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Investigation of growth rate variation between commercial pig herds

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The study was designed to provide quantifiable information on both within- and between-herd variation in pig growth rate from birth to slaughter and to examine how this was influenced by moving pigs at a common age to a common environment. Five litters were selected from each of eight pig herds in Northern Ireland with varying growth performance. All eight herds were offered the same nutritional regime. Five pigs (three boars and two gilts) were selected from each litter. In each herd, 22 pigs (12 boars and 10 gilts) were weighed individually, every 4 weeks, from 4 to 20 weeks of age. At 4 weeks of age (weaning) three non-sibling boars were taken from each herd and brought to a common environment where they received medication, were housed individually from 6 weeks of age and offered the same dietary regime. They were weighed and feed intakes were recorded twice weekly. A growth rate difference of 61 g/day ($P < 0.001$), 112 g/day ($P < 0.01$) and 170 g/day ($P < 0.001$) was observed on farm, between the top and bottom quartile of herds during 4 to 8, 8 to 12 and 12 to 20 weeks of age, respectively. This difference in growth rate equated to an average difference in cost of production of ¢13/kg carcass on a birth to bacon unit. When pigs from the different herds were housed in the common environment, large variation in growth performance (143 g/day ($P < 0.01$) and 243 g/day ($P < 0.001$) for 8 to 12 and 12 to 20 weeks, respectively) was also observed between the top and bottom quartile of herds. Although feed efficiency was similar, a significant feed intake difference of 329 g/day ($P < 0.01$) and 655 g/day ($P < 0.001$) between 8 to 12 and 12 to 20 weeks of age was observed. The variation in growth rate between pigs whether managed on farm or in the common environment was similar (variation in days to 100 kg on farm and in the common environment was 18 and 19 days, respectively). When housed in the common environment, although the top and bottom quartile of pigs converted feed equally efficiently, pigs in the top quartile had significantly higher feed intakes suggesting greater appetites. It is difficult to assess the extent to which these differences can be attributed to genetic effects or pre-weaning environment, and how much the effects of management, disease or genetics contributed to the variation between and within herds.

Keywords: commercial farming, performance, pigs, variation

Introduction

Variation in the growth rate of pigs starts from conception, with pigs of the same litter often varying considerably in birth weight (Milligan *et al.*, 2001). This variation in pig growth performance both within and between litters continues through their lifetime (Kennedy, 1984). Growth rate is largely driven by feed intake (Whittemore and Green, 2001), hence variable growth rate is a reflection of variable feed intake. Research by Geary and Brooks (1998) has shown that each 50 g/day increase in dry-matter feed intake in the week following weaning was associated with an increase of 870 g in 28-day post-weaning weight. Genetic and environmental factors contribute to variable feed intake within and between litters and herds of pigs. Environmentally, variable feed intake can be a result of, for example, birth weight, sex, weaning age, management system, disease status or diet composition (Pajor *et al.*, 1991; Bruininx *et al.*, 2001; Whittemore and Green, 2001; O'Connell *et al.*, 2002). Profitability is also highly variable between herds

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(Stein *et al*., 1990). Within Northern Ireland, the number of pigs produced per sow per year can vary by 4.4 and the overall profitability of herds by €688 per sow per year (Donnelly, 2006).

Many of the studies investigating variability have been conducted under controlled experimental conditions and those studies conducted in the field have only considered the average responses of herds, as opposed to responses of individual pigs within herds. It is recognised that studies of field data are important since results under controlled conditions do not always reflect responses in the field (David *et al*., 1983). The aim of this study was therefore to provide quantifiable information on both within- and between-herd variation in pig growth rate from birth to slaughter and to examine how this was influenced by moving pigs at a common age to a common environment.

