BREED STANDARDS AND TRENDS IN PERFORMANCE TEST TRAITS IN THE NATIONAL BOAR PERFORMANCE TESTING PROGRAM (1990-2016)

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ABSTRACT

Data from 607 performance-tested boars belonging to Landrace, Large White and Duroc breeds and four terminal crossbreeds were obtained from the National Boar Performance Testing Program held by the Philippine Swine Industry Research and Development Foundation, Inc. (PSIRDFI) from 1990 to 2016. Breed standards and trends in age in days at 90 kg body weight, average daily gain (ADG), backfat thickness (BFT), feed efficiency (FE), and selection index (SI) value were determined. Boar performance traits were all found to be significantly affected by auction number (batch effect), farm, and breed (P<0.01). Among pure breeds, Large White boars were most outstanding for age at 90 kg (144.6 days), FE (2.40 g/g), and SI (190.8 points). Landrace was best for its low BFT (1.44 cm), while Duroc was top for ADG (922.9 g/day). Small annual improvements in boar performance traits from 1990 to 2016 were also consistently highest for Large White for age at 90 kg (-1.71 days), BFT (-0.04 cm), FE (-0.03 g/g), and SI value (3.6 points). Among crossbreeds, Pietrain x Large White boars was best for age at 90 kg (141.2 days), ADG (903.8 g/day), BFT (1.33 cm), and SI (194.9 points), while Duroc x Pietrain crosses were had the better FE (2.45 g/g).

Key words: Boars, reproductive performance, swine

INTRODUCTION

The Philippine Swine Industry Research and Development Foundation, Inc. was founded on November 11, 1988 with the aim of continuously informing its members and the swine industry of the latest technical developments, thus empowering the Filipino hog raiser to be internally competitive with world class standards. Aside from the Swine Monitoring Program that allows an index measurement of Philippine standard for the over-all swine industry production performance, the PSIRDFI also holds the National Boar Performance Testing Program (NBPTP) participated in by accredited swine breeder farms nationwide.

The NBPTP traces its origin to the inaugural implementation of the NSPTP by the PSIRDFI in collaboration with the Institute of Animal Science, College of Agriculture, University of the Philippines Los Baños from 1989 until 1995. The goal was to give local swine raisers an impartial assessment of the relative performance of their young boars when raised under the same farm conditions (Bondoc, 2008). Eventually, the boar testing activity led by the PSIRDFI together with the Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development – Department of Science and Technology, was conducted at the Agricultural Training Institute-International Training Center for Pig Husbandry in Lipa City, Batangas. The boar testing activity usually ends with a public boar

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auction, now held every two years since 2004 during the Farmers Congress, also known as the International Animal Health and Genetics. Outstanding boars (and breeding farm) for each breed category are identified solely based on the highest SI value, and recognized as top performing boars (and breeding farms) at the culmination of the public auction.

From 1989 to 2016, a total of 27 boar testing and auctions were held. In this regard, this study aims to establish local breed standards and evaluate trends in boar performance records (i.e. age at 90 kg, ADG, BFT, FE, and SI value). Such information can be used to monitor improvement in boar performance of standard pure breeds (i.e. Landrace, Large White, and Duroc) and other popular terminal crossbred boars. The results of study will also reflect the impact of the National Boar Performance Testing Program in assuring the availability of genetically superior breeds that may be used in our local pig breeding farms.

MATERIALS AND METHODS

Young boars are submitted for performance testing by members from various private and government farms. The test pigs initially weighing 30 to 35 kg each are given a one-week adjustment period. All pigs are placed in individual pens and fed ad libitum. Pigs are weighed bi-weekly until they reach at least 90 kilograms. The average on-test age is about 77 days old, while test period is usually for 66 days. Animals are evaluated in terms of ADG, BFT, and FE. Reproductive soundness is also evaluated based on mating behavior (i.e., libido, ability to mount and copulate) and semen quality (Peñalba, 1989). Unlike performance tests conducted abroad, purebred as well as terminal crossbred boars are allowed to join the boar test in the Philippines.

