## Sponsors

**University of Minnesota**
College of Veterinary Medicine

College of Food, Agricultural and Natural Resource Sciences

Extension Service

Swine Center

Thank you to **IDEXX Laboratories** for their financial support to reproduce conference proceedings

**Production Assistants**
Steven Claas
Michael Klatt

**Layout and CD-ROM**
David Brown

**Logo Design**
Ruth Cronje, and Jan Swanson;
based on the original design by Dr. Robert Dunlop

# Impact of season on production: transport losses

Mike Ellis, PhD, Matt Ritter, MS
Department of Animal Sciences, University of Illinois

## Introduction

Historically, most of the discussion of seasonal variation in swine production has focused on the breeding herd where there is clear evidence of a major impact of season on performance levels. This topic is addressed in a parallel paper presented at this conference. Undoubtedly, there is seasonal variation in the performance of the growing-finishing herd including losses during transport, however, this area has not been well documented. Transport losses have become of increased interest over recent years because of their economic impact but also because of concerns over animal welfare during transportation. Transportation losses include pigs that die during the journey (deads on arrival; DOA) and those that are non-ambulatory on arrival at the plant. This later group includes injured animals (so-called non-ambulatory, injured pigs; NAI) and non-ambulatory, non-injured animals (NANI). In our experience, the majority of NANI animals exhibit characteristic symptoms of an extreme stress response including open-mouth breathing (dyspnea), skin discoloration (cyanosis), muscle tremors, and a characteristics vocalization. Metabolically, NANI pigs exhibit an acidosis with high blood lactate and low blood pH levels combined with a significant elevation of body temperature. Such animals are also commonly referred to as "fatigued". Interestingly, most fatigued pigs will fully recover if held in a low-stress environment; however, a number do not recover from this condition and will eventually die. There has been no comprehensive investigation of the causes of deaths during transport; however, it is likely that elevated body temperature is centrally involved in causing the deaths of some pigs that initially develop the fatigued syndrome.

## Seasonal incidence of transport losses

USDA-FSIS[1] publish national statistics on the incidence of DOA at US slaughter plants, however, there has been no published analysis of seasonal variation in this incidence. As an aside, there have been some interesting trends in the incidence of DOA over the last 15 years or so. In the early 1990's, the incidence of DOA was relatively low at = 0.10% of pigs transported. The incidence increased dramatically during the mid to late 1990's to ~0.30% and has subsequently declined over the last 3 years or so with the incidence in 2004 being 0.22%. The major reasons for these changes are not clear; there were a number of major developments in the US swine industry during this period that could have impacted the incidence of DOA either positively or negatively.

There are no national statistics available on the incidence of non-ambulatory pigs on arrival at the plant. There are data available from surveys of individual producers and production systems, however, these represent a relatively small proportion of the industry and should be interpreted with caution. We have analyzed a number of data sets relating to historical records from production systems and the results of these analyses generally show a similar seasonal pattern. Not surprisingly, transport losses are generally higher in the hot summer months of July and August than in the spring and fall. What is somewhat surprising; however, is that a high incidence of losses was also observed in the winter months in a number of these datasets. For example, in a summary of one year of transportation data from one production system that involved over 2000 loads and in excess of 360,000 animals,[2] total transport losses (dead and non-ambulatory animals) were greater in the summer and the winter than in the spring and fall (total transport losses = 0.79, 1.13, 0.85, and 1.16% of animals transported in the spring, summer, fall, and winter, respectively). Another analysis of data from approximately 6000 loads and 1 million animals from one production system (Ellis, M., unpublished data) showed that total losses were greatest in the cooler months from November to February with a much less pronounced increase in losses in the summer months. Rademacher and Davies,[3] in a paper published at this conference last year, analyzed data collected over a 4 year period from over 7 thousand loads involving more than 1.3 million animals delivered to 37 slaughter plants. This analysis showed a different seasonal pattern for DOA and "slows" (defined as animals that cannot move off the truck and into the plant without some assistance). The incidence of DOA was highest in the summer months and was lower and relatively similar at other times of the year. In contrast, the incidence of slows (which presumably included NAI and NANI animals) was highest in the fall and winter months (September through to January) than at other times of the year. However, care must be taken when interpreting these results as the authors point out that the definition

of slows was not standardized across the various plants represented in this dataset.

