MEASUREMENT AND COMPARISON OF FEED INTAKE AND GROWTH PERFORMANCE DURING LACTATION AND WEAN-FINISH OF GILT-PROGENY PIGS CROSS-FOSTERED ONTO MULTIPAROUS SOWS

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Executive Summary

Gilt progeny growth and health performance is seen as a constraint in production systems. Progeny born to gilts (first litter sows) are usually smaller in birth weight and may have insufficient immunoglobulin protection. The rearing ability of gilts compared to older sows is also observed to be lower, however, factors such as piglet birth weight and suckling demand can affect litter gains from gilts and sows. The project reported here investigated the outcomes from cross-fostering litters of gilt progeny onto older parity sows, and vice versa: heavier sow progeny onto gilts or primiparous sows. These were compared with fostered and un-fostered piglets within gilts and sows.

Two hundred and forty gilts and sows (parity 3-7) were allocated after farrowing to one of six treatments: Gilts with birth progeny (GB); gilts with fostered gilt progeny (GG); gilts with fostered sow progeny (GS); sows with birth progeny (SB); sows with fostered gilt progeny (SG); and sows with fostered sow progeny (SS). The progeny were followed through to weaning and post-weaning growth, feed efficiency and mortality assessments were made until 21 weeks of age when they were slaughtered.

There was no overall net benefit to the weaned population by litter swapping progeny between gilts and sows. The overall effect of crossing litters between gilts and sows was 728 g/d from weaning to sale, compared to 718 g/day in un-fostered litters (Not Significant). We observed that when reared by an older sow, gilt progeny grew faster (223 g/day v 202 g/day, $P<0.001$)) and were weaned heavier by 26 days of age (7.2 kg vs 6.7 kg, $P<0.001$) compared to gilts reared on their birth dam. This weaning weight advantage continued through to sale (95.4 kg vs 90.0 kg live weight, $P<0.001$), however gilt progeny fostered onto other gilts were observed to have a similar final weight (94.0 kg). The reciprocal sow progeny swapped onto gilts gained less than un-fostered sow progeny during lactation (209 g/day vs 230 g/day, $P<0.001$) and were significantly lighter at weaning (7.0 kg vs 7.6 kg, $P<0.001$). By 21 weeks of age sow progeny reared by gilts were lighter compared to un-fostered sow progeny (95.0 vs 97.2 kg, $P<0.001$) or sow progeny fostered onto sows (99.0 kg). Thereby the cross-over fostering between gilts and sows balanced each other out. The project showed that fostering the whole litter within 24 hours of birth did not compromise either gilt progeny or sow progeny growth or health. Although there were advantages in terms of weight gain when fostering gilt litters within gilts it was negated by significant increases in grower and finisher mortality. Fostering gilt progeny onto sows was observed to be a pre-weaning risk with higher incidence of overlain piglets after fostering. However post-weaning there was a substantial improvement in their health in the face of an APP (*Actinobacillus pleuropneumoniae*) challenge in the grower and finisher period. The production dilemma is how to maximize the milking potential of gilts so that she can rear a gilt or sow piglet to a heavier weaning weight.

The project concludes that a cross-fostering practice where litters are swapped routinely between gilts and older sows will not be of net benefit to producers. However, the project also showed that producers should not be reluctant to foster gilt progeny to sows, so long as the rearing sow is suitably matched to minimize overlays. Fostering light to medium weight gilt litters onto a suitable multiparous sow may also reduce weaning weight and potentially sale weight variability. Compared to multiparous sows, the lactation performance of gilts continues to limit gains in weaning weight and hence carcass weight.

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Introduction

Maximizing the growth and health of progeny pigs produced from gilts has been identified as a major issue in pig production. Some production systems have favoured segregation of parities and their progeny in recognition of these differences and for focused management and husbandry of gilts (Boyd 2006). However, not all piggeries can be managed in a segregated way and the majority of farrowing houses produce progeny from a range of parities. The progeny born to gilts (first parity sows) are lighter at birth (Hendrix et al., 1978; Tantasuparuk et al., 2001) and weaning (Burkey et al., 2008; Holyoake, 2006) than progeny from older parity sows. Post-weaning, gilt progeny are also more susceptible to disease than sow progeny with higher rates of medication and mortality (Holyoake, 2006).

Miller et al. 2008 (2D-101-0506) identified that gilt progeny grow more slowly than sow progeny, have increased mortality rates and are treated for ill-health more often than sow progeny both pre- and post-weaning. These differences may be due to one of, or a combination of three variables: i) birthweight; ii) colostrum and milk intake and iii) immunity differences. Although birth weight was strongly correlated with pre- and post-weaning performance, Miller et al. (2008) showed that weight gain in lactation can be influenced by other factors, independent of dam parity, such as teat order (Miller *et al.* 2007a; 2007b). There is also evidence which supports the view that immune differences as a result of early passive immunity are crucial to the health and observed growth differences of the progeny. Klobasa et al. (1986) demonstrated that there are differences in the levels of antibody isotypes in colostrum and milk of sows and gilts and that these differences extend onto differences in circulating antibodies in the progeny. As well as antibodies, lymphocytes, cytokines and growth factors can also be transferred via colostrum and milk (Bandrick and Molitor, 2005). In their project, Miller et al. (2008) reported that immune transfer efficiency was lower in gilts rearing piglets compared to sows.

Previously, it has been shown that gilts are able to increase milk production and litter gain when they rear heavy piglets as a result of cross-fostering (Boyce *et al.* 1997). In their experiment, piglets at 2 days of age were allocated to a different dam based on 2-day live weight (average of 1.5 vs. 1.9 kg). Gilts and 3rd litter sows were able to produce similar milk yields and litter gains by 26 days at weaning. However, the design was such that dam parity of the fostered piglets was randomised so that only lactation ability of the nurse-sow was tested, and the dam parity of the fostered piglets was unknown. Boyce et al (1997) showed that gilts are capable of producing an equivalent milk yield to that of older parity sows when suckling a heavy litter, a result likely to be due to a greater suckling demand (Auldist and King 1995).

