

# RESPONSE TO TEN GENERATIONS OF INDEX SELECTION FOR COMPONENTS OF LITTER SIZE IN SWINE

D. Casey, T.A. Rathje and R.K. Johnson  
Department of Animal Science, University of Nebraska-Lincoln  
Animal Science, Univ. of Nebraska, Lincoln, NE 68583-0908, USA

## SUMMARY

Selection for increased index of ovulation rate (OR) and embryonic survival (ES) at 50 d of gestation (Index line) and random selection (Control line) were practiced for 10 generations. Selection was based on dam's index (I) and selection rates were approximately 40/160 for females and 15/160 for males. Laparotomy at d 50 of gestation was used to expose ovaries and the uterus and index was calculated from counts of corpora lutea and fetuses (F). The index was constructed to maximize response in F. Because the optimum economic weight for OR was the ES mean and the weight for ES was the OR mean, the index was changed after five generations to reflect changes in means from generation 0 to 5. This new index was used to select parents of generations 6 to 10. The mean parents cumulative selection differential was 96.5 points at generation 5 for the first index and an additional 130.6 points from generations 6 to 10 for the second index, for a total of 227.1 points. Regressions on mean parents' cumulative selection differential for generations 0 to 5 were  $.23 \pm .04$  (I),  $.024 \pm .004$  (OR), and  $.012 \pm .003$  (F). For generations 6 to 10 these regressions were  $.256 \pm .027$  (I),  $.033 \pm .003$  (OR), and  $.013 \pm .001$  (F). ES decreased an average of  $-.035\%$  per cumulative selection differential during 10 generations. Number of fully formed pigs at birth increased  $.108 \pm .049$  pigs per generation in the select line compared to the control, but the increase in number born alive was not significant.

## INTRODUCTION

Increasing litter size in swine will improve efficiency of swine production (Tess et al., 1983). Selection for litter size was not successful in some experiments (Rutledge, 1980; Ollivier, 1982), but was successful when practiced in a line previously selected for ovulation rate (Lamberson et al., 1991). Selection for ovulation rate was effective (Zimmerman and Cunningham, 1975; Cunningham et al., 1979), but the response in litter size was only 20% of the increase in ovulation rate (Lamberson et al., 1991). Selection in mice for survival rate of embryos, a ratio of the number of corpora lutea and the number of normal fetuses at 16 d of gestation, caused litter size to increase (Bradford, 1969). In this experiment selection on an index of ovulation rate and embryonic survival at 50 d of gestation was practiced in pigs. This paper describes the results after ten generations.

## MATERIALS AND METHODS

Purebred Landrace and Large White pigs were obtained in 1976 and maintained as pure lines until 1978, when they were crossed. The F1 and F2 generations were randomly mated and pigs in the F3 generation were randomly chosen within litter to be in either the Index (I) or the Control (C) line.

Selection was initiated in 1981 in the I line for an index of ovulation rate (OR) and embryo(fetal) survival (ES) at 50 d of gestation. ES was calculated from OR and number of fetuses (F) as  $ES = F/OR$ . The index used for the first five generations was (I1) =  $10.6 \times OR + 72.6 \times ES$  (Johnson et al., 1984). After 5 generations the genetic parameters for the components were estimated and a new index (I2) =  $9.9 \times OR + 149 \times ES$ ; Neal 1987) was derived and used for selection in generations 6 through 10. Indexes were derived to

maximize response in F.

Each generation all I line female progeny, approximately 150, were mated to 20 sons of the 15 highest indexing dams. Matings were random, but full and half-sib matings were avoided. Laparotomy was performed at 50 d of gestation on these females, an average of 147 per generation. Pregnant gilts were anesthetized and a midventral incision was made to expose the ovaries and uterus. The number of corpora lutea and number of fetuses were counted. The females were ranked on the index and on average 46 of the highest indexing females each generation were retained to farrow. The remaining females were culled before parturition. At birth the number of fully formed piglets (FF) and number of live piglets (NBA) were recorded.

Each generation approximately 55 C line gilts, at least one per litter, were mated to 15 males, one chosen randomly from each half sib family. Matings occurred randomly, but full and half-sib matings were avoided. Laparotomy was performed on approximately half of these females, except in generations 5 and 10 when laparotomy was performed on all C line females. An average of 41 C line gilts farrowed per generation.

Selection differentials for each female were calculated by deviating its index from the line-generation mean. Cumulative selection differentials (CSD) for gilts were calculated as the average CSD of the gilt's parents plus the gilt's selection differential. CSD for boars was obtained by averaging the CSD of the boar's parents.

Individual gilt records for OR, ES, F and I were regressed on the average of parents' CSD for I with generation in the model according to the method described by Richardson et al. (1968). Unique regressions were fitted for generations 0-5 and generations 6-10.

Response to selection for each trait was calculated as the regression of the deviation of each I line female from the respective generation mean of the C line on generation number.

## RESULTS

The average of the parents' CSD was 96.5 points at generation 5 and 227.1 points at generation 10 in the I line. The value for generation 10 includes selection for I1 and I2. Therefore, the total selection applied for I2 was 130.6 points. The CSD for the C line was 1.9 points at generation 10.

The regression coefficients of I, OR, F and ES on parents' average CSD were  $.227 \pm .036$  points,  $.024 \pm .004$  ova,  $.012 \pm .003$  fetuses, and  $-.03 \pm .02\%$ , respectively, for generations 0 to 5. The regressions for generations 6 to 10 were  $.256 \pm .027$  points,  $.033 \pm .003$  ova,  $.013 \pm .001$  fetuses and  $-.04 \pm .01\%$ .

