Livestock Science 154 (2013) 184–192

Contents lists available at SciVerse ScienceDirect

Livestock Science

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

Estimation of deviations from predicted lactation feed intake and the effect on reproductive performance

C.L. Yoder [a], C.R. Schwab [c], J.S. Fix [d], K.J. Stalder [a], P.M. Dixon [b], V.M. Duttlinger [e], T.J. Baas [a,*]

[a] Department of Animal Science, Iowa State University, Ames, IA 50011-3150, USA
[b] Department of Statistics, Iowa State University, Ames, IA 50011-3150, USA
[c] The Maschhoffs, Carlyle, IL 62231, USA
[d] National Swine Registry, West Lafayette, IN 47906, USA
[e] Tempel Genetics, Gentryville, IN 47537, USA

ARTICLE INFO

Article history:
Received 22 January 2013
Received in revised form
11 March 2013
Accepted 12 March 2013

Keywords:
Feed intake
Lactation
Studentized residual
Sow

ABSTRACT

The objectives of this study were to quantify significant negative deviations (DEV) from predicted daily lactation feed intake values and to estimate their effect on reproductive performance and subsequent intake in purebred and F1 sows. Daily lactation feed intake (LFI) records from day 1 to 22 of lactation from purebred Yorkshire ($n=1587$ parity records), purebred Landrace ($n=2197$ parity records), and reciprocal cross F1 ($n=6932$ parity records) females were used to predict daily LFI values. The mixed model included fixed effects of breed, season, parity group (1, 2, 3 and ≥4), day of lactation, and interactions of day with breed and parity group, and a covariate of litter size after cross-fostering. Random effects included litter, contemporary group (herd–year–month), dam, and sire nested within breed. Deviations from predicted LFI values were quantified using an internally studentized residual (SR). A SR≤−1.71, equivalent to observed LFI at least 1.9 kg less than predicted, was considered a DEV. Zero DEV occurred in 60% of lactation records, while 18% of lactation records had 1 DEV, and 22% of lactation records had ≥2 DEV. Thirty-four percent of negative deviations occurred during the summer months (June, July, August) which was more frequent when compared to the spring (26%), fall (23%), and winter (17%) months. Adjusted 21-day litter weaning weight (LW21) decreased as the number of DEV increased within a single lactation period, and wean-to-first service interval (WTSI) increased when at least 3 DEV occurred within a single lactation. An increase in DEV during early lactation did not affect LW21 or WTSI ($P>0.05$), though an increase in number of DEV after day 5 of lactation was associated with lower LW21 and longer WTSI. Odds of a negative deviation from predicted LFI occurring on any given day of lactation were estimated as odds ratios. If a DEV occurred the prior day, a DEV was 8.7 and 39.5 times more likely to occur than if a DEV had not occurred for purebred and F1 sows, respectively. In F1 sows, a DEV was 3.1 ($P<0.01$) times more likely to occur after day 5 of lactation when a DEV occurred on day 1 to 5 of lactation. Negative deviations from predicted LFI values decreased reproductive performance and had a larger effect on performance when they occurred during late lactation.

1. Introduction

Lactation feed intake (LFI) affects reproductive performance; specifically, studies have been completed that quantify the relationship between lactation feed intake and traits

* Correspondence to: 109 Kildee Hall, Iowa State University, Ames, IA 50011-3150, USA. Tel.: +1 515 294 6728; fax: +1 515 294 5698.
E-mail address: tjbaas@iastate.edu (T.J. Baas).

1871-1413/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.livsci.2013.03.012

