Use of a Stochastic Model to Evaluate the Growth Performance and Profitability of Pigs from Different Litter Sizes and Parity of Dams

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Introduction

Pig growth rates, survival rates, and carcass composition measurements have primarily nonlinear relationships with pig birth and weaning weights (Schinckel et al., 2009d). Stochastic models produce a distribution of pigs that better reflect the responses of population performance and profitability to changes in pig birth and weaning weights (Pomar et al., 2003). The objective of this research was to evaluate the growth and profitability of pigs with different litter sizes and parities using a stochastic compositional growth model.

Material and methods

The BW feed intake and carcass data are from a study (Schinckel et al., 2009a, b, c, d, 2010) to evaluate the growth, feed intake and carcass composition of three terminal sire lines.

Fitted BW, Feed Intake and Carcass Backfat and Loin Depth Functions. The Generalized Michaelis-Menten (GMM) function (Schinckel et al., 2009a) was fitted to the BW data using the nonlinear mixed (NLMIXED) procedure of SAS®. Equations were developed to reproduce the variances and covarianes of the random effects of the GMM function (Schinckel et al., 2009d). Regression equations were developed to predict the pig specific GMM random effects as functions of pig birth and 21-d BW. Daily feed intake (DFI) data were fitted to the Bridges function (Schinckel et al., 2009b). Pig to pig variation in DFI was modeled to reproduce its relationships with body composition and growth rate. The optical probe fat and loin depth data for each sex was fitted to an allometric function of BW and polynomial functions of birth BW (BBW, kg; Schinckel et al., 2009d, 2010). The backfat and loin depth measurements were reproduced with addition of pig to pig variation.

Modeling pig survival. The birth survival data of Milligan et al. (2002) was modeled as 0.95 for parities 1 and 2 and birth survival = 0.95 – 0.01125 (parity-2) for parities 3 and

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greater. The data of Knol et al. (2002) was used to estimate a function relating preweaning survival to pig birth BW. The GMM function provided the best fit to the data with the form: preweaning survival = [-107.79 + [(207.555 x $(BBW/0.487)^{2.9156}$]]/100. The nursery survival function was developed from unpublished data of PIC (PIC North America, Hendersonville, TN). The survival function was nursery survival = 1 –(exp (3.635 – 2.5135 BBW + 0.6426 $(BBW)^2$)/100). Barrows were modeled to have 53% greater nursery mortality than gilts.

Accounting for parity one effects. Recently, analyses have found that the performance of pigs from parity 1 sows is different from pigs from older parity sows (D. Boyd, 2006). The BW growth and DFI of gilts was reduced to 0.965 and barrows 0.970 of the values for pigs from older parity dams. The survival of pigs from parity 1 was reduced 1.65 percent for the nursery period and 1.60 percent during the grow-finish period (0.95 versus 0.966).

Simulation of pigs. Two management strategies were simulated, either with or without crossfostering. Without crossfostering litter sizes of 6 to 14 pigs total born were simulated. Without crossfostering, the effects total born and number nursed are combined. With crossfostering within parity, litter sizes of 6 to 20 total pigs born were simulated. Litters were crossfostered to obtain a constant 11 pigs nursed shortly after birth.

Pigs were weaned at 21-d of age and phase fed a series of four nursery diets from weaning to 25 kg BW. The pigs were phase fed a series of five corn-soybean meal based diets from 25 kg BW to market BW. The prices for corn ($0.1378/kg) and SBM (0.3307/kg) reflect current prices. A fixed cost of $0.09 per d in nursery of $0.11 per d in grow-finish was included. Pigs were marketed in three groups: the heaviest 17% of the pigs at 150 d of age; the second group, 34% at 163 d of age; and the remaining pigs marketed at 179 d of age. The carcass lean percentage of each pig was estimated. The profit of each weaned pig was calculated as predicted market value minus nursery and grow-finish feed and fixed costs.

Results and discussion

The model predicted a 0.0425 kg decrease in birth BW for each additional pig born. Piglet weaning BW was reduced as total born increased within each parity. Parity one sows had lighter pigs at weaning than the other parities. Overall, 150-d BW decreased approximately 8 kg within each parity as total born increased from 6 to 14 pigs born.

