Manure Odor Management

Kevin A Janni
Professor & Extension Engineer
Bioproducts & Biosystems Engineering
University of Minnesota

Odor Management Toolkit

- Right tools
- Skilled person
- Job well done

Odor Management Tools

- Understanding odors
- Concern & neighborliness
- Communications
- Siting tools
- Source assessment
- Mitigation practices
- Useful resources
- Implementation & follow up
No single solution

- Sources vary
- Level of mitigation needed
- Impact of practices on operations (ex. feeding, ventilation, manure management and sanitation)
- Management & labor needs
- Capital and operating cost

Manure Odors

- Mixture of volatile gases
- Over 300 volatile compounds identified from animal manures
- Some compounds detectable by humans at extremely low concentrations
- Generally considered unpleasant or offensive

Odors

- Evoke emotional and physiological responses
Pleasant odors
- Evoke emotional and physiological responses

Offensive odors
- Evoke emotional and physiological responses

Points of View
- Source owner or manager
- Neighbor
- Parent of sensitive child
- Community leader or politician
- Regulator
- Academic

Goals

Values

Actions
Unpleasant Odor Concerns

- Smell
  - Nuisance, irritation, lost enjoyment
  - Invite private or public property
- Health
- Costs
- Other

Odor Impacts

- Normally local, depends on source size
- Interfere with use and enjoyment of public areas, private land or home
- Offensive odors may
  - Annoy and agitate people
  - Trigger more symptoms
- Odors do not make people sick

Odor perception depends on

- Frequency
- Intensity or detected concentration
- Duration
- Offensiveness or emotional reaction

Odor Frequency

- Once or twice a month
- Twice a week
- Every day
- All the time

---

Odor Intensity

- Odor strength
- Analogous to sound loudness
- Ranges from
  - Non-detectable
  - Barely detectable
  - Detectable
  - Recognizable
  - Offensive – very loud

---

Odor Duration

- Seconds
- Minutes
- Hours
- Days
- Weeks
- Months
Odor Offensiveness

- Emotional & physiological reaction

Manage FIDO

- Some manure odors are generally acceptable in agricultural communities
- Questions you and your neighbors need to answer and agree on
  - How often?
  - How intense?
  - How long?
  - How offensive?

Managing odors with good communications

- Talk to neighbors about odors
- Ask if they smell odors
- Tell neighbors you are concerned
- Tell neighbors what you are doing to manage odors
- Visit annually
Develop good neighbor relations

- Discuss new building sites and/or expansions
- Inventory impacted areas
  - Nearby neighbors
  - Public areas (parks, lakes)
  - Schools and churches
  - Towns, cities and public roads

Managing odors with site assessment tools

- Minnesota - Odor From Feedlot Setback Estimation Tool (OFFSET)
- Nebraska - Odor Footprint Tool (OFT)
- Iowa - Community Assessment Model for Odor (CAM)
- South Dakota Odor Footprint Tool (SDOFT)

I want to do something... now what?

- Identify odor sources and odor emitting activities
- Prioritize sources or activities
- Investigate mitigating practices
- Implement practice
- Assess impact
Mitigation planning

- For each source to mitigate
- Level of mitigation needed
- Impacts on production practices
- Management
- Capital and operating cost

Overview Manure Management

Manure Sources
- Animals, Milking center, Barns, Mortalities

Collection
- Slatted floors, Pits
- Scrap, Flush

Transport
- Gravity, Pump

Storage
- Pit, Basin, Stack

Treatment
- Anaerobic digestion
- Solid-liquid separation

ODOR SOURCES

Sources
- Animals and buildings
- Manure & wastewater
  - Collection
  - Storage
  - Agitation
  - Land application
- Mortalities
Overview Odor Processes

Generation
- Animals, Manure, Microbial decomposition

Emissions
- Barns, Manure storage units, Land application

Dispersion, Transport & Transformation

Receptor
- Exposure and dose

Impacts

Mitigation approaches

Reduce emissions
- Generation
  - Less generation - less emissions
- Entrainment into air
  - Less entrainment - less emissions
- Capture and treat

Dilute
- Enhance odor dispersion

Common mitigation practices
- Reduce Generation
  - Diet and feed management
  - Additives
- Reduce emissions
  - Covers
- Capture and Treat
  - Biofilters
  - Wet scrubbers
Diet and Feed Management

