IMPACT OF LAMENESS ON PRODUCTIVE POTENTIAL OF THE SOW

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ABSTRACT
The quest for efficient production of pork protein to be able to feed a growing population is critical for the pork industry. A disease that causes a large impact on cost and efficiency of production is lameness. This disease is like a stealthy thief. The losses from this disease often go unnoticed or recognized. The consequences are larger in proportion than most producers are aware.

Lameness is one of the major reasons for culling in gilts and sows. There are several causes of lameness such as arthritis, osteochondrosis, disease and claw lesions to name a few. This article will focus on claw lesions as a cause of lameness. Claw lesions become problematic when the lesions are severe enough that they penetrate the horn wall into the corium causing inflammation and pain. When these conditions exist they impact productivity. A survey taken in 2007 showed that lameness accounts for greater than 15% of the animals that are culled. This number is likely underestimated because animals that are culled for reproductive reasons and for age are also often lame. Besides concerns for welfare of the animals, culling due to lameness impacts herd dynamics and reduces productivity.

Evaluation of many herds will show that the losses or removal due to lameness occur as a gilt and first parity. Generally, the value of herd replacement gilts is not paid for until they have had at least three litters. For each additional litter that a sow can have above the third litter dramatically reduces the fixed cost of piglet production. Factors that improve longevity such as prevention of claw lesions have a large economic impact on the production system. Data shows we can heal and reduce claw lesions by feeding organic minerals. The more important fact is to feed and attend to the management issues that help prevent claw lesions and lameness thus improving longevity. As replacement rates are reduced herds become immunologically more stable and productivity improves.

INTRODUCTION
The level of productivity in a breeding herd is influenced by a number of factors including: genetics, nutrition, health status, housing gilt development, stockmanship and management. Depending on how these factors are managed, the resulting level of performance and productivity achieved by the sow herd can vary significantly. Consumer demand for ethical animal treatment and welfare, concerns for food safety, and interests in reducing the use of antibiotics and growth promoters all impact nutritional decisions. Often we measure the success of feeding programs by the changes to individual sow performance and forget about looking at changes in overall herd performance when altering a production stressor. In reproduction, it is usually not a single factor that drives significant change; several small factors in combination add up to significant impacts and the effect is often underestimated in the swine herds. One of the greatest factors to focus on with nutrition is to reduce the potential for inflammatory
responses in gilts and sows and thus increasing longevity of the sow herd. The greatest percentage of culling often occurs in gilts and parity 1 females. This is not only expensive (because of the cost of replacement gilts) but increases the number of gilts brought into the herd, which can increase the potential for a destabilization of health. These gilts’ litters result in a decreased performance and increased post-weaning morbidity (Holyoake, 2006) of the offspring in grow finish performance and decrease herd feed conversion. Parity one litters have been shown to have lower IgG levels in their colostrum (Miller et al., 2009; Geale et al., 2009) and milk. Improving longevity and increasing the number of sows in parity 3-6 has a large impact on overall productivity of the herd (Smits, 2011).

As we design nutritional programs to reduce claw lesions and lameness, and to improve reproductive performance and longevity, we need to consider consumer opinions and pressures. Factors such as markets, world economies, price of commodities, governmental regulations, and ethanol production alter our choices of food stuffs to supply nutrients for pork protein production.

**LONGEVITY AND CULLING DECISIONS**

Removal of non-productive sows along with introduction of replacements is an essential part of maintaining herd productivity at a constant level. In commercial production 40-50% of the sows are removed prior to third and fourth parities (D’Allaire et al., 1987; Boyle et al., 1998). Increasing longevity or reducing sow attrition is an important consideration in commercial pork production because of the cost of gilt replacement.

Benefits from such a program include improvements in:

- litter size,
- life time productivity of sows,
- non-productive days,
- stability of immunity,
- biosecurity risks,
- salvage value of sows,
- production flows,
- welfare issues for the herd.

Faust et al. (1993)’s simulation model has shown that production systems with lower rates of culling are more profitable than farms with higher rates of culling.

Maximum productivity within a herd is generally parities 3 through 5. There is a significant loss of potential herd output, measured in pigs per sow per year, when young parity animals are culled at a high rate. Stalder et al. (2003) estimated that gilts must produce 3 or 4 litters to pay for the cost of replacement of an older sow. Other authors claim that economically optimal lifetime that sows spend in production is the fifth farrowing (Scholmann and Dijkstra, 1989; Rasmussen 2004). Balogh et al. (2007) quantified by an economic model how the production of a sow influences average cost of the piglets and these authors calculated that the fifth parity litter is the lowest cost per pig placed. High incidences of involuntary culling of the younger parities cause problems with the herd parity profile and minimize the ability to cull because of production parameters or age.
Sows leave the herd through death or culling. The goal is to reduce the number of bad culls, due to reproductive failure and lameness at a young age and to increase the number of good culls, culling for age and low productivity in the older sows. Greater focus needs to be placed on the factors that cause involuntary culling of the young parity sows. Correcting flow and performance of the herd when a bimodal distribution of the parity structure occurs is a difficult and expensive fix in commercial production.