Material and methods

Herds and animals

Eight herds with varying growth performance, offered the same diets from birth to slaughter, were selected from the pig herds of Northern Ireland. Six of the eight herds (B, C, D, E, F and H) had a herd size between 150 and 200 sows while the remaining two herds (A and G) had a herd size of 500 sows. All pigs were $\frac{3}{4}$ Landrace $\times \frac{1}{4}$ Large White with their sires being from Northern Ireland studs. On six of the eight herds, pigs were housed in groups of 20 which remained static from weaning to slaughter. On the remaining two herds, pigs were grouped in batches of 60 at weaning and divided into batches of 20 at the beginning of the finishing stage. All herds were quality assured and therefore maintained high welfare standards, which included adequate floor space per pig, feeder space and water availability. In stage 1/stage 2, all pigs were offered dry pelleted feed from dry multispace feeders (Etra Feeders, Northern Ireland). In the finishing stages, all pigs were offered dry pelleted feed through wet and dry single space feeders (Verba, Verbakel^{TM}, The Netherlands). All pigs were housed on fully slatted flooring (plastic slats in stage 1/stage 2 accommodation and concrete slats in the finishing stages) and houses were ventilated using 'automatic controlled fan ventilation'. Pigs were housed in stage 1 accommodation for 4 weeks, stage 2 accommodation for 4 weeks after which they were transferred to finishing accommodation where they remained until slaughter. All herds were diagnosed as enzootic pneumonia and porcine reproductive and respiratory syndrome (PRRS) (blue-ear disease) positive, one herd was *Haemophilus parasuis* positive and another herd suffered occasional infections of *Escherichia coli* in post-weaned pigs. All herds vaccinated for porcine parvovirus and leptospirosis. All herds were medicated in stage 1 with zinc oxide and chlorotetracycline (CTC) 10%. The mean herd growth rate of pigs between 45 and 100 kg was taken from Benchmark data (Donnelly, 2004) and ranged from 673 to 1064 g/day.

Five litters were randomly selected from each of the eight herds. Within each litter, five pigs (three boars and two gilts) were selected at weaning and tagged. Pigs were selected by sex and weight. The medium weight of the litter was established after which one pig was selected to represent the medium weight and the remaining four pigs were selected either side of the medium weight, i.e. two below the medium weight and two above the medium weight. In total, 25 pigs were selected at weaning on each herd, of which 22 remained on the farm for performance testing and the remaining three (non-sibling boars) were transferred to a common controlled environment where they were housed with the seven other sets of 'three pigs' from the seven other herds in order to test their performance under controlled conditions. All pigs from all herds were born within 3 days of each other.

At birth, the weight of the litter of pigs was recorded and the average weight was taken as the initial birth weight. There was no difference in the management of pigs, within a herd, from birth to weaning at 4 weeks of age. All pigs were offered a creep feed (diet 1) pre-weaning.

On-farm performance testing

In each herd, the aforementioned selected 22 pigs (12 boars and 10 gilts) were randomly distributed across a number of pens of mixed weight pigs. These pigs were weighed individually every 4 weeks, from 4 to 20 weeks of age. The average daily gain (ADG) and coefficient of variation for weight of pigs in each herd was calculated. Pigs were offered commercial pig diets (Table 1) *ad libitum.* The duration of *ad libitum* feeding of each diet varied across pig herds due to producers adopting different diet management strategies.

Economic evaluation

Data on feed usage and efficiency and pig mortality for the top herd and the bottom herd were collected and these data, together with the average growth rate of the pigs on farm were inputted to an economic model (Devenish Nutrition Ltd, Belfast, UK) based on 1100 finishing places, to establish differences in profitability between herds. According to the herd ADG, the throughput of pigs from 1100 finisher pig places was calculated and hence equated to the financial output from the respective units. The economic model was based on an all in/all out system and there were no empty days between batches. The economic model was set to calculate the 'herd net profit' of a birth to bacon production system based on pigs being weaned at 26 days of age, being housed in stage 1 and stage 2 accommodations for 28 and 35 days, respectively, and being housed in finishing accommodation until they reached a live weight of 105 kg. The model also included fixed costs per sow of veterinary expenses (€29), labour (€74), electric (€22), artificial insemination (€15), rent/repayment (€74), miscellaneous (€29), repairs and maintenance (€29) and transport/slurry (€29).

