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Loading gantry versus traditional chute for the finisher pig: Effect on welfare at the time of loading and performance measures and transport losses at the harvest facility

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Abstract

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Keywords

loading gantry, market-weight pig, performance, transport losses, welfare

Disciplines

Agriculture | Animal Sciences | Meat Science

Comments

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Loading gantry versus traditional chute for the finisher pig: Effect on welfare at the time of loading and performance measures and transport losses at the harvest facility[1]

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ABSTRACT: The objectives of these studies were to evaluate the loading system effects [traditional chute (TC) vs. prototype loading gantry (PLG)] on i) welfare measures at loading and ii) performance measures and transport losses at the harvest facility for the market-weight pig (*Sus scrofa*). This study compared first pull (FP), which was the first group of pigs, and close out (CO), which was the last group of pigs marketed from a finishing facility. Experiment 1 evaluated 74 loads for welfare measures at loading on the farm, and Exp. 2 evaluated 497 loads for performance measures and transport losses at the harvest facility. Data were analyzed using the PROC Mixed procedure for Exp. 1 and PROC GLIMMIX procedure of SAS for Exp. 2. In Exp. 1, pigs loaded using the PLG had fewer ($P \times 0.0002$) electric prod touches, slips, falls, vocalizations, and pile ups compared with pigs loaded on the TC during FP and CO. In Exp. 2, there were no ($P > 0.05$) differences for any performance measures between loading systems or by pull. Pigs loaded using the prototype PLG loading gantry experienced fewer ($P = 0.03$) total transport losses than pigs loaded using the TC in the FP. In conclusion, the prototype loading gantry improved all welfare measures at the time of loading and reduced overall total transport losses. These studies demonstrate that loading systems that improve on-farm swine welfare at loading and reduce transport losses at the harvest facility can be designed.

Key words: loading gantry, market-weight pig, performance, transport losses, welfare

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INTRODUCTION

Transport losses of livestock are caused by numerous factors. In North America, research has begun to address the impacts of these factors [i.e., grow–finish facility design (Ritter, 2007; Gesing et al., 2011) and management strategies (Johnson et al., 2009; Gesing et al., 2010] on pigs. Consideration of improving pig movement from the barn to the truck is also important. Gonyou (1993) reported that animal "movement is accomplished by making the target location, or route to it, more attractive than the starting location." Pigs are motivated to move by many factors, including natural curiosity, odors, sounds, co-specifics, food, and fear (McGlone, et al., 2004). It is clear that loading has the potential to be a stressful event for the pig due to the physical exertion, noise, and the effects of close contact with humans (Geverink et al., 1996). Hill et al. (2007a,b) identified loadout system design requirements to minimize stress during loading for the market-weight pig. These requirements included: i) all facilities and handling equipment must be designed based on the pigs behavioral and physiological attributes, ii) design must provide a continuous unidirectional flow of pigs from the pen of origin to the target location, and iii) design must be compatible with site design, facility structure, and transport system. To facilitate these design requirements, key components could include lighting, flooring profile/texture, door seal, and slope of the gantry. Berry et al. (2010a,b) evaluated 2 loadout systems on final pork quality attributes, but little work has been published to link loading gantry design to welfare variables, performance, and overall transport losses for the finisher pig. The objectives of these studies were to evaluate the loading system effects at the farm [traditional chute (TC) vs. prototype loading

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gantry (**PLG**)] on i) welfare measures at loading, and ii) performance measures and transport losses at the harvest facility for the market-weight pig.

MATERIALS AND METHODS

The protocol for these experiments was approved by the Iowa State University Institutional Animal Care and Use Committee (3-06-6080-S).

General Procedures for Both Experiments

Animals, Farms, and Pig Handling. Finisher pigs (barrows and gilts) from the progeny of PIC (Hendersonville, TN) sires and Genetiporc (Alexandria, MN) females were used. All pigs were negative for the halothane gene. One commercial wean-finish facility located in the Midwest was used. Within this facility, 8 grow-finish barns were used for data collection. Within a barn there were 48 pens, and pigs were raised in mixed-sex pens (approximately 24 pigs/pen). Pens measured 7.3 m long by 2.9 m wide and were divided by steel gates with horizontal rods. Each barn was environmentally controlled, using a tunnel ventilation system with double-pleated noninsulated curtains for emergency ventilation. Flooring was fully slatted (slots 2.5 cm wide by 1.3 m long), and manure was collected in pits below and mechanically removed. Pigs were fed a standard finishing diet that met or exceeded the nutritional requirements of the pigs for the phase/BW (National Research Council, 1998). Pigs were provided ad libitum access to water through a stationary nipple drinker system and were observed twice daily beginning at 0800 h to ensure pig health and facility maintenance.

