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Traits associated with sow stayability

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ABSTRACT The purpose of this study was to analyze the complex interactions of factors that influence stayability to parities 1, 3, and 5. The study was carried out by analyzing data from the National Pork Producers Council Maternal Line National Genetic Evaluation Program, which included six genetic lines and consisted of 3,283 female pigs. Genetic lines evaluated included Newsham, National Swine Registry, American Diamond Swine Genetics, Danbred, and two Monsanto (DK44 and GPK347) lines. The affects of genetic line, gilt backfat, average daily gain, and age at puberty on stayability were included in the statistical model for all stayabilities. In addition to these effects, prior lactation: total number born, incoming pre-farrow backfat, backfat loss, and feed intake were also included in the statistical models for stayabilities 3 and 5. The analysis was carried out by a modified chi-squared automated interaction detection algorithm. The results showed that the association between prior lactation feed intake and stayability 3 is not linear, extremes being most detrimental to stayability. The results further showed that age at puberty, lactation feed intake, and backfat loss during lactation were the factors most significantly associated with stayabilities 1, 3, and 5, respectively. High age at puberty, low lactation feed intake, and high backfat loss during the lactation were all associated with low stayability.

Introduction

Poor sow longevity reduces producer economic efficiency and lead to animal welfare concerns (Rodriguez-Zas et al., 2003). In the United States, average reported annual breeding female replacement rates have exceeded 58% in the past several years (PigCHAMP 1998-2002). This is an indication of poor sow longevity. Improved environment and genetics can both improve sow longevity. Heritability estimates for sow longevity indicate that genetic selection is possible (Serenius and Stalder, 2004; Yazdi et al., 2000). Direct genetic selection in nucleus herds for sow longevity is difficult; often females are culled before their genetic potential for longevity is reached. Moreover, selection on sow longevity is based on pedigree information, i.e., sows own longevity records are not available when selection is carried out. Traits measured on sows before their maximum longevity is reached could increase accuracy of estimated breeding values for sow longevity given there is a genetic association between the indicator trait and sow longevity. Similarly, known phenotypic relationships enable the development of farm management practices to account for risk factors of poor sow longevity.

Numerous factors related to genetics and environment influence sow longevity. However, important traits that influence sow longevity need to be quantified. The purpose of this study was to analyze the complex interaction of factors that influence sow stayability, defined as the ability of a sow to reach a certain parity, and identify important traits related to sow longevity.

Materials and Methods

Data

The National Pork Producers Council Maternal Line National Genetic Evaluation Program (**MLP**) was initiated to provide pork producers with unbiased information about the differences in reproduction, growth, carcass, and meat quality traits in commercially available maternal genetic lines. Participation was open to all genetic lines in the United States of America. Management was the same for all sows. Sows were culled if they failed to conceive within 50 days of their last litter. No sows were culled due to poor performance of litter size or litter weight through four parities. After four parities, producers culled on poor performance if desired. For more background on the MLP see (Moeller et al., 2004) or http://www.porkboard.org/ProdIssues/MaternalLineP.pdf.

Data consisted of 3,283 female pigs in six genetic lines. Genetic lines included Newsham Hybrid (NH), National Swine Registry (NSR), American Diamond Swine Genetics (ADSG), Danbred (DB), and two Monsanto (DK and GPK347) genetic lines. Genetic lines were mainly Large White-Landrace crossbreds except the GPK347. The GPK 347 contained 50% of an experimental index line developed at the University of Nebraska. The Nebraska Index Line (Neal et al., 1989; Johnson et al., 1999) was a Large White-Landrace composite closed in 1981 and then selected for increased ovulation rate, embryonic survival and litter size at birth for 16 generations.