Table 1 *Composition of diets offered to pigs on farm and in the common environment (as-fed basis)*

	Diet				
	1 (starter)	2 (starter)	3 (link)	4 (grower)	5 (finisher)
Ingredient[†]					
Wheat	✓	✓	✓	✓	✓
Barley				✓	✓
Maize		✓	✓	✓	✓
Cooked cereal	✓	✓			
Soya	✓(toasted)	✓(toasted)	✓	✓	✓
Potato protein	✓	✓			
Sugar	✓				
Pollard				✓	✓
Rapeseed extract				✓	✓
Natupro		✓	✓		
Whey	✓	✓	✓		
Molaferm				✓	✓
Vegetable oil blend			✓	✓	✓
Soya oil	✓	✓	✓	✓	
Limestone	✓	✓	✓	✓	✓
Mono dicalcium phosphate	✓	✓	✓	✓	
Salt		✓	✓	✓	✓
Lysine	✓	✓	✓	✓	✓
Methionine	✓	✓		✓	
L-Threonine	✓	✓		✓	
Tryptophane	✓	✓			
Devicare			✓	✓	✓
Chemical analysis					
Dry matter (g/kg)	896	885	890	877	877
Digestible energy (MJ/kg)	16.6	16.0	15.1	14.8	14.0
Crude protein (g/kg)	21.4	22.7	19.9	18.9	18.0
Oil A (g/kg)	9.7	7.8	6.5	6.1	4.7
Fibre (g/kg)	2.4	2.5	2.8	2.9	4.5
Ash (g/kg)	4.7	3.6	5.2	4.7	5.2
Digestible lysine (g/kg)	1.21	1.26	1.10	0.97	0.86

[†]The diets were commercially manufactured by Devenish Nutrition Ltd (Belfast, UK) (Diets 1 and 2) and John Thompson and Sons Ltd (Diets 3, 4 and 5). The exact amount of each ingredient cannot therefore be disclosed, however a 'tick' represents the presence of the raw material in the diet.

Performance testing under controlled conditions

Three non-sibling boars, typical of pigs being weaned, were selected at 4 weeks of age in each of the eight herds. In order to select the three boars, three litters were first selected, from the five in each herd, according to their average litter weight, i.e. one litter represented the medium average litter weight and the other two litters had average litter weights either side of the medium. The boars were then selected from these litters according to their weight, which was representative of the average weight of the litter. Immediately after selection they were transferred to a common controlled environment. A total of 24 boars were transferred and mixed at 4 weeks of age in a common environment. They were group-housed to 6 weeks of age, after which they were individually housed until slaughter (115 kg live weight). Pigs were offered the same commercial pig diets as on farm (Table 1) *ad libitum* in the following controlled manner (as-fed basis): diet 1, 3 kg per pig; diet 2, 7 kg per pig; diet 3, offered until pigs were 20 kg; diet 4, offered from 20 to 40 kg live weight; and diet 5, offered from 40 kg live weight to slaughter. All pigs received in-feed medication through diets 1, 2 and 3 (3.1 kg/t Zn (Pigzin), 2 kg/t Stabox, 2 kg/t Pulmotil G1 in each diet). Pigs were weighed individually and feed intakes calculated twice weekly until 20 weeks of age.

Calculations and statistical analysis

Individual pig data on farm and under controlled conditions were analysed by analysis of variance using Genstat (2002). Analysis of variance was used to test the effect of herd and the effect of the top and bottom quartile of herds on pig live weight and growth performance on farm and in the common environment. The estimated time taken for individual pigs to attain a live weight of 100 kg was calculated from individual pig ADG values. The coefficient of variation of pig weight within each farm was calculated by dividing the mean weight of pigs by the standard deviation of the

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Table 2 *Average weight (kg) and daily gain (g/day) of pigs on farm*

