Bedding and boarding while transporting pigs to slaughter-choosing the right amount

Avi Sapkota, TTU
Anna Butters-Johnson, Assoc. Professor, ISU
John J. McGlone, PhD, Professor, TTU

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Overview and Background

• Total number of pigs transported each year: over 100 million

• Rate of DOA: 0.17%

• Rate of NA: > 0.2%

• Pigs with negative welfare problems during transport to market: over 40,000 per year
Overview and Background

Issues:

• Welfare issue
• Public concern
• Economic impact for both farm and plant

So, a major issue

$$$$$$
• At temperatures 0 to 5 C, less NANI pigs with dry bedding as compared to no bedding
• But overall, percentage of DOA and IOT pigs was less in dry bedding trailer as compared to no bedding, but percentage of NANI pigs was higher as compared to no or wet bedding. (Sutherland et al, 2009)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Number of trailer loads</th>
<th>DOA</th>
<th>IOT</th>
<th>NANI</th>
<th>N&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry</td>
<td>9220</td>
<td>0.167\textsuperscript{c} (0.011)</td>
<td>0.038\textsuperscript{c} (0.003)</td>
<td>0.255\textsuperscript{d} (0.009)</td>
<td>0.460 (0.016)</td>
</tr>
<tr>
<td>None</td>
<td>3359</td>
<td>0.204\textsuperscript{d} (0.016)</td>
<td>0.066\textsuperscript{d} (0.005)</td>
<td>0.162\textsuperscript{b} (0.014)</td>
<td>0.432 (0.023)</td>
</tr>
<tr>
<td>Wet</td>
<td>3711</td>
<td>0.177\textsuperscript{d} (0.019)</td>
<td>0.052\textsuperscript{d} (0.006)</td>
<td>0.207\textsuperscript{c} (0.017)</td>
<td>0.436 (0.028)</td>
</tr>
</tbody>
</table>

DOA: dead on arrival, IOT: injured in trailer, NANI: down on trailer or before weighing (non ambulatory, non injured), N&D: total dead
Field data indicate that the rate of non-ambulatory, non-injured pigs increases in **cold weather**, but DOA rate increases with outside temperature (Sutherland, 2009).
Background

Field data indicate that the rate of DOA pigs increases in warm weather (Sutherland, 2009).

\[ y = 0.0062x - 0.1091 \]

\[ R^2 = 0.9774 \]
How to reduce losses??

• Selection of right breed
• Proper handling techniques
• Following a proper guideline and method
• Modifications in existing facilities
The ultimate research goal is to develop industry recommendations for internal trailer environment management protocols that will optimize internal trailer temperature, maintain pig comfort and core body temperature and minimize transport losses.
According to TQA Handbook, in driver code of ethics,

• Transporter must have access to clean bedding approved by the packer, and must be used during transport.

• Provide extra bedding (wood shavings, wheat straw, corn stubble) during winter
TQA recommendations:

<table>
<thead>
<tr>
<th>Air Temp (°F)</th>
<th>Bedding</th>
<th>Side-Slats</th>
<th>Side-Slats</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>Heavy</td>
<td>90% Closed</td>
<td>10% Open*</td>
</tr>
<tr>
<td>10-20</td>
<td>Medium</td>
<td>75% Closed</td>
<td>25% Open*</td>
</tr>
<tr>
<td>20-40</td>
<td>Medium</td>
<td>50% Closed</td>
<td>50% Open</td>
</tr>
<tr>
<td>40-50</td>
<td>Light</td>
<td>25% Closed</td>
<td>75% Open</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>Light†</td>
<td>0% Closed</td>
<td>100% Open</td>
</tr>
</tbody>
</table>

* Minimum openings are needed for ventilation even in the coldest weather.
† Consider using sand or wetting bedding if it is not too humid and trucks are moving.
Bedding Study
Objective

• To define the bedding requirements of pigs during transportation in commercial settings during:
  • Cold weather
  • Mild weather
  • Warm weather
## Study Design and Sample Size