highly related to profitability, including litter weaning weight and wean-to-first service interval (Eissen et al., 2003). During lactation, feed intake and body reserves are the only nutrient sources available for maintenance and milk production and the change of one directly affects the other (Ball et al., 2008). However, feed intake during lactation is frequently inadequate and does not meet the nutrient requirements for the sow and litter, which results in mobilization of body reserves to maintain milk production levels (Noblet et al., 1990). Increasing feed intake during lactation is one solution to minimize the mobilization of body reserves and improve sow and litter performance. Heavier weaning weights are economically valuable as heavier pigs at weaning require less feed during finishing and have a greater growth rate (Cabrera et al., 2010). Slower rate of increase in feed intake during lactation is associated with lower 21-day litter weaning weights (Yoder et al., 2012) and sows with lower average daily feed intake during lactation have litters with lower pre-weaning growth rates (Eissen et al., 2003; Koketsu and Dial, 1997). Inadequate LFI leads to decreased body weight, back-fat depth, luteinizing hormone level and pulse frequency, prompting longer wean-to-estrus intervals (Koketsu et al., 1998). Extended wean-to-estrus intervals, and the sow's ability to re-breed, are the most common reasons for culling from the breeding herd (Engblom et al., 2007; Stalder et al., 2004) and decreased LFI increases the likelihood of a sow being culled (Knauer et al., 2010). Sows in a commercial herd with inadequate feed consumption, or those that consumed no feed during a single day during the first 2 weeks of lactation were more likely to be removed from the breeding herd after weaning (Anil et al., 2006). However, required daily intake varies and is impacted by day of lactation, parity, breed, season, litter size, diet composition, sow management methods, and between populations. Thus, the definition of inadequate intake is system dependent and varies within the industry. A significant deviation from predicted daily LFI can affect performance and occur more frequently in young sows (Schinckel et al., 2010). Variation of observed LFI from predicted LFI values has been associated with reduced 21-day litter weaning weight and longer wean-to-first service intervals (Yoder et al., 2012). The objectives of this study were to quantify significant negative deviations from predicted daily LFI values, estimate the effect of negative deviations from predicted LFI on reproductive performance, and evaluate the impact of a negative deviation on subsequent intake throughout lactation in purebred and F1 sows.

2. Materials and methods

2.1. Animals and data collection

Daily lactation feed intake (LFI) from 10716 parity records was collected on purebred Yorkshire ($n=1587$ parity records), purebred Landrace ($n=2197$ parity records), and Landrace × Yorkshire or Yorkshire × Landrace ($n=6932$ parity records) F1 sows. Data were recorded from January 2007 through March 2011 from sows in 3 production units representing the nucleus, multiplier, and commercial levels of a single genetic system. Records from sows of parity >10 or lactation length (LL) <15 days or >25 days were removed from the data set. The distribution of lactation records by parity, season, and LL were reported by Yoder et al. (2012).

Collection of daily LFI records began post farrowing on sows housed in individual stalls in a totally enclosed, confinement environment. Purebred sows were hand fed 5 times per day and F1 sows were hand fed 2 times per day. Remaining feed was estimated the following morning and subtracted from the previous day's total to calculate daily LFI values. Sows were fed to appetite throughout lactation with increased feed availability when all feed was eaten during the previous feeding. Litter size (LS) was recorded as the number of pigs nursing after cross-fostering (within 24 h post farrowing) occurred. Number of pigs weaned and litter weaning weight were recorded at weaning. Wean-to-first service interval (WTSI) was recorded on sows that remained in the breeding herd for the next lactation.

2.2. Statistical analysis

Predicted values for daily LFI in purebred and F1 sows were estimated with a mixed model using the HPMIXED procedure in SAS (SAS Inst. Inc., Cary, NC). Due to a low number of records that exceeded 22 days of LFI, only day 1 through 22 of lactation were used for prediction of daily LFI values. The model for observed daily LFI included fixed effects of breed, season, parity group (PG), day of lactation, and interactions of day of lactation with breed and PG; a linear covariate of LS, and random effects of litter, contemporary group (herd–year–month), dam of the sow, and sire of the sow nested within breed. Initial analysis included parity as a fixed effect; however, there were no differences ($P>0.05$) in daily LFI values after parity 4 and the final prediction model included the following 4 PG: parity 1, 2, 3 and ≥4.

Lactation feed intake curves were classified into periods of intake based on the shape of the LFI curves and the rate of change in intake between 2 consecutive days. Difference in intake between 2 consecutive days was analyzed utilizing the same mixed model developed for prediction of daily LFI values. Contrast of LS means for day-to-day change in intake (DC) resulted in classification of the LFI curve into different periods for F1 and purebred populations; however, Yorkshire and Landrace LFI curves did not differ ($P>0.05$) and were analyzed together. Evaluation of DC resulted in the following classifications for purebred lines: day 1–6 (PB1), day 7–10 (PB2), day 11–18 (PB3), and for F1 sows: day 1–5 (C1) and day 6–18 (C2). Due to a limited number of observations in late lactation, LFI data from days 19 to 22 were not included. All analyses were conducted separately for purebred and F1 populations due to the distinction of periods of lactation elapsing different days of lactation. Yoder et al. (2012) provides a detailed explanation of analyses used for prediction of daily LFI and LFI period classification.

2.3. Quantifying negative deviations from predicted LFI values

Internally studentized residuals (SR) corresponding to each predicted daily LFI value ($n=195656$) were produced by the HPMIXED procedure in SAS (SAS Inst. Inc., Cary, NC). Studentized residuals are residuals converted to a scale