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Pre-harvest handling defects and measures to alleviate them

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Introduction

Pre-harvest handling defects in pigs are defined as defects that occur either during transportation or during the lairage rest period prior to harvest at the processing facility. These defects include pigs that become injured, stressed/fatigued, or die. Furthermore, defects have economical implications, with higher labor costs in the packing facilities and lost revenue for producers, and of course, animal welfare concerns by the entire swine industry. It has been estimated that dead and non-ambulatory pigs cost the US swine industry between $50 and $100 million each year (Ellis et al., 2003). These defects are a result of multiple stressors that are imposed upon the animals during the marketing process in an additive manner (Ritter et al., 2010). This paper will detail some commercial studies that were conducted to determine the factors that influence pre-harvest handling defects so that measures to alleviate the pre-harvest handling defects could be developed and implemented.

Materials and methods

Data from these experiments were collected within a large integrated pork producer's system in the Midwest. All loads were transported on straight deck side-unloading trailers from 2 different manufacturers. Trailer type 1 had a total floor space of 73.52 m^2 (Barrett Trailers, Purcell, Oklahoma) and trailer type 2 had a total floor space of 72.84 m^2 (Wilson Trailers, Sioux City, Iowa). The side-unloading trailers allowed for unloading at the plant without ramps and electric prods were not used during unloading. During unloading and in the lairage prior to harvest, each load was evaluated for pre-harvest handling defects by trained plant personnel. These defects are defined in Table 1.

Experiment 1: This experiment was conducted to evaluate load chute design. A traditional metal loading chute was compared to a prototype aluminum load chute. This experiment evaluated the effect of the load chute on the first (first cut) and last (closeouts) pigs marketed out of the barn. A total of 211 first cut loads (112 loads with the traditional chute and 99 loads with the prototype chute) and 340 closeout loads (182 loads with the traditional chute and 158 loads with the prototype chute) were used to evaluate the load chutes. The loads in this data set came from 1 farm within the integrated system and the farm consisted of 17 sites with 8 finisher barns (1,150 head).

The traditional load chute was 4.6 m long and 0.76 m wide that allowed for a 19-degree loading angle on the bottom deck of the trailer and the trailer had an internal ramp that allowed for a 23-degree loading angle from the bottom to the top deck of the trailer (Photo 1). The traditional

Table 1: Pre-harvest handling defects abbreviations and definitions

Variable	Definition
IOA	Identified as injured during unloading at the plant.
IIP	Identified as injured prior to harvest while in the abattoir.
DOA	Identified as dead during unloading at the plant.
DIP	Identified as dead prior to harvest while in the abattoir.
SOA	Identified as stressed (downer/NANI) during unloading at the plant.
SIP	Identified as stressed (downer/NANI) prior to harvest while in the abattoir.
Injured	Total injured (IOA + IIP)
Dead	Total dead (DOA + DIP)
Stressed	Total stressed (SOA + SIP)
Total defects	Total defects = injured + dead + stressed

chute used square (2.5 cm) metal cleats which were spaced 20.3 cm apart. Lighting was provided with a single 60 watt incandescent lamp.

The prototype aluminum load chute was designed 9 m long with a 7.9 m angled section that allowed for a 7-degree loading angle on the bottom deck of the trailer and a 18-degree loading angle on the top deck of the trailer (Photos 2 and 3). The prototype chute was designed with extending and lifting systems that allow for proper alignment with both the barn door and trailer. The width (0.91 m) of the prototype chute allowed for pigs to be loaded double-file into the side doors of the trailer instead of single-file in the back of the trailer as with the traditional chute. The flooring and walls of the prototype chute were designed to mimic the color and texture of concrete. Rope lighting was also installed to provide shadow-free lighting in the chute.

Experiment 2: This experiment was conducted to evaluate factors that could affect pre-harvest handling defects. Data (in addition to pre-harvest defects) that were collected on each truck load are shown in Table 2. A total of 9,651 loads of pigs were evaluated over a 1 year period of time. The loads in this data set came from 9 different farms within the integrated system and each farm consisted of multiple sites with 8 finisher barns (either 1,000 or 1,150 head). Loading crews (n = 9) were partially confounded in that a load crew did go to different farms, but not all nine farms. Weather data were collected using a HOBO weather station (Onset Computer Corp., Bourne, Massachusettes) that was located on the property of the packing facility. The weather station was fitted with sensors that measured temperature, barometric pressure, relative humidity, wind speed, and wind direction. The weather station collected weather data every 15 minutes and each trailer load of pigs was assigned the closest weather data point to the time the load arrived at the packing facility. A temperature-humidity index (THI) also was calculated using the following equation: THI = temperature **-** {[0.55 – (0.0055 × relative humidity)] × (temperature – 14.5)} (NOAA, 1976).