- Formulate diets to more accurately meet animal needs
- Reduce nutrients in feces and urine, enteric emissions and stored and land applied manure

Diet and Feed Management

- Examples
  - Phase and Split-sex feeding
  - Reduce crude protein and add amino acids
  - Reduce sulfur
  - Add copper sulfate, fiber or organic acids
  - Use growth promoters
  - Reduce feed waste and dust generation

Additives

- Chemical
  - Oxidize volatile compounds
  - Adjust pH
  - React and form precipitates
  - Masking agents or counteractants
- Biological
  - Modify biochemical pathways
Covers

- Permeable
- Impermeable
- Positive air pressure
- Negative air pressure

Permeable covers

- Geotextile fabric
- Straw
- Natural crust
- Limited life
- Emission reductions depend on % covered and thickness

Impermeable covers

- Highly effective
- Expensive
- Manage
  - Bubbles
  - Precipitation
  - Animals
  - Manure removal
Wet scrubbers

- Liquid spray entraps particulates and absorbs gases
- Factors
  - Gas solubility
  - Liquid pH
  - Air to liquid flow rates
- Wastewater handling
- Potential nutrient recycling

Biofilters

Mechanically Ventilated Building
Odorous Air
Manure Pit
Exhaust Fan
Treated Air Exhaust
Biofilter Media
Air Duct
Media Support
Air Plenum

Media studied
- Wood chips and compost
- Pine nuggets & shredded wood
- Lava rock
- Birch mulch wood chips
- Corn cobs
Biofilter Effectiveness

% Reduction
- Odor detection threshold
  - 78 to 95%
- Ammonia
  - 50 to 82%
- Hydrogen sulfide
  - 86 to 97%

Biofilter Designs

- Effective
- Vertical
- Dairy Deep bed
- A-Frame

Enhance dispersion

- Dilute odors
- Property line limits
- Does not reduce emissions
- Methods
  - Vegetative buffers
  - Wind walls
  - Chimneys
  - Increased separation distance

http://rec.udel.edu/poultryextension/Vegetative%20Environmental%20Buffers/Vegeta1.jpg
Manure treatment

- Anaerobic digestion
- Changes odor character, some reduction

Manure treatment

- Solid-liquid separation
- Not effective odor control

Manure agitation

- Major odorous activity
Land application technique

- Broadcast - surface application
- Broadcast followed by incorporation
- Incorporation, injection
- Irrigation

Land application timing

- Avoid days prior to and of community and neighbor celebrations
- Sunny unstable weather day - lifts odors and mixes more
- Windy day - wind direction
- Dry day

Resources

- Air Quality in Animal Agriculture
- www.extension.org/pages/15538/
Resources

- National Air Quality Site Assessment Tool (NAQSAT)
  naqsat.tamu.edu/

Four video websites

- Policy Considerations
  http://www.extension.org/66999
- Neighbor Relations & Setback Estimate Tools
  http://www.extension.org/67056
- Manure Covers & Biofilters
  http://www.extension.org/67057
- Health Impacts
  http://www.extension.org/67058

Economic Decision Tool

- Feedlot Air Emissions Treatment Cost Calculator
  http://www.extension.org/67055
- Dr. Bill Lazarus, Extension Economist
- Four narrated orientation videos
- Used to compare
  - Technologies
  - Technology costs and benefits
Opening Web Page

Treatment Technologies

- **Biofilters**
- **Manure storage covers** (Safferman, 2011)
- **Vegetative buffers** (Tyndall and Colletti, 2007; Current, 2011)
- **Scrubbers** (Mauzon et al., 2011)
- **Manure belts for layer barns** (Xin, 2012)
- **Link to anaerobic digester tool**

Key Benefit

- **Opportunity for income from new or expanded animal feeding operation**
Additional Benefits

- Shorter driveway and utility lines
  - Locate facilities near road & utilities rather than center of land parcel
- Less interference with crop machinery
  - Locate facility in corner of land parcel to avoid breaking up crop fields
- Avoid interference with center pivot

Additional Benefits

- Preserve land development value
- Preserve fertilizer value of nitrogen by reducing ammonia emissions
  - Covers
  - Manure belts in layer barns

Take home points

- Odors evoke emotional and physiological responses
- Odors are complex mixtures of gases
- Manage FIDO to manage odors
- Go to www.extension.org/pages/15538
- Select and use effective odor control techniques that fit your management