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Effects of different levels of feed intake during four short periods of gestation and housing systems on sows and litter performance

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ABSTRACT

The current study investigated the effects of different levels of feed intake during 4 short periods of gestation and of housing systems on sow and litter performance. A total of 255 multiparous sows were allotted to 1–4 dietary treatments using a randomized complete block design blocking by initial body weight (BW), backfat (BF) and parity. Sows were housed either in individual stalls (n = 129) or group pens (n = 126) with 55 sows in each pen with electronic sow feeder during gestation. All sows were fed one common corn-soybean meal-based diet with the amount of 1.0 × maintenance energy level of feed intake (106 × $BW^{0.75}$) throughout gestation except 4 periods of 7 d when dietary treatments were imposed on day 27, 55, 83 and 97 of gestation. During the 4 periods, sows were fed 1 of 4 different levels of feed intake: 0.5, 1.0, 1.5 and 2.0 × maintenance energy level (0.5 M, 1.0 M, 1.5 M and 2.0 M, respectively). Results showed that both BW gain and BF change during gestation for sows on 1.5 M (49.7 kg and 3.1 mm, respectively) and 2.0 M (52.5 kg and 3.7 mm, respectively) levels of feed intake were significantly ($P < 0.01$) greater than sows on 0.5 M (26.1 kg and −0.1 mm, respectively) and 1.0 M (35.6 kg and 0.1, respectively) levels of feed intake. In contrast, lactation weight gain for sows on 1.5 M (3.3 kg) and 2.0 M (3.4 kg) levels of feed intake during 4 short periods of gestation were significantly ($P < 0.01$) less than sows on 0.5 M (18.4 kg) and 1.0 M (11.4 kg) levels of feed intake during 4 short periods of gestation, whereas BF loss during lactation for sows on 1.5 M (−3.6 mm) level of feed intake during 4 short periods of gestation were significantly ($P = 0.03$) higher than sows on 1.0 M (−2.1 mm) level of feed intake during 4 short periods of gestation. Additionally, average daily feed intake during lactation for sows on 0.5 M (6.6 kg/d) level of feed intake during gestation tended ($P = 0.06$) to be greater than sows on 2.0 M (5.9 kg/d) level of feed intake. There were no differences ($P > 0.1$) among 4 levels of feed intake in terms of numbers of total born and weaning piglets. However, both piglet weight at birth (1.46, 1.52, 1.53 and 1.51 kg for piglets from sows on 0.5 M, 1.0 M, 1.5 M and 2.0 M levels of feed intake during gestation, respectively) and at weaning (6.37, 6.55, 6.64 and 6.38 kg for piglets from sows on 0.5 M, 1.0 M, 1.5 M and 2.0 M levels of feed intake during gestation, respectively) were maximized at 1.5 M level of feed intake. Sows housed in group pens had greater ($P < 0.01$) net BW gain (24.7 vs. 19.2 kg) from day 27 of gestation to weaning compared with sows housed in individual stalls. However, there were no differences ($P > 0.1$) between the 2 housing systems in terms of litter size and piglet weight at birth and at weaning. In conclusion, increasing levels of feed intake during 4 short periods of gestation increased BW and BF gain during gestation and led to less BW gain and more BF loss during lactation. Piglet weight at birth and at weaning was maximized at 1.5 M level of feed intake. However, housing systems did not affect

Abbreviations: BW, body weight; BF, backfat; ADG, average daily gain; ADFI, average daily feed intake; GP, group pen; IS, individual stall

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reproductive performance. Group pen housing system may be beneficial in terms of increased overall BW gain during gestation and lactation.

1. Introduction

Enhancing reproductive performance through nutrition and management strategies in gestating and lactating sows has been the research interest for several decades. It has been proposed that maintaining an ideal body condition throughout a sow lifetime is essential for maximizing reproductive performance and sow longevity (Young et al., 2004). However, modern crossbred sows have been shown to gain adequate body weight over the reproductive cycle while simultaneously losing a considerable amount of fat mass during lactation (Dourmad, 1991; Young et al., 2004), which may compromise subsequent reproductive performance (Lawlor and Lynch, 2007).

