

ANIMAL WELFARE

Title: Using conveyor belt to load and unload pigs to promote self-movement of piglets; -
NPB#15-077

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Industry Summary:

Pigs are not accustomed to climbing sloped ramps. However, sloped ramps are impossible to avoid in regular management and handling practices due to design of the physical facilities at finishing sites, packing plants, and the vehicles used to transport animals. Intense handling that may occur when there is not self-movement of pigs causes strain on animal handlers and can create a welfare problem for the pigs in question. Use of a conveyor belt can reduce the difficulty of loading animals. This study examined the possibility of using a conveyor to move pigs up into a simulated top deck of a straight deck livestock trailer. Two age groups of pigs were tested, Weaned pigs and Nursery pigs. Weaned pigs were moved in groups of 20 while Nursery pigs were moved in groups of 10. Pigs used as a control treatment were herded up the ramp without the conveyor moving, thus keeping the flooring, width, and length the same for both treatments. Treatment pigs were moved using the conveyor in-motion. Heart rate of two sentinel pigs per group, as well as the handler, was recorded during loading. The body temperature of the handler was recorded using infra-red thermography. Pigs were held in the simulated trailer for 30 minutes while heart rate was recorded. After which, they were unloaded and held in a holding pen for an additional 30 minutes while heart rate was again recorded. Based on behavior and physiology the pigs had similar experiences in both treatments, thus conveying the pigs up into the trailer did not decrease their stress, nor did it increase it. Pigs being moved onto the moving conveyor did balk for a few more seconds than when the conveyor was not moving (Control pigs); but total time to load was the same. This study shows that it is feasible to use a conveyor to load pigs and is not detrimental, but it may not be advantageous either.

Keywords: swine, transport, ramp, conveyor, stress, weaned, nursery, pig, piglet

Scientific Abstract:

Transportation is known to be a multi-faceted stressor, with the process of loading being one of the most significant factors impacting the stress to which animals are exposed. However, transportation is unavoidable given that weaned pigs and nursery pigs need to be moved to growing facilities and finished pigs need to be moved to market. Therefore, this project was designed to determine if using a conveyor to load pigs into the top deck of a simulated straight deck trailer

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could lower the stress to which pigs and handlers are exposed. Pigs were assigned to either a Control group which were herded up a stationary conveyor ramp into a top deck trailer (8' 2" above the ground); or Conveyor group which were herded onto a mobile conveyor ramp into a top deck trailer. The conveyor was 25' long, 3' wide and rose to 8' 2" height at a 16 degree slope, and moved 37 feet per minute. It conveyed pigs up to an aluminum, small livestock transporter, 90" L x 44" W x 43" H. Two age groups were tested, Weaned pigs which were moved in groups of 20 (n = 14 groups/treatment); and Nursery pigs which were moved in groups of 10 (n = 15 groups per treatment). Behavior was recorded during loading, including slips and falls, vocalizations, assists, and time to load. Heart rate of 2 sentinel pigs/group and the handler were recorded during loading, and body temperature of the handler after loading. Pigs were held in the simulated trailer for 30 minutes while heart rate was recorded. After which, they were unloaded and held in a holding pen for an additional 30 minutes while heart rate was again recorded. There were no treatment differences for slips or falls ($P < 0.90$). Vocalizations were too few to statistically analyze. Both Weaned (2.8 ± 0.7) and Nursery (1.6 ± 0.5) Conveyor pigs needed to be assisted onto the conveyor more than Weaned (1.6 ± 0.5) and Nursery (0.3 ± 0.1) Control pigs ($P < 0.06$). Although time to load differed in different stages of loading ($P < 0.10$), there was no difference in total loading time between the treatments for any age group ($P < 0.15$), with Weaned and Nursery pigs loading in 50 to 45 seconds respectively. There were no treatment differences for heart rate variability measures ($P > 0.10$). However, loading increased heart rate of Nursery pigs ($P < 0.005$), but not Weaned pigs. Nursery pigs had greater ratio of Low Frequency to High Frequency power (LF/HF) during loading ($P < 0.02$) compared to other phases of the procedure in both Control and Conveyor groups. Heart rate and body temperature of the handler was not effected by treatment ($P < 0.26$). However, the body temperature of the handler when moving Weaned pigs was greater than when moving Nursery Pigs ($P < 0.0006$). Based on behavior and physiology the pigs had similar experiences in both treatments, thus conveying the pigs up into the trailer did not decrease their stress, nor did it increase it. Pigs being moved onto the moving conveyor did balk for a few more seconds than when the conveyor was not moving (Control pigs); but total time to load was the same. This study shows that it is feasible to use a conveyor to load pigs and is not detrimental, but it may not be advantageous either.