Pig Handling and Loading Procedures on Farm. Loading for transport to the harvest facility took place between 1700 and 2200 h. All pigs were moved from their home pen to the loading ramp by the same 5-person marketing crew, and all handling methods were based on the standard operating procedures of the production system. The loadout crew received formal instruction and on-site training by the company to handle finisher pigs in a humane manner. Groups of 4 to 6 market-weight pigs were removed from their pen and moved down the center aisle of the building and onto the transport trailer using sorting boards. Pigs were moved with co-specifics from their home pen but were mixed with unfamiliar pigs on the trailer.

Loading System Design. Berry et al. (2010a,b) have detailed the loading systems used in this experiment. Briefly, a metal covered TC was 76.2 cm in width, 2.3 m in height, and 4.6 m in length, and used square stock (2.5 cm) metal cleats which were spaced 20.3 cm apart. The TC included a flat pivot section on each end to accommodate the angle in which the trailers were positioned relative to the finishing facility. The slope of the chute used to load the pigs onto the trailer was approximately 19 degrees to the bottom deck. The trailer included an internal ramp raised 23 degrees for access to the upper deck. One incandescent lamp fixture (60 W) was placed at the entrance to the TC. The PLG was constructed of an aluminum covered chute and measured 91.4 cm in width, 3.1 m in height, and 9 m in overall length, including a 7.9 m sloped section and 2 dual pivoting extension systems that allowed for proper positioning to both the barn and trailer. A cushioned bumper dock system was incorporated into the loading gantry design to completely eliminate gaps from the barn to the loading gantry. The flooring material consisted of metal coated with epoxy (designed to mimic the feel of concrete on the feet of the pigs) and had an inverted stair step design with cleats 2.5 cm in height and spaced 20.3 cm apart. The gantry slope was approximately 7 degrees to the bottom deck and 18 degrees to the upper deck of the trailer; however, the inverted stair step design reduced the angle to the pig by approximately 5 degrees. The PLG used an industrial rope lighting system designed to provide a soft, continuous light source that minimized shadowing. No sawdust was used to cover either ramps when loading pigs.

Experiment 1: Prototype Loading Gantry vs. Traditional Metal Covered Chute to Determine Differences in Welfare Measures at First Pull and Close Out for Market-Weight Pigs during Loading on the Farm

Treatments. Observations of welfare indices from a total of 74 loads were recorded at loading on the farm (Table 1 indicates the number of loads for loading system by pulls). A total of 44 loads were categorized as first pull (**FP**), which was defined as the first group of pigs marketed from a finishing facility, and these pigs were not fed ractopamine hydrochloride (Paylean; Elanco Animal Health, Greenfield, IN); and 30 loads were close out (**CO**), defined as the last group of pigs marketed from a finishing facility, and these pigs were fed ractopamine hydrochloride. Data was collected from November 2006 to August 2007. Pigs from FP were provided 0.59 m^2/pig, whereas pigs from CO were provided 0.65 m^2/pig.

Welfare and stress measures were recorded by 1 trained observer (defined as a person that had previous experience viewing and scoring) within an empty pen 5 m from the entrance to the chute so that both the alley and the chute could be seen. Each individual pig was evaluated at the time of loading. Welfare measures were collected from when the foreleg of the individual pig passed onto the loading system (either PLG or TC) and ceased when the hind leg of the pig stepped onto the trailer.

Welfare Measures during Loading. Several welfare measures were evaluated: Electric prod use occurred any time the prod touched the pig. The touch was counted whether the prod was energized or not. Slips were instances in which normal mechanics of gait were interrupted. Falls were imbalances resulting in contact between a non-limb portion of the body and the ground. Vocalizations were squeals defined as an extended sound (0.5 to 2.0 s) of both high amplitude and high frequency produced with an open mouth, indicative of a high level of excitement. Vocalizations that occurred when pigs were rooting under each other or jumping on top of each other were counted if the noise was provoked by electric prods, yelling, poking, or hitting the pigs. If there was no way to identify the cause of a vocalization, it was not counted. Pile ups were defined as when 1 or more pigs had either front or rear feet off the ground and on another pig (AMI, 2010).

Experiment 2: Prototype Loading Gantry vs. Traditional Metal Covered Chute to Determine Differences in Performance Measures and Transport Losses at the Harvest Facility for First Pull and Close Out Market-Weight Pigs

Treatments. A total of 497 loads were collected for performance measures and transport losses at the harvest facility. A total of 211 loads were categorized as FP and 286 were CO (Table 1 indicates the number of loads for loading system by pulls). Data was collected from July 2006 to October 2007.

