Finishing pig performance when using single gender grouping and phase feeding

by

Elizabeth Magowan

March 2013

www.afbini.gov.uk

TABLE OF CONTENTS

INDEX OF TABLES

ACKNOWLEDGEMENTS

The authors gratefully acknowledge funding for this research from Pig ReGen Ltd and the Department of Agriculture and Rural Development for Northern Ireland (DARDNI). This experiment was conducted through project DARD E&I 11/1/08. The authors also wish to acknowledge the pig unit staff at AFBI, Hillsborough for the exceptional care of the animals and diligence when conducting the experiment.

The Agricultural Research Institute of Northern Ireland was amalgamated with DARD Science Service to become the Agri-Food and Biosciences Institute (AFBI) on 1 April 2006.

1. Executive Summary

Phase feeding is commonly used throughout Europe. However, the majority of European pig production is based on castrates whilst entire male pigs are used in the UK and Ireland. The UK and Irish pig industries are hesitant about adopting phase feeding due to the unknown effect on pig performance, especially of entire boars. However, phase feeding should reduce diet costs and the excretion of nitrogen and ammonia. This study aimed to compare the performance of gilts and boars when penned in single or mixed gender groups and offered either a single diet throughout the finishing stage or a two-phase dietary regime. A total of 480 pigs were penned in groups of 10 and six treatments were compared (in a 2 x 3 factorial design). 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. The performance of pigs was similar when either of the two dietary regimes were offered ($P>0.05$). Pig growth rate averaged 905 g/day and feed conversion efficiency averaged 2.56 between 44 and 120 kg across the two dietary regimes. There was no overall effect ($P>0.05$) of dietary regime on carcass performance either. The 18% CP, 0.95% lysine diet cost £6 per tonne more than the 16.7% CP, 0.8% lysine diet. 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 compared with when the single diet was offered throughout the finishing period. With regard to the effect of pig gender, the overall performance of gilts was poorer (ADG 865 g/day, FCR 2.70; $P<0.01$ and $P<0.001$ respectively) than that of boars (942 g/day, 2.46) between 44 and 120 kg. Although the kill out percentage of gilts was better than boars (77.7 vs 76.1%, $P<0.01$), their backfat depth at P_2 (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 but the backfat depth of pigs in the mixed gender groups was higher than that of boars or gilts in the single gender groups (13.0 mm). When examining

the effect of grouping on the performance of gilts and boars separately, gilts and boars performed as well in single gender groups as in the mixed gender groups. However, when the boars were in mixed gender groups their backfat depth (probe) was greater than when they were in single gender groups (13.7 vs 11.7 mm, P<0.001).

In conclusion, the phase feeding regime used in this study did not significantly affect the performance of boars or gilts and as a result nitrogen excretion was reduced by approximately 8% and feed costs by approximately £1 per pig compared to when a single diet was offered throughout finish. These findings are in agreement with the results of other studies. In other studies, where differences in the response of gilts and boars were found due to lysine level, the levels used were more extreme than those used in the current study. The overall performance of boars (average daily gain and feed conversion ratio) was better than gilts so the main advantage of split gender grouping would be the ability to market pigs more efficiently, e.g. the more efficient boars could be kept to heavier slaughter weights with less likelihood of becoming excessively fat. However, the backfat depth of boars in mixed gender pens was found to be greater than that of boars in single gender pens which could have implications on grading, especially when pigs are taken to heavy slaughter weights. However, this finding requires further investigation.

2. Introduction

The use of phase feeding, where a number of diets varying mainly in protein (CP) and lysine content are offered during the finishing stages (40 to 110 kg), is common practice across Europe. Indeed research in Europe and Australia is currently investigating the use of blend or precision feeding where a 'high CP and lysine diet' is blended with a diet of lower CP and lysine content and the ratios of mixing are changed weekly or even daily to accurately target the CP and lysine needs of finishing pigs as they grow (Moore *et al.,* 2013a, personal communication Dr David Torrallardona, IRTA, Spain). Lower CP and lysine diets are commonly less expensive but Magowan and Ball (2012) found that when offering a lower CP and lysine diet during the late finishing stage, feed intake can increase thereby negating

the economic benefits of the less expensive diet. However, in agreement with Garry *et al.* (2007) this increase in feed intake was most apparent when pigs were previously offered a diet which over-supplied their needs in the early finishing stages. Therefore Magowan and Ball (2012) suggested that the entire feeding regime during the finishing period had to be carefully targeted to impact on feed costs and nitrogen (N) excretion. Overall, more information in the area of phase feeding to heavy slaughter weights for Northern Ireland (NI) pig production was required since benefits with regard to reduced excretion of N and ammonia should also be real benefits to be realised.

