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Pregnant gilt behavior in outdoor and indoor intensive pork production systems

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Abstract

The behavior of three genotypes of gilts were compared in an English-style intensive outdoor production system or an intensive indoor system, each operated on a common production schedule. The genotypes investigated were PIC Camborough-15 (C-15); PIC Camborough-Blue (CB); and York × Landrace (YL). Behaviors as defined and recorded were mutually exclusive, including: chewing, rooting, standing, sitting, drinking, rubbing, walking, and for outdoor gilts wallowing and grazing. No significant main effects of genotype were found. Gilts kept outdoors were more active and spent more time chewing objects, with less time sitting than gilts indoors. The oral/nasal chewing observed in confined, pregnant pigs was much lower in frequency than similar environment-directed oral/nasal behaviors observed outdoors. Genotypes did not differ in behavior; however, the genotype by environment interaction was significant for lying (resting) behaviors. Outdoor-kept gilts spent less time lying than indoor gilts, but the effect was less pronounced for C-15 than for CB or YL genotypes. The few significant genotype and genotype by environment interactions indicated that these genotypes generally express similar behavior. However, the outdoor environment seemed to induce more oral/nasal behaviors than the indoor production system.

Keywords: Pig; Behavior; Indoor; Outdoor; Welfare

1. Introduction

The past few decades have seen a movement of swine production from outdoor to indoor production situations, and more recently outdoor units have increased in numbers. Evaluation of contemporary production systems should be concurrent with devel-

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opment of new environments and systems (Curtis, 1983). Outdoor production facilities may allow pigs to express certain behaviors or levels of behavior that may differ from confined pigs. Any potential environmental effect on animal behavior may be linked to the development of stereotypic behavior (Lawrence et al., 1993).

In the United Kingdom, outdoor production has increased from less than 6% of herds prior to 1975 to more than 20% owing to economic and welfare concerns (Edwards, 1994). Recent studies of sow behavior have focused primarily on indoor confined sows, but the behavior of outdoor gestating swine is also important. Behavioral differences between group-housed sows in pens indoors and outdoors are reported to be minimal (Barnett et al., 1984, 1985). However, most reports of the behaviors of outdoor-kept sows do not use the generous space allowances of current commercial outdoor systems (e.g. Barnett et al., 1984, 1985; McGlone and Blecha, 1987).

Few studies have examined genotype effects on behavior. Behavioral comparisons between genetic lines selected for increased growth (or not) found increased activity for the selected line among confined tethered or free-stalled gilts (Barnett et al., 1988). Basic behavioral information about common genotypes might help aid in animal management.

This study examined the effects of two environments (indoor and outdoor) and three genotypes (PIC Camborough-15, PIC Camborough-Blue, and York × Landrace) of pregnant gilts to better understand environmental and genetic effects on behavior.

2. Materials and methods

2.1. Animals and environment

The indoor swine unit had been in continuous operation since 1977, and an outdoor English-style swine unit was established in January 1992. For this study, the swine herd was depopulated and repopulated with gilts started and maintained on identical commercial production schedules. The comparisons in this study are for gilts in different, but highly controlled systems (i.e. breeding and farrowing tasks were completed by the same herdsperson for both environments). Several environmental features differ between the indoor and outdoor environments, as they do on commercial farms. The environmental comparison was between production systems.

This study was conducted from June to September 1993. The microbial load (disease exposure) was as similar as possible for gilts in two environments (same workers, same initial intermingled groups of gilts, etc.). The thermal environment was within the thermal neutral zone for animals in each environment during the course of the study. Indoor and outdoor kept sows experienced very similar thermal environments. Outdoor gilts were in a group of 16–20 on 0.81 ha paddocks, with access to grazing and wallows and to huts for shelter. Indoor gilts were housed in group pens of 12–14 in a mechanically ventilated, slotted floor gestation building. Indoor gilts had access feeding stalls (0.6 m × 2.0 m) and a common area 2.4 m in depth behind these stalls. A minimum of 2.7 m^2 per gilt was provided indoors and at least 300 m^2 per gilt was provided outdoors.