Transport Trailers and Transport Floor Spaces. Aluminum straight-deck trailers 16.5 m in length with a diamond plate floor (Wilson Trailers, Sioux City, IA), owned and operated by the production system, were used. During this time period, air vents remained open and in compliance with short-haul recommendations of the company for transport trailer setup. Fresh wood shavings were used as bedding to cover the trailer floor at approximately 2.5 cm in depth. Each trailer had 4 upper deck compartments and 5 lower deck compartments (all compartments in the trailer were stocked according to the current standard operating procedure of the production system of 0.41 m^2/pig, ~174 pigs/load). During loading, treatments were assigned to trailer decks in an alternating pattern, and both treatments were represented within each trailer load of pigs. Immediately after loading was completed, pigs were transported 88.5 km (~1 h) to a commercial harvest facility. At the harvest facility, trained and certified personnel unloaded the trailers using paddles and using docks specifically designed to allow an unimpeded pathway for the pigs from both the upper and lower decks. The trailer side door (2.7 m in width) opened and the receiving dock extended outwards to the truck, allowing the pigs to walk straight off the trailer and into the receiving area. Unloading at the harvest facility took place between 1900 and 2400 h.

Table 1. Number of pigs and loads used in an experiment comparing pigs loaded with either a traditional loading chute or a prototype loading gantry when marketing pigs at first pull or close out

	Loading system design[1]			
	First pull[2]		Close out	
Item	Traditional	Prototype	Traditional	Prototype
Exp. 1[3]				
No. of loads	26	18	20	10
No. of pigs	4227	3072	3223	1631
Avg. No. pigs/load	162.6	170.6	161.2	163.1
Avg. pig BW, kg[4]	–	–	–	–
Exp. 2[5]				
No. of loads	112	99	128	158
No. of pigs	18206	17096	20745	25098
Avg. No. pigs/load	162.6	172.7	162.1	158.8
Avg. pig BW, kg	117.4	115.2	118.2	118.4

[1]Traditional metal covered chute: The chute was 76.2 cm in width, 2.3 m in height, and 4.6 m in length, and used square stock (2.5 cm) metal cleats which were spaced 20.3 cm apart. Prototype loading gantry: The loading gantry was constructed of an aluminum covered chute and measured 91.4 cm in width, 3.1 m in height, and 9 m in overall length, including a 7.9 m sloped section and 2 dual pivoting extension systems that allowed for proper positioning to both the barn and trailer.

[2]First pull was defined as the first group of pigs marketed from a finishing facility and these pigs were not fed ractopamine hydrochloride. Close out was defined as the last group of pigs marketed from a finishing facility and these pigs were fed ractopamine hydrochloride (Elanco Animal Health, Greenfield, IN).

[3]Experiment 1: Prototype loading gantry vs. traditional metal covered chute to determine differences in welfare and stress responses at first pull and close out for market-weight pigs.

[4]Body weight was not collected on finisher pigs for the welfare variables collected in Exp. 1.

[5]Experiment 2: Prototype loading gantry vs. traditional metal covered chute to determine differences in performance at the harvest facility for first pull and close out market-weight pigs.

Event Times at Transport. Average number of pigs/load was defined as the average number of pigs marketed per load. Average pig BW (kg) was defined as the average BW of the entire load. The timing of all events (average load time per pig, travel time, and wait time at the harvest facility before unloading) was recorded. Load time was defined as the period of time when the foreleg of the pig passed onto the loading system (either PLG or TC) and ceased when the hind leg of the pig stepped onto the trailer. Travel time was defined as the time interval from when the truck and trailer left the farm to the time at which the trailer arrived at the harvest facility. Wait time at the harvest facility before unloading was defined as the time interval from when the truck and trailer arrived at the harvest facility to the time at which the driver started unloading the trailer (Gesing et al., 2010, 2011). For each of these events, the mean, SD, and range [minimum and maximum times] were calculated.

Transport Measures. Harvest facility employees identified performance measures and transport losses from pig arrival at the facility. Performance measures were: stressed on arrival (**SOA**), crippled on arrival (**COA**), stressed in plant (**SIP**), and crippled in plant (**CIP**). Stressed (SOA and SIP) pigs were defined as having temporarily lost the ability to walk, but had a reasonable expectation to recover full locomotion with rest. The SOA and SIP pigs were defined as pigs that were in a lying position on the floor (either sternal or lateral) and were unable to regain their posture, stand on all 4 limbs, or walk without assistance. A modified skid loader moved SOA and SIP pigs from where they were lying to a resting pen. The USDA veterinarian on site then allowed the pig to rest for ~2 h and checked its health; if the pig was walking on all fours unassisted the veterinarian would allow the pig to enter processing. Crippled (COA and CIP) pigs were defined as any pig that had received an injury that impeded its movement. Two categories were created that summed SOA and SIP (**total stressed**) and COA and CIP (**total crippled**). Dead (**DOA** and **DIP**) pigs were defined as a pig that had ceased to breathe. An additional category was created that summed DOA and DIP (**total dead**) pigs. Total transport losses were defined as the summation of total crippled, total stressed, and total dead pigs.

