Phenotypic and Genetic Change for Lean Growth Rate and its Components in U.S. Landrace Pigs

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ASL-R660

Summary and Implications

Records on 65,536 Landrace pigs collected between 1985 and 1999 in herds on the National Swine Registry STAGES program were used to estimate genetic change in lean growth rate, days to 250 lb, backfat, and loin eye area. Genetic change was measured as the change in average estimated breeding value (EBV) over years. Analysis was by a multitrait best linear unbiased prediction (BLUP) animal model with fixed effects of contemporary group and sex, and random effects of animal, litter, and residual error. The annual phenotypic trends from 1990 to 1999 were 0.008 lb, -0.85 d, -0.019 in., and 0.12 in.^{2} for lean growth rate, days to 250 lb, backfat, and loin eye area. The overall genetic trends from 1990 to 1999 were 0.85, 0.28, 2.1, 0.95% of their means, respectively. The current rate of genetic improvement in the U.S. Landrace pigs is significant and offers the potential for considerable economic benefit.

Introduction

Lean growth rate is an important part of swine production. The future competitiveness of pork still depends on genetic improvement in the efficiency of quality lean production. Future market pig performance can be characterized by improvement in lean growth and quality traits. Lean growth rate (LGR) has been proposed as the most appropriate expression of the industry’s objective for this phase of production.

Although genetic change for the components of LGR has been widely reported based on the analysis of performance-tested pigs (7, 8), only a few researchers have examined genetic change in LGR (10, 3). Furthermore, the predicted genetic change in LGR in those experiments was based on small specific selection experiments, which may not represent the LGR trend in the pork industry.

Genetic progress in a tiered pig improvement program depends exclusively on the rate of genetic progress achieved in the nucleus level and proper multiplication in the middle levels of the pyramid (1). Estimation of genetic progress in LGR and its components gives an important evaluation of the efficiency of applied improvement schemes. It also supplies the animal breeder with the essential information to develop more successful programs in the future.

The objective of this study was to investigate the nature and magnitude of changes of LGR and its components in purebred Landrace pigs in the United States.

Materials and Methods

Data source

Data were obtained from the National Swine Registry on Landrace pigs born between 1985 and 1999. Numbers of records, animals, litters, contemporary groups, and litters represented are shown in Table 1, along with means for days to 250 lb (Days250), backfat (BF), loin eye area (LEA), and lean growth rate. Data on boars, gilts, and barrows were included in the data set. BF and LEA were measured ultrasonically at the 10th rib. BF, LEA, and Days250 were adjusted using recommendations in Guidelines for Uniform Swine Improvement Programs (14). LGR was calculated using the lean prediction equation recommended by National Pork Producers Council (13).

Table 1. Numbers of records and means for days to 250 lb, backfat, loin eye area, and lean growth rate.

Item	Landrace
Records	65,536
Animals	68,437
Contemporary group	1,202
Litters	14,791
Days to 250, d	174.4 ± 16.46
Backfat, in.	0.68 ± 0.21
Loin eye area, in.^{2}	6.71 ± 0.87
Lean growth rate, lb/d	0.57 ± 0.068

Statistical analysis

The data were analyzed according to the following multiple-trait model:

$$Y_{ijkm} = u + cg_i + sex(herd)_j + litter_k + a_{ijkm} + e_{ijkl}$$

where cg_i is the fixed effect of comtenorary group, $sex(herd)_j$ is the fixed effect of sex within herd, $litter_k$ is the random effect of litter of birth, a_{ijkm} is the random effect of animal, and e_{ijkl} is the random residual error. Estimation of variances and convariances was made using the REMLf90 program provided by I. Misztal (Univ. of Georgia, Athens).

Variances and covariances for use in the multiple-trait analysis were obtained from (4), based on an analysis of the same data under a similar model. Variance and covariances used are shown in Table 2. Means for estimated breeding values of animals were regressed across years to predict annual genetic trend for LGR and its components.