Performance test data were obtained from 607 young boars belonging to 3 pure breeds and 4 terminal crossbreeds through the PSIRDFI website (http://www.swinefoundation.com.ph/boartesting). Boar performance traits included age (in days) at 90 kg body weight, ADG, BFT, FE, and SI value used by the NBPTP (Table 1). The performance-tested boars were mostly purebred Landrace, Large White, and Duroc (87.3%) and the remainder (12.7%) were terminal crossbreeds (i.e. Duroc x Pietrain, Pietrain x Duroc, Large White x Pietrain, and Pietrain x Large White). The performance-tested boars came from 24 different swine breeding farms and were presented and sold in 25 public auction dates from 1990 to 2016. Unfortunately, no data can be found for the first auction conducted in 1989 and the fifth auction in 1995.

For the statistical analysis of each trait, the individual performance-tested boar was considered as an experimental unit.

Simple descriptive statistics were determined for the various boar performance traits using the MEANS procedure of SAS (2009) and are given in Table 2. The Pearson product-moment correlation coefficients were then computed to measure linear relationships among the boar performance traits (see Table 3) using the CORR procedure of SAS (2009).

Boar performance test data were analyzed by the least squares procedures using the following linear "fixed effects" model:

$$\mathbf{y}_{ijkl} = \boldsymbol{\mu} + \mathbf{Breed}_i + \mathbf{Auction}_j + \mathbf{Farm}_k + e_{ijkl}$$

where: $\mathbf{y}_{ijkl}$ is the dependent variable (i.e. boar performance trait),
$\boldsymbol{\mu}$ is the overall mean,
$\mathbf{Breed}_i$ is the ith breed effect (i.e. Landrace, Large White, Duroc, Duroc x Pietrain, Pietrain x Duroc, Large White x Pietrain, Pietrain x Large White),

Auction$_j$ is the j[th] effect of auction number or batch effect (i.e. 2[nd] to 4[th], 6[th] to 27[th] auction)
Farm$_k$ is the fixed k[th] farm effect, and
e$_{ijkl}$ is the error term assumed to be normally distributed with variance of errors as constant across observations.

Least square means (LSM) and standard error for each trait by breed (also called breed standard) and the coefficient of variation are presented in Table 4.

Table 1. Number and distribution of boar performance test records, by breed and by trait (1990-2016).

Breed	Boar performance trait				
	Age at 90 kg	ADG	BFT	FE	SI value
Landrace	134	192	192	192	192
Large White	153	215	215	215	215
Duroc	88	123	123	123	123
Purebred sub-total	375	530	530	530	530
Duroc x Pietrain	32	33	33	33	33
Pietrain x Duroc	27	30	30	30	30
Large White x Pietrain	6	6	6	6	6
Pietrain x Large White	8	8	8	8	8
Crossbred Sub-total	73	77	77	77	77
Total	448	607	607	607	607

Note: There were 105 performance-tested boars belonging to 14 unknown breeds and crossbreeds that were not included in this study.

Table 2. Simple descriptive statistics of boar performance test traits.

Performance test trait	N	Average ± S.D.	Range
Age at 90 kg, days	448	145.9 ± 13.0	112 - 190
Average daily gain, g/day	607	933.0 ± 141.6	594 - 1900
BFT, cm	607	1.52 ± 0.39	0.84 - 2.88
FE, g/g	607	2.44 ± 0.24	1.83 - 3.40
SI value	607	189.5 ± 25.7	108 - 270

Trends in purebred boar performance for the Landrace, Large White and Duroc breeds were determined by fitting a regression line of each trait on year of boar testing and auction from 1990 to 2016, using TrendLine Options of MS® Excel. Intercept was set to the average trait performance in the base year (i.e. 1990). Assuming linear distribution of average performance traits through the years, the computed regression coefficients may provide a simple estimate of the annual change in boar performance for a particular breed. The trends in boar performance traits are shown in Figures 1 to 5.

