Nitrogen Management for Carbon Credit:

Development and Implementation of a Nitrous Oxide Emission Reduction Protocol and Project

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OVERVIEW

Carbon Markets and Offsets

Carbon offsets are credits traded on carbon markets that represent GHG emissions reductions generated from a change in management practice (Figure 1).

Compliance and Voluntary carbon markets are active in the US and globally, and can be an on-farm income source (Figure 2).

Offsets may be in short supply and agriculture can be an important source.

Nitrous oxide (N_2O) with its high global warming potential (GWP) or CO_2e of ~300 provides a high payback for its emission prevention.

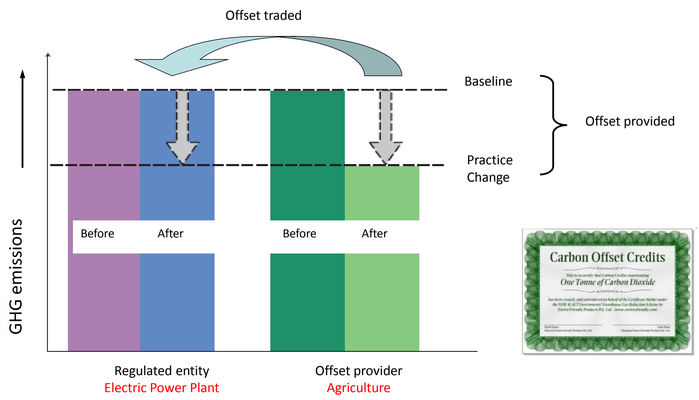


Figure 1. Schematic depicting carbon offset transaction

Nitrous Oxide and Nitrogen

Emissions of N_2O represent the single largest contributor to the global warming impact of US cropping systems.

Nitrogen input to the soil is the single most reliable predictor of N_2O emissions.

Reducing nitrogen (N) fertilizer rate leads to lower N_2O emissions and underpins our approach for generating carbon offsets.

OBJECTIVES

Develop a Protocol and a Project that uses the Protocol to deliver agricultural offsets to the carbon market through N_2O emissions reductions from N fertilizer rate reductions to cropland.

Protocol (to calculate N_2O emissions reductions) must have:

- Scientific integrity and genuine environmental benefits
- Transparency for all stakeholders
- Ease of use for project implementation

Project (contract to reduce N_2O emissions) must have:

- Low farmer effort and cost (data, documentation, invasiveness)
- Low verification complexity
- Fast adoption and broad uptake

METHODOLOGIES

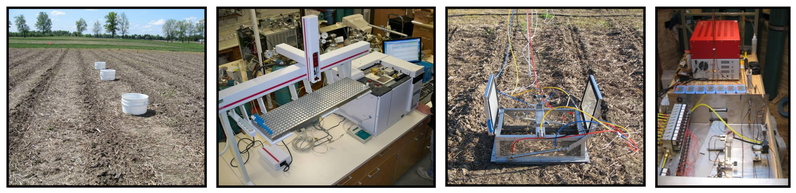


Figure 3. Static and automatic chambers sampling and analysis

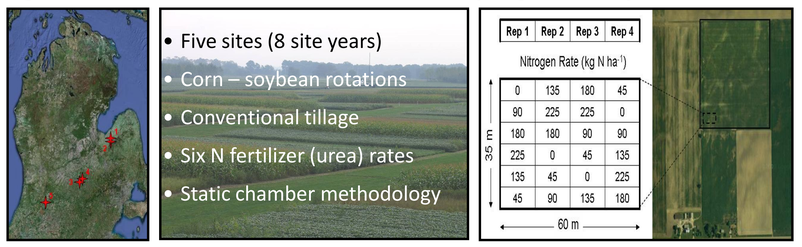


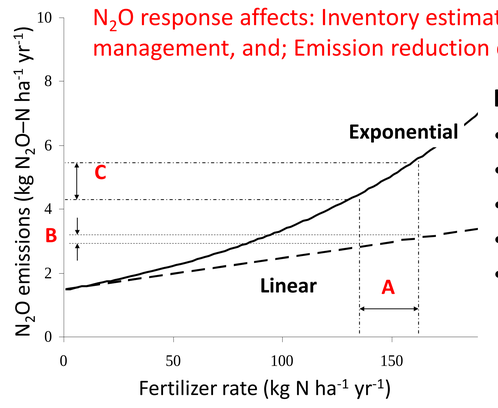
Figure 4. MI field locations, management, and experimental design

FINDINGS

Protocol Accounting and Benefits

Greater N_2O emissions reductions from reduction in N rate (A) with non–linear (C) compared to linear (B) relationship (Figure 5).