Statistical Analysis

Experiment 1. The effects of loading systems (traditional vs. prototype) for welfare measures at FP and CO market-weight pigs at loading on farm were compared using load as the experimental unit. All data were evaluated for normality of their distribution before analysis using PROC Univariate (SAS Inst. Inc., Cary, NC). Data used to evaluate welfare measures during loading met the assumptions of the ANOVA. These data were analyzed using PROC MIXED procedures of SAS. The model included the dependent variable of interest (electric prods, slips, falls, vocalizations, and pile ups). The fixed effect of treatment (the 2 loading systems), load number (number of loads on a given night), date (calendar date for when trailers loaded at the site), month (November through August), and barn (8 grow–finish barns). Fixed effects were fitted with a random effect of date nested within barn. A linear covariate of number of pigs shipped per load was included in the model. A *P*-value of $P \times 0.05$ was used to detect significant treatment differences.

Experiment 2. The effects of loading system (traditional vs. prototype) for performance measures and transport losses at FP and CO market-weight pigs at loading on farm were compared in a randomized complete design and the load was the experimental unit. All data were evaluated for normality of their distribution before analysis using PROC Univariate of SAS. Data for mortality and transport losses at the harvest facility did not meet the normal distribution assumption needed when using the ANOVA. A Poisson distribution was noted for mortality and transport losses. Additionally, these data are count or discrete and hence, the PROC GLIMMIX procedure of SAS was used for analyses. The model included the variable of interest (COA, SOA, DOA, CIP, SIP, DIP, total crippled, total stressed, total dead, and total transport losses), the fixed effects of treatment (the 2 loading systems), date (calendar date for when trailers loaded at the site), and barn (8 grow–finish barns) were fitted with a random effect of date nested within barn. A linear covariate of number of pigs shipped per load was included in the model. The I-Link option was used to transform the mean and SE values back to the original units of measure. A *P*-value of ≤0.05 was used to detect significant treatment differences. The above model is the result of a stepwise process of fitting all 2-way interactions between fixed effects along with second and third order polynomial effects of each covariate and removing nonsignificant ($P > 0.05$) individual effects sequentially. Additional fixed effects of hauler (trucking firm), driver, and load type (all pigs loaded from the same barn or loaded from 2 separate barns), along with covariates of load time (time required to complete a load), travel time (time elapsed from the farm to harvest facility), and wait to unload time (time elapsed between arrival at the harvest facility and unloading of pigs) were tested and found not to describe a significant amount of variation for each dependent variable.

RESULTS AND DISCUSSION

Experiment 1: Prototype Loading Gantry vs. Traditional Metal Covered Chute to Determine Differences in Welfare Measures at First Pull and Close Out for Market-Weight Pigs During Loading on the Farm

Pigs that become nonambulatory or die at any stage during the marketing process are termed “transport losses” (Ritter et al., 2009a). Transport losses present financial, regulatory, and welfare challenges to the U.S. swine industry (Ritter et al., 2009a). These financial losses have been estimated to range between $50 to 100 million annually (Ellis et al., 2003). Efforts to improve welfare during loading at finishing sites, and reduce transport losses during unloading at the harvest facility are imperative for continued welfare practice improvement within the U.S. swine industry.

The average number of pigs loaded for Exp. 1 was similar across both loading system designs (Table 1). Pigs loaded using the PLG experienced fewer ($P \leq 0.0002$) electric prod touches, slips, falls, vocalizations, and pile up incidences per load compared with pigs loaded using the TC during FP and CO (note: 1 pig may have received more than 1 touch with an electric prod, or slip, fall, and so forth, during loading; Table 2). When considering this improvement as a percentage reduction for FP and CO, the

Table 2. On-farm welfare measure least square means (±SE) when loading market-weight pigs for transport using either a prototype loading gantry or a traditional metal covered chute at first pull and close out between November 2006 and August 2007

