Title: Characterization of Sow Longevity and the Developmental Factors that Influence It – **NBP# 02-174**

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Abstract: The length of the adult life of a sow is now recognized as both an economical and a welfare concern. There have been both genetic and non-genetic factors reported to influence the time that a sow is productive. In U.S. pork production, most sows are not uniquely identified until they have been selected and allotted to the breeding herd. Therefore, all factors associated with their rearing cannot be related to their subsequent records as an adult. However, nucleus and multiplier farms offer a unique opportunity to study both genetic and non-genetic influences on sow longevity. Females are uniquely identified at birth and their developmental records are maintained throughout their lifetime. In addition parentage information is also available to estimate the familial influence on longevity. A unique data set was assembled from 21 farms which contained both female developmental records along with subsequent sow productivity records to evaluate differing definitions of sow longevity and how developmental factors may associate with these differing definitions.

Few early life factors consistently influenced longevity across the four definitions of stayability, probability to produce 40 pigs, lifespan and herdlife. For the most part, females that grew slower as a developing gilt and had lower number born alive in their first parity had a lower culling risk. However, this was not the case for the longevity definition of lifespan. Within lifespan, females which had higher first parity number born alive had a greater culling risk. Birth litter traits had minimal impact on longevity. For herdlife, females born into litters which had higher number alive had a lower culling risk. However, this was the only definition in which birth litter factors were significant. Heritability was estimated for the definition of herdlife. The heritability estimate for functional herdlife was 0.18 which suggests that when longevity is defined as time within the herd, it can be improved through genetic selection.

Introduction: Reports from commercial swine records have shown that sow-culling rates within commercial herds are above 50% (Dustan, 1997). This is alarming since decreased sow longevity is a welfare concern as well as a profitability dilemma. In a simulation of farrow to finish swine farms, improved sow lifetime by one parity increased profit potential by $34 to $150 per sow lifetime, depending on the assumptions made regarding pigs per litter sold, market price and replacement gilt costs (Stalder et al., 2000). This was also demonstrated in a simulation of a 1,200 female, breed to wean system (Bates and Schwab, unpublished data). Within this study, changing sow replacement rate by 10% improved profit per sow by $15.70 annually.

Sow longevity is influenced by both genetic and non-genetic factors. In a comparison of purebred and crossbred sows, F_1 Yorkshire by Landrace sows averaged .66 more parities per lifetime than Landrace purebred sows suggesting improved performance of crossbred sows due to differences in genetic merit for longevity, of which both additive and non-additive genes could be contributing (Sehested and Schjerve, 1996). Other studies have reported heritability estimates for differing definitions of sow longevity ranging from 0.064 to 0.268 (Lopez-Serrano et al., 1998; Yazdi et al., 2000a; Gou et al., 2001).

Developmental factors, those experienced from birth through adulthood, have been shown to impact some measures of longevity. It was reported that growth rate to 220 lb or backfat thickness at 220 lb did not significantly impact length of productive life (Yazdi et al., 2000b). However, the converse was true for a study that measured lifetime productivity (Tummaruk et al., 2001). In that study, gilts that grew faster to 220 lb and were fatter had improved farrow rate and number born compared to their slower growing, leaner counterparts. Reduced age at either herd entry or at first farrowing has been shown to favorably impact lifetime productivity (Le Cozler et al., 1997; Guo et al., 2001). However, females with a lower age at first mating either were not affected or had reduced performance than their older counterparts dependent on the parity evaluated (Tummaruk et al., 2001).

Unfortunately, there has not been a standard measure of sow longevity, with differing definitions for longevity used across published studies and reports. This causes difficulty in summarizing results across studies to determine what factors may be influencing sow longevity. Few studies have evaluated differing definitions of sow longevity simultaneously and determined how environmental or developmental characteristics may impact these differing descriptions. Several differing descriptions of female longevity have been proposed (Brotherstone et al., 1997; Visscher et al., 1999). These can be summarized as: 1) stayability, the ability of a sow to complete a predetermined number of parities, 2) lifespan, the number of parities a sow is expected to complete, 3) the probability to produce a predetermined number of offspring, irregardless of the number of parities and 4) the probability of survival as a function of time, using a random regression approach.