Statistical Analysis

A modified chi-squared automated interaction detection algorithm (CHAID) was chosen as the method of analysis because it is a technique used to study complex interactions among factors that determine the outcome of a binary response variable (e.g., stayability). CHAID uses independent variables to split the dependent variable into progressively smaller subgroups. Each category of the most significant independent variable is split further until a category can not significantly split. Results from CHAID produce a multi-level structure that resembles a tree (see Figures 1, 2 and 3). The dependent variable at the top of the tree splits into two or more branches of the most significant independent variable. For a more detailed description of CHAID see Meyer et al. (2000). Analysis was carried out by the TREEDISC macro in SAS (SAS 1995).

CHAID was used to produce "trees" of results for stayabilities 1, 3, and 5. Independent variables included: genetic line, gilt backfat thickness (A-mode ultrasound), average daily gain, and age at puberty for all stayabilities. In addition to these effects, of prior lactation: total number born, incoming pre-farrow backfat, backfat loss, and feed intake were included for stayabilities 3 and 5. Independent variables, except genetic line and total number born, were formed into categories by half standard deviations from the trait mean. Lactation feed intake was adjusted for by parity. Sows with missing data were excluded from the analysis. For that reason, gilts that never farrowed were excluded from stayabilities 3 and 5 as they did not have lactation information.

The GPK347 had a higher percentage of sows finish four parities than the other five genetic lines. Therefore, analysis was done with and without the GPK347 in the model. Similar results were obtained therefore data included all genetic lines.

Results and Discussion

Stayability 1

Age at puberty was the most significant predictor for stayability 1, high age being detrimental (Figure 1). These results are supported by Young (1995) who reported gilts from earlier puberty (½ Meishan crosses) had more gilts reach oestrus compared to later puberty (½ Minzhu) crosses. Similarly, Hutchens et al. (1982) found earlier puberty crossbred gilts had a higher percentage of gilts reach oestrus than the later puberty purebred gilts.

CHAID further subdivided two age at puberty groups into gilt backfat and average daily gain. Within the earliest puberty group (<223 days), low gilt backfat was unfavourable to stayability 1. These results are supported by: Brisbane and Chenais, (1996), Lopez-Serrano et al., (2000), Tholen et al., (1996), and Geiger et al., (1999) who found low backfat detrimental to measures related to sow longevity. In contrast, Yazdi et al., (2000) found no relation between side-fat thickness and longevity in Swedish Landrace. Within another age at puberty group (223-267 days), extreme low average daily gain (<481 g/day) was a detriment to stayability 1. These results are not supported by Tholen et al., (1996), Lopez-Serrano et al., (2000), and Tummaruk et al., (2001) who found antagonistic relationships between growth rate and sow longevity. Yazdi et al., (2000), found no effect of average daily gain on longevity.

