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# **Use of decision science to aid selection of genetically superior animals**

**A Thesis presented in partial fulfilment of the requirements for the degree of**

**Doctor of Philosophy**

**in**

**Animal Science**

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## Abstract

This thesis is concerned with a theoretical simulation model for pig breeding, as part of the ongoing search for the “perfect” genotype. The starting point is an additive model to investigate how accurately the classical, infinitesimal model predicts genetic gain for traits controlled by few loci and few alleles. This initial investigation demonstrates that the infinitesimal model is robust, providing that at least 15 loci are controlling a trait and there is symmetry in the allele distributions.

A Genotype-Pig (GE-Pig) model is then developed to apply the additive effects of alleles on sub-phenotypic traits like maximum protein deposition, minimum lipid to protein content in the whole body, *ad libitum* digestible energy intake, energy for maintenance requirement and water content in the whole body. These parameters are then used in a nutrient partitioning simulation model to grow a pig and calculate traditional breeding traits such as average daily gain, feed conversion ratio, and backfat thickness for any combination of alleles. Three algorithms, Genetic Algorithm, Tabu Search, and Simulated Annealing, are used to investigate the GE-Pig model and find optimal combination of alleles for different dietary and selection objective situations. The two diets investigated were either of a low or high quality, and the three selection objectives used were, maximising average daily gain, minimizing feed conversion ratio, and minimizing back fat. A graphical method is developed for easy comparison of the genotypes.

Of the algorithms, the Genetic Algorithm performed the best, followed by Tabu Search and finally Simulated Annealing. It is demonstrated that, in general, there is a different, single, optimum for any given selection objective and diet. However under the back fat selection objective, both diets produce the same optimal genotype. Also there are many similarities between the optima for the average daily gain and feed conversion ratio selection objectives. When the theoretical minimum number of generations of selection to the optima is considered, the feed conversion ratio selection objective is the quickest for a breeding program to achieve the optimal solutions, followed by back fat, then

average daily gain. It is demonstrated that diet also has an effect on the theoretical number of generations.

A Multiple selection objective, using relative economic values applied to the individual selection objectives, is also investigated. For both diets, the majority of the multiple selection objective solutions are in the vicinity of the feed conversion ratio optima, indicating that feed conversion ratio is the most prominent factor. It is also demonstrated that the optimal solution is most affected by the objective parameter weights under low diet conditions.

## Publications

Studies completed during candidature, some of which are reported in this thesis have been presented in the following communications:

Morel, P.C.H., Alexander, D.L.J., Sherriff, R.L., and Wood, G.R., 2001. Maximisation of gross margin in intensive livestock production. *Acta Horticulture*. 556: 97-103.

Sherriff, R.L., Blair, H.T., Morel, P.C.H., Sridharan, R., Tweedie, J.W. and Wood, G.R. 2003. Theoretical considerations on genetic selection. In *Manipulating Pig Production IX*. J. Paterson (Ed). 66.

Sherriff, R.L., Blair H.T., Morel, P.C.H., Sridharan R. and Wood, G.R. 2003. Searching for the Best Genotype(s) to Optimize Breeding Value for Pigs Using Heuristics. *INFORMS*, Atlanta, USA, October 19-22.  
<http://www.informs.org/Conf/Atlanta2003/ATLANTA%20Tuesday%20PDF.pdf>



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