Improving lactation performance of sows with pST

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Executive Summary

The administration of recombinant porcine growth hormone (pST, Reporcin™) to sows during lactation has the potential to increase sow milk yield. Several investigations were undertaken in the late 1980's-1990's, which suggested milk yield and therefore litter performance may be improved with the use of pST, although the response may be influenced by sow parity and litter size (suckling demand) (Cromwell *et al.* 1992; Harkins *et al.* 1989; Smith *et al.* 1991; Toner *et al.* 1996). A more recent assessment of this technology in sows of current genotypes and under commercial conditions was therefore undertaken to assess the impact of pST administered during lactation on piglet growth performance and survivability.

One hundred and twenty six sows (parity 2 and 3) were selected over a six week period. Within week, sows were randomly allocated prior to farrowing to one of three treatment groups: Control- no pST administration; Extended lactation – 4mg pST per sow per day from the day of farrowing to weaning; Late lactation – 4mg pST per sow per day from day 14 to weaning. Piglets were weaned at an average age of 26.2 days ± 0.19 days.

Sows administered pST for the entire lactation period consumed less feed than the control animals (average daily feed intake 7.16, 6.63 and 6.96 kg/d respectively for the control, extended lactation and late lactation treatment groups, P=0.042) and lost approximately 22 % more back fat (3.6, 4.4 and 4.32 mm back fat loss for the control, extended lactation and late lactation treatment groups, respectively, P=0.57). Average piglet growth rates were similar across the three treatment groups throughout the study, with the exception of the time period from day 7 to day 14. During this period, the piglets suckling sows on the extended lactation treatment group tended to grow more slowly than those suckling sows that had not been administered pST (227.9, 189.6 and 209.9 g/d respectively for the control, extended lactation and late lactation treatment groups, P=0.052).

The daily administration of pST during the lactation period (either from day 1 to weaning or from day 14 to weaning) did not improve lactation performance of sows in this investigation. As such, the use of pST during lactation is not recommended as a strategy to improve litter performance under commercial conditions.

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1. Introduction

Poor lactation performance can have a substantial impact on pre-weaning mortality with sows being unable to maintain milk production throughout lactation. These 'lactation failures' necessitate the use of dame/ foster sows continuously to maintain milk supply to the remaining piglets. A recent study conducted at Rivalea indicates that milking failure between day 2-10 occurs in 15% of the herd, with a greater prevalence in primiparous sows (gilt litters) and over summer. Other farms outside of Rivalea also report similar problems and magnitude of incidence (Lievaart, pers. comm. Project 2D-117). Litter gains on commercial farms are also quite low (2.0-2.2 kg/day), and have increased only marginally over the last 10-15 years (Smits and Dunshea, Pork CRC Lactation Yield Workshop, Melbourne, 2008).

There is the potential to utilise recombinant porcine growth hormone (pST, Reporcin™) to improve sow milk yield. Porcine growth hormone is naturally produced in the pig and is one of the main hormones influencing growth and metabolism. Recombinant pST is registered for use in pigs during the finisher period to improve growth performance and feed efficiency. The administration of growth hormone to lactating animals may also have beneficial effects on milk yield and/or sustaining lactation. The administration of bovine growth hormone (bST) to dairy cows can increase milk yield by as much as 40 %, and is particularly beneficial during declining lactation (Bauman *et al.* 1985). In pigs, the use of pST in lactating gilts and sows to improve milk yield has had variable effects. Harkins *et al.* (1989) reported milk yield to be 22 % greater at day 28 of lactation when sows received 8.22 mg pST/sow/day from day 12 to day 29 of lactation. On the other hand, more recent investigations have not observed the same improvements in lactation performance (Cromwell *et al.* 1992; Toner *et al.* 1996)