PIC Camborough-15 (C-15) and PIC Camborough-Blue (CB) gilts were obtained from PIC (Franklin, KY). The C-15 sow line is derived from Yorkshire, Landrace and Duroc breeds in a crossbreeding program. The CB sow line is a crossbred line derived from Yorkshire, Landrace and Wessex Saddleback breeds. York × Landrace (YL) gilts were bred on site with seedstock from Brichwood Genetics (West Manchester, OH). All gilts were raised in commercial indoor confinement buildings. Gilts were then moved to the two treatment areas. Genotypes were mixed within pens in both housing systems.

Gilts were heat checked daily in their home pens by a boar. If gilts were detected in estrus, they were removed from the pen and bred. Indoor gilts were fed in individual feeding stalls, while outdoor gilts were fed on the ground with the same ration but in pelleted form. Rations were 14% CP sorghum–soybean meal based diets formulated to meet the National Research Council (NRC, 1988) requirements. Gilts were fed 2 kg per animal once daily in the morning in each production system.

2.2. Observations

A total of 155 observations were collected using a 5 min scan technique (Altmann, 1974), collecting 12 observations per hour. Both environments were simultaneously observed by trained observers. One observer recorded behavior on six or fewer gilts every 5 min.

Vieuille-Thomas et al. (1995) observed sows for 1 h after feed was given. We used a modification of the sampling technique of Vieuille-Thomas et al. (1995) in that we also included an evening observation. Gilts were observed at two times of day: 1 h post feeding (AM) and 1 h before sunset (PM). At least ten observations were collected for each genotype/environment/time. Animals were individually identified with a unique mark prior to the observation period. Gilts were in mid-gestation during observations and had been in their respective treatment environments for at least 45 days prior to observations.

Table 1
Definitions of observed behaviors

Measure	Description of behavior	Oral [a]	Oral/nasal plus graze and drink [a]	Active [a]
Indoor and outdoor				
Chew	Jaw movement without contact with any substrate	✓	✓	✓
Root	Rooting disk contact with the ground or feed trough	✓	✓	✓
Drink	Mouth contact with drinker		✓	✓
Stand	Supported by all legs, no oral actions or locomotion			✓
Sit	Animal supported by front legs only			✓
Rub	Non-oral body movement against a substrate			✓
Walk	Locomotion towards a given point			✓
Lie	Animal not supported by its legs			
Outdoor only				
Graze	Jaw movement with contact on vegetable matter		✓	✓
Wallow	Animal located in a depression in the earth filled with water			✓
In hut	Out of view in hut			

[a] Behavior composed of the sum of the behaviors with a ✓ symbol.

Table 2
Behaviors of three genotypes of gilts group housed *indoors* (*In*) or *outdoors* (Out) (least squares mean ± SE)