Introduction:

Over 111 million pigs are transported from finishing sites to abattoirs yearly. At least the same number of pigs are transported from farrowing sites to finishing sites during the same year. Therefore, pigs are exposed to at least two transportation events in their lifetime. Transportation has already been established as a multi-factorial stressor; the stress starts at the farm facility even before the pigs are loaded into the trailers. The overall objective of this study was to use a conveyor belt to promote self-movement of pigs (two age groups: Weaned piglets and Nursery pigs), reduce handling stress to handlers and animals, and thus improve the overall welfare.

We hypothesized that an automated conveyor belt should be able to promote self-movement of pigs. This would reduce intervention by the handlers while the pigs are loading up a sloped ramp, reduce slips and falls, and the stress associated with loading. Reducing stress before and after transport of piglets can have a long term effect on growth and efficacy of piglets. Slips and falls can induce stress, bruises, lacerations and injuries to the pigs. Therefore, slips and falls during loading and unloading pigs are major concerns of the industry as well as from an animal welfare perspective.

Because pigs are not used to walking long distances and handling, pigs balk when loaded using a sloped ramp. This jams the flow of pigs into the trailer. Handlers often use electric prods in such cases. The aim of this study was to use a conveyor belt to promote self-movement of pigs, thus

reducing intervention of the pigs, increasing efficiency, and creating an animal welfare friendly and handler friendly method of loading pigs.

Objectives: To reduce handling stress to animals as well as handlers by promoting self-movement of pigs during loading and unloading

Materials & Methods:

The study was conducted at the Animal Science Research and Education Center (ASREC) Swine Unit at Purdue University, Indiana. All animal procedures were approved by Purdue Animal Care and Use Committee. Weaned piglets of 10-15 lbs. (18-23 d old) and Nursery pigs of 30-40 lbs. (approximately 6 weeks old) were used. The pigs were tested to determine if loading using a conveyor belt loader could promote self-movement of pigs, reduce stress to animals and handlers, and improve overall welfare.

Piglets were weaned at approximately 21 days of age and randomly assigned to one of two treatments. Pigs were loaded into the upper deck of a simulated straight-deck trailer using one of the following methods: Control, 1) Pigs were loaded using the immobile conveyor ramp, but without the conveyor turned on; or Conveyor, 2) Pigs were loaded using a mobile conveyor ramp custom made for this experiment. The conveyor was 25' long, 3' wide and rose to 8' 2" height at a 16 degree slope, and moved 37 feet per minute (Figure 1). It conveyed pigs up to an aluminum small livestock transporter, 90" L x 44" W x 43" H, bedded with straw. The surface of the conveyor was slightly textured with a chevron pattern approximately 1/8 inch in height (Figure 2.).

This study was conducted in 4 and 3 replications for Weanling and Nursery pigs respectively during the months of November through March. Temperature averaged 46.0 °F and ranged from 33.3 °F to 72.1 °F. Piglets were only used once to ensure that the piglets were equally novel to the handling and loading experience.

Step-wise procedure:

Two randomly selected pigs in a group were fitted with heart rate monitors around their chest to record heart rate variability. Pigs remained in their home pen for 30 minutes to let them calm down and collect baseline heart rate data. The handler was also fitted with a heart rate monitor to collect their own heart rate data during handling. Pigs were herded in a group of 20 (Weaned piglets) or 10 (Nursery pigs) through a distance of approximately 131 feet with an average alley width of 53" and loaded into the upper deck of a simulated straight-decked trailer (Figure 3). The handler used a plastic board and shaker paddle to move the pigs. When pigs were loaded, a handler stood at the top of the conveyor (out of site, on the outside) to assist piglets moving forward when they reach the upper deck. Pigs remained in the trailer for 30 minutes and were unloaded down the non-moving ramp (Figure 4) and returned to a holding pen for 30 minutes. Heart rate recording was continued for another 30 minutes after they were in the holding pen. Pigs were video recorded during loading.

