Genotype x environment interactions for growth and backfat thickness traits in Yorkshire and Landrace pigs

N.H. Tinh[1], N.T. Linh[2], A.P.N. Bui[3]*

[1]Institute of Animal Sciences for Southern Vietnam, Hiep Thang quarter, Binh Thang ward, Di An town, Binh Duong city, [2]School of Agriculture and Aquaculture, Tra Vinh University, 126 Nguyen Thien Thanh, Hamlet 4, Ward 4, Tra Vinh City, Tra Vinh Province, [3]Institute of Applied Technology, Thu Dau Mot University, Binh Duong province, Vietnam

*Corresponding author e-mail: buiphunamanh@yahoo.com

Abstract

Genotype by environment interactions (GxE) may reduce the response of performance traits.The aim of this study is to estimate the genetic correlation of the same traits between two genetically linked of Binh Thang farm and Dong A farm. The total of 10 boars, 15 gilts and 442 semen dozes of Yorkshire and Landrace boars had been exchanged between two farms from 2000 to 2007. Records of individual performance test were obtained from 881 Landrace and 652 Yorkshire pigs in Binh Thang farm, and 835 Landrace and 1326 Yorkshire pigs in Dong A farm. Measurements were adjusted to days to 90 kg (D90) and backfat (mm) at 90 kg liveweight (BF90) referred on the recommendations of NSIF (2002). For Landrace pigs, genetic correlations of the same trait between two environments estimated using REML (restricted maximum likelihood) method in VCE5 software were 0.51 and 0.63 for D90 and BF90 traits, respectively. For Yorkshire pigs, these values were higher, 0.93 for D90 and 0.99 for BF90, respectively. Thus, the evidence of genotype by environment interactions was found in Landrace pigs for measured traits D90 and BF90, while this was not presented in Yorkshire pigs. This means the adaptation to alternative environments in Yorkshire pigs is better than in Landrace pigs.

Key words: genetic correlation, GxE interaction, production traits, pigs, Yorkshire, Landrace

Introduction

The effect of GxE is resulted from the lack of adaptation of genotypes to specific environments (Montaldo 2001, Rauw and Gomez-Raya 2015). It is difficult to specify a specific environmental factor in GxE. Therefore, differences between two environments may be considered as husbandry circumstances in general between farms or herds. The GxE for a trait may be represented by a genetic correlation between genotypic values of trait in different environments (Falconer and Mackay 1996). To assess the effect of GxE in a breeding program, the same trait in two environments must be treated as two different traits and consequently genetic correlation between the genotypic values of trait in different environments must be obtained. The efforts have been made in the past to study different protein diets (Tedtova et al 2020; Niyazov & Ostrenko, 2020) and mineral supplements (Ostrenko et al. 2020) to increase the productivity of pigs. Efforts are in progress to use upcoming state of the art technologies like Crispr/Cas9 for improvement in pig breeding (Tinh et al 2020).

Previous studies on the different aspects of GxE have been focused on the estimation of genetic correlations between the same traits measured across various herds (Merks,1988), between purebred and crossbred performance (Bonneau and Lebret 2010, Lee et al. 2015, Wakchaure et al. 2016), purebred performance in nucleus herds versus commercial crossbred (Mulder and Bijma 2005), and purebred performance in tropical versus temperate environment (Mote et al. 2000). The aim of this study is to estimate the genetic correlation of the same traits between two pig breeding farms linked genetically in Southern Vietnam.

Materials and methods

Data: Records on individual production with full pedigree of Landrace and Yorkshire pigs were obtained between 2000 and 2007 in two breeding farms Binh Thang and Dong A in Southern Vietnam. Management practices in both farms were performed according to (Kouam et al. 2020). Genetic linkages across two farms have been created by sending 10boars (5 Yorkshire and 5 Landrace), 18 gilts (10 Yorkshire and 5 Landrace) and 442 semen dozes from 12 service sires of Yorkshire and 12 service sires of Landrace to Dong Af arm from Binh Thang farm between 2000 and 2007. The most important difference between two environments across two farms is about housing environment for individual performance test. Growing pigs for performance test were housed in individual pens at Dong A farm, while they were tested in groups of 12 -15 animals using chipcards at Binh Thang farm. Other conditions like feeding, regime, ratio, started and finished age were nearly the same. The initial weight was 35 kg and final weight was around 90 kg. Production records were adjusted to days to 90kg (D90) and backfat at 90kg liveweight (BF90) based age finished, weight finished, backfat at age finished and sex, using the recommendations of National Swine Improvement Federation, United States (NSIF, 2002). After adjusting for all measurements, data structure is indicated as in Table 1.