In summary, the limited survey data that are available on seasonal variation in transport losses suggest that losses are generally higher in the summer months and can also be relatively high in the fall/winter months. However, much larger surveys involving a greater number of production systems and slaughter plants are very much needed to clearly establish seasonal patterns in transport losses.

## Potential causes of seasonal variation in transport losses

What are the possible causes of seasonal variation in transport losses and, particularly, the high levels observed during the summer and the fall/winter months? As previously described, NANI pigs which represent a significant proportion of total losses result from an extreme stress response. This leads to an increase in metabolic rate which ultimately results in an abnormally low blood pH and a substantial increase in body temperature. High ambient temperature in the summer is obviously an additional stressor which of itself will increase metabolic rate (through panting activity in heat stressed animals) and elevate body temperature and is likely to increase the incidence of NANI pigs.

However, the increase in transport losses in the colder months of the year is difficult to understand. One potential explanation is that it results from cold stress. Generally speaking, with the exception of the hot summer period, the majority of finishing pigs are reared under thermo-neutral conditions, even in the cold winter months. However, when they are transported in the winter they commonly experience extremely low temperatures, often combined with a substantial wind-chill when the truck is moving. In our experience, it is not uncommon for pigs to experience a temperature decline as extreme as 60oF between the barn temperature and that on the trailer, and this change occurs very rapidly, often in a matter of a few seconds. With pigs that are adapted to thermo-neutral temperatures throughout the growing period, this sudden and extreme temperature decline represents an extremely severe cold stress. The animals' response to cold conditions is to increase its metabolic rate, initially through shivering, and, as discussed above, increased metabolic rate and the associated decline in blood pH and elevation in body temperature is centrally involved in the development of the NANI pig.

It needs to be stressed that this explanation of the possible cause of higher levels of NANI pigs in the cooler periods of the year is at this stage only a theory and that this needs to be supported by appropriate experimental validation.

Another explanation that has been suggested for the increase in transport losses observed in the fall is the increased growth rates that are commonly observed at this time of year. Growth rates are generally reduced in the summer months where heat stress reduces feed intakes and pig consequently grow slower. It has been suggested that the live weight of pigs transported to the plant is generally higher in the fall compared to other times of the year because of this increase in growth rate. However, we have observed this increase in transport losses in the colder months of the year in survey data where the average and range of live weights of pigs transported has shown little or no seasonal variation.

## Reducing seasonal variation in transport losses

There are many potential stressors that can impact pigs and affect the incidence of losses during the transportation process, including factors at the farm, on the trailer, and at the plant. Although it is important to minimize the stress that pigs experience at any time during transport, it is particularly critical at those times of the year when losses are likely to be greatest, i.e., in the summer and fall/winter.

Floor space on the trailer is one of the major factors affecting transport losses. For example, total transport losses were more than two-fold higher for pigs transported at a floor space of 0.39 $m^2$/pig (total losses = 0.88% of pigs transported) compared to 0.48 $m^2$/pig (total losses = 0.36%).[4] The difference in total losses was due to lower DOA and NANI, but not NAI, pigs. In a subsequent study,[5] floor spaces of 0.39, 0.46, and 0.54 m2/pig were compared during the spring (February and March) and the summer (August and September). The impact of floor space on total transport losses varied with season (**Table 1**); there was no effect of floor space on losses in the loads transported in the spring, however, losses were significantly higher at the lowest floor space in the summer. It has been common commercial practice to reduce the number of pigs per load in the summer to reduce losses. However, the impact of floor space on transport losses across all seasons has not been established; this information is critical to defining the optimum floor space for transporting pigs under all environmental conditions.