<table>
<thead>
<tr>
<th>Months</th>
<th>Bedding levels, bales/trailer*</th>
<th>Air Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-Feb</td>
<td>6, 12</td>
<td>8 to 68 F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-13 to 20 C</td>
</tr>
<tr>
<td>March-May</td>
<td>3, 6, 12</td>
<td>28 to 70 F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-2 to 21 C</td>
</tr>
<tr>
<td>June-July</td>
<td>3, 5, 7, 9</td>
<td>61 to 113 F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16 to 45 C</td>
</tr>
</tbody>
</table>

* 22.7 kg/bale or 50 lb
* 0.2 m³/bale or 7 ft³/bale
### Background

For a straight deck 53’ X 102” trailer

<table>
<thead>
<tr>
<th>Number of bales/deck</th>
<th>mm</th>
<th>inches</th>
<th>Eights of an inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.5</td>
<td>3/8</td>
<td>3/8</td>
</tr>
<tr>
<td>1.5</td>
<td>11.1</td>
<td>3.5/8</td>
<td>3.5/8</td>
</tr>
<tr>
<td>3</td>
<td>15.9</td>
<td>5/8</td>
<td>5/8</td>
</tr>
<tr>
<td>6</td>
<td>25.4</td>
<td>1</td>
<td>8/8</td>
</tr>
</tbody>
</table>

1 Bale

3 Bales

6 Bales
### Study Design and Sample Size

<table>
<thead>
<tr>
<th>Months</th>
<th>Temperature</th>
<th>Number Trailers</th>
<th>Number pigs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-Feb</td>
<td>Cold</td>
<td>174</td>
<td>28,855</td>
</tr>
<tr>
<td>March-May</td>
<td>Mild</td>
<td>345</td>
<td>58,007</td>
</tr>
<tr>
<td>June-July</td>
<td>Warm</td>
<td>254</td>
<td>41,824</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>--</strong></td>
<td><strong>773</strong></td>
<td><strong>128,686</strong></td>
</tr>
</tbody>
</table>
Materials and Methods

At finishing site:

• Random assignment of bedding level

• Information on bedding level, number of loads on that bedding, boarding percentage

• Five sensors collected temperature and humidity in different four compartments and one outside the trailer from start of load to unload

• Handling methods, handling devices, intensity (on a scale of 1 to 5, 1 being the mildest; 5 being aggressive/abusive)
Materials and methods

At finishing site:

• Number of vocalizations, slips/falls, signs of stress

• Management aspects of farms: type of barn, facilities like pen size, aisle, chute, floor type, walls etc., and weather information (temperature, humidity, and wind speed)

• Surface skin temperatures on the pigs flank/side of 10 randomly selected pigs (5 of first 50 and 5 of last 50 pigs loaded into the trailer) in each load using laser thermometer with sensitivity of 0.1°F
Materials and methods

At plant:

• Air temperature, humidity, surface temperature of 10 pigs (as in finishing site)

• Handling device(s), handling intensity (as in finishing site), vocalizations, slips/falls, time of arrival, waiting and unloading

• Collected bedding samples to determine moisture %

• Record DOA, NA and D & D in each trip
Primary models, by season, effects of:

• Level of bedding

• Air temperature (in 5 °C bins)

• Interaction of bedding and air temperature

All data entered in Excel and analyzed using SAS (General Linear Model). Regression lines calculated using Excel and SAS.
Results

Ranges of conditions during data collection:

• Load time: 13 to 94 min
• Transit time: 16 to 459 min
• Waiting time at plant: 0 to 198 min
• Total D & D in a trip: 0 to 8
• Handing Intensity ranged: 1-5
• 43/440 (9.8%) loads at finishing sites had a handling intensity of 5 (aggressive, abusive)
• 1/429 (0.23%) observations at plants had a handling intensity of 5
Results – Jan-Feb Bedding Effects

**DOA % by Bedding level**
(P=0.13)

**NA % by Bedding level**
(P=0.73)

**D & D % by Bedding level**
(P=0.29)

No effect of bedding
Results – Jan-Feb Temp Effects

No interaction between bedding and air temperature

DOA% by outside temperature bin
P-value>0.05

\[ y = 0.0192x + 0.0341 \]
\[ R^2 = 0.8595 \]

