Summary of Research findings funded by Pig Regen Ltd 2009 - 2013

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Since 2009 Pig Regen Ltd have funded research in five main areas:

1) The efficient and effective use of starter diets pre and post weaning
2) The adoption of phase feeding for finishing pigs
3) Rate of feed use efficiency deterioration as pigs get heavier
4) Reducing the prevalence of salmonella on pork
5) Sow productivity

AFBI gratefully acknowledge funding for these studies from Pig Regen Ltd and the Department of Agriculture and Rural Development. The assistance of commercial farmers for validation of results was also gratefully received as was the assistance by AFBI, Hillsborough pig unit staff. The dedication by Dr Peter Cottney to complete a PhD in the area of sow productivity is also gratefully acknowledged as it was a significant contribution to the diversity of research conducted at AFBI, Hillsborough in recent years.

The following are short summaries of the studies conducted in the areas listed above. Full reports are available from Elizabeth Magowan, AFBI (028 92682484, Elizabeth.magowan@afbini.gov.uk) or Pig Regen Ltd.

The efficient and effective use of starter diets pre and post weaning

Greenmount benchmarking data suggested that some pig producers offered post weaned pigs on average 6 kg per pig of a starter 1 diet followed by 13 kg per pig of a starter 2 diet. It was suggested these levels could be significantly reduced and therefore savings could be made in the area of feed costs directly after weaning. Furthermore, the use of starter diets offered pre weaning i.e. creep feeding, was evaluated to investigate any opportunity for further reductions in feed costs at this early stage. A total of eight trials were completed which assessed the use of starter diets pre and post weaning on pig performance. Four of these trials were conducted on the research farm at Hillsborough and results were validated across four commercial farms.

Trials 1 – 5:

In the first five trials the starter 1 and 2 diets used were similar. Starter 1 diet contained 16.5MJ/kg of digestible energy, 22.5% crude protein and 1.7% total lysine. The starter 2 diet contained 15.5MJ/kg digestible energy, 21.5% crude protein and 1.55% total lysine. Both diets were commercially available and commonly used throughout Northern Ireland.

Findings:

In trials 1, 2 and 3 pigs reared on the AFBI, Hillsborough herd, were weaned at 28 days of age and weighed on average 9 kg at the start of the trials. In trial 1 pig performance (weaning to 10 weeks of age, approximately 30 kg) was similar whether they were offered 2, 4, 6, or 8 kg per pig of starter 1 diet. All pigs were also offered 10 kg per pig of starter 2 diet followed by a standard grower diet in the trial. In trial 2 all pigs were offered 4 kg per pig of starter 1 diet and pig performance (weaning to 10 weeks of age, approximately 30 kg) was similar whether pigs were then offered 6, 8, 10 or 12 kg per pig of starter 2 diet. Average daily gain of pigs across these two trials was 512 g/day and feed conversion efficiency was 1.32 between weaning and 10 weeks of age. In trial 3 when pigs were offered no starter 1 diet, their average daily gain and weight at 10 weeks of age was lower (by 57g/day and 2.2kg respectively) and their feed conversion ratio was poorer (by 5%) than that of pigs offered 2 kg per pig of starter 1 diet after weaning. In trial 3 the combination of better growth rate and

an improved feed conversion ratio when pigs were offered 2 kg per pig of starter 1 diet outweighed the extra investment in feed cost. Trials 4 and 5 were conducted on commercial farms. In these trials the initial average wean weight of pigs was lower (7.3 and 8.4kg respectively) but no improvement in growth rate or weight of pigs approximately 5 weeks after weaning was found when a higher allowance of starter diets (4 kg per pig of starter 1 diet followed by 8 kg per pig of starter 2 diet) were offered compared with a lower allowance (2 kg per pig of starter 1 diet followed by 6 kg per pig of starter 2 diet) (Table 1). However, feed conversion ratio (FCR) was improved significantly by 5% on Farms 1, and numerically by 3% on Farm 2 when the higher allowances of starter diets were offered.

Table 1 Effect of starter diet allowance on post weaning pig performance on two commercial farms

	Farm 1			**Farm 2**		
Starter diet allowance:	**Low**	**High**	**Different**	**Low**	**High**	**Different**
Wean weight (kg)	7.4	7.2	No	8.6	8.6	No
Weight (kg) : 37 days on Farm 1 41 days on Farm 2	9.7	9.5	No	12.3	12.1	No
Weight (kg): 58 days on Farm 1 62 days on Farm 2	18.4	18.9	No	23.5	23.8	No
Average daily gain (g/day)	350	361	No	438	439	No
Average daily feed intake (g/day)	455	449	No	595	561	No
Feed conversion ratio	1.30	1.23	Yes	1.32	1.28	No

Low allowance: 2 kg per pig of starter 1 diet followed by 6 kg per pig of starter 2 diet
High allowance: 4 kg per pig of starter 1 diet followed by 8 kg per pig of starter 2 diet.

Trial 6:

In this trial the same starter 1 and 2 diets were offered as in trials 1 to 5 above and starter 1 diet was also offered for 10 days before pigs were weaned, or not. In this trial there were four treatments: 1) pigs received no creep feed pre weaning and 2 kg/pig of starter 1 diet post weaning, 2) pigs received no creep feed pre weaning and 6 kg/pig of starter diet post weaning, 3) pigs received creep feed (starter 1 diet) for 10 days before weaning and 2 kg/pig of starter 1 diet post weaning, 4) pigs received creep feed (starter 1 diet) for 10 days before weaning and 6 kg/pig of starter 1 diet post weaning. All pigs then received 6 kg/pig of starter 2 diet, followed by a grower diet to 12 weeks of age and then a typical finisher diet to finish weight. Pig performance was monitored between weaning and slaughter.