Cross-fostering routinely occurs on commercial farms due to sow death or milking failure; udder damage; variable litter size born; neonatal mortality. Benefits of cross-fostering include a more uniform litter maximising lactation and sow productivity; improved pre-weaning mortality; and weaning weight. In some cases, cross-fostering practices can have adverse effects on piglet weight gain and immunity development due to a re-establishment of teat preference and colostrum and milk intake early in life (Robert and Martineau, 2001). This project seeks to determine the progeny and dam factors that contribute to the differences in the pre and post weaning performance and health of gilt and sow progeny. The project also enabled us to evaluate whether or not gilt progeny can perform better when cross-fostered at a very early age onto multiparous sows than progeny reared on gilt dams. Secondly, the project will demonstrate if there is a net benefit to progeny weaning weight and sale weight by adopting a cross-fostering routine management system whereby gilt progeny are reared by sows, whilst gilts rear sow progeny with a greater lactation demand.

Methodology

The project was conducted as a single experiment. The experiment tested a number of hypotheses:

i) Gilt progeny reared by lactating sows will outperform gilt progeny reared by lactating gilts.

ii) Lactating gilts are capable of rearing a heavy litter from older sows

iii) Progeny nursed by their birth dam are healthier and grow faster than cross-fostered progeny.

Treatments and animal allocation

Two hundred and forty first-litter (gilt litters) and older (parity 2-7) Large-White x Landrace F1 cross (PrimeGro™ Genetics) sows were allocated to one of six treatment groups at birth. These were:

i). Gilts/birth progeny (GB) - Gilts nursing her own un-fostered litter*
ii) Gilts /gilt progeny (GG) - Gilts nursing fostered gilt progeny
iii) Gilts/sow progeny (GS) - Gilts nursing fostered sow progeny
iv) Sows/birth progeny (SB) - Sows nursing her own un-fostered litter*
v) Sows/sow progeny (SS) - Sows nursing fostered sow progeny
vi) Sows/gilt progeny (SG) - Sows nursing fostered gilt progeny

*All piglets in these litters were born to the gilt or sow. Some birth piglets were fostered off the litter to standardise litter size.

Sows were selected as parity 1 (Gilt) and between parity 3 to 7 (3^{rd} to 7^{th} litter) at farrowing (Sow). The mean ± SE parity of the rearing sow in treatments SB, SG and SS were similar (3.96± 0.07). Sows entered the farrowing house facility in their final week of gestation and were allocated at farrowing. All sows were allowed to farrow without any exogenous induction hormones and approximately two-thirds of farrowings occurred overnight (1600-0600 h). Each day, farrowed sows were paired with an alternative treatment (e.g. GS with SG; GG with GG; SS with SS), and the GB and SB treatments were selected from litters that had a live born litter size of or above 11 or 12 respectively. By 1000h, all litters that had farrowed overnight had been allocated to treatment and cross-fostering completed. Those litters born in the morning and completed farrowing by 1000 h were processed by 1400 h. Litters that commenced farrowing between 1200 and 1600 were excluded from the study. The experiment was conducted over nine weeks with treatments allocated evenly within time block. The experiment commenced in January.

Husbandry and management

Sows were housed individually in farrowing crates (0.8 x 2.0 m) on top of steel tribar flooring. The sheds were insulated with blinds automatically controlled by thermostat sensors set at 22 ^{o}C in the youngest shed and declining to 19 ^{o}C after three weeks. Sows were cooled with a drip-cooling system set on a thermostat set at 26 ^{o}C and run for three minutes every 20 minutes. Creep zones were heated with a 175W heat lamp set at 28 ^{o}C for the first 14 days and 26 ^{o}C for the third week. A plastic composite creep mat was located under the heat lamp for the first three weeks of age. Farrowing crates were fitted with a sow bite nipple drinker located outside the feeder, delivering 2 l/minute. Feeders were an open bowl with a 6 kg capacity.

Pregnant gilts and sows were sourced from commercial farms at QAF, Corowa, NSW at 15 weeks of gestation. Sows and gilts were fed a similar diet during gestation (13.9 MJ DE/kg; 130 g crude protein, 6 g lysine/kg). All sows were fed the same lactation diet (13.9 MJ DE/kg; 189 g crude protein/kg; 9.1 g lysine/kg) on entry to the farrowing house until weaning. Prior to farrowing, sows were restrictively fed once a day at 3 kg/day. After 24 hours post-farrowing (day 1), all sows were offered the lactation diet up to four times a day to appetite. Litters were adjusted in size by cross-fostering according to experimental treatment, or by fostering birth piglets off sows (GB and SB). The litter size within gilts ranged between 7 to 12 piglets and 7 to 14 in sows. Once established after Day 1, no further cross-fostering occurred on the experimental animals. If piglets were unthrifty and in poor condition due to scours, starvation or injury, they were removed from the litter and either euthanased or relocated onto off-trial sows.

After fostering was complete, litters were weighed and the average piglet weight of the litter was calculated. Litter weights were recorded at 14 days and at weaning (26.4±0.15 days of age). Following weaning, progeny were grouped according to treatment and randomly housed within the shed in commercial weaner, grower and finisher accommodation. Weaners were individually weighed for an individual weaner-finisher growth rate assessment. Weaners were housed in pens of 10 (0.53 m^2/pig) on tribar flooring and offered a commercial weaner phase feeding program *ad libitum* (10 days weaner creep:15.1 MJ DE/kg,13.6 g av. lysine/kg; 12 days stage 1 weaner, 14.8 MJ DE/kg, 14 g av. lysine/kg; 21 days stage 2 weaner, 14.5 MJ DE/kg, 12.0 g av. lysine/kg). All weaners were managed equally and received the same feed and water medications. Feeders and bite drinkers were provided in each pen for *ad libitum* access. In the grower, pigs were housed in pens of 18 (0.53 m^2/pig) on partially slatted concrete floors. All pigs were offered a phase 1 grower diet for 49 days *ad libitum* (13.8 MJ DE, 9.7 g av.lysine/kg). In the finisher period, pigs were moved into pens of 9 pigs/pen (0.74 m^2/pig) and offered a phase 1 finisher diet *ad libitum* (13.8 MJ DE/kg, 7.2 g av.lysine/kg). Feed consumption in the weaner, grower and finisher periods was measured using an automatic feeding trolley (BPR Engineering, Corowa, NSW) which dispensed diets through an overhead auger into feed bins and the weight of feed delivered was measured using electronic load cells. Live weights were assessed at the start of each growth phase and a mid-point on a pen basis and individually at weaning and at sale. Carcass weights and back fat P2 was recorded from abattoir records.

