Quantitative Microbial Risk Assessment for Estimating Setback Distance from Aerial Irrigation of Dairy Manure

Tucker Burch, Mark Borchardt, Susan Spencer
USDA – Agricultural Research Service
Joel Stokdyk and Aaron Firnstahl
US Geological Survey Wisconsin Water Science Center
Becky Larson, Dept Biological Systems Engineering UW-Madison
Burney Kieke, Marshfield Clinic Research Foundation
Ana Rule, Bloomberg School of Public Health, Johns Hopkins University

Definitions

Risk: cases of illness/people exposed
– Can also be interpreted as probability

Example:
10 people exposed
2 cases of illness (red)
Risk = 2/10
Probability = 0.2 (or 20%)

Definitions

QMRA: quantitative microbial risk assessment
– Predicts risk using mathematical models
– Prediction is based on average pathogen dose

Alternative is epidemiology
– Measures risk directly
– Expensive $$

The archived presentation is available at:
http://articles.extension.org/pages/21819/chronological-webcast-archive
Project Objectives

1. Identify the risk of illness from airborne pathogens during manure irrigation.
   - Acute gastrointestinal illness (AGI)
   - Relate to distance

2. Identify other variables (e.g., weather conditions) most important for airborne pathogen transport during manure irrigation
Livestock and Poultry Environmental Learning Center Webinar Series

June 15, 2018

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Research Approach

Field Data → Modeling → Risk Assessment

- 25 field trials
  - 15 traveling gun, 8 center pivot, 2 tanker
- Measured microbe concentrations in manure and at multiple distances for each trial
  - qPCR and culture
- Collected weather data for each trial

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Measurements during Irrigation Trials

- Portable Weather Station
  - wind direction and speed
  - air temperature
  - solar radiation
  - relative humidity
  - precipitation (always = 0)

- Microbes and Pathogens
  - qPCR
  - conventional culture

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Typical field sampler configuration

- Wind direction
- 500 Ft. gun tow path distance
- 400 Ft
- 200 Ft wide spray path
- 100 Ft
- 250 Ft
- 400 Ft
- 500 Ft
- 650 Ft
- 0 Ft
- Upwind control

Note: Paired samplers were located 50 Ft apart.

Weather Conditions during Manure Irrigation Trials

<table>
<thead>
<tr>
<th>Mean temperature (°F)</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean relative humidity (%)</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Mean wind speed (MPH)</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Max wind speed (MPH)</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Mean solar irradiance (W/m²)</td>
<td>0</td>
<td>200</td>
<td>400</td>
<td>600</td>
<td>800</td>
</tr>
</tbody>
</table>

Gram-Negative Bacteria in Air During Travelling Gun Manure Irrigation

May 22, 2014; 11 mph wind; 530 W/m² solar irradiance; 50% relative humidity; 68 °F temp

Notes:
- MacConkey agar in Anderson samplers
- Air sample volume was 540 liters
- Downwind distances were perpendicular to gun movement
- Manure diluted 1:100 before plating 100 µl

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Research Approach

Field Data → Modeling → Risk Assessment

• Statistical modeling (i.e., regression)
  • 2 objectives:
    – Predict air concentrations for risk assessment
    – Relate air concentrations to weather conditions and microbe concentrations in manure

Research Approach

Field Data → Modeling → Risk Assessment

• Statistically most important variables:
  – Distance from irrigated manure
  – Wind speed
  – Pathogen concentrations in manure

Research Approach

Field Data → Modeling → Risk Assessment

• Quantitative microbial risk assessment
  • Average dose calculated from: pathogen prevalence, distance, age, inhalation rate, time spent outdoors
  • 2 pathogen surrogates: bovine Bacteroides and gram negative bacteria

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Acknowledgements

• We thank ...
• Jan Altmann, Jordan Gonnering, Hana Millen and Zach Zopp for field and laboratory work
• John Panuska for contributions to the study design
• Scott Fischer and owners and staff of participating dairy farms
• Philip Schmidt, Peter Teunis, and Norval Strachan for dose-response parameter distributions
• This study was funded in part by the Wisconsin Department of Natural Resources