Feeding behavior traits and its impact on economically important traits

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INTRODUCTION

New approaches for improving production efficiency and improving animal well-being are especially desirable. A greater understanding of the relationship between pig feeding behavior and economically important traits could lead to advances in both production efficiency and well-being. It is important to determine if average daily feed intake provides all the information needed regarding feeding behavior or is the manner in which feed is consumed also important. We know that pigs with identical average daily feed intake sometime perform differently. This can easily be shown by comparing pigs with identical values for feed intake and different growth rates which results in differences in feed conversion rate. Could the manner in which pigs consume feed be partially responsible for observed differences in feed conversion? What about pigs which eat similar amounts of feed and grow at similar rates but differ in body composition? Could feeding behavior be a contributing factor to those differences also? The project reported herein is our initial attempt to address these questions.

Differences in feeding behavior based on breed (Labroue et al., 1994), sex (de Haer and de Vries, 1993) and group size (Hyun and Ellis, 2002) have been studied. A pig can have only one "feeding behavior". However, several indicator traits which partially describe that feeding behavior can be measured. Indicators of feeding behavior that have been evaluated include number of visits/meals per day, occupation time per visit/meal, occupation time per day, feeding rate per visit/meal, feed intake per visit/meal and average daily feed intake (de Haer et al., 1993). Prior to the development of electronic feeders, measuring individual feed intake required individual housing and was expensive and labor intensive (Nielsen et al., 1995). The development of computerized food intake recording systems allowed for recording of individual feeding behavior while housing pigs in groups through the use of electronic transponders (Young and Lawrence, 1994).

Previous studies which looked at purebred pigs have focused on maternal breeds such as Landrace, Yorkshire and Large White (de Haer et al., 1993; Labroue et al., 1994). The purebred pigs in this study are from lines selected for paternal traits. Although research has been done on feeding behavior in crossbred pigs (Hyun and Ellis, 2001, 2002), it has not been compared to feeding behavior in purebred pigs.

MATERIALS AND METHODS

Experimental Design

Data on 8601 purebred boars from 4 sire lines (A, B, C, and D) were collected. Boars were on-test for 13 wk and removed from performance test from May 10 to November 8, 2004. Boars were housed 15 pigs per pen on two farms. Contemporary group was defined as those boars that completed growth test at the same time from the same farm. Data were also collected on 1728 crossbred gilts and barrows, representing three sire lines (A, B, and C) and two dam lines (E and F), from two replicates. Pigs for this portion of the study were housed 18 pigs per pen with eight pens per finishing room. Replicate 1 ran from February 26 to August 9, 2004 and replicate 2 ran from July 1 to December 13, 2004. Pigs went on-test at an average weight of 38

kg and completed growth test at an average weight of 114 kg. Contemporary group was defined as those pigs in the same replicate and finishing room.

Data were collected using Feed Intake Recording Equipment (**FIRE**; Osborne Industries Inc., Osborne, KY) electronic feeders which record ear transponder, entrance time, start weight of feed, exit time, and end weight of feed. Each feeder was used for two pens with a switch gate controlling access to the feeder weekly. On alternating weeks, a conventional feeder was used. Seven behavior traits were derived from feeder data and are average daily feed intake (**ADFI**), average number of visits per day (**ANV**), average feed intake per visit (**AFIV**), average feeding rate per visit (**AFRV**), average occupation time per day (**AOTD**), average occupation time per visit (**AOTV**), and consistency of average daily feed intake **(C**ADFI**)**. The CADFI was a measure to determine if pigs ate approximately the same amount of feed during each 24 hour period and was calculated by fitting a feed intake curve to each pig and then averaging the absolute values of the difference between actual feed intake and predicted feed intake. Feeding behavior traits were adjusted for initial weight and feeder prior to analysis.

Performance traits for purebred pigs were; average daily gain (**ADG**), backfat (**BF**), loin depth (**LD**), feed conversion ratio (**FCR**), and ADFI. Crossbred pigs were individually weighed at birth, weaning, 42 days in nursery, on-test, and every thirty days during test period. Ultrasound backfat thickness and loin depth were measured on-test and every thirty days during test period. Performance traits for crossbred pigs were; ADG, change in backfat over the test period (Δ**BF**), change in loin depth over the test period (Δ**LD**), FCR, and ADFI. The ADFI is a feeding behavior trait as well as a performance trait in this study.

Least square means were calculated for performance and feeding behavior traits by sire x dam line, sire line, and dam line for crossbred data and by sire line for purebred data using the PROC GLM procedure in SAS (SAS Inst., Inc., Cary, NC). The model used accounted for contemporary group, line, sex (crossbred only), initial weight of pig, and line x sex interaction (crossbred only).