Statistical analysis

Differences in progeny pre- and post-weaning growth performance and subsequent weaning to remating interval were assessed using a general linear model (GLM) univariate ANOVA. The experimental unit for the pre-weaning growth performance data was the litter, with the model including the fixed effect of fostering treatment. Weaning age was a significant non-treatment variable and was included in the pre-weaning GLM univariate ANOVA as a co-variate. Post-weaning growth performance, feed intake and feed efficiency was analyzed using GLM univariate ANOVA with the pen as the experimental unit. Again, the model included the fixed effect of the fostering treatment. When found to be a significant non-treatment response, random factors including sex and block were included in the model, and means expressed as Least Square Means ± SE. An assessment of weaner to finisher growth performance was also undertaken using the individual pig as the experimental unit using the model described above. All GLM univariate ANOVA was analyzed using SPSS v 17.0 (SPSS, 2008). Differences in pre-and post-weaning mortalities and the proportion of sows displaying oestrus with 7 days due to the fostering treatments imposed were analysed by chi-square analyses.

Results

Litter and sow performance

The number of litters that were successfully fostered and remained on the study until weaning is summarized in Table 1. Nineteen sows were excluded from the dataset due to mortality (7 sows), milking issues (6 sows), and litters that were either below 8 born live or farrowed outside of the time period allowed for fostering (6 sows). There was a significant effect of the birth dam on average piglet weight at day 1 (P<0.001). The values for gilt and sow litters were 1.56 kg and 1.70 kg respectively.

Litter weight gain, average piglet gain and weaning weight of gilt progeny reared by gilts (GB and GG) was significantly lower (P<0.05) than sow progeny reared by sows (SB and SS) (Table 2). The hypothesis that gilt progeny reared by sows (SG) would grow faster and be heavier at weaning compared to gilt progeny reared by gilts (GB, GG) was supported. Gilts were also shown to be capable of rearing sow progeny (GS) with a higher litter gain (P<0.05) compared to gilt progeny (GG). The result supports the hypothesis that a heavier suckling demand is able to be met by a higher milk production from gilt dams. However, comparing SS to GS litters, the litter gains in the sow-reared treatment (2.20kg/d) exceeded that of the gilt-reared treatment (1.94 kg/d). The average piglet growth rate was significantly lower in GS (209 g/d) compared to both sow –reared sow progeny treatments (230 g/d and 235 g/d for SB and SS respectively).

The treatment differences in Day 1 weight between gilt reared progeny (GB and GG) compared to sow reared progeny (SB and SS) were still evident after 26 days of lactation (Table 2). Progeny on the GG and GB remained the lightest of the groups. For the sow-reared litters, SB and SS treatments were equal in terms of piglet gain, litter gain and weaning weight and were the heaviest and fastest growing of the treatment regimens. The results did not support the experimental hypothesis that piglets reared by their birth dam would perform better than those reared by a foster dam of similar treatment parity. Piglet removals due to mortality or ill thrift were also not reduced when birth progeny remained on their dam (Table 2).

The data showed that gilt progeny did best when nursed by sows (SG) in terms of weight gain in the pre-weaning period and consequently weaning weight. However, total piglet removals after fostering were higher (P<0.01) when gilt progeny were reared by sows (SG). When assessed as total numbers, there were 159 losses of the 1,111 piglets present at Day 1 born to gilts (GB, GG and SG) compared to 135 of 1,289 piglets born to sows (SB, SS and GS). As a proportion of the Day 1 numbers, there was a significantly higher (P<0.01) loss in gilt progeny (14.3%) compared to sow progeny (10.5%). The majority of deaths across all treatments were due to overlain piglets. Other major reasons included unthrifty piglets in poor condition, assumed to have insufficient milk intake, and non-haemolytic *E. coli* scours. The losses in the SG treatment were evenly distributed between parity 3 to 7 foster sows. There were no significant differences in pre-weaning losses between fostered or un-fostered gilt litters (GB vs. GG) or between fostered or un-fostered sow litters (SB vs. SS) (Table 2).

There was a significant difference between gilts and sows in the resumption of oestrus of the sows in the subsequent parity (Table 3). SB and SS treatments resumed oestrus in a relatively short period of time despite having a high litter rate of gain compared to GB and GG (Table 2). The extra litter demands by placing sow progeny onto gilts (GS) did not delay the resumption of oestrus compared to other gilt-reared treatments GB and GG. The treatment analysis on subsequent farrowing rate and litter size was inconclusive due to the small sample size per treatment (data not presented). There was no significant difference in the subsequent parity litter size born of gilt litters (2nd litter) and older sows (≥3rd litters) with a mean born live of 11.0±0.2.

Table 1. Litter performance of sows at farrowing and after treatment allocation at Day 1 of birth

Treatment (sow/progeny)	Litters allocated	Av. weight Day 1 (kg)	Fostered litter size	Litter weight fostered (kg)
Gilts/birth	37	1.57±0.03[ab]	9.8±0.20[a]	15.3±0.03[a]
Gilts/Gilts	36	1.52±0.04[a]	10.0±0.21[ab]	15.1±0.42[a]
Gilts/Sows	36	1.64±0.03[b]	10.6±0.22[c]	17.4±0.43[b]
Sows/birth	37	1.76±0.03[c]	10.9±0.18[c]	19.2±0.44[c]
Sows/Sows	38	1.71±0.03[bc]	10.9±0.17[c]	18.6±0.44[c]
Sows/Gilts	37	1.58±0.04[ab]	10.5±0.24[bc]	16.5±0.50[b]
P value		<0.001	<0.001	<0.001

[abc]Mean values with different superscripts within columns differ at $P<0.05$.

Table 2. Lactation performance of sows rearing either their own progeny, or progeny from gilt litters or parity 3+ sow litters between Day 1 to weaning (26.4±0.15 Days[1]).

Treatment (sow/progeny)	Av. piglet daily gain (g/d)	Litter gain (kg/d)	Av. piglet wt Day 26 (kg)	Total piglets removed after D1
Gilts/birth	202±0.6[a]	1.63±0.08[a]	6.7±0.18[ab]	49/362 (0.135)[ab]
Gilts/Gilts	194±0.9[a]	1.65±0.10[a]	6.5±0.23[a]	41/359 (0.114)[a]
Gilts/Sows	209±0.6[ab]	1.94±0.08[b]	7.0±0.17[bc]	37/382 (0.097)[a]
Sows/birth	230±0.6[c]	2.08±0.08[bc]	7.6±0.18[d]	53/492 (0.108)[a]
Sows/Sows	235±0.6[c]	2.20±0.08[c]	7.7±0.15[d]	45/415 (0.108)[a]
Sows/Gilts	223±0.6[bc]	1.84±0.10[ab]	7.2±0.16[cd]	69/390 (0.177)[b]
P value	<0.001	<0.001	<0.001	<0.001

[abcd] Mean values with different superscripts within columns differ at $P<0.05$.