It is imperative to evaluate these four definitions of sow longevity and determine their practicality for use as reporting variables within the industry as well as determine their underlying genetic control. In addition, developmental factors that females experience (e.g. birth litter size, growth rate, body composition, age at first farrowing, etc.) should be examined to ascertain their influence on these four descriptors of sow longevity.

Objectives: The objectives for this project are to 1) assess four different measures of longevity and determine what relationship developmental performance characteristics may have with these differing definitions and 2) estimate the genetic variation for herdlife and determine if non-genetic factors influence the heritability estimate.

Materials and Methods: A unique data set was assembled to complete this project. The data set is an accumulation of both nucleus and multiplication records of Yorkshire sows from four swine seedstock systems (Waldo Farms, DeWitt, NE; Premier Swine Systems, Michigantown, IN; Whiteshire/Hamroc, Albion IN; and The Zierke Co., Morris, MN). Individual pig performance and farrowing records from 21 different farms, which are associated within these four seedstock systems have been merged into one data set for analysis. Herd production data from computer software (HERDSMAN^{TM}) have been extracted from each of these farms and have been merged into common data sets for analysis purposes.

From these 21 farms, data from 15,347 females that include information from their birth litter along with their individual performance for age at 250 lb and backfat thickness adjusted to 250 lb have been merged with subsequent sow records and is summarized in Tables 1 and 2. Female records for reproductive productivity did include individuals that were allocated as a replacement gilt but did not farrow a litter. Individual parity records were then summed across parities to accumulate total sow performance and determine the last record in the database for an individual female. In addition a code indicating if an animal had been culled or was still in production was available and was used to indicate censoring.

Four different definitions of longevity have been developed. The specific definitions were: 1) stayability – the probability of a female to complete 4 parities, 2) the probability to produce 40 pigs before culling 3) lifespan – assessment of the number of parities a female has accumulated before culling, and 4) Herdlife – the probability of survival over time (time from first farrowing to culling).

Due to incomplete data recording not all sows had complete records for birth litter traits, growth rate and backfat thickness. To make optimal use of the data, the data set was split into three. The largest data set (Data A; 12,307 sows) included a sow's first parity information along with her lifetime productivity data. The second data set (Data B; 8,010) contained information related to the sow's birth litter records along with her first parity and lifetime productivity data. The third data set (Data C; 5,963 sows) contained the females' adjusted age and backfat at 250 lb along with records of a female's birth litter information and first parity and lifetime productivity data. Age and backfat at 250 lb were deviated from the birth herd-year-month mean of purebred females raised within a farm and then standardized by division with the herd-year-month standard deviation.

A Cox proportional hazards model was used to determine the relationship of developmental factors and lifetime productivity traits with longevity. Time of removal was evaluated and determined to follow a Weibel distribution with an example for herdlife shown in Figure 1. All models contained herd-year as an independent variable. In addition all models (except for probability to produce 40 pigs) contained the sum of productivity measures across each sow's lifetime to adjust for productivity not necessarily related to time. Definitions of variable acronyms used across the data sets are in Table 3.

Variables associated with first parity performance, litter birth records and age and backfat adjusted to 250 lb were grouped into three categories and included into the model to facilitate further understanding of how these variables influenced longevity. Each grouping contained one-third of the females. Definitions of these categories are in Table 4.

The second objective, estimation of the genetic variation for herdlife was conducted using proportional hazards models in which familial relationships could be accounted for and an estimate of the sire variance generated (Ducrocq and Sollker, 2001). The sire variance can only be estimated for those definitions of longevity which are continuous by nature, such as herdlife, which is defined in days within the herd. The methodology to estimate the sire variance of longevity definitions which are categorical in nature or defined as probabilities (i.e. probability to produce 40 pigs, stayability and lifespan) has not been developed.

The sire variance for herdlife was calculated using a complete versus a reduced model. The reduced model contained only the Herd-year and sire terms and is referred to as true herdlife. The complete model included those variables listed in Table 17 and the sire term to estimate sire variance. This is defined as functional herdlife, since it is corrects for non-genetic factors impacting this definition of longevity. Heritability was calculated using the formula;

$h^2 = 4\sigma_s^2 / (\pi^2/6 + \sigma_s^2)$ as reported by Ducrocq (2001).