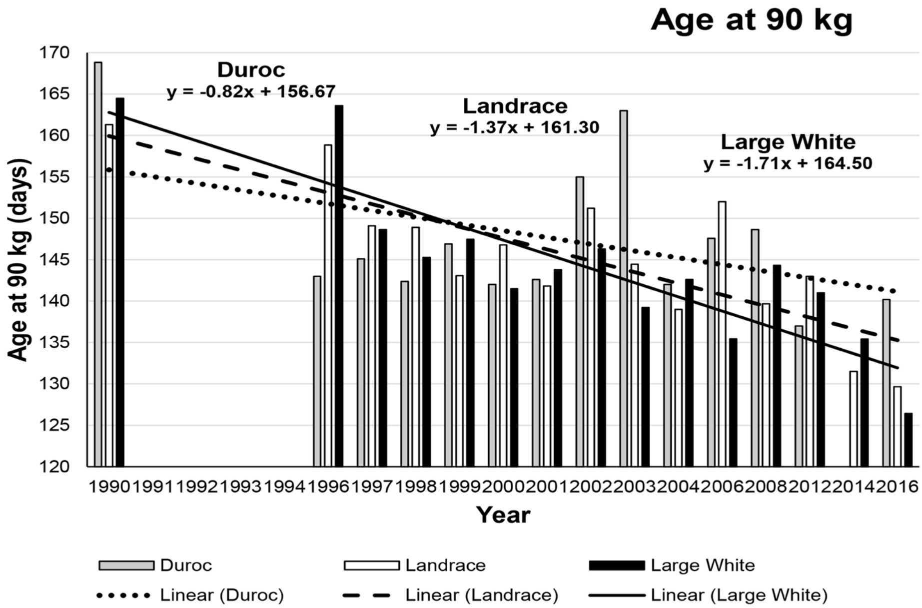

Fig. 1. Trends in age (days) at 90 kg body weight in Landrace, Large White and Duroc performance-tested boars.

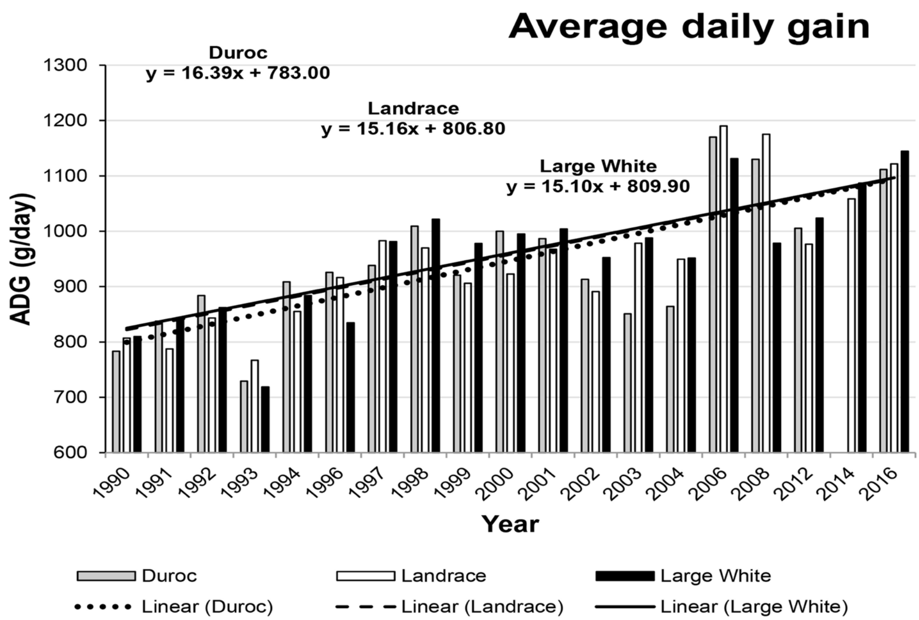

Fig. 2. Trends in average daily gain (g/day) in Landrace, Large White and Duroc performance-tested boars.

