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Split suckling to improve colostrum ingestion, survival and performance of gilt progeny

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1.0 Acknowledgements

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2.0 Executive Summary

Split suckling is a management technique that involves separating the larger piglets in a litter from the sow for a predefined interval, allowing the smaller piglets a chance to consume adequate colostrum (Johnson 1970). Parity effects on piglet survival, the relative contribution of the maternal environment that the sow/gilt provides (colostrum quality and quantity, suckling frequency etc.) versus the direct piglet effect (or vigour) remains to be elucidated.

Immunocrit was measured as a crude but effective quantification of IgG in the piglet's serum and subsequently a measure of colostrum ingestion (Vallet et al. 2013b). Immunocrit had a small but significant relationship with survival from day 0 to weaning. Piglets from gilt litters had lower colostrum ingestion and hence a much greater incidence of scours, requiring more health treatments than sow litters (Table 2). No split suckling treatments were significantly different between gilts and sows. The overall survival rate was 90.3% of piglets and was not affected by split suckling or different between piglets from gilts or sows. The relative proportions of cause of death between gilt and sow piglets differed. Sow litter deaths dominantly occur by crushing whereas scours and Strep Suis were much greater in gilt piglets. Similarly, split suckling treatment did not influence piglet growth pre- or post-weaning and were not different between gilts and sows. This suggests that the increased levels of IgG previously reported in split suckling experiments are valid under good farrowing house management with typical Australian litter sizes.

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3.0 Background to Research

Pre-weaning mortality is a source of economic loss with the lack of colostrum ingestion in the first 24 hours of life influencing this. Colostrum intake is strongly related to piglet survival (Vallet 2013a) as the benefits of colostrum include energy for heat production, antibodies (from the sow to combat disease), growth factors, hormones, gut development and growth and feed efficiency performance post-weaning (Bartolet al. 2013; Curtis and Bourne 1971; Frenyo et al. 1981; Le Dividich et al. 2005; Porter 1969; Xu et al. 2000).

Whilst efforts to increase colostrum production by the sow have been carried out (Jang et al. 2013; Wang et al. 2013), there is little literature available investigating management techniques aimed at increasing colostrum intake by piglets. There is some evidence to suggest that split suckling may be of benefit to piglet survival and growth (Donovan and Dritz 2000). Split suckling is a technique that involves separating the larger piglets in a litter from the sow for a predefined interval, allowing the smaller piglets a chance to consume adequate colostrum (Johnson 1970). Whilst it is clear that there are parity effects on piglet survival, the relative contribution of the maternal environment that the sow/gilt provides (colostrum quality and quantity, suckling frequency) versus the direct piglet effect (or vigour) remains to be elucidated. Given there are significant differences in placental development between gilts and sows, it is not unreasonable to assume that there may be differences in piglet vigour between parities. If this is indeed the case, and that piglets from gilt litters are at a disadvantage with regards to vigour following birth, they may benefit from intensive farrowing husbandry techniques such as split suckling. Improvements in colostrum intake will increase piglet viability, immune defence and improve thermoregulation in the first few crucial days after birth.

4.0 Objectives of the Research Project

- Quantify the benefits of split suckling on colostrum ingestion and immunity.
- Quantify the benefits of split suckling on health, survivability and performance.
- Quantify the benefits of split suckling on health, survivability and performance of the sow compared with gilt progeny pre- and post-weaning.

5.0 Research Methodology

5.1. Animals, housing and diet

The experiment was conducted in accordance with the guidelines set out in the 'Code of Practice for the Care and Use of Animals for Experimental Purposes' and received approval from the University of Adelaide Animal Ethics Committee (no. 017761). This experiment utilised 423 sows from parities 0-7 and their litters, giving a total of some 4,600 piglets. On days 111 to 114 of gestation, sows were loaded into traditional farrowing crates containing a creep area with solid mat flooring and heat provision via a creep lamp. Sows were fed 2.5kg/day of a commercial lactation diet until farrowing, and fed ad libitum from farrowing to weaning.

