Livestock Science 170 (2014) 193–202

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Relationships among sow productivity traits within purebred and crossbred litters

R.L. Cutshaw [a], A.P. Schinckel [a,*], M.M. Schultz [a], J. Fix [b], M. Brubaker [c], M. Einstein [a]

[a] Purdue University, West Lafayette, IN 47907, United States
[b] National Swine Registry, West Lafayette, IN 47906, United States
[c] Whiteshire Hamroc LLC., Albion, IN 46701, United States

A R T I C L E I N F O

Article history:
Received 6 May 2014
Received in revised form
7 October 2014
Accepted 8 October 2014

Keywords:
Swine
Birth weight
Weaning weight
Loin muscle area
Days to market

A B S T R A C T

The purpose of this study was to evaluate the relationships of litter weaning weight (LWW), number weaned (NW), mean pig weaning weight (PWT), litter birth weight (LBW), and survival percentage (%S) with number after transfer (NAT) and number born alive (NBA) on purebred and crossbred litters. Data consisted of purebred Duroc (29,297), Landrace (34,177), and Yorkshire litters (40,301) as well as Yorkshire × Landrace (8061) and Landrace × Yorkshire (4028) crossbred litters. The data were distributed into 4 time periods of 1980 through 1997, 1998 through 2002, 2003 through 2008, and 2009 through 2011. All variables were initially modeled with the fixed effects of litter breed, period, NAT, farm, parity-age class (P-AC) groupings and interactions, and random effects of sow and contemporary group. Non-significant variables and interactions ($P > 0.05$) were removed from final models. Periods 1 and 2 as well as 3 and 4 were combined based on non-significant main effects and interactions. The effect of NAT on LWW differed by time period ($P < 0.01$) such that heavier litters were achieved at larger litter sizes (NAT > 11) in Landrace and Yorkshire litters ($P < 0.05$) in period 2. Mean PWT decreased as NAT increased with less effect on PWT during the second time period. Also %S decreased in a linear fashion from 6 to 12 NAT then decreased at an increasing rate for NAT > 12, with a slight increase in %S over time for all breeds. Number weaned increased in a linear fashion up to NAT equal to 11 then increased at a decreasing rate to a maximum value depending on breed; above that value of NAT, NW decreased. There were no significant ($P > 0.05$) NBA by parity interactions for traits that were measured after processing and transfer. In every statistical analysis, farm was a significant and major source of variation. Also %S, and NW were greatly affected by NAT, and LBW was greatly affected by total number of pigs born (TNB). As litter size increases, greater emphasis should be placed on preweaning survival. The data indicate the effects of NAT on LWW, and PWT should be revaluated periodically.

1. Introduction

Sow performance records are important for monitoring and quantifying commercial production levels and for genetic selection. Sows should farrow a greater number of live piglets (NBA) to reduce the cost of each piglet at birth, although increasing the litter size has an adverse effect on piglet birth weight (PBW) and weaning weights (PWT) (Roehe, 1999; Quiniou et al., 2002; Fix et al., 2010a). Swine producers aim to wean a larger number of pigs by reducing the number of stillbirths and maximizing the survival of piglets born alive (Le Dividich, 1999). Genetic improvement made in the past can be attributed to the

* Correspondence to: Purdue University, 915 W. State St., Rm. 3-231, West Lafayette, IN 47907, United States. Tel.: +1 765 494 4836.
E-mail address: aschinck@purdue.eud (A.P. Schinckel).

http://dx.doi.org/10.1016/j.livsci.2014.10.007
1871-1413/

development of statistical methods used to remove and overcome many non-genetic sources of variation from field data (Bourdon, 1998). Number weaned (NW) data has typically been adjusted by using a grouping that consists of the parity of the dam, as well as the as the number of piglets on the litter after cross fostering 24 h after birth (NAT, Brubaker et al., 1994; Culbertson et al., 1997). An underlying trait associated with NW is the percentage of piglets the sow is allowed to nurse (NAT) that survive to weaning (%S). Piglet survival is affected by several environmental factors (Stansbury et al., 1987; Kuhlers et al., 1989). Preweaning survival is a measure of the mothering ability of dam.

