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P. Chen  
Iowa State University

J. W. Mabry  
Iowa State University

T. J. Baas  
Iowa State University

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Genetic Parameters for Lean Growth Rate and Its Components in U.S. Landrace Pigs

Abstract
Records on 65,536 Landrace pigs collected between 1985 and 1999 in herds on the National Swine Registry STAGES program were used to estimate additive genetic (animal), common environmental (litter), and residual variances and covariances for days to 250 lb, backfat, loin eye area, and lean growth rate. Analysis was by the REMLf90 program of I. Misztal using a multiple-trait animal model with fixed effects of contemporary group and sex and random effects of animal, litter, and residual error. Heritability estimates were 0.54, 0.39, 0.49, and 0.48 for days to 250 lb, backfat, loin eye area, and lean growth rate, respectively. Genetic correlations for lean growth rate with days to 250, backfat, and loin eye area were -0.83, -0.38, and 0.40, respectively. Phenotypic correlations for lean growth rate with days to 250 lb, backfat, and loin eye area were -0.80, -0.40, and 0.56, respectively. Litter effects were large only for days to 250 lb. Lean growth rate should be used as an important selection criteria in genetic improvement in pigs.

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Disciplines
Agriculture | Animal Sciences

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Genetic Parameters for Lean Growth Rate and Its Components in U.S. Landrace Pigs

P. Chen, research assistant; J. W. Mabry, professor; and T. J. Baas, assistant professor
Department of Animal Science

ASL-R661

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 additive genetic (animal), common environmental (litter), and residual variances and covariances for days to 250 lb, backfat, loin eye area, and lean growth rate. Analysis was by the REMLf90 program of I. Misztal using a multiple-trait animal model with fixed effects of contemporary group and sex and random effects of animal, litter, and residual error. Heritability estimates were 0.54, 0.39, 0.49, and 0.48 for days to 250 lb, backfat, loin eye area, and lean growth rate, respectively. Genetic correlations for lean growth rate with days to 250, backfat, and loin eye area were -0.83, -0.38, and 0.40, respectively. Phenotypic correlations for lean growth rate with days to 250 lb, backfat, and loin eye area were -0.80, -0.40, and 0.56, respectively. Litter effects were large only for days to 250 lb. Lean growth rate should be used as an important selection criteria in genetic improvement in pigs.

Introduction

Increased participation in merit buying programs by producers has increased the emphasis given to leanness. However, the future competitiveness of pork depends on genetic improvement in the efficiency of quality lean production. The biological index of lean growth rate (LGR) has been proposed as the most appropriate expression of the industry’s objective for this phase of production. Selection for lean growth rate has been practiced for many years in swine production, and the effectiveness of selection for this trait has been demonstrated by many researchers. However, the degree of the effectiveness of selection is variable, primarily due to different selection criteria applied.

(2) reported the effectiveness of selection for LGR in a synthetic line of Yorkshire-Meishan pigs based on the lean prediction equation recommended by National Pork Producers Council (12). Although estimates of genetic parameters for the components of LGR have been widely reported (7, 9, 10, 11) parameter estimates for LGR in the literature are variable and from relatively small samples of the population (2, 11, 13). The objective of this study was to obtain genetic parameter estimates for LGR and its components in a large data set of purebred Landrace pigs in the United States.

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 (15). LGR was calculated using the lean prediction equation recommended by National Pork Producers Council (14).

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Landrace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Records</td>
<td>65,536</td>
</tr>
<tr>
<td>Animals</td>
<td>68,437</td>
</tr>
<tr>
<td>Contemporary group</td>
<td>1,202</td>
</tr>
<tr>
<td>Litters</td>
<td>14,791</td>
</tr>
<tr>
<td>Days to 250, d</td>
<td>174.4 ± 16.46</td>
</tr>
<tr>
<td>Backfat, in.</td>
<td>0.68 ± 0.21</td>
</tr>
<tr>
<td>Loin eye area, in.²</td>
<td>6.71 ± 0.87</td>
</tr>
<tr>
<td>Lean growth rate, lb/d</td>
<td>0.57 ± 0.068</td>
</tr>
</tbody>
</table>

Statistical analysis

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

\[ Y_{ijklm} = u + c_{gi} + \text{sex(herd)}_{j} + \text{litter}_{i} + a_{ijklm} + e_{ijkl} \]

where \( c_{gi} \) is the fixed effect of contemporary group, sex(herd)\( j \) is the fixed effect of sex within herd, litter\( i \) is the random effect of litter of birth, \( a_{ijkl} \) is the random effect of animal, and \( e_{ijkl} \) is the random residual error. Estimation of variances and covariances was made using the REMLf90 program provided by I. Misztal (Univ. of Georgia, Athens).

