Breeding sows better suited to group housing

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Introduction

Housing of pregnant sows is currently being revolutionised around the world. Group housing enhances opportunities for improved sow health and welfare through enabling exercise and social interactions. However, because it enables social interactions, group housing can also be detrimental to welfare and production, particularly if sow aggression occurs. Detrimental effects of adverse interactions between sows include increased injuries to sows, poor body condition and ultimately reproductive failure due to increased stress, all of which will contribute to increased rates of sow culling. Achieving both favourable welfare and reproductive outcomes for group housed sows is possible, but it relies on establishing low stress levels, favourable social interactions and sufficient feed intake for all sows. This requires not only well designed facilities coupled with appropriate animal management; it also requires populations of individual sows that are physically and behaviourally better suited towards group housing systems. This project is intended as a step towards developing breeding programs to create these populations.

The Pork CRC project has three primary aims:

1) to establish whether “competitive” or “social genetic” effects influence sow reproductive outcomes, and whether these are correlated with competitive effects estimated from finisher groups recorded with performance data;

2) to provide a “proof of concept” that proximity logging networks can provide an effective and efficient way to collect additional behavioural data on group housed sows; and

3) to investigate the heritabilities of and associations between novel traits with performance of group housed sows.

Recording sow behaviour

Efficient recording of sow behavioural attributes under group housing is difficult. Typically studies on behaviour are either small in scale (eg individual video recording), use behavioural tests which are impractical to apply to individuals routinely in large populations (eg the resident-intruder test or other individual pen based tests) or recording is not performed at the individual sow level; only at the group level. This makes it very difficult to make genetic progress in improving sow welfare by influencing sow behavioural attributes while also improving performance under group housing because the data or established tests are generally unsuitable or poorly defined. The absence of meaningful behavioural phenotypes on individuals also means that supplementary calibration of genetic tools (eg genomic selection) for these traits has yet to be established. In this project, we will focus on investigating strategies which already have demonstrated utility in other species or trait groups, but which need further development for applications in group housed sows.

1. Social genetic effects models

The first approach, which has become more feasible with increased computing power, is the analysis of existing individual data recorded within known groups using “social” or “competitive” effects models. These analyses are an expansion of traditional BLUP procedures, and account for the impact an individual animal has on its contemporaries (ie its “social” effect) concurrent with estimates of its own merit independent of the group. The philosophy is that animals which perform better to the detriment of their pen mates would not be identified under conventional BLUP analyses, but would be identified as having a negative social effect under the alternative “competitive effects” models. Therefore, selection decisions could be altered to favour animals with good performance that does not result from negative influences on other animals and the overall performance of groups of animals will be improved more efficiently, particularly when competition between individuals can have severe consequences (eg mortality).

The impact of selection for reduced competitive effects was first illustrated by Muir and Schinckel (2002) in a selection experiment using quail, and later for laying hens (Muir and Bijma, 2006). Apart from reduced mortality and increased production, the incidence of feather pecking was also reported to be negligible after a full production cycle in the “socially” selected hens, providing production independent evidence of improved welfare in these birds. In 1996, Newsham Choice Genetics subsequently implemented their Gentel™ group selection, which works under the same assumption of reduced competition between individuals. However, insufficient sib-groups and low selection pressure were generally limiting in pigs. Muir and Schinckel subsequently developed an extension of the normal genetic evaluation models to incorporate competitive effects, and this eliminated the need to operate group selection with specific group structures, since solutions for social effects could be derived directly from a competitive effects model provided individuals within groups were known.

The contributions of social effects to heritable variation were subsequently illustrated for growth and feed intake traits of finishers by Bergsma *et al.* (2008) and others. Variation due to pen effects, which contains the effect of pen environment and the net effect of social interactions amongst individuals within the pen, is significant for finisher traits (eg growth rate, feed intake) in several studies and populations, including Australian pigs. Jones *et al.* (2011) recently demonstrated that calmer groups (based on the average flight time of a pen of animals) had less negative pen effects, consistent with anecdotal observations from Newsham that the Gentel™ selection process produced quiet, calm, easy to handle animals with low aggression towards each other. Ongoing research at Wageningen University in this area is now connected with research arms of other commercial pig breeding companies (eg TOPIGs, Danbred), so the methodology is well accepted.

While applications for competitive effects models are becoming more mainstream, these models have not yet been investigated for reproductive traits in pigs, mainly due to lack of data for group housed sows during gestation. Further, since behavioural characteristics are both inherited and learnt, it is possible that social effects estimated from finisher data recorded at an earlier time point would already provide information on behavioural attributes of sows prior to their selection as breeding replacements. Preliminary analyses from project APL 2009/2303 indicated that post-finisher behavioural attributes (such as aggression delivered or received) recorded in pens were correlated with the same attributes during gestation. The possibility of earlier performance measures needs to be examined further, since it implies that selection of breeding herd replacements post-finishing could already include social effects criteria, which could be estimated from normal finisher performance data structures.