The dietary requirements of boars and gilts also differ significantly throughout the finishing period (O'Connell *et al*., 2006). The growth rate and feed conversion efficiency of gilts has often been found to be poorer than that of boars (O'Connell *et al*., 2006; Moore *et al*., 2013b; Walker 1989). This difference in growth rate potential posed the question as to the effectiveness of separating gilts and boars when adopting a commercial phase feeding system and questioned the effectiveness of phase feeding for both entire boars and gilts.

The current experiment therefore compared the performance of each gender of pig when offered the normal practice of a single diet during the finishing period or a two-phase dietary regime.

3. Materials and Methods

3.1 Animals and housing

Over eight time periods a total of 480 pigs (PIC337 x (Landrace x Large White)) were penned in groups of ten and offered feed from a single space wet and dry verba feeder. Pigs were transferred to the finishing accommodation at 10 weeks of age. At this stage they were weighed and randomised onto treatment. They were weighed again at 12 weeks of age to ensure randomisation to treatment remained balanced for weight after which they were offered the dietary treatments. The space allowance for pigs was 10.7 m^2 per 10 pigs (1.1 m^2 per pig). The finishing house used automatically controlled natural ventilation and room temperature was maintained at 18°C. The flooring was fully slatted concrete flooring.

3.2 Experimental treatments

This trial aimed to compare the performance of gilts and boars and the performance of pigs when offered either a single diet throughout finishing or a two-phase dietary regime. Therefore there were six treatments in total arranged in a 2 x 3 factorial design. Three 'gender groups' were compared: only boars, only gilts or a 50:50 mixture of boars and gilts in the pen. The two dietary treatments used in this experiment are very similar to those used by Magowan and Ball (2012) and were :

1: Single diet:
Diet A (18% CP, 9.5 g/kg total lysine) offered between 40 and 120 kg

2: Two phase regime:
Diet A offered between 40 and 80 kg followed by
Diet B (16.7% CP, 8 g/kg total lysine) offered between 80 and 120 kg

The dietary ingredients and analysis of the diets are shown in Tables 1 and 2 respectively.

Table 1 Dietary ingredients (g/kg)

	Diet A	**Diet B**
Wheat	400	400
Barley	200	200
Maize	43	77
Soya	220	190
Pollard	96	93
Limestone	14	14
Vegetable Oil	11	10
Mono DCP	5.2	5.9
Devicare Pig Finisher (Minerals and Vitamins)	5	5
Salt	4	4.2
Lysine	1.1	1.3
Methionine	2.2	

Additional additives: Deviguard was included as a rate of 2 kg/tonne and Bac-A-Cid was included at a rate of 2 kg/tonne to both diets

Table 2 Formulated and actual chemical composition, on a fresh matter basis, of the three diets

	Diet A	Diet B
Formulated		
Crude protein (%)	18	16.7
DE (MJ/kg)	13.5	13.5
Fibre (%)	3.45	3.37
Ash (%)	5.45	5.35
Lysine (%)	9.5	8
Methionine (%)	2.8	2.5
Methionine + Cystine (%)	6.2	5.7
Threonine (%)	6.6	6.1
Tyrosine (%)	2.2	2.1
Arginine (%)	11.7	10.7
Actual		
Crude protein (%)	18.5	17.1
Gross Energy (MJ/kg)	16.6	16.5
Oil B (%)	2.89	2.96
NDF (%)	11.3	11.6
Lysine (%)	1.01	0.80
Methionine (%)	0.40	0.27
Cystine (%)	0.24	0.30
Threonine (%)	0.68	0.69
Tyrosine (%)	0.67	0.53
Arginine (%)	1.18	1.05

3.3 Measurements

Individual pig weight was recorded at 12 weeks of age, change of diet (target 80 kg at ~17/18 weeks of age) and slaughter (target 120 kg). Feed intake per pen was continuously recorded and the feed intake and FCR of pigs between 12 weeks of age and 80 kg (change of diet) and 80 and 120 kg were determined. All pigs in each replicate were sent to slaughter on the same day when the average weight of the pen was 120 kg. Pigs were sent for slaughter first thing on Tuesday mornings. In order to attain an accurate kill out percentage, feeders were allowed to run out on

Sunday evening so that an 'empty' live weight of pigs could be recorded on the Monday morning, the day before slaughter. Feeders were filled again after weighing and pigs were sent for slaughter the following morning. Forty-five minutes after slaughter carcass weight was taken and 'probe' (backfat depth at P_2, which is 65 mm for the midline at the level of the last rib) was measured using the Ulster Probe. Nitrogen excretion was estimated by subtracting the amount of N retained by the pig from the total N intake. Total N intake was calculated by multiplying the CP content of the diet by 0.16 (proportion of N in protein) and by the total intake of the pig (as calculated from pen mean data). The amount of N retained was calculated by multiplying average daily gain (on a pen mean basis) by 0.16 (the proportion of protein within overall weight gain) and again by 0.16 (the proportion of N within the proportion of protein gain). The cost per kg gain and overall cost of the diet was based on Diet A costing £306 per tonne, Diet B costing £300 per tonne (Prices as of November 2012).

