Welcome

A Lunchtime Webinar Series

Serving Pennsylvania’s Best Practices on Animal Ag, Water-, and Air Quality

Today’s Speakers

- Karl Brown, Executive Secretary, Pennsylvania State Conservation Commission
- Doug Beegle, Professor of Agronomy, Penn State University
- Eileen Wheeler, Professor of Agricultural and Biological Engineering, Penn State University

Hosting

Kristen Saacke Blunk
Penn State Agriculture & Environment Center
Manure Du Jour: Serving Pennsylvania’s Best Practices on Animal Agriculture, Water and Air Quality

Karl Brown
Executive Secretary
PA State Conservation Commission
“In coming decades, we need to double food production, meet food safety standards, enhance rural livelihoods, and stimulate economic growth in an environmentally and socially sustainable manner.”

Cont.
“The new agricultural revolution we will need to meet this challenge will require a fundamental rethink of the role of agricultural knowledge, science and technology. Agriculture can no longer be thought of as production alone, but the inescapable interconnectedness of agriculture’s economic, social and environmental roles and functions must be explicitly recognized.”

—Robert Watson
“Growth Factors” The Guardian, April 30, 2008
## Historical Statistics & Rankings

By Sandra F. Gratson

### Pennsylvania: Record Highs and Lows in PA Agriculture

<table>
<thead>
<tr>
<th>Field Crops and Vegetables</th>
<th>Year Estimates Started</th>
<th>Record</th>
<th>Acreage Harvested</th>
<th>Year</th>
<th>Unit</th>
<th>Per Acre</th>
<th>Year</th>
<th>Production Total</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn for grain.............</td>
<td>1866</td>
<td>High</td>
<td>1,590</td>
<td>1918</td>
<td>Bu.</td>
<td>140</td>
<td>2004</td>
<td>151,800</td>
<td>1985</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>672</td>
<td>1966</td>
<td></td>
<td>22</td>
<td>1930</td>
<td>19,074</td>
<td>1930</td>
</tr>
<tr>
<td>Corn for silage ...........</td>
<td>1919</td>
<td>High</td>
<td>590</td>
<td>1999</td>
<td>Ton</td>
<td>18.0</td>
<td>2006</td>
<td>7,975</td>
<td>2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>156</td>
<td>1921</td>
<td></td>
<td>6.0</td>
<td>1930</td>
<td>1,326</td>
<td>1923</td>
</tr>
<tr>
<td>Wheat ........................</td>
<td>1866</td>
<td>High</td>
<td>1,610</td>
<td>1901</td>
<td>Bu.</td>
<td>59</td>
<td>2006</td>
<td>26,565</td>
<td>1901</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>135</td>
<td>2004</td>
<td></td>
<td>10.5</td>
<td>1872</td>
<td>6,615</td>
<td>2004</td>
</tr>
<tr>
<td>Oats ........................</td>
<td>1866</td>
<td>High</td>
<td>1,330</td>
<td>1888</td>
<td>Bu.</td>
<td>70</td>
<td>1985</td>
<td>44,165</td>
<td>1918</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>80</td>
<td>2007</td>
<td></td>
<td>17.5</td>
<td>1890</td>
<td>4,480</td>
<td>2007</td>
</tr>
<tr>
<td>Barley ......................</td>
<td>1866</td>
<td>High</td>
<td>245</td>
<td>1955</td>
<td>Bu.</td>
<td>81</td>
<td>2006</td>
<td>9,900</td>
<td>1967</td>
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<tr>
<td></td>
<td></td>
<td>Low</td>
<td>7</td>
<td>1915</td>
<td></td>
<td>16.5</td>
<td>1874</td>
<td>130</td>
<td>1914</td>
</tr>
<tr>
<td>Soybeans ........................</td>
<td>1924</td>
<td>High</td>
<td>425</td>
<td>2006</td>
<td>Bu.</td>
<td>46</td>
<td>2004</td>
<td>19,550</td>
<td>2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>2</td>
<td>1935</td>
<td></td>
<td>13</td>
<td>1957</td>
<td>33</td>
<td>1935</td>
</tr>
<tr>
<td>Dry hay, all..............</td>
<td>1866</td>
<td>High</td>
<td>3,300</td>
<td>1892</td>
<td>Ton</td>
<td>2.93</td>
<td>2006</td>
<td>5,302</td>
<td>1985</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>1,600</td>
<td>2005</td>
<td></td>
<td>1.00</td>
<td>1911</td>
<td>2,255</td>
<td>1866</td>
</tr>
<tr>
<td>Dry hay, alfalfa...........</td>
<td>1919</td>
<td>High</td>
<td>850</td>
<td>1987</td>
<td>Ton</td>
<td>3.30</td>
<td>1985</td>
<td>2,772</td>
<td>1985</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>31</td>
<td>1919</td>
<td></td>
<td>1.60</td>
<td>1932</td>
<td>65</td>
<td>1919</td>
</tr>
</tbody>
</table>
# PA Agriculture Statistics