	Loading system design[1]		
Item	Traditional	Prototype	*P*-value
First Pull[2]			
Avg. No. pigs/load	162.6	170.6	
Electric prod use[3]			
No. incidences/load	161.6 ± 14.1	96.3 ± 12.9	0.0001
Percentage/load[4]	99.4± 8.7	56.4± 7.6	
Slips			
No. incidences/load	247.9 ± 20.5	96.0 ± 18.9	0.0001
Percentage/load[4]	152.5 ± 12.6	56.3 ± 11.1	
Falls			
No. incidences/load	100.4 ± 9.1	20.2 ± 8.3	0.0001
Percentage/load[4]	61.8 ± 5.6	11.8 ± 4.9	
Vocalizations			
No. incidences/load	138.1 ± 12.1	69.1 ± 11.1	0.0001
Percentage/load[4]	84.9 ± 7.4	40.5 ± 6.5	
Pile ups			
No. incidences/load	3.6 ± 0.5	0.01 ± 0.5	0.0001
Percentage/load[4]	2.2 ± 0.3	0.0006 ± 0.3	
Close out[5]			
Avg. No. pigs/load	161.2	163.1	
Electric prod use			
No. incidences/load	188.2 ± 10.5	108.1 ± 12.9	0.0001
Percentage/load	116.7± 6.5	66.3± 7.9	
Slips			
No. incidences/load	302.5 ± 23.2	106.0 ± 25.7	0.0001
Percentage/load	187.7± 14.4	64.5± 15.8	
Falls			
No. incidences/load	115.4 ± 13.9	24.8 ± 15.7	0.0001
Percentage/load	71.6± 8.6	15.2± 9.6	
Vocalizations			
No. incidences/load	140.4 ± 7.6	79.2 ± 9.4	0.0002
Percentage/load	87.1± 4.7	48.6± 5.8	
Pile ups			
No. incidences/load	4.6 ± 0.4	0.1 ± 0.5	0.0001
Percentage/load	2.9 ± 0.2	0.06 ± 0.3	

[1]Traditional metal covered chute: The chute was 76.2 cm in width, 2.3 m in height, and 4.6 m in length, and used square stock (2.5 cm) metal cleats which were spaced 20.3 cm apart. Prototype loading gantry: The loading gantry was constructed of an aluminum covered chute and measured 91.4 cm in width, 3.1 m in height, and 9 m in overall length, including a 7.9 m sloped section and 2 dual pivoting extension systems that allowed for proper positioning to both the barn and trailer.

[2]First pull was defined as the first group of pigs marketed from a finishing facility and these pigs were not fed ractopamine hydrochloride.

[3]Welfare measures parameters evaluated included electric prod use, defined as any time the prod touched the pig. Slips were instances in which normal mechanics of gait were interrupted. Falls were imbalances resulting in contact between a non-limb portion of the body and the ground. Vocalizations were squeals defined as an extended sound (0.5 to 2.0 s) of both high amplitude and high frequency produced with an open mouth, indicative of a high level of excitement. Pile ups were defined as when one or more pigs had either front or rear feet off the ground and on another pig.

[4]Percentage/load was calculated as number of (incidences/load for a given variable)/(avg. number pigs/load for a given variable).

[5]Close out was defined as the last group of pigs marketed from a finishing facility and these pigs were fed ractopamine hydrochloride (Elanco Animal Health, Greenfield, IN).

differences are more evident. For FP, there was a reduction of 43% electric prod use, 96% slips, 50% falls, 44% vocalizations, and 2% pile ups for pigs loaded with the PLG compared with the TC. For CO there was a reduction of 50% electric prod use, 123% slips, 56% falls, 39% vocalizations, and almost 3% pile ups for pigs loaded with the PLG compared with pigs loaded using the TC. The authors paid close attention to the optimal design features of a loading gantry outlined by the work of Hill et al. (2007a,b). The results provide consistent and convincing evidence that the design of the loading system has a significant effect on pig welfare indices during loading.

The feed additive ractopamine, a β-adrenergic agonist, acts as a repartitioning agent, promoting lean tissue deposition in pigs (Watkins et al., 1990). The use of ractopamine and its effect on swine welfare has been raised (Schaefer et al., 1992). Marchant-Forde et al. (2003) compared the behavior of pigs during handling on farm. The authors noted that at the beginning of the trial there were no differences in behavioral responses to handling. However, over each of the next 4 wk, fewer ractopamine pigs exited the home pen voluntarily, they took longer to remove from the home pen, longer to handle into the weighing scale, and needed more pats, slaps, and pushes from the handler to enter the scales. Therefore, it would be interesting to conduct another trial that compares the PLG to the TC for FP pigs with and without the use of ractopamine to see if these welfare variables changed.

