Group characteristics influence the performance of individual commercially raised pigs

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Introduction

It is has been well documented that the performance of group housed pigs is considerably lower than the performance of their genetic contemporaries when housed singularly in idealistic environments (Black *et al*. 2001). The review by Black *et al*. (2001) suggested that within commercial environments group housed pigs had depressed feed intakes and efficiency of feed usage as well as a tendency toward increased fat deposition. Undoubtedly management, environmental and within group interactions all contribute to the sub optimal performance of commercially grown pigs. The review by Black *et al*. (2001) listed numerous factors as contributing to this sub optimal performance including; group size, stocking density, air quality and cleanliness of the environment, microbial load and disease, climate, pig temperament and a pigs physiological response to stress.

Griffing (1967) postulated that the selection of better performing individuals within groups may have led to the selection of more dominant animals. Dominant or aggressive animals would most likely have a detrimental effect upon their pen mates and the selection for such animals could be contributing to the growth gap between individual and group housed pigs discussed by Black *et al*. (2001). Studies by Arango *et al*. (2005) and Bergsma *et al*. (2008) have indicated that social or group effects influence a pig's average daily gain. It is intuitive that interactions among individual group members would affect the performance of individuals within the group, but what are these interactions, and do some combinations of animals perform better than others? This study aimed to determine which fixed effects and group characteristics were influencing the average daily gain and backfat levels of individual, group housed, commercially grown pigs.

Materials and methods

Data used in this study were supplied from the Belmont piggery located in southern Queensland and were previously described by Jones and Hermesch (2008) in the paper "When pigs fly; what does it mean?". Pigs grown in pens were selectively removed in sub groups from these pens when they reached market weights. Pig grower groups were reconstructed from these data with animals recorded from the same pen within 15 days combined into single grower groups. Post-editing grower group size averaged 28 pigs per pen and group sizes ranged from 22 to 37 pigs (Table 1). Groups consisted of all boars (88), all gilts (83) and mixed sexes (171). The mixed sex groups varied in their proportion of male pigs per group from 3% to 97%. The proportion of males per group was broken into a class effect of seven levels. There were 16 individual pens which were 24 m^2 (8m x 3m) and were constructed for groups of 30 pigs at an average space of $0.8m^2$ per pig. The pens were separated into two sub-groups consisting of pens 1 to 8 (pen group 1) and pens 9 to 16 (pen group 2). Pen group 1 predominantly housed male pigs and pen group 2 predominantly housed gilts. Animals within pen group 1 were fed a higher energy diet (14.5 to 14.7 MJ ME/kg) than animals in pen group 2 (14.0 to 14.2 MJ ME/kg). Pigs weighed during the months May through to October of each year were assigned to a cool growing season class and pigs grown and tested in other months were assigned to a warm growing season class.

Animals exceeding 3 standard deviations of the mean for weight, age, average daily gain and backfat were removed from the data as were animals in groups containing less than 22 or over 37 animals. From these data pig ages at testing and pig average daily gains were derived (Table 1). Three breeds were represented in the data, 63% Large White, 29% Landrace and 8% Duroc. Groups were composed of differing breed proportions (Table 2).

Table 1. Belmont data set record numbers (N), means, standard deviations (SD), minimum (Min) and maximum (Max) values for data characteristics

variable	N	Mean	SD	Min	Max
Individual pigs					
Weight (kg)	9429	103	9.27	75	131
Average daily gain (g/d)	9429	671	67.8	467	870
Backfat (mm)	9429	11.4	2.12	7.0	18.0
Age (days)	9429	154	8.28	130	190
Flight time (seconds)	9275	2.09	1.14	0.08	9.4
Groups					
Group size (n)	353	28.4	3.78	22	37
Group flight time (seconds)	353	2.09	0.34	1.28	3.07

Table 2. Mean breed proportion per group, standard deviation (SD), minimum (Min) and maximum (Max)

	Mean	SD	Min	Max
Large White	61	16	19	100
Landrace	27	14	0	67
Duroc	08	10	0	52

Effects were statistically significant when they exceeded a 0.05 threshold in a linear model (SAS, 1999). The effects found significant for average daily gain and backfat are listed in Table 3. Group size within temperature class was fitted as a linear and quadratic covariate for both average daily gain and backfat. Further linear covariates for both traits were percent Duroc of the group and the mean flight time of the group. The backfat model also included test weight as a linear covariate.