Twelve to 24 hours following parturition, piglets were fostered to the number of functional teats on the sow's udder. The only case in which additional litter disturbance occurred was when piglets were observed to be losing condition. When this occurred, a new nurse litter was created by removing all poor condition piglets and placing them on a weaned or recently farrowed sow depending on the age of the piglets. All piglet movements were recorded. Every piglet was given the same level of husbandry. Piglets received medication on an as needs basis for diseases with all piglet medications recorded. Piglets were weaned at an average age of 24 days.

The experiment was conducted over three batches between the end of April and July 2014. Within each batch all treatments were represented equally. The farrowing location of each sow and litter was recorded.

5.2. Experimental Treatments

Each sow was randomly allocated to one of the following three treatment groups:

5.2.1. Treatment 1: Rotational Split Suckling.

The rotational method of split suckling (143 sows (41 nulliparous sows, 102 multiparous sows)) involved the whole litter being split into two random groups. Groups were rotated hourly for four hours. Piglets were either in the farrowing crate with access to the udder or they were placed inside a warm, dry box at the rear of the crate. This allowed each group of piglets to receive two suckling events.

5.2.2. Treatment 2: Conventional Split Suckling.

The Conventional Split Suckling (139 sows (41 nulliparous sows, 98 multiparous sows)) treatment involved separating the two to six largest piglets that had a stomach full of colostrum into a warm, dry box from the sow for approximately two hours, leaving the smaller piglets on the sow with reduced competition at the udder.

5.2.3. Treatment 3: Control.

The control (141 sows (42 nulliparous sows, 99 multiparous sows)) treatment involved no split suckling.

Treatment one and two were implemented between the hours of 0700 and 1100 before any piglet fostering occurred to ensure the split suckling event was conducted on the birth sow.

5.3. Data collection

Only sows that had farrowed the previous night were included in the investigation. For each litter the sow identification, parity, litter size and functional teat number was recorded.
Litter size was counted when treatment had commenced and so was defined as number of live piglets, i.e. did not include the piglets which were born alive and had died before treatment had commenced. On day 0, all piglets received an individual identification ear tag, were weighed, recorded for rectal temperature, sexed and scored for vigour (Table 1).

Table 1: Subjective vigour score (0-3) adapted from Herpin et al. (1996)

Vigour score	
0	Dead
0.5	Alive but no noise, barely moving
1	Moving slightly
1.5	Movement, stands up willingly
2	Must make noise, confident movements
2.5	Makes noise, some attempts of escaping (when holding must try to look at handler), rapid movements
3	Actively looking for something, moving around in box, makes noise and attempts to escape, when holding resists restraints.

On day 1, the two largest and two smallest piglets from each litter were chosen as 'focus piglets' (n = 1751). Each focus piglet had their rectal temperature taken, a day 1 vigour score (Table 1) and a 3mL blood sample collected from the jugular vein using a 21g needle into serum blood tubes. Glucose was recorded immediately after blood collection (Accu-chek, Australia). After glucose analysis, the blood was stored at 4°C overnight. The following day, blood tubes were centrifuged at 3000 rpm for 30 minutes and duplicate serum samples were then frozen at -20°C and stored for later analysis. Serum samples from individual piglets were measured using a previously validated estimation of IgG concentration (Immunocrit; Vallet et al. 2013b). Immunocrit is defined as a proportion of protein in serum and therefore is unit-less.

All pre-weaning deaths were recorded along with a cause of death. Survival was treated as three traits: survival during the first three days, from days 4-7, from day 8-weaning and the combined trait from day 0-weaning.

Individual piglets were weighed on day 0 and day 21 relative to farrowing. At weaning, piglets were weaned into treatment group pens (n=33/pen), and pen weights were taken on day 0, day 10 and day 35 relative to weaning.

5.4. Statistical analysis

Pre-weaning traits were analysed with a generalised linear mixed model (SAS 9.3), with birth sow and rearing sow fitted as random effects. Fixed effects included sex, litter size, sow parity, and split suckling treatment after adjustment for birth weight. Post-weaning fixed effects included replicate, sex after adjustment for initial pen weight. Binary traits (survival) were analysed with a logistic transformation.