Outside temperature bin, °C

Death on arrival %

NA% by outside temperature bin
P-value>0.05

\[ y = 0.011x^3 - 0.106x^2 + 0.276x - 0.126 \]
\[ R^2 = 0.905 \]

Outside temperature bin, °C

Non-ambulatory %

D&D by outside temperature bin
P-value>0.05

\[ y = 0.0172x^3 - 0.1564x^2 + 0.4273x - 0.1901 \]
\[ R^2 = 0.9796 \]

Outside temperature bin, °C

Total dead and down %
Results – March-May Bedding Effects

DOA % by Bedding level
(Treatment not significant, P=0.21)

NA % by Bedding level
(Treatment not significant, P=0.84)

D & D % by Bedding level
(Treatment not significant, P=0.34)

No effect of bedding
No interaction between bedding and air temperature
Results – June-July Bedding Effects

More bedding is harmful in warm weather
Results – June-July Temp Effects

No interaction between bedding and air temperature.
Overall DOA, NA and D&D % with outside temperature

**Dead on arrival %**

\[
y = 0.0076x^2 - 0.0394x + 0.126 \\
R^2 = 0.8148
\]

**Non-ambulatory %**

\[
y = -0.0023x^4 + 0.0456x^3 - 0.3037x^2 + 0.7553x - 0.4407 \\
R^2 = 0.7526
\]

**Total dead and down %**

\[
y = -0.0037x^4 + 0.0733x^3 - 0.4755x^2 + 1.1484x - 0.615 \\
R^2 = 0.9
\]
Skin Surface Temperature

Average skin surface temperature in relation to outside temperature bin

\[ y = 0.3729x + 23.909 \]
\[ R^2 = 0.9459 \]

P-value:<0.001
The warmer the outside temperature, the warmer was the pig surface
Total dead and down %

$y = 0.1093x - 3.3455$

$R^2 = 0.8013$

Skin Surface Temperature and Dead and Downs
Results

3 bags, second load

Fresh bedding (6 Bags)

6 bags, second load
Results

12 bags, first load, 26% moisture

Fresh bedding with only 5% moisture

12 bags, second load, 51% moisture
Results

Used bedding inside the trailer

73.87% moisture, 6 bags, 4th load, 60% boarding
Results

Inside trailer temperature

Temperature of Trailer Compartments

- Front Top
- Front Bottom
- Rear Top
- Rear Bottom
- Outside
Results

Inside trailer relative humidity

Relative Humidity of Trailer Compartments

- Front Top
- Front Bottom
- Rear Top
- Rear Bottom
- Outside

Relative Humidity (°C)

4:45 5:45 6:45 7:45 8:45
## Conclusions – Bedding

<table>
<thead>
<tr>
<th>Season</th>
<th>Temp range</th>
<th>Significant bedding effect?</th>
<th>Conclusions</th>
<th>Recom, Bales/trailer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold weather</td>
<td>&lt; 32 F</td>
<td>No</td>
<td>Added bedding -- no advantage beyond 6 bales</td>
<td>6*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* No data on less than 6 bales</td>
</tr>
<tr>
<td>Mild weather</td>
<td>32 - 70 F</td>
<td>No</td>
<td>Added bedding – no advantage above 3 bales</td>
<td>3</td>
</tr>
<tr>
<td>Warm weather</td>
<td>&gt; 70 F</td>
<td>Yes</td>
<td>Added bedding <strong>negative</strong> effect on DOA</td>
<td>3*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* No data on less than 3 or 0 bedding</td>
</tr>
</tbody>
</table>
## Economics of Bedding Use

<table>
<thead>
<tr>
<th><strong>Item</strong></th>
<th><strong>Amount</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate number of pigs processed per day in the USA</td>
<td>420,000</td>
</tr>
<tr>
<td>Average pigs per truck/trailer</td>
<td>170</td>
</tr>
<tr>
<td>Approximate number of trucks/trailers/day</td>
<td>2,470</td>
</tr>
<tr>
<td>% fresh bedding used per truck/trailer</td>
<td>50%</td>
</tr>
<tr>
<td>Trailers using new bedding/day</td>
<td>1,235</td>
</tr>
</tbody>
</table>
## Economics of Bedding Use

