RESPONSES IN PERFORMANCE TEST TRAITS TO SELECTION ON COMPONENTS OF EFFICIENT LEAN GROWTH IN PIGS

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SUMMARY

Correlated responses in performance test traits were estimated for populations of Large White (LW) and British Landrace (LR) pigs to four generations of divergent selection for lean growth rate (LGA), lean food conversion (LFC) and daily food intake (DFI) with *ad-libitum* feeding. Totals of 3537 LW and 2642 LR pigs were performance tested in Edinburgh and Wye, respectively. Selection for lean growth rate, in LW and LR pigs, increased growth rate (54 and 101 g/day), but reduced backfat (-3.9 and -2.0 mm), food conversion ratio (-0.23 and -0.25) and total food intake (-11.8 and -12.6 kg). There was no change in daily food intake in LW pigs (-19 g/day), but daily food intake increased in the LR pigs (69 g/day). With selection for lean food conversion in LW and LR pigs, there was no response in growth rate (9 and 9 g/day), but backfat (-4.1 and -2.1 mm), total (-6.6 and -11.8 kg) and daily food intake (-90 and -172 g) were reduced, as animals had lower food conversion ratios (-0.13 and -0.22). LW and LR pigs selected for daily food intake ate more food in total (6.8 and 5.9 kg) and on a daily basis (314 and 230 g), grew faster (94 and 51 g/day) and had higher food conversion ratios (0.12 and 0.13). Backfat was increased in LW pigs (3.7 mm), but not in LR pigs.

In general, efficiency of lean growth was improved by increasing growth rate, with negligible change in daily food intake given selection for lean growth rate, but was primarily due to reduced daily food intake given selection on lean food conversion.

INTRODUCTION

Alternative selection strategies for genetic improvement of efficient lean growth in pigs can be evaluated by comparing responses to selection on components of efficient lean growth. This study determined the responses in performance test traits after four generations of divergent selection for lean growth rate (LGA), lean food conversion ratio (LFC) and daily food intake (DFI) with *ad-libitum* feeding, in Large White and British Landrace pigs. Genetic and phenotypic relationships between performance test traits were estimated.

MATERIAL AND METHODS

Animals. Details on establishment of the Large White and British Landrace populations and the three selection groups, the performance test and the selection objectives and criteria are given by Cameron (1994) and Cameron and Curran (1994). Within each of the three selection groups, there were high and low selection lines with a control line, each consisting of 10 sires and 20 dams, with an average of 3 boars and 3 gilts tested per litter. A total of 3537 Large White and 2642 Landrace pigs were performance tested in Edinburgh and Wye, respectively. The performance test was over a fixed weight range of 30±3 kg to 85±5 kg. All pigs were individually penned, with *ad-libitum* feeding of a high energy (13.8 MJ DE/kg DM) and high protein (210 g/kg DM crude protein) pelleted ration.

Selection objectives. The selection objectives for LGA and LFC were to achieve equal correlated responses, measured in phenotypic s.d., in carcass lean with growth and food conversion ratio, respectively. Genetic and phenotypic parameters from a literature review were used to determine the selection criteria.

Statistical analysis. Additive genetic and common environmental (co)variances for performance test traits were estimated using the individual animal model in a multivariate derivative-free residual maximum likelihood analysis (Graser, Smith and Tier, 1987), for each population, using an adaptation of the algorithm of Meyer (1989), as proposed by Thompson and Hill (1990). Fixed effects for sex, testing house and month or period at the start of performance test were included in the model. Covariates for weights on and off test, separately for each sex, were included in the model, as in the experimental design the performance test was on a fixed weight basis. Correlated responses in performance test traits to selection on LGA, LFC and DFI were estimated from the mean within-generation selection line breeding values for each trait, calculated using estimates of additive genetic, common environmental and residual variances.

RESULTS

Correlated responses. Large White (LW) and Landrace (LR) pigs selected for high DFI ate more food in total and on a daily basis, grew faster but had higher food conversion ratios than low line pigs (Table 1). Mid-back fat depth was greater in high DFI LW pigs, but not for LR pigs. Selection for LGA increased growth rate and reduced backfat, food conversion ratio and total food intake. There was no response in daily food intake to selection on LGA in LW pigs, but in the high LGA LR pigs daily food intake was marginally higher. Selection for LFC produced no response in growth rate, but backfat depth, total and daily food intake were reduced, as animals were more efficient with lower food conversion ratios.

Responses to selection in the LR selection groups were symmetric about the control line for the performance traits. In contrast, responses in performance traits to selection in LW pigs were asymmetric. In the LGA selection group, responses in backfat depth and food conversion ratio were largely due to the difference between the low line and the control and the response in growth rate was due to the difference between the high line and the control. Responses in food conversion ratio and backfat depth in the low LFC line were greater than in the high line. In the DFI selection group, responses in growth rate, daily food intake and backfat depth were of substantially larger magnitude in the high DFI line than in the low line, as the low line was not significantly different from the control line.