2. What can we do with proximity logging networks?

The second approach is to directly examine behavioural characteristics of sows or groups of sows. The question then becomes exactly which behavioural characteristics should be measured and what traits defined, to indicate individual and group welfare or performance, and can such behavioural measures be efficiently recorded prior to selection on all selection candidates. This is because recording traits only on already selected sows limits response to selection. Currently researchers into animal behaviour favour techniques such as video-image analysis (VIA), lesion scoring of finishers (Turner *et al.*, 2006, 2009), specific behavioural tests for individual sows (Lensink *et al.*, 2009) or sows within groups, and physiological measures such as circulating cortisol. However, with the exception of lesion scoring which is a relatively simple procedure, such approaches are typically limited in utility by high labour and/or testing costs, limited field of vision and therefore restricted group size (eg VIA), low volumes of data collection or lack of individual identity associated with specific observations, and sometimes the requirement for maintaining specific individual "test" housing areas (eg for resident –intruder tests) which will have no utility for other activities, and which in any case do not represent recording of outcomes recorded within groups.

For genetic studies, the inability to generate complete and meaningful data for all individuals within groups of individuals makes it very difficult to develop further selection strategies targeted directly towards improving performance and welfare of group housed sows. Selection of sows which perform well under group housing will not necessarily reduce aggression, since these sows may perform well at the expense of others. The "competitive effects" models are essentially indirect selection to meet these goals, but solutions from these models are generic and do not elucidate what form the competitive interaction took. What is required for further genetic studies is an approach which makes behavioural data collection feasible in all group housed sows, or preferably in all candidate gilts prior to selection. It is proposed that this could be achieved by automation of proximity data collection and recording for all individuals within contemporary groups. These data can then be associated with complementary behavioural and/or physiological observations to demonstrate that proximity data can be analysed to form traits which are representative of sow behaviours. The link to following reproductive performance and welfare can then be established using reliable data volumes obtained on individual animals in group settings.

Proximity logging devices are radio-based data loggers that record the duration and frequency of all close proximity encounters within a pre-defined distance. The loggers overcome many data collection deficiencies associated with visual observations as they are able to record continuously without an observer being present. Proximity loggers have been successfully used to determine maternal linkages in cattle and sheep (Swain and Bishop-Hurley, 2007; Broster *et al.*., 2010), wildlife disease transmission routes (Bohm *et al.*., 2009; Hamede *et al.*., 2009) and relationship development in cattle (Patison *et al.*., 2010). The application of proximity logging to establish the hierarchy of social interactions of extensively managed cattle was illustrated in the study of Handcock *et al.* (2009). Proximity devices are generally considered reliable in extensive applications. However, refinement of hardware and software is required to get meaningful results in intensive systems. Previous work (APL Project 2010/1023.342) was unsuccessful in an application intended to record animal visits to feeders. This outcome was attributed to difficulties in fitting loggers to the age class of animals used, difficulty in achieving distance settings, and possibly interference from metal feeders and housing. However, logger to logger duration events were highly correlated and the study did not investigate the data for animal to animal interactions or alternative raw data filters (to remove erroneous signals), the latter of which is generally required to get meaningful data from proximity loggers. Therefore, the potential has not yet been fully explored in the piggery environment.

Other traits to measure

The third part of the project will investigate some already promising traits where associations with some behavioural or performance measures have been illustrated, but associations with sow performance and welfare have not yet been widely established. These traits include post-mixing lesion scoring as proxies for the traits like delivery and receipt of aggression (Turner *et al.*. 2009), flight time, sow locomotion pre-farrowing along with some targeted measures for sow lameness and foot health arising from Pork CRC project 2D-115.

Lesion count traits are heritable and may be a relatively simple way of establishing some behavioural attributes of sows (Turner *et al.*, 2009) which ultimately may be associated with performance outcomes. Flight time is another moderately heritable trait (h2~0.20) in both pigs (Hansson *et al.*, 2005) and cattle. Previously researchers investigating this trait have suggested that slower animals (high flight time) are calmer, more relaxed animals with a lower fear response to humans. Groups of finisher pigs containing more “slow” flight time animals (ie a high group average) or containing more full-sibs have demonstrably higher growth rates (Jones *et al.*, 2011). Such results are consistent with the positive implications of calm animals or a stable social structure for the end-result represented by performance traits. Associations between flight time or lesion count traits and sow reproductive performance traits have not been established to date.

Sow locomotion scores are associated with the number of piglets a sow weans and lactation feed intakes of sows (Tabuaciri, PhD thesis submitted); while both lameness and lactation intake have also been associated with sow longevity in several studies. Sows are easily scored for the quality of their locomotion during the movement from gestation to farrowing housing, and this trait is both heritable and repeatable (Tabuaciri, PhD thesis submitted). Sow lameness and foot health data were also collected at Rivalea under Project 2D-115 on pedigreed sows, so it is possible to estimate heritabilities for the traits represented in this data and to establish whether any of these traits are also potential selection criteria. The data collection for project 2D-115 will be completed by late 2012.

Acknowledgements

This project is funded by the Pork CRC under project 1C-107.

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