

## **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 the conference proceeding book.

### **Production Assistant**

Janice Storebo

### **Formatting**

Tina Smith

### **CD-ROM**

David Brown

### **Logo Design**

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

The University of Minnesota is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, color, creed, religion, national origin, sex, age, marital status, disability, public assistance status, or sexual orientation.

# Effects of facility design on the stress response of market weight pigs during loading and unloading

A. K. Johnson<sup>1</sup>, BS, MS, PhD Assistant Professor; L. J. Sadler<sup>1</sup>, BS Ag Specialist; M. Faga<sup>2</sup>, Director of Human Resources; Corky Feuerbach<sup>2</sup>, Director of Crew Services; H. Hill<sup>2</sup>, DVM, C.O.O.; R. Bailey, Procurement Manager JBS-Swift and Company, Marshalltown, Iowa; M. J. Ritter<sup>3</sup>, BS, MS, PhD, Swine Technical Consultant

<sup>1</sup>Department of Animal Science, Iowa State University, Iowa; <sup>2</sup>Iowa Select Farms, Iowa Falls Iowa; <sup>3</sup>Elanco Animal Health, Greenfield, Indiana

## Abstract

The objective of this study was to determine the effects of finisher pig facility design on pig stress responses at the time of loading for the market weight pig. The new (NEW) design had 192 pigs / pen with internal swing gates that were used to manually pre-sort market weight pigs on the day before loading. Traditional (TRAD) design had 32 pigs / pen; it was not feasible to pre-sort market weight pigs prior to loading. During loading, treatments were alternatively assigned to trailer decks. Pigs were loaded onto straight deck trailers, provided with ~0.41 m<sup>2</sup> / pig and were transported ~1 h to a commercial plant. During loading and unloading, the number of pigs displaying open mouth breathing, skin discoloration and muscle tremors were recorded. At the plant, dead and non-ambulatory pigs were recorded during unloading, and non-ambulatory pigs were classified as fatigued (stress-related) or injured. Total losses were defined as the sum of dead + non-ambulatory pigs at the plant. Data were analyzed by Proc Glimmix of SAS. NEW pigs had lower ( $P < 0.05$ ) percentages of open mouth breathing, skin discoloration and muscle tremors during loading and unloading compared to TRAD pigs. NEW pigs had fewer ( $P < 0.05$ ) dead pigs (0.01 vs. 0.23 ± 0.05 %), total non-ambulatory pigs (0.29 vs. 0.66 ± 0.12 %) and total losses (0.30 vs. 0.89 ± 0.14 %) at the plant compared to TRAD pigs. In summary, utilizing large pens and pre-sorting prior to loading, reduced physical signs of stress during loading and unloading, and reduced total losses at the plant by 0.59 % compared to pigs from traditional pens.

## Introduction

Animal transportation losses (fatigued, injured and dead) of market weight pigs are a challenge around the world. While these losses are often attributed or labeled as transportation losses, in reality a significant portion of these losses are a result from the way the animal was handled prior to / during the load out process (Ritter et al., 2007), and the design of the load out facilities (Berry et al., 2007a, b). The consequences of poor finisher pig handling and system design flaws can be seen through a variety of welfare and economical measurements. For example, market pig mortalities that occur during shipment from the farm to the processing plant, termed “dead on arrival” (DOA), and mortalities at the harvest

facility, typically referred to as “dead in plant” (DIP) have been estimated to cost the U.S. pork industry 50 to 100 million dollars annually (Ellis et al., 2003). Based on previous work pertaining to the additive stressor model in chicks (McFarlane et al., 1989a, b) and pigs (Hyun et al., 1998), Ellis and Ritter (2005) hypothesized that pre-slaughter stressors also have additive effects that affect the incidence of the non-ambulatory or dead pigs at the plant. By identifying and then reducing or eliminating these sequential stressors during the marketing process, swine producers might be able to reduce pig losses. Known identified stressors are; group size (Street and Gonyou, 2008), sorting pigs from the pen (Chevillon, 2000; Tarrant, 1989), loading chute angle (van Putten and Elshof, 1978; Warriss et al., 1991), chute length (Hill et al., a, b) and floor surface (Applegate et al., 1988). The objective of this study was to determine the effects of two grow-finish (traditional small pens vs. large new pens) facility designs and pre-sorting for the market weight pig on the stress response and incidence of fatigued, injured, and dead pigs at the time of loading and unloading.