3.4 Statistical analysis

The main data set were analysed as a 2 x 3 factorial design to investigate the direct effect of gender group and dietary regime as well as any interactions between the two. The 12-week weight of pigs was used as a covariate in the analysis of pig performance data and finish weight was used as a covariate in the analysis of carcass performance. The main effects above were analysed on a pen mean basis. However, to further investigate the performance of boars and gilts within each form of grouping (i.e. single gender or mixed gender groups) individual pig data were used. Data were initially analysed to investigate for the presence of any three-way interactions between animal gender, group gender and dietary treatments. Subsequent two-way interactions were also tested for before main effects of animal gender, group gender or dietary treatment were commented on. Data were further segregated to test for the specific effects of dietary treatments on boars and gilts separately. Data were statistically analysed using Analysis of Variance (ANOVA) in Genstat V 10. Significance of effect was tested at the 5% level. The probability value (P) describes the probability that the difference being assessed was due to random variation (chance) or not. Figures used are $P<0.05$, $P<0.01$ or $P<0.001$ which imply that the probability of the result obtained being due to random variation was less than 5%, 1% or 0.1%. Therefore a probability of

P<0.001 is a very highly significant result in statistical terms and means that the effects observed were mainly due to the treatments imposed and not random variation. NS means that the values are not significantly different, i.e. the results obtained were more than 5% due to random variation. Lack of significance does not necessarily mean that there was no treatment effect at all, rather, if it did exist, it was too small to distinguish from random variation.

4. Results

When data were analysed on a pen basis there were no significant interactions between group gender (single or mixed gender) and dietary treatment. The direct effects are therefore reported.

4.1 Effect of phase feeding

Pig performance was similar whether pigs were offered a single diet or two-phase dietary regime between 12 weeks of age (44 kg) and 120 kg (Table 3). Pig growth rate averaged 907 g/day between 40 and 120 kg and feed conversion ratio averaged 2.57 (Table 3). Pigs took on average 84 days to reach slaughter weight (121 kg) from 12 weeks of age. Dietary regime had no significant effect on the carcass performance of pigs either and the backfat depth of pigs was within code one (average of 12.3 mm) when pigs were on average 121 kg (Table 3). Using the feed intake data generated in the trial but applying a fixed weight gain of 80 kg (40 to 120 kg) the diet costs and N excretion were calculated (Table 4). Due to the lower CP content and lower cost of the second diet in the two-phase dietary regime, N excretion was reduced by 8% and diet costs were approximately £1/pig lower when the two-phase dietary regime was used compared with the single diet throughout the finishing period (Table 4).

Table 3 Effect of dietary regime on finishing pig and carcass performance

		Dietary regime			
	Age	Single diet	Two phase	Sem	Sig
Live weights (kg)	12 weeks	44.8	44.4	0.48	NS
	17 weeks	74.7	75.3	0.67	NS
	18 weeks	81.2	81.9	0.59	NS
	21 weeks	101	101	1.38	NS
	Finish	121	121	1.17	NS
Average daily gain (g/day)	12 - 18 weeks	874	890	14.3	NS
	18 weeks – finish	940	918	19.3	NS
	12 weeks – finish	908	905	12.9	NS
Average daily feed intake (g/day)	12 - 18 weeks	2009	2013	31.7	NS
	18 weeks – finish	2687	2612	38.2	NS
	12 weeks – finish	2342	2310	25.7	NS
Feed conversion ratio	12 – 18 weeks	2.30	2.26	0.032	NS
	18 weeks – finish	2.88	2.86	0.049	NS
	12 weeks – finish	2.59	2.56	0.029	NS
Carcass performance	Carcass weight (kg)	92.9	93.0	0.31	NS
	Probe (mm)	12.3	12.2	0.27	NS
	Kill out (%)	76.9	76.9	0.27	NS

Table 4 The N excretion and cost of diet per pig comparing the use of a single diet and two-phase dietary regime

		Dietary regime	
Pig weight:		**Single diet**	**Two-phase**
40-80 kg	Total cost of diet (£/pig)	24.62	24.22
	Cost/kg gain (£)	0.70	0.69
	N excreted (kg)	1.42	1.38
80-120 kg	Total cost of diet (£/pig)	35.86	35.00
	Cost/kg gain (£)	0.87	0.85
	N excreted (kg)	2.33	2.07
40-120 kg	Total cost of diet (£/pig)	60.48	59.22
	Cost/kg gain (£)	0.80	0.78
	N excreted (kg)	3.75	3.45

