Air Quality Program

Institute of Bioenergy, Climate, and Environment
National Institute of Food and Agriculture

• Catalyzes transformative discoveries, education, and engagement to address agricultural challenges.
• Brings groundbreaking discoveries from research laboratories to farms, communities, and classrooms.
• Integrate (research, education and extension) and transdisciplinary approaches.
National Institute of Food and Agriculture (NIFA)

• Mission -- financial assistance and national leadership

• $1.3 – 1.7 B per year of extramural competitive funds such as the Agriculture Food Research Initiative (AFRI) and capacity funds such as those to land-grant institutions through the Smith-Lever (extension) and Hatch Act (research).
NIFA AFRI Challenge Areas

• Climate Variability and Change
• Water for Food Production Systems
• Food Safety
• Childhood Obesity Prevention
• Food Security
• Sustainable Bioenergy
NIFA AFRI Foundational Science

- Plant health and production and plant products
- Animal health and production and animal products
- Food safety, nutrition, and health
- Bioenergy natural resources and environment
- Agriculture systems and technology
- Agriculture economics and rural communities
Critical Issues for Stakeholders

• The effects of climate change on rangelands and grasslands.

• Water quality, quantity, and drought—no longer a western state problem.

• The need for hard data and better communication among landowners, policy makers and appropriators, and non-farmers.

• “Bring research to management” and we need more “conservation on working lands.”
NIFA’s Air Quality Program Goals

• To predict an emission rate at any point in the production cycle for the whole farm.
• To predict the fate and transport of emissions downwind.
• To validate regional and local transport models.
• To mitigate emissions.
• To measure dry and wet deposition.
What have we learned over the last 5 years?

– Better understanding of gas and particulate matter concentrations in animal and crop production systems
– Better understanding of the fate and transport of gas and particulates
– Better characterization of the diurnal and seasonal nature of gas concentrations
– Better monitoring and measurement systems
– Better understanding of particle size distributions
– Better estimates of errors associated with particulate matter measurements and methods
# NIFA Air Quality Investments (2009 – 2014)

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Total Capacity Expenditures</th>
<th>Total Competitive Grant Obligations</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Air Resources Protection and Management (KA:141 &amp; SOI: 0410)</td>
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<tr>
<td>2009</td>
<td>$1,312,000</td>
<td>$7,508,167</td>
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<tr>
<td>2010</td>
<td>$1,211,000</td>
<td>$8,889,819</td>
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<tr>
<td>2011</td>
<td>$1,722,000</td>
<td>$4,050,984</td>
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<tr>
<td>2012</td>
<td>$2,209,000</td>
<td>$3,624,513</td>
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<tr>
<td>2013</td>
<td>$1,917,000</td>
<td>$3,126,329</td>
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<tr>
<td>2014</td>
<td>$1,259,000</td>
<td>$2,405,561</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$9,630,000</strong></td>
<td><strong>$29,605,373</strong></td>
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NIFA Funding (AIR)
Past 6 years

CAPACITY

$10M

COMPETITIVE

$30M
NIFA Air Quality Investments 2001-2014

- **Air Quality**: 187 Competitive, 199 Capacity, 386 Total
- **Ammonia**: 160 Competitive, 158 Capacity, 318 Total
- **PM**: 58 Competitive, 108 Capacity, 166 Total
- **Nitrous Oxide**: 68 Competitive, 62 Capacity, 130 Total
- **Prescribed Fire & Wildfire**: 47 Competitive, 157 Capacity, 204 Total

Legend:
- Red: Competitive
- Blue: Capacity
- Yellow: Total
NIFA Air Quality Program Emphasis Areas

• New focus on understanding the Nitrogen Cycle and the role of Reactive Nitrogen (Nr) on Environment and Air Quality

• Emission data from production practices – particulates, gases/odors (more focus on crop production).

• Improved measurement protocols/ instrumentation for within field and edge of field boundaries

• Practices for mitigating emissions

• Fate and transport of emitted particulates and gases
Reactive Nitrogen (Nr)

In contrast to non-reactive gaseous N\textsubscript{2}, includes all biologically active, chemically reactive, and radiatively active nitrogen compounds in the atmosphere and biosphere of the earth.
Atmospheric Nitrogen

\[ \text{N}_2 \quad 78\% \]

Energy production - NO\(_x\)

Food/Biofuel production - NH\(_x\)

US-Reactive Nitrogen (Tg N/yr)

\[ \begin{align*}
\text{NO}_x & \quad \text{Natural} \\
N_r & \quad 6.4 \\
\text{NH}_x & \quad 28.5 \\
\text{Anthropogenic} & \quad 34.9
\end{align*} \]
Implications of different forms of N lost from plant-soil systems

Gaseous losses

$\text{N}_2$

$\text{N}_2\text{O}$  $\text{NO}$  $\text{NO}_2$

$\text{NH}_3$

Negative environmental or health impacts.

- Atmospheric aerosols
- Formation of tropospheric ozone
- Depletion of stratospheric ozone
- Acid rain, acidification of soils
- N deposition
- Impacts on aquatic & terrestrial ecosystems
- Can provide a secondary source for re-emissions
- Contamination of ground & surface water
- Blooms of toxic algae
- Eutrophication & hypoxia in coastal ecosystems
- Increases in disease vectors such as mosquitoes
- Soil acidification

Source: Steffen and others, 16 January 2015, Science
Nitrogen Sources

Gulf of Mexico

Chesapeake Bay

Goal: Reduce the global pool of reactive nitrogen

- Reduce the fixation of reactive nitrogen
  - Improved N use efficiency of plant and animal systems
- Recycle more reactive nitrogen
  - Life-cycle analysis (farm to fork)
  - Cover crops
- Convert reactive nitrogen to dinitrogen gas
  - Edge-of-field treatments
Adapted from: Giller et al. (2004) SCOPE 65 *Agriculture & the N Cycle*, (Island Press), pp 35-52

 Likely impact of research investment in different areas towards improving N use efficiency (NUE)

- **Current level of N use efficiency**
- **Increased N use efficiency**
  - Improved agronomic management
    - Maximize potential for plant growth
  - Implementation of existing knowledge
    - N provided on a crop need-basis
    - Control availability of inorganic N
  - Genetic modification
  - Plant selection & breeding

**Research effort (years)**

**Increase in N use efficiency**
Transformative vs. Incremental

The trajectory of research discovery should be commensurate with the scope of the problem to be solved:

– Reduce nutrient loading to Gulf of Mexico by 40% in 20 yrs

– Reduce deposition of nitrogen in Rocky Mountain National Park to 3 kg/ha/yr
Differences in protein production (blue line), consumption (red line), and the impact of eliminating food waste (“An opportunity”) and consuming the recommended amount of protein (“Another one”). Source: Dr. Jim Galloway
Biogeochemical vs. Social Science

- Creating markets that reward sustainability
  - Educating consumers
    - Sustainable diet
    - Food waste
- Policy analysis
  - Voluntary vs. regulatory
- NIFA is developing Nr Initiative. This initiative is summarized in the following graphical presentation.
Questions

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