6.0 Discussion of Results

Immunocrit was measured as a crude but effective quantification of IgG in the piglet's serum and subsequently a measure of colostrum ingestion (Vallet et al. 2013b). IgG is the main antibody passed from sow to piglet through the colostrum (Curtis and Bourne 1971; Nguyen et al. 2013). In the present trial, treatment had no significant effect on the immunocrit reading. Split suckling treatment and litter size interaction only moderately improved immunocrit in the large litters in the SSam treatment (Table 2; P<0.05). Given the relatively low Australian litter sizes this is not likely to be of any commercial significance. These findings contradict those of Vallet (2013a) who indicated that split suckling improved access to colostrum for smaller sized piglets and piglets which are born later in the birthing process. This discrepancy may have been due to missing the crucial window of colostrum absorption by piglets as discussed in the limitations to the study. Split suckling did not influence the incidence of disease as expressed by litter scours, or the number of antibiotic treatments required for the incidence of all health issues until day 21 of lactation. Immunocrit had a small but significant relationship with survival from day 0 to weaning. Piglets from gilt litters had lower colostrum ingestion and hence a much greater incidence of scours, requiring more health treatments than sow litters (Table 2). No split suckling treatments were significantly different between gilts and sows.

The overall survival rate was 90.3% of piglets from 0 to weaning and this was a function of 95.1% 0-3 days, 98.3% 4-7 days and 96.3% from day 8 to weaning (Table 3). Of all the survival traits analysed, there was no significant effect of either of the split suckling treatments after day 3. From day 0 to 3 the SSam treatment had a small improvement (~3%; P<0.05) in survival over the control and rotational split suckling treatments, however, this improvement was not sustained until weaning. Immunocrit, which was an indication of colostrum intake, was related to survival, but the split suckling treatments did not affect immunocrit. Mortality of piglets form gilts compared to sows is as expected. A higher proportion of mortality occurred earlier in lactation in sow piglets and later in lactation for gilt piglets reflecting the type of mortality (i.e. crushing compared to scours/disease respectively; Figures 1 and 2). This is also reflected in the average age of death (Table 3).

Table 2: Mean ± s.e. immunocrit, incidence of scours (day 0-21) and number of treatments for scours of piglets from control (no split suckling), rotational (half litter split suckled and rotated hourly) and SSam (largest half of the litter removed for two hours)*

	Control	**Rotational**	**SSam**	**P-Value**	**Gilt**	**Sow**	**P-Value**
Immunocrit*	0.14 ± 0.00	0.13 ± 0.00	0.13 ± 0.00	NS	0.12^{a} ± 0.00	0.15^{b} ± 0.00	<0.0001
Scours (%)	20.5 ± 2.44	23.3 ± 2.39	24.1 ± 2.37	NS	37.9^{a} ± 3.02	7.20^{b} ± 1.95	<0.0001
No. of treatments	3.58 ± 0.07	3.62 ± 0.07	3.66 ± 0.07	NS	4.09^{a} ± 0.09	3.15^{b} ± 0.06	<0.0001

*Proportion; ^{ab}Means within row differ significantly at P<0.05
NS=Not significantly different

Table 3: Mean ± s.e. pre- and post-weaning survival of piglets from control (no split suckling), rotational (half litter split suckled and rotated hourly) and SSam (largest half of the litter removed for two hours from 0700) litters and gilt compared to sow litters

	Control	**Rotational**	**SSam**	**P-Value**	**Gilt**	**Sow**	**P-Value**
Pre-weaning							
Day 0-3 (%)	94.7^{a} ± 1.33	93.3^{a} ± 1.38	97.4^{b} ± 1.26	<0.05	97.1^{a} ± 0.97	93.5^{b} ± 0.78	<0.0001
Day 4-7 (%)	98.9 ± 0.98	97.8 ± 0.96	98.3 ± 0.98	NS	98.3 ± 0.97	98.3 ± 0.97	NS
Day 8-Wean (%)	97.1 ± 1.46	96.2 ± 1.44	95.5 ± 1.31	NS	93.3^{a} ± 1.11	97.5^{b} ± 0.86	<0.001
Day 0-Wean (%)	90.9 ± 1.92	88.6 ± 1.95	91.4 ± 1.88	NS	89.1 ± 1.49	89.6 ± 1.14	NS
Age at Death (day)	8.81 ± 2.11	5.63 ± 2.02	7.97 ± 1.73	NS	9.74 ± 1.47	5.21 ± 1.17	<0.05
Post-weaning							
Day 0-35 (%)	99.4 ± 0.44	99.5 ± 0.38	99.3 ± 0.39	NS	99.5 ± 0.43	99.5 ± 0.27	NS