Findings:

Average litter size was 10.4 pigs weaned and 83% of pigs offered creep before weaning were found to have consumed creep. Litters that received creep ate an average of 6.2kg (SD 3.3 kg) over the 10 day period pre weaning. However, offering creep had no significant effect on the growth rate of pigs over the 10 day pre weaning period (305g/day). Creep feeding pre weaning had no significant effect on pig weight, growth rate or feed conversion ratio at any stage of growth between weaning and slaughter. However, feed intake was significantly higher at several time points during the 12 days after weaning (Figure 1). There was no significant effect of starter 1 diet allowance on the weight of pigs at 10 or 20 weeks of age (average 30.3 and 87.7kg respectively). Pigs offered 6 kg/pig of starter 1 diet after weaning had a better ADG and FCR between 5 and 7 weeks of age than pigs that were offered 2 kg/pig which was expected. Furthermore, the average daily gain of pigs that were offered 6 kg/pig of starter 1 diet after weaning was 23 g/day better between weaning and 20 weeks of age than that of pigs that were offered 2 kg/pig of starter 1 diet after weaning (Table 2).

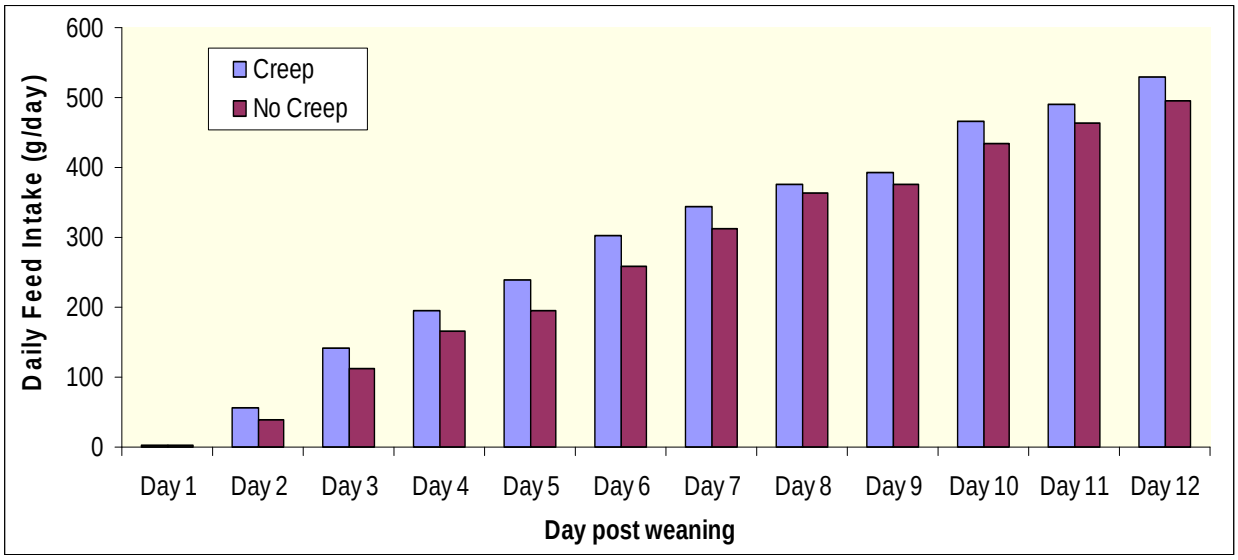


Figure 1 Feed intake in the days after weaning is increased when creep is offered for 10 days before weaning

Table 2 Effect of starter diet allowance on lifetime performance

		Starter 1 diet allowance		
	Pig Age:	**2 kg/pig**	**6 kg/pig**	**Different**
Live Wt (kg)	**10 days pre wean**	6.5	6.5	No
	Wean	9.6	9.5	No
	7wks	16.7	17.2	Almost
	10wks	29.9	30.7	Almost
	15wks	53.7	55.7	Almost
	20wks	86.8	88.6	No
Average daily gain (g/day)	**Wn-10wks**	494	517	Almost
	10-20wks	778	793	No
	Wn-20	702	725	Yes
Average daily feed intake (g/day)	**Wn-10wks**	722	719	No
	10-20wks	1962	1995	No
	Wn-20	1490	1505	No
Feed conversion ratio	**Wn-10wks**	1.47	1.39	Yes
	10-20wks	2.74	2.72	No
	Wn-20	2.13	2.08	Almost

Trials 7 and 8

Trials 7 and 8 investigated the use of creep feeding pre weaning on two commercial farms which weaned large numbers per litter.

Farm A:

Farm A had an average litter size of 12.8 piglets reared per sow and piglets had an average birth weight of 1.78kg. A total of 16 sows were used and all feed (sow and creep feed) was offered in dry pelleted form. On Farm A piglets were offered creep from 2 weeks of age at which stage they had an average weight of 4.3kg.

Farm B:

Farm B had an average litter size of 13 piglets reared per sow and the average birth weight of piglets was 1.55kg. Twenty sows were used and all sows received liquid feed during lactation. Piglets also received feed in liquid form (1 to 2.5 ratio of dry feed to water) which was offered from 10 days old when piglet average weight was 2.9kg.

Findings

Table 3 reports pig performance to the end of stage 1 on both farms when piglets were offered creep before weaning or not. Creep feed 'usage' per litter averaged 5.7 kg on Farm A and 7.3 kg (dry feed) per litter on Farm B. On Farm A there was an improvement in wean weight as a result of creep feeding however there was no improvement found on Farm B. The improvement in wean weight on Farm A supported an improvement in stage one weight but the effect disappeared by the time pigs reached the end of stage two (51kg).