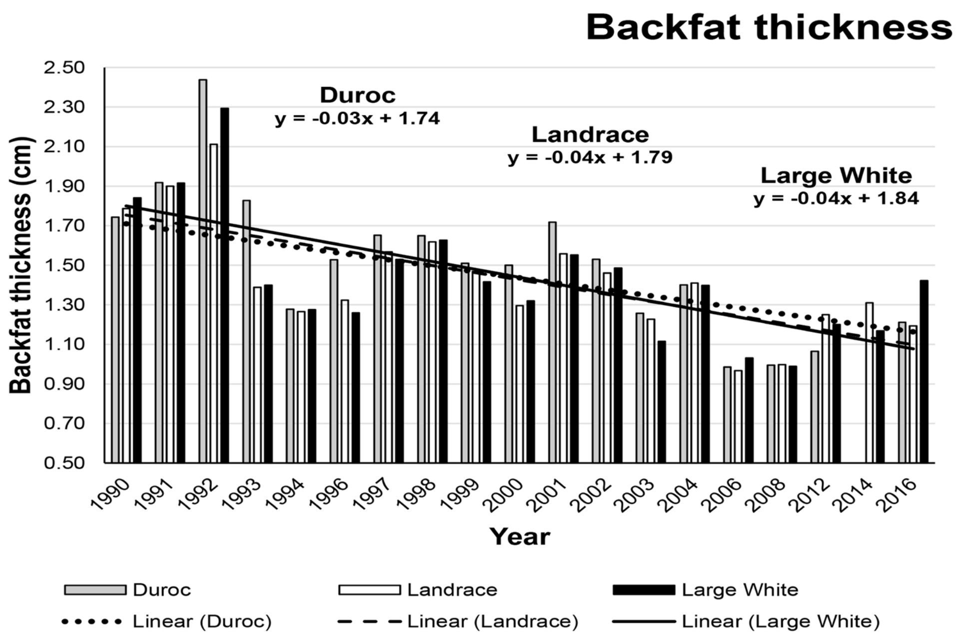

Fig. 3. Trends in backfat thickness (cm) in Landrace, Large White and Duroc.

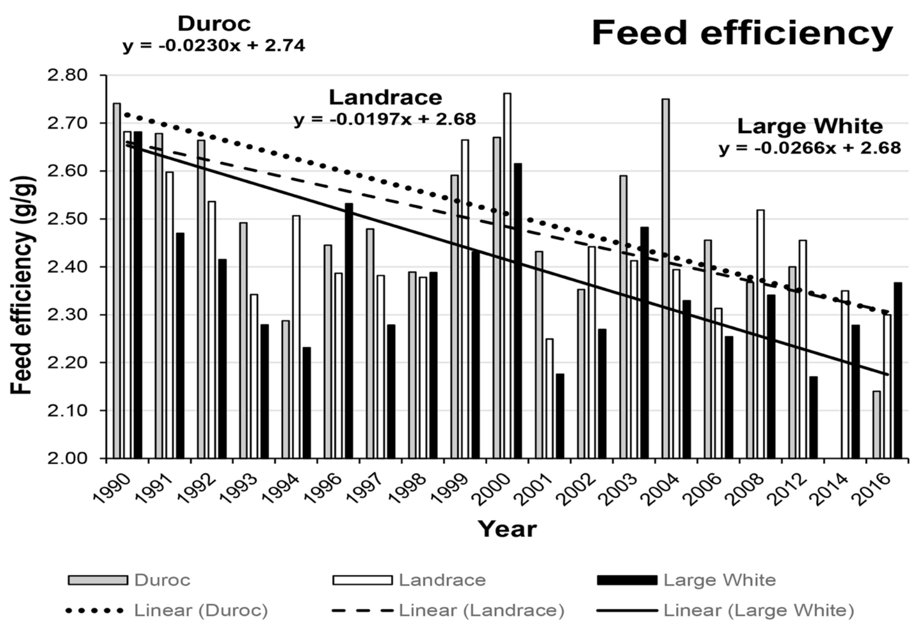

Fig. 4. Trends in feed efficiency (g/g) in Landrace, Large White and Duroc performance-tested boars.