Statistical analysis**:** In both of these experiments, the dependent variables were binomial with a poisson distribution and not a normal distribution. Thus, data were analyzed using PROC GLIMMIX in SAS (SAS Inst., Cary, North Carolina). In experiment 1, the fixed effects included chute, date, month, barn, and site with the random effect of date nested within complex. A linear covariate for number of pigs shipped per load was included in the model. In experiment 2, a backward stepwise procedure was used to remove variables from the model that did not significantly ($P <$ 0.10) contribute to the variation observed. The final model included the fixed effects of week, driver, farm, load crew, barn cut, load type, and receiving crew. A linear covariate was used for THI, wind speed, load time per pig, and wait time. A quadratic covariate also was used for THI.

Photo 1

Photo 2

Photo 3

Table 2: Traits measured and definitions of those traits

Variable	Definition
Farm	Source farm of the truck load of pigs
Load crew	Load crew at the farm (11 different crews)
Load time	Time taken to load the truck on a per pig basis
Load type	Either from a single (normal) or multiple (split) barns
Distance	Distance from the farm to the packing plant
Barn cut	Marketing of pigs including 1 cut and a barn closeout
Trailer type	Manufacturer of the trailer (2 types)
Driver	Driver of the truck (29 different drivers)
Wait time	Time from arrival of load at the plant and initiation of unloading
Number of hogs	Number of hogs loaded on the truck
Avg. live weight	Average live weight determine by the total load weight
Load density	Load live weight divided by trailer space (kg/m2)
Rest time	Amount of time pigs were held in lairage
Receiving crew	Unloading crew at the plant (day or night shift)
Week	Week of the year that the load was delivered
Weather data	
Temperature	Temperature at time of unloading
Relative humidity	Relative humidity at time of unloading
Dew point	Dew point at time of unloading
Barometric pressure	Barometric at time of unloading
Wind direction	Wind direction at time of unloading
Wind speed	Wind speed at time of unloading
Wind gust	Wind gust at time of unloading
THI	Temperature-humidity Index at time of unloading

Results

In experiment 1, the use of the prototype load chute reduced ($P < 0.03$) total defects in first cut pigs, but not in the closeout pigs. However, total defects were numerically lower ($P = 0.21$) in the closeout pigs (Table 3). The individual defects (injured, stressed, and deads) were not affected by load chute type ($P > 0.05$), but many of the defects were numerically reduced in pigs loaded with the prototype chute, especially in the first cut pigs.

In experiment 2, the variables that were removed from the model because they did not affect transport losses were the linear covariates wind gust ($P = 0.72$) and distance transported ($P = 0.46$), trailer ($P = 0.43$), and wind direction ($P = 0.13$). Week, driver, farm, load crew, barn cut, load type, receiving crew, linear covariates of THI, wind speed, load time per pig, and wait time and quadratic covariate of THI all had a significant effect on transport losses ($P < 0.05$). Trailer density had the largest amount of variation in total losses ($P < 0.0001$; Figure 1) with increased trailer density resulting in increased total defects. Total defects were influenced by barn cut ($P < 0.0001$) with first cuts having fewer total defects than closeouts (0.51% vs. 0.78%). Week of the year (or season) had an effect on total defects as well ($P < 0.0001$), with the most defects occurring in November and December and the fewest defects occurring in June and July (Figure 2). As expected, farm, loading crew and driver had an effect on total defects with substantial ranges between the best and worst farm (0.28% to 1.21%), driver (0.54% to 0.78%), and load crews (0.35% to 0.86%).

Implications

These data indicate that pre-harvest handling defects can be influenced by many factors and these factors can be additive. Trailer loading density accounted for the most

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Table 3: Effects of load chute on pre-harvest defects on different marketing sorts[a]