A recent study showed that 23% of the culling reasons were judged as recorded inaccurately by the farm workers (Knauer et. al., 2007). However, these listed surveys, and many others, do show trends and areas of emphasis that need to be investigated to see if we can develop management schemes to help prevent early sow removal and thus improve longevity. A trend in these surveys was that young sows (under parity 3) were culled largely due to feet and leg problems and reproductive failure, while parity 6 sows and older were culled mainly due to age and performance. There was a trend for larger farms to have a slightly higher rate of sow removal and death loss compared to smaller farms.

**SOW LAMENESS**

Lameness has long been recognized as a problem in the reproductive herd. Removal of non-productive sows along with introduction of replacements is an essential part of maintaining herd productivity at a constant level. There are both economic and welfare impacts of a lower sow retention rate due to lameness.

Knowledge and understanding of lameness in swine is increasing as more research groups are reporting data. Odds ratios have been reported for sows with elongated claws, claw cracks, heel erosion and overgrowth and uneven toes has been shown to significantly impact the incidence of lameness (Vestergaard et al., 2006; Anil et al., 2008). Lameness increases odds ratios of early removal and has shown a highly significant decrease in sow productivity due to lameness (Anil et al., 2008).

One of the obvious consequences of lameness is pain and inflammation causing a reduction of feed intake. If a younger parity sow does not eat well they generally have reduced reproductive performance. The reduction in energy and protein consumption during lactation may disrupt or change the amount of signal from the hypothalamus of GnRH, which impacts the amount of release of LH and FSH and subsequently impacts steriodogenesis of the ovary. Often sows or gilts with low intakes in lactation are under conditioned with a body condition score of 1 on a 1-5 scale, with 5 being over conditioned. Sows with inadequate feed intake during lactation increased their odds of removal from the breeding herd (Anil et al., 2006). Inflammatory cytokine-driven responses of the neuroendocrine system are similar and resemble those seen in starvation: reduced thyroid function, reduced levels of GH-dependent peptides, and suppression of gonadal function (Reichlin, 1999). Metabolic response to starvation and severe inflammation essentially cause similar brain signalling and responses to metabolism within the animal. Australian researchers (King and Dunkin, 1986) were some of the first to demonstrate the linear relationship between daily feed intake during lactation and increased time required for sows to express estrus after weaning. Younger first litter gilts were more sensitive to negative effects of reduced feed intake during lactation than older gilts and multiparous sows (Eissenet al., 2003).

Lactation is one of the most energetically expensive and challenging activities that a female can undertake. The reproductive effects of inadequate lactation feed intake seems to be mediated, at
least in part, through LH secretion and embryo mortality (King and Martin, 1989). Sows with a body condition score (BCS) of 1 have a higher frequency of acyclic ovaries than sows with a BCS of 4. It is reasonable that some of the body weight loss was due to increased protein loss from these sows. Clowes et al. (2003) reported that body protein mass loss greater than 9 to 12% rapidly reduced ovarian function. Protein restriction throughout lactation alters circulating concentrations of somatotrophic hormones and insulin at the end of lactation and negatively impacts post weaning ovulation rate (Mejia-Guadarrama et al., 2002). Limited follicular development and incomplete recovery of the reproductive axis at weaning seem to be the most likely causes of decreased embryonic survival in second parity sows with earlier weaning age (Willis et al., 2003). A low feed intake during lactation involves mobilization of body tissues and can lead to an excessive loss of body weight, reducing sow longevity (Gaughan et al., 1995) and reproductive performance (Quesnel, 2005). Prevention and early treatment of lameness and claw injuries will help maintain appetite and feed consumption.

INFLAMMATORY RESPONSES

Severe tissue injury induced a relatively stereotypical pathophysiologic response manifested by fever, catabolism, and sickness behaviour. All organ systems are altered by acute and chronic inflammatory states. Activation of inflammatory cytokines by toxins or products of cell injury leads to a variety of metabolic and endocrine changes, mediated in part by the direct action of cytokines on tissue function and by changes in pituitary-endocrine end organ function (Reichlin, 1999). Many of the claw lesions and injuries fall into these inflammatory type wounds. Investigating the possible mechanisms for these lameness and foot injuries impacting reproduction becomes quite plausible when one sees how lack of nutrients cause some of the same responses as an inflammatory response due to cytokine release. Is it any wonder that we see more sows abort or absorb embryos, decreased litter sizes born, and a lack of return to estrus when sows are severely lame? Organ systems are altered by acute and chronic inflammatory states. In livestock production most recognize the dramatic changes to acute phase responses where dramatic changes occur in liver function such as suppression of albumin, transferrin and ceruloplasmin and increased synthesis of proteins such as fibrinogen and C-reactive protein (Dinarello and Wolff, 1993). When an animal gets an insult or injury most of the changes that happen in the body are mediated by a cascade of polypeptide molecules called inflammatory cytokines. These cytokines are released from immune barrier functioning cells such as endothelial cells, specialized immune cells such as lymphocytes, monocytes, macrophages and several other types of parenchymal cells. Examples of some of these cytokines that are released are interleukin (IL)-1, IL-2, IL-6 just to name some of the first ones identified. In addition, tumor necrosis factor-alpha (TNF-α), interferon-gamma (INF-γ) and several other cytokines with anti-inflammatory activity such as IL-10, IL-1 receptor antagonist, transforming growth factor-B all work in a synergistic reaction to regulate body metabolism to get the animal to survive. One of the major impacts of cytokines is a profound change in neuroendocrine function during inflammatory disease (Reichlin, 1993; Wilder 1995).