	Herd									
	A	B	C	D	E	F	G	H	s.e.	Significance
Weight (kg)										
Wean	9.0[de]	9.9[e]	8.4[bcd]	7.9[abc]	8.7[cd]	7.7[ab]	7.4[a]	8.7[cd]	0.30	***
20 weeks	81.5[cd]	85.0[d]	83.1[d]	76.3[bc]	71.9[ab]	71.1[ab]	69.3[a]	67.7[a]	2.20	***
Average daily gain (g/day)										
0 to 4 weeks	262[c]	277[d]	239[c]	234[bc]	252[c]	205[ab]	199[a]	245[c]	10.6	***
4 to 8 weeks	368[cd]	424[e]	384[de]	309[b]	327[bc]	227[a]	360[cd]	326[bc]	14.9	***
8 to 12 weeks	649[e]	590[de]	596[de]	453[ab]	522[bcd]	517[bcd]	526[bcd]	435[a]	24.3	***
12 to 20 weeks	762[cd]	803[cd]	817[d]	815[d]	673[ab]	734[bc]	629[a]	651[a]	25.7	***
0 to 20 weeks	557[cd]	577[d]	568[d]	522[bc]	489[ab]	482[ab]	471[a]	460[a]	15.3	***
4 to 20 weeks	625[cd]	647[d]	644[d]	588[bc]	545[ab]	546[ab]	532[a]	510[a]	17.6	***

[a,b,c,d,e]Means with the same superscript are not significantly different. Data were analysed using Duncan's multiple range test within ANOVA.
***$P<0.001$.

Table 3 *The average growth rate (g/day) and estimated days to 100 kg of pigs in the top and bottom quartile of herds*

	Top quartile	Bottom quartile	s.e.	Significance
4 to 8 weeks	404	343	12.5	***
8 to 12 weeks	593	481	15.4	**
12 to 20 weeks	810	640	19.9	***
Estimated days to 100 kg	162	180	4.6	***

**$P<0.01$; ***$P<0.001$.

data set at any given age. Correlations were established between the weights of pigs at various ages in one case on the top and in the other case on the bottom quartile of herds using Genstat (2002) and taking into consideration farm effects.

Results

On-farm performance

The ADG of herds differed significantly ($P<0.001$) at all stages of growth (Table 2). Overall, from birth or wean to 20 weeks of age, herds B and C had the highest growth rates, while herds G and H had the poorest. Data from herds B and C were amalgamated to represent the top quartile of herds and data from herds G and H were amalgamated to represent the bottom quartile of herds (Table 3).

Growth rate differed significantly between the top and bottom quartile of herds by 61, 112 and 170 g/day for the growth periods of 4 to 8 ($P<0.001$), 8 to 12 ($P<0.01$) and 12 to 20 weeks of age ($P<0.001$) (Table 3). This resulted in the pigs from the top quartile of herds attaining a live weight of 100 kg on average 18 days earlier than those from the bottom quartile of herds (Table 3).

The coefficient of variation for weight was lower at any stage of growth for pigs on the top quartile of herds than on the bottom quartile of herds (Figure 1).

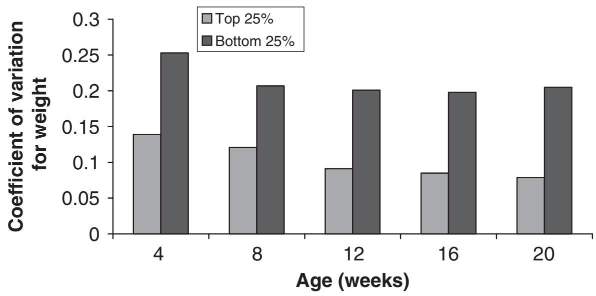

Figure 1 The coefficient of variation for weight of pigs on farm from 4 to 20 weeks of age in the top and bottom quartile of herds.

Overall, the correlations between the weights of pigs at different ages were weaker for pigs from the top quartile of herds than for those from the bottom quartile of herds (Table 4). The correlations between the weights of pigs at different ages from the bottom quartile of herds were strong, highly significant ($P<0.001$) and similar. The correlations between the weights of pigs from the top quartile of herds tended to weaken as pigs got older and the correlations between the weaning weight and 16 and 20 week weight were not significant.

Economic evaluation

The top herd was identified as herd C and the bottom herd as herd H. The total feed cost per pig was greater on the

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bottom farm due to poorer feed efficiency (Table 5). Fewer pigs could be produced per year using 1100 finisher places on the bottom farm due to the slower growth rate (Table 6). A lower carcass weight was also attained due to higher post-weaning mortality on the bottom farm (Table 6).