Table 2. Estimates of genetic, litter, and error variances for days to 250 lb, backfat, loin eye area, and lean growth rate.

Component	Days to 250, days	Backfat, in.	Loin eye area, in.^{2}	Lean growth rate, lb/d
Genetic	109.27	0.015	0.23	0.0014
Litter	0.24	0.0013	0.053	0
Residual	89.98	0.022	0.24	0.0015
Heritability	0.54	0.39	0.49	0.48
Litter variance to phenotypic variance (c^2)	0	3.3	0.10	0

Results and Discussion

The annual phenotypic and genetic trends for LGR and its components are presented in Table 3 and Figures 1–8. Estimated phenotypic trends for all traits were relatively large ($P < 0.05$) and favorable. The phenotypic trends for Days250 and BF are -0.86 d/year and -0.019 in/year, respectively. (8) reported a range in phenotypic trend for days to 100 kg of -0.83 to -1.15 d/year and for BF of -0.12 to -0.39 mm/year for four breeds. (7) also reported annual phenotypic trends of -2.76 d for days to 110 kg and -0.065 mm for BF in Polish Large White pigs. Annual phenotypic trends for LEA and LGR were 0.12 in.^{2} and 0.008 lb, respectively.

All estimated genetic trends for LGR, Days250, BF, and LEA were favorable and significant ($P<0.05$) (Figures 5–8; Table 3). The annual rates of genetic change in Days250 and BF were -0.49 d and -0.014 in, respectively, which were similar to estimates of the annual rates of genetic change for days to 110 kg (-0.53 to -0.80 d) and for BF (-0.13 to -0.32 mm) for four Canadian breeds reported by (8). However, the estimates in this study were higher than the values of -0.01 d for days to 110 kg and 0.009 mm for BF in Polish Large White pigs reported by (7). The rates of genetic change were 0.28 and 2.1% of the means per year for Days250 and BF, respectively, over the entire period. Rate of change in some experimental programs and industry trends in other countries are reviewed in Table 4. Theoretical rates of changes of 1.5% for days to 100 kg and -1.7 to -2.9 % for BF were estimated by (8). Selection experiments have achieved rates of genetic change of this magnitude (5, 6). Rates of genetic change in LEA and LGR were 0.064 in.^{2} and 0.0048 lb/day, respectively. These rates of genetic change in LEA and LGR were 0.95 and 0.85% of their means per year, respectively, over the entire period. Some selection experiments have achieved greater rates of genetic changes of LGR (3, 9). The current rates for LGR and its components being achieved in the U.S. Landrace breed are positive but still offer room for further improvement.

Table 3. Annual phenotypic and genetic trends for lean growth rate and its components.

Trait	Phenotypic	Genetic
Days to 250, d	-0.86 ± 0.20	-0.49 ± 0.10
Backfat, in.	-0.019 ± 0.002	-0.015 ± 0.001
Loin eye area, in.^{2}	0.12 ± 0.01	0.064 ± 0.006
Lean growth rate, lb/d	0.008 ± 0.001	0.0048 ± 0.0005

Table 4. Rates of theoretically possible genetic change and some rates achieved in selection experiments and in industry for reduced fatness and increased growth rate.

	Reference	Rate of genetic change (% of mean)	
		Reduced fatness	Increased growth rate
Theoretically possible			
selection experiments	15	3-5	2.7
	6	2.1	---
	5	2.8	1.1
	10	---	1.8
	2	0.5	1.4
Industry trends			
Finland	11	3.9	1.3
Spain	16	0.5	0.1
Canada	8		
1976–1993		1.4	0.4
1989–1993		2.0	0.6

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Figure 1. Phenotypic trend for days to 250 pounds

