13663: Genetic Parameters and Trends for Length of Productive Life and Lifetime Production Efficiency Traits in Thai Landrace and Yorkshire Sows

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ABSTRACT

Data from a commercial swine population in Northern Thailand were used to estimate genetic parameters and trends for length of productive life (**LPL**), lifetime number of piglets born alive per year (**LBAY**), lifetime number of piglets weaned per year (**LPWY**), lifetime litter birth weight per year (**LBWY**), and lifetime litter weaning weight per year (**LWWY**). Phenotypic records were from 2,259 Landrace and 826 Yorkshire sows that had their first farrowing between 1989 and 2013. An average information restricted maximum likelihood procedure was used to estimate variance and covariance components, heritabilities and correlations. The 5-trait animal model included first farrowing year-season, breed group, and age at first farrowing as fixed effects, and sow and residual as random effects. Heritability estimates were 0.17 ± 0.04 for **LPL**, 0.07 ± 0.03 for **LBAY**, 0.13 ± 0.03 for **LPWY**, 0.04 ± 0.02 for **LBWY** and 0.13 ± 0.03 for **LWWY**. Genetic correlations between **LPL** and all lifetime production efficiency traits (**LBAY**, **LPWY**, **LBWY** and **LWWY**) were all positive ranging from 0.66 ± 0.14 (**LPL-LBAY**) to 0.95 ± 0.02 (**LPL-LBWY**). Rank correlations between EBV for **LPL** and lifetime production efficiency traits were, on the average, higher for boars than for sows in the top 5% (0.51 vs. 0.19), 25% (0.68 vs. 0.42) and 50% (0.86 vs. 0.58). Sire genetic trends were negative for **LPL** (-2.41 ± 0.59 d/yr; P < 0.001) and **LWWY** (-0.14 ± 0.06 kg/yr; P < 0.04) and near zero for **LBAY**, **LPWY**, and **LBWY**. Conversely, dam genetic trends were positive for **LPL** (1.10 ± 0.39 d/yr; P < 0.01), **LPWY** (0.12 ± 0.01 piglets/yr; P < 0.0001), and **LWWY** (0.26 ± 0.04 kg/yr; P < 0.0001) and near zero for **LBAY** and **LBWY**. Sow genetic trends were near zero for all traits. ***Improvement for LPL and lifetime production efficiency traits in this commercial swine population will require these traits to be included in the selection indexes used to identify replacement boars and gilts.***

INTRODUCTION

Length of productive life (**LPL**) is important for the efficiency of commercial pig production systems. Commercial swine operations with higher **LPL** sows require lower number of replacement gilts than commercial operations with lower **LPL** sows. Efficient sows with high lifetime productivity levels per year have a greater opportunity to remain longer in the herd than sows with lower yearly productivity. Thus, both **LPL** and lifetime production efficiency are essential for the survival of commercial swine operations. Reported estimates of heritability under temperate environmental conditions indicated that these traits were low to moderately heritable. The only available heritability in Thailand was the near zero values for **LPL** in Landrace (L) and Yorkshire (Y) herds in two farms; Keonouchanh, 2002). Estimation of associations between **LPL** and lifetime production efficiency traits and genetic trends for these traits have not been done in Thailand. To develop genetic improvement programs for these traits, the genetic parameters (heritabilities and genetic correlations) need to be obtained. ***Thus, the objectives of this research were: 1) to estimate genetic parameters for LPL, lifetime number of piglets born alive per year (LBAY), lifetime number of piglets weaned per year (LPWY), lifetime litter birth weight per year (LBWY), and lifetime litter weaning weight per year (LWWY), and 2) to estimate genetic trends for LPL, LBAY, LPWY, LBWY and LWWY in an open-house commercial swine population in Northern Thailand.***