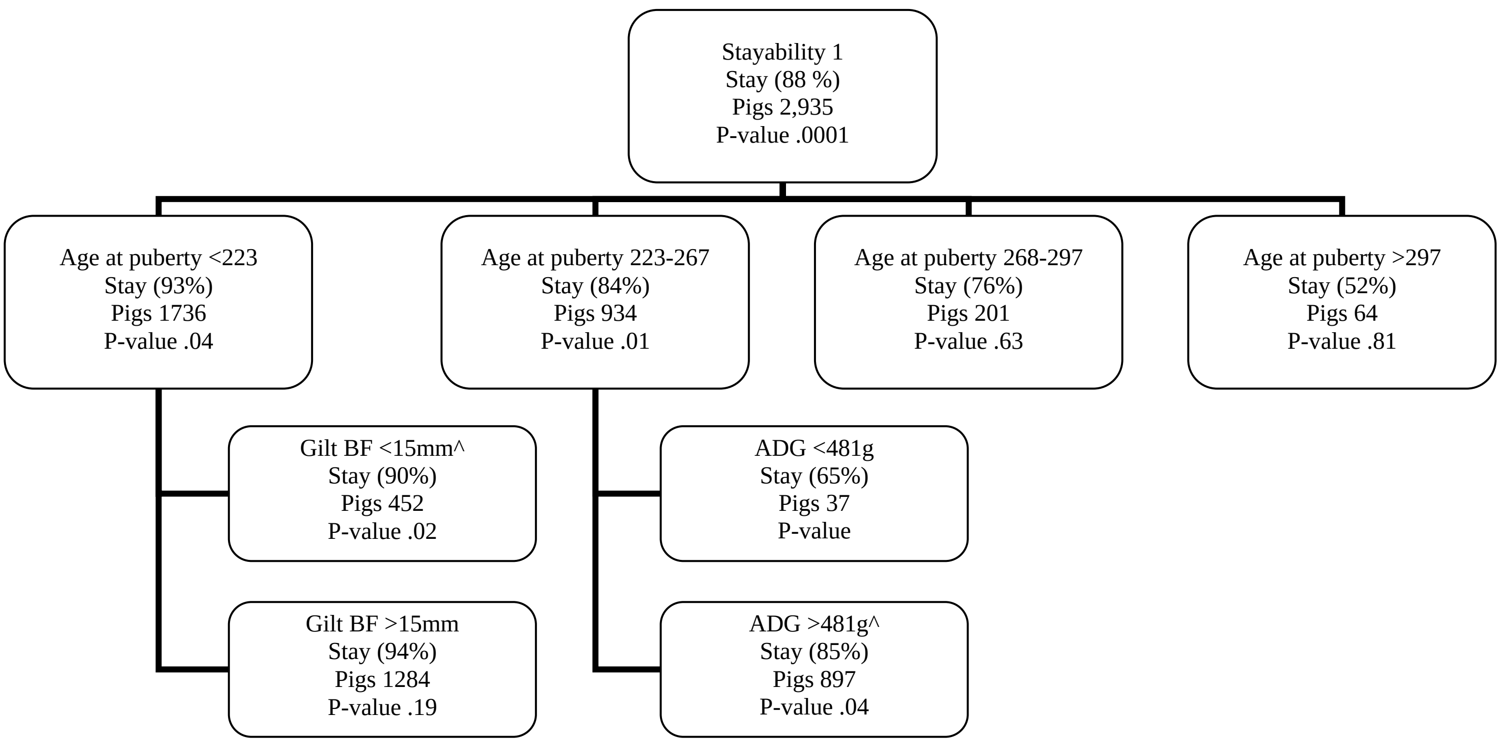

Figure 1. The most significant predictor split into categories as a result of CHAID analysis for stayability 1. Within each leaf, range of group (1st row), % gilts farrowed 1st litter (Stay), number of pigs in each group (Pigs), and p-value of trait to be subdivided are presented.

Stayability 3

Lactation feed intake was the best predictor of stayability 3 (Figure 2), low lactation feed intake being detrimental. These results are substantiated by Kirkwood et al. (1987), Baidoo (1989), and Koketsu et al. (1994) who found low lactation feed intake unfavourable to subsequent conception rate, a measure that influences sow longevity. Our results further showed lactation feed intake to be nonlinear with high values (>110 kg) somewhat detrimental to stayability 3.

CHAID subdivided the high feed intake group into total number born. Low total born was adverse to stayability 3. These results are strengthened by Yazdi et al. (2000) who found small litters increased a sows' risk of being culled. Serenius and Stalder (2004) reported favourable correlations between number weaned and length of productive life in Finnish Landrace and Large White populations.

CHAID subdivided two lactation feed intake groups into age at puberty and lactation backfat loss. High age at puberty and high lactation backfat loss were undesirable for stayability 3. These results are supported by Sterning et al. (1990) who found sows that had improved subsequent reproductive performance lost less backfat during lactation.

