RESEARCH REPORT
ANIMAL WELFARE

Title: Establishing Bedding and Boarding Requirements for Finisher Pigs Through Scientific Validation – Macro Study. – **NPB #11-181**

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Industry Summary:

1. Establishing bedding requirements during transport and monitoring skin temperature over seasons after transport for finishing pigs.

   The objective of this study was to determine how much bedding should be provided in the transport trailer for finishing weight pigs in cold, mild, and warm weather. Pigs were raised to finishing weight and then transported to commercial processing plants. Upon arrival at the processing plants, the numbers of dead on arrival, non-ambulatory, and total dead and down pigs were counted. Non-invasive infrared thermography was used to collect skin surface temperature. Total dead and down was not affected by bedding level in cold and mild temperatures; however, when air temperature exceeded 32 °C, numbers of total dead and down drastically increased. Skin surface temperature increased linearly with air temperature in all temperature ranges. These findings suggest that excessive bedding may be economically inefficient, and may actually increase pig losses in warm weather.

2. Establishing boarding requirements for finishing pigs during transport

   The objective of this study was to determine the level of boarding that should be provided on transport trailers for finishing weight pigs in mild weather. Pigs were transported from finishing sites to commercial processing plants in temperatures between 5 and 24 °C. Numbers of dead on arrival (DOA), non-ambulatory (NA), and total dead and down (D&D) were counted upon arrival at the processing plant. Boarding on each trailer was either low (0-30 %), medium (31-60 %), or high (> 61%). Data for DOA, NA, and D&D were considered in 4 temperature ranges (< 5 °C, 5.10 – 10.00 °C, 10.10 – 15. 00 °C, and > 15.00 °C). D&D was highest in trailers with low boarding level at temperatures < 5 °C. Boarding levels had no effect on pig losses in any temperature range above 5.10 °C. These results will provide scientifically supported guidelines for swine transport personnel, with the goal of improving animal welfare and reducing economic losses.

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Scientific Abstract

1. Establishing Bedding Requirements during transport and monitoring skin temperature over seasons after transport for finishing pigs.

The broad aim of this study was to determine whether bedding level in the transport trailer influenced pig performance and welfare. Specifically, the objective was to define the bedding requirements of pigs during transportation in commercial settings during cold, mild, and warm weather. Animals (n = 112,078 pigs on 572 trailers) used were raised in commercial finishing sites and transported in trailers to commercial processing plants. Dead on arrival (DOA), non-ambulatory (NA), and total dead and down (D&D) data were collected and skin surface temperatures of the pigs were measured by infrared thermography. Data were collected during winter (experiment 1), fall/spring (experiment 2), and summer (experiment 3). Total D&D percent showed no interaction between bedding level and outside air temperature in any experiments. Average skin surface temperature during unloading increased with outside air temperature linearly in all three experiments ($P < 0.01$). When air temperature exceeded 32 °C, a sharp increase in D&D was observed. In conclusion, over-use of bedding may be economically inefficient and, in warm weather, it might increase the rate of D&D pigs. Pig skin surface temperature could be a useful measure of pig welfare during or after transport.

2. Establishing boarding requirements for finishing pigs during transport

Specifically, this study aimed to establish boarding level requirements, or amount of ventilation, for finishing pigs in mild weather (8.80 ± 0.30 °C, 71.70 ± 1.12 % humidity). Pigs from commercial finishing sites were transported in 302 pot-bellied trailers to commercial processing plants. Measures collected at the processing plant were rates of dead on arrival (DOA), non-ambulatory (NA), and total dead and down (D&D). Boarding levels were divided into 3 bins: low (0 – 30 %), medium (31–60 %) and high (> 61 %) and outside temperature was divided into 4 bins < 5°C, 5.10 - 10 °C, and 10.10 - 15 °C and > 15 °C. Average rates of DOA, NANI, NAI, and D&D were approximately 0.30, 0.12, 0.04, and 0.46 %, respectively. The D&D was highest when boarding percentage was low with temperatures < 5 °C ($P < 0.05$). When air temperature was less than 5 °C, low boarding level increased rate of D&D. However, variations in boarding level (medium and high boarding) in temperature range 5.10 to 23.30 °C did not affect pig losses.

Introduction:

Over 100 million pigs go to market in the USA yearly. Transport losses are most commonly in the form of dead on arrival (DOA), and non-ambulatory (NA) pigs. Based on a sample of 2.7 million commercial pigs, the rate of DOA in the USA was 0.2% and the rate of NA pigs was 0.22 % (1). Total transport losses (D&D) which is the summation of DOA and NA exceed 0.22% year-round in the USA. One factor that has been incompletely evaluated as a cause of transport losses is the configuration of trailers pulled by semi tractors (trucks).