MATERIALS AND METHODS

Data, animals and traits. The data for this research were collected in a commercial swine farm from Northern Thailand. The original dataset of 3,541 sows (2,646 Landrace; L and 895 Yorkshire; Y) was edited for missing, erroneous and incomplete information. Gilts younger than 300 d or older than 500 d of age at first farrowing, incomplete lifetime production or missing records were eliminated from the analyses. Only sows that had at least one lifetime production efficiency trait and known date of first farrowing and date of last weaning were included in the final dataset. After the editing process, the final dataset consisted of 3,085 records from 2,259 L and 826 Y with complete lifetime records whose first farrowing occurred between July 1989 and August 2013. These 3,085 sows were the offspring of 615 sires and 1,336 dams. Traits included in the analyses were **LPL** and four lifetime production efficiency traits (i.e., **LBAY**, **LPWY**, **LBWY** and **LWWY**). The **LPL** was defined as the number of days between age of sow at first farrowing and age of sow at weaning of her last litter. The lifetime production efficiency traits were calculated as ratios of sums of numbers of piglets and litter weights at birth and at weaning during the lifetime of a sow to **LPL** times 365 d.

Climate, nutrition and management. The average temperature over the last thirteen years was 27°C, the average humidity was 73.2%, and the average rainfall was 1,218 mm. Seasons were winter (November to February), summer (March to June) and rainy (July to October). Gilts and non-lactating sows received 2.5 kg/d of feed with 16% crude protein and 3,200 to 3,500 kcal/kg twice a day, whereas nursing sows received 5 to 6 kg/d of feed with 17 to 18% crude protein and 4,060 kcal/kg four times a day. Replacement gilts were inseminated when they reached at least 140 kg of body weight, or they were 8 to 9 mo age, or they had their third observed estrus (12 hr after detecting estrus and 12 hr later). Gilts and sows were kept in individual stalls within open-house buildings with dripping, fogging, and fans placed in the farrowing unit approximately 7 d before farrowing. After weaning, sows were moved to the mating building. Piglets were weaned when they reached 5 to 7 kg of body weight or 26 to 30 d of age.

Statistical analysis. Variance and covariance components were estimated using restricted maximum likelihood procedures (REML) and computed using an average information algorithm. The 5-trait mixed animal model included the fixed effects of first farrowing year-season (FYS; 73 year-season combinations), breed group (Landrace and Yorkshire) and age at first farrowing. Random effects were sow and residual.

$$y = Xb + Z_aQ_ag_a + Z_aa_a + e$$

$$\begin{bmatrix} y \\ a_a \\ e \end{bmatrix} \sim MVN\left(\begin{bmatrix} Xb + Z_aQ_ag_a \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} Z_aG_aZ'_a + R & Z_aG_a & R \\ G_aZ'_a & G_a & 0 \\ R & 0 & R \end{bmatrix}\right)$$

Estimates of variance components were used to calculate heritabilities, genetic correlations, and phenotypic correlations among the five traits. Spearman rank correlations between estimated breeding values (EBV) for **LPL** and lifetime production efficiency traits were computed separately for groups of boars and sows in the top 5%, 25%, and 50% for any of the five traits to assess changes in rank correlations between pairs of traits at each replacement rate. Weighted yearly EBV means for **LPL**, **LBAY**, **LPWY**, **LBWY** and **LWWY** were computed for sows, sires and dams and used to evaluate genetic trends.

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RESULTS AND DISCUSSION

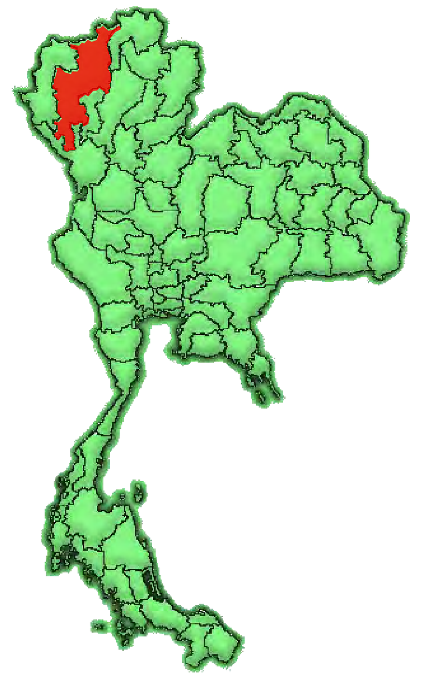
Table 1. shows estimates genetic parameters for **LPL**, **LBAY**, **LPWY**, **LBWY** and **LWWY**. The heritability estimate for **LPL** in this swine population was higher than values from two other swine herds in Thailand (Keonouchanh, 2002), but within the range of values reported from swine populations in Finland (Serenius and Stalder 2004; Serenius et al., 2008), US (Nikkilä et al., 2013) and Poland (Sobczyńska et al., 2013). Estimates of heritability for all traits suggest that selection for these traits is feasible in this population. Genetic correlations among LPL and lifetime production efficiency traits were all positive and moderate to high (**Table 1**)

