Use of Terminal and Nucleus Birth Weights to Improve Commercial Pig Performance

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Introduction

Historically, attempts to realize genetic improvement at the commercial level in swine have relied heavily upon measuring and selecting for traits in purebred, nucleus populations. Yet, it is recognized that differences such as management, disease challenge, stocking density, and population structure often exist among these operations. We have demonstrated that levels of genotype by environment interaction exist between nucleus and commercial environments in swine (Zumbach et al. (2007)) and have offered alternative means of more effectively realizing commercial level gain such as utilization of commercial data for genetic improvement. Here, we attempt to identify other effective predictors of commercial grow-finish performance and offer additional insight to genetic improvement strategies for those traits.

Material and methods

Commercial data. Live born piglets used were from non-pedigreed Large White x Landrace females bred to pedigreed Duroc sires. Pigs with carcass weights were born in multiple commercial sow farms and uniquely identified within 24 hours of birth. A subset of these piglets from a single commercial sow farm were individually weighed at birth (BWT). After weaning, animals were transferred to a commercial nursery facility for 7 wk and then to a commercial finishing facility until harvest. Pigs with recorded BWT were again inidividualy weighed within 5 d of finisher placement and subsequently weighed again at 16 wks into finishing (FIN16; 172.8 ± 1.8 d of age). These two weights were used to compute finishing average daily gain (FADG). Pigs remained in their weaning groups through the nursery and finishing phases. Pigs with individual BWT as well as a broader group of pigs without recorded BWT were sent to a commercial harvest facility where carcass weights (HCW) were collected. Carcass weights were collected over six years whereas the individual live weight data were collected over 7 months. Carcass weight per day of age (WDA) was then defined as HCW divided by age at slaughter.

Of great interest to swine producers is the likelihood of a pig being *full value* at finishing barn closeout. The ability of a pig to reach full value is dependent on mortality, sufficient growth to reach minimum weight requirements, and pig quality. At the conclusion of finishing, light weight pigs (BW < 100 kg) and pigs with injuries, navel hernias, poor health,

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etc. were sent to an alternative harvest facility. The combination of pigs sent to the alternative market along with pre-weaning, nursery and finishing mortalities were classified as non-full value. All pigs sent to the primary harvest facility were classified as full value (FV).

Purebred data. Purebred Duroc pigs were born at three high-health, nucleus farrow-to-finish farms. Individual BWT were collected on all piglets within 24 hr of birth. All nucleus farms were genetically connected and supplied boars to the stud which in turn supplied semen to the above referenced commercial sow farms.

Statistical analyses.

Phenotypic prediction models

From the commercial data phenotypic predictions utilizing BWT were developed for FADG, FIN16 and FV. Data were analyzed using the Mixed and GLIMMIX procedures of SAS (SAS Inst. Inc., Cary, NC). Kenward-Roger adjustments for degrees of freedom were used for all models. For FV prediction models, the binary distribution option was used with a logit link function.

All prediction models included a random effect of birth litter and fixed effects of sex, weaned group, and cross foster status. For FADG and FIN16 weight, linear and quadratic effects of BWT were included in the models as covariates. The FV model include a linear covariate for BWT.

Genetic parameter estimation

A series of single and multiple trait linear models were utilized to estimate (co)variances for nucleus BWT, commercial BWT and commercial WDA. Analyses were performed using REMLF90 (Misztal et al. (2002)). For nucleus and commercial BWT, the models included a random direct genetic effect of animal, random effect of birth litter and fixed effects of birth litter size, farm-week-year combination, gender and birth dam parity. The model for commercial WDA included a random genetic effect of animal and random birth litter effect. Fixed effects included litter size, gender, dam parity and a farm - birth week - slaughter date contemporary group effect.

