Proc. Assoc. Advmt. Anim. Breed. Genet. ***16****: 91-94*

POTENTIAL QUANTITATIVE GENETIC INDICATORS OF PIG TEMPERAMENT

R.E. Crump[1], A.C. Hansson[1], H.-U. Graser[1] and R. Sokolinski[2]

[1]Animal Genetics and Breeding Unit*, University of New England, Armidale, NSW 2351
[2]Cefn Genetics, King Street, Clifton, QLD 4361

SUMMARY
Two temperament traits, the standard deviation of 50 weights recorded in a 20 second period (SDWT) and flight time over a 1m distance on exiting the weigh scales (FT), were recorded in a commercial nucleus population. After editing, 4,879 SDWT records (mean=0.85 kg, CV=50%) and 3,567 FT records (mean=2.03 seconds, CV=63%) remained. Individual animal model residual maximum likelihood analyses were performed to ascertain the variance parameters of these traits. Both SDWT and FT were heritable ($h^2 = 0.10$ and $h^2 = 0.20$, respectively), and there was a significant common litter of birth effect for SDWT ($c^2 = 0.04$).
Keywords : Temperament, flight time, movement meter, heritability, pigs

INTRODUCTION
Inclusion of appropriate temperament traits in the selection index for pigs may result in a number of direct economically beneficial outcomes, such as easier handling and better sow behaviour. The flight time temperament measure in beef cattle has also been shown to be genetically correlated with meat quality traits such that animals with a genetically better temperament have superior meat quality (Reverter *et al.* 2003). It is hypothesised that similar relationships will exist across domestic livestock species. In addition, Kanis *et al.* (2004) proposed selection for temperament as a means of genetically improving animal welfare.

Routine recording of temperament in pigs requires traits that can be measured objectively for little additional labour or equipment cost. Therefore, recording would ideally occur within the framework of the standard performance test procedures. Assessment of temperament often involves study of response to stress, and restraint can be used to induce stress. For example, in the back-test (Hessing *et al.* 1993) young piglets are held on their back and escape attempts are recorded. In beef cattle, the animal is restrained in a crush before flight time is recorded upon release. Additional stress may be caused by human interaction with the animal, e.g. other recording or husbandry procedures being carried out while the animal is in the crush. In both cattle and sheep, movement meter devices have been developed that record how much an animal moves while restrained in an isolation box or a weighing crate. Stookey *et al.* (1994) devised a movement meter as part of the weigh scales for beef cattle and recently Roger Giles collaborated with Ruddweigh International to develop a weigh scale-based movement meter for pigs (Giles *et al.* 2003). In this study, data on flight time and from the Giles/Ruddweigh movement meter were analysed to investigate whether these traits are heritable and hence worthy of further investigation as quantitative genetic indicators of temperament in pigs.

*AGBU is a joint venture of NSW Department of Primary Industries and The University of New England

MATERIAL AND METHODS

The movement meter equipment consists of weigh bars plus a display unit. The display unit has been modified so that as well as presenting a single weight measurement the monitor passes individual weight measurements through to a connected device at a rate of 2.5 weights per second. In the current case, a notebook computer with custom data recording software was used as the recording device. The flight time equipment was the same as that used in beef cattle (Burrow *et al.* 1988); two light-emitting diodes (one to start and one to stop recording) connected to a time-recording display unit. The start diode was positioned 25cm from the weigh scales' exit and the stop diode was 1m further down the race, both diodes were 50cm from the ground. For comparison, in beef cattle the start diode is routinely placed at the exit from the crush and the stop diode is 1.7m after this.