Results: Results from Data A for each of the four definitions of longevity are found in Tables 6, 9, 12 and 15. Results from Data B for each of the four definitions of longevity are found in Tables 7, 10, 13, 16. Results from Data C for each of the four definitions of longevity are found in Tables 8, 11, 14 and 17. Within each table the sign of the parameter estimate signifies the relationship the corresponding variable has with the indicated definition of longevity. If the sign of the parameter estimate is positive this indicates that as the variable increases in size there is greater risk of culling within the particular definition of longevity. For example in Table 6, the parameter estimate of parity 1 lactation length for stayability is positive. This indicates that females with longer parity 1 lactation length had an increased risk of culling within the definition of stayability. In other words females that lactated longer during parity 1 had a greater chance of being culled before completing 4 parities than sows with shorter first parity lactation lengths.

The opposite is true for parameter estimates with a negative sign. Variables with negative parameter estimates suggest that as the variable increases there is reduced risk of being culled within the specified definition of longevity. In Table 6, first parity number born alive has a negative parameter estimate for stayability. This indicates that sows which had larger litters at first parity had a decreased risk of being culled within the definition of stayability. This suggests that sows with smaller litter size at first parity had a greater chance of being culled before completing 4 parities than sows which had an increased first parity litter size.

Within Data A, first parity number born alive was significant across the four definitions of longevity; however it had a positive relationship with lifespan (Table 6) and negative relationships with the other three definitions (Tables 6, 9, and 15). This suggests that sows with higher first parity number born alive had an increased risk of culling for the lifespan definition but the converse was true for the other three longevity definitions. First parity lactation length was significant and positive for all longevity definitions except herdlife. For stayability, probability to produce 40 pigs and lifespan, increasing first parity lactation length increased the risk of culling for these three longevity definitions.

Within Data B, first parity number born alive was significant for all four longevity definitions. Similar to Data A, first parity number born alive had a positive relationship with lifespan and a negative relationship with the other three longevity definitions. For birth litter traits, the size of the birth litter was the only birth litter characteristic that significantly influenced any of the longevity definitions investigated. Herdlife was significantly influenced by birth litter total number born and number born alive but their impact was opposite in sign. Females from litters with higher total number born had a greater risk of being culled, but the opposite was true for females with higher number born alive. Birth litter traits were not significant with any of the other three longevity definitions investigated.

Within Data C, age at first farrowing was significant and positive for stayability, probability to produce 40 pigs and lifespan. Age at first farrowing was not significant for herdlife. This suggests that females which were older at first farrowing had a greater risk to be culled within the stayability, probability to produce 40 pigs and lifespan definitions. The standardized deviation for days to 250 lb was the only variable significant across all four longevity definitions. The relationship of the standardized deviation for days to 250 lb was negative for all four longevity definitions. This suggests that females which were faster growing (younger at 250 lb) had a greater chance of being culled within each of these definitions of longevity. The standardized deviation for backfat thickness was significant for stayability, probability to produce 40 pigs and lifespan. As with days to 250 lb, the relationship was negative. This suggests that females which were leaner within their contemporary group had a greater chance to be culled within these definitions of longevity.

The heritability for herdlife is found in Figure 2. Heritability estimates for both true and functional herdlife were 0.12 and 0.18, respectively. This suggests that there is genetic control of herdlife and it can be improved through genetic selection. In addition heritability estimates for functional herdlife were larger than for true herdlife. This indicates that when estimating the genetic component of herdlife, non-genetic factors which impact herdlife should be corrected for. This effectively increases the heritability of herdlife which in turn will allow for greater progress over a defined period of time when selecting for this trait.

Discussion: For Data A, variables influencing longevity were similar across the definitions of stayability, probability to produce 40 pigs and herdlife. However for the definition of lifespan age at first farrowing and first parity number born alive were different in their relationship when compared with the other three definitions. This indicates that the manor in which longevity is defined can impact what factors may influence it.

A similar situation existed within Data B. Parity 1 number born alive had a negative association with stayability, probability to produce 40 pigs and herdlife. However, for lifespan, first parity number born alive had a positive association. For birth litter characteristics, only birth litter size significantly influenced any of the longevity definitions. For herdlife, birth litter total pigs born caused an increased culling risk, but higher number born alive was associated with a decreased culling risk.