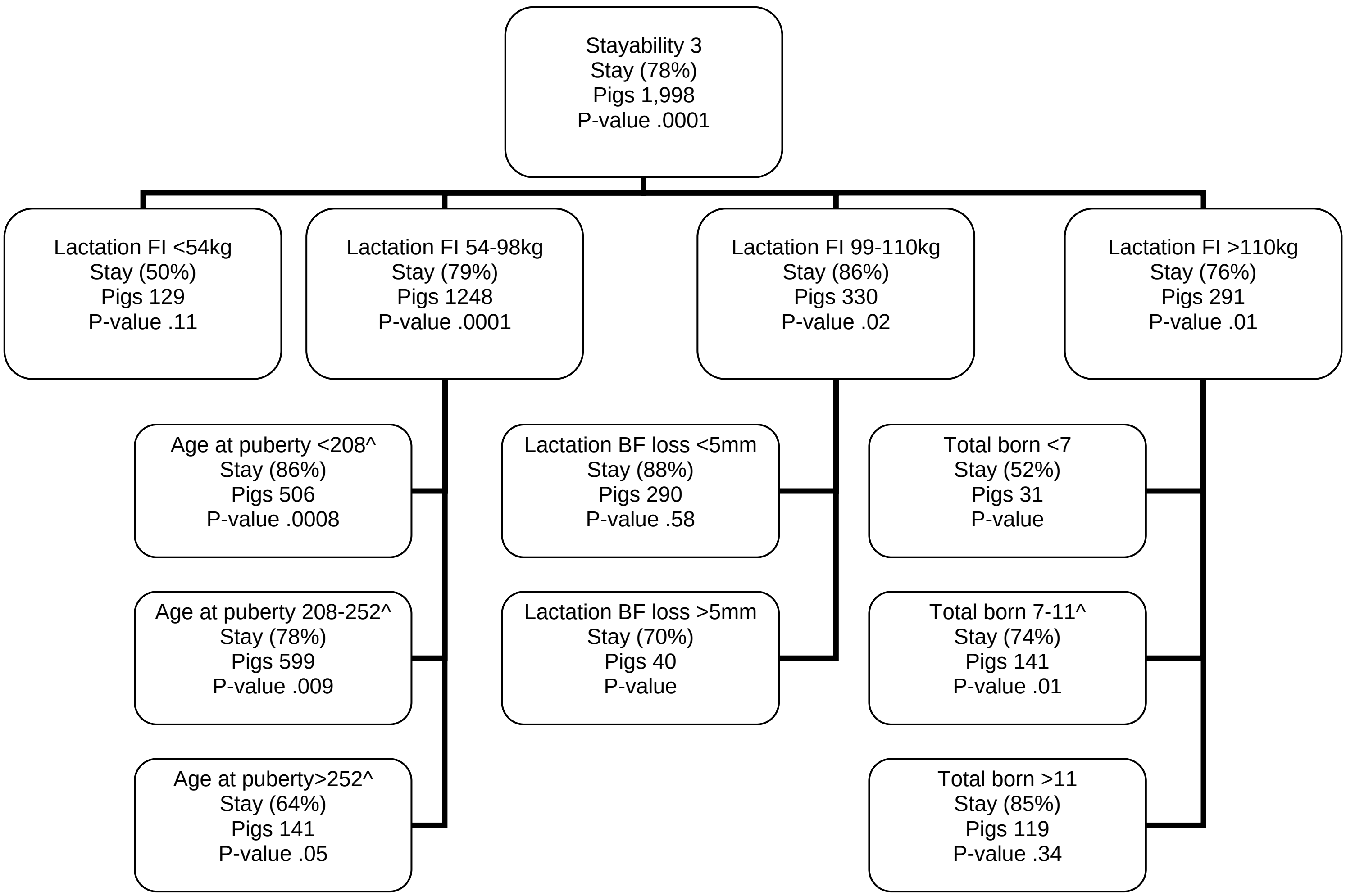

Figure 2. The most significant predictor split into categories as a result of CHAID analysis for stayability 3. Within each leaf, range of group (1st row), % of sows farrowed 3rd litter (Stay), number of pigs in each group (Pigs), and p-value of trait to be subdivided are presented.