Measure [a]	Genotype × Environment effect										Environment effect		*P*-value		
	C-15 [b]			CB [b]			YL [b]								
	In		Out	In		Out	In		Out		All In	All Out	*Env*	*Geno*	Geno × Env
N	41		22	28		22	21		21		90	65	–	–	–
All inactive [c]	8.2 ± 0.66	*	5.8 ± 0.90	9.8 ± 0.82	* *	4.4 ± 0.90	9.1 ± 0.97	* *	3.3 ± 0.94		9.1 ± 0.48	4.5 ± 0.53	0.0001	0.49	0.045
Lying	8.2 ± 0.55	* *	4.4 ± 0.74	9.8 ± 0.68	* *	0.74 ± 0.75	9.1 ± 0.80	* *	1.1 ± 0.78		9.1 ± 0.40	2.1 ± 0.44	0.0001	0.18	0.0004
In-hut	–		1.4 ± 0.98	–		3.7 ± 0.99	–		2.2 ± 1.0		–	2.4 ± 0.57	–	–	
All active [d]	3.8 ± 0.66	*	6.2 ± 0.90	2.2 ± 0.82	* *	7.6 ± 0.91	2.9 ± 0.97	* *	8.7 ± 0.94		2.9 ± 0.48	7.5 ± 0.53	0.0001	0.54	0.095
Stand	1.3 ± 0.42		1.6 ± 0.57	0.74 ± 0.52		1.5 ± 0.58	1.3 ± 0.62		3.1 ± 0.60		1.1 ± 0.30	2.1 ± 0.34	0.0395	0.18	0.46
Sit	0.21 ± 0.07		0 ± 0.10	0.10 ± 0.10		0 ± 0.10	0.45 ± 0.11		0 ± 0.11		0.25 ± 0.05	0 ± 0.06	0.0022	0.22	0.22
Walk	0.08 ± 0.13		0.48 ± 0.17	0.10 ± 0.16	* *	0.66 ± 0.18	0 ± 0.19	* *	1.8 ± 0.18		0.06 ± 0.09	0.77 ± 0.10	0.0001	0.19	0.063
Rub	0.08 ± 0.04		0.1 ± 0.06	0.07 ± 0.05		0.05 ± 0.06	0 ± 0.06		0.06 ± 0.06		0.05 ± 0.03	0.07 ± 0.03	0.68	0.54	0.80
Wallow	–		1.8 ± 0.85	–		2.4 ± 0.85	–		3.1 ± 0.88		–	2.5 ± 0.50	–	0.56	–
Drink	0.33 ± 0.08		0.03 ± 0.10	0.19 ± 0.09		0.08 ± 0.10	0.25 ± 0.11		0.32 ± 0.11		0.26 ± 0.05	0.14 ± 0.06	0.15	0.33	0.16
Graze	–		1.2 ± 0.50	–		2.7 ± 0.50	–		1.5 ± 0.52		–	1.8 ± 0.29	–	0.10	–
Chew	0.71 ± 0.34		2.7 ± 0.46	0.50 ± 0.42		2.8 ± 0.46	0.73 ± 0.50		1.5 ± 0.48		0.64 ± 0.24	2.3 ± 0.27	0.0001	0.38	0.24
Root	1.4 ± 0.29		0.48 ± 0.39	0.88 ± 0.35		0.26 ± 0.39	0.43 ± 0.42		0.94 ± 0.40		0.89 ± 0.21	0.56 ± 0.23	0.27	0.60	0.16
Oral [e]	2.1 ± 0.46		3.2 ± 0.62	1.4 ± 0.56		3.0 ± 0.63	1.2 ± 0.67		2.4 ± 0.65		1.5 ± 0.33	2.9 ± 0.37	0.0075	0.39	0.89
Ongrdr [f]	2.4 ± 0.60		4.4 ± 0.81	1.6 ± 0.74		5.8 ± 0.82	1.4 ± 0.87		4.3 ± 0.85		1.8 ± 0.43	4.8 ± 0.48	.0001	0.60	0.33

[a] See Table 1 for an explanation of these behaviors.
[b] C-15, PIC Camborough-15; CB, PIC Camborough-Blue; YL, York × Landrace.
[c] Lie + in-hut.
[d] Stand + Sit + Walk + Rub + Wallow + Drink + Graze + Chew + Root.
[e] Chew + Root.
[f] Chew + Root + Drink + Graze.
Asterisks indicate that the given genotype differs between indoor and outdoor environments by predicted differences test: * $P < 0.05$; * * $P < 0.01$.

The list of mutually exclusive behaviors as defined and recorded included chewing, rooting, drinking, standing, sitting, rubbing, walking, and lying for both environments. Exclusively occurring outdoor behaviors were grazing, wallowing and in-hut (definitions of these behaviors are given in Table 1). Wallowing was classified as an active behavior as most gilts exhibited active behaviors while in the wallow.

2.3. Statistical analysis

Data were analyzed using the analysis of variance and GLM procedure of SAS (Statistical Analysis Systems Institute Inc., 1988). The main plot effects were environment, genotype, and environment by genotype interactions and were tested using the individual animal nested within (environment by genotype) as the error term. Effects of time, genotype by time, environment by time, and genotype by environment by time interactions were tested using the residual error as the error term. We observed 21–41 gilts per treatment and at least ten sows per AM or PM observation per treatment.

3. Results

3.1. Main plots

The animals in the outdoor environments were more active overall, and exhibited a greater frequency of standing ($P < 0.05$), walking, chewing, oral and oral/nasal plus graze and drink behaviors ($P < 0.01$) than the indoor gilts (Table 2). Indoor gilts were less active than outdoor gilts and had a higher frequency of sitting and drinking ($P < 0.001$). There were no environment effects on rubbing or rooting behaviors.

No genotype effects were found for behaviors other than grazing. CB gilts tended to show a higher ($P < 0.1$) rate of grazing than C-15 or YL gilts.

