Offset Opportunities for Row–Crop Agriculture in the Midwest: The Role of Nitrogen Fertilizer in Developing a Nitrous Oxide Reduction Protocol

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Presentation Overview

• Objective
• Carbon Offset Market
• Nitrous Oxide and Nitrogen Management
• Project Overview
• Protocol Development
• Protocol Results
• Conclusions
Objective

Develop and implement an agricultural \( \text{N}_2\text{O} \) emissions reduction protocol for the US carbon offset market with potential for widespread farmer adoption.
Nitrous Oxide (N\textsubscript{2}O)

N\textsubscript{2}O is formed in soil primarily through nitrification and denitrification.

N\textsubscript{2}O emissions contribute to global warming and ozone destruction.

One ton of avoided N\textsubscript{2}O emissions equivalent to 298 tons of sequestered CO\textsubscript{2}
Nitrogen Management

Apply the correct nutrient in the amount needed, timed and placed to meet crop demand*

- Right product
- Right rate
- Right time
- Right place

Current understanding of US (Midwest) row–crop studies:

N fertilizer rate is best predictor of N$_2$O emissions

Project Overview

• Five sites (8 site years)
• Corn – soybean rotations
• Conventional tillage
• Six N fertilizer (urea) rates
• Static chamber methodology

• Empirical field data
• Biological basis – threshold response
• N fertilizer rate proxy for N$_2$O emissions
• Regional emissions factor
• GHG credits from reduction in N rate

Protocol Development

Emission Factor (EF)

Fraction of N Fertilizer applied emitted as N\textsubscript{2}O–N

**EF\textsubscript{1} = 0.01 \times N rate**

Linear relationship

EF\textsubscript{1}: Default value - constant EF

**EF\textsubscript{2} = \exp(0.0082 \times N rate)**

Exponential relationship

EF\textsubscript{2}: Regional value – variable EF

Implications for N\textsubscript{2}O emissions reduction and project incentives
Protocol Development

N rate recommendations

- Maximum Return To N (MRTN)
- Economically profitable N range

Emissions reduction (Credit)

- Credit generated by N rate reduction from high to low profitable MRTN rate
- Virtually no yield effect
Protocol Results: N$_2$O Reductions

- **Linear**: N$_2$O emissions reduction $\sim$ 0.3 kg N$_2$O–N ha$^{-1}$ yr$^{-1}$ (B)
- **Exponential**: N$_2$O emissions reduction $\sim$ 1.1 kg N$_2$O–N ha$^{-1}$ yr$^{-1}$ (C)

Millar et al. 2010. Mitigation and Adaptation Strategies for Global Change
Results: Carbon Offset Credits

Potential Impact of protocol

Linear: Reduction (139 → 118 lb N/ac) ~ 0.05 tons CO$_2$e a$^{-1}$ yr$^{-1}$

Exponential: Reduction (225 → 190 lb N/ac) ~ 0.6 tons CO$_2$e a$^{-1}$ yr$^{-1}$

CCX Conservation Tillage Practice = 0.4 – 0.6 tons CO$_2$e a$^{-1}$ yr$^{-1}$

86 million acres of US farmland planted to corn in 2009 (USDA)
Potential reduction of 52 million tons CO$_2$e a$^{-1}$ yr$^{-1}$
Conclusions

Protocol Attributes

- Scientifically robust
- Environmental integrity
- Transparent to all stakeholders
- Cost-effective

Protocol Provisions

- Negate / Minimize Productivity Loss
- Economic Incentive (MRTN rate)
- Environmental Incentive (N₂O reduction)
- Fungible Emission Reduction Credits
Thank You
Project Impact (Stakeholders)
- Producers
- Aggregators
- Validators and Verifiers
- Emitters
- Conservationists
- Concerned citizens
- Public and private entities

Protocol Considerations
- Baseline
- Variability
- Additionality
- Permanence
- Leakage
- Effectiveness

Project Overview