Objectives:

The objective of this paper is to summarize a series of studies that were conducted over all seasons over the past three years to evaluate trailer bedding and boarding levels.

Materials and Methods:

Typical pig trailers in this study were trailers that measured about 16 m long by 2.6 m wide with two decks. Decks were in a "pot belly" configuration (the compartment between the wheels was lower in elevation than the compartments over the wheels). In both studies, investigators collected data on 1,005 trailers (the experimental unit) containing 158,688 pigs.

In the bedding study, 3 data sets were generated when trailers had varying amounts of bedding (1 to 12 bales of bedding; each bale 0.3 m3 of wood shavings) in each season applied to them. In the winter, we examined 6 or 12 bales/trailer while trailers. In the mild season (spring and fall) we evaluated 3, 6 and 12 bales/trailer and in the summer 3, 5, 7, and 9 bales were evaluated. Boarding levels followed the Transport Quality Assurance Program guidelines (2).

In the boarding study, bedding was held constant by covariate (range = 1 to 10 bales/trailer) while the boarding levels were varied over a range of seasons and air temperatures.

Results:

Bedding study: Transport losses did not change in the winter when either 6 or 12 bales were applied per trailer. In the Spring/Fall and Summer, transport losses did not vary significantly with bedding ranging from 3 to 12 bales/trailer. However, we observed a tendency for more transport losses in the summer when heavier (7 or more bales) were used per trailer.

Table 1. Effect of bedding level on the percentage of dead on arrival (DOA), non-ambulatory (NA), and total dead and down (D&D) pigs during experiment 1 (cold weather, air temperature -13 °C to 20 °C).

Condition upon arrival [%]	Bedding level [bales[1]/trailer]			*P*-values		
	6	12	SEp	Bedding	Temperature	Bedding × Temperature
No. of trailers	103	69				
No. of pigs	17,100	11,403				
DOA	0.06	0.12	0.03	0.13	0.95	0.56
NA	0.05	0.07	0.03	0.73	0.53	0.54
D&D	0.11	0.18	0.04	0.29	0.73	0.47

[1]One bale = 22.7 kg, 0.2 m^3

Table 2. Effect of bedding level on percentage of dead on arrival (DOA), non-ambulatory (NA), and total dead and down (D&D) pigs during experiment 2 (mild weather, air temperature -2 °C to 21 °C).

Condition upon arrival [%]	Bedding level [bales[1]/trailer]				*P*-values		
	3	6	12	SEp	Bedding	Temperature	Bedding × Temperature
No. of trailers	105	122	38				
No. of pigs	17,745	21,080	6,075				
DOA	0.11	0.12	0.03	0.03	0.21	0.86	0.30
NA	0.09	0.10	0.13	0.03	0.84	0.01	0.19
D&D	0.20	0.22	0.09	0.05	0.34	0.07	0.17