Heavy pigs at weaning tend to grow faster (Lawlor et al., 2002; Schinckel et al., 2009c) than their lighter counterparts. Lighter pigs at birth and weaning tend to grow more slowly, and have a greater mortality rate from weaning to market than heavier pigs at birth and weaning (Fix et al., 2010b; Schinckel et al., 2010a). Litter weaning weight (LWW) must be adjusted to a standardized age to allow for accurate genetic comparisons of individual animals (Bereskin and Horton, 1982). For genetic selection of animals, LWW must be adjusted for number after transfer (NAT), and the age of the dam. Twenty-one day litter weight is a good indication of a sow's milking ability (Wood et al., 1990). Litter size and milk production have steadily increased over the past decades (Revell et al., 1998; Bergsma et al., 2008). It is likely that the relationships of LWW and individual piglet weaning weight with weaning age, litter size and birth weight have changed with genetic selection.

It is important for producers to understand the relationships among these sow productivity traits to evaluate alternative management practices. Also non-genetic factors associated with sow productivity must be accounted for in genetic evaluation. An earlier study (Brubaker et al., 1994) suggested that the relationships amongst these traits have likely changed based on a variety of factors including, changes in management and genetic selection. Also the future direction of genetic selection programs should consider the relationships amongst these factors and sow performance to maximize the profitability of the pork production system (Stewart et al., 1991; Bergsma et al., 2008).

The objectives of this study were to evaluate the relationships amongst sow productivity traits in purebred and crossbred litters and to what extent the relationships have changed with time.

2. Materials and methods

Data were collected from 14 of the largest US purebred swine producers. The data had been submitted to the STAGES program of the National Swine Registry (Stewart et al., 1991). The dataset consisted of purebred Duroc (29,297), Landrace (34,177), and Yorkshire litters (40,301) with Yorkshire sire by Landrace dam (8061) and Landrace sire × Yorkshire dam (4028) crossbred litters. All 14 farms had purebred Yorkshire and Landrace data. Eight farms had purebred Duroc data. Only two farms had crossbred litter data. The data was divided into four time period to evaluate changes in relationships amongst the sow productivity traits over time, to evaluate if different adjustments are needed over time as the mean performance of the sows may change. Initially, the 4 time periods were from 1986 through 1997, 1998 through 2002, 2003 through 2008, and 2009 through 2011. The four time periods represent each represent approximately one quarter of the overall number of observations. Data that did not include birth date were deleted as were LBW's that were missing, and any litters that were determined to have a %S of greater than 1.00 were removed. The data were further edited to include only litters where the recorded value for number born alive (NBA), number after transfer (NAT), and total number born (TNB) were greater than 5 and a maximum values of 18 used for NBA, 16 for NAT, and 10 for parity. The number of crossfostered piglets was not included in the data.

Sow productivity traits were NBA, litter birth weight (LBW), number of pigs weaned (NW), survival percentage (%S), piglet weaning weight (PWT), and litter weaning weight (LWW). The number after transfer (NAT) was recorded as the number of piglets on the litter after cross fostering 24 h after birth. Mean piglet weaning weight was calculated from the data as LWW/NW, %S was calculated by NW/NAT, and mean piglet birth weight (PBW) was calculated similarly using LBW/NBA. Litter birth weight was collected on the farm as only piglets that were fully formed, live piglets. The breeding date of each sow was determined by taking the birth date of the litter and subtracting a constant of 114 days. A variable was created and called Parity-Age class grouping (P-AC) which was determined by taking the age of the sow at breeding and combining it with the parity for the sow. In preliminary analyses sows of each parity-age were split up into four age classes. Different contiguous age groups that were not significantly different ($P > 0.05$) based on a Student–Newman–Keuls test were combined.

Data were analyzed using the PROC MIXED procedure in SAS (SAS, 2012). The models for the sow productivity traits of NBA, LBW, and PBW were included the main effects of farm, dam breed (DB), period (TIME), P-AC, TNB, with all two and three way interactions, later non-significant interactions were removed from final models. Models for litter birth weight and mean piglet birth weight also included the effect of total born as a covariate. The models for number weaned, litter weaning weight and piglet weaning weight also included the effect of NAT. The models included the random effects of contemporary group (week to two week time period within each farm) and sow. When significant ($P > 0.05$) differences were found for main effects, means for the effect were evaluated using the Student–Newman–Keuls multiple range test.

The LWW data was adjusted for weaning age (wage) of the litter by the use of the equation based on the relationship of wage and the Least squares means of LWW:

$$\text{LWW} = actual \times (2.3967 - 0.0951 \times \text{wage} + 0.0014 \times \text{wage}^2),$$

where LWW is the adjusted value for LWW, *actual* is the reported weaning weight of the litter; wage is the weaning age (d) of the litter. The regression of the least squares means for each weaning age had an R^2 value of 0.9962. The sow productivity traits of NW, %S, LWW, and PWT were modeled with main effects of farm, dam breed (DB), TIME, P-AC, NAT and all two and three way interactions, later