Stayability 5

Lactation backfat loss was the best predictor of stayability 5 (Figure 3), high backfat loss being detrimental. These results concurred with stayability 3. CHAID subdivided lactation backfat loss into age at puberty, lactation feed intake, and genetic line. Two lactation backfat loss categories were split into age at puberty. High age at puberty was undesirable for stayability 5. These results are substantiated by Holder et al. (1995) who reported a higher percentage of gilts completed five parities from the early puberty group (58.8% vs. 39.4%), though not statistically significant ($p<0.18$). The high lactation backfat loss category (>4 mm) was subdivided into lactation feed intake. Low lactation feed intake was unfavourable for stayability 5. These results agreed with stayability 3. One lactation backfat loss category (2-4 mm) was subdivided by genetic line. For this category of lactation backfat loss MXP347 was superior to NSR, who was better than the other four genetic lines combined. After parity four producers culled on poor performance if desired. This could have affected results of stayability 5.

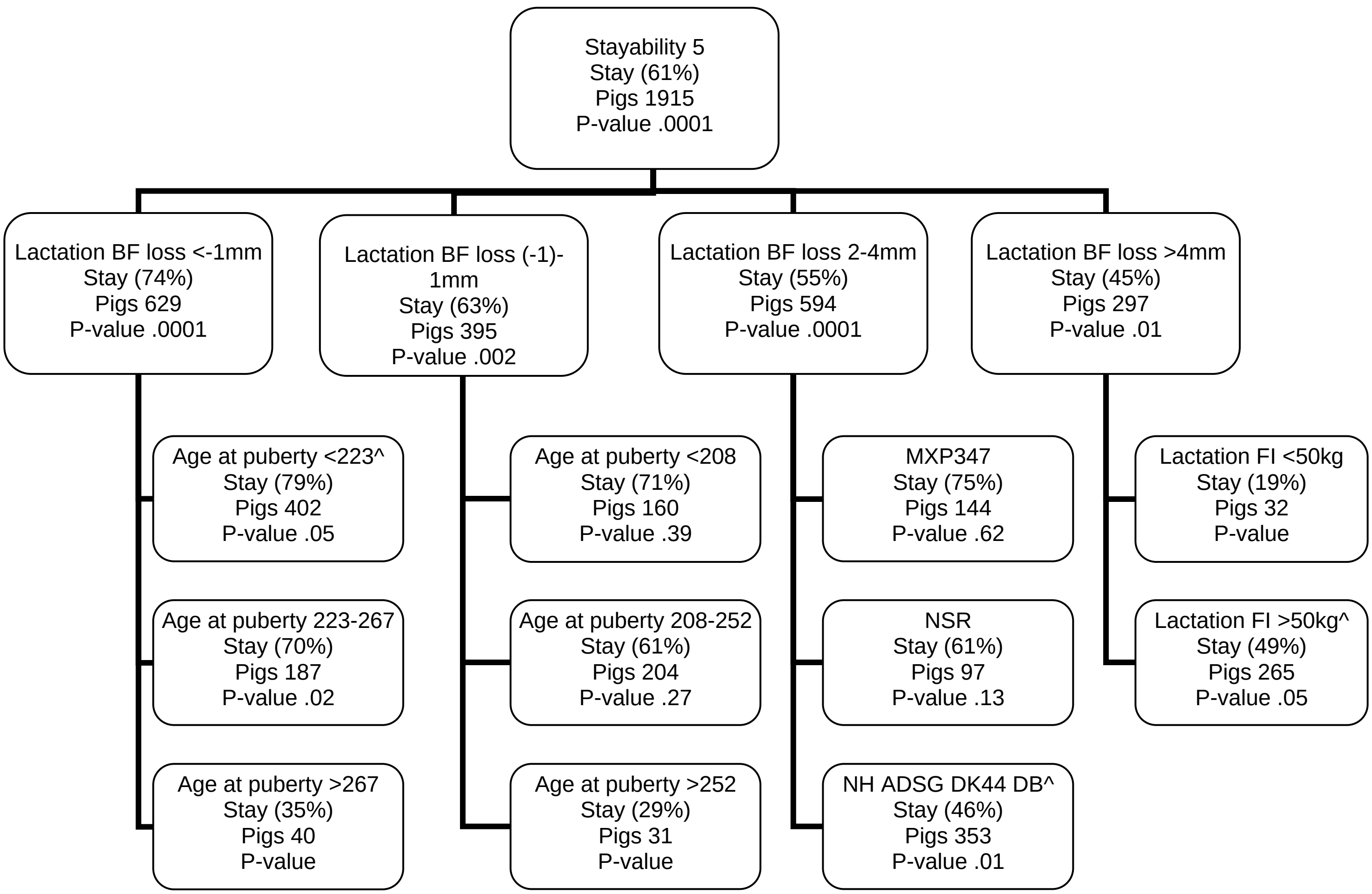

Figure 3. The most significant predictor split into categories as a result of CHAID analysis for stayability 5. Within each leaf, range of group (1st row), % of sows farrowed 5th litter (Stay), number of pigs in each group (Pigs), and p-value of trait to be subdivided are presented.

Summary

Age at puberty, lactation feed intake, and lactation backfat loss are indicators of fleshing ability, the ability of an animal to deposit flesh. Fleshing ability may be a large genetic component of sow longevity.