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
<th>Dollar amount, @ $6/bale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trailers using new bedding/day</td>
<td>1,235</td>
<td></td>
</tr>
<tr>
<td>Number of daily bales at 3 extra bales/day (in summer)</td>
<td>3,705</td>
<td>$22,230</td>
</tr>
<tr>
<td>Number of daily bales at 6 extra bales/day (in winter)</td>
<td>7,410</td>
<td>$44,460</td>
</tr>
<tr>
<td>30 days cold, added bedding cost</td>
<td>6 extra bales</td>
<td>$1,333,800</td>
</tr>
<tr>
<td>120 days warm, added bedding</td>
<td>3 extra bales</td>
<td>$2,667,600</td>
</tr>
<tr>
<td>Total added bedding cost</td>
<td>Per year</td>
<td>$4,001,400</td>
</tr>
</tbody>
</table>
Conclusions – Air Temperature

- Cold weather increased NA
- Warm weather increased DOA
- No interaction between bedding and air temperature
Conclusions – Pig Surface Temperature

- Pig surface temperature changes with air temperature
- In warm weather, increased surface temperature predicts increased DOA
Conclusions

Overuse of bedding causes:

• Increased bedding cost for no return

• Increased pigs losses (dead and down)

• At least a $4 million economic cost just by using extra bedding (exact pig losses due to extra bedding yet to be determined) per year unless bedding levels are adjusted

• A welfare problem in warm weather
What Next??

• Is bedding needed and positive for the pig?
  • Examine zero bales in the summer and less than 6 bales in cold weather for efficacy

• Define the boarding needs for the industry

• Define misting requirements
Boarding Study
Determining the proper use weather boards/plugs in controlling the internal environment of the trailer to provide for the thermal comfort of the pig during cool temperatures.
### Materials and Methods

<table>
<thead>
<tr>
<th>Air temperature, F</th>
<th>Current TQA</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
<th>Treatment 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-19 F</td>
<td>75</td>
<td>50</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>20-39 F</td>
<td>50</td>
<td>25</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>40-49 F</td>
<td>25</td>
<td>0</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>50-60 F</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>--</td>
</tr>
</tbody>
</table>

100 trailers per temperature bin (400 trailers in total) will be used
Materials and methods

Truck status at the farm

- bedding depth, boarding rate, trailer type (straight deck vs. pot), air temperature and humidity (by Hobos; 4 inside per trailer and 1 outside on a sample of trailers), load time at the farm

- A data sheet completed at the farm site and handed to the driver for delivery to researchers at the plant.
Materials and methods

Truck status at the plant

- bedding status, boarding rate, straight deck vs. pot, travel time

- Times
  - arrival time at the plant, wait time at the plant, time to unload

- Environmental measurements at the plant:
  - air temperature & relative humidity: internal on trailer at pig level & outside
  - wind speed & wind chill index will be determined
Materials and methods

Truck status at the plant
- pig temperature (at least 10 pigs) – skin surface temps
- transport loss incidence (NANI, NAI, DOA; some plants collect only DOA and Non-ambulatory[NA])
- trim loss per trailer
- audit of pigs coming off the truck – slips & falls, vocalizations, incidence of frostbite, signs of stress (ex., open-mouth breathing, skin discoloration, muscle tremors)
Till now

• Only 74 trailers covered (out of 400 required), so analysis is not complete yet.

• Minimum temp: 32 F, Max: 73.2 F

• If boarding percentage <40%, then low (total: 29) and

• If boarding percentage 40-59%, then medium (total: 34)

• If boarding percentage >59%, then high (total: 11)
Results

DOA

NANI

NAI

D&D
Result
Conclusion

• DOA highest when boarded highest
• NANI, NAI, D & D did not differ significantly with boarding percentage
• EOA highest when highly boarded
Thank you

Questions?