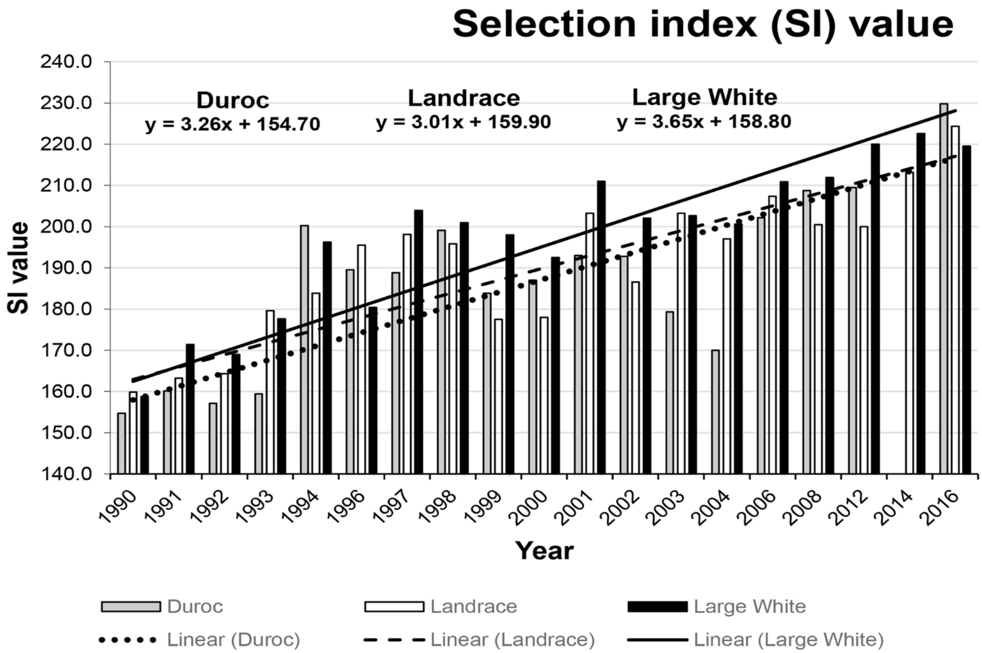

Fig. 5. Trends in selection index values in Landrace, Large White and Duroc performance-tested boars.

Table 3. Pearson correlation coefficients among boar performance traits.

	ADG	BFT	FE	SIvalue
Age at 90 kg	-0.56**	0.10*	0.27**	-0.54**
ADG	-	-0.26**	-0.43**	0.74**
BFT	-	-	0.22**	-0.49**
FE	-	-	-	-0.81**

Note: ns - not significantly different from r=0 (P>0.05)
* - significantly different from r=0 (P<0.05)
** - highly significant different from r=0 (P<0.01)

RESULTS AND DISCUSSION

Correlations among Boar Performance Traits

Table 3 shows that age at 90 kg was negatively correlated to ADG (r=-0.56), but positively correlated to BFT (r=0.10) and FE (r=0.27). This means that performance-tested boars reach 90 kg at an earlier age with higher ADG, better feed conversion, although slightly adding more backfat. Similar phenotypic correlations between age at 90 kg and ADG (r=-0.96) and between age at 90 kg and BFT(r=0.18) were reported by Akanno *et al.* (2013) based on the results of their meta-analysis of reproduction and growth traits of pigs in the tropics.

Average daily gain is negatively correlated to BFT (r=-0.26) and FE (r=-0.43). Also, BFT is positively correlated to FE (r=0.22). By comparisons, Akanno *et al*. (2013) reported similar correlation coefficients of r=-0.35, r=-0.83, and r=0.22 between ADG-BFT, between ADG-FE and between BFT-FE, respectively. This means that improvements in ADG would most likely lead to more efficient and leaner pigs.