A reduction in electric prod use and fewer pilling incidences demonstrated that the width of the gantry worked (2 pigs could walk up at the same time and allowed for the "follow the leader and herd" behaviors; Gonyou, 1993). Pigs were not stopping at the gantry entrance and or on the gantry itself, indicating that the lighting used was diffuse, at a good illumination level, and that few shadows were cast. Floor texture mimicked the feel the pigs experienced within the home pen flooring (it was anecdotally noted by the researchers that pigs exhibited fewer "stopping events" when moving from the grow finisher barn onto the gantry), and the texture reduced the instances of pigs slipping and falling. Improvements in all the welfare measures collected when pigs were loaded at the finishing sites were noted over both FP and CO.

Experiment 2: Prototype Loading Gantry vs. Traditional Metal Covered Chute to Determine Differences in Performance Measures and Transport Losses at the Harvest Facility for First Pull and Close Out Market-Weight Pigs

Event Times at Transport. The marketing process may expose the pig to a barrage of external and internal stimuli that may be unfamiliar in some situations. One physical stressor for the pig is walking up an inclined chute onto the trailer (van Putten and Elshof, 1978; Warris et al., 1991; Brown et al., 2005). In concert with this physical stress, the pig is in closer contact with humans (Hemsworth et al., 1989, 1993) may be mixed with unfamiliar pigs (Lewis and McGlone, 2007) and may receive a shock from an electric prod (McGlone et al., 2004; Ritter et al., 2009b). Although the majority of pigs make it through the marketing process with no adverse effects (Ritter et al., 2009a), a minority show signs of stress, and outcomes may range from a fatigued and or injured pig (often defined as nonambulatory), with the extreme being death. Furthermore, Hambrecht et al. (2004) and Bertol et al. (2005) have noted detrimental carcass quality effects for pigs that make it through the harvesting process, but are stressed.

The average number of pigs loaded for Exp. 1 was similar across both types of loading system designs (Table 1). For FP, 18 s/pig were needed to complete the loading process using the PLG. Similarly, 15 s/pig were needed to complete the loading process when the TC was used. Travel time from the farm site to the harvest facility and waiting before unloading were similar between the 2 treatments. During CO, pigs were taking approximately 2 s longer during the loading process with the PLG when compared with their traditional counterparts. Travel time from the farm site to the harvest facility and waiting before unloading were similar between the 2 treatments (Table 3).

Transport Measures. There were no ($P > 0.11$) differences for any performance measures from market-weight pigs loaded using the PLG when compared with market pigs loaded with the TC between either pull. One trend ($P = 0.06$) was noted for pigs at CO with the PLG having fewer total crippled (summation of COA and CIP) at the plant (0.1 vs. 0 incidents/load), but both levels would be considered very low by industry standards (Table 4). Pigs loaded using the PLG tended ($P = 0.06$) to have fewer total dead pigs (summation of DOA and DIP) and experienced fewer ($P = 0.03$) total transport losses (summation of total crippled and total stressed) than pigs loaded using the TC in the FP (Table 5).

In the United States, the percentage of dead pigs at USDA-inspected harvest facilities are reported by the Food Safety and Inspection Service (**FSIS**) as “swine condemned ante-mortem for deads.” The national statistics are available to the public via the Freedom of Information Act. The current U.S. national average for percentage of pigs dead at the processing plant is 0.22%. In this study, the percentage of total deads when pigs were loaded using the TC for FP and CO was 0.4 and 0.2%. Similarly, when the PLG was used to load pigs, total dead pigs at FP and CO were 0.2 and 0.2%,respectively.

Table 3. Loading on farm, travel to plant, and waiting time at plant for market-weight pigs when loaded using either a traditional loading chute or a prototype loading gantry at first pull or close out from July 2006 to October 2007

	Loading system design[1]							
	Traditional				Prototype			
Item	Mean	SD	Min.[2]	Max.	Mean	SD	Min.	Max.
First Pull[3]								
No. loads		112				99		
Avg. load time per pig, s[4]	15.0	3.0	6.6	25.8	18.0	3.6	9.6	27.0
Avg. load time per pig, min	0.25	0.05	0.11	0.43	0.30	0.06	0.16	0.45
Travel time, min[5]	64	9	48	129	61	5	47	74
Wait time at the harvest facility before unloading, min[6]	6	3	1	18	8	8	2	70
Close out[7]								
No. loads		128				158		
Avg. load time per pig, s	13.8	3.6	6.6	26.4	16.2	3.6	5.4	31.8
Avg. load time per pig, min	0.23	0.06	0.11	0.44	0.27	0.06	0.09	0.53
Travel time, min	63	8	46	125	62	6	36	89
Wait time at the harvest facility before unloading, min	7	9	1	49	7	6	1	35

[1]Traditional metal covered chute: The chute was 76.2 cm in width, 2.3 m in height, and 4.6 m in length, and used square stock (2.5 cm) metal cleats which were spaced 20.3 cm apart. Prototype loading gantry: The loading gantry was constructed of an aluminum covered chute and measured 91.4 cm in width, 3.1 m in height, and 9 m in overall length, including a 7.9 m sloped section and 2 dual pivoting extension systems that allowed for proper positioning to both the barn and trailer.