Table 3 Effect of feeding starter diet before weaning (creep feeding) on two commercial farms

		Farm A			Farm B		
		Creep	**No Creep**	**Different**	**Creep**	**No Creep**	**Different**
Live weight (kg)	**Wean**	8.45	8.06	Almost	8.69	8.74	No
	Stage one	27.3	25.2	Yes	24.8	24.3	No
	Stage two	51.3	51.2	No	-	-	-
Average daily gain (g/day)	**Period of creep feeding**	266	247	Almost	283	284	No
	Stage one	498	453	Yes	473	458	No

Conclusions:

Starter diet allowance after weaning:

- Producers could feed lower allowances of starter diets than those identified as being offered by Greenmount Benchmarking data.
- However, the elimination of starter 1 diet from the post weaning dietary regime reduced pig performance and the financial investment in starter 1 diet was outweighed by the improved performance
- Overall, starter diets are required, in the correct balance, to optimise production performance.
- The correct balance will vary between farms but it is suggested that producers should investigate allowances of between 2 and 4 kg per pig of starter 1 diet and between 4 and 8kg per pig of starter 2 diet when trying to identify the correct balance for their pig production system.
- Lifetime improvements in ADG and FCR are possible when offering higher levels of starter 1 diet but the improvements are small. Therefore the economic benefit of higher starter 1 diet allowances is questionable when feed costs are high.

Offering starter diets before weaning (creep feeding)

- Feed intake after weaning will be improved when creep is offered for 10 days pre weaning
- Other studies have found no further benefits when offering creep feed pre weaning for longer time periods
- However creep feeding pre weaning has rarely been fund to translate into improved growth rate after weaning but has been found to improve gut health and structure.
- When litter size is low and sow feed intake is high and therefore wean weights are good (approximately 8.5kg), creep feeding is unlikely to improve the wean weight of piglets.
- However, when litter size is high, creep feeding may improve wean weight on some farms.

The adoption of phase feeding for finishing pigs

The diet of finishing pigs in Northern Ireland commonly contains at least 18.5% crude protein (CP) and 1.1% total lysine and this diet is normally offered throughout the entire finishing period. However, it was suggested that there is an opportunity to reduce the level of lysine and crude protein offered to pigs in Northern Ireland and hence lower feed costs. Over two studies the use of diets with lower lysine content in the late finish period were trialled (i.e. the use of phase feeding). In addition the individual response of boars and gilts to diets varying in lysine content was compared.

Trial 1

Three diets, as similar in ingredients as possible, were formulated to contain either (1) 1.1% total lysine, 18% CP; (2) 0.95% total lysine, 18% CP or (3) 0.8% total lysine, 16.7% CP. A total of 160 pigs (Tempo crossbred) were offered these diets within four dietary regimes which were (1) 1.1% total lysine diet offered from 40 to 120 kg; (2) 0.95% total lysine diet offered from 40 to 120 kg; (3) 1.1% total lysine diet offered from 40 to 80 kg followed by the 0.8% total lysine diet offered from 80 to 120 kg and (4) 0.95% total lysine diet offered from 40 to 80 kg followed by the 0.8% total lysine diet offered from 80 to 120 kg.

Findings:

Pig performance (growth rate, feed intake and feed conversion ratio) was similar across all four dietary regimes when the entire finishing period (40 to 120 kg) was considered (941 g/day, 2387 g/day and 2.55 respectively). However, the feed intake of pigs in the latter finishing period (80 to 120 kg) increased significantly when the 0.8% lysine diet was offered and this effect was most pronounced when the 1.1% lysine diet preceded it during the early finishing period. Overall feed costs were reduced by £1.24 per pig when a 0.95% lysine diet was offered compared with a 1.1% lysine diet throughout the whole finishing period. While no saving in feed cost or reductions in nitrogen excretion were realised using the two phase regime of 1.1 to 0.8% lysine diets (due to the elevated feed intakes during the late finish period) there were significant feed cost savings and a lowered N excretion when the two phase regime of 0.95% lysine (18% CP) to 0.8% lysine (16.7% CP) diets were used. Feed costs were lowered by £1.96 per pig and a 5.6% reduction in N excretion was

estimated using the two phase regime of 0.95 to 0.8% compared with when the 1.1% lysine diet was offered. However, feed costs and the cost per kg gain was similar when the 0.95% lysine diet was offered throughout the entire finishing period compared with the two phase regime of 0.95 – 0.8% total lysine.

Trial 2

A total of 480 pigs (PIC 337 cross bred) were penned in groups of 10 and six treatments were compared. Pens of pigs represented 1) all boars, 2) all gilts and 3) 50:50 mixture of gilts and boars. These pens of pigs were offered either a single diet between 12 weeks of age (44 kg) and 120 kg (crude protein (CP) 18%, lysine 0.95%) or a two phase dietary regime where the aforementioned diet was offered between 44 and 80 kg and a diet containing 16.7% CP and 0.8% lysine was offered between 80 and 120 kg. This phase feeding regime was similar to that used in trial 1 above.

Findings:

The performance of pigs was similar when the phase feeding or single diet was offered throughout the finish period. Pig growth rate averaged 905 g/day and feed conversion ratio averaged 2.56 between 44 and 120 kg across the two dietary regimes. The 18% CP, 0.95% lysine diet cost £6 per tonne more than the 16.7% CP, 0.8% lysine diet. Therefore, due to the lack of difference in the performance of pigs but differences in feed cost and nitrogen content of the diets, nitrogen excretion was reduced by approximately 8% and finisher diet costs were approximately £1.00 per pig lower when the two phase dietary regime was offered.