[1]Mean values expressed as estimated marginal means with weaning age included in the model as a co-variate factor.

Table 3. The reproductive performance of sows in the subsequent parity

Treatment (Sow/progeny)	Sows re-mated	Wean to oestrus (days)	Proportion mated within 7 days
Gilts/birth	34	11.1±2.4[b]	26/34 (0.76)[ab]
Gilts/Gilts	36	7.4±1.3[ab]	30/36 (0.83)[ab]
Gilts/Sows	31	10.8±2.3[b]	20/31 (0.64)[a]
Sows/birth	36	4.3±0.1[a]	36/36 (1.00)[c]
Sows/Sows	36	4.7±0.3[a]	35/36 (0.97)[bc]
Sows/Gilts	35	7.8±1.9[ab]	30/35 (0.86)[b]
P value		0.008	0.001

[abc]Mean values with different superscripts within columns differ at P<0.05.

Progeny performance

Growth performance over 39 days in the weaner pens is summarized in Table 4. There were significant treatment differences throughout the weaner period. Gilt-reared progeny irrespective of parity were significantly slower growing than sow-reared progeny. Analyzing the data for main effects of rearing parity and progeny parity is somewhat limited due to significant treatment interactions. However, in relation to the hypothesis that gilt progeny reared on sows outperform those reared by gilts, weaners of SG grew faster than those from GG, reflecting differences (P<0.10) in weaning weight (Table 2). By the end of the weaner period, cross-fostered gilt progeny SG (27.0 kg) were significantly heavier than GG (+1,600 g), but statistically similar to GB. Alternatively, the progeny from GS grew slower and were significantly lighter (26.8 kg) than either SB or SS litters by the end of the weaner phase (-1,600 g; P<0.05). There was no evidence of a better growth advantage in the weaner phase by rearing either gilt-progeny or sow-progeny on their birth dam (GB v GG; SB v SS). Small numerical differences in daily gain appeared to reflect differences in weaning weight. Average piglet feed intake was also significantly affected by pre-weaning fostering treatment (Table 4) and reflected the growth pattern during the weaner phase. Feed efficiency on a pen basis (including losses) was unaffected by post-farrowing treatment. The pattern of growth performance and intake due to treatment regimen was unaffected by the sex of the progeny (male or female) and was consistent throughout the weaner period.

Table 4. Growth evaluation (mean±SE[1]) in commercial weaner pens over 39 days following post-farrowing foster treatment.

Treatment (sow/progeny)	No. pens	Daily gain 0-39d (kg/d)	Av. daily intake (kg/d)	Pen FCR (feed: gain)
Gilts/birth	29	0.494±0.01[ab]	0.64±0.01[ab]	1.39±0.01
Gilts/Gilts	33	0.479±0.01[a]	0.62±0.01[a]	1.38±0.01
Gilts/Sows	33	0.502±0.01[b]	0.66±0.01[bc]	1.34±0.01
Sows/birth	40	0.525±0.01[c]	0.69±0.01[c]	1.37±0.01
Sows/Sows	39	0.528±0.01[c]	0.71±0.01[d]	1.36±0.01
Sows/Gilts	33	0.503±0.01[b]	0.66±0.01[bc]	1.36±0.01
P value		<0.001	<0.001	0.182

[abc]Mean values with different superscripts within columns differ at P<0.05. [1]Mean values are estimated marginal means from GLM model with block and number of pigs per pen included in the model.

Weaner losses were significantly higher from litters where gilt progeny were raised by gilts, either as GB or GG (Table 5). These were also the lighter groups at weaning (Table 4). There was no evidence that fostering of litters in either gilts or sows had an adverse effect on weaning mortality (GB vs. GG; SB v SS; Table 5). The high losses recorded in the farrowing house in the SG group were not observed once the piglets had moved to the weaner facility.

After weaning, pigs moved into different facilities and different pens in the grower and again in the finisher, so small differences in the average weights in and out of facilities occurred between growth phases. However the treatment effects were retained between the end of one phase and the start of another. Not all pigs on the study in the weaner were assessed in the grower if there were insufficient numbers to make up a pen of 18.

Table 5. Progeny losses during the weaner period (4-10 weeks of age) broken down by post-farrowing foster treatment.

Treatment (sow/progeny)	Pig removals 4-10 weeks age (proportion of no. entered)
Gilts/birth	22/299 (0.074)[b]
Gilts/Gilts	19/294 (0.069)[b]
Gilts/Sows	5/301 (0.017)[a]
Sows/birth	15/381 (0.039)[ab]
Sows/Sows	9/396 (0.023)[a]
Sows/Gilts	9/294 (0.031)[a]

[ab] Mean values with different superscripts within columns differ at P<0.05.

The growth and mortality observations for the grower period between 11 to 16 weeks of age are summarized in Tables 6 and 7. During this period, differences in the weight gain and FCR between entire males and females became significant and the data was analyzed with sex included in the GLM model.

There were no overall treatment effects in daily gain, feed intake or feed efficiency during the grower phase (Table 6). Post-hoc analysis comparisons between daily gain of GB and GG progeny tended to be different (P=0.090). The benefits observed at the end of the weaner by cross-fostering gilt progeny onto sows continued with SG progeny (67.8 kg) 2,500 g heavier than GB or GG by the end of the grower (P<0.05). The reciprocating litters of GS (67.5 kg) weighed 3,200g less than the sow progeny reared by sows (70.7 kg and 70.6 kg for SB and SS; P<0.05).

Table 6. Estimated marginal mean values[1] (±SE) for growth performance in commercial grower pens over 49 days following post-farrowing foster treatment.

