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GxE interactions for growth and carcass leanness: Re-ranking of boars in organic and conventional pig production

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ABSTRACT

The objective of this study was to evaluate genotype by environment interactions for growth rate and carcass leanness in organic and conventional pig production environments. Organic breeding values for fattening traits were estimated for 37 Hampshire AI-boars based on slaughter records registered for 1805 crossbred offspring raised in an organic environment. The offspring were born and raised in herds certified for organic production. The statistical model included the fixed effects of sex, litter size at 2 weeks and herd. It also included the random effects of herd-year-season, birth litter and animal. Conventional breeding values for the same boars were captured from the breeding organization's genetic evaluation. In the organic environment h^2 was estimated to 0.30 and 0.37 for growth rate and carcass leanness, respectively ($r_g = -0.11$). Spearman rank correlations between organic and conventional breeding values, based on 29 boars with ≥20 progenies, were 0.48 for growth rate and 0.42 for carcass leanness. Both correlations were significantly different from 0 and 1. In conclusion, the results of the present study indicate weak genotype by environment interactions for both growth rate and carcass leanness in organic and conventional pig production environments, and there is some re-ranking of boars' breeding values between environments.

1. Introduction

The genetic material used in organic pig production is normally the same as that used in conventional pig production. These animals are bred for high performance in a conventional production environment. Presently there are no separate organic breeding programs for commercial pig breeds, which mean that organic producers have few alternatives when choosing genetic material.

As a result of differences in ethical values and the rules governing production, the environments in organic and conventional pig production differ. In Europe these differences are determined by regulations covering organic production set out by the EU (1999) and certification organizations. These regulations principally affect three areas: housing, feeding and medical care (Boelling et al., 2003).

To devise an organic breeding strategy it is necessary to investigate genotype by environment (GxE) interactions in conventional and organic production systems (Boelling et al., 2003). Where GxE interactions occur, the trait is partly influenced by different genes in different environments. Weak GxE interactions result in non-identical differences between animals' breeding values but little or no re-ranking of animals within the studied environments (Fig. 1a). Strong GxE interactions result in significant re-ranking of animals' breeding values in the differing environments (Fig. 1b). GxE interactions that result in re-ranking are of considerable economic importance to producers if the genetic evaluation is based on information from only one of the environments. Strong GxE interactions result in large over-prediction of economic outputs if these interactions are not accounted for in the breeding program (Dominik and Kinghorn, 2008).

To our knowledge, no studies of GxE interaction in organic and conventional pig production environments based on estimated breeding values have been published. However, Werner et al. (2007) found significant GxE interactions when

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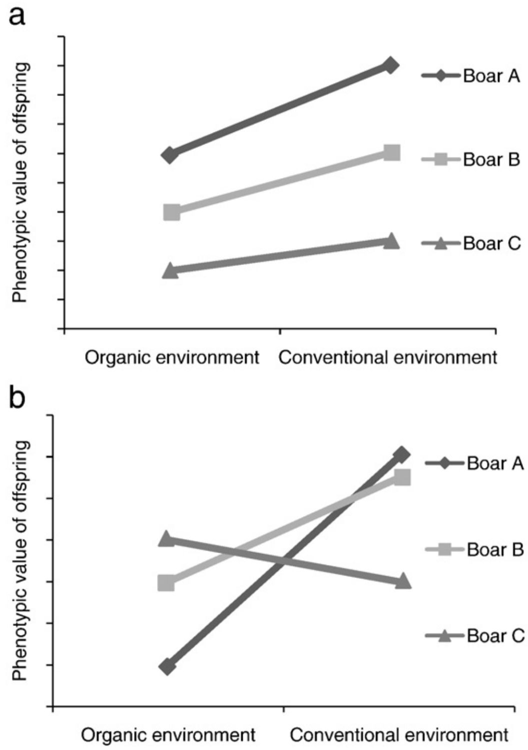

Fig. 1. a. Schematic presentation of weak genotype by environment interaction, no re-ranking of boars. b. Schematic presentation of strong genotype by environment interaction, re-ranking of boars.

investigating growth rate and carcass leanness in seven different breeds and breed-crosses in organic and conventional environments. Kelly et al. (2007) found no significant GxE interactions when comparing a traditional breed, a modern breed, and a cross between the two, in outdoor and indoor organic environments.