[2]Min. = minimum, Max. = maximum.

[3]First pull was defined as the first group of pigs marketed from a finishing facility and these pigs were not fed ractopamine hydrochloride.

[4]Load time was defined as the period of time (s) when the foreleg of the pig passed onto the loading system (either prototype or traditional) and ceased when the pig's hind leg stepped onto the trailer.

[5]Travel time was defined as the amount of time (min) required to travel from the finishing site to the harvest facility.

[6]Wait time at the harvest facility, min was defined as the amount of time (min) from the truck pulling onto the harvest facility grounds and for the first pig to begin unloading from that trailer.

[7]Close out was defined as the last group of pigs marketed from a finishing facility and these pigs were fed ractopamine hydrochloride (Elanco Animal Health, Greenfield, IN).

These ranges are similar to what has been reported by the FSIS data (Ritter et al., 2009a).

National statistics are not available for the incidence of nonambulatory pigs at U.S. harvesting facilities, but Ritter et al. (2009a) summarized several commercial field trials and reported that 0.44% were nonambulatory pigs (range: 0.11 to 2.34%). In the present study, total stressed and total crippled would be the equivalent to a nonambulatory pig previously described by Ritter et al. (2009a). When the TC was used to load market pigs at FP and CO, stressed and crippled levels were 0.7 and 1.1%, respectively. The stressed and crippled percentages were 0.4 and 0.4%, respectively, when the PLG was used to load market pigs for transport. Therefore, the PLG reflected the summarized report averages more closely for nonambulatory pigs, whereas the TC resulted in greater nonambulatory percentages for both FP and CO.

Total transport losses at CO did not differ between loading system designs. At FP, pigs loaded using the TC had similar results (1.6 pigs/load or 1%) when compared with other published trials (Ellis et al., 2003; Hambrecht et al., 2004; Ritter et al., 2006). Encouragingly, the PLG had significantly fewer losses at FP (1.1 pigs/load or 0.6%). Saving 0.5 pigs/load when loading market-weight pigs with the gantry over the TC, producer revenues would have increased by $44 million in 2010 (personal communication with Paragon Economics, 2010). Pigs marketed at FP can be subjected to additional handling stress when removed from their home pen environment, due to the sorting process in their home pen (Gesing et al., 2010). In contrast, pigs marketed at CO are all removed from their home pen at once with no differential selection, potentially eliminating the stress due to sorting market ready pigs from the pen. These data noted no differences for CO pigs when loaded between the 2 loading systems (1.3 pigs/load or 0.8% for the traditional vs. 1 pigs/load or 0.6% for the prototype).

Table 4. Performance measures least square means (±SE) when comparing market-weight pigs loaded for transport to the harvest facility using either a traditional metal covered chute (TC) or a prototype loading gantry (PLG) at first pull (FP) and close out (CO) from July 2006 to October 2007

	Loading system design[1]							
	FP[2]			CO			*P*-value	
Item	TC	PLG	SE	TC	PLG	SE	FP	CO
No. of loads	112	99		128	158	–	–	–
Stressed on arrival[3]								
No. incidences pig/load	0.6	0.5	0.1	0.6	0.5	0.1	0.29	0.19
Percentage/load[4]	0.4	0.2	0.06	0.4	0.3	0.8		
Crippled on arrival								
No. incidences/load	0.1	0.0	0.0	0.0	0.0	0.0	0.33	0.41
Percentage/load	0.06	0.0	0.0	0.0	0.0	0.0		
Stressed in plant								
No. incidences/load	0.3	0.2	0.1	0.2	0.2	0.1	0.59	0.86
Percentage/load	0.2	0.1	0.06	0.1	0.1	0.06		
Crippled in plant								
No. incidences/load	0.0	0.0	0.0	0.0	0.0	0.0	0.58	0.11
Percentage/load	0.0	0.0	0.0	0.0	0.0	0.0		
Total stressed								
No. incidences/load	0.9	0.7	0.1	0.8	0.7	0.1	0.23	0.29
Percentage/load	0.6	0.4	0.06	0.5	0.4	0.06		
Total crippled								
No. incidences/load	0.1	0.0	0.1	0.1	0.0	0.0	0.27	0.06
Percentage/load	0.06	0.0	0.06	0.06	0.0	0.0		

[1]Traditional metal covered chute: The chute was 76.2 cm in width, 2.3 m in height, and 4.6 m in length, and used square stock (2.5 cm) metal cleats which were spaced 20.3 cm apart. Prototype loading gantry: The loading gantry was constructed of an aluminum covered chute and measured 91.4 cm in width, 3.1 m in height, and 9 m in overall length, including a 7.9 m sloped section and 2 dual pivoting extension systems that allowed for proper positioning to both the barn and trailer.