RESULTS AND DISCUSSIONS

Least square means for performance and feeding behavior traits are reported in Tables 1, 2, and 3. Line B stands out for feeding behavior traits in both crossbred and purebred data sets. Line B pigs had more but shorter visits to the feeder, ate less per visit, ate at a slower rate, spent more time in the feeder per day, and were more consistent eaters than pigs from Lines A and C. Lines A and C did not differ ($P > 0.05$) for feeding behavior traits. Line A grew slower and had smaller loins, on average, than lines B and C with Line C having the largest loins.

Table 1. Least square means for crossbred pigs by line[1]

	Line[2]						
Trait[3]	AE	AF	BE	BF	CE	CF	SEM
FCR	2.43^{ab}	2.48^{ac}	2.39^{bd}	2.50^{c}	2.34^{d}	2.43^{b}	0.035
ADG	0.869^{ab}	0.856^{a}	0.894^{c}	0.872^{b}	0.890^{c}	0.888^{c}	0.011
ΔLD	20.5^{ab}	19.9^{a}	21.7^{c}	21.2^{bc}	23.1^{d}	22.0^{c}	0.720
ΔBF	7.98^{a}	9.41^{b}	8.19^{a}	9.18^{b}	8.47^{a}	9.49^{b}	0.454
ADFI	2.11^{ab}	2.12^{ac}	2.14^{ad}	2.16^{d}	2.08^{b}	2.16^{cd}	0.032
AOTD	3981^{ab}	4103^{ac}	4239^{cd}	4251^{d}	3919^{b}	4170^{cd}	104
AOTV	888^{a}	857^{ab}	851^{ac}	811^{c}	844^{ac}	844^{bc}	28.4
AFRV	33.8^{ab}	33.8^{ab}	32.9^{a}	33.2^{a}	35.0^{b}	34.4^{b}	0.911
AFIV	489^{a}	470^{ab}	449^{bc}	436^{c}	477^{ad}	463^{bd}	15.1
ANV	4.77^{a}	4.98^{ab}	5.28^{cd}	5.51^{c}	4.87^{a}	5.20^{bd}	0.180
CADFI	0.198^{ab}	0.193^{a}	0.191^{ac}	0.183^{c}	0.207^{b}	0.196^{a}	0.0068

[1] Values within a row without a common superscript differ (P<0.05).
[2] Line as sire line (A, B, C) x dam line (E, F).
[3] Traits: FCR = feed conversion ratio (feed/gain); ADG = average daily gain (kg/day); ΔLD = change in loin depth over test period (mm); ΔBF = change in backfat over test period (mm); ADFI = average daily feed intake (kg/day); AOTD = average occupation time per day (s/day); AOTV = average occupation time per visit (s/visit); AFRV = average feeding rate per visit (g/min); AFIV = average feed intake per visit (g/visit); ANV = average number of visits per day; CADFI = residual daily feed intake (kg/day).

Table 2. Least square means for crossbred pigs by sire line and by dam line[1]

	Sire line				Dam line		
Trait[2]	A	B	C	SEM	E	F	SEM
FCR	2.46^{a}	2.45^{a}	2.40^{b}	0.026	2.38^{a}	2.47^{b}	0.022
ADG	0.862^{a}	0.882^{b}	0.889^{b}	0.008	0.885^{a}	0.873^{b}	0.007
ΔLD	20.1^{a}	21.4^{b}	22.5^{c}	0.52	21.8^{a}	21.0^{b}	0.44
ΔBF	8.82^{a}	8.75^{a}	9.06^{a}	0.33	8.22^{a}	9.37^{b}	0.28
ADFI	2.12^{a}	2.15^{a}	2.13^{a}	0.023	2.11^{a}	2.15^{b}	0.020
AOTD	4054^{a}	4246^{b}	4064^{a}	75.7	4041^{a}	4176^{b}	63.9
AOTV	870^{a}	828^{b}	844^{ab}	20.7	859^{a}	838^{a}	17.4
AFRV	33.8^{ab}	33.0^{a}	34.6^{b}	0.66	33.9^{a}	33.8^{a}	0.56
AFIV	477^{a}	442^{b}	469^{a}	11.0	471^{a}	456^{b}	9.3
ANV	4.90^{a}	5.41^{b}	5.06^{a}	0.13	4.97^{a}	5.23^{b}	0.11
CADFI	0.195^{a}	0.187^{b}	0.201^{a}	0.005	0.199^{a}	0.191^{b}	0.004

[1] Values within a row and comparison without a common superscript differ (P<0.05).
[2] Traits: FCR = feed conversion ratio (feed/gain); ADG = average daily gain (kg/day); ΔLD = change in loin depth over test period (mm); ΔBF = change in backfat over test period (mm); ADFI = average daily feed intake (kg/day); AOTD = average occupation time per day (s/day); AOTV = average occupation time per visit (s/visit); AFRV = average feeding rate per visit (g/min); AFIV = average feed intake per visit (g/visit); ANV = average number of visits; CADFI = residual daily feed intake (kg/day).