Table 3. Effects influencing average daily gain (ADG) and backfat (BF) with their F and P values and degrees of freedom (DF)

Fixed effect	Levels	ADG		BF	
		F value	P value	F value	P value
Sex	2	77.51	0.0001	152.5	0.0001
Pen group	2	18.83	0.0001	5.59	0.0038
Percent male of the group	7	16.93	0.0001	1.8	0.095
Percent Duroc of the group	1	16.76	0.0001	0.29	0.5885
Test date within temperature class	127	15.18	0.0001	5.8	0.0001
Group size within temperature class (q*)	2	10.02	0.0001	3.72	0.0243
Group size within temperature class (l*)	2	9.11	0.0001	4.7	0.0091
Mean flight time of the group	1	9.42	0.0022	2.36	0.1242
Temperature class	2	7.73	0.0054	1.82	0.1771
Breed	3	4.76	0.0086	0.98	0.3742
Sire (random effect)	106	3.41	0.0001	6.72	0.0001
Dam (random effect)	490	2.73	0.0001	2.66	0.0001
Test weight	1	-	-	1283	0.0001

* q = quadratic; l = linear

Percent male

The proportion of male pigs per group was found to have an impact upon individual average daily gain (Figure 1). Growth rate was lowest when groups contained 9 to 30 % males or 70 to 90 % males. This indicates that the most efficient way to pen animals is based upon their sex. If mixed sex groups are created then an attempt should be made to ensure that the groups contain roughly equal numbers of both sexes wherever possible. Without an observational study, reasons for this decrease in performance are only speculatory but they could include an increase in aggression between both males and females in groups with 9 to 30 % of a minority sex in order to establish a breeding hierarchical order. This factor did not significantly affect backfat.

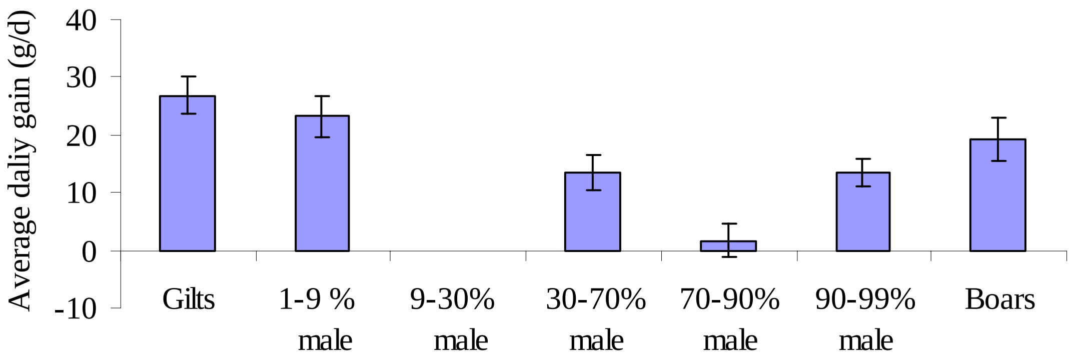

Figure 1. Relative influence of varying group sex proportions on average daily gain (with the lowest class (9-30% male) set to zero)

Percent Duroc

The proportion of Duroc pigs present in a grower group positively affected individual average daily gain (Figure 2). As the proportion of Duroc animals within a group increased so did the average daily gain of the group after correction for all other significant effects. Exactly why this effect occurred is unknown, although a personal communication with the owner/manager of the Belmont piggery indicated that Durocs were always the last pigs to move when being handled by staff. Grandin (1992) also reported that observations on farms and in abattoirs indicated that pigs containing Duroc genetics were calmer. It appears that the presence of these pigs has a calming influence upon the entire grower group. It is hypothesised that less energy is expended in these groups on playing, fighting or on general interaction and as a result more energy is available to each pig to be used for growth. When the proportion of Duroc pigs per group was analysed within each temperature class the effect was only significant during the cooler months. This may indicate that heat stress had already curtailed excess activity in warmer months or the presence of calmer pigs facilitated a tighter packing during cooler temperatures thereby reducing heat loss. Backfat was not affected by the proportion of Durocs within a group.