The following measures were taken:

Slips and falls: The number of times pigs slipped (foot misses a step) or fell (imbalance of pig's body with its body touching floor) as defined by American Meat Institute.

Vocalizations: Any squeals by pigs, other than grunts.

Number of Assists: The number of times the handler needed to push or lift a pig onto the conveyor was recorded from the time the pigs entered the ramp and until they were on the conveyor. The

ramp was a 55 inch textured board that was used to elevate the pigs to the height of the conveyor, approximately 12 inches (Figure 1).

Time to load: Total time to load and unload the group of pigs. Time started when the first pig of the group put its first step onto the ramp and the time ended when the last pig put its head and shoulders into the simulated trailer.

Pig and Handler Heart rate: Heart rate was recorded using telemetric recorders wrapped around the pigs' and handler's rib cage.

Handler Body Temperature: Handler body temperature was recorded after loading using infrared thermography. An area around the eye and neck were marked and the maximum temperature of each was recorded (Figure 5).

Data Analysis

Data were analyzed to compare slips and falls, vocalizations, handling assists, time to load and unload, heart rate variability of pigs, heart rate of handler, and body temperature of the handler. Analysis of variance using mixed models (treatment was a fixed effect and day, outside temperature, and baseline values as random effect) was used to analyze all data. Data that were not normal were transformed, and if normality could not be achieved data were analyzed using the Wilcoxon-Mann-Whitney test. Group was considered the statistical unit. Non-normal data were transformed and significance was set at $P < 0.05$.

Results:

Slips and falls: There were no treatment differences ($P < 0.90$) for slips or falls for Weaned or Nursery pigs, with pigs from both treatments having very few of either. Weanling pigs had 1.6 ± 0.8 and 1.7 ± 0.9 slips during loading for the Control and Conveyor treatment respectively. While Nursery pigs had 1.8 ± 0.5 and 1.7 ± 0.4 slips for the Control and Conveyor treatments respectively. Weanling pigs had 0.4 ± 0.2 and 0.8 ± 0.7 falls during loading for the Control and Conveyor treatment respectively. While Nursery pigs had 0.9 ± 0.4 and 0.7 ± 0.3 falls for the Control and Conveyor treatments respectively.

Vocalizations: The number of times piglets squealed during loading was also recorded. Due to the very low number they were not analyzed statistically. Regardless of age category (Weanling or Nursery) Control pigs squealed 1.4 ± 0.6 times and Conveyor pigs squealed 1.1 ± 0.5 times during loading.

Number of assists: Weaned Conveyor pigs tended to be assisted (pushed or placed) onto the conveyor more ($P < 0.06$) than Control pigs, 2.8 ± 0.7 and 1.2 ± 0.4 respectively (Table 1). Similarly, Nursery Conveyor pigs also needed to be assisted onto the conveyor more ($P < 0.03$) than Control pigs, 1.6 ± 0.5 and 0.3 ± 0.1 respectively.

Time to load and unload: Overall it took Conveyor pigs several seconds longer to step onto the conveyor than it did the Control pigs. From the time the first Weaned pig approached the conveyor and stepped onto the conveyor was 11.4 ± 1.8 seconds for Control pigs and 22.6 ± 3.3 seconds for Conveyor pigs ($P < 0.007$, Table 1). Similarly, from the time the first Nursery pig approached the conveyor and stepped onto the conveyor (non-moving) was 12.0 ± 2.7 seconds for Control pigs and 17.6 ± 2.0 seconds for Conveyor pigs ($P < 0.07$, Table 1). This longer time for the first Conveyor pig to get onto the conveyor is reflected in the longer time for the entire group to be loaded onto the conveyor. From the time the group approached the conveyor it took Weaned Control pigs 31.8 ± 2.4 seconds for the group to be on the conveyor and 46.4 ± 4.7 seconds for the group of Conveyor pigs to be loaded