The objective of this study was to investigate GxE interactions for fattening pig traits in organic and conventional pig production environments.

2. Materials and methods

The study was performed in accordance with Swedish regulations governing animal use in experiments.

2.1. Organic animals and herds

2750 crossbred offspring of 37 Hampshire AI-boars and 174 sows were marked with a litter and sex identity. The sows were in most cases Swedish Landrace x Yorkshire crosses and in some cases purebred Swedish Landrace or Yorkshire. Individual slaughter records from 1805 of these offspring were collected at the slaughter plants.

The organic fattening pigs included in the study were raised in 3 commercial organic piglet producing herds and 6 different commercial organic fattening herds. One herd was a farrowing to finishing herd and 5 herds were specialized fattening herds. All the herds were located in the central and southern parts of Sweden. All were organically certified. There was no mixing of piglets from different piglet producing herds in the fattening herds. The fattening pigs were slaughtered at one of two slaughter plants (Fig. 2). The piglet producing herds had on average 77 sows (55–96) in production and the fattening herds sent on average 993 (700–1600) pigs to slaughter every year. In two of the piglet producing herds, the sows farrowed indoors in individual farrowing pens without crates. Sows and their litters were group-housed 2–7 weeks post partum (pp) indoors in pens with deep straw bedding and with outdoor access on concrete flooring. In one of these two herds, sows and their litters had additional access to pasture during the vegetative season (approximately May to September). In the other of the two herds where sows farrowed indoors, sows and their litters were kept in huts on pasture 2–7 weeks pp during the vegetative season. In the third piglet-producing herd sows farrowed outdoors in huts throughout the year. In this herd sows and their litters were kept in groups on pasture with access to individual farrowing huts and family huts. Family groups consisted of 5–10 sows and their litters. In the fattening herds the pigs were kept in buildings with deep straw bedding and outdoor access on concrete floor. The fattening pigs were fed restrictively following the SLU-norm, according to weight (Simonsson, 1994) and had access to pasture during the vegetative season. Both slaughter plants were certified by KRAV to slaughter organic pigs (KRAV, 2005).

KRAV is the largest certification organization for organic production in Sweden. It is accredited by, and follows, the standards of IFOAM (International Federation of Organic Agriculture Movements). The herds included in the present study were organically certified by KRAV. The main differences between conventional and organic pig production required by KRAV are given in Table 1 (KRAV, 2005).

2.2. Identification and registrations

Sows were inseminated with semen from Hampshire AI-boars from February 2003 to August 2004. AI-doses were provided by the breeding organization Quality Genetics. Hampshire AI-boars are continuously exchanged at the boar station, thus AI-doses from each individual boar are available for approximately 12 months. To ensure that the boars were used evenly across the three herds and over time, herdsmen were instructed to follow an insemination scheme designed for this study. When the study began, 15 Hampshire AI-boars were selected for the insemination scheme. New boars were added to

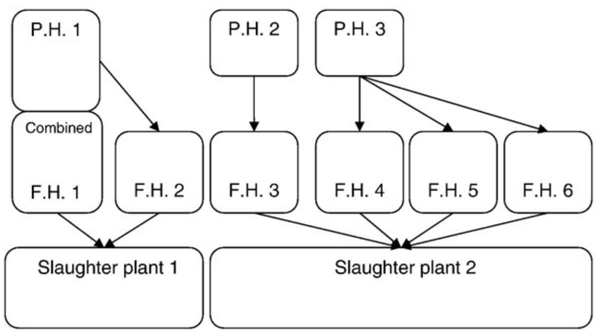

Fig. 2. Herd structure of piglet producing herds (P.H.), fattening herds (F.H.) and slaughter plants.