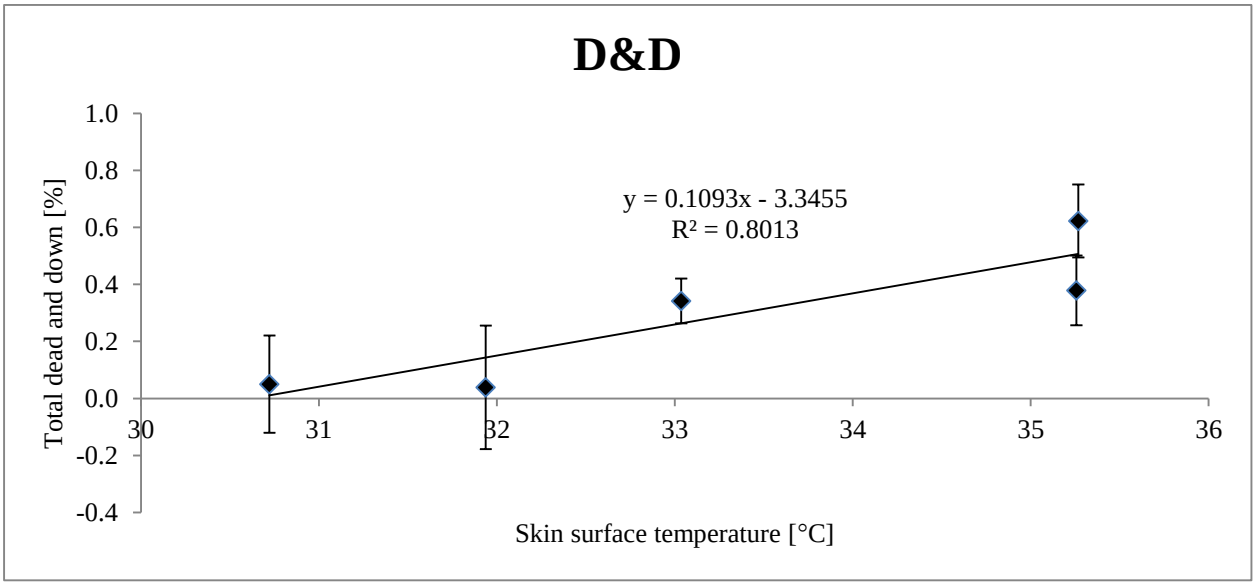
[1]One bale = 22.7 kg, 0.2 m^3

Table 3. Effect of bedding level on the percentage of dead on arrival (DOA), non-ambulatory (NA), and total dead and down (D&D) pigs during experiment 3 (warm weather, 16 °C to 29 °C).

Condition upon arrival [%]	Bedding level [bales[1]/trailer]					*P*-values		
	3	5	7	9	SEp	Bedding	Temperature	Bedding × Temperature
No. of trailers	104	34	85	12				
No. of pigs	17,183	5,616	13,887	1,989				
DOA	0.13[a]	0.27[ab]	0.35[b]	0.42[ab]	0.08	0.05	0.10	0.90
NA	0.04[a]	0.20[b]	0.13[ab]	0.11[ab]	0.06	0.20	0.07	0.11
D&D	0.17[a]	0.42[ab]	0.47[b]	0.53[ab]	0.12	0.07	0.04	0.30

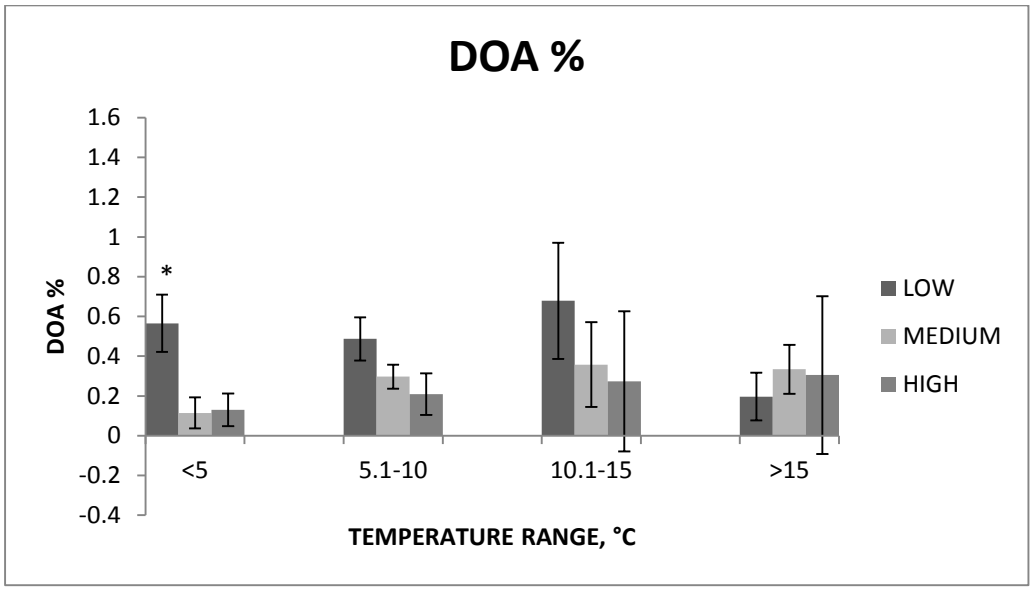
[a,b]Within a row, least squares means lacking a common superscript letter differ, $P < 0.05$ by unprotected F-test.

Figure 1. Relationship between skin surface temperature on flank of pigs during unloading at the processing plant and total dead and down (D&D) percentage during warm weather.



Boarding Study: When bedding was held constant by covariate, the boarding levels did not impact transport losses during mild air temperatures (5.1 to over 15 C). However, during cold weather (< 5 C), transport losses increased when less than 30% boarding was used. This loss was primarily in DOA pigs (60% of D&D) in cold weather.