onto the conveyor ($P < 0.02$, Table 1). Nursery pigs behaved similarly but there were no treatment differences ($P < 0.15$) for the entire group to move onto the conveyor (Table 1). The time from the first pig stepping onto the conveyor until the first pig entering the trailer was not different for Weaned pigs in either treatment (Table 1), averaging approximately 26.5 seconds to move up the conveyor. In contrast, Nursery Conveyor pigs tended to move onto the conveyor more quickly ($P < 0.06$), taking 19.8 ± 2.8 seconds, compared to Nursery Control pigs that took 28.9 ± 5.1 seconds (Table 1). Although we have found differences at particular stages of loading, there was no treatment difference ($P < 0.15$) in the total time it took for pigs to step onto the conveyor and be completely loaded into the trailer, with all Weaned pigs being loaded in approximately 50 seconds, and Nursery pigs in approximately 45 seconds (Table 1).

Pig and Handler Heart Rate: No treatment differences were found for any measures of heart rate variability ($P > 0.10$, Table 2) for either Weanling or Nursery pigs. There was an effect of 'phase' for some variables for Nursery pigs, but not for Weanling pigs. Phase was defined as data collected at 1) baseline in the home pen, 2) during loading, 3) in the trailer, or 4) in the holding pen after unload (Table 2). Mean R-R, defined as the time between the R peaks of a QRS complex in the heart beat, was greater for Nursery pigs during loading when compared to being in the trailer or holding pen ($P < 0.13$, Table 2); but no differences were detected for Weaned pigs. The SDNN, defined as the standard deviation of normal R-R intervals, followed a similar pattern as expected ($P < 0.02$, Table 2). The mean heart rate also differed by phase for Nursery pigs ($P < 0.01$) with rates being higher in the trailer and holding pen when compared to loading ($P < 0.01$). And finally, the ratio of low frequency to high frequency power (LF/HF) differed by phase for Nursery pigs ($P < 0.02$), characterized by more low frequency power during loading when compared to that during the time on the trailer and in the holding pen (Table 2).

The heart rate of the handler immediately after loading the Weaned pigs was not different between treatments ($P < 0.75$), averaging 93.8 ± 1.9 beats per minute when loading the Control pigs and 93.9 ± 1.9 beats per minute when loading the Conveyor pigs. The same was found to be true when loading the Nursery pigs, although a small numerical difference is apparent it was not significant ($P < 0.26$), with heart rate at 95.0 ± 2.0 beats per minute when loading the Control pigs and 91.5 ± 2.1 beats per minute when loading the Conveyor pigs.

Handler Body Temperature:

There were no treatment differences when comparing both eye and neck temperature of the handler ($P < 0.68$). However, there was a pig age effect ($P < 0.0006$, Figure 5) characterized by the handler having a higher body temperature when loading Weaned pigs as compared to Nursery pigs.

Discussion:

The results from this study indicate that it is feasible to load pigs using a conveyor. However, there appears to be no advantage in doing so, based on behavioral and physiologic data, in terms of decreasing the amount of stress to which pigs are exposed. Although pigs hesitated for a few more seconds when approaching the moving conveyor, the total time to load between Conveyor pigs and Control pigs was the same.

Slips and falls were minimal and this measure of loading stress is likely more applicable as a measure of stress to market weight animals. Similarly, vocalizations characterized as squeals, is a useful measure of handling distress for market weight pigs, but does not appear to be useful in weanling and nursery pigs. The number of assists was recorded as a measure of how many pigs would balk at stepping onto the conveyor, thus the work required to load the pigs. More conveyor pigs needed to be assisted onto the conveyor. Pigs typically hesitate from moving to one surface to another, based on texture, lighting and color. The fact that the conveyor was moving increased this hesitation by

several seconds; however, when the pigs were on the moving conveyor they easily walked up and down the conveyor as well as investigated the conveyor, indicative of a low stress situation.