Genetic line was not the best predictor of stayabilities 1, 3, or 5. This indicated genetic lines were more alike than different. Age at puberty, lactation feed intake, and lactation backfat loss appeared to be good indicator traits of sow longevity. High age at puberty, low lactation feed intake, and high lactation backfat loss were unfavourable for sow stayability. Lactation feed intake affected sow stayability in a nonlinear manner. However, genetic lines may differ in their relationships with traits that affect sow longevity.

Literature Cited

PigCHAMP. PigCHAMP 1998 Datashare. PigCHAMP Inc. Ames, Iowa, USA. 1998. Available at: www.pigchamp.com/1998Datashare.htm Accessed: 20, June, 2005.

PigCHAMP. PigCHAMP 1999 Datashare. PigCHAMP Inc. Ames, Iowa, USA. 1999. Available at: www.pigchamp.com/1999Datashare.htm Accessed: 20, June, 2005.

PigCHAMP. PigCHAMP 2000 Datashare. PigCHAMP Inc. Ames, Iowa, USA. 2000. Available at: www.pigchamp.com/2000Datashare.htm Accessed: 20, June, 2005.

PigCHAMP. PigCHAMP 2001 Datashare. PigCHAMP Inc. Ames, Iowa, USA. 2001. Available at: www.pigchamp.com/2001Datashare.htm Accessed: 20, June, 2005.

PigCHAMP. PigCHAMP 2002 Datashare. PigCHAMP Inc. Ames, Iowa, USA. 2002. Available at: www.pigchamp.com/2002Datashare.htm Accessed: 20, June, 2005.

Baidoo, S.K., 1989. Ph.D. Thesis, University of Alberta.

Brisbane, J.R., and J.P. Chenais. 1996. Relationship between backfat and sow longevity In Canadian Yorkshire and Landrace pigs. In: Proceedings of the National Swine Improvement Federation, Ottawa, Ontario, Canada. Available at: www.nsif.com/Conferences/1996/brisbane.htm Accessed: 20, June, 2005.

Geiger, J.O., Irwin, C., and S. Pretzer. 1999. Assessing sow mortality. Proceedings of the Allen D. Leman Swine Conference. 26:84-87.