## Materials and methods

### Housing and animals

A total of 5901 finisher pigs (PIC<sup>®</sup> sires) were used for this study. Pens were mixed sex. Data collection occurred from June 7<sup>th</sup> to July 19<sup>th</sup>, 2007. This project was approved by the Iowa State University Institute for Animal Care and Use (IACCU). Research was conducted on three commercial finisher farm sites at a Midwest integrator. All sites were identical in their system design, had the same management, feed and water delivery systems. Pigs were housed in standard finisher style housing. Pens (7.32 m × 2.93 m) were divided by metal piping gates (0.88 m high). Flooring was cement slated (2.54 cm × 131.45 cm). All sites were equipped with natural ventilation systems which included side-curtains. Pigs were checked daily during the morning (0800 h) to ensure health of the pigs and maintenance of the facility. Pigs had ad libitum access to feed and water during the grow-finish period. All pigs were fed a standard finishing diet (CP 14.57 %; ME 720 kcal / kg; Lysine 0.74 %) that met the pigs’ requirements (NRC, 1998). Feed was delivered on demand to a wet / dry feeder (1.4 m high × 43.18 cm wide × 1.52 m long; with a 12 cm deep pan).

### Treatments and experimental design

This study utilized 33 trailer loads of market weight pigs. The experimental design was a randomized complete block design comparing two facility design treatments **TRAD** vs. **NEW**. The trailer deck was the experimental unit and the trailer load of pigs was the blocking factor. This design confounds the effects of pen size with pre-sorting. Each finisher site had two, 1200 head rooms. Within each room, one side of the aisle was set-up with the traditional facility design (**TRAD**; **Figure 1**), while the other side was set-up with the new (**NEW**; **Figure 2**) facility design. Therefore, both treatments were represented in each room. **TRAD**; Pigs were housed 32 pigs per pen, providing 0.67 m<sup>2</sup> per pig of floor space. Space was not adjusted after first pull, and thus both treatments would have higher floor space allotment as pigs were removed from the facility, as is traditional. In **TRAD** pens, marked pigs were sorted from pen mates during loading by the loading crew.

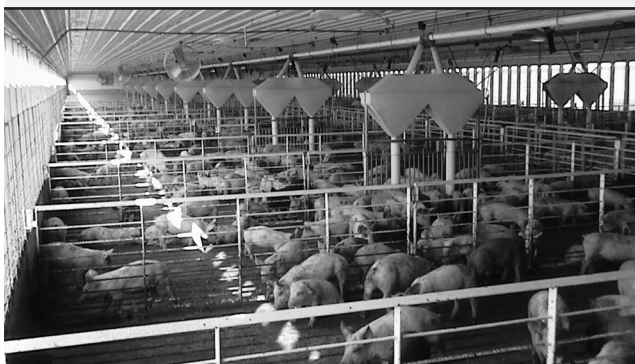
### Pig handling and loading

Pigs were moved from one of three finisher sites in the Midwest to a commercial packing plant over 33 loads. Average load weight per pig was 116.27 kg. Pigs were 203 ± 18 d of age at the time of marketing. Pigs were moved from the pen to the chute by the same five man loading crew.

### Trucks, trailers, and transport conditions

The trailers used were owned and operated by the integrator. All trailers used in the study were of similar design and dimensions. Trailers were a straight floor double deck trailer composed of aluminum. Each trailer was divided into 4 upper deck compartments and 5 lower deck compartments. The trailers internal ramp was constructed

**Figure 1: TRAD system** **NEW**; back gates of four consecutive pens were opened allowing the pigs access to 6 pens at a space allowance of 0.67 m<sup>2</sup> per pig. This resulted in 192 pigs being housed in one large pen. Pigs in this treatment were presorted the day prior to loading. Pigs were sorted into one of the middle pens from the set of six consecutive pens. This design confounds the effects of facility design with pen size and pre-sorting, but this is how the two facility designs are being utilized under commercial conditions.