Table 1. Data structure of traits D90 and BF90 inYorkshire and Landrace pigs between 2000 –2007

Farm	Breeds	Numbers of records	D90 (Mean ±SD)	BF90 (Mean ±SD)
Binh Thang	Landrance	881	184.8 ± 21.0	8.9 ± 1.0
	Yorkshire	652	184.7 ± 19.8	8.7 ± 1.0
Dong A	Landrance	835	174.0 ± 12.9	11.5 ± 1.4
	Yorkshire	1326	175.4 ± 12.5	11.3 ± 1.9

Statistical analysis. The same traits in two environments at Binh Thang farm and Dong A farm were treated as two different traits and then genetic correlations were estimated by REML using VCE5 software (Groeneveld, Kovac et al. 2010) by the mixed animal models as follows:

$$Y_{ijkl} = \mu + hys_i + s_j + a_k + e_{ijkl}$$

Where, y_{ijkl}: phenotypic observations;μ: population mean; hys_i: farm x year x season; s_j: sex effect; a_k: random additive genetic effect and e_{ijkl}: residual effect.

Results and Discussion

When genetic data were sent from Binh Thang farm to Dong A farm, there was a specific change in environment for individual performance test as indicated in previous section. The alternative environment influenced a little on heritability estimates for measured traits at different levels (Table 2). Estimates of heritability for D 90 in both Landrace and Yorkshire pigs were nearly the same between two farms (0.31 – 0.34). For BF 90 in Landrace, heritability under Dong A farm environment (0.53) was slightly lower than under Binh Thang farm environment (0.59). In contrast for this trait inYorkshire, heritability under Dong A farm conditions (0.64) was slightly higher than under Binh Thang farm conditions (0.59). This showed that there is an advantage for genetic improvement by selection for BF90 trait in Landrace under Binh Thang farm environment conditions and in Yorkshire under Dong A farm environment conditions.

Yorkshire lactating sow

In pigs, the studies on practical implications of GxE showed that the presence of GxE or low genetic correlation among environments are very important (Brascamp et al. 1985, Webb and Curran 1986) in animal breeding programs. The economic consequence of animal importation may be negative if genetic correlation between the two environments is less than one due to reduced accuracy of estimated breeding values (Montaldo 2001) or changed optimal composition of the selection and rejected groups across environments (Cooper and DeLacy 1994). However, the serious reductions in the efficiency of animal breeding programs may occur when the genetic correlation between environments is lower than 0.8 (Camerlink et al. 2018). In current study (Table 2), genetic correlations between two environments Binh Thang farm and Dong A farm for D90 and BF90 traits in Yorkshire pigs were high and not significantly different from one (0.93-0.99). But in Landrace pigs, genetic correlations between two environments for these traits were not very high, varying from 0.51 for D90 to 0.63 for BF90 trait. These figures indicated that the presence of GxE for D90 and BF90 in Landrace pigs is very significant and should be considered for the design of across herds genetic valuation.

Table 2. Heritability and genetic correlations between farms for D90 and BF90 in Landrace and Yorkshire pigs

Breeds	Traits	Heritability at Binh Thang farm $(h2 \pm SE)$	Heritability at Dong A farm $(h2 \pm SE)$	Genetic correlations between Binh Thang farm and Dong A farm $(rG \pm SE)$
Landarce	D90	0.34 ± 0.06	0.32 ± 0.07	0.63 ± 0.16
	BF90	0.59 ± 0.07	0.53 ± 0.05	0.51 ± 0.15
Yorshire	D90	0.31 ± 0.08	0.32 ± 0.06	0.93 ± 0.18
	BF90	0.58 ± 0.09	0.64 ± 0.05	0.99 ± 0.17

Conclusions

Genetic correlations between environments (Binh Thang and Dong A pig breeding farms) for the traits of days to 90 kg and backfat thickness at 90 kg were very closed to one in Yorkshire pigs and not high in Landrace pigs. Therefore, the current study suggested that the influence of genotype with environment interactions for these measured traits is quite clear and should be interested in the pig breeding program

Conflict of interest

The authors declared that present study was performed in absence of any conflict of interest**.**

Author contributions

Conception, data analysis, revision and final approval were done by NHT and APNB. Data analysis was done by NTL and APNB.

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