The overall performance (ADG and FCR) of gilts was poorer than that of boars between 44 and 120 kg (Table 4). Although the kill out percentage of gilts was better than boars (77.7 vs 76.1%), their back fat depth (probe) was 0.9 mm greater (12.4 vs 11.5 mm). The performance of the ‘mixed’ gender pens was intermediate to that of gilts and boars during the finishing period which was expected and gilts and boars performed equally in either single of mixed gender groups. Furthermore, the performance of gilts offered the single diet or two phase dietary regime was similar as was that of boars when offered either dietary regime.

Table 4 Effect of pig gender on finishing pig performance

		Boars	**Gilts**
Average daily gain (g/day)	45 – 80kg	911	850
	80-120kg	972	874
Feed conversion ratio	45 – 80kg	2.21	2.39
	80-120kg	2.71	3.06

Conclusion

A total lysine level of 0.95% is adequate to support pig growth rate in early finish (40 to 80kg) and 0.8% lysine is adequate to support it in late finish (80 to 120kg). Offering a two phase feeding regime where lysine is reduced from 1.1% to 0.8% could increase feed intake in late finish and therefore null any economic or environmental benefits due to phase feeding. However, a phase feeding regime where lysine content is reduced from 0.95 to 0.8% supports pig performance and economic benefits (approximately £1 per pig in finishing pig costs) and environmental benefits (a reduction in N excretion) can be realised. Using these levels of lysine, the performance of boars and gilts was not negatively affected. Overall the performance of boars was better than gilts but their combined performance was similar when they were in allocated to single gender or mixed gender pens. However, due to the difference in the performance between boars and gilts, split gender grouping may have benefits when marketing pigs as it will be noted in the next few pages how the rate of feed use efficiency deterioration as pigs get heavier is different for different categories of pigs.

Rate of feed use efficiency deterioration as pigs get heavier

It is well known that as a pig grows it becomes less efficient at converting feed to weight gain (i.e. FCR deteriorates). When feed costs are high, producers aim to extract as much carcass value from each pig as possible. As such, taking pigs to heavy slaughter weights is an attractive method to combat high feed costs. However, the point at which this becomes uneconomic is dependent on the rate of FCR deterioration.

Trial

One hundred and fifty three Tempo cross bred pigs were housed in the specialised pig research facility which records the daily feed intake of individual pigs housed in groups. The feed intake of each pig was recorded from 16 weeks of age (approximately 67 kg) to a slaughter weight of 120 kg. Pigs were weighed twice weekly. Pigs were sent for slaughter over a three week period. Twenty-nine pigs reached at least 120 kg when they were approximately 22 weeks of age and they were sent in week 1 (fast growing pigs), 43 pigs reached at least 120 kg the following week (medium growing pigs) and the remaining 80 pigs were sent in the 3rd week (slow growing pigs).

Findings

In agreement with the work presented in the previous summary, the ADG and FCR of boars was better than gilts. As such the majority of the fast growing pigs were boars and they had an average daily gain between weaning and slaughter of 891 g/day. The medium growing pigs were a mixture of gilts and boars and had an average daily gain of 853 g/day between weaning and slaughter. The slow growing pigs were mainly gilts and had an average daily gain of 770 g/day between weaning and slaughter. It should be noted that the growth rate of all the pigs was considered good. Table 5 reports the performance characteristics of the fast, medium and slow growing pigs. As expected the slow growing pigs were the lightest at the start of the test period and the fast growing pigs were the heaviest (Table 5). In this study it took an extra 26.2 kg of feed/pig to get the slow growing pigs to 120 kg compared with the fast growing

pigs. This was mainly due to the fact they were on farm for a longer period of time since they were lighter at the start of the test period.

Figure 2 shows the feed cost, which is a reflection of feed intake, of the fast, medium and slow growing pigs for each 10 kg increase in slaughter weight between 90 and 120 kg. As slaughter weight increased it took an increasing amount of feed to gain 10 kg which indicates that FCR was deteriorating, as expected. Furthermore, Figure 2 demonstrates that the FCR of slow growing pigs was deteriorating faster than that of medium and fast growing pigs. For example, the FCR of fast growing pigs between 90 and 100 kg was 1.82 but between 110 and 120 kg was 2.23. For slow growing pigs the FCR between 90 and 100 kg was 2.26 but between 110 and 120 kg was 3.24. The feed costs in Figure 2 are based on the finisher ration costing £300 per tonne. Assuming that carcass value for code 1 pigs is £1.36 per kg, the economics appear to remain positive, using only feed costs, to take fast and medium growing pigs to 120 kg, even if these pigs slipped into code 2 due to increased fatness at this heavy weight. However, the feed cost to increase the weight of slow growing pigs from 110 to 120 kg would almost out-weight the extra carcass value attained. However, it is reiterated that the growth rate of all the pigs in this study was good and even the 'slow' growing pigs were on average 117 kg at 169 days of age. Furthermore, in this study, the space allowance of pigs was adequate up to 120 kg. If space allowance is restricted, previous research has shown that in addition to other negative implications, feed intake will decrease and growth rate will be slower. Therefore if producers plan to take pigs to heavy slaughter weights they need to ensure space allowance is adequate in order to maximise growth rate.

Conclusion

The FCR of all pigs deteriorated as pig weight increased. However, the FCR of slower growing pigs (which are usually mainly gilts) deteriorates faster than that of fast growing pigs (which are usually mainly boars) as pigs approach heavy slaughter weights. As such, when feed costs are high it is unlikely that there are any economic benefits in rearing slow growing pigs to 120 kg live weight. It should be noted that although the pigs were sent for slaughter over a 3-week period, which is similar to commercial practice, the growth rate of even the slow growing pigs was good. They

achieved weights of on average 117 kg at 169 days of age. It should also be noted that the average backfat depth of all the pigs was over 14 mm. If taking pigs to heavy slaughter weight, producers need to examine the effect of this practice on backfat depth (using PiGIS for example), the cost of feed to get their pigs to 90 kg and if space allowance is adequate.