Heart rate and heart rate variability were calculated in pigs as a measure of distress. Greater heart rate and less heart rate variability are indicative of distress. No treatment differences were found for Weanling pigs, and interestingly the measures in the home pen were numerically higher (not statistically) for heart rate compared to loading and holding in the trailer. This may be due to inherent variability over time. In contrast, heart rate and heart rate variability did differ for Nursery pigs, by phase of loading but not by treatment. Nursery pigs exhibited a decrease in R-R intervals when they were in the trailer and the holding pen. This is indicative of a higher heart rate being controlled by both sympathetic and parasympathetic stimulation; and likely due to the fact that they were in a novel environment and mixed with unfamiliar pigs. Nursery pigs showed a significant increase in low frequency power during the loading phase. This is indicative of an increase in sympathetic activity, meaning that they were more distressed, during loading as compared to all other phases of the procedure. Loading is known to be stressful, but it is interesting that weanling pigs did not show the same response. Evaluation of the data does show a similar arithmetic response, which was not statistically significant. This may be due to the relative under development of the autonomic nervous system at this age in weanling pigs. The fact that mean heart rate was lower during loading but the low frequency power was higher during loading is a clear sign of sympathetic dominance, indicative of distress due to loading in Nursery pigs.

The heart rate and body temperature of the handler were recorded as measures of exertion from the work of loading. Neither measure differed between treatments, indicating that the handler had to work to a similar effort for both Conveyor and Control pigs. This is likely due to the fact that even if Conveyor pigs were being automatically conveyed up to the trailer, the handler was still walking up the conveyor to ensure they entered the trailer. The body temperature of the handler did indicate that it takes more work to load weanling pigs than it does to load nursery pigs. Based on observations in this study this is simply due to weanling pigs not knowing how to walk down an alley and having never experienced a larger space than their home farrowing pen, and thus needing to be pushed along the alley. In contrast, nursery pigs easily walked down alley spaces and moved freely away from the handler.

In conclusion, the use of a conveyor to load pigs into the top deck of a straight deck livestock trailer works very well. However, it does not decrease the stress of loading for the pig, or the work required by the handler.

Table 1. Behavior of pigs during the process of loading. Table A is the behavior of Weaned pigs, and Table B is the behavior of Nursery pigs. Control pigs were herded onto the immobile conveyor ramp, while Conveyor pigs were herded onto the mobile conveyor ramp. The time it took pigs to move between different facets of loading was recorded as follows. ConvLat is the time from the first pig stepping on the ramp to the first pig stepping onto the conveyor. OnConv is the time from the 1st pig approaching the conveyor to the 1st pig stepping onto the conveyor. BotLoad is the total loading time at the bottom of the conveyor, from the 1st pig stepping on the ramp to the last pig stepping onto the conveyor. Assists are the number of times the handler had to push or lift a pig onto the conveyor. TrailAppr is the time from the 1st pig stepping onto the conveyor to the 1st pig arriving at the trailer. TrailLat is the time from the 1st pig stepping on the conveyor to the 1st pig stepping into the trailer. TotTime is the total time from the 1st pig stepping onto the conveyor to the last pig stepping into the trailer.

A

Variable	Control	Conveyor	<i>P</i> =
ConvLat (s)	11.4 ± 1.82	22.6 ± 3.29	0.007
OnConv (s)	1.9 ± 0.52	8.6 ± 2.72	0.01
BotLoad (s)	31.8 ± 2.42	46.4 ± 4.66	0.02
Assists (#)	1.2 ± 0.42	2.8 ± 0.68	0.06
TrailAppr (s)	22.33 ± 2.34	21.25 ± 1.77	0.83
TrailLat (s)	27.22 ± 3.41	26.0 ± 1.86	0.91
TotTime (s)	57.17 ± 5.06	46.64 ± 4.39	0.14

B.