4.2 Pig performance when in single or mixed gender groups

Gender had a significant impact on the performance of pigs. Pens of gilts had a lower average daily gain and poorer feed conversion ratio throughout the entire finishing period compared with boars (Table 5). The performance of 'mixed gender' pens was intermediate as expected (Table 5). Gilts had a better kill out percentage than boars but they were on average 0.9 mm fatter (the analysis took consideration of the fact that they were 6 kg lighter at slaughter so this cannot be used as a reason for the difference in backfat depth) (Table 5). The carcass weight and KO% of pigs in 'mixed gender' groups was intermediate but the backfat depth of these pigs was the highest (Table 5). This effect is further investigated through Table 8 later in this report.

Table 6 also reports the performance of pigs in the single or mixed gender groups but in this table the performance of gilts and boars in the single gender groups is combined to provide a 'commercial' comparison. Overall the combined performance of boars and gilts in the single gender pens was similar to that of the mixed gender pens. However, the effect on probe was also present in this analysis

with the backfat depth of pigs in the mixed gender pens being greater than that of pigs in the single gender pens.

Table 5 The effect of group gender on finishing pig performance and carcass performance

		Group gender				
	Age	**Boars**	**Gilts**	**Mixed**	**Sem**	**Sig**
Live weight	12 weeks	44.8	44.8	44.2	0.60	NS
	17 weeks	76.2	74.1	74.6	0.80	NS
	18 weeks	82.7	80.3	81.7	0.69	0.058
	21 weeks	102	98.3	101	1.65	NS
	Finish	124[b]	118[a]	121[ab]	1.3	<0.01
Average daily gain (g/day)	12 - 18 weeks	911[b]	850[a]	886[ab]	16.5	<0.05
	18 - finish	972[b]	874[a]	941[b]	21.6	<0.01
	12 - finish	942[b]	865[a]	913[b]	13.7	<0.01
Average daily feed intake (g/day)	12 - 18 weeks	2015	2026	1991	38.9	NS
	18 - finish	2625	2656	2667	48.0	NS
	12 - finish	2319	2338	2321	31.9	NS
Feed conversion ratio	12 - 18 weeks	2.21[a]	2.39[c]	2.25[b]	0.035	<0.01
	18 - finish	2.71[a]	3.06[b]	2.84[a]	0.048	<0.001
	12 - finish	2.46[a]	2.70[c]	2.55[b]	0.025	<0.001
Carcass performance	Carcass wt (kg)	92.2[a]	93.7[b]	92.9[ab]	0.37	<0.05
	Probe (mm)	11.5[a]	12.4[b]	13.0[b]	0.31	<0.01
	Kill out (%)	76.1[a]	77.7[b]	76.8[ab]	0.31	<0.01

[a, b, c] numbers with common superscripts are not significantly different (P>0.05)

Table 6 The effect of group gender on pig performance

		Group Gender				
		Mixed	Single sex[1]	Sed	F.Pr	Sig
Average daily gain (g/day)	12 - 18 weeks	886	880	21.56	0.982	NS
	18 - finish	941	923	29.12	0.463	NS
	12 - finish	913	903	19.33	0.644	NS
Average daily feed intake (g/day)	12 - 18 weeks	1991	2021	47.36	0.329	NS
	18 - finish	2667	2640	58.48	0.717	NS
	12 - finish	2321	2328	38.90	0.658	NS
Feed conversion ratio	12 - 18 weeks	2.25	2.30	0.048	0.275	NS
	18 - finish	2.84	2.88	0.074	0.406	NS
	12 - finish	2.55	2.58	0.044	0.274	NS
Carcass performance	Carcass weight (kg)	92.89	92.81	0.633	0.955	NS
	Probe (mm)	12.97	11.83	0.348	0.001	<0.01
	Kill out (%)	76.8	77.02	0.280	0.373	NS

[1] Combined performance of boars and gilts in single gender pens

4.3 Effect of treatment on pig performance.

As noted there were no significant interactions between group gender and dietary treatment. However, Table 7 outlines the effect of each individual treatment on pig performance. This table reaffirms the remarks and results noted above with regard to the effect of gender group and dietary regime. This table also demonstrates that the performance of boars was similar when they were offered the single diet or two phase dietary regime as was the performance of gilts (the superscripted letters above the values associated with boars offered the single and two phase dietary regimes are similar as are the superscripted letters above the values associated with the gilts offered the single and two phase dietary regimes therefore confirming that these values are statistically similar).