Results and discussion

Visualization of the phenotypic predictions of the impact of birth weight on FADG, FIN16 and the probability of being FV are provided in Figure 1. The association with BWT was especially true for lighter birth weight pigs. Conversely, the strong association of birth weight with growth begins to plateau with heavier birth weight pigs. While not shown individually, the impact of birth weight on the ability to reach full value was a combination of its negative impact on mortality, overall quality, and growth. Pigs not becoming FV either provide no or minimal revenue while incurring similar or greater costs as FV pigs. Based on our modeling, they clearly are produced at an economic loss. These biological results are consistent with those reported by Schinckel et al. (2007).

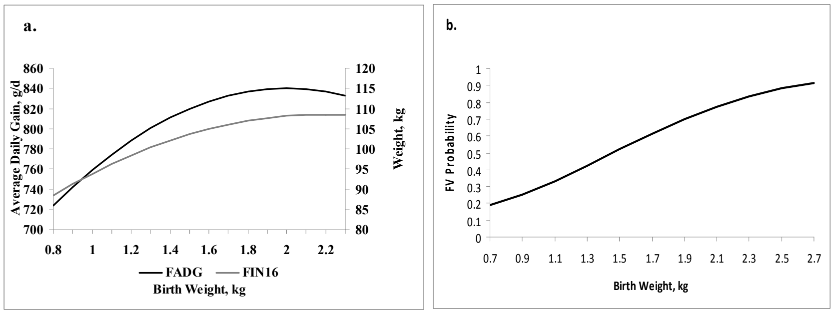

Figure 1: Effect of birth weight on average daily gain and body weight during finishing and the probability of being a full-value pig

It is apparent that the swine industry has continued to increase litter size (10.2 vs. 11.35 from 1998 to 2008 (PigCHAMP (1998) and PigCHAMP (2008)); and that increased litter size results in lighter, individual piglet birth weights (Roehe (1999) and Quiniou et al. (2002)). This is most likely, at least in part, due to most maternal breeding objectives being heavily weighted for increased litter size with little to no emphasis on traits associated with piglet quality.

As shown in Table 1, we estimated direct heritabilities of .24 and .10 for purebred and commercial BWT, respectively. These were considerably greater than the direct heritability of .04 we reported in a purebred, maternal population (Arango et al. (2006)) and indicate there is opportunity to make considerable progress in this terminal, nucleus population. We should point out that we attempted further parameterization of the nucleus model to include maternal genetic effects, but unrealistic estimates were computed. For the commercial data, sows were not pedigreed nor did they have repeated records. Therefore, additional models were not considered. There was a moderate genetic correlation between the nucleus and commercial birth weight (r_g=.55). This may be of particular interest since these traits were expressed in sow lines with very different expressions of litter size. In this data set, the purebred terminal, females averaged 9.4 while the commercial sow parents averaged 13.0 fully formed pigs at birth.

As noted earlier, we have already demonstrated that selection for growth in the nucleus population may not have the same result in this same commercial population (Zumbach et al. (2007)). The results in Table 1 demonstrated that selection for nucleus birth weight is moderately related to commercial level growth (r_g=.43) and could be used in a BLUP for genetic selection. Finally and obviously, nucleus BWT is expressed earlier and may provide opportunity to shorten the generation interval and enhance accuracy of programs that utilize commercial level data for genetic improvement.

Table 1: Estimates of genetic parameters for birth weight and growth in purebred and crossbred populations[α]

Traits	n	Nucleus BWT	Commercial BWT	Commercial WDA
Nucleus BWT	116,473	.24	.55	.43
Commercial BWT	9,621		.10	.69
Commercial WDA	110,381			.22

[α]Heritabilities on the diagonal and genetic correlations above the diagonal.

Conclusion

These results clearly demonstrate piglet birth weight is an important predictor of commercial growth performance as well as profit potential. We have also shown that BWT has a direct genetic component and that reasonable genetic progress could be attained in this purebred, nucleus population. These results also demonstrate that improvements in commercial level growth could be expected from such use.

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