Variable	Control	Conveyor	<i>P</i> =
ConvLat (s)	12.0 ± 2.70	17.64 ± 1.98	0.07
OnConv (s)	1.61 ± 0.29	6.78 ± 2.04	0.006
BotLoad (s)	31.08 ± 5.28	46.75 ± 9.47	0.15
Assists (#)	0.33 ± 0.14	1.64 ± 0.45	0.03
TrailAppr (s)	20.3 ± 2.55	14.8 ± 1.43	0.03
TrailLat (s)	28.9 ± 5.17	19.78 ± 2.77	0.06
TotTime (s)	49.69 ± 6.15	40.07 ± 3.69	0.15

Table 2. Measures of heart rate variability during four phases of the experiment. Table A represents data for weanling pigs and Table B for Nursery pigs. Control pigs were herded onto the immobile conveyor ramp, while Conveyor pigs were herded onto the mobile conveyor ramp. Heart rate was recorded when the pigs were in their home pen (Baseline Pen), during Loading, when they were held in the Trailer for 30 minutes, and after unloading when they were held in a Holding Pen. Mean R-R is defined as the time between the R peaks of a QRS complex in the heart beats. The SDNN is defined as the standard deviation of normal R-R intervals. Mean HR is the mean heart rate during a specific phase of the process. Std HR is the standard deviation of the heart rate. RMSSD is the root square mean of successive differences. And LF/HF is the ratio of low frequency and high frequency power of the spectral analysis.

A

HRV Parameters	Control				Conveyor				P=	
	Baseline Pen	Loading	Trailer	Holding Pen	Baseline Pen	Loading	Trailer	Holding Pen	Phase	Trt
Mean R-R (ms)	340.6 ± 12.8	400.1 ± 9.5	372.1 ± 16.5	367.0 ± 17.2	351.7 ± 14.9	377.5 ± 10.9	369.9 ± 15.4	364.5 ± 18.3	0.98	0.49
SDNN (ms)	14.7 ± 1.6	12.2 ± 1.7	11.3 ± 1.1	10.31 ± 0.8	13.1 ± 1.3	9.1 ± 1.1	11.1 ± 1.5	10.0 ± 0.9	0.21	0.68
Mean HR (bpm)	181.5 ± 6.4	150.8 ± 3.4	168.5 ± 8.4	171.5 ± 8.7	177.5 ± 7.3	153.8 ± 7.0	165.2 ± 8.6	172.7 ± 9.2	0.84	0.76
Std HR (bpm)	8.0 ± 0.9	4.5 ± 0.6	4.9 ± 0.5	5.0 ± 0.5	6.8 ± 0.7	3.8 ± 0.4	5.4 ± 1.1	4.9 ± 0.7	0.62	0.18
RMSSD (ms)	7.5 ± 0.9	3.9 ± 0.6	4.5 ± 0.3	4.2 ± 0.4	6.6 ± 0.5	4.8 ± 0.8	4.7 ± 0.7	5.1 ± 0.7	0.95	0.16
LF/HF	6.9 ± 2.8	20.7 ± 14.4	4.9 ± 1.2	8.4 ± 2.3	2.9 ± 1.1	10.6 ± 4.3	3.1 ± 0.3	4.6 ± 1.2	0.87	0.13

B

HRV Parameters	Control				Conveyor				P=	
	Baseline Pen	Loading	Trailer	Holding Pen	Baseline Pen	Loading	Trailer	Holding Pen	Phase	Trt
Mean R-R (ms)	323.00 ± 14.1	333.2 ^a ± 17.4	295.4 ^b ± 9.0	298.6 ^b ± 11.0	310.1 ± 9.1	344.6 ^a ± 16.2	301.8 ^b ± 10.3	301.0 ^b ± 12.0	0.01	0.26
SDNN (ms)	13.9 ± 1.2	13.0 ^a ± 2.2	11.3 ^b ± 1.0	11.5 ^b ± 0.8	14.00 ± 1.3	14.12 ^a ± 2.1	12.9 ^b ± 1.2	11.1 ^b ± 1.1	0.02	0.80
Mean HR (bpm)	193.3 ± 6.5	187.2 ^a ± 9.7	206.7 ^b ± 4.8	205.8 ^b ± 5.3	197.5 ± 4.7	180.0 ^a ± 8.61	202.5 ^b ± 5.5	204.0 ^b ± 6.1	0.01	0.25
Std HR (bpm)	8.3 ± 0.7	7.2 ± 1.3	7.9 ± 0.6	8.1 ± 0.6	8.9 ± 0.8	7.8 ± 1.4	8.8 ± 0.8	7.7 ± 0.7	0.94	0.92
RMSSD (ms)	6.6 ± 0.6	5.3 ± 0.8	5.9 ± 0.6	6.6 ± 0.7	7.1 ± 0.6	6.0 ± 0.8	6.5 ± 0.5	6.2 ± 0.9	0.46	0.71
LF/HF	3.42 ± 0.84	6.71 ^a ± 1.90	2.58 ^b ± 0.60	2.49 ^b ± 0.57	2.8 ± 0.4	4.3 ^a ± 1.4	1.8 ^b ± 0.3	2.3 ^b ± 0.4	0.02	0.14