Sow parity and litter size (suckling demand) may influence the degree to which pST can improve lactation performance. Toner *et al.* (1996) did not observe any increases in milk production in first litter sows when 10 mg pST was administered per day from day 8 to day 39 of lactation. It is hypothesised that in these gilts, the metabolic drive for muscle deposition may have reduced the effect of pST on milk production. The authors also suggest that the absence of a significant decline in milk production of the control gilts during late lactation would have reduced the impact of pST on milk yield during this time. An additional study by Smith *et al.* (1991) indicated that the response to pST was greater in sows with heavier litters, suggesting that the intrinsic limit to milk production must be exceeded before milk production will respond to pST. This observation is supported by the results of Cronwell *et al.* (1992) and Toner *et al.* (1996) in which small litter size, and hence lactation demand may have been the limiting factor in sow milk yield (8.0 and 8.2 pigs respectively), and therefore the lack of response to pST administration. Therefore, the greatest potential for pST to improve lactational milk yield and reduce pre-weaning mortality is in situations where milk production is limiting during periods of high litter demand (ie during late lactation, large litter sizes, larger piglet weights) (Auldist and King 1995). Given the potential for increased milk yield, a more recent assessment of this technology in sows of current genotypes and under commercial conditions is warranted to assess its impact on piglet growth performance and survivability.

2. Methodology

Animals and treatments

One hundred and twenty six sows (Large White x Landrace, PrimeGro™ Genetics) were selected over a six week period. Sows were parity two and three upon entry to the farrowing house. Within week, sows were randomly allocated prior to farrowing to one of three treatment groups: Control- no injections; Extended lactation – 4mg pST per sow per day from the day of farrowing to weaning; Late lactation– 4mg pST per sow per day from day 14 to weaning. Recombinant pST (Reporcin™) was prepared prior to the commencement of the study in small sterile dose packs of the appropriate concentration and volume, and frozen until required. All pST injections were given intramuscularly into the muscle immediately behind the ear, with the treatment occurring once a day in the morning at the time of feeding. The dose of pST utilised in this investigation is much lower than that used in previous studies (up to 16 mg recombinant pST/d from day 7 to day 20 of lactation (Smith *et al.* 1991), 6 mg pST per day from day 108 of gestation to day 24 of lactation (Cromwell *et al.* 1992)) due to the apparent sensitivity of sows to high doses of pST. In these earlier studies a number of sow deaths were reported, with the cause of death linked to heat stress, particularly at or around the time of farrowing. Combined with the reduced dose of pST, this current investigation was undertaken during spring in an further attempt to minimise heat stress of the sows. All animal procedures outlined in this investigation were approved by the Rivalea Animal Ethics committee.

Husbandry and feeding

Sows were housed in farrowing crates in an insulated shed from approximately day 110 of gestation. Sows were offered 3 kg/d of the lactation diet until farrowing (14.8 MJ digestible energy (DE)/kg, 0.50 g available lysine/ MJ DE), after which time they were offered the lactation diet 3 times per day to appetite up until weaning. Sows farrowed naturally at term, with litters processed within 24 hrs of birth. Litter size was standardised to 11-12 piglets (or the maximum functional teats) using a minimal cross fostering approach with piglets born on the same day. Piglets were tagged at processing to allow for individual identification. Individual piglet weights were recorded at day 1 (post foster), day 7, day 14, day 21 and at weaning (average weaning age 26.2 days ± 0.19, mean ± SE). Litter size was maintained as high as possible for the entire lactation period by replacing piglets that were removed due to death or illthrift with another piglet of a similar age. Any piglets that were transferred on were weighed at the time of transfer. Sow weight and back fat at the P2 site (65 mm from the midline over the final rib) was measured on day 2 (day after processing the litter) and again at weaning (four weeks into lactation, all sows within replicate weaned on the same day). Feed intake was measured on a per sow basis from day 1 through to weaning using calibrated scoops. All pre-weaning piglet and sow mortalities and removals were recorded including the reason and date. Any lactation failures (defined as the sow's milk production drying up within the first 10 days of lactation) were also recorded.