Table 4 *Correlations between the weight of pigs at various ages in the top and bottom quartile of herds (n = 44 each) with farm effects*

Age (weeks)	4	8	12	16	20
4	–†	0.863***	0.733***	0.812***	0.800***
8	0.565***	–†	0.884***	0.844***	0.836***
12	0.461**	0.816***	–†	0.886***	0.874***
16	0.278NS	0.610***	0.663***	–†	0.917***
20	0.077NS	0.447**	0.463**	0.861***	–†

†Values below the diagonal report correlations between the weights of pigs in the top quartile of herds whereas values above the diagonal report correlations between the weights of pigs in the bottom quartile of herds.
NS = not significant, *$P<0.05$; **$P<0.01$; *** $P<0.001$.

Table 5 *Feed usage, efficiency and resultant cost per pig on the top herd and bottom herd*

	Top herd	Bottom herd
Feed usage (g/day)		
First stage	456	429
Second stage	1311	1041
Finisher	2226	1836
Feed conversion ratio		
First stage	1.20	1.30
Second stage	2.26	2.54
Finisher	2.80	3.06
Feed cost†		
Per kg of feed	299.8	322.8
Cost/tonne (€ per pig)	71.6	76.2

†Feed cost = first + second + finisher stage feed costs combined.
NB The average weight of the pigs at 20 weeks of age was taken as the finish weight.

Overall, the difference in herd net profit between the top and bottom herds was €45 795 per year which equated to a difference in carcass value of ¢13/kg.

Performance of pigs in the common environment

The ADG ($P<0.01$) and average daily feed intake (8 to 12 weeks $P<0.05$; 12 to 20 weeks $P<0.001$) of pigs from the eight herds differed significantly between herds through both stages of growth in the common environment whereas the feed conversion efficiency differed significantly ($P<0.01$) only in the early stages (8 to 12 weeks) (Table 7). Pigs from herds A and B tended to have the highest growth rate and feed intake from 8 to 12 and 12 to 20 weeks of age whereas pigs from herds C and G had the lowest. However, the feed conversion ratio (FCR) of pigs from herds A, B, C and G were similar. The FCR of pigs from herds E and H was significantly ($P<0.01$) poorer.

Data from herds A and B were amalgamated to represent the top quartile of pigs and data from herds C and G were amalgamated to represent the bottom quartile of pigs in the common environment (Table 8). The ADG and average daily feed intake of the top quartile of pigs was significantly higher from 8 to 12 ($P<0.01$) and 12 to 20 ($P<0.001$) than that of the bottom quartile of pigs. The top quartile of pigs reached a live weight of 100 kg on average 19 days earlier ($P<0.001$). There was no significant difference in the FCR of pigs in the top or bottom quartile.

Table 6 *Economic return for top and bottom herd using 1100 finishing pig places*

	Top herd	Bottom herd
Number of pigs at 105 kg produced per year	4500	3200
Post weaning mortality (%)	2.8	7.1
Carcass weight (kg)	79.90	78.45
Carcass value (€)	104.57	102.68
Total cost per pig (€)	84.66	90.24
Herd net profit (€)	91 618	45 823

Table 7 *Performance of pigs from different herds when managed in the common environment*

	Herd									
	A	B	C	D	E	F	G	H	s.e.	Significance
Average daily gain (g/day)										
8 to 12 weeks	838c	824c	683ab	769bc	662a	743abc	692ab	690ab	33.6	**
12 to 20 weeks	1018bc	1110c	815a	1023bc	1006bc	863a	827a	946ab	47.7	**
Average daily feed intake (g/day)										
8 to 12 weeks	1658d	1571c	1310ab	1519bcd	1462abcd	1394abc	1260a	1549bcd	80.3	*
12 to 20 weeks	2631d	2624d	2010ab	2462cd	2413cd	2206abc	1935a	2281bc	94.2	***
Feed conversion ratio										
8 to 12 weeks	1.97a	1.91a	1.92a	1.97a	2.21b	1.89a	1.82a	2.26b	0.077	**
12 to 20 weeks	2.56	2.37	2.47	2.42	2.40	2.56	2.34	2.41	0.063	NS

[a,b,c,d,e]Means with the same superscript are not significantly different.
*$P<0.05$; **$P<0.01$; ***$P<0.001$; NS = not significant.