N_2O response affects: Inventory estimates; Incentive to change management, and; Emission reduction credits



Benefits include

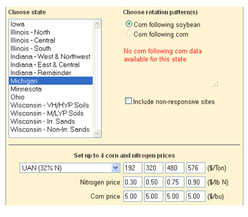
- Reduced agricultural GHGs
- Reduced levels of reactive N
- Delivery of offset credits
- No productivity penalty
- Farmer financial compensation

Figure 5. (left) N fertilizer rate vs. N_2O emissions

Protocol Flexibility and Impact

N rate reduction achieved through:

- Economic optimization (Figure 6);
- Timing;
- Formulation;
- Cover-crop N capture



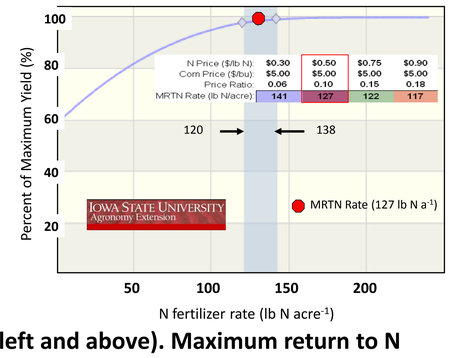


Figure 6 (left and above). Maximum return to N (MRTN) approach uses fertilizer : crop price ratios.

Potential Carbon Volumes from corn

Linear: Reduction (138 → 120 lb N a^{-1}) = 0.04 tons CO_2e a^{-1} yr^{-1}

Exponential: Reduction (225 → 175 lb N a^{-1}) = 0.35 tons CO_2e a^{-1} yr^{-1}

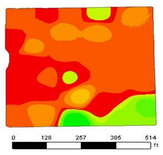
North Central Region: ~40 Million Metric Tons of CO_2e over five-years

CHALLENGES

Protocol Validation Issues

Baseline Establishment

- Base Years
- Proof of Practice
- Proof of ownership



Proving Additionality

- Regulatory Surplus
- Performance Standard
- Social Barriers

Permanence and Reversal

- N_2O emissions avoided are: **Immediate; Irreversible; Permanent**
- Producer aggregation

Proving No Project Leakage

Farmers can reduce N rate without yield reduction through:

Yield Goal → Economic Optimization approach

- Yield goal - N rate recommendations from yield history
- Economic optimization - Fertilizer : Grain price ratio (Figure 6)

No yield reductions, therefore no yield compensation
No additional N use, therefore no added N_2O emissions

Protocol Progress

Carbon Standard, Registry, and Regulatory Organizations

American Carbon Registry — Validated July 2012*

California Environmental Protection Agency Air Resources Board — Utilized? Cap and Trade Program 2013

Climate Action Reserve — Utilized NMPP - Validated July 2012

VCS Verified Carbon Standard, A Global Benchmark for Carbon — Validation expected Fall 2012

* First carbon market methodology in the world to be derived directly from empirical field studies and published in peer-reviewed scientific literature

Project Progress

One year (2011) 'proof of concept' project reduced N fertilizer rate (~15%) on 40 acres of corn in Tuscola county, MI.

- Project Document submission – expected September 2012
- Validation and carbon offset delivery – expected December 2012

American Carbon Registry · Delta · Environmental Services, Inc. · The ClimateTrust

Conclusions

- Carbon credits needed and agriculture can provide them
- N_2O reduction is promising source
- Protocols need to be robust and transparent
- Projects need to be low cost and low complexity

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EPRI Electric Power Research Institute · KBS LTER Kellogg Biological Station Long-term Ecological Research · Michigan State University AgBioResearch

Bibliography: **Millar et al. 2010**. Mitigation and Adaptation Strategies for Global Change, 15:185–204. **Hoben et al. 2011**. Global Change Biology. 17:1140–1152. Millar et al. 2012. American Carbon Registry, Winrock International, Little Rock, Arkansas.