Table 7 The effect of treatment on pig performance

	Age:	Single diet			Two-Phase				
		Boars	**Gilts**	**Mixed**	**Boars**	**Gilts**	**Mixed**		**Sig**
Live weights	12 weeks								
	17 weeks	76.7	73.6	73.8	75.7	74.7	75.5	**Sem** 1.13	NS
	18 weeks	83.4	79.7	80.6	82.0	80.9	82.9	0.96	0.078
	21 weeks	104	97.7	100	101	99.0	102	2.39	NS
		126^{b}	117^{a}	121^{a}	122^{ab}	119^{a}	121^{ab}	1.80	<0.05
Average daily gain (g/day)	12 - 18 weeks	928	836	860	894	864	913	22.9	0.059
	18 – finish	1003^{c}	864^{a}	954^{bc}	941^{abc}	886^{ab}	928^{abc}	30.6	<0.05
	12 - finish	965^{c}	851^{a}	908^{b}	918^{bc}	879^{ab}	918^{bc}	19.0	<0.01
Average daily feed intake (g/day)	12 - 18 weeks	2062	2029	1937	1968	2024	2045	54.70	NS
Finish	18 – finish	2700	2651	2709	2551	2662	2624	67.70	NS
	12 – finish	2379	2334	2313	2260	2342	2328	44.80	NS
Feed conversion ratio	12 - 18 weeks	2.22^{a}	2.43^{b}	2.26^{a}	2.20^{a}	2.34^{ab}	2.25^{a}	0.049	<0.05
	18 – finish	2.70^{a}	3.09^{c}	2.85^{ab}	2.72^{a}	3.03^{bc}	2.83^{ab}	0.070	<0.001
	12 – finish	2.46^{a}	2.74^{b}	2.55^{a}	2.46^{a}	2.67^{b}	2.54^{a}	0.035	<0.001
Carcass performance	Carcass weight (kg)	92.7	93.2	92.9	91.9	94.2	92.9	0.51	0.079
	Probe (mm)	11.4^{a}	12.2^{ab}	13.1^{b}	11.5^{a}	12.5^{ab}	12.8^{b}	0.44	<0.05
	Kill out (%)	76.6^{ab}	77.4^{bc}	76.7^{abc}	75.6^{a}	77.9^{c}	76.9^{bc}	0.43	<0.05

4.4 Effect of grouping gender structure on the performance of gilts and boars

The following tables describe the performance of boars when in mixed gender or single gender pens (Table 8) and the performance of gilts when in mixed or single gender pens (Table 9). Since the individual performance of gilts and boars were extracted from mixed gender pens it was not possible to compare feed intake or FCR data for these analyses and analyses were conducted on an individual pig basis. There was no three-way interaction between the gender of the animal in the pen (i.e. boar or gilt), the method of grouping i.e. mixed or single gender and the dietary treatment was tested. No two-way interactions between any of the above factors (group gender, animal sex and dietary treatment) were found either. Therefore the effect of pig gender within the groups could be directly compared.

Table 8 Performance of boars in mixed and single gender groups

		Boars only 12 week weight as covariate			
	Age	**Mixed**	**Single Sex**	**Sed**	**Sig**
Live weight (kg)	12 weeks	44.0	44.8	0.61	NS
	18 weeks	82.7	82.7	0.74	NS
	21 weeks	102.4	102.3	1.436	NS
	Final weight	121.1	120.0	1.597	NS
Average daily gain	12 - 18 weeks	908	908	17.50	NS
	18 - finish	976	964	27.22	NS
	12 - finish	945	936	17.52	NS
	Carcass weight	93.62	94.18	0.894	NS
	Probe	13.71	11.73	0.470	<0.001
	KO (%)	75.78	76.22	0.346	NS

The average daily gain of boars was similar when they were in either mixed or single gender groups (Table 8) as was the growth rate and carcass performance of gilts (Table 9) which supports the results reported in Table 5. However, the backfat depth of boars was 2 mm more when they were in mixed gender groups compared

to when they were in single gender groups (Table 8). In Tables 4 and 5 the backfat depth of pigs in mixed gender groups was found to be greater than that of pigs in single gender groups. Results reported in Tables 8 and 9 suggest that the backfat depth of boars is the main contributing factor to this increase in backfat depth in mixed gender groups.