**Figure 2: NEW system** In both treatments the pigs were marked on the back by the general manager of the facility using an animal safe spray marker (Prima Spray-on, Prima Tech, NC, USA) one day prior to loading so treatments could be tracked from the pen to the weigh scale at the packing plant.



of aluminum utilizing a diamond pattern for traction and wave type cleating spaced 20.32 cm. Cleats were 4.45 cm high and 5.08 cm wide. All compartments on the trailer were stocked according to the current standard operating procedure for this production system (~0.41 m<sup>2</sup> / pig; 180 pigs / load). After the truck was loaded, pigs were transported 84.81 ± 7.16 km to the packing plant. During loading, treatments were alternatively assigned to trailer decks and both facility designs were represented on each trailer load of pigs.

### Stress responses at loading and unloading

Stress responses were recorded by four trained observers during loading (two at the farm) and unloading (two at the plant). During loading and unloading, the number of pigs displaying open mouth breathing, skin discoloration, and the number of fatigued pigs were recorded. At the plant, dead and non-ambulatory pigs were recorded up to the weight scale. Non-ambulatory pigs were classified as fatigued or injured. Total losses were defined as the sum of dead and non-ambulatory pigs at the plant.

### Statistical analysis

The experimental unit was the trailer deck of finisher pigs (**TRAD** [n = 33] **NEW** [n = 33]). PROC Glimmix (SAS®) was used to analyze the data. The model included the fixed effect of treatment and the random effects of date (farm) and load (date × farm × trailer). Number of pigs loaded was used as a linear covariate. A Poisson distribution was noted and I-Link was used to transform values for means and standard errors. A *P* value of < 0.05 was considered to be significant.

## Results and discussion

### Results

NEW pigs had lower ( $P < 0.05$ ) percentages of open mouth breathing, skin discoloration and muscle tremors during loading and unloading compared to TRAD pigs however, there were no ( $P > 0.05$ ) differences in the number of fatigued between systems (Tables 1 & 2).

NEW pigs had fewer ( $P < 0.05$ ) dead pigs ( $0.01$  vs.  $0.23 \pm 0.05$  %), total non-ambulatory ( $0.29$  vs.  $0.66 \pm 0.12$  %) and total losses ( $0.30$  vs.  $0.89 \pm 0.14$  %) at the plant compared to TRAD pigs (Table 2).

### Conclusion

By implementing the facility design change and the management tool of pre-sorting the day before marketing, changes were reported in regards to the physical signs of stress imposed on the individual pig. Open mouth breathing, skin discoloration and muscle tremors decreased for pigs housed in the NEW facility at the time of loading and unloading compared to pigs reared and loaded from the TRAD facility design. Total transport losses (fatigued, injured and dead, pigs) were reduced by  $0.59$  % ( $0.89 - 0.30$  %). As noted previously in this paper the study

design confounded the effects of facility design (TRAD versus NEW) and the process of pre-sorting. Therefore future research should begin tweaking apart some of these factors. For example, comparisons of small and large pens with no presorting, and large pen design comparing presort and no pre-sort would help identify which factors are improving more or less stress on the market weight pig at the time of transport and marketing.

### Summary

In summary, utilizing large pens and pre-sorting prior to loading, reduced physical signs of stress during loading and unloading, and reduced total losses at the plant by  $0.59$  % compared to pigs from traditional pens.

### Acknowledgements

Support was provided by Iowa Select Farms, Swift Packing Plant, Elanco Animal Health and ISU Animal Science start up funds.

### References

- Applegate, A. L., S. E. Curtis, J. L. Groppel, J. M. McFarlane and T. M. Widowski. 1988. Footing and gate of pigs on different concrete surfaces. *J. Anim. Sci.* 66:334–341.

**Table 1:** Least squared means and standard errors for treatment on physical signs of stress and losses at the time of marketing from the farm. Number of head per trailer deck was used as a linear covariate.

Measure, %	Treatment		P-values
	TRAD	NEW	
Open mouth breathing	$30.07 \pm 4.20$	$22.59 \pm 3.19$	$< 0.0001$
Skin discoloration	$16.39 \pm 4.30$	$12.98 \pm 3.41$	0.0005
Muscle tremors	$0.73 \pm 0.14$	$0.33 \pm 0.14$	0.0292
Fatigued	$0.07 \pm 0.04$	$0.02 \pm 0.02$	0.20

**Table 2:** Least squared means and standard errors for treatment on physical signs of stress and total losses at the time of marketing at the packing plant. Number of head per trailer deck was used as a linear covariate.