Seasonal interactions, such as the one involving floor space described above, are most likely the result of the differing environmental conditions experienced by the pigs, particularly on the trailer, at different times of the year. Low floor spaces on the trailer under hot conditions may result in heat stress, whereas under cooler conditions they may have limited effect on the temperature experienced by the animal. There is little if any published data on changes in the environmental conditions on the trailer in different seasons and at different stages of the journey. Research in this area is critical to improving our understanding of the conditions experienced by pigs during transportation

Table 1: Interaction between transport floor space and season for total transport losses (%)[A]

| | Floor space, $m^2$/pig | | | | |
|---|---|---|---|---|---|
| **Months of transport** | **0.39** | **0.46** | **0.54** | **SEM** | **P value** |
| February and March | 0.26[C] | 0.23[C] | 0.27[C] | 0.13 | 0.02 |
| August and September | 0.72[B] | 0.16[C] | 0.000[C] | | |

[A]DOA, NAI, and NANI pigs
[B,C]Means with differing superscripts differ (P < 0.05)

Table 2: Interaction between trailer deck and season for total transport losses (%)[A]

| | Deck of trailer | | | |
|---|---|---|---|---|
| **Season** | **Top** | **Bottom** | **SEM** | **P value** |
| Summer | 0.18[BC] | 0.41[B] | 0.08 | 0.02 |
| Winter | 0.40[BC] | 0.11[C] | -- | -- |

[A]DOA, NAI, and NANI pigs
[B,C]Means with differing superscripts differ (P < 0.05)

and their impact on transport losses. One interesting finding from one of our recent research studies was that there was a difference between the decks of the trailer in the incidence of transport losses but that this difference varied with season (**Table 2**).[5] Losses were higher on the top compared to the bottom deck in the winter whereas the reverse appeared to be the case in the summer. To what extent different climatic conditions on the two decks in the different seasons contributed to these results is impossible to determine. However, these findings again point to the need to understand how environmental conditions differ between areas of the trailer (decks and compartments) and how these vary with factors such as season of the year, stage of the journey, and transport conditions (e.g., floor space per pig).

Obviously, problems with heat stress are more likely to occur in the hot summer months but can also happen under relatively mild conditions. For example, a recent study we loaded pigs onto a trailer at an ambient environmental temperature of 18ºC, however, within 10 minutes of loading while the truck was still standing at the farm the temperature in the front compartments of the top and bottom decks increased by between 8 and 10ºC and all the animals in these compartments were showing obvious signs of heat stress. Also, the relative humidity in these compartments at this time was high at around 90 to 100%, suggesting that evaporative cooling would be ineffective. One commonly used approach to reducing heat stress is to spray the pigs on the trailer with water in an attempt to increase evaporative heat loss, however, this is unlikely to be very effective when the humidity levels in the trailer are high such as described above and care is needed when using this approach when the trailer is not moving.

Because of the uncertainty over the precise cause(s) of the increase in transport losses that has been observed in the fall and winter, it is impossible to give specific recommendations to address those causes. However, as at other times of the year, reducing the amount of stress experienced by the pigs at all stages of transportation from the farm through to the plant is critical to minimizing transport losses.

## Acknowledgement

The authors would like to thank the National Pork Board and Elanco Animal Health for financial support for the research studies reported here and the Maschhoffs, Inc. and Cargill Meat Solutions for access to facilities and assistance with data collection.

## References

1. USDA-FSIS *Animal Disposition Reporting System (ADRS) Fiscal Year Data*. http://www.fsis.usda.gov/OPHS/adrsdata/adrsfydx.htm.
2. Hamilton, D.N., M. Ellis, G.E. Bressner, B.F. Wolter, D.J. Watkins. 2003. Relationships between environmental conditions on trucks and losses during transport to slaughter in finishing pigs. *J. Anim. Sci*. 8 (Suppl. 2):53.
3. Rademacher, C., P. Davies. 2005. Factors associated with the incidence of mortality during transport of market hogs. *Proc. Allen D. Leman Swine Conf.* pp. 186-191.
4. Ritter, M.J., M. Ellis, J. Brinkmann, J.M. DeDecker, K.K. Keffaber, M.E. Kocher, B.A. Peterson, J.M. Schlipf, B.F. Wolter. 2006. Effect of floor space during transport of market-weight pigs on the incidence of transport losses at the packing plant and the relationships between transport conditions and losses. *J. Anim. Sci*. 84:(In press).
5. Ritter, M.J., M. Ellis, C.R. Bertelsen, R. Bowman, J. Brinkmann, J.M. DeDecker, O. Mendoza, C.M. Murphy, B.A. Peterson, A. Rojo, J.M. Schlipf, B.F. Wolter. 2006. Impact of animal management and transportation factors on the transport losses in market weight pigs at the packing plant. *National ASAS Meeting*, Minneapolis (Abstract).