[2]First pull was defined as the first group of pigs marketed from a finishing facility and these pigs were not fed ractopamine hydrochloride. Close out was defined as the last group of pigs marketed from a finishing facility and these pigs were fed ractopamine hydrochloride (Elanco Animal Health, Greenfield, IN).

[3]Stressed (stressed on arrival and stressed in pen) pigs were defined as having temporarily lost the ability to walk, but had a reasonable expectation to recover full locomotion with rest. Crippled (crippled on arrival and crippled in pen) pigs were defined as any pig that had received an injury that impeded its movement. Two new categories were created that summed stressed on arrival and stressed in pen (total stressed) and crippled on arrival and crippled in pen (total crippled).

[4]Percentage/load was calculated as (number incidences/load for a given variabler)/(avg. number pigs/load for a given variable).

Table 5. Market pig transport loss least square means (±SE) measured at the harvest facility when pigs were loaded for transport using either a traditional metal covered chute (TC) and a prototype loading gantry (PLG) at first pull (FP) and close out (CO) from July 2006 to October 2007

	Pull[1]							
	First Pull			Close Out				
	Loading system Design[2]						*P*-value	
Item	TC	PLG	SE	TC	PLG	SE	FP	CO
No. of loads	112	99	–	128	158	–	–	–
Dead on arrival[3]								
No. incidences/load	0.3	0.2	0.1	0.2	0.2	0.0	0.16	0.86
Percentage/load[4]	0.2	0.1	0.06	0.1	0.1	0.0		
Dead in plant								
No. incidences/load	0.3	0.2	0.1	0.2	0.1	0.0	0.37	0.49
Percentage/load	0.2	0.1	0.06	0.1	0.06	0.0		
Total dead								
No. incidences/load	0.6	0.4	0.1	0.4	0.3	0.1	0.06	0.74
Percentage/load	0.4	0.2	0.06	0.2	0.2	0.06		
Total transport losses								
No. incidences/load	1.6	1.1	0.2	1.3	1.0	0.2	0.03	0.21
Percentage/load	1.0	0.6	0.1	0.8	0.6	0.1		

[1]First pull was defined as the first group of pigs marketed from a finishing facility and these pigs were not fed ractopamine hydrochloride. Close out was defined as the last group of pigs marketed from a finishing facility and these pigs were fed ractopamine hydrochloride (Elanco Animal Health, Greenfield, IN).

[2]Traditional metal covered chute: The chute was 76.2 cm in width, 2.3 m in height, and 4.6 m in length, and used square stock (2.5 cm) metal cleats which were spaced 20.3 cm apart. Prototype loading gantry: The loading gantry was constructed of an aluminum covered chute and measured 91.4 cm in width, 3.1 m in height, and 9 m in overall length, including a 7.9 m sloped section and 2 dual pivoting extension systems that allowed for proper positioning to both the barn and trailer.

[3]Dead (dead on arrival and dead in pen) pigs were defined as a pig that had ceased to breathe. Dead on arrival and dead in pen were summed to make a new category called total dead pigs. Total transport losses were defined as the summation of total crippled, total stressed, and total dead pigs.

[4]Percentage/load was calculated as (number of incidences/load for a given variable)/(avg. number pigs/load for a given variable).

Implications

Berry et al. (2010a) had previously reported that pork quality attributes improved for pigs when loaded using the PLG for both FP and CO pulls. This study further demonstrates that the PLG provided superior animal welfare measures at loading. Although performance measures were not different at the harvest facility, pigs loaded for transport using the prototype loading gantry did have 2 interesting trends (fewer total crippled and fewer total dead pigs at the harvest facility), and that may become significant if more loads for both the PLG and the TC were compared. Overall transport losses were lower for FP when pigs were loaded using the PLG compared with the TC. Improved welfare at loading, combined with a reduction in total transport losses for FP pigs, are also of economical importance for the U.S. swine industry. By saving 0.5 pigs/load when loading market-weight pigs with the PLG over the TC, producer revenues would have increased by $44 million in 2010. These studies demonstrate that loading systems that improve on-farm swine welfare at loading and reduce transport losses at the harvest facility can be designed.

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