Treatment (sow/progeny)	No. pens	Daily gain 0-49d (kg/d)	Av. intake (kg/d)	Pen FCR (feed: gain)
Gilts/birth	16	0.797±0.01	1.63±0.02	2.14±0.02
Gilts/Gilts	16	0.818±0.01	1.64±0.02	2.27±0.02
Gilts/Sows	17	0.824±0.01	1.70±0.02	2.09±0.02
Sows/birth	16	0.859±0.01	1.73±0.02	2.12±0.02
Sows/Sows	17	0.852±0.01	1.72±0.02	2.09±0.02
Sows/Gilts	16	0.827±0.01	1.71±0.02	2.16±0.02
P value		0.153	0.128	0.101

[1]Mean values are estimated marginal means from GLM model with block and sex as a random factor included in the model.

Towards the end of the grower period, an outbreak of *Actinobacillus pleuropneumonia* (APP) occurred and continued during the finisher. There were statistical differences in mortalities between treatments with GG pigs suffering the most impact of the disease challenge (Table 7).

Table 7. Progeny losses during the grower period (11-16 weeks of age) broken down by post-farrowing foster treatment.

Treatment (sow/progeny)	Pig removals 11-16 weeks age (proportion of no. entered)
Gilts/birth	6/230 (0.026)[a]
Gilts/Gilts	17/255 (0.067)[b]
Gilts/Sows	3/256 (0.012)[a]
Sows/birth	10/275 (0.036)[ab]
Sows/Sows	5/298 (0.017)[a]
Sows/Gilts	6/252 (0.024)[a]

[ab] Mean values with different superscripts within columns differ at P<0.05.

In the finisher, the average daily gain, daily intake and feed efficiency were not significantly different between treatments overall (Table 8). A post-hoc comparison showed that the difference in daily gain between GG (0.855 kg/d) and SG (0.815 kg/d) were significant (P<0.05).

Average daily intake and pen FCR were not significantly different between treatments. As for the growers, the finishers were affected by a health challenge of APP. There was a significant post-fostering treatment effect on finisher losses (Table 9). Gilt progeny, particularly those reared by gilts (GB and GG) had a higher mortality than pigs on SS treatment. As in the grower, the GG treatment resulted in numerically the highest losses.

Table 10 summarizes the weaning to finisher growth performance, live weight at sale and carcass performance of each treatment group, analyzed using individual records. There were highly significant treatment effects on weaner to finisher live weights and rates of gain and carcass performance. By weaning, the fostering responses had become clearly evident with gilt reared gilt progeny GB and GG weighing significantly less than sow-reared sow progeny SB and SS. With the power of a larger sample size from individual records, the effect is clearer than average weaning weight of the litter presented in Table 4. Piglets that were un-fostered on either gilts (GB) or sows (SB) were no different in weaning weight than those fostered onto foster gilts (GG) or foster sows (SS). Sow–reared gilt progeny SG were weaned 400 g heavier than gilt reared gilt progeny (GB and GG; P<0.05). However, by the end of the finisher period, GG progeny had a faster growth (Table 8). As a result, by 21 weeks of age the difference between GG and SG progeny was reduced (Table 10). The reciprocal GS progeny were weaned 800 g lighter than sow reared sow progeny (SB and SS; P<0.05). By 21 weeks of age, GS progeny were significantly lighter (average of -3,100 g) than sow reared sow progeny (P<0.05). Carcass weights and P2 reflected the 21 week final live weight pattern, with the exception that the carcasses of gilt progeny reared by sows (SG) were less fat than SB progeny at a similar carcass weight (P<0.05).

Table 8. Estimated marginal mean values[1] (±SE) for growth performance in commercial finisher pens over 35 days following post-farrowing foster treatment.

Treatment (sow/progeny)	No. pens	Daily gain 0-35d (kg/d)	Av. daily intake (kg/d)	Pen FCR (feed: gain)
Gilts/birth	22	0.780±0.02	2.23±0.07	2.96±0.05
Gilts/Gilts	26	0.855±0.02	2.32±0.07	2.72±0.05
Gilts/Sows	25	0.833±0.02	2.37±0.07	2.84±0.05
Sows/birth	27	0.812±0.02	2.38±0.07	3.03±0.05
Sows/Sows	27	0.829±0.02	2.40±0.07	2.89±0.05
Sows/Gilts	27	0.811±0.02	2.31±0.07	2.91±0.05
P value		0.119	0.678	0.071

[1]Mean values are estimated marginal means from GLM model with block and sex included in the model.

Table 9. Progeny losses during the finisher period (17-21 weeks of age) broken down by post-farrowing foster treatment.

Treatment (sow/progeny)	Pig removals 17-21 weeks age (proportion of no. entered)
Gilts/birth	16/219 (0.073)[bc]
Gilts/Gilts	20/238 (0.084)[c]
Gilts/Sows	7/253 (0.028)[a]
Sows/birth	20/265 (0.076)[bc]
Sows/Sows	12/293 (0.041)[a]
Sows/Gilts	11/246 (0.045)[abc]

[abc]Mean values with different superscripts within columns differ at P<0.05.

Table 10. Effect of cross-fostering between gilt and sow litters on finisher on mean[1] (± SE) values for weaner live weight, daily gain between 4 weeks and 21 weeks of age and carcass performance.

Treatment (sow/progeny)	No records	Weaned weight(kg)	Weight 21 weeks (kg)	Daily gain (kg/d)	Carcass wt (kg)	Back fat P2 (mm)
Gilts/birth	197	6.93±0.12[a]	90.0±1.03[a]	0.695±0.01[a]	68.0±0.71[a]	8.3±0.14[a]
Gilts/Gilts	201	6.82±0.12[a]	94.0±0.83[b]	0.725±0.01[b]	71.0±0.65[b]	8.8±0.13[bc]
Gilts/Sows	236	7.30±0.11[b]	95.0±0.77[b]	0.728±0.01[b]	71.5±0.67[b]	8.5±0.14[ab]
Sows/birth	234	7.99±0.11[c]	97.2±0.76[cd]	0.743±0.01[bc]	72.8±0.64[bc]	9.0±0.13[c]
Sows/Sows	258	8.14±0.10[c]	99.0±0.70[d]	0.754±0.01[c]	74.0±0.63[c]	9.0±0.13[c]
Sows/Gilts	229	7.33±0.11[b]	95.4±0.96[bc]	0.731±0.01[b]	72.6±0.64[bc]	8.4±0.13[ab]
P value		<0.001	<0.001	<0.001	0.001	0.001

[abc]Mean values with different superscripts within columns differ at P<0.05.
[1]Mean values are estimated marginal means from GLM model with block and sex included in the model.