Growth and backfat thickness did influence the longevity of a sow. Regardless of definition, faster growing gilts had an increased probability to be culled sooner as sow. In addition, backfat thickness was significant for probability to produce 40 pigs, lifespan and stayability. Gilts which were leaner within their contemporary group had a greater risked to be culled earlier in their productive life as a sow. In addition, age at first farrowing was significant and positive for stayability, probability to produce 40 pigs and lifespan. This suggests that gilts which were younger at first farrowing had a lower risk of being culled at an early productive life than gilts which were older at first farrrowing.

Heritability estimates were positive which would facilitate the estimation of genetic merit (e.g EBVs, EPDs, etc) of herdlife. This indicates that longevity can be incorporated into a genetic improvement program in seedstock herds serving the commercial industry. Effectively correcting the data for non-genetic factors that impact herdlife increased estimated heritability. As heritability increases so can the rate of genetic improvement for the trait in question. To improve rate genetic improvement for herdlife in a selection program, models which calculate genetic merit for individual animals should include non-genetic factors which influence herdlife.

Lay Interpretation: Longevity as a female trait has several different definitions. Each definition has a somewhat different interpretation, depending on the intent. Some definitions are based more on production efficiency while others are more time dependent.

The makeup of the litter a female is born into and how she performs through development can impact her subsequent longevity. In addition, the number of pigs within her first litter also significantly influences her survival risk.

This study has demonstrated that identifying which factors impact longevity depends somewhat on the definition. Thus caution should be used when interpreting what factors influence longevity and thus what possible management changes or policy decisions are needed, since which factors influence longevity is dependent on what definition is used to define longevity.

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Table 1. Litter and individual performance for females which had subsequent reproductive records.

Trait	No.	Mean	Standard Deviation	Minimum	Maximum
Total pigs born	14,401	11.6	3.1	1	30
Number born alive	14,401	10.8	2.9	1	20
Adjusted litter birth weight, lb	8,972	35.5	9.8	3.0	75.0
Ratio of gilts in birth litter,%	9,938	54.4	15.3	7.1	100
Adjusted backfat at 250 lb, in	5,977	0.65	0.16	0.27	1.55
Adjusted age at 250 lb, d	6,078	174.7	15.2	131	248

Table 2. Summary of total sow performance lifetime.

Trait	No.	Mean	Standard Deviation	Minimum	Maximum
Days from birth to culling	14,401	869.1	436.1	305	3,932
Days from first farrow to cull	14,401	502.9	435.7	10	3,548
Age at First Farrowing, d	14,401	366.2	46.03	251	600
First parity farrow interval, d	10,731	156.4	30.7	120	360
Total pigs born, lifetime	14, 401	35.5	27.95	0	188

Table 3. Summary of survival data statistics.

Seedstock System	Females “at Risk”	Incidence Rate
1	7,930	0.3084
2	1,780	0.0820
3	2,251	0.3199
4	3,386	0.1353
Total	15,347	.2457

Table 4. Definitions of variable acronyms used in model development

Variable	Acronym
Number born in female's birth litter	Pborn
Number born alive in female's birth litter	Pnba
[a]Standardized deviation for adjusted backfat thickness	DevBF
[a]Standardized deviation for adjusted days to 250 lb	Devdays
Age at first farrowing, d	AGEFF
Parity 1 lactation length, d	P1LACT
Number of gilts in parity 1litter	P1gilt
Parity 1 born alive	P1NBA
Total number born alive over lifetime	SNBA
Total lactation days over lifetime	SLACT
Total number of gilts produced over lifetime	SGILT
Last parity total number born	LPNB

[a]Adjusted female record was deviated from the birth month and year mean for gilts tested within herd and divided by the standard deviation.

Table 5. Categorical definitions of independent variables.

Trait	Acronym	Group 1	Group 2	Group 3
Number born in female's birth litter	Pborn	≤ 10	11-13	> 13
Number born alive in female's birth litter	Pnba	≤ 9	10-11	> 12
[a]Standardized deviation for adjusted backfat thickness at 250 lb	DevBF	≤ -0.568	-0.569 to 0.119	> 0.119
[a]Standardized deviation for adjusted days to 250 lb	Devdays	≤ -0.68	-0.68 to 0.19	> 0.19
Age at first farrowing, d	AGEFF	≤ 342	343 to 370	> 370
Parity 1 lactation length, d	P1LAC	< 18	18 to 22	> 22
Number of gilts in parity 1 litter	P1gilt	< 4	4 to 6	> 6
Ratio of gilts in parity 1 litter	P1grat	< 0.33	0.34 to 0.47	> 0.48
Parity 1 born alive	P1NBA	< 10	10 to 13	> 13
Last parity total number born	LPNB	< 10	10 to 12	> 12

[a]Adjusted female record was deviated from the birth month and year mean for gilts tested within herd and divided by the standard deviation.