^{ab}Means within row differ significantly at P<0.05
NS=Not significantly different

This study included large numbers of sows and piglets and despite multiple statistical models being fitted, there was no overall effect of split suckling treatment on piglet survival, other than that of small sized piglets. This was surprising given the finding of Vallet (2013a) who reported an increase in survival of 3.4% with split suckling. One possible explanation for this discrepancy is the reported relatively high survival rate in the present investigation. Over 90% of piglets survived to weaning. The survival rate in the study reported by Vallet (2013a) was considerably lower in control sows (84.9%) than that reported here. So, by implementing split suckling they improved survival to the same mean level in the present investigation. It could be argued that the rate of gain in survival would be more difficult at higher survival rates. One possible reason for the high survival rates could be the increased level of supervision provided on the commercial unit where the experiment was conducted. Similarly, given the very high post-weaning survival of this unit during the time the study was conducted it would be expected that split suckling treatment would have no impact.

The relative proportion of cause of death between gilt (Figure 1) and sow (Figure 2) piglets differed. Cause of death of sow piglets was dominated by crushing, whereas health issues (scours and Strep Suis) were much greater in gilt piglets. This may be supported by the lower colostrum ingestion of gilt piglets (immunocrit; Table 2). Given the large standard errors associated with cause of death and relatively low mortality in this study, split suckling treatment had no impact.

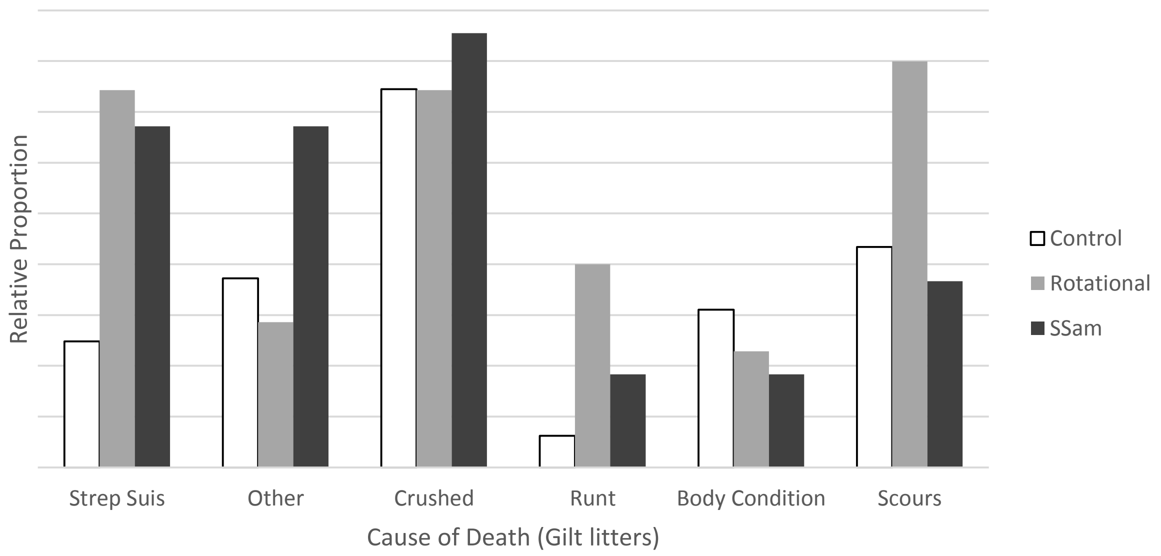

Figure 1: Relative proportion of cause of death of piglets from control (no split suckling), rotational (half litter split suckled and rotated hourly) and SSam (largest half of the litter removed for two hours from 0700) gilt litters