The number of pigs removed due to mortality over the 10 week grower-finisher period when APP was prevalent was analyzed as a proportion of the pigs entering the grower (Table 11). The grower-finisher losses during the APP challenge were highest in GG. Any adverse consequence of fostering practices on G-F mortalities were not clearly evident, with GG>GB, whereas SS<SB. Gilt progeny reared by sows (SG) had a significantly lower mortality compared to gilt-reared gilt progeny (GG). The results supported the hypothesis that gilt progeny fostered onto sows are better able to withstand health challenges post-weaning and tend to produce heavier carcasses than those gilt progeny fostered onto gilt dams (P<0.10).

Table 12 summarizes the weaning to finisher growth period for the different fostering combinations. The treatment combination of fostering between gilts and sows (GS swapped with SG) was compared to the progeny that were fostered within gilts and within sows (GG and SS), and a third cohort that compared un-fostered gilt and sow treatments (GB and SB). By weaning, the treatment combinations were similar in live weight. By 21 weeks of age, there were small significant differences between cohorts, such that progeny fostered either within gilts and sows, or between gilts and sows were heavier than those left un-fostered. There was no significant net live weight gain in fostering gilt progeny onto sows and vice versa compared to fostering gilt within gilts and sows within sows.

Regression analysis weaning weight effect on finisher weight

The individual live weight recorded at weaning was analyzed by regression with individual final weight at 21 weeks of age. The data set contained 1353 individual records with a weaning weight range from 2.4 kg to 13.9 kg. The slope of the relationship between weaning weight and final weight at 21 weeks of age (B coefficient) and the r^2 values were highest for the GB and SB litters (Table 13). Numerically, there was a larger response to weaning weight (B coefficient value) and r^2 value in GG progeny compared to SS progeny, suggesting that final slaughter weights of gilt-reared gilt progeny are more sensitive to weaning weight.

Table 11. Progeny losses during the finisher period (11-21 weeks of age) broken down by post-farrowing foster treatment.

Treatment (sow/progeny)	Pig removals 11-21 weeks age (proportion of entered)
Gilts/birth	22/230 (0.096)[b]
Gilts/Gilts	37/255 (0.145)[c]
Gilts/Sows	10/256 (0.039)[a]
Sows/birth	30/275 (0.109)[bc]
Sows/Sows	17/298 (0.057)[a]
Sows/Gilts	10/252 (0.068)[ab]
	P<0.001

[abc]Mean values with different superscripts within columns differ at P<0.05.

Table 12. Individual average weaning weight, wean-finish daily gain and sale weight at 21 weeks of age when GS and SG progeny are combined to represent a cross-fostering management system and compared with un-fostered progeny (GB+SB) and fostered only within parity group (GG+SS).

Treatment Regimen (sows/progeny)	No. records	Weight weaning (kg)[1]	Daily gain Wean-sale (kg/d)[1]	Live weight at sale[1] (kg)
Fostered between (GS+SG)	465	7.40±0.13	0.728±0.007[ab]	94.9±0.84[ab]
Un-fostered (GB+SB)	431	7.43±0.13	0.718±0.007[a]	93.8±0.85[a]
Fostered within (GG+SS)	459	7.57±0.08	0.742±0.004[b]	96.9±0.54[b]
P value		0.430	0.008	0.005

[ab]Mean values with different superscripts within columns differ at P<0.05.

[1]Mean values are estimated marginal means from GLM model with block and sex included in the model.

Table 13. Regression analysis between individual weaning live weight and final live weight at 21 weeks of age.

Treatment (sow/progeny)	Number records	B coefficient	Constant	R square value	P value
Gilts/birth	197	3.99±0.49	64.6±3.47	0.255	<0.001
Gilts/Gilts	201	3.50±0.44	70.9±3.07	0.240	<0.001
Gilts/Sows	236	2.58±0.49	76.6±3.64	0.107	<0.001
Sows/birth	234	3.54±0.28	69.3±2.34	0.400	<0.001
Sows/Sows	258	2.40±0.42	79.2±3.48	0.115	<0.001
Sows/Gilts	229	2.68±0.41	76.0±3.07	0.158	<0.001
Pooled dataset	1355	3.14±0.16	72.5±1.24	0.216	<0.001

DISCUSSION

The results supported the hypothesis that gilt progeny reared by mature sows can be weaned heavier than gilt-reared gilt progeny. This weight advantage continued through to slaughter age. Average piglet weight gain pre-weaning was 500g higher ($P<0.05$) in sow-reared gilt litters (GS) compared to un-fostered gilt progeny (GB). The reciprocating litters to sow-reared gilt progeny (SG) were the gilt-reared sow progeny (GS treatment). The weaning weight of sow progeny was significantly reduced when fostered onto gilts at Day 1 by 600 g (GS vs SB). Thus there was no net improvement in terms of live weight gain by the cross-fostering technique compared to no litter fostering. For the cross-fostering practice to be of net benefit, the weight gain and final live weight of the sow progeny reared on gilts must be similar to those reared by sows. However in our experiment, live weight at 21 weeks of age in GS progeny were significantly lighter than sow reared progeny SB and SS. We hypothesised that piglets from sows that are heavier than gilt piglets should grow at the same rate on gilts and multiparous sows. Boyce et al. (1997) reported that gilt litters were capable of rearing heavier litters when sufficient lactation demands were imposed. King et al. (1997) conducted an experiment that involved cross-fostered litters of 2 week old piglets onto gilts at day 2 of lactation. All treatments were conducted using gilt progeny reared by gilts. They reported that gilts that reared 2 week old progeny increased milk yield between day 4 to 8, but by day 11 to 15 further increases in lactation were not observed so that the gilts rearing almost double the litter weight produced a litter gain at similar levels as control sows. King et al. (1997) concluded that the lack of growth rate difference may have been due to the extra milk being required to support a higher maintenance requirement of the heavier piglets. Although average piglet weight at Day 1 was similar between GS and SS, by weaning the sow progeny reared by gilts (GS) were significantly lighter. This difference continued through to 21 weeks of age, such that GS progeny were on average 3 kg lighter than SS and SB progeny. The challenge remains for producers to increase the lactation performance of gilts to produce heavy weaners.