Table 5 Performance characteristics of the pigs sent for slaughter over the 3-week period.

		Fast growers	Medium growers	Slow growers
Age at slaughter (days)		156	162	169
16 week weight (kg)	**Average**	70	67	61
	Minimum	62	58	48
	Maximum	79	77	74
Slaughter weight (kg)	**Average**	123	123	117
	Minimum	118	118	97
	Maximum	133	132	130
Average daily gain (g/day)	**16 weeks of age to slaughter**	1198	1129	1002
	Weaning to slaughter	891	853	770
Feed intake (kg)	**16 weeks -120 kg**	122.3	132.9	148.5
Feed use efficiency	**16 weeks -120 kg**	2.32	2.35	2.60

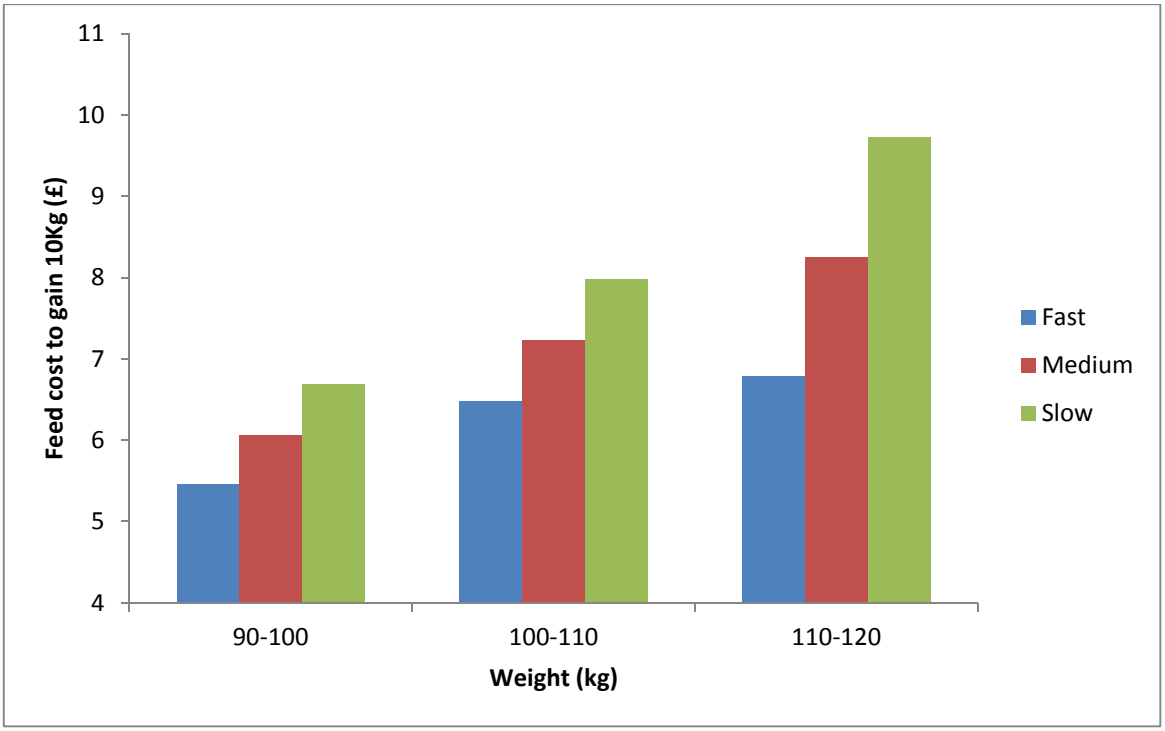


Figure 2. Feed cost (£) for each 10 kg increase in live weight of fast, medium and slow growing pigs between 90 and 120 kg (feed cost based on £300/tonne)

Reducing the prevalence of *Salmonella* on pork

Unfortunately *Salmonella* infection from pork remains a risk factor to human health and as such requires a concerted effort within the pig industry to ensure it is minimised between farm and fork. To support these efforts and in conjunction with the UP&BF, Pig Regen Ltd successful attained funding under DARD's Research Challenge Fund programme to conduct studies which focused on reducing *salmonella* on pork. The research programme encompassed a total of 6 studies which were conducted across two large abattoirs and a number of farms. Five studies have been completed and the last study is currently underway. The following outlines the main findings from the five studies:

1) Longitudinal farm study

In total 5 herds with high ZNCP scores were identified. Within these herds, 10 sows were identified and 5 piglets from the litter of each sow were followed from weaning to slaughter. Blood and faeces samples from sows were taken at weaning. Blood and pen faeces samples from pigs were taken at weaning, 7, 10, 13, 16, 19 and 22 (before slaughter) weeks of age. Before slaughter, on farm the rectum of pigs was swabbed and faeces from their gut were taken after slaughter. The lorry interior and lairage floor were swabbed both before and after the pigs were present.