## 2007-2008

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>1930-1930</th>
<th>2004-2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn for Grain</td>
<td>22 bu/acre</td>
<td>140 bu/acre</td>
</tr>
<tr>
<td>Corn for Silage</td>
<td>6 ton/acre</td>
<td>18 ton/acre</td>
</tr>
<tr>
<td>Soybeans</td>
<td>13 bu/acre</td>
<td>46 bu/acre</td>
</tr>
</tbody>
</table>
## PA Agricultural Statistics
### 2007-2008

<table>
<thead>
<tr>
<th>Livestock and Products</th>
<th>Year Estimates Started</th>
<th>Units</th>
<th>Inventory January 1 or Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Record</strong></td>
</tr>
<tr>
<td>Cattle and calves</td>
<td>1867</td>
<td>1,000 Head</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Milk cows</td>
<td>1867</td>
<td>1,000 Head</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Hogs and pigs</td>
<td>1867</td>
<td>1,000 Head</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Sheep</td>
<td>1867</td>
<td>1,000 Head</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Chickens, all</td>
<td>1924</td>
<td>1,000 Head</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Turkeys, raised</td>
<td>1929</td>
<td>1,000 Head</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Broilers produced</td>
<td>1939</td>
<td>1,000 Head</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Milk</td>
<td>1924</td>
<td>Million Lbs.</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Eggs</td>
<td>1924</td>
<td>Million Eggs</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Wool</td>
<td>1909</td>
<td>1,000 Lbs.</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
</tbody>
</table>
PA Agricultural Statistics 2007-2008

- **Milk Cows**
  - 1945 – 943,000
  - 2007 – 550,000

- **Milk**
  - 1928 – 4.2 mill lbs
  - 2000 – 11.15 mill lbs

- **Broilers**
  - 1939 – 2,500,000 head
  - 2006 – 153,500,000 head

- **Hogs**
  - 1918 – 1,265,000 head
  - 1965 - 425,000 head
  - 2006 – 1,080,000 head
Interconnectedness?
Understanding Cause and Effect Relationships

Nitrogen
Flow Adjusted Concentrations

Monitoring data from major rivers entering tidal waters of the Bay show that nitrogen concentrations are decreasing in the Susquehanna, Patuxent, Potomac, Rappahannock, and James rivers. The Pamunkey shows an increasing trend.

Phosphorus
Flow Adjusted Concentrations

Monitoring data from major rivers entering tidal waters of the Bay show that phosphorus concentrations are decreasing in the Susquehanna, Patuxent, Rappahannock, and James rivers. The Potomac, Pamunkey, and Appomattox show increasing trends.
“We shall never achieve harmony [balance] with land any more than we shall achieve justice or liberty for people. In these higher aspirations the important thing is not to achieve, but to strive”

~ Aldo Leopold
Manure Du Jour

January 14, 2009

Doug Beegle

Penn State Crops & Soil Sciences
Manure Du Jour:
Serving PA’s Best Practices on Animal Ag, Water, and Air Quality

NUTRIENT MANAGEMENT AND WATER QUALITY

Douglas Beegle
Department of Crop and Soil Sciences
Penn State University

Office: 410 ASI, Ph (814) 863-1016, email: dbb@psu.edu
**Nutrients and Water Quality**

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td>N is an essential element for plants and animals</td>
<td>P is an essential element for plants and animals</td>
</tr>
<tr>
<td>Often the most limiting nutrient for crop production</td>
<td>High P is generally non-toxic to plants or animals</td>
</tr>
<tr>
<td>High N can be toxic to animals – especially infants</td>
<td>Relatively immobile in soil</td>
</tr>
<tr>
<td>PHS for drinking water: 10 ppm NO₃-N</td>
<td>P causes accelerated eutrophication</td>
</tr>
<tr>
<td>Very dynamic and mobile in the soil water system</td>
<td>Excessive growth of algae and aquatic plants</td>
</tr>
<tr>
<td>Very difficult to keep out of the environment – even with good management</td>
<td>Limits use of water for drinking, fishing, recreation, etc.</td>
</tr>
</tbody>
</table>
Nutrients and Water Quality

Source

- Leaching
- Tile flow
- Subsurface flow
- Ground Water

Transport

- Runoff
- Volatilization
- Denitrification

- N P K
- Ground Water
- Water Body
Why is there a water quality problem with nutrients?