Pigs from parity one dams had 4.5 kg lighter carcass weight than pigs from older parity dams. Increasing total born from 6 to 14 decreased carcass weight from 5.8 (parity 6) to 6.2 kg (parity 1).

The differences in carcass weight for pigs from litters of 6 and 14 total pigs born are 6.1, 6.0, 6.1, 5.9, 5.8 and 5.8 kg for parities one through six respectively. The actual differences predicted for carcass value (11.10, 10.00, 10.10, 9.70, 9.50 and 9.50 dollars) are greater than expected based on the product of base carcass price times the difference in carcass weight. This was primarily due to increased lightweight discounts for pigs from large litters.

The revenue above feed and fixed costs for each pig weaned are shown in Table 1. At 21 d of age, pigs from parity one dams were 5.82 to 7.68 dollars less valuable than pigs of older parities dams. The profitability of pigs at weaning from litters of 14 total born are 6.17 to 7.37 dollars less valuable than pigs from litters of six.

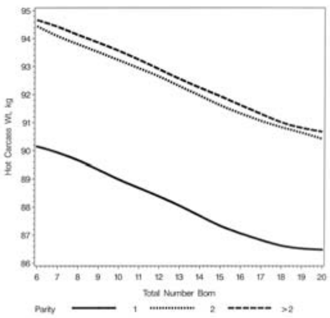
With crossfostering to 11 pigs within each parity, the differences in pig performance are due to the effect of total born. As total born increased, 21-d weaning BW decreased even with intensive crossfostering. The change in carcass weight per additional pig born was -0.30 kg from 6 to 16 pigs born and -0.25 from 16 to 20 pigs total born. The change in carcass value was essentially linear with a $0.64 change in carcass value per additional pig born from 6 to 16 pig born and $0.59 less per pig born from 16 to 20 total pigs born.

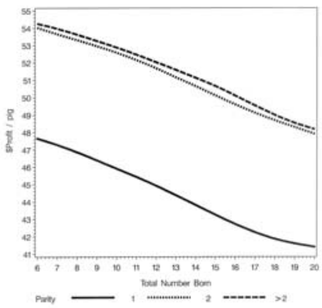
The impact of parity and total born with crossfostering on the profit for each weaned pig is presented in Figure 1. Overall, weaned pigs born and nursed by parity 1 dams at the same total born and number nursed were $6.70 and $7.06 less profitable than weaned pigs from parity 2 and parity 3 and greater dams. The predicted decrease in profitability of weaned pigs per pig was $0.45 from 6 to 16 pigs born and $0.40 from 16 to 20 pigs born.

As total born increased, pig birth BW, weaning BW, carcass market weights, and survival rates decreased. In most cases, the value of weaned pigs has been assumed to be constant across litter sizes (Stewart et al., 1990). The decreased survival and growth rates of pigs from large litters should be taken into account in the evaluation of the economic value of litter size (Quinton et al., 2006).

Table 1: Impact of parity and total born on profit per pig weaned ($/pig) with no crossfostering.

	Parity					
Total born	**1**	**2**	**3**	**4**	**5**	**6**
6	**49.35**	**55.17**	**55.40**	**55.30**	**55.32**	**55.45**
7	**48.86**	**54.99**	**55.13**	**55.16**	**55.22**	**55.27**
8	**48.31**	**54.51**	**54.78**	**54.78**	**54.79**	**54.87**
9	**47.43**	**53.88**	**54.20**	**54.27**	**54.35**	**54.36**
10	**46.58**	**53.08**	**53.67**	**53.63**	**53.74**	**53.84**
11	**45.77**	**52.40**	**52.93**	**52.90**	**52.93**	**52.93**
12	**44.70**	**51.27**	**51.88**	**52.04**	**52.05**	**52.14**
13	**43.30**	**49.95**	**50.32**	**50.67**	**50.80**	**50.98**
14	**41.98**	**48.54**	**48.84**	**49.11**	**49.19**	**49.28**





Figures 1 and 2: Impact of total born and parity with crossfostering to 11 pigs nursed on carcass value ($/pig) and profit per pig.

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