Holder, R.B., Lamberson, W.R., Bates, R.O., and T.J. Safranski. 1995. Lifetime productivity in gilts previously selected for decreased age at puberty. Anim. Sci. 61:115-121.

Hutchens, L. K., R. L. Hintz, and R. K. Johnson. 1982. Breed comparisons for age and weight at puberty in gilts. J. Anim. Sci. 55:60-66.

Johnson, R. K., M. K. Nielson, and D. S. Casey. 1999. Responses in ovulation rate, embryonic survival, and litter traits in swine to 14 generations of selection to increase litter size. J. Anim. Sci. 77:541–557.

Kirkwood, R.N., Baidoo, S.K., Aherne, K.X., and A.P. Slather. 1987. The influence of feeding level during lactation on the occurrence and endocrinology of the post weaning oestrus in sows. Can. J. Anim. Sci. 67:405-415.

Koketsu, Y., Dial, G.D., Marsh, W.E., Pettigrew, J.E., and V.L. King. 1994. Returns to estrus after mating and reproductive failure in commercial swine herds. J. Anim. Sci. Suppl 1. 72:1282.

Lopez-Serrano, M., Reinsch, R., Looft, H., and E. Kalm. 2000. Genetic correlations of growth, backfat thickness, and exterior with stayability in Large White and Landrace sows. Livest. Prod. Sci. 64:121-131.

Meyer, C.L., P.J. Berger, and K.J. Koehler. 2000. Interactions among factors affecting stillbirths in Holstein cattle of the United States. J. Dairy Sci. 83:2657-2663.

Moeller, S. J., R. N. Goodwin, R. K. Johnson, J. W. Mabry, T. J. Baas, and O. W. Robison. 2004. The National Pork Producers Council Maternal Line National Genetic Evaluation Program: A comparison of six maternal genetic lines for female productivity measures over four parities. J. Anim. Sci. 82:41–53.

Neal, S. M., R. K. Johnson, and R. J. Kittok. 1989. Index selection for components of litter size in swine: response to five generations of selection. J. Anim. Sci. 67:1933–1945.

Rodriguez-Zas, S.L., Southey, B.R., Knox, R.V., Connor, J.F., Lowe, J.F., and B.J. Roskamp. 2003. B.J. Bioeconomic evaluation of sow longevity and profitability. J. Anim Sci. 81: 2915-2922.

SAS. 1995. SAS sample library: TREEDISC macro beta version. SAS, Inc., Cary, NC.

Serenius, T. and K.J. Stalder, 2004. Genetics of length of productive life and lifetime prolificacy in the Finnish Landrace and Large White pig populations. J. Anim. Sci. 82:3111-3117.

Serenius, T. and K.J. Stalder, 2004. Sow Longevity Calculator Ver. 2.0: Farrow-to-Finish. Metric and English unit measures. Available at: http://www.extension.iastate.edu/ipic/information/FFSLv2.html Accessed: 28, September, 2004.

Tholen, E., Bunter, K.L., Hermesch, S., and H.U. Graser. 1996. The genetic foundation of fitness and reproduction traits in Australian pig populations. 2. Relationships between weaning to conception interval, farrowing interval, stayability, and other common reproduction and production traits. Australian Journal of Agriculture Research. 47:1275-1290.

Tummaruk, P., Lundeheim, N., Einarsson, S., and A.M. Dalin. 2001. Effect of birth litter size, birth parity number, growth rate, backfat thickness, and age at first mating on gilts on their reproductive performance as sows. Animal Reproduction Science. 66:225-237.

Yazdi, M. H., L. Rydhmer, E. Ringmar-Cederberg, N. Lundeheim, and K. Johansson. 2000. Genetic study of longevity in Swedish Landrace sows. Livest. Prod. Sci. 63:255–264.

Young, L.D., 1995. Reproduction of F1 Meishan, Fengjing, Minzhu, and Duroc gilts and sows. J. Anim Sci. 73: 711-721.