- **Common Misconception:**
  - Farmers are mismanaging nutrients.
    - All we have to do is get them to do things right, they will make more money, and the problem will be solved!
  - Management can always be improved but this is not the fundamental problem
Contemporary Nutrient Cycle

Crops

Soil

Global

Animals

Manure

1/4

3/4

?
Why is there a water quality problem with nutrients?

Real Reason:
- Not generally mismanagement
- The structure of agriculture has evolved based on technological, economic, and policy drivers...

But, agriculture has evolved with little or no economic cost associated with nutrient pollution.

- Given the way animal agriculture has evolved, today the economic impact of nutrient management will generally be negative for farms with nutrient problems.
- If there was additional profit in nutrient management we probably wouldn’t have the problem.
Strategic Conflict Between Food Production and the Environment

Adapted from Lanyon, 2000
Strategic Conflict Between Food Production and the Environment

To achieve balance . . .

. . . We need to internalize the environmental costs of food production

Adapted from Lanyon, 2000
Future Animal Ag Nutrient Cycle

- Production Efficiency
- Reconnect Nutrient Flow
- Restructuring animal ag
- Alternative uses for manure
- Bioenergy
- New Technologies

Economical & Sustainable Food Production System

Achieve Nutrient Balance
- Reconnect Nutrient Flow
- Restructuring animal ag
- Alternative uses for manure
- Bioenergy
- New Technologies
Addressing the Real Solution to the Nutrient Management Imbalance?

- This is not just an agricultural issue, it is a food issue.
  - Producing food in a way that does not cause pollution is more expensive

- More than just improving on-farm nutrient management
  - Improving management is beneficial
  - This is the thrust of most current policies
  - Does not address the root problem - Imbalance

- We must take a broad view
  - Economics/Environment
  - Water/Air
  - Farm/Watershed

- **We must achieve better overall nutrient balance**
Addressing the Real Solution to the Nutrient Management Imbalance?

- Improved Management is important but...

- Solution will require changes and restructuring in our food systems
  - In the home
  - In the grocery store
  - On the farm
  - In government policy
Manure Du Jour

Eileen Wheeler
Penn State Agricultural and Biological Engineering
Overview of Challenges Facing Animal Agriculture:

Air Quality

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Professor of Air Quality
Agricultural & Biological Engineering
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814-865-3552
Air Quality Regulated

- U.S. Environmental Protection Agency (EPA) is asking agriculture to “take its turn” in improving national air quality
  - manufacturing, transportation, energy, etc. have taken their “turns”

Donora, PA @ noon 29 Oct 1948
Agriculture Air Emissions appear to be more subtle

-- But what about haze?
-- Global warming?
Odor Problems in Animal Agriculture
Odor Difficult to Regulate

- EPA has virtually no odor regulations or criteria so citizen complaints against local animal agriculture air quality are not easily evaluated

  - Scentometer used in some EPA regions
  - Odor compounds of interest?
    - Hydrogen sulfide
    - Ammonia
    - 180 compounds in swine odor
EPA Air Quality Regulations

• CAA - Clean Air Act

• CERCLA – “Superfund” -- Comprehensive Environmental Response, Compensation and Liability Act

• EPCRA – Emergency Planning and Community Right-to-Know Act
CERCLA “Superfund” and EPCRA “Right-to-Know” Acts require an emission source to report any toxic gas release that is over a threshold level. This initiates a response by authorities.

- Threshold Levels of interest to animal ag
  - 100 pounds/day ammonia
  - 100 pounds/day hydrogen sulfide
CERCLA “Superfund” and EPCRA “Right-to-Know” Acts require emission source to REPORT any toxic gas release that is over a threshold level. This initiates a RESPONSE by authorities.

