Busting myths to broaden our horizons

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Introduction

Historically, pig breeding programs have focused on a limited number of traits. Often growth rate, back fat and a measure of litter size at birth were the only traits considered. Genetic relationships with other unrecorded traits were ignored in this simple approach, although selection for these traits leads to correlated responses in feed efficiency, lean meat growth, carcase characteristics, meat quality, survival of piglets, disease resistance as well as characteristics of the sow such as mature weight, body composition and feed intake capacity. This long list of traits may seem daunting. However, ignoring (unfavourable) genetic associations between traits in pig breeding programs will lead to sub-optimal performance and ultimately impair health and welfare of pigs and sows (e.g. Rauw *et al*., 1998; Prunier *et al*., 2010).

Ten years ago, Jaco Eissen (Eissen, 2000) proposed selection for a higher feed intake during lactation as a strategy to overcome longevity and reproductive problems in sows, which were thought to be largely due to a widening gap between nutrients available from decreasing fat reserves at farrowing and nutrients required to meet increasing demands of litters. However, focus on a single trait is inadequate, given the complex associations between the physiological states of sows during transition from gestation to lactation and finally to mating following the weaning process. In addition, various physiological parameters of the sow may interact with the changing requirements of the litter during gestation and lactation.

Genetic and phenotypic relationships between sow weight and body composition, lactation feed intake, reproductive traits of sows and lean meat growth of growing pigs have been outlined in a number of papers presented at this workshop, as well as the previous workshop in 2008. In this paper we look at some common paradigms in regard to sow and piglet performance and try to place them in context with alternative management or selection choices that could be made.

Some common myths

1. Myth: Phenotypic associations give accurate genetic information

Higher feed intake during lactation of primiparous sows reduced tissue loss of sows, increased litter weight gain and reduced weaning to conception interval after the first parity (Eissen, 2000) demonstrating the direct effect of a higher feed intake on concurrent sow characteristics. Phenotypic correlations between lactation feed intake and ability of the sow to farrow in later parities (stayability) were positive, **in contrast to** strong negative genetic correlations between these traits estimated from much larger data sets (Bergsma *et al*., 2008; Bunter *et al*., 2010). Sows with genetic potential for higher feed intake capacity are genetically larger animals with higher maintenance requirements. This is a disadvantage for later survival in an environment where the specific nutrition and housing requirements of larger sows are less likely to be met.

Feed intake during lactation should not be viewed in isolation, but evaluated in context with associated changes in weight and fat during lactation, and other issues such as diet formulations, feed delivery strategies, and sow health. On the phenotypic level, sows with less weight and fat loss were more likely to stay in the herd longer (Bergsma *et al*., 2008; Bunter *et al*., 2010). This association corresponds to the positive phenotypic correlation between feed intake and survival. In addition, the negative genetic association between feed intake of sows during lactation and survival was reflected in negative genetic associations between change in fat levels during lactation and survival of sows found in both studies. On the genetic level, the association of a larger fat loss during lactation with better survival of sows may be a reflection of the favourable genetic association between fatness prior to farrowing and survival. That is, sows do not lose as much fat if they do not have much fat to lose! Genetically fatter sows also have fewer demands from the litter due to at least two reasons. Firstly, their piglets are genetically less demanding, however, these sows have sufficient resources to favourably moderate the birth weight of their piglets, which is favourable for piglet survival. In addition, genetically fatter sows are able to mobilise more fat during lactation and therefore genetically do not require a high feed intake during lactation.

The discrepancy between genetic and phenotypic correlations may be larger in environments with larger constraints for animal performance, highlighting the potential effect of the environment on estimates of genetic correlations. Sometimes, the environment is modified on purpose to generate favourable genetic correlations between performance traits. An example is the restriction of feed intake to exhibit a lower and therefore more favourable genetic correlation between growth rate and backfat (i.e. Hermesch, 2004). It is possible that feeding to better meet individual sow (and litter) requirements during gestation might also influence the genetic correlations between sow performance and traits such as lactation feed intake.

In summary, phenotypic correlations do not always reflect genetic correlations. Genetic and environmental effects have to be disentangled for the development of breeding programs that are to effectively consider survival of sows.

2. Myth: Feed intake in the growing pig and feed intake of sows during lactation is highly correlated genetically

Based on a very small data set, van Erp *et al*. (1998; cited in Eissen, 2000) found a strong but imprecise genetic correlation of 0.92±0.50 between feed intake of gilts during rearing and feed intake of sows during lactation. This strong genetic correlation was not confirmed in recent publications. In Australian data, feed intake data were available on gilts tested from 20 to 26 weeks of age, and during lactation in their subsequent first and second parities. Estimates of genetic correlations were moderate (0.26 and 0.39) and only significantly different from zero for lactation feed intake in the second parity (Bunter *et al*., 2010). In Dutch data, finisher feed intake was available from progeny of sows and genetic correlations with reproductive traits of sows were estimated via pedigree links (Bergsma *et al*., 2010). Overall, no significant genetic correlations between feed intake of sows during lactation and performance traits recorded in progeny were found and the magnitude of genetic correlations between feed intake measures was low.