Measure, %	Treatment		P-values
	TRAD	NEW	
Open mouth breathing	$14.02 \pm 3.80$	$8.64 \pm 2.36$	$< 0.0001$
Skin discoloration	$3.61 \pm 0.92$	$2.06 \pm 0.55$	0.0007
Muscle tremors	$0.61 \pm 0.16$	$0.30 \pm 0.10$	0.05
Dead	$0.23 \pm 0.09$	$0.01 \pm 0.00$	0.0059
Total non-ambulatory	$0.66 \pm 0.14$	$0.29 \pm 0.09$	0.04
Injured	$0.20 \pm 0.08$	$0.07 \pm 0.05$	0.17
Fatigued	$0.45 \pm 0.12$	$0.22 \pm 0.08$	0.11
Total losses	$0.89 \pm 0.18$	$0.30 \pm 0.09$	0.0031

*Effects of facility design on the stress response of market weight pigs during loading and unloading*

2. Berry, N., A. Johnson, K. Stalder, T. Baas and L. Karriker. 2007a. Loading gantry versus traditional chute for the finisher pig: Effect on transportation and packing plant losses. *J. Anim. Sci.* 86(1):612.
3. Berry, N. L., A. K. Johnson, J. Hill, T. Baas, L. Karriker, and K. J. Stalder. 2007b. Loading gantry versus traditional chute for the finisher pig: Effect on welfare parameters at time of marketing. *J. Anim. Sci.* 86(1):612.
4. Chevillon, P. 2000. Pig welfare during pre-slaughter and stunning. Proceedings of I Conferência Virtual Internacional sobre Qualidade de Carne Suína, Embrapa, Brazil.
5. Ellis, M., and M. Ritter. 2005. Impact of animal handling and transport conditions on losses of slaughter weight swine during transport. Pages 199–202 in Proceedings of the American Association of Swine Veterinarians, Toronto, Canada.
6. Ellis, M., F. McKeith, D. Hamilton, T. Bertol, and M. Ritter. 2003. "Analysis of the current situation: what do downers cost the industry and what can we do about it?" Pages 1–3 in Proceedings of the 4<sup>th</sup> American Meat Science Association Pork Quality Symposium, Columbia, MO.
7. Hill, J., N. Berry and A. K. Johnson. 2007a. Marketing the finisher pig: The impact of facility design. *Pork Information Gateway*. PIG 09–08–01.
8. Hill, J., N. Berry, and A. K. Johnson. 2007b. Handling and loadout of the finisher pig. *PIG* 09–08–02.
9. Hyun, Y., M. Ellis, G. Riskowski, and R. W. Johnson. 1998. Growth performance of pigs subjected to multiple concurrent environmental stressors. *J. Anim. Sci.* 76:721–727.
10. McFarlane, J. M., S. E. Curtis, R. D. Shanks, and S. G. Carmer. 1989a. Multiple concurrency stressors in chicks. 1. Effect on weight, feed intake and behavior. *Poult. Sci.* 68:501–509.
11. McFarlane, J. M., S. E. Curtis, J. Simon, and O. A. Izquierdo. 1989b. Multiple concurrent stressors in chicks. 2. Effects on hematological body composition, and pathological traits. *Poult. Sci.* 68: 510–521.
12. Ritter, M. J., M. Ellis, C. R. Bowman, J. Brinkmann, J. M. DeDecker, K. K. Keffaber, C. M. Murphy, B. A. Peterson, J. M. Schlipf, and B. F. Wolter. 2007. Effects of distance moved during loading and floor space on the trailer during transport on losses of market weight pigs on arrival at the packing plant. *J. Anim. Sci.* 85:3454–3461.
13. Street, B. R., and H. W. Gonyou. 2008. Effects of housing pigs in two group sizes and at two floor space allocations on production, health, behavior, and physiological variables. *J. Anim. Sci.* 86:982–991
14. Tarrant, P.V. 1989. The effects of handling, transport, slaughter and chilling on meat quality and yield in pigs – a review. *Irish J. Food Sci. Tech.* 13:79–107.
15. van Putten, G., and W. J. Elshof. 1978. Observations on the effect of transport on the well-being and lean quality of slaughter pigs. *Animal Regulation Studies.* 1:247–271.
16. Warriss, P. D., E. A. Bevis, J. E. Edwards, S. N. Brown, and T. G. Knowles. 1991. Effect of the angle of slope on the ease with which pigs negotiate loading ramps. *Vet. Rec.* 128:419–421.