- Threshold Levels of interest to animal ag
  - 100 pounds/day ammonia
  - 100 pounds/day hydrogen sulfide

EPA Air Quality Regulations

Ammonia & Hydrogen Sulfide

Reporting requirements recently relaxed for all but the largest animal farms. [see manure.unl.edu for fact sheet]

EPA has never initiated a response based upon notification of a hazardous substance release to the air from animal waste at farms.
- Citizen concern and lawsuits over odor, air emissions, and mega-livestock farms
- Individual EPA actions
- 2003 National Academy of Sciences report
  - Insufficient scientific data to regulate
- Consent Agreement between EPA and livestock organizations to support National Air Emissions Monitoring Study currently at 22 farms

Agriculture and Air Quality

- What emissions are of regulatory concern and being monitored?
  - Ammonia, NH$_3$
  - Hydrogen sulfide, H$_2$S
  - Particulate matter, PM (dust)
  - Volatile organic compounds, VOCs
  - Greenhouse Gases
    - Carbon Dioxide, CO$_2$
    - Methane, CH$_4$
    - Nitrous oxide, N$_2$O
Most Ammonia Sources in USA are from Animal Agriculture

- Cattle: 43%
- Poultry: 27%
- Swine: 10%
- Fertilizer: 10%
- Human Sources
  - Combustion: 5%
  - Waste Treatment: 5%
  - Refrigeration: 5%
  - Sheep: 5%

Ammonia and the Environment

- “Local” deposition in sensitive areas
- “Global” combination with atmospheric trace gases to form small particles (PM$_{2.5}$)
  - Reduced visibility-haze
  - Respiratory problems

Fugitive Dust

- The generation of particulate matter where some portion of the material escapes beyond the property where source is located.

- EPA estimates that 50% of PM$_{2.5}$ emissions arise from fugitive dust sources.
Air Quality Impact

- Concept of the “air-shed”
  - Part of the atmosphere that behaves in a coherent way with respect to the dispersion of emissions.

“water flows downhill” like...

“air pollutants flow downwind”

Chesapeake Air- & Water-sheds
## Emissions Animal Agriculture

### Global Impact

<table>
<thead>
<tr>
<th>Emission Compound</th>
<th>Global Effect</th>
<th>Local Effect</th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>Major</td>
<td>Minor</td>
<td>Deposition Haze</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>Significant</td>
<td>Insignificant</td>
<td>Climate change</td>
</tr>
<tr>
<td>Methane</td>
<td>Significant</td>
<td>Insignificant</td>
<td>Climate change</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>Significant</td>
<td>Insignificant</td>
<td>Climate change</td>
</tr>
</tbody>
</table>

Adapted from: Air Emissions from Animal Feeding Operations. 2003. NRC
## Emissions Animal Agriculture

### Local Impact

<table>
<thead>
<tr>
<th>Emission Compound</th>
<th>Global Effect</th>
<th>Local Effect</th>
<th>Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odor</td>
<td>Insignificant</td>
<td>Major</td>
<td>Quality of human life</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>Insignificant</td>
<td>Significant</td>
<td>Quality of human life</td>
</tr>
<tr>
<td>Coarse “dust” PM$_{10}$</td>
<td>Insignificant</td>
<td>Significant</td>
<td>Haze</td>
</tr>
<tr>
<td>Fine “dust” PM$_{2.5}$</td>
<td>Insignificant</td>
<td>Major</td>
<td>Health Haze</td>
</tr>
</tbody>
</table>

Adapted from: Air Emissions from Animal Feeding Operations. 2003. NRC
Emission from Animal Production Systems

Lesson 40  www.lpes.org

Nutrient management web site
nutrient.psu.edu
Overview of Challenges Facing Animal Agriculture: Air Quality

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Question and Answers

• Questions received in writing will be directed to the speakers by the host.
• If your question is not answered during the time remaining, responses to the questions will be posted at www.aec.cas.psu.edu
• Recordings of this session can also be viewed at the URL listed above.
Next Week on Manure Du Jour

Focus on
Water Quality and Nutrition

Featuring

• **Ms. Jana Malot**, Natural Resource Conservation Service (NRCS), Pennsylvania Office.

• **Dr. Sarah Dinh**, Dairy and Environment Extension Educator, Penn State Cooperative Extension, Lancaster County

• **Dr. Paul Patterson**, Professor of Poultry Science, Penn State Department of Poultry Sciences

For more information  [www.aec.cas.psu.edu](http://www.aec.cas.psu.edu)