Table 6. [a]Estimated hazard ratios for first parity performance for stayability.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
AGEFF	0.0181	0.1323	1.9	0.1722	1.018	0.992	1.045
P1LACT	0.0821	0.0165	24.9	<0.0001	1.086	1.051	1.121
P1gilt	0.0021	0.02652	0.006	0.9362	1.002	0.951	1.056
P1grat	0.0198	0.0212	0.867	0.3517	1.02	0.9780	1.063
P1NBA	-0.1148	0.0299	14.7	0.0001	0.892	0.841	0.945
SNBA	-0.0089	0.0015	35.8	<0.0001	0.991	0.988	0.994
SLACT	-0.0089	0.0007	172.8	<0.0001	0.991	0.99	0.992
SGILT	0.0109	0.0016	48.7	<0.0001	1.011	1.008	1.014
Herd-Year	0.0015	0.0008	404.9	<0.0001	1.002	1.001	1.002
LPNB	-0.0634	0.0285	4.9	0.0262	0.939	0.888	0.993

[a]Number of observations=12,307

[b]See Tables 4 and 5 for acronym definitions.

Table 7. [a]Estimated hazard ratios for birth litter and first litter performance for stayability.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
PNBA	0.0083	0.0301	0.08	0.7823	1.008	0.951	1.07
Pborn	-0.0181	0.0298	0.37	0.5442	0.982	0.926	1.041
P1gilt	0.0374	0.0207	3.3	0.0709	1.038	0.997	1.081
P1NBA	-0.1816	0.0240	57.3	<0.0001	0.834	0.796	0.874
Herd-Year	0.0014	0.0001	251.5	<0.0001	1.001	1.001	1.001
SNBA	-0.0082	0.0017	24.5	<0.0001	0.992	0.989	0.995
SLACT	-0.0116	0.0001	227.8	<0.0001	0.988	0.987	0.99
SGILT	0.0166	0.002	67.4	<0.0001	1.017	1.013	1.021
AGEFF	-0.0156	0.0169	0.88	0.3470	0.984	0.952	1.017

[a]Number of observations=7,885.

[b]See Table 4 and 5 for acronym definitions

Table 8. [a]Estimated hazard ratios for birth litter performance, adjusted backfat and growth rate and first parity performance for stayability.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
P1NBA	-0.0054	0.0388	0.019	0.8895	0.995	0.922	1.073
LPNB	-0.0783	0.0383	4.2	0.0407	0.925	0.858	0.997
Pnba	0.0196	0.0331	0.3489	0.5548	1.02	0.956	1.088
Pborn	-0.0004	0.0330	0.0001	0.9909	1.00	0.937	1.067
DevBF	-0.0587	0.0176	11.1	0.0009	0.943	0.911	0.976
Devdays	-0.0316	0.0187	2.9	0.0908	0.969	0.934	1.005
Herd-Year	0.0012	0.0001	139.3	<0.0001	1.001	1.001	1.001
SNBA	-0.0189	0.0008	502.4	<0.0001	0.981	0.98	0.983
AGEFF	0.0499	0.0181	7.6	0.0059	1.051	1.015	1.089

[a]Number of observations=5,963.

[b]See Table 4 and 5 for acronym definitions.

Table 9. [a]Estimated hazard ratios for first parity performance for probability to produce 40 pigs.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
AGEFF	0.0098	0.0132	0.55	0.4564	1.01	0.984	1.036
P1LACT	0.0978	0.0152	40.96	<0.0001	1.103	1.07	1.136
P1gilt	0.0051	0.0257	0.04	0.8439	1.005	0.956	1.057
P1grat	0.0414	0.0207	3.9	0.0459	1.042	1.001	1.085
P1NBA	-0.2321	0.0286	65.9	<0.0001	0.793	0.75	0.839
SLACT	-0.0087	0.0003	872.8	<0.0001	0.991	0.991	0.992
Herd-Year	0.0016	0.0001	425.3	<0.0001	1.002	1.001	1.002
LPNB	-0.0794	0.0285	7.7	0.005	0.924	0.873	0.977

[a]Number of observations=12,307

[b]See Tables 4 and 5 for acronym definitions.

