BREEDING OBJECTIVES AND GENETIC EVALUATION TO IMPROVE PIG FARM PROFITABILITY

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Errata Note

- It was recently found (D. Johnson private communication) that the AIREML programme was incorrectly calculating the standard errors (s.e.) of variance and covariance components. The standard errors in Table 4.5 (page 107) and in Table 4.7 (page 110) are underestimated by a square root of 2. For example, the s.e. of 0.015 should be $0.015 * \sqrt{2} = 0.021$.
- The Duroc annual genetic trend in ADG (page 140, line 8) should read 4.33 g/day, as in the preceding Table 5.6.

ABSTRACT

The optimal design of a pig improvement programme requires the choice of an appropriate breeding objective and relevant economic values for objective traits, the choice of selection criteria and consequent genetic and phenotypic parameters, determination of selection indices and predicted genetic gains, and choice of an appropriate population structure.

A computer model simulating life cycle production of a breeding sow and growth performance of her offspring was developed to estimate economic values (EV's) of reproduction and growth performance traits. A biological growth model simulating the digestion and metabolism of dietary energy and nitrogen in growing pigs, based on the linear/plateau relationship between daily protein deposition and digestible energy intake, was part of the life cycle model. The upper limit to body protein deposition rate (Pd_{max}), mean daily *ad libitum* digestible energy intake (DEi) and minimum lipid to protein deposition ratio (R_{min}) were assumed the major genetic determinants of pig growth. EV's were calculated per gilt life cycle by simulating effects of genetic changes in several biological components, in a farrow-to-finish production system, assuming *ad libitum* feeding. For unimproved genotypes (Pd_{max} < 140 g/day, DEi > 30 MJ/day, $R_{min} \geq 1$), the EV of 1 g/day improvement in Pd_{max} ranged from \$12 to \$22, DEi EV's ranged from \$–20 to \$–123 per 1 MJ/day increase, and EV's below \$–500 were found per one unit increase in R_{min}. EV's for number born alive/litter (NBA) were below \$12 per extra pig. For improved genotypes, EV's for Pd_{max} had values below \$14 per unit increase and became zero at high Pd_{max} levels exceeding 180 g/day, when full expression of Pd_{max} was restricted by insufficient digestible energy intakes. The DEi EV's for improved genotypes with insufficient amounts of metabolisable energy became positive. Improved genotypes had high EV's for NBA, exceeding \$70 per 1 extra pig. Relatively low negative EV's were found for one unit increase in other reproduction traits: gilt age at first oestrus, interval weaning-oestrus, and pre-weaning mortality percentage. Results demonstrated EV's of traits depended on the average genetic merit in the pig herd and its interaction with the management circumstances (level of feeding, nature of the diet, life cycle length) of the production system.

Multivariate animal models and Restricted Maximum Likelihood (REML) methods were used to estimate (co)variance components, heritabilities, genetic correlations and common environmental effects of reproduction and growth performance traits for on-farm tested Large White, Landrace and Duroc pigs. Best Linear Unbiased Prediction (BLUP) methods were applied for breeding value estimation allowing determination of genetic, environmental and phenotypic trends in the studied populations. The annual realised genetic gains ranged from 2.1 to 4.3 g/day for average daily gain (ADG) and –0.2 to –0.3 mm for ultrasonically-measured backfat thickness (BF). The realised genetic trends in ADG and BF compared favourably with the rate of improvement found in similar overseas studies but were substantially lower than the respective predicted gains of 4.13 g/day/year and –0.88 mm/year, except for the Duroc ADG where predicted and actual gains were similar. The NBA genetic trends were negligible for Large White and Landrace, but favourable (+0.07 pigs/litter/year) for the Duroc breed. Mixed model techniques (BLUP and REML) offered efficient and accurate prediction of breeding values and estimation of parameters, utilising all available information from relatives, traits and environments.

Different selection strategies were investigated and predicted genetic gains were estimated, based on indices derived for a range of improved and unimproved pig genotypes. The effect of different sets of selection criteria on the efficiency of selection, use of restricted selection indices, and sensitivity to changes in the economic values and in the structure of future costs and returns were studied, and the effects of these changes on the predicted selection response were analysed. The increase in profit resulting from further selection was lower in pig populations representing improved genotypes, as a result of lower predicted genetic gains in growth and carcass traits. This reduced rate of increase in profit was partially offset by the increase in predicted genetic gains in reproductive performance. For improved genotypes, the predicted increase in profit per gilt life cycle after one generation of selection ranged from $26 to $98 for one standard deviation of index selection with a selection intensity of 1. For unimproved genotypes, higher genetic gains in growth and carcass traits resulted in profits exceeding $120 per generation of selection. Greater economic emphasis on litter size resulted in lower predicted genetic gains in growth and carcass traits.

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