As expected, SI values were positively correlated to ADG(r=0.74) but negatively correlated to age at 90 kg (r=-0.54), BFT (r=-0.49), and FE (r=-0.81). This means that faster rate of gain in weight, leaner backfat, and better feed conversion all contribute to performance-tested boars with higher SI values. A high SI value also implies younger age of pigs to reach 90 kg (i.e. r=-0.54).

Age at 90 kg

Table 4 shows that age at 90 kg of performance-tested boars were significantly affected (P<0.01, CV=6.6%) by different auction number (i.e. batch effect) and farm. Age at 90 kg is also significantly different between breeds (P<0.05). Among the purebreds, Large White reaches 90 kg the fastest (144.6 days), followed by Landrace (146.5 days) and Duroc (149.7 days). Among the crossbreeds, Pietrain x Large White crosses reached 90 kg the fastest (141.2 days), and slowest for the Large White x Pietrain cross (152.1 days). Differences in LSM for age at 90 kg between the purebreds were smaller than between the terminal crossbred boars. The younger age to reach 90 kg in crossbred boars may be due to heterosis effects brought about by non-additive genes.

Figure 1 shows faster annual improvement in age at 90 kg for the Large White (-1.71 days) than Landrace (-1.37 days) and Duroc (-0.82 day).

Average Daily Gain

Table 4 shows that ADG of performance-tested boars were significantly affected by different auction number (i.e. batch effect) and farm (P<0.01, CV=10.8%). ADG is also significantly different between breeds (P<0.05). Among the purebreds, Duroc had the highest ADG (922.9 g/day), followed by Large White (918.7 g/day) and Landrace (894.0 g/day). Among the crossbreeds, Pietrain x Large White boars had the highest ADG (903.8 g/day), and lowest for the Large White x Pietrain cross (813.9 g/day). Large differences in LSM are found between terminal crossbred boars than purebred boars. The large variability in ADG among the crossbred boars may be due to non-additive genes (i.e. specific combining abilities).

Figure 2 shows faster annual improvement in ADG for the Duroc (16.39 g/day) than Landrace (15.16 g/day) and Large White (15.10 g/day).

Backfat Thickness

Table 4 shows that BFT of performance-tested boars were significantly affected by different auction number (i.e. batch effect), farm, and breed (P<0.01, CV=11.4%). Among the purebreds, Landrace boars had the lowest BFT (1.44 cm), followed by Large White (1.46 cm), and highest BFT in Duroc (1.55 cm). Among the crossbreeds, Pietrain x Large White boars had the lowest BFT (1.33 cm) while Pietrain x Duroc crosses had the highest BFT (1.50 cm). Differences in LSM for BFT between the purebreds were smaller than between the terminal crossbred boars. The large variability in ADG among the crossbred boars may be due heterosis effects brought about by dominance and epistasis.

Figure 3 shows faster annual improvement in BFT for the Large White (-0.04 cm) and Landrace (-0.04 cm) than Duroc (-0.03 cm).

Table 4. Breed standards (LSM ± SE), effects of breed, auction number, and farm, and coefficient of variation for boar performance traits, by breed.

Breed	Age at 90 kg (days)	ADG (g/day)	BFT(cm)	FE (g/g)	SIvalue
Landrace	146.5 ± 1.5	894.0 ± 13.6	1.44 ± 0.02	2.51 ± 0.03	182.3 ± 2.3
Large White	144.6 ± 1.5	918.7 ± 12.8	1.46 ± 0.02	2.40 ± 0.02	190.8 ± 2.2
Duroc	149.7 ± 1.8	922.9 ± 15.8	1.55 ± 0.03	2.52 ± 0.03	183.7 ± 2.7
Duroc x Pietrain	149.2 ± 2.6	859.0 ± 26.9	1.43 ± 0.05	2.45 ± 0.05	186.6 ± 4.6
Pietrain x Duroc	152.0 ± 2.4	864.0 ± 24.1	1.50 ± 0.04	2.50 ± 0.05	177.7 ± 4.1
Large White x Pietrain	152.1 ± 5.0	813.9 ± 52.3	1.40 ± 0.09	2.53 ± 0.10	178.9 ± 8.9
Pietrain x Large White	141.2 ± 4.3	903.8 ± 45.3	1.33 ± 0.08	2.47 ± 0.09	194.9 ± 7.7
Differences between breeds	*	*	**	**	**
Differences between auction number	**	**	**	**	**
Differences between farms	**	**	**	**	**
Coefficient of variation (CV), %	6.6	10.8	11.4	8.3	9.1