Table 10. [a]Estimated hazard ratios for birth litter and first parity performance for probability to produce 40 pigs.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
PNBA	-0.0044	0.0300	0.02	0.8845	0.996	0.939	1.056
Pborn	-0.0020	0.0299	0.004	0.9481	0.998	0.941	1.058
P1gilt	0.0844	0.0189	20.1	<0.0001	1.088	1.049	1.129
P1NBA	-0.3004	0.0211	202.3	<0.0001	0.741	0.711	0.772
Herd-Year	0.0014	0.0001	257.9	<0.0001	1.001	1.001	1.001
SLACT	-0.0097	0.0004	713.0	<0.0001	0.99	0.99	0.991
AGEFF	-0.0147	0.0167	0.78	0.3777	0.985	0.954	1.018

[a] Number of observations=7,885.

[b] See Table 4 and 5 for acronym definitions.

Table 11. [a]Estimated hazard ratios for birth litter performance, adjusted backfat and growth rate and first parity performance for probability to produce 40 pigs.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
P1NBA	-0.3393	0.0373	82.9	<0.0001	0.712	0.662	0.766
LPNB	-0.1790	0.0381	22.1	<0.0001	0.836	0.776	0.901
Pnba	0.0200	0.0329	0.37	0.5436	1.02	0.956	1.088
Pborn	0.0006	0.0328	0.003	0.9855	1.001	0.938	1.067
DevBF	-0.0852	0.0176	23.5	<0.0001	0.918	0.887	0.95
Devdays	-0.0642	0.0187	11.9	0.0006	0.938	0.904	0.973
Herd-Year	0.0008	0.0001	70.4	<0.0001	1.001	1.001	1.001
AGEFF	0.0590	0.0181	10.7	0.0011	1.061	1.024	1.099

[a] Number of observations=5,963.

[b] See Table 4 and 5 for acronym definitions.

Table 12. [a]Estimated hazard ratios for first parity performance for lifespan.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
AGEFF	0.0392	0.0134	8.5	0.0036	1.04	1.013	1.068
P1LACT	0.2448	0.0164	221.7	<0.0001	1.277	1.237	1.319
P1gilt	0.0955	0.0272	12.4	0.0004	1.1	1.043	1.16
P1grat	-0.0300	0.0216	1.9	0.1636	0.97	0.93	1.012
P1NBA	0.0838	0.0293	8.2	0.0042	1.087	1.027	1.152
SNBA	-0.0498	0.0016	1029.7	<0.0001	0.951	0.949	0.954
SLACT	-0.0277	0.0007	1661.1	<0.0001	0.973	0.971	0.974
SGILT	0.0209	0.0017	158.7	<0.0001	1.021	1.018	1.024
Herd-Year	0.0007	0.0001	83.5	<0.0001	1.001	1.001	1.001
LPNB	-0.0109	0.0284	0.15	0.698	0.989	0.936	1.046

[a] Number of observations=12,307

[b] See Tables 4 and 5 for acronym definitions.

Table 13. [a]Estimated hazard ratios for birth litter and first parity performance for lifespan.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
PNBA	0.0529	0.0299	3.1	0.0773	1.054	0.994	1.118
Pborn	-0.0335	0.0296	1.3	0.2578	0.967	0.913	1.025
P1gilt	0.1513	0.0208	52.7	<0.0001	1.163	1.117	1.212
P1NBA	0.1576	0.0241	42.8	<0.0001	1.171	1.117	1.227
Herd-Year	0.0007	0.0001	51.8	<0.0001	1.001	1.00	1.001
SNBA	-0.0637	0.0019	1132.7	<0.0001	0.939	0.936	0.943
SLACT	-0.0276	0.0001	1206.2	<0.0001	0.973	0.971	0.974
SGILT	0.0255	0.0022	135.5	<0.0001	1.026	1.021	1.03
AGEFF	-0.0105	0.0169	0.3813	0.5369	0.99	0.957	1.023

[a] Number of observations=7,885.

[b] See Table 4 and 5 for acronym definitions.

