Community and Environmental Health
Issues Relating to Agriculture and Rural Areas
Nelson Institute Community Environmental Health Forum 9/19/08

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Changes in Agriculture

- Fewer but bigger farms
- Increased animal density
Changes in hog production

- Iowa farms producing hogs decreased from 64,000 in 1980 to 10,500 in 2000 (84% decrease)
- While average number of hogs/farm increased from 250-1,430
- Farms producing > 500 hogs now account for 65% of Iowa and 75% US.
  - Thorne P. Environmental health effects of CAFOS
  - Iowa City March 29-31, 2004. To be published in Environmental Health Perspectives
Conflict of small scale vs. large scale operation acceptance
The changing face of large animal production......
...leads to localized issues of manure management and water degradation

Unenclosed manure Lagoon

33 gallons of manure per dairy cow/day
Manure production kg/day

- Cow-30
- Hog-8
- Human-1.5
- Sheep-1.5
- Chicken-0.14

National Issues

- 130 more times animal waste than human waste produced
- Animal waste is not treated like human waste
- 360,000-450,000 animal feeding operations (AFOs) in U.S.
  - Approximately 10,000 concentrated animal feeding operations (CAFOs)
The issues impacting agricultural operations and communities

- The struggle to balance an essential industry with rural economic significance and quality of life and health impacts.
- The increasing issue of contiguity of non-agricultural populations and traditional rural land use.
Spectrum of Potential Community Health Effects

- Environmental
  - Water contamination
  - Acute gastrointestinal infections from coliforms
  - Air-borne dispersal of organic dusts and gases
  - Odor issues and quality of life
  - Zoonotic disease concerns with increasing animal density
  - Antimicrobial resistance from production practices
Water contamination

- Soil saturation from excessive manure application resulting in ground water contamination by nitrates
  - Nitrosamines and potential carcinogens
  - Na, K, Cu, P, and Zn increased
- Overflow of manure lagoons with excessive rain/floods, breakthrough of lagoon berms causing ground water and surface water contamination
Environmental Risks of Run-off

- Infections (listeriosis)
- Eutrophication-algae growth
- Depressed dissolved $O_2$
- Toxicity to aquatic life due to ammonia
  - Fish, invertebrate, amphibian, plant kill offs
DNR 2001-2002 Wisconsin Well Survey

- DNR 2001-2002 survey 64% (216/336 wells) had detectable nitrates –0.5 mg/L to 41.6 mg/L
  - 16% > 10 mg/L
- 5% of community wells had at least one detectable VOC
  - 1% over the state health advisory
  - Trichloroethylene, perchloroethylene, trichloroethylene, benzene, toluene, xylenes
Pesticides in drinking water

- Pesticides-38% of wells had detectable herbicide (alachlor metabolites)
- 10% atrazine
What is contaminating the drinking water?

- Chemical Spills and Landfills
- Septic Tanks
- Road Salts
- Animal Waste
- Petroleum Storage Tanks
- Pesticide Application
- Chemicals “down the drain”
  - detergents, oils, cleaners
SOURCES OF NITRATES

- One of three principle water quality issues
  - coliforms, toxic chemicals other 2
- Feedlots, barnyards, chemical fertilizers, sewage disposal systems
- Risks-shallow wells < 35 feet deep up to 95 feet
- Boiling increases concentration
- Droughts, after heavy rains
Sources of nitrogen
PHYSIOLOGIC EFFECTS-
NITRATES

- Nitrates converted to nitrites by GI flora
  - Oxidation of hemoglobin (Hb)-methemoglobin
- Infants in first 4 months of life
  - lower circulating Hb levels
  - Fetal Hb more susceptible to oxidation
  - Decreased amount of methemoglobin reductase
  - Alkaline gastric conditions enhance GI flora
PREVENTION

- Scheduled assessment of well water nitrate levels
- Reverse osmosis or deionization
- Proper placement - wells and septic tanks
- Proper manure storage
- Appropriate application of manure, fertilizer
Residential water risks and recommended water assessments