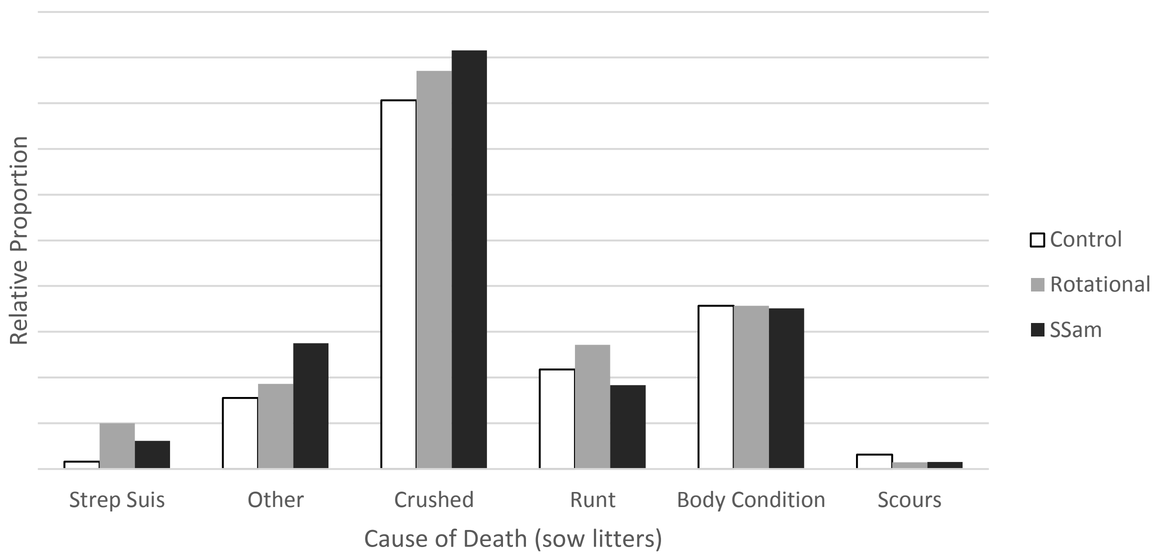

Figure 2: Relative proportion of cause of death of piglets from control (no split suckling), rotational (half litter split suckled and rotated hourly) and SSam (largest half of the litter removed for two hours from 0700) sow litters

Survival of small piglets from the SSam treatment was 13% greater than small piglets in the rotational and control treatments (Figure 3; P<0.05). Change in vigour from day 0 to day 1 in small piglets from the SSam treatment was different by half a score from small piglets in the rotational split suckling and control groups (Figure 4; P<0.05). No change in vigour score was seen between treatment groups in large or normal piglets.

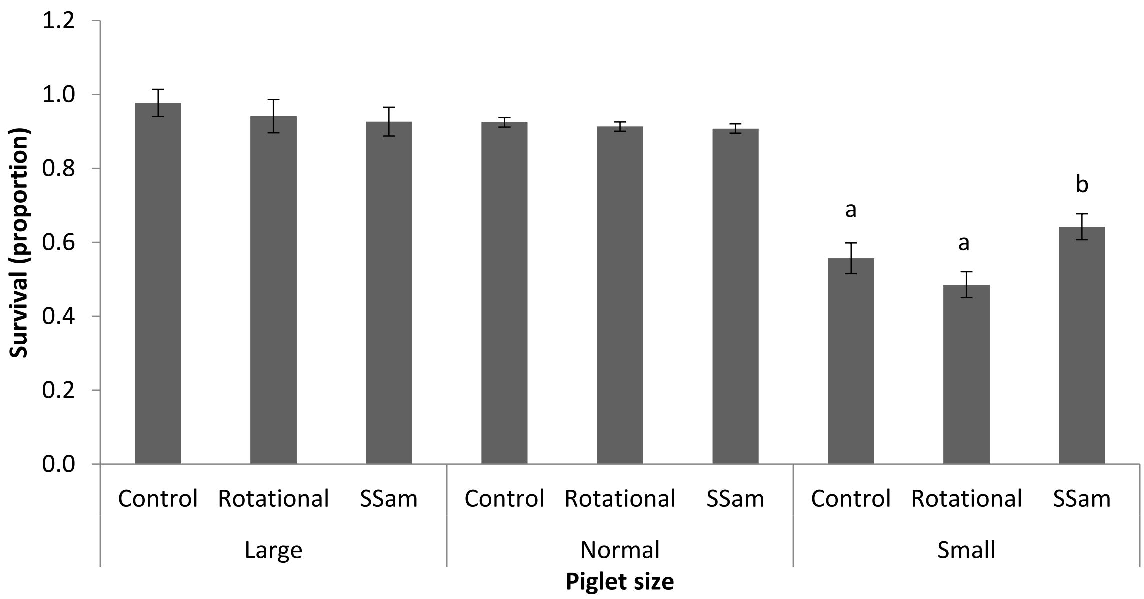

Figure 3: The relationship between pre-weaning survival and piglet size (small<0.85kg; 0.86kg>normal<2.07kg; large<2.08kg) from split suckling treatment groups and the control.