The equipment was installed at a large commercial operation to record their nucleus herd. Recording was carried out on male and female pigs from four selection lines. Approximately 100 animals were tested per week. Pigs were reared in single sex pens and one pen at a time was transferred to the testing shed, although the pen in which animals were reared was not recorded. The computer recorded 51 weights for each pig, starting automatically when the pig entered the weigh scales. During this recording period staff interaction with the pig was kept to a minimum. Ultrasonic scanning for backfat and muscle depth was carried out after weighing and prior to release from the weigh scales. On release from the weigh scales, the flight time was recorded, along with a score between 0 and 5 indicating the level of encouragement required to get the pig to leave the weigh scales and an operator code. Operator was constant within week. The first weight record for each animal was discarded and the standard deviation of the remaining 50 records (SDWT, kg) was used to define the movement meter trait. Flight time (FT) was recorded in seconds.

In the absence of pen information, temperament records were assigned to processing groups (PG). All records were assigned to PG during generation of SDWT records from the database and the order of the records within the PG was stored. Assignment to PG was based on the time between records on consecutive animals. If the time between animal records exceeded 5 minutes, a new PG was started. Subsequently, if the PG formed contained more than 20 records, it was split at the longest time interval within the group. This second step was repeated until no PG contained more than 20 records. This procedure resulted in an average PG size before data editing that was close to the reported average of 12 recorded animals per pen.

The movement meter and flight time equipment was installed at different times, resulting in movement meter recording beginning earlier than flight time recording. In addition, occasional equipment failures meant that not all animals had a record on both temperament traits. All analysed temperament records were recorded for animals between 130 and 160 days of age, with liveweights in the range 70 to 115 kg. Records for SDWT greater than 4.5 kg or FT greater than 9 seconds were set to be missing. Following these edits, PG represented by less than 5 animals with a valid record on at least one temperament trait were discarded, leaving 485 PG. These edits resulted in a data set containing 4,879 SDWT and 3,567 FT records averaging 0.85 kg (CV=50%) and 2.03 seconds (CV=63%), respectively. All known ancestors of the recorded animals were included in the pedigree, which contained 6,971 animals, including 131 sires and 565 dams of animals with records. The recorded animals came from 989 litters.

Fixed effect models were investigated using the R statistical package (R Development Core Team 2004). Investigated explanatory variables included sex (2 levels), selection line (4 levels), PG, operator (6 levels), encouragement score (for FT only, 6 levels), age and weight at measurement, size of PG, position within PG and size of litter the animal was born in, plus interaction terms. Significant terms only were retained in the model used for estimating genetic parameters. Fixed effects fitted in the genetic parameter analyses for SDWT were line, litter size, linear regressions on age and weight at recording and linear, quadratic and cubic regressions on position within PG (nested within PG size). In comparison to the model used for SDWT, the fixed effect model for FT excluded the linear regression on age at recording, but included encouragement score. An individual animal model with and without common litter of birth effects was fitted using the average information residual maximum likelihood algorithm as implemented in ASREML (Gilmour *et al.* 1999).

RESULTS AND DISCUSSION

Results of the genetic parameter estimation are presented in Table 1. Both SDWT and FT are heritable in pigs. The heritability of FT is lower than that reported for beef cattle (0.29; Reverter *et al.* 2003). Although the differences are not significant, the heritability of FT was higher than that of SDWT. A significant common litter of birth effect was detected for SDWT, but not for FT. While there were fewer records and represented litters for FT, each litter was represented by an average of 4.5 FT records and so this result should not be the result of uninformative data for litter effects. Log transformation of the data (analysis results not shown) had little impact upon the parameter estimates.

Table 1. Results of univariate individual animal model residual maximum likelihood analysis of the standard deviation of 50 weights recorded over a 20 second period (SDWT) and flight time on exiting the weigh scales (FT)

Trait	$\sigma_p^{2\mathrm{A}}$	$h^2 \pm$ s.e.$^{\mathrm{B}}$	$c^2 \pm$ s.e.$^{\mathrm{C}}$	$\Pr\left(c^2 = 0\right)^{\mathrm{D}}$
SDWT	0.1640	0.14 ± 0.03	–	
SDWT	0.1635	0.10 ± 0.03	0.04 ± 0.01	< 0.01
FT	1.297	0.19 ± 0.04	–	
FT	1.295	0.18 ± 0.04	0.01 ± 0.02	> 0.50

– Not fitted. [A]Phenotypic variance. [B]Heritability. [C]Common litter of birth variance as a proportion of the phenotypic variance. [D]Based on a likelihood ratio test with one degree of freedom.