- Yearly-total coliforms to assess surface contamination of ground water
- Every 2-3 years-nitrates
  - Every year if children < 6 months or previous elevated levels
  - Levels should be below 10 mg/LN-NO₃ as nitrates
- Agricultural chemicals
  - Pesticides
Concentrated animal feeding operation (CAFO)

- Facilities that contain more than 1,000 animal units (au)
- Smaller facilities that contain 300-1000 au and discharge wastes into navigable waters or into waters that originate outside of and pass through the facility
- Examples:
  - feed lots, hog confinement, large dairies, poultry operations
Potential exposures resulting from CAFOs

- Sources: air and water contamination from bacterial decomposition of wastes
- Organic dusts
  - Dried feces, animal dander, hair, endotoxin, bioaerosols
- Microorganisms - bacterial resistance
- Gases - $\text{H}_2\text{S}$, ammonia (nitrogen), methane
- Odors
- Pharmaceuticals
  - Antibiotics, parasiticides, growth promoters
Environmental management practices

- All concentrated animal feeding operations require a manure management permit.
- Issued by the states and counties under the requirements of the Environmental Protection Agency (EPA).
Air quality issues

- **Gases**
  - Ammonia
  - Hydrogen sulfide
  - Volatile organic compound (VOC) particles

- **Particulate matter**
  - Primarily coarse particles (PM$_{2.5-10}$)
  - Visibility
  - Exacerbation of underlying respiratory disease
  - Ultrafine-urban (< PM$_{2.5}$) associated with cardiovascular and respiratory deaths
Indoor Air Issues-AG

- Increasing time indoors-40-50 hours
- Gases and fumes
- Allergens
- Dusts and molds
  - Beta glucans
- Endotoxins
Endotoxin

- Inflammatory nonimmune lipopolysaccharide (LPS) component of cell walls in primarily Gram negative bacteria
  - May increase severity of disease in those with established asthma
  - Significant factor in organic dust conditions (ODTS)
  - Fungal beta D-glucans
Common Issues in Gases

- Worse in winter
- Inadequate ventilation increases concentration
- Agitation increases levels
- Dust masks not adequate
- High concentrations require SCBA
  - H2S, CO,
Diseases of confinement

- **Upper airway**
  - Sinusitis
  - Irritant rhinitis
  - Allergic rhinitis
  - Pharyngitis

- **Lower airway**
  - Organic dust toxic syndrome (ODTS)
  - Acute/subacute bronchitis
  - Chronic bronchitis
  - COPD
  - Occupational asthma
    - Allergic
    - Non-allergic
ASPHYXIANT GASES

- HYDROGEN SULFIDE
- Chemical asphyxiant similar to cyanide
  - Potent inhibitor of cytochrome oxidase interrupting oxidative phosphorylation
  - Arrest of respiratory center
- Colorless, heavier than air
- Rotten egg smell at 0.13 ppm
- Paralyzes olfactory nerve above 150 ppm
- 500 ppm unconsciousness and death
  - Up to 1500 ppm with agitation
ANIMAL CONFINEMENT ODORS

- Do they cause health problems?
- Depression, fatigue, moods affected
- Respiratory symptoms: cough
- No studies with actual dose-response measurements have been performed
WHAT CAUSES THE ODOR

- Odor testers, olfactory meters
- 168-400 compounds identified
- Chemical soup of volatile organic compounds
  - amines, amides
  - alcohols, mercaptans
  - fatty acids, sulfides, phenols
  - cresols, indoles, skatole
Odor dispersion research issues

- Each localized area is unique due to weather conditions
- Solar radiation the most important factor in odor dispersion
  - Increased with dispersion with increased solar radiation
- Worst case scenario is night time and stable conditions
- Determination of Emission factor by seasons is the goal
Odors and asthma

- Odors can aggravate asthma
- Dusts, gases adsorbed on dust, endotoxin can be in odor plume (co-pollutant)
- Sloughing of respiratory epithelium exposes nerve endings to VOCs and particulates that can set up a low grade neurogenic inflammation and leukocyte recruitment aggravating asthma and allergy
Environmental measurements

- Outdoors total dust, endotoxins, H$_2$S generally non detectable > 300 m from farm
- H$_2$S under 1 ppm (10-100 ppb) adjacent to CAFOs
- Ammonia < 1 ppm
  - OSHA level 25 ppm
A potential silk purse from a sow’s ear?