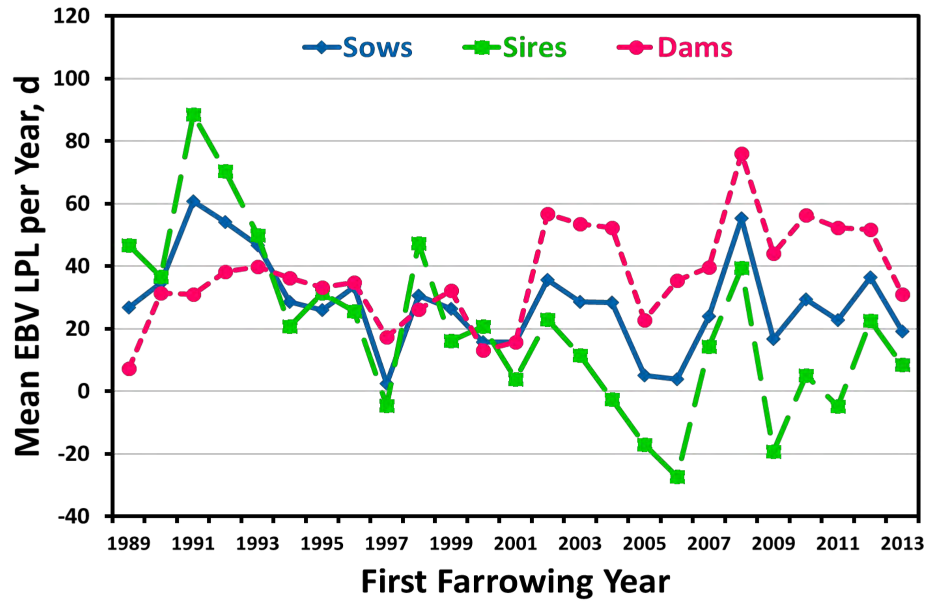
Table 1. Heritabilities (diagonal), genetic (above diagonal) and phenotypic (below diagonal) correlations between length of productive life and lifetime production efficiency traits

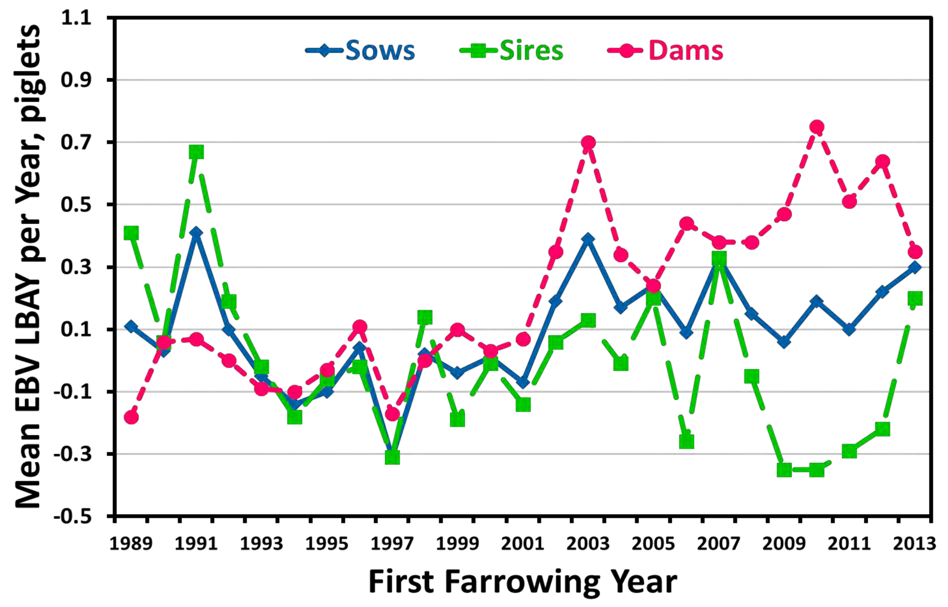
Traits[a]	LPL	LBAY	LPWY	LBWY	LWWY
LPL	0.17 ± 0.04	0.66 ± 0.14	0.91 ± 0.06	0.95 ± 0.20	0.86 ± 0.07
LBAY	0.53 ± 0.01	0.07 ± 0.03	0.78 ± 0.08	0.85 ± 0.07	0.70 ± 0.10
LPWY	0.59 ± 0.01	0.81 ± 0.01	0.13 ± 0.03	0.75 ± 0.11	0.95 ± 0.02
LBWY	0.53 ± 0.01	0.94 ± 0.00	0.79 ± 0.01	0.04 ± 0.02	0.76 ± 0.11
LWWY	0.59 ± 0.01	0.76 ± 0.01	0.95 ± 0.00	0.79 ± 0.01	0.13 ± 0.03