Genotype by environment interactions were significant for general activity ($P < 0.10$) and inactivity ($P < 0.05$). All genotypes were less active in the indoor environment ($P < 0.05$) than in the outdoor system. Genotypes did not differ in behavior; however, the genotype by environment interaction was significant for lying (resting) behaviors. Outdoor-kept gilts spent less time lying than indoor gilts, but the effect was less pronounced for C-15 than for CB or YL genotypes. The few significant genotype and genotype by environment interactions indicate that these genotypes generally express similar behavior. However, the outdoor environment seemed to induce more oral/nasal behaviors than the indoor production system. Outdoor-kept gilts also tended to walk at a higher frequency than the indoor gilts ($P < 0.1$).

3.2. Subplot analysis

Overall time effects were significant ($P < 0.05$), showing lower frequency of behaviors in the PM observation for active behaviors, standing, sitting, drinking, grazing, chewing, oral and oral/nasal plus graze and drink behaviors (Table 3). An increased frequency of wallowing and inactive behaviors was found when the PM observations were compared with the AM observations ($P < 0.005$).

Table 3
Behavior of indoor and outdoor housed gilts, influence of time and interactions including time of day (least squares mean ± SE)

Measure [a]	Indoors		Outdoors		*P*-value			
	AM	PM	AM	PM	Time	Geno × Time	Env × Time	Geno × Env × Time
N	42	48	32	33				
All inactive [b]	6.9 ± 0.59	** 11.2 ± 0.56	4.3 ± 0.66	4.4 ± 0.65	0.0005	0.088	0.0009	0.27
Lying	6.9 ± 0.48	** 11.2 ± 1.90	1.9 ± 0.54	2.2 ± 0.53	0.0001	0.39	0.0001	0.38
In-hut	–	–	2.4 ± 0.76	2.1 ± 0.74	0.83	0.048	–	–
All active [c]	5.1 ± 0.59	** 0.83 ± 0.56	7.7 ± 0.66	7.6 ± 0.65	0.0005	0.088	0.0009	0.27
Stand	2.1 ± 0.44	0.20 ± 0.42	3.1 ± 0.45	1.9 ± 0.48	0.0006	0.12	0.49	0.25
Sit	0.44 ± 0.08	** 0.08 ± 0.08	0 ± 0.09	0 ± 0.09	0.03	0.06	0.03	0.06
Walk	0.10 ± 0.12	0.05 ± 0.12	0.80 ± 0.14	0.68 ± 0.13	0.49	0.85	0.80	0.26
Rub	0.11 ± 0.04	0.02 ± 0.04	0.07 ± 0.05	0.09 ± 0.04	0.40	0.47	0.18	0.04
Wallow	–	–	0.97 ± 0.62	3.5 ± 0.61	0.005	0.90	–	–
Drink	0.41 ± 0.07	0.07 ± 0.07	0.26 ± 0.08	0.09 ± 0.08	0.007	0.37	0.24	0.57
Graze	–	–	2.6 ± 0.44	1.1 ± 0.43	0.021	0.39	–	–
Chew	1.3 ± 0.38	0.16 ± 0.36	3.7 ± 0.42	1.4 ± 0.42	0.0001	0.47	0.15	0.70
Root	1.3 ± 0.26	** 0.41 ± 0.25	0.41 ± 0.29	0.60 ± 0.29	0.18	0.60	0.04	0.83
Oral [d]	2.7 ± 0.46	0.57 ± 0.44	4.1 ± 0.51	2.0 ± 0.51	0.0001	0.31	0.98	0.94
Ongrdr [e]	3.1 ± 0.54	0.63 ± 0.52	7.0 ± 0.61	3.2 ± 0.60	0.0001	0.38	0.24	0.56

[a] See Table 1 for an explanation of these behaviors.
[b] Lie + in-hut.
[c] Stand + Sit + Walk + Rub + Wallow + Drink + Graze + Chew + Root.
[d] Chew + Root.
[e] Chew + Root + Drink + Graze.
** A given environment differs between AM and PM observations ($P < 0.01$) by predicted differences test.

Indoor YL gilts sat more during the AM observation (0.91 ± 0.15) than CB (0.25 ± 0.14) or C-15 (0.16 ± 0.11). Indoor gilts of the C-15 line sat more in the PM observation (0.23 ± 0.11) than the indoor CB (mean = 0) and YL (mean = 0). During the AM observation, C-15 and CB spent more time in the hut than YL. During the PM observation, C-15 spent less time in the hut than either CB or YL.