Statistical analyses

The influence of pST treatment on sow lactational performance was analysed using an analyses of variance (ANOVA) with the main effect of treatment and the random effect of replicate (week). Co-variates were included in the model where there were significant effects and are indicated in the text and footnotes of the tables. Chi-squared analyses was undertaken to determine differences in mortalities and removals across the three treatments groups. The subsequent reproductive data was also analysed by chi square and univariate ANOVA. All statistical analyses were undertaken using GenStat 10th Edition (Payne *et al.* 2005).

3. Outcomes

The administration of pST to lactating sows did not have any significant effects on sow weight at weaning or weight change from day 2 of lactation to weaning, as displayed in Table 2. Sow weight change (loss) from day 2 to weaning was however almost 20 % less when sows were administered the extended lactation pST treatment compared to the control animals (20.1, 16.1, 17.7 kg weight loss respectively for the control, extended lactation and late lactation treatment groups, P=0.29). Similarly, pST had no significant impacts on P2 at weaning or the change in P2 from day 2 of lactation to weaning. The loss of P2 backfat was however 22 % greater in sows administered pST for the entire lactation period compared to the control animals, 3.6, 4.4 and 4.3 mm back fat loss for the control, extended lactation and late lactation treatment groups, respectively, P=0.57. Average daily feed consumption was reduced when sows were administered pST for the entire lactation period compared to the control sows (average daily feed intake 7.16, 6.63 and 6.96 kg respectively for the control, extended lactation and late lactation treatment groups, P=0.042).

The influence of pST treatment regime on litter weight gain and piglet performance to weaning is displayed in Table 3. Average piglet weights from day 1 to weaning were not influenced by either the extended lactation or late lactation pST treatments. Weaning age did differ slightly between the three treatment groups, 27.5, 25.2 and 25.7 days respectively for the control, extended lactation and late lactation treatment groups (P<0.001). This effect was due to slight differences in farrowing dates across treatments, with sows allocated to their respective treatments prior to farrowing and all sows within replicate weaned on the same day. As such, weaning age was used as a co-factor in the statistical analyses for average piglet weight at weaning and average daily piglet gain to weaning. Piglet growth rates were similar across the treatment groups with the exception of the time period from day 7 to 14. During this period, the piglets suckling sows on the extended lactation treatment group tended to grow more slowly than those suckling sows that had not been administered pST (227.9, 189.6 and 209.9 g/d respectively for the control, extended lactation and late lactation treatment groups, P=0.052). The administration of pST did not influence average litter size at any time point from day 1 to weaning, nor were there any significant effects on litter weight gain. There were two incidences of sow lactation failure

during the experiment (Table 1). Both of these were observed to occur in the pST treatments, one in the extended lactation treatment and one in the late lactation treatment group.

Following weaning, the number of sows re-mated in each of the treatments was 35, 36 and 38 sows respectively for the control, extended lactation and late lactation pST treatment groups. The subsequent farrowing rates were similar between treatments (77.1%, 83.3%, 73.7%; χ^2 0.44; P=0.80). Subsequent litter size total born was also statistically insignificant (P=0.45), but seems to reflect a response to lower tissue catabolism over lactation in the pST treated sows (12.4±0.57, 12.7±0.54 and 13.4±0.56 for the control, extended lactation or late lactation treatment groups.

Table 2. Influence of pST treatment regime on sow weight, P2 back fat depths and feed intake

	pST Treatment Regime			SED	Significance
	Control	Extended Lactation	Late Lactation	pST Treatment	pST
Number of sows	42	42	42		
Sow weight day 2 (kg)	296.9	297.9	296.9	5.88-5.98	0.98
Sow weight weaning (kg)	275.6	280.2	282.0	5.25-5.29	0.47
Change sow weight day 2 to weaning (kg)	-20.1	-16.1	-17.7	2.52-2.57	0.29
P2 Day 2 (mm)	22.2	21.5	22.7	1.07-1.09	0.47
P2 Weaning (mm)	18.3	16.9	18.3	0.90-0.92	0.23
Change P2 day 2 to weaning (mm)	-3.6	-4.4	-4.3	0.80-0.82	0.57
Average daily feed intake (day farrowing to weaning) (kg/d)	7.16[a]	6.63[b]	6.93[ab]	0.205-0.210	0.042

[ab] Within rows, means not followed by a common superscript differ (P<0.05), while in the absence of superscripts means are not different.