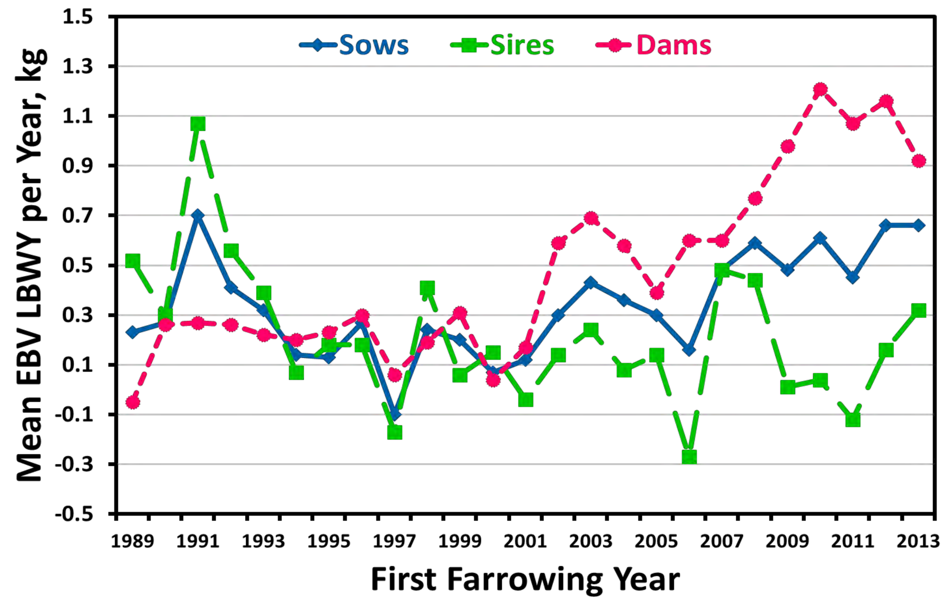
[a] Length of productive life; LBAY = Lifetime number of piglets born alive per year; LPWY = Lifetime number of piglets weaned per year; LBWY = Lifetime litter birth weight per year and LWWY = Lifetime litter weaning weight per year