Table 1. Correlated responses in performance test traits after four generations of divergent selection on lean growth (LGA), lean food conversion (LFC) or daily food intake (DFI)

Population	Large White - Edinburgh					Landrace - Wye				
Trait	Mean	LGA	LFC	DFI	s.e.d.†	Mean	LGA	LFC	DFI	s.e.d.
Average daily gain (g/day)	835	54	9	94	18	834	101	9	51	19
Daily food intake (g/day)	1936	-19	-90	314	40	2286	69	-172	230	48
Days on test	65.1	-4.4	-0.7	-5.7	1.4	67.0	-7.4	-1.0	-3.3	1.6
Food intake (kg)	124	-11.8	-6.6	6.8	2.2	152	-12.6	-11.8	5.9	3.8
Food conversion ratio	2.36	-0.23	-0.13	0.13	0.04	2.79	-0.25	-0.22	0.12	0.07
Mid-back fat depth (mm)	13.4	-2.9	-3.5	3.2	0.4	10.5	-1.7	-1.8	-0.2	0.3

† : Standard error of the difference between the high and low selection lines

Genetic parameters. Estimates of the genetic and phenotypic parameters (x100) for performance test traits are given in Table 2. Heritability estimates were higher in the LW than in the LR population. Genetic and phenotypic correlations were of the same order of magnitude between populations, except for the genetic correlation between growth rate and backfat depth. The genetic and phenotypic correlations indicated that animals with high daily food intakes were faster growing, were fatter and less efficient.

Table 2. Estimates of genetic and phenotypic parameters (x100) for performance test traits

Population	Large White - Edinburgh				Landrace - Wye			
Trait	ADG	DFI	FCR	BFAT	ADG	DFI	FCR	BFAT
Average daily gain (ADG)	<u>37</u> †	64	-44	25	<u>14</u>	37	-66	-3
Daily food intake (DFI)	76	<u>29</u>	38	39	41	<u>19</u>	42	13
Food conversion ratio (FCR)	-52	14	<u>19</u>	15	-52	55	<u>15</u>	14
Mid-back fat depth (BFAT)	26	51	28	<u>46</u>	-25	24	36	<u>25</u>
	s.e.(h^2)=0.05		s.e.(r_A)=0.12		s.e.(h^2)=0.06		s.e.(r_A)=0.17	

† : Heritabilities (h^2) on diagonal, genetic correlations (r_A) below and phenotypic correlations above diagonal

DISCUSSION

Selection on lean food conversion (LFC) increased efficiency primarily through reduced daily food intake, rather than increased growth rate. Growth rate and efficiency were both increased with selection on lean growth rate (LGA), without a significant change in daily food intake. The experimental results confirmed the Fowler, Bichard and Pease (1976) hypothesis that efficiency of lean growth, in the short term, would be improved by increased growth rate with selection for LGA, without changing daily food intake, but would be primarily due to reduced daily food intake with selection on LFC.

In both the LW and LR populations, the direct response in LGA and correlated response in LGA, with selection on LFC, were both at least greater than the associated correlated and direct responses in LFC (Cameron, 1994; Cameron and Curran, 1994). Within-populations, responses in backfat depth were similar with selection on either LGA or LFC, such that the different responses in LGA and LFC were due to changes in components of the selection criteria, *viz.* growth rate and food conversion ratio. The difference between selection on LGA and on LFC, in terms of the response in food conversion ratio, was the emphasis on increased growth rate and reduced DFI, respectively. Selection on LGA resulted in a larger reduction in food conversion ratio, due to the large negative correlation of growth rate with food conversion ratio, than selection on LFC, due to the smaller positive correlation between daily food intake and food conversion ratio. Therefore, given the comparable heritabilities of LGA and LFC (Cameron, 1993; Cameron and Curran, 1994) and the genetic relationships between component traits of the selection criteria, then selection on LGA is expected to have larger direct and correlated responses in LGA and LFC, respectively, then selection on LFC.

Estimation of the genetic and phenotypic parameters and the correlated responses to selection in component traits of the selection criteria have enabled an explanation for the different responses in the three selection groups, in particular the greater indirect response in LFC with selection on LGA, than the direct response. However, in the long term, selection on LGA may be preferable to selection on LFC, to avoid the reduction in daily food intake. The comprehensive set of selection lines form an experimental resource to study correlated responses in carcass composition, meat and eating quality and reproductive performance. Further, the divergent selection lines enable efficient estimation of the genetic and phenotypic relationships between traits, such that responses to selection can be predicted for the evaluation of alternative selection strategies.

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