Table 3. Least square means for purebred pigs by line[1]

Trait[2]	Line				
	A	B	C	D	SEM
FCR	2.33[a]	2.21[b]	2.22[c]	2.26[d]	0.007
ADG	0.962[a]	1.009[b]	1.050[c]	1.005[b]	0.003
LD	62.8[a]	67.0[b]	73.9[c]	71.3[d]	0.19
BF	10.6[a]	11.1[b]	11.7[c]	11.0[b]	0.07
ADFI	2.22[a]	2.22[a]	2.32[b]	2.26[c]	0.007
AOTD	4212[a]	4460[bc]	4416[b]	4484[c]	28.8
AOTV	824[a]	744[b]	825[a]	849[c]	7.4
AFRV	32.4[a]	31.4[b]	33.7[c]	32.4[a]	0.23
AFIV	455[a]	393[b]	462[a]	455[a]	3.8
ANV	5.40[a]	6.37[b]	5.61[c]	5.51[d]	0.05
RESID	0.359[a]	0.342[b]	0.363[a]	0.361[a]	0.003

[1] Values within a row without a common superscript differ ($P<0.05$).
[2] Traits: FCR = feed conversion ratio (feed/gain); ADG = average daily gain (kg/day); LD = loin depth (mm); BF = backfat depth (mm); ADFI = average daily feed intake (kg/day); AOTD = average occupation time per day (s/day); AOTV = average occupation time per visit (s/visit); AFRV = average feeding rate per visit (g/min); AFIV = average feed intake per visit (g/visit); ANV = average number of visits; CADFI = residual daily feed intake (kg/day).

Previous studies have shown that differences in group size affect feeding behavior. Hyun and Ellis (2002) found that, as group size increased, ANV and AOTD decreased and AFIV, AOTV, and AFRV increased. Other studies support these findings such as Nielsen et al. (1995) which found that, as group size increased, ANV and feeder AOTD decreased whereas AOTV, AFIV, and AFRV increased. Both studies found no significant effect of group size on ADG, FCR, or ADFI (Hyun and Ellis, 2002; Nielsen et al., 1995). The lack of an effect of group size on performance traits when group size does effect feeding behavior may explain some of the differences in results between crossbred and purebred pigs. Crossbred pigs had more pigs per pen than purebred pigs and, therefore, would be expected to have different feeding behavior from purebred pigs.

Previous studies have found differences between sexes for performance and feeding behavior traits. Boars have been shown to have higher ADG and lower FCR than gilts (de Haer and de Vries, 1993; Hyun et al., 1997). Hyun et al. (1997) found that barrows had higher ADG than gilts and FCR intermediate to but not different from boars and gilts. Hyun et al. (1997) also found that although barrows ate more meals per day than boars and gilts, there were no differences between sexes for other feeding behavior traits. This differs from the findings of de Haer and de Vries (1993) where gilts had more frequent visits to the feeder but consumed less feed per visit than boars. Labroue et al. (1994) found that barrows ate longer both by day and by visit and had higher ADFI than boars with no difference in the number of meals consumed per day. These studies show that the effect of sex on feeding behavior is still unclear. Therefore, the difference between crossbred and purebred pigs may also be influenced by sex.

A third possibility for differences between crossbred and purebred pigs is the effect of dam line on crossbred performance and behavior. Previous studies have shown that breed has an effect on feeding behavior. Labroue et al. (1994) found that, when penned together, French

Landrace pigs had ANV, AFIV, and AOTV than Large White pigs. When penned separately, the only feeding behavior that differed significantly was the ANV with French Landrace pigs having lower ANV than Large White pigs (Labroue et al., 1994). De Haer and de Vries (1993) found that Dutch Landrace and Great Yorkshire pigs differed in both performance and feeding behavior. Great Yorkshire pigs had higher ADG and lean percentages, lower FCR, and less backfat than Dutch Landrace pigs. Great Yorkshire pigs also ate more frequently and faster than Dutch Landrace pigs with more ANV, lower AFIV, higher AFRV, and lower AOTD (de Haer and de Vries, 1993).

Hall et al. (1999) looked at the predicted responses to selection when including feeding behavior traits along with ADG, BF, and ADFI in a selection index. The three traits that Hall et al. (1999) looked at were AFIV, ANV, and AOTV because they had favorable correlations with performance traits and other feeding behavior traits are a function of those three traits, therefore adding no new information. Those three traits also happen to be the three traits that primarily compose PC1 in this study. Hall et al. (1999) concluded that the use of feeding behavior traits increased genetic gain potential for ADG, percent lean, FCR, and ADFI but accuracy of selection was decreased. Hall et al. (1999) also concluded that the most effective and robust index included ADG, BF, ADFI, and ANV.

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