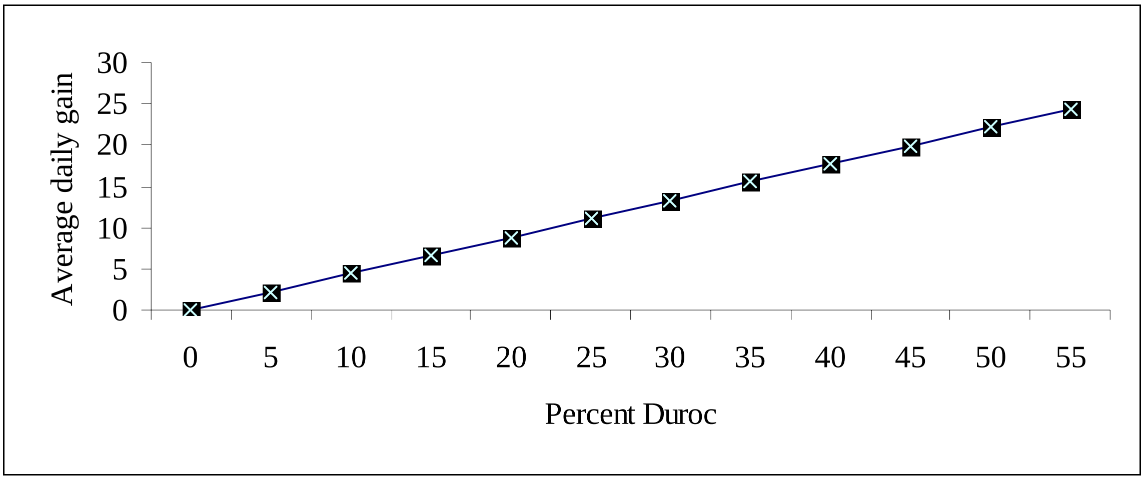

Figure 2. Influence of the proportion of Duroc pigs within a group on average daily gain

Group size

The optimal grower group size for this enterprise was 28 pigs per pen (0.86m^2 per pig) during the warmer months and 30 pigs per pen (0.80m^2 per pig) during the cooler months (Figure 3). As group size increased the space for each animal decreased suggesting that the optimal group number is related to the thermal environment encountered by each pig. In a review of published experiments regarding floor space Black *et al*. (1999) (cited by Black *et al*. 2001) found that a depression in feed intake occurred at stocking densities above 0.035m^2/live weight$^{0.67}$. At a live weight of 103 kg this would equate to a requirement of 0.78m^2 per pig. This closely approximates the ideal stocking density at Belmont during cooler months. From the optimal stocking densities it appears that Belmont pigs require 0.036m^2/live weight$^{0.67}$ during cooler months and 0.038m^2/live weight$^{0.67}$ during warmer months. These values suggest that the reduction in average daily gain is likely to be caused by a similar depression in feed intake at stocking densities above 0.036m^2/live weight$^{0.67}$ as reported by Black *et al.*

(2001). The results shown in Figure 3 are relative reductions in average daily gain compared to the average daily gain of the optimal group sizes (average daily gain of group size 30 = 0 in cool months and average daily gain of group size 28 = 0 in warm months).

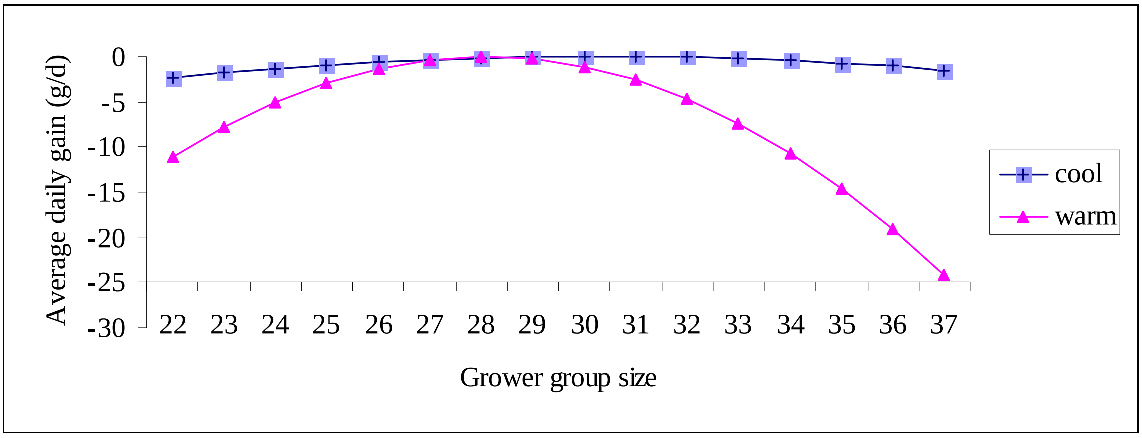

Figure 3. The effect of group size on average daily gain in cool and warm seasons

The effect of group size within temperature was also significant for backfat depth. The results indicated that the lowest backfat depths in cool months occurred at a group size of 34 and in warm months the effect was not significant.

Mean group flight time

In this study the average daily gain of an individual pig was influenced by the average flight time of the group that the pig was grown in (Figure 4). As the mean group flight time increased so did an individual's average daily gain. Interpretation of this result again indicates that a calm group facilitates growth. An increase in flight time means that an animal moves more slowly when exiting the restraint and this has been related to an animal's fearfulness and stress (Petherick et al. 2002). This would then serve to reinforce the positive effects of the proportion of Duroc animals in a group and the negative effects of increasing the proportion of males. Again the benefits would occur through resource partitioning resulting in more energy being available for growth. It would be expected therefore that calmer less stressed groups would also facilitate a higher feed efficiency.