* - Significant differences between breeds ($P<0.05$)
** - Highly significant differences between breeds ($P<0.01$)

Feed Efficiency

Table 4 shows that FE of performance-tested boars were significantly affected by different auction number (i.e. batch effect), farm, and breed ($P<0.01$, CV=8.3%). Among the purebreds, Large White was most efficient (2.40 g/g) followed by Landrace (2.51 g/g) and least efficient in Duroc (2.52 g/g). Among the crossbreeds, Duroc x Pietrain boars were most efficient (2.45 g/g) and least efficient in the Large White x Pietrain cross (2.53 g/g/), suggesting that lower FE is associated with Pietrain mothers of terminal crossbred boars. Figure 4 shows faster annual improvement FE for the Large White (-0.03 g/g) and Duroc (-0.02 g/g) and Landrace (-0.02 g/g).

Selection Index Value

Table 4 also shows that SI values of performance-tested boars were significantly affected by different auction number (i.e. batch effect) and farm ($P<0.01$, CV=9.1%). Among the purebreds, Large White had the highest SI (190.8 points), followed by Duroc (183.7 points) and Landrace (182.3 points). The high SI values in Large White boars were mainly due to higher FE. Among the crossbreeds, Pietrain x Large White crosses had the highest SI (194.9 points), while Pietrain x Duroc crosses had the lowest average SI values (177.7 points). The high SI values in Pietrain x Large White were mainly due to higher ADG and lower BFT. Large differences in SI values are also found between terminal crossbred boars than purebred boars. The large variability in SI values among the crossbred boars may also imply that the traits included in the SI are also affected non-additive genes.

Figure 5 shows faster annual improvement in SI values for the Large White (3.65 points) than Duroc (3.26 points) and Landrace 3.01 points).

At present, reports of local improvement of performance traits are inadequate and with very little practical applications, since very few swine breeding farms actually conduct performance test to support their local selection program (Bondoc *et al.*, 1998). The results of this study highlight the breed standards for age at 90 kg, ADG, BFT, FE and SI values for Landrace, Large White and Duroc breeds and four other terminal crossbred boars raised under Philippine conditions. Improvements in performance test traits for purebred boars were however, generally small. These may be due to a lack of a selection program (within the breed) in participating breeding farms, or the performance levels of locally available Landrace, Large White, and Duroc are generally considered high to begin with and so the improvement due to selection could hardly be detected. This may also mean that the local swine industry is assured of using available boars with high genetic potential at least in terms of ADG, BFT, and FE.

Furthermore, the large variability in performance traits among the crossbred boars may be due to heterosis effects brought about by non-additive genes. On the other hand, terminal crossbred boars may still be considered in the National Boar Performance Testing Program due to the increasing demand for terminal crossbred boars by local hog raisers, but the number of crossbreed combinations should be limited to at most four breed categories. Statistical evaluation of the performance-tested crossbred boars should then include non-additive models to be able to estimate quite accurately the individual breeding values often required in selection programs within a breed.

In conclusion, the National Boar Performance Testing Program should be sustained as it is able to contribute significantly to the technical information on performance traits of commercial boar breeds in the country, thereby ensuring the availability of genetically superior breeds that may be used by our Filipino pig raisers. A regular technical evaluation of performance-tested boars in the future, should consider the number of young boars that entered the boar test and the number of boars which actually finished the test and were sold by auction. The reasons for boars failing or disqualified from the test should also be recorded and analyzed.

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