Figure 1. The ramp and conveyor used to load pigs into the simulated trailer. The time pigs spent on the ramp (A), prior to stepping onto the conveyor is denoted as “Botload” in Table 1. The time on the conveyor (B) is denoted as “TrailLat” in Table 1. And the total time to load the pigs starting from when they stepped on the ramp (C) is denoted as “TotTime” in Table 1. The length and height are indicated in the figure.



Figure 2. This figure displays the chevron pattern of flooring that comprised the belt of the conveyor. The rise of the texture was approximately 1/8 inch.



Figure 3. The figure on the left is the alley used to herd pigs to the conveyor. Black cloth was laid down to make continuous flooring from the barn to the conveyor. The figure on the right depicts pigs being conveyed on the mobile conveyor (treatment Conveyor) up into the simulated trailer. The pigs with black belts around their chest are sentinel pigs used to assess heart rate. The grey tape around the handler's chest is securing a heart rate monitor as well. Note that pigs are investigating the conveyor and also that they appear to hesitate at the top before entering the transporter.



Figure 4. Pigs are being unloaded from the simulated trailer onto a small ramp that connects the conveyor to the ground.

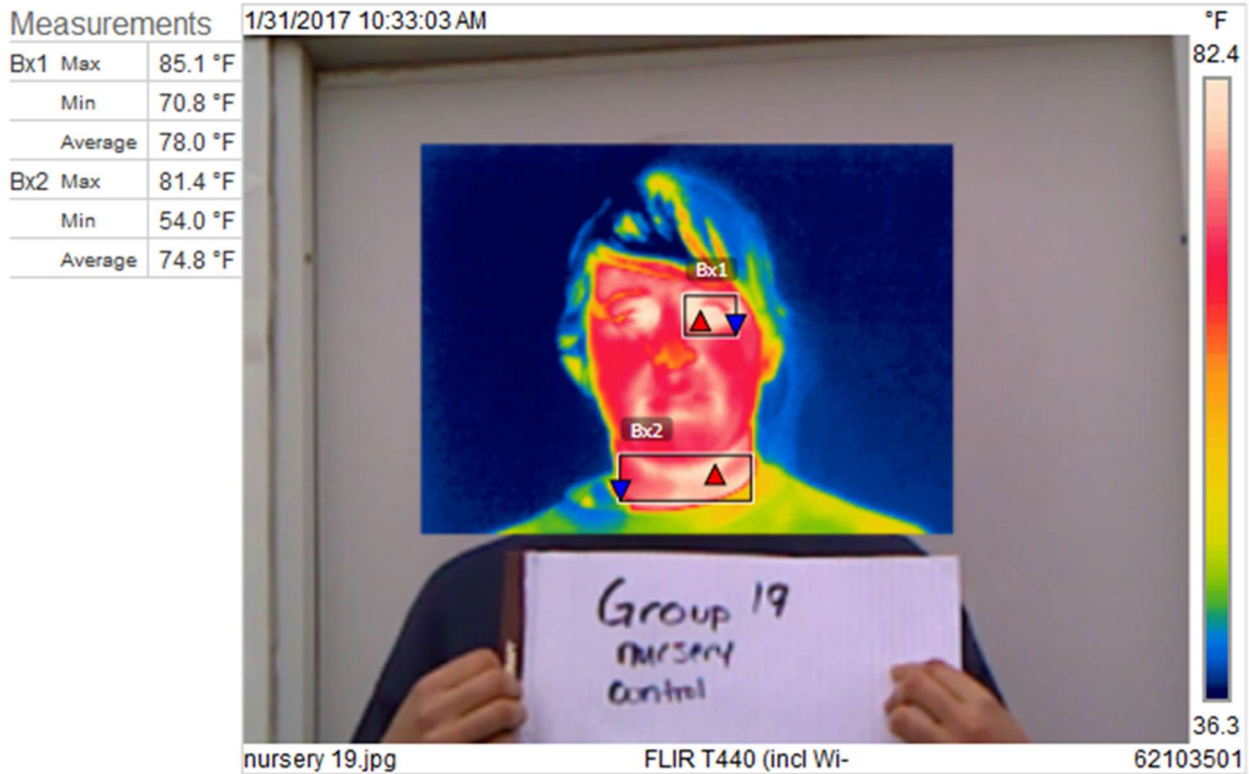


Figure 5. This thermal image is of the handler immediately after loading group 19, nursery pigs. Body temperature of the handler was measured by drawing a square around the eye and neck and recording the maximum temperature in each area. The scale on the right shows the range in temperature in the photo. The box on the top left provides the maximum, minimum and average temperature.

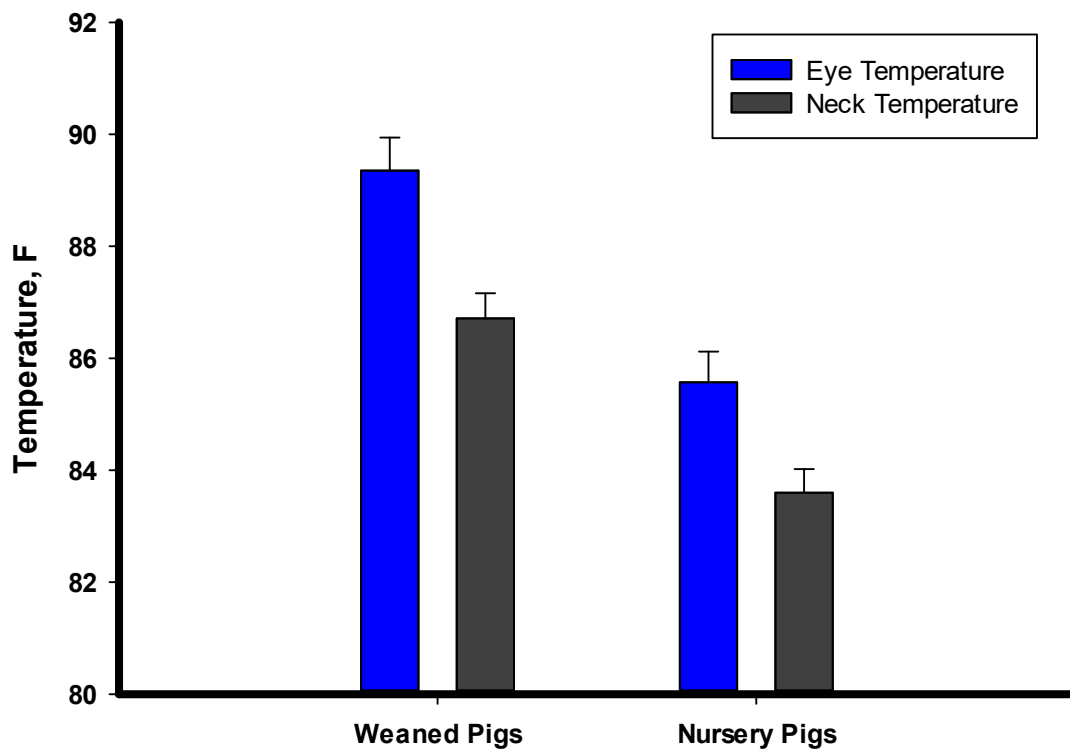


Figure 6. Eye and neck temperature of the handler immediately after loading Weaned and Nursery pigs. Body temperature was greater after handling Weaned pigs as compared to Nursery pigs ($P < 0.0006$).