Feed intake during lactation is an adaptive trait of the sow to balance the requirements of the litter with the resources available for mobilising from the sow. In addition, expression of feed intake capacity is affected by health status of sows, which affects the information content of feed intake data and which may also affect genetic parameters (Bunter *et al*., 2009). Therefore, feed intake records of lactating sows may reflect the feed intake capacity of sows associated with productivity as a growing pig poorly, which may explain the low genetic associations between feed intake in the growing pig and the lactating sow observed in recent studies.

3. Myth: Lactation feed intake is a breeding objective trait

Selection for higher feed intake during lactation was proposed to prevent reproductive problems in sows (Eissen, 2000). However, feed costs imply a negative economic weight for feed intake during lactation. For a lactation length of 28 days, a reduction in feed use of 28 kg per lactation occurs if feed intake is reduced by one kg per day during lactation. Given approximate feed costs of $400 per tonne, this would reduce feed costs by $11.2 per litter or approximately $1 per pig, which is equivalent to $0.36 per genetic standard deviation, based on variance components presented by Bunter *et al*. (2010). The magnitude of this economic weight is very small in comparison to the magnitude of economic weights used for other production traits, which are generally within the range of two to four monetary units per genetic standard deviation (i.e. Knap, 2005).

Further, this simple approach to assessing the relative economic value for lactation feed intake ignores the fact that a certain level of feed intake is required for production output. For example, higher lactation intake is phenotypically associated with increased litter weight at weaning, and improved sow longevity.

Genetic correlations indicate that selection for reproductive performance, rebreeding success and sow longevity will not affect sow feed intake during lactation significantly. However, selection for higher growth rate, which affects mature weight of sows, is likely to increase feed intake capacity of sows during lactation which is more likely to be better expressed by sows with good health status during the cooler months of the year in Australia.

Overall, these complex relationships between trait groups have not been adequately considered in bio-economic models to derive economic weights for performance of the growing pig and the sow, which are not independent. Underlying biological parameters may be required to better describe the economic effects of changes in maintenance requirements of the sow and body reserves available, productivity of piglets and adaptation processes during lactation, while taking the health status of sows into account.

4. Myth: There is one generic breeding strategy for improving sow lifetime performance

A number of traits are used to describe lifetime performance of sows. Generally, traits describing survival or longevity of sows are lowly heritable and limited data are available due to the single late expression of these traits by sows. These trait characteristics limit the potential for genetic improvement of sow survival. Providing an adequate environment for sows is therefore the first step towards improvement of sow lifetime performance.

Overall, genetic associations between lean meat growth characteristics and traits describing sow body composition were moderate to high (Bergsma, et al., 2010; Bunter et al., 2010; Hermesch et al., 2010). Selection for lean meat growth has consequences for weight and fat levels of sows that may not be fully expressed in current management systems. For example, phenotypic correlations between growth and sow weight as well as between fat depth in the growing pig and fat depth prior to farrowing were considerably lower than the corresponding genetic correlations. Therefore, the observed changes in body composition characteristics of sows are likely to be an under-estimate of the potential for changes in sow weight and fatness levels resulting from genetic improvement. The magnitude of genetic associations should also be used to predict the emerging future requirements of sows, which may change more rapidly than is currently anticipated.

Fatness levels of sows had high genetic correlations with survival of sows in both the Dutch and Australian studies (Bergsma *et al*., 2008; Bunter *et al*., 2010). The heritability for fat depth was slightly higher in primiparous sows (0.33) versus second parity sows (0.22). Fat depth in gilts prior to their first farrowing also had stronger genetic correlations with survival until the fourth and fifth parity (Bunter *et al*., 2010). It is less labour intensive to record a single fat measure prior to farrowing than feed intake during lactation. This information will provide an indication of the specific nutritional and husbandry requirements of individual sows, which can be used to optimise care of individual sows. Fat depth at finishing and prior to farrowing provide information towards genetic evaluation of sow survival, such that recording of these traits could be recommended for lean genotypes.

In lean populations of sows, fatness at farrowing is most important, genetically and phenotypically, for sow survival. However, fat loss was less heritable since it can only be expressed when sows have sufficient fat reserves to exhibit variation in fat loss. Fat loss had a heritability of 0.13 in the study by Gilbert *et al*. (2010) where management of sows generated high fat levels pre-farrowing and allowed expression of fat loss during lactation. In contrast, fat loss was only heritable in gilts in the study by Bunter *et al*. (2010). This makes fat loss a less useful source of information for sow longevity.

Genetic correlations between weight and weight loss of sows with sow survival were not consistent between the Australian and Dutch studies. A high weight prior to farrowing and subsequently a high weight loss during lactation was favourably genetically correlated with the ability of gilts to have a second parity (Bergsma *et al*., 2008). In contrast, the corresponding genetic correlations were not significant in the study by Bunter *et al*. (2010). Overall, weight loss and fat loss are co-regulated genetically, depend on both protein and fat mass, and are not independent of initial phenotypic levels and environmental constraints.