The experiment confirmed that gilt-reared gilt progeny weighed significantly less than sow progeny following day 1, and this continued through to 21 weeks of age. The neonatal weight of gilt progeny was 200 g lighter than sow progeny by day 1. Although birth weight was not recorded in this experiment due to the treatments being imposed after birth, the difference in neonate body weight of gilt and sow progeny by Day 1 was similar to those reported by Miller et al. (2008) that were conducted on animals of the same genotype and in the same research facilities. In both gilt and sow treatments rearing their own progeny (GB and SB), neonatal weight at Day 1 tended to be higher than the average weight of GG and SS following fostering. It is reasonable to infer from the Day 1 weights that the fostering practice disrupted colostrum and milk intake in the GG and SS treatments as reported by Robert and Martineau (2001). Fostering involved whole litter swaps and was done as early as possible following the completion of farrowing. All piglets were allowed their first suckle on their birth dam before being moved. Despite this initial setback in weight, we did not observe any further disadvantage to litters fostered within their parity group. Prior to weaning, there was no significant difference in piglet daily gain or mortality between GB and GG, or between SB and SS treatments. By 21 weeks of age, the live weight of fostered gilt progeny GG were significantly heavier than un-fostered GB progeny, whereas the weights of sow progeny reared by foster-sows or birth sows were similar at 21 weeks of age. As such, the hypothesis that progeny reared by their birth dams are healthier and grow faster than cross fostered progeny was not supported. When the data was pooled (Table 12), litters that were fostered within parity group grew significantly faster and were 3 kg heavier on average compared to un-fostered litters (P<0.05). Fostering gilt progeny within gilts produced a larger response than sow progeny fostered onto other sows. The weaner to sale average daily gain was significantly higher in fostered gilt progeny within gilts (GG) compared to un-fostered gilt progeny, GB (0.725 vs. 0.695 kg/d; P<0.05). The difference between SB and SS progeny was less (0.754 v 0.743 kg/d) and was not significant. During the pre-weaning phase and the weaner phase up to 10 weeks of age, there was no difference in the mortality rates between fostered progeny within parity group and those reared by their birth dams. Mortalities were significantly higher between 11-21 weeks of age in GG compared to GB litters (14.5% v 9.6%; P<0.05), whereas in sows, there were fewer losses within SS litters compared to SB litters (5.7% v 10.9%; P<0.05). We do not know why the gilt progeny fostered onto other gilts performed better. The response was more pronounced in the grower and finisher periods of growth. By weaning, the GG piglets did not weigh more than the GB litters, so any effect of fostering on stimulating suckling pressure or milk production is unlikely. Immunological measures were not conducted, but differences in immunoglobulin and antibody transfers between birth dams and non-birth dams may provide an explanation.

Gilt progeny were again shown to be more susceptible to health challenges than sow progeny. One possible explanation for this is that the acquisition of active immunity in gilt progeny may be compromised due to the presence of higher concentrations of maternal antibodies at weaning compared to sow reared progeny (Miller et al. 2008). The present study differed in design to Experiment 4 of Miller et al (2008) who cross-fostered all piglets from birth delivery prior to colostrum intake. They did not include a GB or SB treatment. In our experiment, the fostering practice would have allowed maternal colostrum intake prior to fostering (the majority of litters were fostered after 12-18 hours post-birth. Mortalities between GB and GG groups were similar post-weaning, whilst in the grower-finisher period, there were significantly higher mortalities during an APP challenge in the GG treatment, indicating a less-developed active immune system. By contrast, in sow litters, birth reared progeny (SB) losses were higher in the grower-finisher than fostered progeny (SS). Miller et al. (2008) did not report on mortality, whilst our data confirmed that gilt progeny are more at risk to health challenges than sow progeny. However, whether this is explained by differences in the active immune system is unclear. Our data showed that grower-finisher losses were not related to live weight. The reason for the higher grower-finisher mortality in SB progeny could be due to the nature of APP challenge affecting most pigs within a pen, thereby causing some bias when individual numbers are assessed. Still, the result was unexpected and contrary to the response to GB progeny under the same challenge.

Although cross-fostering gilt progeny to sows improved piglet and litter weight gain over lactation, during the same period there was a higher incidence of mortality and ill thrift compared to gilt progeny fostered to gilt dams. The losses were predominantly overlays, and it is likely that the combination of larger sows and smaller size fostered piglets predisposed them to higher risk. Older parities within the sow group were not over-represented in the incidence of overlays. Once weaned, the losses from the SG group remained low, whilst live weight gains continued to be higher than gilt progeny fostered onto gilts. The result highlights the risks associated with cross-fostering small piglets onto large sows. Although older sows have a greater capacity to rear them, access to teats and mothering ability still needs to be evaluated on an individual basis if it is to be successful. The fostering practice used in this study involved whole litter swaps and then litter size reduced to an average of 11 on sows and 10 on gilts. Fostering the entire litter may have different outcomes to fostering partial litters or individuals. Teat preferences and competition for anterior teats that produce large weight gains (Miller et al., 2007a) would likely be higher when individual piglets are fostered on day 1, compared to a whole litter which would reduce the benefits observed in our study.

The experimental hypothesis that gilt progeny reared on multiparous sows would outperform those reared on gilts was supported when compared to un-fostered gilt progeny GB. SG progeny grew faster and were heavier than GB or GG progeny by weaning and this 6% difference between SG and GB progeny carried through to 21 weeks of age. At weaning, SG progeny were significantly heavier (500 g) than GG progeny, whilst at 21 weeks, live weight differences were not significant (Table 10). Importantly, there were fewer losses in the SG group compared to GG and GB in the weaner period and compared to GG in the grower period. The finding provides strong evidence that gilt progeny themselves are not inherently compromised if they are given adequate milk intake and a suitable rearing dam. During the weaner period, feed intake was 6.5% higher in SG compared to GG groups, so the fostering practice pre-weaning had a flow on effect to the weaner phase. There was no evidence for feed efficiency effects due to pre-weaning treatment or effects of weaning weight on FCR values.

The importance of weaning weight on progeny growth performance was evident through the weaner phase. By the grower and finisher periods, statistical differences in daily gain between treatments differing in entry weight were no longer evident. Between treatments, rate of gain remained constant however live weights out of the grower facility and at sale were reflective of differences at Day 1 and weaning. Miller et al (2008) reported no significant differences in live weights by 10 weeks, 17 weeks and at 22 weeks between gilt-reared progeny and sow-reared progeny. The size of the data set in the present experiment was larger and therefore may have statistically detected similar differences, but it also suggests that there are other important factors that affect growth rate in the older pig other than weaning weight. Ilsley et al (2003) reported that weaning weight and post-weaning growth were more important factors in determining live weight at slaughter than birth weight and pre-weaning growth. The regression data analysis produced an interesting finding for the differences in B coefficient values between gilts and sows. The results suggest that the final live weight of gilt progeny were more dependant on weaning weight (i.e. had a higher B coefficient) than sow progeny (GG and GB> SS and SB values). The data set did not include individual birth weight or Day 1 weights, so it is not possible to conclusively test the hypothesis that light-weight gilt progeny before fostering treatments gained more as a result of fostering compared to light-weight sow progeny. The data however allows us to propose that the impact of pre-weaning growth on weaning weight and slaughter weight is likely to be more apparent in gilt litters than in sow litters.

