PH), meat colour (based on Japanese colour scale; COLOR), drip loss (%; DRIP), intramuscular fat content (%; INTMF), and maximum shearforce (N; SHEAR).

Fertility traits were not considered in the breeding goal, assuming that correlations between fertility and production traits (Brien, 1986) and between fertility and meat quality traits are zero.

Economic values for all breeding goal traits are given in Table 1. Economic values for the production traits for the Dutch situation were quantified by De Vries (1989). Economic values for the meat quality traits are calculated as described by Hovenier et al. (1993[a]), using the optimum ranges, mean population levels and standard deviations given in Table 1. Mean population levels are based on a sample taken at random of 100 Dutch slaughter pigs (Hovenier, unpublished results).

The genetic parameters used are given in Table 2. The parameters are mainly based on results of Hovenier et al. (1992), completed with results of Cameron (1990) for correlations with SHEAR and with results of Buddiger (1988) for correlations with FI.

RESULTS

In Table 1, results are given for the three options. For Option 1, total financial superiority (ΔG_{tot}) and financial superiority for the meat quality traits (ΔG_{qual}) after one round of selection (i = 1) are calculated assuming the economic values given. The correlated responses of the meat quality traits result in a deterioration of overall meat quality of ΔG_{qual} = Dfl -.18 and in a ΔG_{tot} of Dfl 5.03.

For Option 2, the financial superiority for production traits (ΔG_{prod}) decreases with Dfl 0.32 as a result of the higher increase of FI and the lower response of LMC which are not fully compensated by the higher gain of DG. ΔG_{qual} improves Dfl 0.65 in comparison with Option 1, ΔG_{tot} increases with Dfl 0.33 to Dfl 5.36. In Option 2, all meat quality traits show a response in the desired direction.

For Option 3, the same trends as for Option 2 are found. A higher FI in comparison with Option 1 and a decrease of LMC result in a lowered ΔG_{prod}, now equal to Dfl 4.19. The, in comparison with Option 2, stronger and desired changes for the meat quality traits result in a ΔG_{qual} equal to Dfl 1.75. For Option 3, ΔG_{tot} equals Dfl 5.94, Dfl 0.91 higher than for Option 1.

DISCUSSION

Two points are shown by the three options. First, selection for production traits only will probably result in a decrease of meat quality. Secondly, taking into account all assumptions given here, inclusion of meat quality traits in the breeding goal already results in an improvement of meat quality traits. This means that meat quality may be improved by breeding at relatively low costs. This may be important if prices are not based on the quality of the products.

As can be shown by further calculations, the economic values of the traits in the breeding goal have a large influence on the results (Hovenier, 1993). As stated before, economic values are dependent on the mean levels of the breeding goal traits. However, this point needs extra attention for traits with an economically optimum level. For these traits, not only the level of the economic weight changes when the current population mean is changed, but even the sign of the economic value may change when the population mean passes the optimum value of the trait considered. This may be illustrated by the fact that in case of a population mean of INTMF of 2.5% and using the data given in Table 1, the corresponding economic value would be Dfl -11.23. Use of this economic value results in considerably different changes for some traits and for the financial superiorities. For instance, in Option 3 LMC would change with 10.6 $\%\sigma_p$ instead of -.7$\%\sigma_p$. It should be concluded, therefore, that a regular determination of levels and standard deviations of breeding goal traits and a regular optimization of the breeding goal and selection index used is necessary.

The economic values used here are based on a price difference of Dfl 0.50 kg^{-1} between meat within and outside the optimum range. However, the validity of this value is questionable. From a study among Dutch consumers (Steenkamp and Van Trijp, 1988), it was concluded that consumers are not willing to pay more for a better quality of pork-steak, but that consumers are willing to pay about Dfl 0.46 kg^{-1} extra for a better quality chops. From meat industry, no information is known about price differences between meat of different qualities. When we assume that Dfl 0.50, at least for the time being, will be a maximum value, this means that the results given here will be the extremes to be expected. The values for ΔG_{prod} for Option 2 and 3 will be closer to ΔG_{prod} given for Option 1, the values for ΔG_{qual} will be closer to zero for all the three options given.

The results given in Table 1 are valid for one round of selection. It must be noted that, when products from two breeding programs are compared (one with and the other without meat quality in the breeding goal), differences between the levels of production and meat quality traits will increase each generation. When meat quality is included in the breeding goal, this difference will be disadvantageous for the production traits; for the meat quality traits, however, the differences will be positive. But the ultimate difference will be a result of both the choice of the breeding goal and selection index used and the mean population levels of the different breeding goal traits.

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