Findings

A high prevalence of *Salmonella* was present in the sows (10% in faeces at weaning and 80% antibody response). The probability of piglet blood having a positive antibody response was high (91%) when the mother's faeces tested positive for *Salmonella*. It was not possible to comment if these antibodies are maternally derived or as a result of an immune response. Over the period studied there were few strong correlations between the presence of *Salmonella* in faeces and blood antibody status. There was a strong probability (94%) that gut faeces post slaughter would be positive if faeces just before slaughter was positive. However, there was also a 33% probability of gut faeces being positive post slaughter when faeces sampled just before slaughter were negative. Overall the prevalence of *salmonella* found in the gut of animals after slaughter was double the prevalence of *salmonella* found in faeces

samples on farm in the few days before slaughter. This suggests a significant impact of transport. One farm offered pigs 'Bact-A-Cid' in the finisher diet and this was the only farm where gut faeces were negative on the slaughter line. The final trial in this programme of research is designed to test the effect of Bac-A-Cid in finisher feed to decrease the prevalence of *salmonella* in the gut after slaughter.

2) Carriage of *Salmonella* by pigs at slaughter.

To determine the prevalence of *Salmonella* in the gut of pigs on the slaughter line 120 herds were studied (40 at Dunbia and 80 at Vion). A sample of faeces was taken from the gut of each of 5 pigs from each herd after the viscera had been sent to the gut room. The ZNCP status of these herds was attained and matched with presence or absence of *Salmonella*. PCR-based analysis was also conducted on positive samples to quantify the level of *Salmonella* in the faeces.

Findings

The prevalence of *salmonella* in faeces samples taken from the gut after slaughter was 54%. However, the actual level of *salmonella* present in samples was low which negated the overall risk of the high prevalence. Whilst the number of herds with positive faeces samples increased as ZNCP score increased, the prevalence of *salmonella* in faeces from pigs whose herd had a ZNCP score of less than 10% was also 54%. This prevalence supports the theory that transport (and possibly lairage) are key factors in the transfer of *salmonella* from farm to abattoir.

3) One week surveillance of carcass hygienic quality

Over the period of one week a total of 100 carcasses (5 carcasses at 4 time points per day over 5 days) at each abattoir (Dunbia and Vion) were swabbed to assess the effectiveness of slaughterhouse hygiene to produce 'clean carcasses'. Overall, abattoir practices were found to be highly effective at reducing any contamination of carcasses as they entered the chill.

4) Use of farm factors to predict *salmonella* risk

A total of 71 herds in NI were surveyed to attain a profile of their farm practices and the total number of sows included in the dataset represented 40% of the NI herd. The results from the survey were correlated with the ZNCP score of the herd.

Findings

Housing and feeding practices did not varying greatly for dry or farrowing sows or weaned pigs. This lack of variation in farm practices limited the ability of the statistical analysis to determine factors promoting good or poor ZNCP scores but ZNCP scores ranged from 10 to 70% across similar practices for these categories of pigs. However, practices varied more for growing and finishing pigs. Overall no individual farm practice explained any level of variation in ZNCP score. After a multi variate analysis, a 'best fit' equation was established. The variables within this equation included 1) the method used to clean and disinfect growing pig accommodation, 2) whether producers mixed their own meal for growers or not, 3) the strategy to empty growing pig pens, 4) whether producers offered growers wet feed or not and 5) the number of key elements met with regard to the management of sick and dead animals. This equation was statistically significant but explained only 34% of the variance in ZNCP score observed and therefore the equation was weak in its ability to predict ZNCP score. However, the variables used in the equation were also found by other workers to affect the *Salmonella* prevalence on pig farms. In agreement with other workers, the combination of effects, especially of feeding and biosecurity practices for growing pigs, appeared to promote a lower level of *Salmonella* prevalence on farms. With regards to feed, coarse grinding and feed in meal form appeared to lower *Salmonella* prevalence but it should also be noted that this feed form has been found to significantly reduce the feed use efficiency (FCR) of pigs by 9% compared with 'fine pelleted' feed.

5) Prevalence of *salmonella* on final product

In each of the two major processing plants in Northern Ireland up to five random samples per working day over a 3-month period were collected. These samples represented product that was packed and ready to be distributed for human consumption. Overall, 415 samples were analysed and 14 (3.37%) yielded *salmonellas.* The results indicate that hygienic slaughter and processing practices are minimising the transfer of *salmonellas* from live pigs to final product in the two principal abattoirs in Northern Ireland.

Sow productivity

This series of five studies represents a PhD study funded by Pig Regen Ltd and conducted by Dr. Peter David Cottney at AFBI, Hillsborough. Two studies focused on 'gilts', two on nutrition during gestation and one on nutrition during lactation.

Trial 1: The optimum heat number to serve gilts.

Current recommendations are to mate gilts on their second or third oestrus cycle (heat). However, to reduce non-productive days it is tempting to serve gilts earlier and on the other hand gilts are sometimes not served until later heats for a range of reasons. Using a total of 157 gilts born between 2002 and 2006 and mated on either their 1st, 2nd, 3rd, 4th or 5th heat number the optimum heat number to serve gilts on to optimise lifetime performance was investigated. Litter and reproductive data were collected on a continual basis until all animals had completed their commercial reproductive life. Sows were culled as of normal commercial practice and reason for culling was classified into groups.

Findings

There was no effect of heat number at first service on first litter performance (piglet birth weight, number or daily gain between birth and weaning) or sow performance (feed intake during lactation, weight change during lactation or weaning to service interval). However, over their lifetime, gilts served on their fourth and fifth heat had fewer numbers of piglets born alive and weaned and gilts served on their fifth heat also completed fewer parities compared with gilts served on their first, second or third heat (Table 6). Gilts served on their third heat had the greatest number of piglets born alive and weaned over their lifetime but completed a similar number of parities to those gilts mated on their first, second and fourth heat (Table 6). Although, there was no statistically significant effect of heat number at first service on the total weights of piglets born alive or weaned over the sows lifetime (Table 6) data reflect that of number born and weaned and overall gilts served on their 3rd heat weaned 150kg more weight of pigs than gilts served on their fifth heat. There was no effect of heat number

at first service on reason for culling (e.g. lame, poor performance, reproductive problems, age).