Different levels of feed intake during certain periods of gestation (Musser et al., 2006; Lawlor et al., 2007; Heo et al., 2008; McNamara et al., 2008; Cerisuelo et al., 2009; Hoving et al., 2011b; Ren et al., 2017a,b) or whole gestation (Dourmad, 1991; Amdi et al., 2013) have been conducted to evaluate their effects on gilt/sow and litter performance in one or several reproductive cycles. These studies consistently showed that increasing levels of feed intake during gestation increased sow body weight gain during gestation, but caused sows to lose more body weight and backfat during lactation, with inconsistent results for litter performance.

Uterine capacity can be defined as the relative surface area of placental endometrial attachment required to support the nutrient requirement of an individual fetus throughout gestation (Ford et al., 2002). Uterine crowding would exert detrimental effect on fetal development through the insufficient development of placental vascularization (Argente et al., 2006), which would be the major limitation to litter size (Ford et al., 2002). Placental efficiency can be measured as the ratio of fetal weight to placental weight (Biensen et al., 1998), which varies depending on the size of placenta, various aspects of placental development such as depth of folds, increased complexity of epithelial bilayer and the distance between the maternal and fetal capillaries (Friess et al., 1980). Maternal nutrition during gestation, especially the amount of nutrients provided to fetus via utero-placental circulation and umbilical vein, would affect the placental efficiency and therefore the growth rate of fetus through modulation of placental lipid and energy metabolism (Wu et al., 2004; Che et al., 2017).

It is known that epitheliochorial placenta is established around day 26–30 of gestation in pregnant sows (Dantzer, 1985) and 10–15% of conceptus are lost during day 30–40 of gestation (Ford et al., 2002). Additionally, modification of feed intake/energy intake during early gestation (d 0–50; Bee, 2004) and mid gestation (d 45–85; Cerisuelo et al., 2009) can modify the ratio of secondary to primary muscle fibers in progeny, which can eventually influence postnatal growth performance and carcass quality of pigs (Amdi et al., 2013, 2014). Furthermore, fetal growth increases dramatically in the last third of gestation (Biensen et al., 1998). In our former study, we examined the effect of modification of feed intake during 3 critical periods of gestation (day 27–34, day 55–62, day 83–90) in short term (1 wk) on gilt/sow and litter performance (Ren et al., 2017a,b). These two studies showed that increasing levels of feed intake during these 3 short periods of gestation increased piglet birth weight, but did not affect piglet weaning weight and numbers of piglets at birth and at weaning. We hypothesized that extending the experimental period for one more week in the late gestation (day 97–104) could exert more impact on fetal development, which may eventually affect litter performance at birth and at weaning. Therefore, the first objective of this study was to investigate effect of different levels of feed intake during 4 critical periods of gestation in short term (day 27–34, day 55–62, day 83–90 and day 97–104, respectively) on sow and litter performance.

Housing systems for gestating sows have become the research interest in recent years. Similar reproductive performance was found for sows housed either in group pens or in individual stalls (Anil et al., 2005). However, Li et al. (2014) reported that long-term housing of sows in group pens decreased litter size and sow longevity, which may be due to the fact that sows moved the group pens one week after breeding and the sows in group pens were managed in a dynamic manner, with sows adding to the group pens at different time points. Our previous studies demonstrated that energy and nutrient digestibility were affected by levels of feed intake during gestation (Ren et al., 2017b). It is also known that sows housed in group pens exhibited higher activity levels compared with sows housed in individual stalls (Salk-Johnson, 2017). We hypothesized that levels of feed intake during periods of gestation may interact with gestation housing systems on sow and litter performance. Therefore, the second objective of this study was to examine the interaction effects of different levels of feed intake during four short periods of gestation and housing systems on sow and litter performance.

2. Materials and methods

The Institutional Animal Care and Use Committee of University of Minnesota approved the experimental protocol used in this study.

2.1. Animals and management

The current experiment was conducted at the Southern Research and Outreach Center, University of Minnesota in Waseca, MN. A total of 255 (parity 2: n = 44, parity 3: n = 43, parity ≥4: n = 168) multiparous Large White × Danish Landrace crossbred sows (Topigs 20, Topigs Inc.; Winnipeg, Manitoba, Canada) in 5 batches were used and artificially inseminated twice during each estrus