Table 14. [a]Estimated hazard ratios for birth litter performance, adjusted backfat and growth rate and first parity performance for lifespan.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
P1NBA	0.4323	0.0391	122.1	<0.0001	1.541	1.427	1.664
LPNB	-0.0309	0.0383	0.65	0.4210	0.97	0.899	1.045
Pnba	0.0369	0.0332	1.2	0.2670	1.038	0.972	1.108
Pborn	0.0459	0.0332	1.9	0.1672	1.047	0.981	1.117
PBF	-0.0848	0.0177	22.9	<0.0001	0.919	0.887	0.951
Devdays	-0.0479	0.0187	6.6	0.0105	0.953	0.919	0.989
Herd-Year	0.0006	0.0001	38.76	<0.0001	1.001	1.001	1.001
SNBA	-0.0862	0.0015	3450.5	<0.0001	0.917	0.915	0.92
AGEFF	0.1016	0.0183	31.1	<0.0001	1.107	1.068	1.147

[a]Number of observations=5,963.

[b]See Table 4 and 5 for acronym definitions.

Table 15. [a]Estimated hazard ratios for first parity performance for herdlife.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
AGEFF	-0.1371	0.0137	100.5	<0.0001	0.872	0.849	0.896
P1LACT	-0.0136	0.0159	0.74	0.3940	0.986	0.956	1.018
P1gilt	-0.1047	0.0269	15.1	0.0001	0.901	0.854	0.949
P1grat	0.1266	0.0214	35.1	<0.0001	1.135	1.088	1.183
P1NBA	-0.1459	0.0299	23.9	<0.0001	0.864	0.815	0.916
SNBA	-0.0166	0.0014	126.3	<0.0001	0.984	0.981	0.986
SLACT	0-0.0153	0.0007	510.5	<0.0001	0.985	0.984	0.986
SGILT	0.0157	0.0016	93.14	<0.0001	1.016	1.013	1.019
Herd-Year	0.0008	0.0001	75.3	<0.0001	1.001	1.001	1.001
LPNB	0.0127	0.0283	0.20	0.6537	1.013	0.958	1.071

[a]Number of observations=12,307

[b]See Tables 4 and 5 for acronym definitions.

Table 16. [a]Estimated hazard ratios for birth litter and first parity performance for herdlife.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
PNBA	-0.1155	0.0302	14.7	0.0001	0.891	0.84	0.945
Pborn	0.1112	0.0302	13.6	0.0002	1.118	1.053	1.186
P1gilt	-0.0046	0.0206	0.05	0.8241	0.995	0.956	1.036
P1NBA	-0.0496	0.0232	4.6	0.0326	0.952	0.909	0.996
Herd-Year	0.0008	0.0001	60.8	<0.0001	1.001	1.001	1.001
SNBA	-0.0238	0.0017	197.3	<0.0001	0.984	0.983	0.986
SLACT	-0.157	0.0008	414.8	<0.0001	0.984	0.983	0.986
SGILT	0.0198	0.0021	86.5	<0.0001	1.021	1.016	1.024
AGEFF	-0.1152	0.0171	45.3	<0.0001	0.891	0.862	0.922

[a] Number of observations=7,885.

[b] See Table 4 and 5 for acronym definitions.