Conclusion

Whilst the heat number that gilts are first mated on may not affect first litter performance, it affects the lifetime performance of gilts. This study suggests that the third heat is the optimal heat to mate gilts, as this resulted in these gilts producing significantly more piglets over their lifetime. This improvement in lifetime performance offset the cost associated with extra feed required to keep the gilts until their 3rd heat.

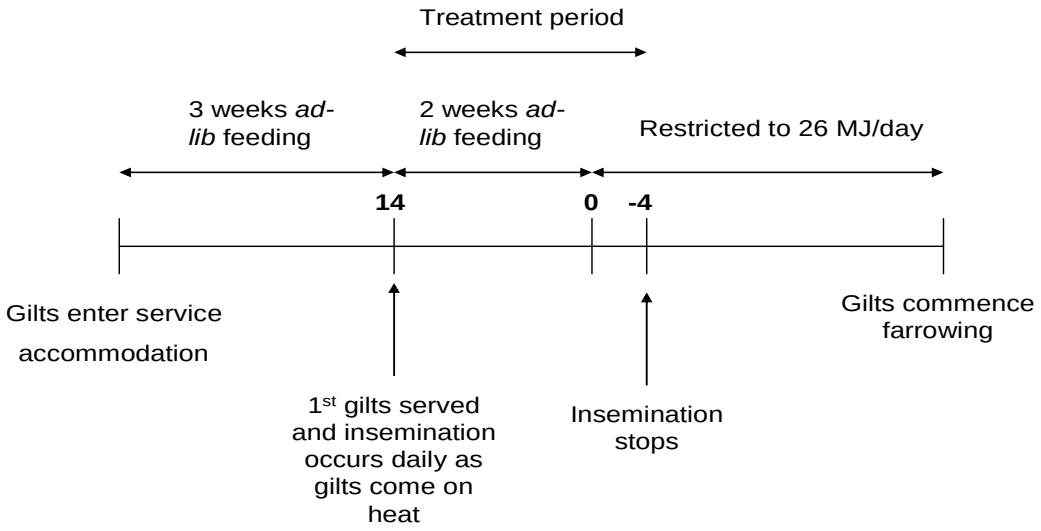
Table 6 Lifetime performance of gilts when first served on different heat numbers

	Heat number at 1st service					
	1	**2**	**3**	**4**	**5**	**Statistically Different**
Number of completed parities	6.26[b]	6.01[b]	6.57[b]	5.43[ab]	4.61[a]	Yes
Age at culling (d)	1183	1127	1246	1173	1029	No
Number of piglets born alive	71.8[c]	72.7[c]	78.7[d]	64.8[b]	53.3[a]	Yes
Number of piglets weaned	59.1[cd]	56.7[c]	61.4[d]	49.7[b]	42.5[a]	Yes
Weight born alive (kg)	105	107	119	95	80	No
Total weight weaned (kg)	505	488	526	446	377	No

[a,b,c] Means sharing the same letter in their superscript are not different from each other

Trial 2: The effect of *ad libitum* feeding after insemination on the litter performance and farrowing rate of gilts

Ad-libitum feeding gilts pre-service (flush feeding) is a common practice used to maximize ovulation rate and litter sizes. However, it is often continued post service due to gilts being penned together but served over a three week period. Using data from a large commercial herd the effect of *ad lib* feeding post insemination was investigated. Treatments were based on the length of time that gilts were *ad libitum* or restrictively fed around the time of insemination. Within each time period, all gilts were penned together and inseminated over a 3 week period. *Ad libitum* feeding was implemented for a 3 week period prior to the 'insemination' period. However, over the three week 'insemination' period feed was offered *ad libitum* for 2 weeks after which it was restricted (see diagram below). Therefore, if gilts were inseminated on day 1 of the insemination period they would have been offered feed *ad lib* for 2 weeks (14 days) after insemination. Therefore treatments were the number of days (14 to 0) which gilts receive *ad libitum* feeding post insemination. Due to the restriction period, 4 additional treatments were included which represented the period of 'restricted feeding' post insemination.



Findings

Ad libitum feeding duration had no effect on the number of piglets born alive, dead or total born. However, the duration of *ad libitum* feeding post insemination did affect the percentage of sows that failed to farrowing (100 – farrowing rate). As the length of *ad lib* feeding post insemination increased, so did the proportion of gilts which failed to farrow. This amounted to an 8.7% increase in the number of gilts that failed to farrow between gilts which received 14 days *ad libitum* feed compared to those that received 0 days *ad libitum* feeding. In conclusion, this study found that *ad libitum* feeding post insemination had no effect on litter size at birth but did affect the percentage of gilts which failed to farrow. This research suggests that *ad libitum* feeding should be stopped prior to, or immediately after, insemination to increase the farrowing rates of gilts.

Trial 3: Effect of altering feed allowance in early gestation on sow and piglet performance at farrowing

Nutrition during early and mid gestation has been found to affect the reproductive performance of a number of species (e.g. sheep) but there is a lack of scientific knowledge on the effects of nutrition in early gestation on sow performance especially of more prolific genotypes.