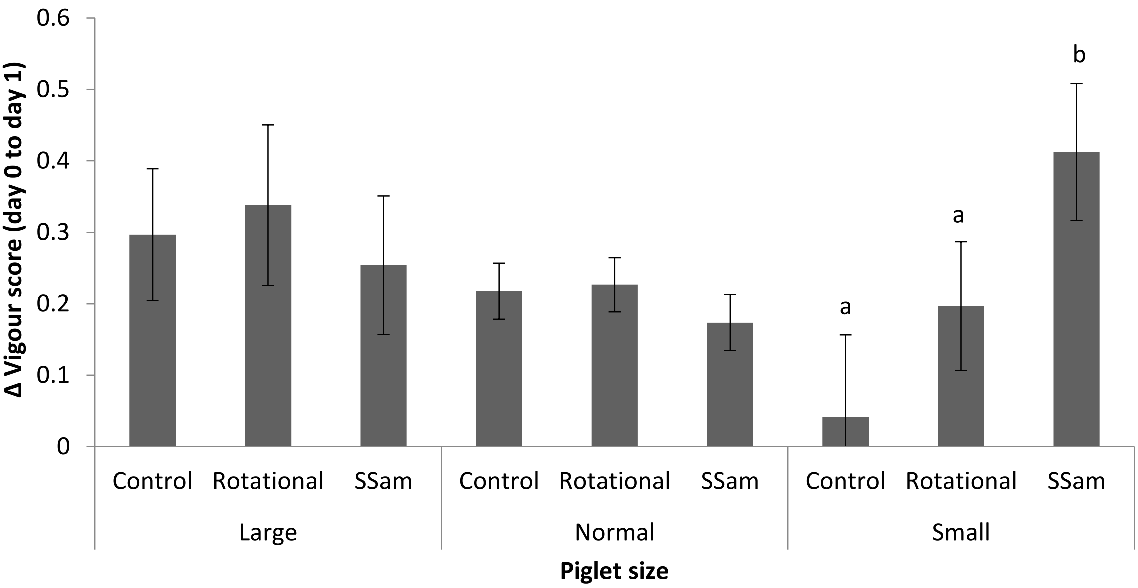

Figure 4: The relationship between change in vigour from day 0 to day 1 and piglet size (small <0.85kg; 0.86kg>normal<2.07kg; large<2.08kg) from split suckling treatment groups and the control.

Gilt piglets were more vigorous on days 0 and 1, had greater day 1 temperature and blood glucose on day 1 than sow piglets likely due to differences in gestation management between gilts and sows (Table 4). Change in vigour was not different between gilt and sow piglets indicating that lactation management did not play a role in the greater vigour, temperature and glucose parameters in gilt compared to sow piglets. It is unlikely that these improvements are of commercial significance though it must be noted that survival of gilt piglets in the first 3 days was greater. What role these parameters had in the improvement in survival of gilt piglets cannot be determined from the data set collected. Split suckling treatment had no effect on these parameters (Table 4).

During the pre-weaning stage, there was a negative effect of litter size on average daily gain (AGD; Table 5; P<0.001). Piglets from gilt litters recorded a lower ADG than those from sow litters at all times measured (Table 5; P<0.001). There was no effect (P>0.05) of split suckling treatment on the growth of piglets before weaning (Table 5; P>0.05). Similarly, split suckling treatment did not influence ADG after weaning (Table 5; P>0.05). No split suckling treatment by litter parity (gilt compared to sow) were significant. This suggests that the increased levels of IgG previously reported by Vallet (2013a) do not translate to significant improvements in growth under good management either pre- or post-weaning.

Table 4: Mean ± s.e. day 0 and day 1 vigour (0-3 scale), temperature (°C), change in vigour from day 0 to day 1 and day 1 blood glucose (mmol/L) of piglets from control (no split suckling), rotational (half litter split suckled and rotated hourly) and SSam (largest half of the litter removed for two hours from 0700) litters and gilt compared to sow litters.