Table 3. Influence of pST treatment regime on litter weight gain and piglet growth

	pST Treatment Regime			SED	Significance
	Control	Extended Lactation	Late Lactation	pST Treatment	pST
Average piglet weight (kg)					
Day 1	1.66	1.75	1.66	0.046-0.047	0.12
Day 7	2.97	2.94	2.96	0.098-0.100	0.97
Day 14	4.63	4.42	4.54	0.156-0.150	0.43
Day 21	6.34	6.08	6.22	0.193-0.194	0.41
Weaning*	7.65	7.26	7.46	0.242-0.305	0.35
Average litter size					
Day 1	11.4	11.6	11.5	0.14	0.19
Day 7	10.6	10.9	10.5	0.20-0.21	0.25
Day 14	10.2	10.1	9.9	0.26-0.27	0.61
Day 21	9.8	9.8	9.6	0.32	0.81
Weaning	9.7	9.5	9.5	0.35-0.37	0.85
Average piglet growth rates (g/d)					
Day 1-7	176.8	165.5	171.7	13.45-13.79	0.74
Day 7-14	227.9	189.6	209.9	15.05-15.54	0.052
Day 14-21	228.8	212.4	223.5	13.12-13.14	0.45

	pST Treatment Regime			SED	Significance
	Control	Extended Lactation	Late Lactation	pST Treatment	pST
Day 21-weaning*	215.5	238.2	231.5	17.78-22.33	0.58
Day 1-weaning*	227.9	210.9	222.0	8.21-9.66	0.20
Average litter weight gain (kg/d)					
Day 1-7	1.78	1.69	1.72	0.169-0.175	0.88
Day 7-14	2.31	1.84	2.04	0.192-0.198	0.06
Day 14-21	2.17	2.22	2.02	0.192-0.193	0.57
Day 21-weaning*	2.04	1.78	2.18	0.288-0.362	0.39
Day 1-weaning*	2.16	1.86	2.00	0.145-0.170	0.23

* Weaning age used as a covariate (see text for details). [ab] Within rows, means not followed by a common superscript differ (P<0.05), while in the absence of superscripts means are not statistically different.

4. Application of Research

The administration of pST from day 1 of lactation to weaning did not improve litter growth performance or pre-weaning mortality. These results suggest that there was no increase in milk yield due to the administration of pST, when measured indirectly through litter gain. Previous studies have shown variable effects of pST administration on milk yield. Harkins *et al.* (1989) reported milk yield to be 22 % greater at day 28 of lactation when sows received 8.22 mg pST/sow/day from day 12 to day 29 of lactation. Despite this, several other studies have not observed any improvements in milk yield following pST administration (Cromwell *et al.* 1992; Toner *et al.* 1996). The authors in this latter investigation suggested that the equivocal response to exogenous pST administration may in part be influenced by litter size and therefore suckling demand. An earlier study by Smith *et al.* (1991) reported increased piglet weaning weights when pST was administered daily from day 7 to day 20 of lactation only when average piglet weight was greater than 2.6 kg on day 7 of lactation. The studies by Cromwell *et al.* (1992) and Toner *et al* (1996) both investigated the effects of exogenous pST administration to sows that supported relatively small average litter sizes, (8.0 and 8.2 piglets per litter respectively). Toner et al. (1996) suggested that the intrinsic limit for milk production must be exceeded before any benefits of recombinant pST administration are observed. The sow's genetic potential for milk production may also play a crucial role in the response to exogenous pST administration. In this present investigation, average piglet weight was greater than the 2.6 kg at day 7 suggested by Smith et al. (1991), and average litter size was maintained as high as possible throughout the study (minimum 9.5 piglets at weaning). Despite this, there was no improvement in litter weight gain with pST administration in this study. This may indicate that the intrinsic limit for milk production was still not achieved during this study despite the greater litter size/ weight. Alternatively, it is possible that under commercial conditions other factors such as disease status have a much greater impact on sow lactational milk yield and litter performance.