Environment by time interactions were significant for inactive behaviors ($P < 0.0001$), and for sitting and rooting behaviors ($P < 0.05$). Sitting, rooting and active behaviors were observed at a lower frequency indoors in the PM than the AM observation period.

4. Discussion

Outdoor gilts were more active and spent more time chewing than indoor gilts. Oral/nasal behaviors in the form of chewing occurred more often among outdoor-kept gilts than indoor-kept gilts (Table 1). These data show a marked increase in the components of oral/nasal behavior in the outdoor environment. The increased oral/nasal chewing was not associated with rooting, and rooting occurred at statistically similar

levels indoors and outdoors. The lower level of chewing indoors compared with that outdoors was quite surprising (0.64 ± 0.24 vs. 2.3 ± 0.27, $P = 0.0001$). These observations agree with earlier work (Barnett et al., 1984) which showed gilts housed outdoors in a paddock were more active overall. Barnett et al. (1984) reported gilts kept outdoors had a higher level of licking, biting and nosing, and other active behaviors including chomping, than those housed indoors in groups.

Pregnant pigs may be highly motivated to show oral behaviors, regardless of the environment. Sows have been shown to perform the same amount of nesting behavior in the same environments with and without straw; however, these nesting behaviors were shown at different stages prior to parturition (Jensen, 1993). The indoor environment seemed to stimulate much less chewing than the outdoor environment.

Few genotype effects on behavior were found in this study. A study comparing the effects of genotypes on the behavior of gilts found that highly selected productive lines exhibited higher total activity than an unselected line (Barnett et al., 1988). The group housing situation with mixed genotypes (under observation at the same time) used in this study was a similar model to that used by Barnett et al. (1988). However, Barnett et al. (1988) showed differences in genotypes within housing treatments that indicated inactivity by one genotype. In spite of diverse environments, gilts in this study did not differ in behavior among genotypes, nor were most genotypes by environment interactions significant. All genotypes were less active indoors than outdoors. The magnitude of the environmental effect was less for the C-15 genotype. C-15 was 39% less active indoors than outdoors, while CB and YL were 71% and 67% less active indoor than outdoors (see lying, Table 2). In part, this increase in activity was due to the increased frequency of walking found outdoors (see Table 2). The waterer and wallows were located some distance from the hut in which gilts rested. Therefore, the particular design of the outdoor system might encourage, or even require, a greater level of activity.

Gilts showed a decreased amount of active behaviors from the AM to the PM observation periods. The active behaviors standing, sitting, drinking, grazing, chewing, oral and oral/nasal plus graze and drink showing a significant decline in frequency during the PM observations. Walking, rubbing and rooting, occurred at the same frequency during both observation periods. Wallowing was the only active behavior to increase in frequency during the PM observation. Although gilts were less active in the PM than the AM, the PM activity was quite often wallowing. This indicates active thermoregulation on the part of the outdoor gilts as the temperature increased over the course of the day.

Previous investigators have studied the effects of level of feed intake on oral/nasal/facial behaviors. In our work, feed and nutrient intake was held constant. Still, outdoor-kept sows could obtain some nutrients from grass and/or earth. Increasing feed intake or increasing total feed intake by feeding diets high in fiber or in contrast feeding very low levels of feed intake each tends to reduce pig general activity and to reduce oral/nasal/facial behaviors directed towards available substrates (Terlouw et al., 1991; Terlouw and Lawrence, 1993; Brouns et al., 1994). Therefore, the relationship between level of feed intake and oral/nasal/facial behaviors is not linear.

What may appear as a high level of chewing behaviors among indoor gilts may actually be lower than that expressed when housed outdoors. Therefore, one should be

very careful when interpreting animal welfare based on behavior data from a single system (such as the indoor systems that have been criticized because sows show an apparently high level of oral/nasal/facial behaviors which might actually not be abnormally high at all).

The genotypes investigated differed mainly in the magnitude of difference between lying behaviors expressed in the indoor and outdoor environments. The difference between environments in frequency of active behavior should be confirmed with 24-h around-the-clock observations.

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