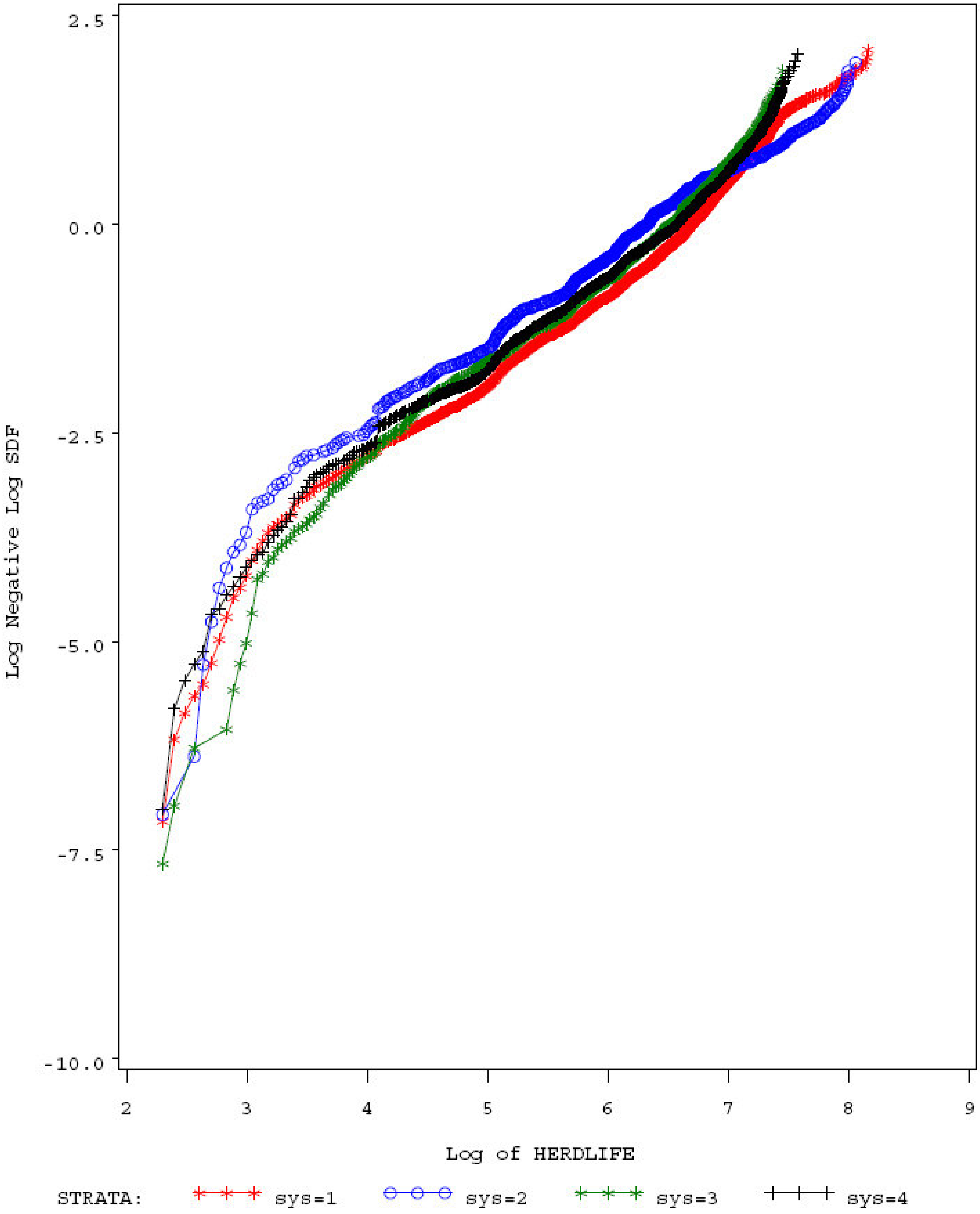
Table 17. [a]Estimated hazard ratios for birth litter performance, adjusted backfat and growth rate and first parity performance for herdlife.

[b]Variable	Parameter Estimate	Standard Error	Chi-Square	Prob. > Chi-Square	Hazard Ratio	95% Hazard Ratio Confidence Limits	
P1NBA	0.0234	0.0386	0.37	0.5446	1.024	0.949	1.104
LPNB	0.0399	0.0384	1.1	0.2984	1.041	0.965	1.122
Pnba	-0.0636	0.0327	3.8	0.0515	0.938	0.88	1.00
Pborn	0.1193	0.0329	13.1	0.0003	1.127	1.056	1.202
DevBF	-0.0186	0.0177	1.1	0.2955	0.982	0.948	1.016
Devdays	-0.0806	0.0186	18.67	<0.0001	0.923	0.889	0.957
Herd-Year	0.0012	0.0001	115.40	<0.0001	1.001	1.001	1.001
SNBA	-0.0432	0.0008	2815.6	<0.0001	0.958	0.956	0.959
AGEFF	0.0181	0.0184	0.96	0.3233	1.018	0.982	1.056

[a] Number of observations=5,963.

[b] See Table 4 and 5 for acronym definitions.

Figure 1. Survivor Functions of herdlife[a].



[a]A straight line indicates that the Weibull function fits the data and parallel lines of different stratums indicate that one baseline hazard function for the data can be assumed .

Figure 2. Estimated Heritability for Herdlife