Table 9 Performance of gilts in mixed and single gender groups

		Group gender			
	Age	**Mixed**	**Single Sex**	**Sed**	**Sig**
Live weight (kg)	12 weeks	44.5	44.8	0.63	NS
	18 weeks				NS
	21 weeks	98.91	98.78	1.347	NS
	Finish	115.5	114.8	1.435	NS
Average daily gain	12 - 18 weeks	863	850	17.45	NS
	18 - finish	908	875	24.03	NS
	12 - finish	881	865	15.37	NS
	Carcass weight	92.21	91.45	0.9012	NS
	Probe	12.19	11.93	0.5098	NS
	KO (%)	77.84	77.79	0.3891	NS

5. Discussion

5.1 Effect of phase feeding

Pig performance throughout the finishing period and carcass performance was similar when a two-phase dietary regime was offered compared with a single diet between 44 and 120 kg live weight. This is in agreement with Moore *et al*. (2013a), O'Connell *et al*. (2005) and Lee *et al.* (2001) who also found no difference in pig performance when a 'phase feeding' dietary regime was used. In the current study the lower lysine diet which was offered during late finish in the two-phase regime was £6 per tonne less expensive and contained 13 g/kg less CP than the diet which was offered throughout the whole finish period. As a result feed costs were lowered

by approximately £1 per pig and N excretion was 8% lower when the two-phase feeding regime was used compared with the single diet in the current study. This is in agreement with Lee *et al*. (2001) who found a 6% reduction in N excretion when lysine was reduced by 1% unit and O'Connell *et al*. (2005) who found a 12.6% reduction in N excretion using diets ranging in total lysine content of 1.1 to 0.9% compared to a single diet offering 1.1% total lysine. However, the effect of phase feeding on N excretion has been inconsistent. For example, Garry *et al.* (2007) and Magowan and Ball (2012) found no effect on N excretion when using phase feeding since they noted an increase in feed intake in the late finish stage when pigs moved onto the low lysine and CP diets. Moore *et al.* (2013a) also found no economical benefit to using the phase feeding method over a single diet. However, they also compared the use of a 'blended dietary regime' where a high lysine/crude protein diet was mixed with a low lysine/crude protein diet and the mixture changed on a weekly basis to target the reducing protein requirements of pigs as they got heavier. Using the blended regime they found a reduction in N excretion due to a reduced N intake. Han *et al*. (1998) also found a greater reduction in N excretion using a 'blend feeding' regime compared to a 'phase feeding' regime.

Overall, the use of phase feeding to match the nutrient requirements of pigs has not been found to reduce pig performance and it has often been found to reduce N excretion and reduce feed costs. Overall detrimental effects of phase feeding have rarely been reported and more often than not beneficial effects have been found. However reducing the lysine level below 8 g/kg in the late finish period is not advisable based on results from other workers. It is also advisable that pigs should be as uniformly grouped as possible to avoid 'under feeding' light weight pigs. This may mean that diet changes could occur later for light weight pigs.

5.2 Effect of gender

In the current study the growth rate of boars was 77 g/day greater than gilts and their feed conversion ratio was 9% better. These results are in agreement with other workers, for example Moore *et al.* (2013b), Conte *et al.* (2011), O'Connell *et al*. (2005 and 2006) and Walker (1989) all found that boar performance (average daily gain and feed conversion ratio) was better during the finishing period than gilt performance. In the current study, the kill out percentage of boars was poorer than

gilts but this is commonly found and is due to the extra weight of genitals in boars (O'Connell *et al*., 2006; Andersson *et al*., 2005). In the current study when boars were penned in single sex pens, they were found to be leaner than gilts which is in line with their improved feed use efficiency and has been found historically e.g. Magowan and McCann (2009). However, this clear distinction in backfat depth between boars and gilts has not been found in other studies such as Moore *et al*. (2013b), Conte *et al*. (2011), O'Connell *et al*. (2005) and Walker (1989). However, in most studies the lean meat content of boars is greater than that of gilts e.g. Andersson *et al*. (2005) and Moore *et al*. (2013b). Furthermore, there are a range of sire line breeds used across these studies and most studies work with mixed sex pens which may have an impact on grading as noted below. The current study also examined the effect of group gender (i.e. mixed or single sex) on the daily gain and carcass performance of gilts and boars separately. The daily gain and carcass performance of gilts was similar when they were in either single or mixed gender pens. The daily gain of boars was also similar when they were in either mixed or single gender pens but the backfat depth of boars in mixed gender pens was significantly greater than that of boars in single gender pens. This effect has not been reported or thoroughly investigated in the open literature and it is difficult to comment on why this effect is present. However, as noted above a lack of gender effect has often been found in studies and in these studies pigs have been housed in mixed gender pens, so it may be the case that backfat depth of boars is greater when they are housed with gilts compared with when they are housed separately, hence the lack of difference noted across some studies. It is suggested that the sexual contact with female pigs may contribute to this although Andersson *et al*. (2005) found that although gilts reproductive organs were more developed when they were grouped with boars, the reproductive organs of boars were at a similar developmental stage when they were housed in either single or mixed gender pens. Further investigation is required to validate and fully understand this finding. From a welfare perspective, Conte *et al*. (2011) found no adverse effect of single gender grouping of entire males and females taken to slaughter weights of 105 kg.