The major fixed effect of PG accounts for sex differences, since pigs were reared and subsequently performance tested in single sex pens, differences across weeks of recording, PG size and operator. In fixed effects analyses, the final models had R^2 of 19% and 32% for SDWT and FT, respectively. Omission of PG from the fixed effect models reduced the R^2 to approximately 7% for SDWT and 19% for FT. Regressions on position in PG nested within PG size account for the impact of order of processing upon the observed record. The effect of position in PG differs for different sized PG, presumably because of the different proportions of pen-mates already beyond and remaining behind the weigh scales. The encouragement score was only included for FT, since it was recording required encouragement to leave the weigh scales and therefore could not have an effect upon SDWT. While different operators may have recorded the encouragement score differently, no significant interaction was detected. Both weight and age had a positive relationship with SDWT, while weight also had a positive relationship with FT. Animals that received higher encouragement scores had high FT values.

The movement meter provides a considerable quantity of data on each animal. There may be alternative traits that can be formed from this data that are either more heritable or are better predictors of other traits, such as meat quality. For example, the variability of weight records decreases across the 20-second period and this decline may be heritable and informative with regards to temperament. Further research continues in this area.

Requiring a 20-second period to weigh each animal adds a considerable amount to the time required for performance testing each week. This adds to the labour costs associated with the use of the movement meter and decreases its appeal as a routine method of temperament recording. It may be possible to utilise the data from a shorter period to the same effect. If SDWT and FT are highly genetically correlated with one another, then the speed with which FT can be recorded would make it a more practical measure of temperament. Hansson *et al.* (2005) showed that the genetic correlation between SDWT and FT was significantly different from -1, indicating that there may be benefit from the further consideration of both traits.

CONCLUSIONS

Given that both SDWT and FT were heritable, they are suitable for further investigation as potential selection criteria. Their relationships with each other, with other breeding objective traits (see Hansson *et al.* 2005) and with other traits of interest, such as meat quality traits, need to be investigated. Further studies in these areas are being planned.

ACKNOWLEDGEMENTS

This work was supported by Australian Pork Limited under project APL 1711. Thanks to staff at Cefn Genetics for diligent data recording.

REFERENCES

Burrow, H.M., Seifert, G.W. and Corbet, N.J. (1988) *Proc. Aust. Soc. Anim. Prod.* **17**:154.

Giles, R., Lansdowne, R. and James, K. (2003) In "Pig Genetics Workshop Notes" p. 70, Animal Genetics and Breeding Unit, University of New England, Armidale.

Gilmour, A.R., Cullis, B.R., Welham, S.J. and Thompson, R. (1999) "ASREML Reference Manual" NSW Agriculture Bulletin No. 3.

Hansson, A.C., Crump, R.E., Graser, H.-U. and Sokolinski, R. (2005) *These proceedings*.

Hessing, M.J.C., Hagelso, A.M., van Beek, J.A.M., Wiepkema, P.R., Schuten, W.G.P. and Krukow, R. (1993) *Appl. Anim. Behaviour Sci.* **37**:285.

Kanis, E., van der Belt, H., Groen, A.F., Schakel, J. and de Greef., K.H. (2004) *Anim. Sci.* **78**:315.

R Development Core Team (2004). R Foundation for Statistical Computing, Vienna, Austria. URL `http://www.R-project.org`.

Reverter, A., Johnston, D.J., Ferguson, D.M., Perry, D., Goddard, M.E., Burrow, H.M., Oddy, V.H., Thompson, J.M. and Bindon, B.M. (2003) *Aust. J. Agric. Res.* **54**:149.

Stookey, J.M., Nickel, T., Hanson, J. and Vandenbosch, S. (1994) *J. Anim. Sci.* **72**(Suppl. 1):207.