Antibiotics Resistance, Manure Technologies, and Value-Added Treatment

Dr. Stephanie Lansing
Associate Professor
Department of Environmental Science and Technology
University of Maryland
slansing@umd.edu
Presentation Overview

• Value-Added Products
  • Bedding, Compost and Digestate Products
  • Nutrient Extraction after Digestion

• Antibiotics in Agriculture

• Antibiotic Resistance (AR) and AR Policy

• Antibiotic Resistance and Manure Treatment
Bedding for on-Farm Use

- Solid Separation after digestion. Solids can be:
  - Used directly as bedding (or sold to other farms)
  - Composted and used on fields or sold
  - Partially dried (air injection) and used as bedding

- Our prior analyses of small-scale digesters (250 cows or less) showed the use of digested solids for bedding generated the highest revenue ($100 per cow per year), followed by biogas use for electrical generation ($47 to $70 per cow per year) and CO₂ credits ($7 per cow per year). (Klavon et al., 2013)
• Ammonium scrubber drives NH₃ from the digester effluent into an ammonia-rich solution, which can be transportable fertilizer.
• Solid presses and nutrient extraction takes nutrients from a solid matrix (poultry litter) into a concentrated form, with reusable water produced after nutrient removal.
What are other value-added benefits?

- Are there other value-added benefits?
  - Pathogen reduction
  - Odor reduction
  - GHG reductions (and $$ on the carbon market)

- Does anaerobic digestion reduce other contaminants?
  - Nutrients are not reduced by much in the digester (settled and some bacterial uptake), but nutrients are transformed.
  - What about Antibiotic destruction?
  - Is caffeine, estrogens, and personal care products reduced in wastewater treatment plant digesters?
  - Nanoparticles?
Informed Consent

• You are being asked to participate in a research study. The purpose of this study is to understand perceptions of antibiotic use for livestock.

• You are being asked to volunteer because you are a stakeholder with an interest in antibiotic policy. You are free to withdraw at any time.

• You will be asked to answer questions about agriculture, animal health, farm management, antibiotic regulations, decision making, and use. This survey should take about five minutes to complete.
Informed Consent

• We do not ask or identify any individuals who plan to participate in this survey.

• You must be of 18 years or older to participate in this survey.

• There are no known risks involved in completing the survey. There are no tangible benefits for completing the survey.

• Participation is entirely voluntary; you may at any time withdraw from participation.

• All data obtained will be anonymous. Your data will not be shared with any other parties under any circumstance.
Informed Consent

• This study has been reviewed and approved by the UMBC Institutional Review Board (IRB). A representative of that Board, from the Office of Research Protections and Compliance, is available to discuss the review process or my rights as a research participant. Contact information of the Office is (410) 455-2737 or compliance@umbc.edu.

• The PI for this study is David Lansing
  • email: dlansing@umbc.edu
  • Phone: 410-455-2971
Survey: Antibiotic usage and antibiotic resistance knowledge and perceptions

https://umdsurvey.umd.edu/jfe/form/SV_72o3cJsTEmMN3yB

• Please take out your phones and answer the questions found at the following link:
Antibiotic Use: Humans and Animals

(Hillerton et al. 2016)
Antibiotic Usage in Animal Husbandry

ANTIMICROBIAL DRUGS APPROVED FOR USE IN FOOD-PRODUCING ANIMALS\(^1\)
ACTIVELY MARKETED IN 2015
DOMESTIC SALES AND DISTRIBUTION DATA
REPORTED BY MEDICAL IMPORTANCE AND DRUG CLASS

(FDA, 2015)
Pathways of Antibiotic Resistance (AR)

• Why do we care? Antibiotic resistance (AR) can cause administrated antibiotics to be ineffective in disease control.

• Where/how does this happen?
  • Horizontal gene transfer can pass antibiotic resistant genes (ARG) from resistance bacteria (ARB) to other bacteria in soil/water/manure/guts. Once ARG is acquired, these unrelated bacteria will gain AR and can then pass ARG on to their offspring or to other unrelated bacteria.