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Table 8 *Performance of pigs in the top and bottom quartile of herds when managed in the common environment*

	Top quartile	Bottom quartile	s.e.	Significance
Average daily gain (g/day)				
8 to 12 weeks	831	688	16.9	**
12 to 20 weeks	1064	821	41.2	***
Estimated days to 100 kg	139	158	5.1	***
Average daily feed intake (g/day)				
8 to 12 weeks	1614	1285	52.8	**
12 to 20 weeks	2628	1973	78.0	***
Feed conversion ratio				
8 to 12 weeks	1.94	1.87	0.035	NS
12 to 20 weeks	2.47	2.40	0.042	NS

$^{**}P < 0.01$; $^{***}P < 0.001$; NS = not significant.

Discussion

The financial impact of variable growth rates is not commonly recognised by producers but is a very real and often a hidden cost to the pig industry that is difficult to quantify (Payne *et al.*, 1999). Some attempts have been made to quantify the economic effect of growth rate variation within a group of pigs. Using the 'AUSPIG' simulation model, Payne *et al.* (1999) estimated that if 100% of pigs in a group had a level of performance classified as medium, then 'profitability' was €8.97 per pig sold. However, if the distribution of pigs was such that 20%, 60% and 20% of the pigs were classified as low, medium and high, respectively, then overall 'profitability' was reduced by ¢55 per pig sold. In the current study, the difference in performance between the top and bottom producers equated to an average difference in cost of production of ¢13/kg of carcass on a birth to bacon herd. In addition, larger weight variation occurred at all stages of growth within poorer performing herds implicating large variation in growth rate.

Some variation in growth rate between pigs is inevitable, for example entire male pigs have been shown to grow 7.7% faster than females, thus creating variation in finish weights (Payne *et al.*, 1999). Frey (1998) listed other sources of variation in the growth rate of grower/finisher pigs including: genotype; disease; management system; weight at entry; group size; space allocation; dominant or submissive behaviour; stockmanship; and season. In the current study, all of the above factors varied between herds except season. However, when pigs were brought to a common environment, the only differences were genotype, pre-weaning environment and health status and weight at entry, yet large variations in growth rate still occurred between pigs from different herds. In addition, within a herd factors like management system, disease exposure, group size, space allocation and stockmanship should have been constant but variation in growth rate within herds was still observed with its extent varying dramatically between herds. It could be suggested that these aforementioned factors were better managed or kept more constant within herds with overall good performance and resulted in lower variable growth within the herd.

As mentioned, variation in the performance of pigs from different herds was also noted when they were managed in the common environment, with variation being similar to that observed on farm. However, although trends were similar, the two top and bottom performing herds in the common environment were not the same as the two top and bottom performing herds 'on farm'. From each herd, three boars, representative of pigs being weaned on farm, were performance tested in the common environment and this, in addition to the medication pigs received on entry, may be a significant factor in the re-ranking of herd performance in the common environment. The top performing pigs in the common environment had a similar feed efficiency but ate significantly more than the poorer performing pigs. Genotype, pre-weaning environment and health status, and weight at entry were the main differences between pigs in the common environment. Although all the same breed, differences in pig genotype may be a significant contributor to the variable growth rate observed between pigs from different herds. Hall *et al.* (1999) reported coefficients of variation for food conversion ratio of 11%, ADG of 13% and daily feed intake of 13% from records of 1832 pigs of a Large White sire line selected for lean tissue growth. These differences were attributed to different phenotypes, i.e. the same genotype interacting with different environments to cause variation (Hall *et al.*, 1999).

Although the effect of disease on growth performance is well documented (Muirhead (1986) cited by English *et al.*, 1988), its effect on variable growth is not (Payne *et al.*, 1999). Variation in growth rate within groups of pigs infected with pneumonia has been found to be up to 80% greater than that in a group of non-infected pigs (Skirrow, 1993). In addition, Patrick *et al.* (1993) found that pigs exhibiting clinical disease and then treated, took an additional 15.3 days to reach slaughter weight. In the current study, the disease status of the pigs pre-environment, i.e. on farm from birth to wean, varied between herds and it was noted that pigs from the bottom quartile of herds had visibly more evidence of clinical disease on farm than pigs from the top quartile of herds. This is reflected in the variations in growth rate of pigs within the bottom quartile of herds being much greater than that observed with pigs in the top quartile of herds. Medication of pigs using tylosin and bacitracin methylene disalicylate has been found to decrease variable growth (Tillman, 1997; Deen *et al.*, 1998). In the common environment, although pigs were medicated in order to equilibrate their disease status, it is highly likely that their pre-environment disease exposure affected their subsequent growth rate in the common environment. It is possible that if pigs had not been medicated, variation in growth rate in the common environment may have been even greater.