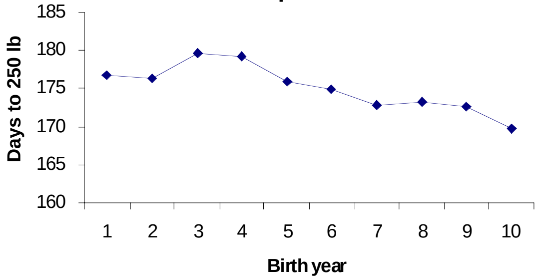

Figure 2. Phenotypic trend for backfat

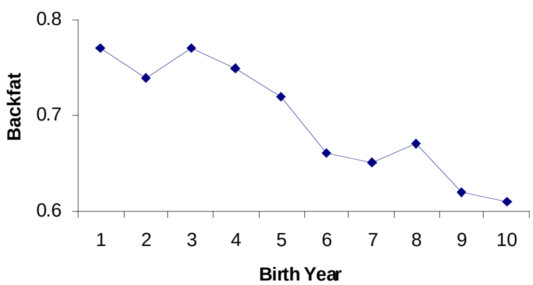

Figure 3. Phenotypic trend for loin eye area

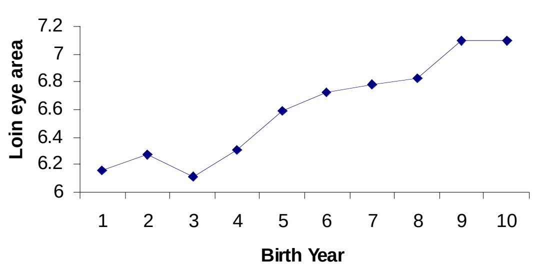

Figure 4. Phenotypic trend for lean growth rate

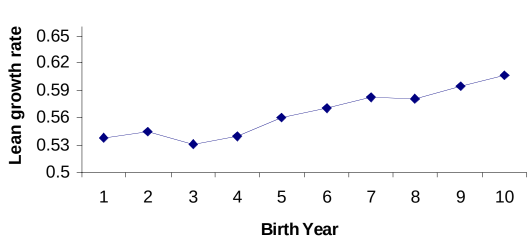

Figure 5. Genetic trend for days to 250 pounds

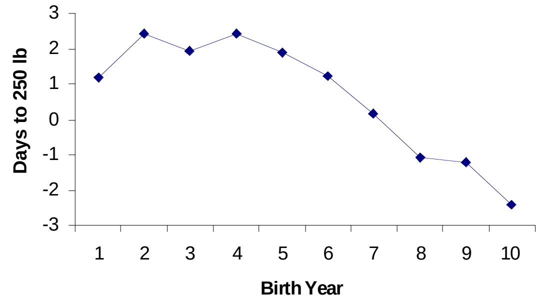

Figure 6. Genetic trend for backfat

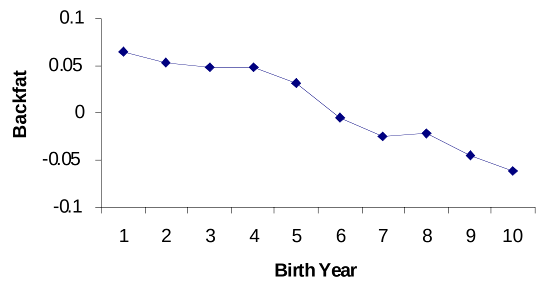

Figure 7. Genetic trend for loin eye area

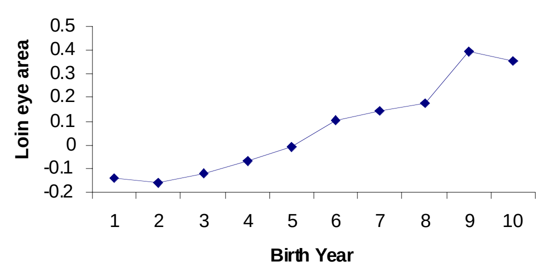

Figure 8. Genetic trend for lean growth rate