Trial

A total of 106 multiparous sows on a large commercial herd in Northern Ireland (average parity of 4.6) were offered one of four feed allowance regimes during early gestation: 1) Flat rate: 2.4 kg/d from days 4-85 of gestation (total intake = 197 kg); 2) Low-High (L-H): 2.1 kg/d from days 4-28 of gestation and 2.6 kg/d from days 29-85 of gestation (total intake = 200 kg); 3) High-Low (H-L): 2.7 kg/d from days 4-28 of gestation and 2.3 kg/d from days 29-85 of gestation (total intake = 199 kg); 4) Low-High-Low (L-H-L): 2.0 kg/d from days 4-5 of gestation, 2.7 kg/d from days 6-28 of gestation and 2.3 kg/d from days 29-85 of gestation (total intake = 197 kg). After day 85 of gestation, all sows were offered a constant rate of 3.2 kg/d of gestation diet to day 108. Sows were then offered 2.5 kg/d of lactation diet until farrowing.

Findings:

Sows offered the flat rate and L-H treatments had a higher total weight of piglets born (22.44 and 22.06 kg, respectively) than sows offered the L-H-L and H-L treatments (20.10 and 20.29 kg, respectively). However, the sows offered the flat rate and L-H dietary regimes also had the highest number of mummified piglets at birth and overall there was no effect of dietary regime on the number or weight of live born piglets. Therefore, feed allowances in early gestation appear to have an effect on litter performance (total weight of piglets born) but the next challenge is to manipulate these allowances to improve the weight of live pigs born.

Trial 4: Use of high feed allowances in late gestation

There also appears to be a lack of scientific information in the area of nutrition in late gestation for modern, highly prolific sows. This study aimed to investigate the effects of offering high allowances of gestation and lactation diet between day 85 of gestation and farrowing on piglet and sow performance.

Trial

In total 81 multiparous sows were offered one of five feed allowance regimes. The feeding regimes were: 1) Control: 2.5kg/day of gestation diet from day 85 to 108 of gestation and 2.5 kg/day of lactation diet from day 109 of gestation until farrowing; 2) Medium – Low (M-L): 3.0 kg/day of gestation diet from day 85 to 108 of gestation and 2.5 kg/day of lactation diet from day 109 of gestation until farrowing; 3) Medium – high (M-H): 3.0 kg/day of gestation diet from day 85 to 108 of gestation and 3.0 kg/day of lactation diet from day 109 of gestation until farrowing; 4) High –Low (H-L): 3.5 kg/day of gestation diet from day 85 to 108 of gestation and 2.5 kg/day of lactation diet from day 109 of gestation until farrowing; 5) High-High (H-H): 3.5 kg/day of gestation diet from day 85 to 108 of gestation and 3.0 kg/day of lactation diet from day 109 of gestation until farrowing.

Findings

There was no effect of feed allowance in late gestation on piglet performance including piglet birth weights (1.72 ± 0.059 kg) or changes in sow condition (as determined by back fat depth). However, sows offered a high allowance between day 85 and 108 tended to put on more body weight in this period. During lactation, sows on the control treatment lost most body weight, followed by sows offered the H-H dietary regime. Sows on the other regimes lost little body weight during lactation. The total weight of piglets weaned per sow was greatest using the M-H treatment (100kg) but poorest using the M-L treatment (89kg). Although there were few significant benefits of a higher feed allowance on piglet or sow performance found, the results suggest that increasing feed allowance levels in late gestation may minimise weight loss compared with ‘flat’ feeding. Furthermore, benefits in total weight of pigs weaned may be realised using the correct combination of feed allowances (M-H in this study). On the other hand, very high feed allowances (e.g. H-H in this study) could negatively impact sow weight during lactation and does not further improve the total weight of pigs weaned.

Trial 5: Increasing the energy and lysine level of the lactation diet

The voluntary feed intake of sows, and especially gilts, during lactation is often lower than that required to support maximum litter performance and maintain the sow's body condition. Therefore the wean weight of piglets is often compromised. One way to compensate for this lower feed intake is to increase the levels of energy and lysine in the lactation diet so that more nutrients are consumed for every kg of feed.

Trial

A total of 51 sows and 61 gilts were offered either a normal lactation diet (13.7 MJ/kg DE, 190 g/kg CP, 10 g/kg total lysine) or a high energy and amino acid (lysine, methionine and threonine) lactation diet (14.4 MJ/kg DE, 190 g/kg CP, 12 g/kg total lysine) over a 28 day lactation period.

Findings

Voluntary lactation feed intake was high in this study (average of 6.6kg/day for gilts and 7.6 kg/day for sows) and it is likely that this was a large contributing factor to the lack of diet effect found. However, the average wean weight of pigs reared on sows which were offered the high energy and amino acid lactation diet tended to be higher (9.8kg) than that of sows offered the normal lactation diet (9.3kg). On the other hand, when gilts were offered the high energy and amino acid diet the wean weights of piglets tended to be lower (8.6kg) compared with when gilts were offered the normal lactation diet (9.0kg). This effect of diet was not reflected in other piglet performance measurements which suggests that it was a weak effect. Overall, parity was found to have a significant effect on sow feed intake and piglet performance (Table 7).

In conclusion, in this study, when lactation feed intake was naturally high, there were no benefits to using a high energy and amino acid lactation diet. However, in other studies where lactation feed intake has been lower, benefits on piglet performance have been found. Overall the performance of piglets reared on gilts was lower than that of piglets reared on sows, which was expected.

Table 7 Lactation feed intake and piglet performance when reared on sows or gilts

	Sows	Gilts	Different
Total 28 day lactation feed intake (kg)	213	185	Yes
Number of piglets born alive	12.1	10.4	Yes
Total litter size	13.0	11.2	Yes
Live litter weight (kg)	19.6	15.0	Yes
Average live birth weight (kg)	1.65	1.48	Yes
Number weaned	10.7	9.7	No
Weight weaned (kg)	103	84	Yes
Average wean weight (kg)	9.6	8.8	Yes