Overall the performance (daily gain, daily feed intake and feed use efficiency) of gilts and boars combined across the single gender pens was not different to the performance of boars and gilts in mixed gender pens. However, the backfat depth

of boars appeared to be greater when they were in mixed gender pens and as a result the average backfat depth of pigs from mixed gender pens was greater than that of pigs in single gender pens.

5.3 Effect of dietary regime specific for each gender

In this study boars and gilts responded similarly to both dietary regimes i.e. there was no statistically significant effect of dietary regime on the performance of either boars or gilts over the finishing period. Therefore the phase feeding method used in this study supports the optimum performance of both boars and gilts and does not significantly affect carcass performance of either. This is in agreement with O'Connell *et al.* (2005) who also penned gilts and boars in single gender pens and compared their performance when offered a single diet containing 18% CP and 11.1 g/kg lysine with a five-phase dietary regime where CP and lysine content was reduced every two weeks between 39 kg and slaughter. Lysine was reduced from 11.1 to 10.5, 10.1, 9.5 and 8.9 g/kg over the 10-week period. As noted above the overall performance of gilts and boars differed in terms of growth rate and FCR but their response to the diets was similar and overall growth rate and FCR did not differ when they were offered this five-phase feeding regime compared with the single diet. An Australian study by Moore *et al.* (2013b) using Australian genetics compared entire male and female performance during the early and late finishing periods when offered varying levels of lysine in relation to energy content. The average daily gain and FCR of pigs on their study between 22 and 53 kg was 873 g/day and 1.70 respectively and between 48 and 104 kg was 994 g/kg and 2.37 respectively. These figures suggest that the pigs on the study by Moore *et al.* (2013b) were highly performing pigs and comparable to those on the current study. In the early finishing stage (22.3 to 53 kg), boar performance (ADG and FCR) increased as the lysine content of the diet increased (0.71 to 1.20 g Lysine/MJ DE). However, for gilts, performance improved between 0.71 and 0.83 g lysine/MJ DE but there was no further significant improvements in performance of gilts when higher lysine contents were offered. For pigs in late finish, diets containing 0.48 and 0.59 g lysine/MJ DE reduced the performance of both gilts and boars but the diet containing 0.71 g lysine/MJ DE optimised the average daily gain of gilts and boars. Diets with a higher lysine content (0.83 and 0.95 g lysine/MJ DE) further improved the FCR of boars but had no effect on the FCR of gilts. Overall the work

concluded that the nutritional requirements of gilts and boars differed, especially during the early finishing period and overall boars responded to a higher level of lysine than gilts. In the current study, as mentioned above, there was no statistically significant difference in the performance of boars when offered either the single diet or two-phase dietary regime but in Table 7 it is noted that the performance of boars from 18 weeks of age to finish was numerically 47 g/day better when they were offered the single diet i.e. lysine content of 0.95 g/kg compared with the two-phase diet at which stage they would have been offered a diet containing 0.8 g/kg lysine. It is also noted that the difference in the two levels of lysine used in the current study is significantly less than those tested by Moore *et al*. (2013b). Therefore the lack of difference in growth response between the two genders in this trial was not unexpected but the potential for differences to arise should be noted should levels of lysine become significantly divergent.

With regard to other reports in the open literature, boars have been found consistently to respond to higher levels of lysine than gilts due to their higher potential for protein deposition, e.g. Yen *et al*. (1986), Campbell *et al*. (1988) and O'Connell *et al*. (2006), although all these workers again used levels which were more divergent than those used in the current study. In the work by O'Connell *et al*. (2006), lysine levels of 7.0, 7.9, 8.8, 9.7, 10.7 and 11.7 g/kg were compared on pig performance in late finish (80 to 100 kg). The response to dietary lysine content was similar for both boars and gilts when lysine increased from 7.0 to 9.7 g/kg and levels of 8.8 and 9.7 g/kg optimised average daily gain and feed conversion efficiency in both boars and gilts. These levels are slightly higher than the levels used in the current study but previous work at Hillsborough has found that lysine levels greater than 9.5 g/kg for finishing pigs do not significantly improve the growth rate or feed use efficiency of pigs typically used in Northern Ireland. Furthermore, the feed use efficiency of pigs on the current study average 2.88 during the late finish period (80 to 120 kg) which is similar to the optimum minimum feed use efficiency attained in the study by O'Connell *et al*. (2006) which was 2.91 using the 9.7 g/kg lysine diet.