- Can the waste be utilized for renewable energy production and decrease environmental effects?
Manure from lagoons piped to sealed anaerobic digester.

Sealed to prevent release of infectious bioaerosols into the environment; hydrogen sulfide decreased.
Biogases (methane) are generated to run diesels to produce electricity. Hydrogen sulfide scrubbers to reduce sulfur.
Pathogens are reduced by 90%, P/N by 70%. Dry residue used and reused for bedding

1. Decrease green house gases
2. Decrease odors
3. Decrease biological oxygen demand
4. More consistent concentrations and bioavailable nutrients for fertilizer.
5. Decrease loss of nutrients
Regulatory responses

- State specific responses.
  - 32 states have regulations for hydrogen sulfide air levels
- WI (240 ppb/24 hours)
- MN (30 ppb ½ hr 2x/yr)
- IA (30 ppb for 1 hr no greater than 7 x/yr)
- Department of Natural Resources or Pollution Control Agencies will respond to complaints and monitor levels of hydrogen sulfide (H2S)
- There are no present national standards
Fecal coliforms

- Bacteria that live in the intestines of warm-blooded animals and are passed in the feces.
- Many are harmless, others cause reportable human illnesses
- Indicator species-indicate contamination of water from multiple organisms
  - Pathogenic bacteria
  - Viruses, protozoans
Microbes

- Gram $^+$ and Gram $^-$ bacteria, mainly saprophytic, few pathogens
- *Helicobacter pylori*, *Camplyobacter* spp.
- *Salmonella* spp., *Escherichia coli* (E. coli)
- *Listeria monocytogenes*-listeriosis, Weil’s
- *Streptococcus suis* (Strep suis)
- *Brucella suis*
- *Yersinia enterocolitica*
- *Pfiesteria piscicida*-secondary
1346 people in Walkerton, Ontario (4900 residents) developed gastroenteritis from multiple fecal coliforms (\textit{E. coli}, \textit{Campylobacter}) from contaminated community water supply in 2000.

- 1000 people treated, 65 admitted, 27 developed hemolytic uremic syndrome with resulting 6 deaths.
Diseases associated with fecal coliforms

- Acute diarrhea
  - Campylobacter, E. coli, Salmonella, Shigella, Yersinia enterocolitica
  - All reportable to the Department of Health
  - Other causes of diarrhea
    - Cryptosporidium-protozoan
    - Viruses
    - Listeria monocytogenes-Gram + bacteria
Review of E. coli outbreaks 1982-2002

- 350 outbreaks with 8600 cases
- 17% hospitalized, 4% hemolytic uremic syndrome, 40 (0.5%) deaths
- 52% foodborne, 9% waterborne
- 14% person-to-person, 3% animal contact
- 21% unknown
  - Rangel, 2005. Emerging Infectious Diseases
E. Coli 0157:H7

- 73,000 illnesses; 60 deaths per year
- Associated with bloody or nonbloody diarrhea, fever, cramps
- Lasts 5-7 days
- Healthy cattle the main reservoir, passed in feces
- Outbreaks of 0157:H7 occurred in visits to petting farms (53 at one farm)
E. Coli 0157:H7

- Children or older adults more severely affected
- Leading cause of kidney failure in children
- Hemolytic uremic syndrome can develop in 2-7% of infections
  - Red blood cells destroyed and kidneys fail
References

- Von Essen S and B. Auvermann. Health effects from breathing air near CAFOs for feeder cattle or hogs. 2006 Journal of Agromedicine. 10(4):55-64