The release of cytokines also causes a decrease in GnRH which reduces the amount of FSH and LH released from the pituitary. A severe inflammatory response from a wound may release large amounts of cytokines such as TNFα which cause a direct effect on the ovary. The effect on the ovary will cause a reduction in steroidogenesis and even apoptosis of the ovarian cells and the pregnancy will be lost. The most common reproductive anomaly found (9%) when harvesting
reproductive tracts from cull sows was acyclic ovaries (Knauer et al., 2007). The occurrence of acyclic ovaries increased (P<0.05) as Body Condition Score (BCS) of the sow decreased. Acyclic ovaries were also positively correlated (P<0.01) with rear foot abscesses. Again we see a correlation between lameness and reproductive problems as acyclic ovaries increase in sows with rear foot abscesses. Not all sows with claw lesions will see changes in appetite and feed consumption. The injury must be inflammatory to see the responses described above.

**NUTRITIONAL INTERVENTIONS TO REDUCE LAMENESS**

Tomlinson et al., (2004) has written an excellent review of how the impact of nutrition, protein, energy, macro minerals, trace minerals and vitamins have been implicated in maintaining claw health. An eight trial summary shows an improvement in feet lesion scores, improved milk production and improved reproductive performance in dairy cattle (Siciliano-Jones et al., 2008) with the addition of complexed organic minerals from Zinpro Corporation. Claw health is improved in the dairy cow by feeding complexed Zinpro minerals (Noceket al., 2000, Noceket al., 2006). Although further research is needed in sows, these examples suggest that nutrition may play an important role in supporting the immune system and improving lameness and reproductive performance.

When Zn, Mn and Cu as amino acid-complexed minerals were supplemented to sows in a controlled experiment, results showed a decrease in claw lesions of sows housed in gestation crates (Anil et al., 2009). These sows were fed gestation and lactation diets that were identical except for the source of Zn, Mn and Cu where treated animals had a partial substitution with the amino acid-complexed minerals (50 ppm of Zn, 20 ppm Mn, 10 ppm of Cu) with the remainder of total added levels being supplied by sulfates used in control diet (Zn 125 ppm, 40 ppm Mn and 15 ppm of Cu). Results indicated that the sows fed trace minerals as amino acid complexes had less (P<0.05) lesions on the hind limbs than control sows. These sows had fewer lesions on the lateral claws and fewer total number of lesions (P<0.07). Analysis on prevalence of lameness was lower (P<0.05) for the sow fed trace mineral amino acid complexes (34% vs. 51%) over sows fed inorganic trace minerals (Anil et al., 2010a). In this same study, lesion scores were lower (P<0.05) for total lesion score and for total later claw lesion score when sows were fed diets containing trace minerals as amino acid complexes. When reproductive performance was evaluated the treated sows had more (P<0.05) pigs born alive (11.07 ± 0.21 vs. 10.44 ± 0.22) and litter birth weight tended to be higher (P<0.07) (16.99 ± 0.31 vs. 16.16 ± 0.33, kg) (Anil et al., 2010b). In the second examination of side wall cracks of group housed sows in the same experiment, results showed that the sows fed trace mineral amino acid complexes had a higher (P<0.05) proportion of sows with lesions that either improved or stayed the same than the controls (91% vs. 73%) (Anil et al., 2010c).

**CONCLUSION**

Claw health is crucial to the overall well-being of the sow. Claw lesions are an important cause of lameness in sows. Claw lesions that penetrate the corium increase the potential for inflammatory response and are associated with pain, lameness and decreased productivity. If not properly treated, negative claw conditions can lead to lameness and may result in further complications. This causes a devastating loss to swine producers by decreasing reproductive performance and longevity.
Lameness and reproductive failure are two of the most prominent reasons for early removal from the sow herd. Feeding and management to help prevent claw lesions and lameness should begin early in development and selection of gilts. Focusing efforts to improve longevity pay large economic dividends by directly and indirectly reducing whole herd feed conversion, improved pounds of pork per sow space, and growth performance of the offspring.

REFERENCES