6. Conclusions

Overall it appears that the use of a two-phase dietary regime where CP is lowered from 180 to 167 g/kg and lysine content from 9.5 to .8.0 g/kg when pigs reach 80 kg supports the growth rate and feed use efficiency of pigs (gilts and boars combined) since the performance of pigs was similar to when a single diet containing180 g/kg CP and 9.5 g/kg lysine was offered. Since there was no difference in pig performance but a difference in feed cost and N content, finisher feed cost was reduced by £1/pig and N excretion was 8% lower when the two-phase dietary regime was used between 40 and 120 kg. The daily gain and feed use efficiency of boars was better than that of gilts which has been commonly found. In this study, when boars and gilts were penned in single gender pens, the backfat depth of boars was lower than that of gilts but when the two genders were penned in mixed gender groups the backfat depth of boars was significantly greater than that of boars in single gender groups. This effect has not been tested or reported previously, especially when taking pigs to heavy slaughter weights and therefore further research is required to validate and understand these results. However, overall the combined performance (average daily gain and feed conversion efficiency) of gilts and boars in single gender pens was similar to that of gilts and boars in mixed gender pens. This study found no difference in gilt or boar performance when using the two different dietary regime. This is in agreement with other studies but some workers have found differences in gilt and boar response using greater extremes of phase feeding and lysine allowances. This is something to consider should crude protein and lysine levels be further reduced.

Overall the need for split sex grouping to optimise pig performance using the two-phase approach adopted in this study was not needed. However, the use of single gender grouping may help manage the marketing of pigs since the more efficient boars could be taken to heavier slaughter weights, providing adequate space allowance. Single gender grouping may also improve the grading of boars although this aspect requires further investigation.

7. References

Andersson, H.K., Andersson, K., Zamaratskaia, G., Rydhmer, L., Chen, G. And Lundström, K. (2005). Effect of single-sex or mixed rearing and live weight on performance, technological meat quality and sexual maturity in entire male and female pigs fed raw potato starch. *Acta Agriculturae Scand Section A*, **55:** 80-90.

Campbell, R.G., Taverner, M.R. and Curic , D.M. (1988). The effect of sex and live weight on the growing pig's response to dietary protein. *Animal Production*, **46:** 123-130.

Conte, S., Boyle, L.A., O'Connell, N.E., Lynch, P.B. and Lawlor, P.G. (2011). Effect of target slaughter weight on production efficiency, carcass traits and behaviour of restrictively-fed gilts and intact male finisher pigs. *Livestock Science*, **136:** 169-174.

Garry, B.P., Pierce, K.M. and O'Doherty, J.V. (2007) The effect of phase-feeding on the growth performance, carcass characteristics and nitrogen balance of growing and finishing pigs. *Irish Journal of Agricultural and Food Research,* **46:** 93–104.

Han, I.K., Kim, J.H., Chu, K.S., Xuan, Z.N., Sohn, K.S. and Kim, M.K. (1998) Effect of phase-feeding on the growth performance and nutrient utilisation in finishing pigs. *American Journal of Animal Science,* **11:** 559-565.

Lee, J.H., Kim, J.H., Kim, J.D., S. W. Kim and Han, In K. (2001) Effect of Low crude protein diets supplemented with synthetic amino acids on performance, nutrient utilisation and carcass characteristics in finishing pigs reared using a phase feeding regime. *Asian-Australasian Journal of Animal Science,* **14:** 655-667.

Magowan, E. and Ball, M.E.E. (2012). The effect of lower lysine diets for finishing pigs. Technical report to Pig ReGen Ltd, September 2012.

Magowan, E. and McCann, M.E.E. (2009). The effect of sre line breed on the lifetime performance of slaughter generation pigs. A technical report for Pig Regen Ltd.

Moore, K.L., Mullan, B.P., aPd Kim, J.C. (2013a). Blend-feeding or feeding a single diet to pigs has no impact on growth performance or carcass quality. Animal production Science 53: 52-56.

Moore, K.L., Mullan, B.P., Campbell, R.G. and Kim, J.C. (2013b). The response of entire male and female pigs from 20 to 100-kg liveweight to dietary available lysine. Animal Production Scienc*e,* **53:** 67-74.

O'Connell, M.K., Lynch, P.B. and O'Doherty, J.V (2005) A comparison between feeding a single diet or phase feeding a series of diets, with either the same or reduced crude protein content, to growing finishing pigs. *Animal Science,* **81:** 297-303.

O'Connell, M.K., Lynch, P.B. and O'Doherty, I.V. (2006). Determination of the optimum lysine concentration for boars and gilts penned in pairs and in groups in the weight range 60 to 100 kg. *Animal Science*, **82:** 65-73.

Walker, N. (1989). The interactions of stocking density, form of diet and sex group of finishing pig fed *ad libitum*. Irish Journal of Agricultural Research 28: 109-113.

Yen, J.P., Cole, D.J.A. and Lewis, D. (1986). The response of pigs from 50 to 90 kg live weight to dietary ideal protein. *Animal Production*, **43:** 155-165.