Defect	Traditional chute	Prototype chute	*P*-value
First cut			
Number of loads	112	99	-
Injured on arrival, %	0.05 ± 0.02	0.02 ± 0.02	0.33
Stressed on arrival, %	0.62 ± 0.10	0.48 ± 0.09	0.29
Dead on arrival, %	0.33 ± 0.07	0.21 ± 0.05	0.16
Injured in pen, %	0.01 ± 0.01	0.00 ± 0.00	0.58
Stressed in pen, %	0.28 ± 0.06	0.24 ± 0.06	0.59
Dead in pen, %	0.31 ± 0.05	0.19 ± 0.05	0.37
Total injured, %	0.06 ± 0.06	0.02 ± 0.02	0.27
Total stressed, %	0.93 ± 0.13	0.73 ± 0.11	0.23
Total dead, %	0.64 ± 0.09	0.42 ± 0.07	0.06
Total defects, %	1.61 ± 0.18	1.15 ± 0.15	0.03
Closeout			
Number of loads	182	158	-
Injured on arrival, %	0.02 ± 0.01	0.01 ± 0.01	0.41
Stressed on arrival, %	0.62 ± 0.10	0.48 ± 0.09	0.19
Dead on arrival, %	0.18 ± 0.03	0.17 ± 0.04	0.86
Injured in pen, %	0.03 ± 0.01	0.00 ± 0.00	0.11
Stressed in pen, %	0.19 ± 0.04	0.20 ± 0.05	0.86
Dead in pen, %	0.17 ± 0.04	0.13 ± 0.04	0.49
Total injured, %	0.05 ± 0.02	0.01 ± 0.01	0.06
Total stressed, %	0.80 ± 0.11	0.67 ± 0.11	0.29
Total dead, %	0.36 ± 0.06	0.33 ± 0.07	0.74
Total defects, %	1.19 ± 0.15	0.99 ± 0.15	0.21

[a] Marketing sorts included the first (1st cut) and last (closeouts) pigs marketed out of the barn.

Production

variation in total defects in these data, but barn cut also contributed to a large amount of variation in total defects as well. Care should be taken to insure proper loading densities particularly in the cooler months when average live weights are higher. Factors such as farm, load crew, and driver should be monitored closely to determine areas for improvement and define trouble spots.

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Figure 1: Effect of trailer density on total losses

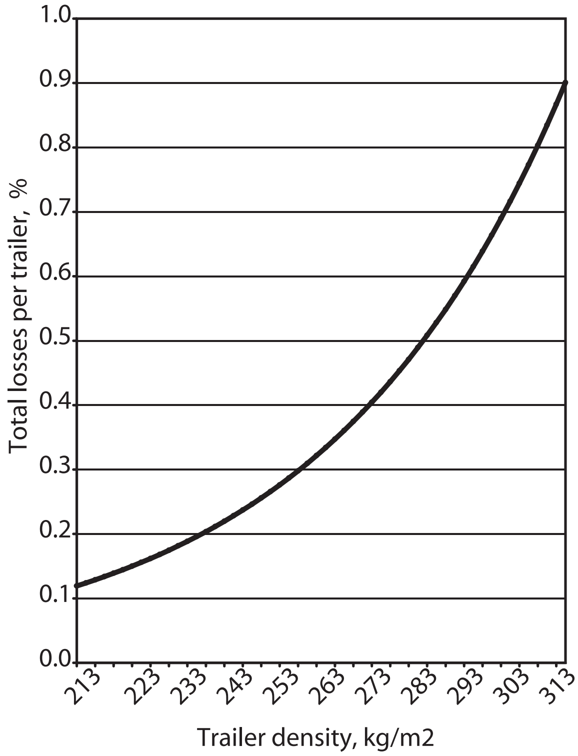
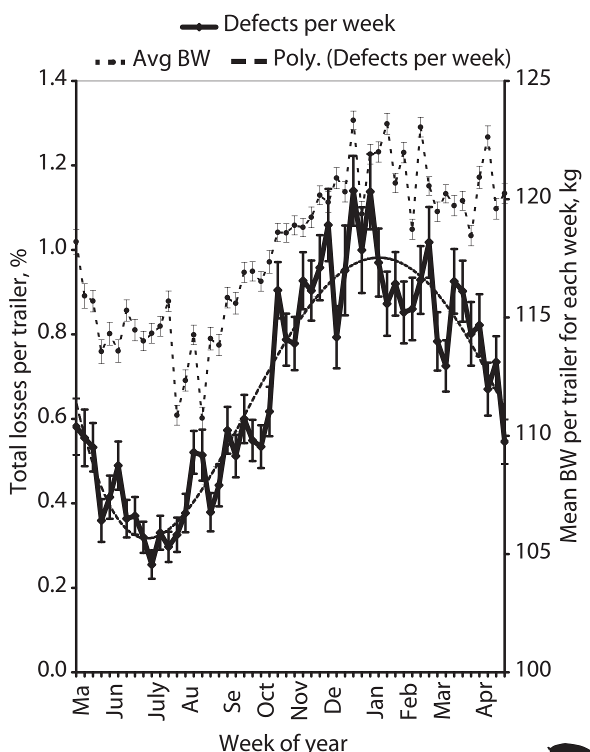


Figure 2: Effect of week (season) on total pre-harvest defects and average live weight



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