Regressions of I line gilt records deviated from the C line mean on generation number over all generations were  $.78 \pm .04$  ova,  $.32 \pm .02$  fetuses,  $-.9 \pm .1\%$  embryonic survival,  $.11 \pm .05$  fully formed pigs at birth and  $.002 \pm .049$  live pigs born.

## DISCUSSION

Responses in ovulation rate and number of fetuses are illustrated in Figure 1. The divergence between lines was quite consistent over generations. At generation 10, the difference between the I and C lines was 6.7 ova and 3.3 fetuses. Embryonic survival declined in the I line and was 4.5% less than in the C line at generation 10. The difference in Index was 59.3 points.

The difference between lines was 2.4 fully formed pigs at birth in generation 5 and 3.1 pigs at generation 10. However, the lines differed by .7 pigs at generation 0. The initial difference, and a portion of the difference in each subsequent generation, is probably because only gilts with large index values, the selected sample, farrowed in the I line. The phenotypic regression of number of fully formed pigs on gilts' selection differential was  $.026 \pm .005$  for generations 0 to 5. The average selection differential was 29 points per generation. Therefore, the expected difference between lines due to high index values of the selected sample was  $29 \times .026$ , or .75 pigs, very similar to the difference in generation 0. Subtracting this value from the difference between lines in generation 10 gives an estimated genetic difference of 2.35 pigs between the I and C lines.

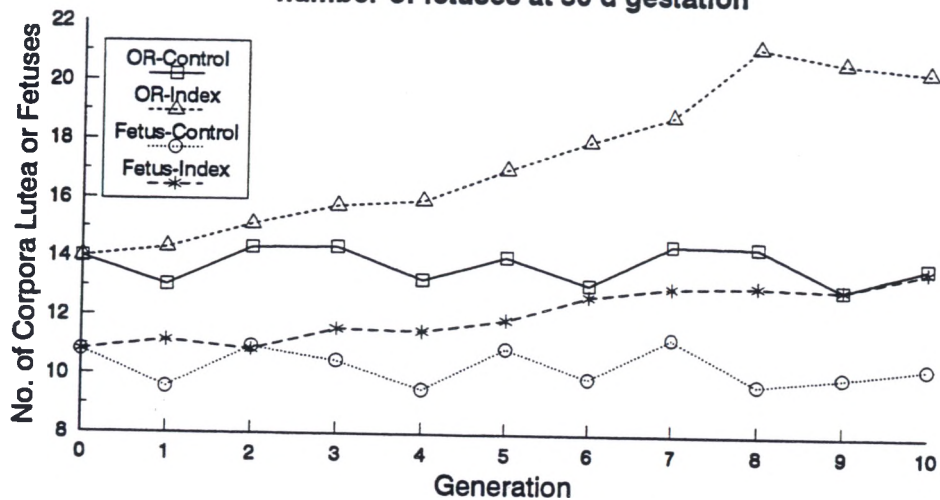
The line difference in live pigs at birth was 1.6 in generation 10. However, the divergence was not uniform. The difference occurred very early and did not continue to increase; therefore, the average change per generation was not significant. There was greater loss of fetuses after 50 d of gestation in the I line and more stillborn pigs at birth. Whether these losses are correlated responses to selection, associated with the trauma of laparotomy, a characteristic of gilts with large litters at 50 d of gestation, or interactions among these factors is not known. Evaluations of random samples of the lines without surgical intervention are needed to determine the causes.

The realized heritability for the index used in generations 0-5 was .23, lower than the value of .30 reported by Neal et al., 1989 using the same data. The difference in the regression methods explains the discrepancy. Neal et al., 1989 regressed line means on mean cumulative selection differential, which had been weighted by the number of daughters measured in the next generation. We calculated the cumulative selection differential for each individual and regressed the individual's phenotype on the average of their parents' cumulative selection differential. Expected values of regressions by the methods are equal, but the method we used accurately accounts for selection in the ancestry of each individual, considers different numbers of observations per generation, and utilizes within line variation and therefore should be more precise.

#### REFERENCES

- BRADFORD, G.E. (1969) *Genetics*, 61:905-921.
- CUNNINGHAM, P.J., ENGLAND, M.E., YOUNG, L.D. and ZIMMERMAN, D.R. (1979) *J. Anim. Sci.*, 48:509-516.
- JOHNSON, R.K., ZIMMERMAN, D.R. and KITTOCK, R.J. (1984) *Livest. Prod. Sci.*, 11:209.
- LAMBERSON, W.R., JOHNSON, R.K., ZIMMERMAN, D.R., LONG, T.E. (1991) *J. Anim. Sci.*, 69:3129-3143
- NEAL, S.M., JOHNSON, R.K. and KITTOCK, R.J. (1989) *J. Anim. Sci.*, 67:1933-1945.
- NEAL, S.M. (1987) PhD Dissertation.
- OLLIVIER, L. (1982) *Pig News and Information*, 3:383.
- RICHARDSON, R.H., KOJIMA, K. and LUCAS, H.L. (1968) *Heredity*, 23:493-506.
- RUTLEDGE, J.J. (1980) *J. Anim. Sci.*, 51:868-870.
- TESS, M.W., BENNETT, G.L. and DICKERSON, G.E. (1983) *J. Anim. Sci.*, 56:354-368.
- ZIMMERMAN, D.R. and CUNNINGHAM, P.J. (1975). *J. Anim. Sci.* 40:61-69.

**Figure 1. Number of corpora lutea (OR) and number of fetuses at 50 d gestation**



**Figure 2. Number of fully formed pigs (FF) and number of pigs born alive (NBA) at 50 d gestation**