	Control	**Rotational**	**SSam**	**P-Value**	**Gilt**	**Sow**	**P-Value**
D0 Vigour (0-3)	2.12 ± 0.03	2.02 ± 0.03	2.07 ± 0.03	NS	2.13^{a} ± 0.03	2.01^{b} ± 0.02	<0.0001
D1 Vigour (0-3)	2.31 ± 0.04	2.28 ± 0.04	2.35 ± 0.04	NS	2.37^{a} ± 0.03	2.26^{b} ± 0.03	<0.001
Change in Vigour (0-3)	0.19 ± 0.05	0.26 ± 0.05	0.28 ± 0.05	NS	0.24 ± 0.04	0.26 ± 0.03	NS
Day 0 Temp. (°C)	37.6 ± 0.07	37.6 ± 0.07	37.7 ± 0.07	NS	37.6 ± 0.06	37.6 ± 0.04	NS
Day 1 Temp. (°C)	38.1 ± 0.08	38.2 ± 0.07	38.2 ± 0.07	NS	38.3^{a} ± 0.06	38.1^{b} ± 0.05	<0.001
Day 1 Glucose (mmol/L)	6.65 ± 0.12	5.84 ± 0.12	5.96 ± 0.12	NS	5.93^{a} ± 0.11	5.69^{b} ± 0.08	<0.05

^{ab}Means within row differ significantly at P<0.05

NS=Not significantly different

Table 5: Mean ± s.e. average daily gain (ADG) of piglets from control (no split suckling), rotational (half litter split suckled and rotated hourly) and SSam (largest half of the litter removed for two hours from 0700) litters and gilt compared to sow litters.

	Control	**Rotational**	**SSam**	**P-Value**	**Gilt**	**Sow**	**P-Value**
Pre-weaning							
ADG day 0-21	225 ± 6.0	219 ± 5.8	220 ± 5.4	NS	193^{a} ± 4.4	225^{b} ± 3.4	<0.0001
Post-weaning							
ADG day 0-10	222 ± 5.2	227 ± 5.1	228 ± 5.3	NS	209^{a} ± 4.9	258^{b} ± 3.8	<0.0001
ADG day 10-35	551 ± 6.8	534 ± 6.7	554 ± 6.9	NS	543^{a} ± 6.6	563^{b} ± 5.1	<0.0001
ADG day 0-35	458 ± 5.3	447 ± 5.2	462 ± 5.4	NS	447^{a} ± 4.9	478^{b} ± 3.8	<0.0001

ADG=Average daily gain (grams/day); ^{ab}Means within row differ significantly at P<0.05

NS=Not significantly different

7.0 Limitations to Study

In the present study, split suckling treatments were implemented between the hours of 0700 and 1100 before any piglet fostering occurred to ensure the split suckling event was conducted on the birth sow with the treatments only applied after parturition was completed. Sows may have farrowed during the early afternoon or early hours of the evening but treatment implementation occurred the next day and could be up to 16 hours after farrowing, after sow colostrum production/quality has deteriorated and the gut permeability of piglets to large proteins (immunoglobulins) has declined. Most recommendations suggest that split suckling implementation should occur before 12 hours after the birth of the last piglet, and preferably during or immediately after parturition to ensure gut permeability of piglets and sow colostrum quality is maximised. The SSam treatment is the standard operating procedure on the commercial unit where the experiment took place.

8.0 Implications & Recommendations

- Split suckling does not improve colostrum ingestion, survival or performance of gilt piglets compared to sow piglets during the period the experiment was conducted.
- Split suckling improves the survival of smaller piglets within large litters through enhancing vigour of these piglets and not colostrum ingestion.
- Management techniques such as split suckling are a possible aid to help improve farrowing house performance, however, under already good management, and with Australia's relatively low litter size, the effects are likely to be minimal.

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10.0 Publications Arising

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Huser, JS, Kennett, TE, Plush KJ, Pitchford, WS, Lines, DS (2015) Neonatal split suckling has no impact on pre- and post-weaning piglet growth. In 'Manipulating Pig Production XV". Eds J, Pluske, J Pluske) Australasian Pig Science Association, Melbourne, Australia.