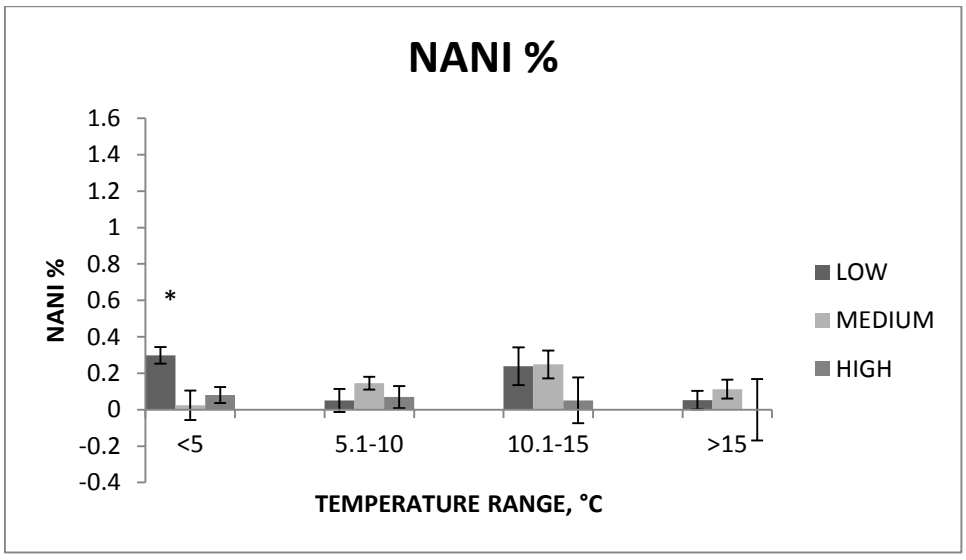
Figure 2. Rate of dead on arrival (DOA) for each boarding level[1] across all temperature bins.



*P < 0.05 within temperature bin.

[1]Low: boarding level < 30 %; medium: boarding level = 31 to 60 %; high: boarding level > 60 %.

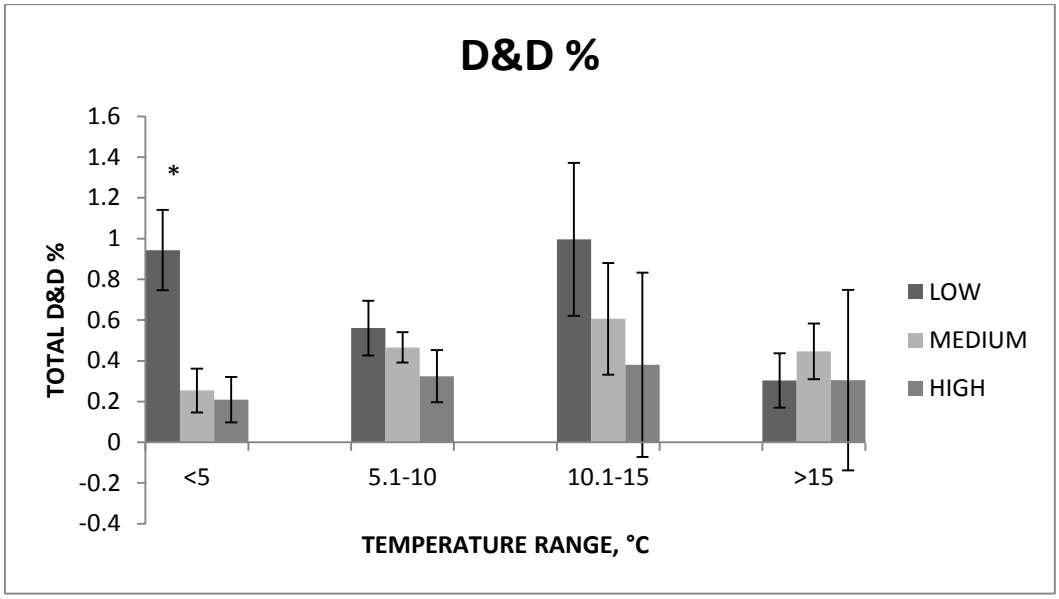
Figure 2. Rate of non-ambulatory, non-injured (NANI) for each boarding level[1] across all temperature bins



*P < 0.05 within temperature bin.

[1]Low: boarding level < 30 %; medium: boarding level 31 to 60 %; high: boarding level > 60 %.

Figure 3. Rate of total dead and down (D&D) for each boarding level across all temperature bins.



*$P < 0.05$ within temperature bin.

[1]Low: boarding level < 30 %; medium: boarding level 31 to 60 %; high: boarding level > 60 %.

Discussion:

Overusing bedding with no associated benefit has an economic cost. During all seasons, pigs with less bedding had similar transport losses as did pigs with more bedding. Trailers are typically fully open in warm weather (0 % boarding) and nearly fully closed in very cold weather. Changing the boarding levels from 25 to 75% closed had little impact on pig transport losses from 5.1 to 15 C. When air temperature was below 5 oC, having less than 30% boarding caused an increase in transport losses and should be avoided.

Data from this study can serve as a basis to make objective decisions about bedding and boarding levels used on trailers to improve pig welfare and economics.