Results

Estimates of genetic, litter, and residual variances are shown in Table 2. Heritabilities for Days250, BF, LEA, and LGR were 0.54, 0.39, 0.49, and 0.48, respectively. The estimate of Days250 was consistent with the result of 0.57 in the National Genetic Evaluation Program (13). It was higher, however, than the average literature estimates of 0.47 reported by (5) and 0.25 by (16). (3) reported an estimate of 0.32 for days to 100 kg. (9) also reported estimates of heritabilities for days to 100 kg ranging from 0.26 to 0.32 based on Yorkshire, Landrace, Duroc, and Hampshire data from the Canadian Swine Improvement Program.
The estimate of heritability for BF in this study was in the range of previous estimates. (8) reported heritabilities for backfat at 90 kg ranging from 0.40 to 0.44 for different breeds of performance-tested pigs. (10) found an estimate of 0.54 for real-time ultrasonic backfat thickness. (1) used Yorkshire records from U.S. central test stations and reported a heritability estimate for backfat of 0.56. (4) used data from herds of Landrace and Large White pigs and estimated heritabilities of 0.39 and 0.50 for backfat. (11) reported an estimate of 0.59 for backfat by using pen averages for Yorkshire, Landrace, and Duroc boars. (9) measured backfat thickness ultrasonically at the midback and on both sides of the loin 5 cm from the midline. Average backfat was adjusted to 100 kg and the average heritability for four breeds was 0.52. (6) reported a heritability estimate of 0.36 for backfat.

The estimate of heritability for LEA was consistent with previous estimates of 0.46 by (16), 0.46 by (10), and 0.48 in the National Genetic Evaluation Program (13). It was higher, however, than the estimate of 0.24 reported by (6). The estimate of heritability for LGR was 0.52. This is similar to the estimate of 0.50 in the National Genetic Evaluation Program (13), but higher than the values of 0.39 estimated by (11) and 0.30 by (2).

Litter effects were significant sources of variation only for LEA in this experiment (Table 2). (4) reported that 5% of the phenotypic variation in backfat of Landrace and Large White pigs was due to litter environmental effects. (9) reported average common environmental litter effects of 0.26 for days to 100 kg and 0.10 for backfat in Yorkshire, Landrace, Duroc, and Hampshire pigs. (6) reported litter effects of 0.13 and 0.18 for BF and LEA, respectively.

LGR and its components are interrelated. Genetic and phenotypic correlations among traits are given in Table 3. Genetic correlations for Days250 with BF and LEA were estimated to be 0.04 and 0.10, respectively. (8) estimated the genetic correlation between BF and days to 230 lbs to be -0.11 for Durocs and -0.17 for Yorkshires. (1), using Yorkshire records from U.S. central test stations, reported a genetic correlation near zero (-0.05) for average daily gain and backfat. LEA was negatively associated with BF ($r_g = -0.35$) in this study. This is higher than the value of -0.27 reported by (11) and (6), but lower than the values of -0.66 in the NGEP (13) and -0.61 in (10). LGR had a negative genetic correlation with Days250 (-0.83) and with BF (-0.38), but a positive genetic correlation with LEA. Thus, selection for leanness in pigs based on LGR (higher values) can be accomplished without an adverse effect on Days250, BF, and LEA.

Results of this study indicate that LGR is highly heritable and should respond to selection. The National Pork Producers Council has developed a new lean prediction equation (14) that should be used when evaluating and selecting for a combination of leanness and growth in pigs.

References


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

<table>
<thead>
<tr>
<th>Component</th>
<th>Days to 250, days</th>
<th>Backfat, in.</th>
<th>Loin eye area, in.²</th>
<th>Lean growth rate, lb/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic</td>
<td>109.27</td>
<td>0.015</td>
<td>0.23</td>
<td>0.0014</td>
</tr>
<tr>
<td>Litter</td>
<td>0.24</td>
<td>0.0013</td>
<td>0.053</td>
<td>0</td>
</tr>
<tr>
<td>Residual</td>
<td>89.98</td>
<td>0.022</td>
<td>0.24</td>
<td>0.0015</td>
</tr>
<tr>
<td>Heritability</td>
<td>0.54</td>
<td>0.39</td>
<td>0.49</td>
<td>0.48</td>
</tr>
<tr>
<td>Litter variance to phenotypic variance (c²)</td>
<td>0</td>
<td>3.3</td>
<td>0.10</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3. Estimates of genetic (r_g) (above diagonal) and phenotypic (r_p) (below diagonal) correlations between traits.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Days to 250, days</th>
<th>Backfat, in.</th>
<th>Loin eye area, in.²</th>
<th>Lean growth rate, lb/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to 250</td>
<td>0.04</td>
<td>0.1</td>
<td>-0.83</td>
<td></td>
</tr>
<tr>
<td>Backfat</td>
<td>0.05</td>
<td>-0.35</td>
<td>-0.38</td>
<td></td>
</tr>
<tr>
<td>Loin eye area</td>
<td>-0.07</td>
<td>-0.38</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>Lean growth rate</td>
<td>-0.80</td>
<td>-0.40</td>
<td>0.56</td>
<td></td>
</tr>
</tbody>
</table>