Mean group flight time was also found to be significant for individual backfat expression. Results indicated that as group flight time increased so did individual backfat depth although over the entire range of group mean flight times this only resulted in a 0.23 mm increase in backfat depth of pigs.

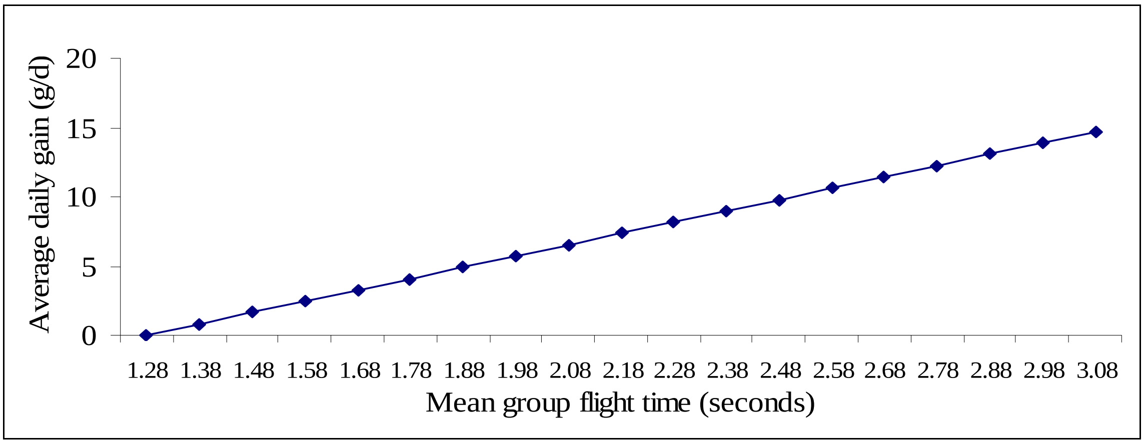

Figure 4. Influence of group mean flight time upon individual average daily gain

Sex, Breed, Test date, Pen group and Temperature class

The inclusion of Sex, Breed, Test date, Pen group and Temperature class parameters in the model allow the impact of these factors on performance to be accounted for when predicting the effects of other group factors. The animal's own sex was the fixed effect that explained the most about the average daily gain of an individual pig. It is well known that boars grow faster and are leaner than gilts predominantly through the effects of testosterone and this was also observed in this study. After adjustment for significant fixed effects it was found that boars in this study grew 20.3 grams per day faster than gilts. Boars had on average 0.89 mm less backfat than gilts after linear adjustment for test weight. Breed differences existed for both, backfat depth and average daily gain.

The growth of a pig is influenced by effects that can best be accounted for by fitting a contemporary group in the explanatory model. Effects like variations in feed quality, air quality, bacterial load, water quality and daily temperature extremes all impact upon an individual's ability to convert feed to body mass. Animals tested upon a particular date have been exposed to similar variations in their growing environment. The inclusion of the test date in the model adjusts the pig's performance for these variations and gives more credibility to other effects which remain significant after the contemporary group effects have been accounted for.

After adjusting for all other significant factors the pigs grown in pen group1 (pens 1 to 8) were found to have 8.70 g/d lower growth than pigs from pen group2 (pens 9 to 16). This result was unexpected as the animals from pen group1 were fed the higher energy diet. Pen group1 were also found to have a 0.21 mm higher backfat depth after adjustment compared to animals in pen group2.

Temperature class was also significant in the model. It is know that high temperatures are detrimental to feed intake. Digestive processes are energetically expensive and evolve heat. During periods of high temperature, animals limit their feed intake in order to limit the evolution of heat within their bodies. Quiniou *et al*. (2000) found that this effect is exacerbated as an animal's live weight increases.

Conclusions

It appears that individual average daily gain can be increased by understanding and manipulating group characteristics. These are, in order of importance, the proportion of males within a group, the proportion of Durocs within a group, the size of the group dependant upon the growing season and the mean flight time of the group. With the exception of group flight time these group characteristics can be manipulated through management decisions. Flight time can be manipulated over generations as this has been shown to be a heritable trait. Overall group characteristics were of a higher importance for average daily gain than for backfat. This corresponds to the higher random group effect found in these data for average daily gain. Often group size and pen information is not routinely recorded on farm and breeders should be recording this information as it appears to be an important aspect of individual animal performance and can be used in future studies to enable further genetic progress.

Acknowledgments

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