Commercially, this could have benefits if light weaned pigs are a contribution to light weight-for-age pigs in the finisher. In most production systems, pigs are sold to meet the market weight specification rather than an age specification. Under these weight-sorted marketing systems, the proportion of small light pigs poses an economic problem as they take longer to reach market weight and in cases of all-in-all-out production, may need to be sold at sub-optimal weights. In mixed parity farming systems, gilt progeny take longer to reach a specified market weight compared to sow progeny, and our current data supports this. A strategic cross-fostering system in a commercial farrowing house with a mixture of gilt and sow litters has potential to reduce the variation in the individual weight of weaners produced each week. In a commercial piggery, selection of light to average gilt litters for a litter swap fostering program onto suitable sows is likely to improve the weight gain of these progeny and their survival post weaning. Most current practices would only contemplate swapping a litter if it is deemed to be unthrifty or if the gilts' milk supply ceases.

In conclusion, the experiment provides sufficient evidence to conclude that cross-fostering within 12-18 hours does not compromise the piglet, with the exception of a higher risk of overlay when gilt progeny are fostered to older sows. Fostering of gilt progeny onto sows increased their pre-weaning growth and weaning weight. These benefits continued through the post-weaning period. But overall, the advantages of fostering gilt progeny onto sows is negated by the equal reduction in the weight of sow progeny when reared by gilts though the mortality of sow progeny reared by gilts was not increased above any of the sow reared treatments. In contrast fostering gilt progeny onto sows reduced weaner,grower and finisher losses but as mentioned previously increased pre weaning losses. Fostering of litters within 24 hours gilts within gilts was shown to have an overall benefit of 3 kg live weight at 21 weeks of age. However, the practicality of fostering gilt progeny within gilts would need to be balanced with the higher risk of mortality.

Application of Research

The project provides sufficient evidence to support the use of fostering practices onto older parity sows to improve growth and survival of gilt progeny. Provided with heavier piglets, lactating primiparous sows (lactating gilts) have the capacity to milk more, however they still have a lower capacity for milk production or litter weight gain compared to multiparous sows nursing the same litter weight from Day 1. However, a net benefit of a cross-fostering management system to achieve an overall increase in weaning weight of both gilt and sow progeny was not observed.

The commonly-held belief that gilt and sow progeny perform best if left on their birth dams was not supported in this investigation. The practice of litter cross-fostering is labour intensive and is in contradiction to a minimal fostering industry recommendation. However by fostering gilt progeny to dame or nurse Parity 2+ sows rather than dame gilts, significant gains to weaning weight which carry through to slaughter and an improvement in progeny survivability post-weaning are likely outcomes.

A possible alteration to the cross-fostering system could be to (very) early wean gilt litters and foster their progeny onto lactating older sows. This concept of dairy sows has been proposed by some but is yet to be evaluated commercially. The considerations would be how quickly the very early weaned gilt can be re-mated; the length of time a sow can lactate to the same level of milk production as a sow 3-4 weeks into lactation; and how fertile a weaned sow would be after 6-8 weeks of lactation.

Conclusion

The project evaluated the outcomes from cross-fostering whole litters between gilts and sows and demonstrated that gilt progeny reared by sows outperform those reared by gilt dams. However, an equal reduction in weaning weight of reciprocal sow progeny reared by gilts negated any overall net benefit of a cross-fostering regimen. Given sufficient milk intake, the gap between gilt progeny and sow progeny was significantly reduced. Gilt progeny do not appear to have an inherent pre- or post-weaning growth or health limitation. Day 1 weight appeared to be the primary driver of growth potential in gilt litters. The project also highlighted that keeping birth progeny on their birth dams did not improve their weaning weight or slaughter weight. Although there was a significant increase in final live weight and carcass weight by fostering gilt progeny onto other gilts, higher grower finisher mortality was recorded. Pre-weaning and post-weaning mortalities up to 10 weeks of age were similar between fostered and un-fostered progeny in gilts. The strategic use of weaned or dame Parity 2+ sows to improve the weaning weight of gilt progeny is shown as a way to reduce the growth and health difference between gilt and sow progeny through to slaughter. Ways to increase the lactation performance of gilts or to produce gilt or sow piglets of a heavier weaning weight remains a constraint to weaning weight in commercial production environments.

Limitations/Risks

Fostering of gilt progeny onto sows significantly increased pre-weaning mortality due to overlays. However once weaned, growth performance was increased and post-weaning mortalities in the weaner and grower were reduced. The suitability of each foster sow of parity 2+ (previous rearing history, udder conformation, number of functional teats) needs to be considered to achieve the full benefits of the cross-fostering technique. Although whole litters were swapped in the experiment, minimal fostering after Day 1 should be practiced.

Recommendations

As a result of the outcomes in this study the following recommendations have been made:

1. As there was no net improvement in Sow-reared gilt progeny (SG) + Gilt-reared sow progeny (GS) by weaning or sale, a routine cross-fostering husbandry regimen cannot be recommended.
2. There was no evidence of a benefit to weaning weight, slaughter weight or post-weaning mortality by having dams rear their own piglets.
3. Producers should expect similar growth and mortality responses through to slaughter when whole litters are swapped within parity.
4. In the event of using weaned off nurse dames, gilt progeny should be reared by suitable Parity 2+ sows instead of gilt dames to maximize weaning weight and post weaning survival.
5. When suitable multiparous sows are available, litter swapping with a light to average gilt litter is recommended to reduce individual variation within the weaned population.
6. Increasing the milk production from gilts remains a limitation to maximizing weaning weights from both gilt and sow progeny. Either increasing gilt milk production or using more sows for rearing piglets needs to be further researched. Minimizing the proportion of gilts in the herd through sow longevity should be encouraged as a way of increasing weaning weights and hence carcass weight.

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