Nitrous Oxide emissions from Ag Soil Management and GHG Credits

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Why are we Talking About N$_2$O

• It’s a potent Greenhouse Gass
  – Its global warming potential is 300 times greater than CO$_2$

• EPA estimates that 68% of N$_2$O emissions come from Ag Soil Management
  – Inorganic N, manure N, and leguminous N

• Represents approximately 3% of total U.S. GHG emissions
Why are we Talking About N$_2$O

• It’s an ozone depleting gas
• International treaties in the 1990’s phased out CFC’s
• Now N$_2$O is the #1 ozone depleting gas emitted by human activity

Greenhouse Credit from Reductions in N$_2$O emissions

- Reducing its emission can produce a marketable GHG credit
- Similar to carbon credit
- N$_2$O credits are for Avoidance
  - Much more attractive to EPA and GHG credit buyers
- Carbon credits are for Sequestration or removal
  - Sequestration has a problem with permanency
  - No-till soils can be tilled, releasing CO$_2$
California’s Effort to Reduce GHG Emissions

- In Oct. 2010 California voted to adopt cap and trade
- This provides a market for GHG credits
- Currently, many efforts are being made to develop protocols to generate GHG credits from N$_2$O emission reductions
  - Protocols outline the requirements for the generation of GHG credit.
Activities in Oklahoma

• OSU Extension and the OCC were asked to participated in a pilot project partially funded by the USDA.
  • National Wildlife Federation
  • Delta Institute
  • Conservation Technology Information Center
  • American Farmland Trust
  • DNDC Applications, Research and Training, LLC
  • EKO Asset Management Partners
  • American Carbon Registry
Activities in Oklahoma

• Project Goals:
  – Evaluate effectiveness of different BMPs in reducing N$_2$O emission, thereby creating a GHG credit
  – Contract with producers to sell GHG credits generated though adoption of BMP’s

• OSU Extension
  – Provide technical expertise on Best Management Practices to reduce N$_2$O emissions
How is a GHG Credit Generated?

- A credit is generated when a practice is adopted that reduces $\text{N}_2\text{O}$ emissions compared to business as usual.
Generating a $\text{N}_2\text{O}$ credit

- Water quality concerns associated with N fertilizers are localized within a watershed.
  - Problems can be solved by simply reducing N fertilizer applications in watershed regardless of impact on crop production

- $\text{N}_2\text{O}$ emissions is a global issue
  - Reducing crop production is not an option
Nature of Global Air Quality Issues

• Decreased production in a locality due to decreased N fertilizer application will be offset by production increases somewhere else
  – No change in net N$_2$O emissions

• We must decrease emissions without decreasing productivity
What Factors Influence $\text{N}_2\text{O}$ Emissions

• $\text{N}_2\text{O}$ is produced during denitrification and nitrification
  – Occurs in oxygen depleted conditions
• Emissions are influenced by soil moisture, organic matter, temperature and inorganic N concentrations
• Emissions are similar for Urea, $\text{NH}_4\text{,}$ and $\text{NO}_3$ containing fertilizers
What Factors Influence $N_2O$ Emissions

• Moisture:
  – Emission will occur at 60% water filled pore space
    • In a silt loam = 30% moisture by weight
  – Anoxic or oxygen depleted conditions
N\textsubscript{2}O Emissions will Spike after Rainfall Event

Forage Sorghum
Stillwater, 2010
Relationship between $\text{N}_2\text{O}$ emissions and N Rate

• Rule of Thumb:
  – 0.01 lbs $\text{N}_2\text{O}$ per lbs N fertilizer applied.

• Data from Stillwater in 2010-11 shows
  – 0.014 lbs per lbs

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\text{N}_2\text{O} \text{ Emissions} = 0.0141 \text{N rate} + 1.1644
\]
How can we decrease $\text{N}_2\text{O}$?

• Many environmental groups believe we can simply decrease N rates?
  – Some research from across the U.S. suggest this is correct.

• Enhanced N fertilizers have shown some promise but results are not consistent?

• Utilization of leguminous cover crops

• Split applications of N fertilizer
Decreasing N Rates?

• Assumes that producers over apply fertilizers
  – Sometimes they do
• How are N fertilizer rates determined?
Basis of N Recommendations

• Yield Goal!
  – Average yield
    • Can be calculated from historic yields
  – Maximum yield
    • Doesn’t happen very often
  – Potential yield
    • Difficult to determine without some help

• If yield goal is somewhere between average yield and maximum we are more often than not over applying.
Our primary approach in Oklahoma

• Utilize sensor based technology to determine potential wheat yield and topdress N rate
  – Increases NUE?
  – Maintains or increased Yield?
  – Create GHG credits?
Our primary approach in Oklahoma

• Drawback to this approach is that it will not always decrease N$_2$O emissions per acre
  – SBNM can recommend N applications that are higher than business as usual (Farmer Practice)
  – Currently GHG credits are valued on a per acre basis
  – A GHG credit will not be generated every year?
• SBNM will decrease N$_2$O emissions per bushel
  – Perhaps this is how credits should be valued
There are other options.

- There is very little data for this region of the U.S.
- Application timing may be very important to reducing $\text{N}_2\text{O}$ emission
Application of N Fertilizer prior to Rainfall Event

Stillwater, 2011
Application of N Fertilizer prior to Rainfall Event

Forage Sorghum
Stillwater, 2010
How will Split Applications impact N2O emissions

• For summer crops N$_2$O emissions may be increased sidedress?

• For Wheat and Canola we should get a significant decrease in N$_2$O emissions from split applying N

• Research is needed
Generating a GHG Credits

• A credit will be generated when a BMP is implemented that decreases N$_2$O emissions compared to business as usual.

100 % preplant  $\leftrightarrow$  Split applications
Split applications  $\leftrightarrow$  Sensor based Rec.
Summary

• $\text{N}_2\text{O}$ represents a small fraction of the total GHGs emitted into atmosphere annually

• There are many efforts underway to create protocols for the generation of GHG credits based on reductions in N2O emissions

• I believe they must result in increased NUE to be agronomic ally and environmentally sound
Questions

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