CDC. www.cdc.gov/getsmart/community/about/antibiotic-resistance-faqs.html
Antibiotics are manufactured...

with some factory effluent transferred...

where antibiotics used as medicines can pass through patients and select for antibiotic resistant bacteria which can be transferred...

via wastewater plants with only modest treatment ability...

to the public, where antibiotic resistance is a major global health concern.

via contaminated meat and dairy products...

to other farm animals and wildlife...

via farm workers and food processors...

to fish, vegetables and fruit.

to land and water resources via applied antibiotics, bio-solids, manure, runoff, and effluents;

effective reservoirs and proliferating environments of AR bacteria and genes, ...
Survey: Perception of policy regulations on antibiotic administration

https://umdsurvey.umd.edu/jfe/form/SV_72o3cJsTEmMN3yB

• Please take out your phones and answer the questions found at the following link:
Veterinary Feed Directive (VFD)

• 1996: Animal Drug Availability Act (ADAA)
  • Created category of Veterinary Feed Directive Drugs

• 2013: Guidance For Industry #209
  • Eliminates feed and water use of medically important antimicrobials for production purposes

• 2015: GFI #213
  • Process and timeline for implementing #209

• VFD Final Rule
  • December 2016: Full Implementation of GFI #213
Veterinary Feed Directive – Jan 2017

• Cannot use medically important antibiotics for production purposes
• Must obtain a VFR from a veterinarian to use antibiotics
  • Producer must be in context of a Veterinarian Client Patient Relationship (VCPR)
  • VCPFR defined by states
    • Responsibility for animal health; knowledge of animal; available for follow up
VFR Impacts on Farms

• Potential for Financial Impact
  • Complete ban would reduce profits by $1,400 per hog house
  • No determinative studies yet

• Early Qualitative Studies
  • Hog and Beef Cattle Producers (Lee Schultz, Iowa State)
    • few complaints about the VFD process, paperwork etc.
  • Dairy Producers (Kelsey O’Shea, Cornell):
    • Increased capital investments
      • Different barn design; more monitoring technology
    • Less availability of in-feed antibiotics: Feed mills often out of stock
State Antibiotic Laws

- Maryland: Keeping Antibiotic Effective Act
- California: SB27
  - Both took effect in 2018
  - California’s seen as more stringent
  - Key difference: Preventative Use
- Poultry Industry (i.e. Purdue) has gone antibiotic free ahead of industrial regulations
Survey: Perception of the role of anaerobic digestion in antibiotic mitigation

https://umdsurvey.umd.edu/jfe/form/SV_72o3cJsTEmMN3yB

- Please take out your phones and answer the questions found at the following link:
Pathways of Antibiotic Resistance (AR): Influence of Manure

- Manure management varies greatly: composting, solid-liquid separation, digestion, lagoon storage, packed bedding.
- Some farms have physical separation of sick cows and separation of milk supply, but manure may not be separated.

(Khachaturians, 1998)
Prior Research: Fate of antimicrobials in Digesters

- Antibiotics residuals in digesters are often close to zero, but can spike with animal treatments.
- With various retention times throughout the manure treatment process, it difficult to show treatment effect.
- Our lab studies of antibiotic spikes showed 100% reduction of SDM in digesters, but inconsistent (0-80%) removal of TC, likely due to the highly sportive nature of TC.
- Lab extraction of antibiotics is more difficult in digester influent compared to effluent.
New studies:

- Effect of temperature and thermal hydrolysis prior to digestion on ARG and antibiotics for both wastewater and dairy manure.

**Pulper**
- Influent solids 15 to 18.5 %TS
- Preheated to 140-210° F with recycle steam
- Mixing pumps

**Reactors**
- Batch process
- Heated to 302-356° F - 160 C
- 87 psi
- ~ 30 minute detention time

**Flash Tank**
- Depressurization destroys cell walls
- Cools down to 158-239° F
- 8-12 %TS to digesters

*Thermal Hydrolysis FOR CLASS A*

DCWater's Process Flow - THP Before Anaerobic Digestion
Questions?