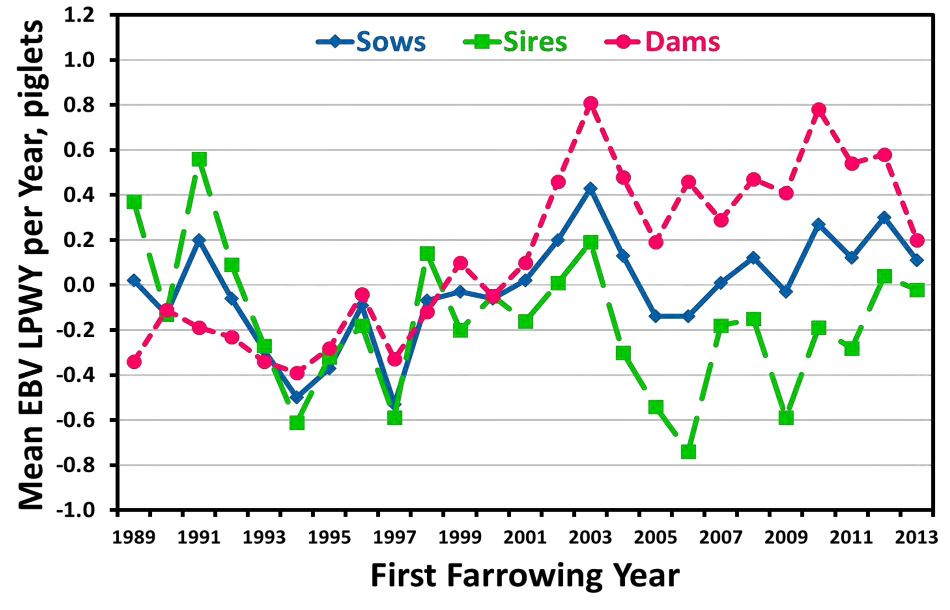
The highest estimate was between **LPWY** and **LWWY** (0.95 ± 0.02) and the lowest estimate was between **LPL** and **LBAY** (0.66 ± 0.14). Similarly, phenotypic correlations were all positive, ranging from 0.53 ± 0.01 (**LPL-LBAY** and **LPL-LBWY**) to 0.95 ± 0.00 (**LPWY-LWWY**). The high and positive genetic correlations among LPL and lifetime production efficiency traits indicated that selection for any of these traits would positively impact the others, thus increasing the overall sow **LPL**. Rank correlations among **LPL** and lifetime production efficiency traits tended to be higher for sows than for boars across all replacement percentages (top 5%, 25%, and 50%). Similarly, rank correlations tended to be higher for the top 50% than the top 25% and the top 5% tended to have the lowest values. Dam EBV yearly means tended to increase for **LPL** and lifetime production efficiency traits from 1989 to 2013. Conversely, sire EBV yearly means tended to decrease for **LPL** and lifetime production efficiency traits from 1989 until 2013. Sow EBV yearly means for **LPL** and lifetime production efficiency traits had intermediate values between dam and sire EBV yearly means, and they also tended to increase from 1989 to 2013.

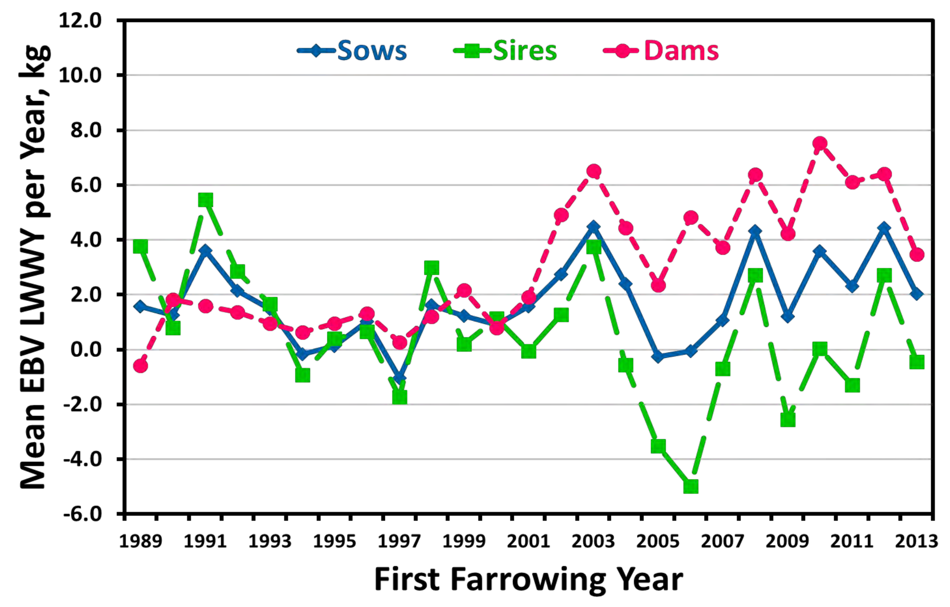












FINAL REMARKS

- Low heritabilities for LPL, LBAY, LPWY, LBWY and LWWY indicated that genetic progress for these traits would be slow
- Positive genetic correlations among LPL and lifetime production efficiency traits would help simultaneously improve all these traits
- Rank correlations between LPL and LPWY, LBWY and LWWY were higher than between LPL and LBAY
- Rank correlations among EBV for any of the five traits were higher for boars than for sows in the top 5%, 25% and 50%
- Genetic trends were negative for sires, positive for dams, and near zero for sows

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