Sows administered pST from day 1 of lactation through to weaning consumed less feed than the control animals (7.4 %) and increased back fat loss by approximately 22 %. These results are consistent with previous studies in which decreased intake and/or greater back fat loss have been reported (Cromwell *et al.* 1992; Harkins *et al.* 1989; Toner *et al.* 1996). The greater back fat loss in the sows administered the extended pST treatment regime in this present investigation combined with the reduced body weight loss suggests greater body protein retention during lactation. Previous studies have detailed the metabolic changes associated with pST administration to sows during lactation. Toner *et al* (1991) reported reduced plasma urea nitrogen concentrations with the administration of pST, indicating a greater use of amino acids for protein accretion. The

body composition and live weight data obtained in this present study support this observation and indicates that older parity sows may also preferentially utilise exogenous pST for increased lean tissue deposition rather than improving milk yield. The herd's maternal genetics may also play a role in the sow's preference for lean tissue accretion versus increased milk yield, with the genetic potential of growing animals known to influence the response to pST administration (Krick *et al.* 1992).

There was a small concern that the daily administration of pST to sows during lactation may have adverse effects on sow health. This concern arose from studies in the 1980's to early 1990's in which several authors reported a number of sow deaths. In one such study, Smith *et al.* (1991) reported a high proportion of sow deaths when sows were administered up to 16 mg recombinant pST/d from day 7 to day 20 of lactation. In this study, the authors indicated that the deaths were caused from haemorrhaging of ulcers that developed at the pars esophagea. In a subsequent study by Cromwell *et al.* (1992), sows administered 6 mg pST per day from day 108 of gestation to day 24 of lactation suffered from apparent heat stress when the treatments were imposed during the summer months. This resulted in a number of sow deaths, with the majority of deaths occurring immediately prior to farrowing, during farrowing or within 2 days after farrowing. The administration of pST from day 1 of lactation in this present study did not have any negative effects on sow health. This may be due to the lower dose of pST administered in this present study compared to those of Smith *et al.* (1991) and Cromwell *et al.* (1992), combined with the fact that this present investigation was undertaken during spring, and that pST was not administered prior to or during farrowing.

5. Conclusion

The daily administration of recombinant pST during the lactation period (either from day 1 of lactation to weaning or from day 14 of lactation to weaning) did not improve lactation performance of sows in this investigation. The absence of any improvement in piglet growth rates or pre-weaning mortality suggests that milk yield was not increased by the administration of pST. As such, the results from this investigation do not support the use of pST to sows during lactation when sows are producing litter gains of 2.2 kg/day under commercial conditions. Furthermore, the use of pST did not prevent cases of milking failure from occurring, so it is unlikely to be successful as an amelioration strategy for agalactia. In the absence of any improvement in litter performance in this study, together with the results from Toner *et al.* (1996) in which the administration of pST to first litter sows did not improve milk production, further investigation with first litter sows under commercial conditions does not appear warranted.

6. Limitations/Risks

Under commercial conditions there is likely to be many other factors that will have a large impact on sow milk yield and litter performance. The litters in this present investigation gained on average 2.2 kg/d, a satisfactory but not exceptional growth rate. It is possible that the response to pST during lactation may differ between herds due to other environmental, management or health factors.

7. Recommendations

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

- The administration of pST to sows during lactation (either the entire lactation period or from day 14 to weaning) is not supported under commercial conditions
- The administration of pST to sows during lactation as an amelioration strategy for agalactia is not recommended
- Investigation of the impact of pST administration during lactation to first litter gilts (CRC Stop/Go milestone) does not appear warranted

8. References

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