On farm, litters of pigs were mixed across different groups, although group size remained constant within a herd. Research evidence suggests that a certain degree of variation in weight of pigs in a group is necessary for the development and maintenance of a social order and, that in the absence of variation in weight when a group is formed, it will develop over time (Tindsley and Lean, 1984; Gonyou, 1998). Hessing *et al*. (1994) found that when pigs which had an 'active' coping style to stress were mixed with pigs which had a 'passive' coping style, they grew faster with less variation in growth rate (801 g/day, CV = 7.1%) than when 'active' (761 g/day, CV = 11.8%) and 'passive' (773 g/day, CV = 10.5%) pigs were grouped separately. In addition, similar variations in growth rate have been found in group sizes ranging from 20 to 60 pigs per pen (O'Connell *et al*., 2004).

A strong relationship has been reported between the initial weight of pigs on entry to a finisher unit (12-week weight) and slaughter weight (Patrick *et al*., 1993), which is in line with results of this study with pigs from the bottom quartile of herds. However, a much weaker relationship between slaughter weight and 12-week weight was observed for pigs on the top quartile of herds.

Several studies have demonstrated the effect of weaning weight on days to market. Mahan and Lepine (1991) showed that pigs weighing from 7.3 to 8.6 kg at weaning (25.3 days old) reached a weight of 105 kg approximately 15 days earlier than pigs that weighed from 4.1 to 5 kg at weaning at 23.8 days, regardless of the lighter group being fed a higher quality starter diet than that offered to the heavier pigs. Miller *et al*. (1999) demonstrated that the weaning weight of pigs in the 1st week after weaning was a significant predicator of subsequent performance, but Slade and Miller (1999) added that the significance of this factor reduced with time post-weaning. Results from the current study support partially these findings, although weaning weight was a good predictor of 20-week weight only for pigs in the bottom quartile of herds. It is also interesting to note that the significance of weaning weight on subsequent weight decreased with time with pigs in the top quartile of herds. The weaker correlation between the wean and 20-week weights for pigs from the top quartile of herds suggests that management factors on the top quartile of herds influenced growth performance to a larger extent than on the poorer herds and promoted faster growth of pigs. Further work is required to quantify the contribution of management practices to the variation in growth rate on commercial pig herds.

Performance of pigs raised under commercial conditions is generally well below their genetic potential (Black *et al*., 2001). For example, the growth rate of growing and finishing pigs housed individually can increase by up to 200 and 300 g/day, respectively, compared with when they are housed in groups (Campbell and Taverner, 1985; Weatherup *et al*., 2002). The depression in performance under commercial conditions may be attributed to a reduction in feed intake (English *et al*., 1988) and Black *et al*. (2001) have suggested that a number of factors within a commercial environment may contribute to this including: the number of pigs per pen; space allowance; the prevalence of disease; and the temperament/genotype of the pig. However, in the current study, when pigs were housed individually many of the commercial stressors were absent and large differences in feed intake were still observed. Although the feed efficiency and breed (Large White × Landrace) of the top and bottom performers in the common environment was similar, it is possible that feed intake was reduced as a result of a lower voluntary feed intake, influenced mainly by differences in pig phenotype. Large variations in the performance of pigs within a breed have been shown by McCann and Beattie (2004).

In conclusion, large variation in growth rate between pigs within herds is a major contributor to poor herd performance and reduced profitability. Within a breed, major variations in feed intake can contribute to the variation in growth rate. More research is required to investigate the interactive effects between nutrition, management and disease and their contribution to the wide variation in growth performance between and within herds. In addition, research should focus on strategies to manage such variation and ultimately to maximise the full genetic growth rate potential of pigs.

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