Feed intake during lactation is an adaptive trait and genetic correlations with sow survival after a specific parity were negative in contrast to positive phenotypic correlations in the studies by Bergsma *et al*. (2008) and Bunter *et al*. (2010). In contrast, strong positive genetic correlations were found between lactation feed intake and total number of parities or piglets born alive per sow by Hermesch *et al*. (2008). The different trait definitions for sow longevity may have contributed to these differences, however, the exact reasons for this discrepancy in genetic associations are not known.

5. Myth: It is important not to over condition sows because fat sows do not milk

There is certainly data to support a detrimental sequence of physiological events affecting lactation outcomes for very fat sows during lactation. However, the desirable body condition of sows at farrowing needs to be properly defined. For example, recommendations for fat depth at farrowing range from 14 to 16 mm (Jackson, 2009) to 20-22 mm in gilts and 25 to 26 mm in multiparous sows for French production systems (Isabelle Merour, pers. comm). In Australian data sets, mean back fat levels were 15.7 mm in gilts weighing 197 kg at weaning (Bunter *et al*., 2008) and 17.2 mm in multiparous sows with a mean body weight of 237 kg at farrowing. There was still evidence for lower intake in fatter sows, but did this reflect a failure to milk, or the lower genetic merit and demands of their offspring during lactation?

Litter weight gain is often a proxy for milk production of sows. However, litter weight gain depends not only on milk production, but also on piglet survival and the genetic potential of the piglets to grow. Piglets of genetically fatter sows will be lighter at birth with poorer growth potential, but with a tendency for better survival. Higher fat reserves available at the start of the second parity was phenotypically associated with higher litter weight gain until day 10 of lactation (Bunter *et al*., 2010). There was no significant phenotypic association between these traits in the first parity, which corresponds with results from the Dutch study by Bergsma *et al*. (2008) who found a phenotypic correlation between litter weight gain and fat mass at start of lactation of exactly zero.

Acknowledgement

Preparation of this workshop note was funded by Australian Pork Limited under APL2133.

References

Bergsma, R., Kanis, E., Verstegen, M.W.A. and Knol, E.F. 2010. “Genetic correlations between lactation performance and growing-finishing traits in pigs.” *Proceedings of the 9th World Congress of Genetics Applied to Livestock Production*, Leipzig, Germany, 1-6 August, paper 0697.

Bunter, K.L., Lewis, C.R.G., Hermesch, S., Smits, R. and Luxford, B.G. 2010. “Maternal capacity, feed intake and body development in sows.” *Proceedings of the 9th World Congress on Genetics Applied to Livestock Production*, Leipzig, Germany, 1-6 August, paper 0071.

Bunter, K.L., Lewis, C.R.G. and Luxford, B.G. 2009. “Variation in sow health affects the information provided by lactation feed intake data.” *Proceedings of the 18th Conference of the Association for the Advancement of Animal Breeding and Genetics*, Barossa Valley, South Australia, September 28-October 1, pp.504-507.

Gilbert, H., Billon, Y., Lagant, H., Calderon, J.A., Guillouet, P., Bidanel, J.-P., Noblet, J., Sellier, P. and Hermesch, S. 2010. “Correlated responses in sow feed intake, body composition and reproduction after divergent selection for residual feed intake in the growing pig.” *Proceedings of the 9th World Congress on Genetics Applied to Livestock Production*, Leipzig, Germany, 1-6 August, paper 0293.

Hermesch, S. 2004. “Genetic improvement of lean meat growth and feed efficiency in pigs.” *Aust. Journal of Experimental Agriculture* 44:383-391.

Hermesch, S., Jones, R.M. and Bunter, K.L. 2008. “Feed intake of sows during lactation has genetic relationships with growth and lifetime performance of sows.” AGBU Pig Genetics Workshop Notes, pp.55-66.

Hermesch, S., Jones, R.M., Bunter, K.L. and Gilbert, H. 2010. “Consequences of selection for lean growth and prolificacy on sow attributes.” *Proceedings of the 9th World Congress on Genetics Applied to Livestock Production*, Leipzig, Germany, 1-6 August, paper 0292.

Knap, P.W. 2005. “Breeding robust pigs.” *Australian Journal of Experimental Agriculture* 45:763-773.

Prunier, A., Heinonen, M. and Quesnel, H. 2010. “High physiological demands in intensively raised pigs: impact on health and welfare.” *Animal* 4: 886-898.

Rauw, W.M., Kanis, E., Noordhuizen-Stassen, E.N. and Grommers, F.J. 1998. “Undesirable side effects of selection for high production efficiency in farm animals: a review.” *Livestock Production Science* 56:15-33.

Van Erp, A.J.M., Molendijk, R.J.F., Eissen, J.J. and Merks, J.W.M. 1998. “Relation between *ad litibum* feed intake of gilts during rearing and feed intake capacity of lactating sows.” In *49th Annual Meeting EAAP*, G5.10 (abstract), Warsaw, Poland, pp. 42.

Whittemore, C.T. 1996. “Review: Nutrition reproduction interaction in primiparous sows.” *Livestock Production Science* 46:65-83.