Livestock Science 157 (2013) 28–37

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Genetic analysis of behavior traits in swine production ☆

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ARTICLE INFO

Article history:
Received 27 September 2012
Received in revised form
13 June 2013
Accepted 1 July 2013

Keywords:
Behavior
Genetic parameters
Performance
Pigs

ABSTRACT

Estimates of genetic parameters related to pig behavior under stressful situations are required before selection programs can be designed to produce more docile pigs. Pig behavior was evaluated in a pedigreed Landrace–Duroc–Yorkshire composite population. Piglets were evaluated for their response to handling at 1 d of age ($n=11069$), being placed on their back for 60 s at ~24 d of age ($n=975$), and being confined in a scale while backfat measurements were being collected ($n=9035$). Feeding behavior was monitored in a growing–finishing facility ($n=1162$) including preferences for feeding positions. Feeders were placed along a fence with one end adjacent to a gate (gate-end) and the other end open. An animal model was fitted to the data using WOMBAT where litter was included for d 1 activity scores and backtest traits. Fixed effects of sex, pen/year-season/date of collection in all analyses along with scorer (d 1 activity score) and a covariate of age (d 154 weight and backfat). Multiple trait models were fit to estimate genetic covariances among traits. All estimates of heritability were significantly different than zero. Activity scores and backtest traits had the lowest estimates of heritability (0.15–0.19), measures of feeding behavior were more variable (0.16–0.60) while production data had high heritabilities (>0.5). Genomic heritability estimates were similar to standard heritability estimates for most traits, except traits measured at a young age. All traits measured during the backtest had strong genetic correlations and similar estimated heritability. Among feeding behavior traits, number of meals/d and average meal length were highly correlated with total daily meal time. In addition, animals that preferred to eat alone avoided the open-end position at the feeder. The only behavioral traits with genetic correlations significantly different from zero with production traits were associated with feeding behavior where animals that ate longer meals and spent more time at the feeder/d tended to be heavier and fatter at 154 d. In addition, animals that ate more meals/d were fatter and animals that preferred the gate-end position of the feeder were heavier. Pigs with more reactive personalities tended to eat fewer meals/d, each longer in duration, and they preferred the gate-end feeder position. The measures of pig behavior studied were heritable and selection for more docile pigs should not have large detrimental effects on performance.

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1871-1413/$ - see front matter Published by Elsevier B.V.
http://dx.doi.org/10.1016/j.livsci.2013.07.002

1. Introduction

Stress in livestock reduces production, and is a well-being or welfare concern. Stressors can be production environments, interaction with humans or other animals in their pen among many other factors. Aggressive animals can cause injuries to other pigs and decrease performance due to the stress they inflict on pen mates. While an initial feature of animal domestication is selection for docility, most selection after domestication is focused on production. Modern swine production facilities rely heavily on automation reducing the number of positive human–pig interaction events (Rushen et al., 1999). As selection focuses on performance when there is less human interaction, fear of humans may inadvertently increase (Rushen et al., 1999). Furthermore, selection of high lean growth pigs may have produced animals which are less able to cope with environmental stressors (Wellock et al., 2004) or are more aggressive (Cassady, 2007).

Understanding an animal's ability to cope with stressors is important to optimize performance. Solutions to improve docility problems include modifications to the production environment, animal handling as well as genetics. However, few studies have been conducted evaluating pig behavior on large groups of pigs raised in a modern commercial production environment. To understand the genetic architecture of behavior and formulate a genetic solution to animal stress response, estimates of the genetic parameters for behavior traits are needed. Ideally, measurements of behavior should be collected early in life to permit selection.

Genetic influences on coping behavior, activity scores and feeding behavior have each been individually documented. Velie et al. (2009) evaluated multiple measures of pig behavior including coping and aggressive behavior measures. They found that considerable genetic variation existed for behavior traits recorded during the backtest with estimates of heritability being 0.49 for total time spent struggling and 0.53 for number of attempts to escape. Likewise, Turner et al. (2009) estimated heritabilities for multiple measures of aggression in pigs to range between 0.31 and 0.43. Activity scores while collecting weights and backfat measurements were studied by Holl et al. (2010) and Schneider et al. (2011). Both studies found this measure to be heritable (0.23) and genetically correlated with weight at 154 d. Studies have been conducted evaluating the feeding behavior using individual feeding stations and estimated moderate heritabilites for feeding behavior (Chen et al., 2010) and QTL have been identified (Zhang et al., 2009). However, the pigs in these studies are protected/secluded from pen mates while feeding which is not representative of commercial production. Unfortunately, comprehensive studies evaluating multiple pig behavior traits are lacking. While selection can obviously change the behavior of pigs, additional estimates of heritability for behavior traits as well as genetic correlations with performance traits are needed before a selection index can be derived.

Therefore, measures of coping behavior, activity scores and feeding behavior were collected in a pedigreed population managed similar to commercial production systems to estimate components of genetic variation. In addition, this study attempted to determine which, if any, of the behaviors recorded were associated with pig performance, measured as weight and backfat depth at approximately 154 days of age.

2. Materials and methods

2.1. Phenotypic measurements

A composite population of 1/2 Landrace 1/4 Duroc 1/4 Yorkshire described by Holl et al. (2008) was studied. Animals included in the analyses were from generations 5 through 10 after the population was closed. Two distinct, but partially overlapping, experiments were conducted to collect data for estimation of heritability for traits measured during a backtest and measures of feeding behavior. In addition, standard production data collected at USMARC analyzed included activity scores at day 1 and 154, as well as weight and backfat depth at 154 d of age. All measurements recorded were approved by the U.S. Meat Animal Research Center's Animal Care Guidelines and conformed to the Guide for Care and Use of Agricultural Animals in Research and Teaching (FASS, 2010).

2.1.1. Activity scores

In March of 2006, observation of activity during collection of weight and ultrasonic measures of backfat depth at approximately 154 d of age (154AS) was initiated. These measures began on animals born in November of 2005 and continued throughout all farrowing groups produced through the end of 2010. The description of measurements and results of earlier analyses on a subset of the animals included in this study have been reported (Holl et al., 2010; Schneider et al., 2011). Briefly, the scoring system ranged from 1 (animal remained calm with little movement) to 5 (animal vocalizing and attempting to escape). Measurements were recorded on all gilts and boars who were potential candidates for breeding, as well as barrows that were being studied for behavior or carcass evaluation. A total of three people have evaluated pigs at 154 d, but over 90% of the evaluations were conducted by one evaluator. All pigs evaluated on the same day were evaluated by the same person.

Beginning in January 2008 an assessment of activity was made at 1 day of age while caretakers were conducting routine evaluation of the piglet and counting the number of teats (1AS). This is the first time a piglet is routinely handled and secluded from its littermates. A five point scoring system similar to the one developed for 154AS was created. Descriptions of behaviors characterized for scores of 1, 3 and 5 were defined as

1: Animal remained extremely calm during handling.

3: Animal vocalized and attempted to escape during a portion of the handling.

5: Animal constantly vocalized and attempted to escape during handling.

Animals whose behavior was intermediate to these rankings were scored as either a 2 or 4, as appropriate. Five different people evaluated piglets at 1 d of age and more than one person conducted evaluations on most days.