Nitrogen Management for Carbon Credit

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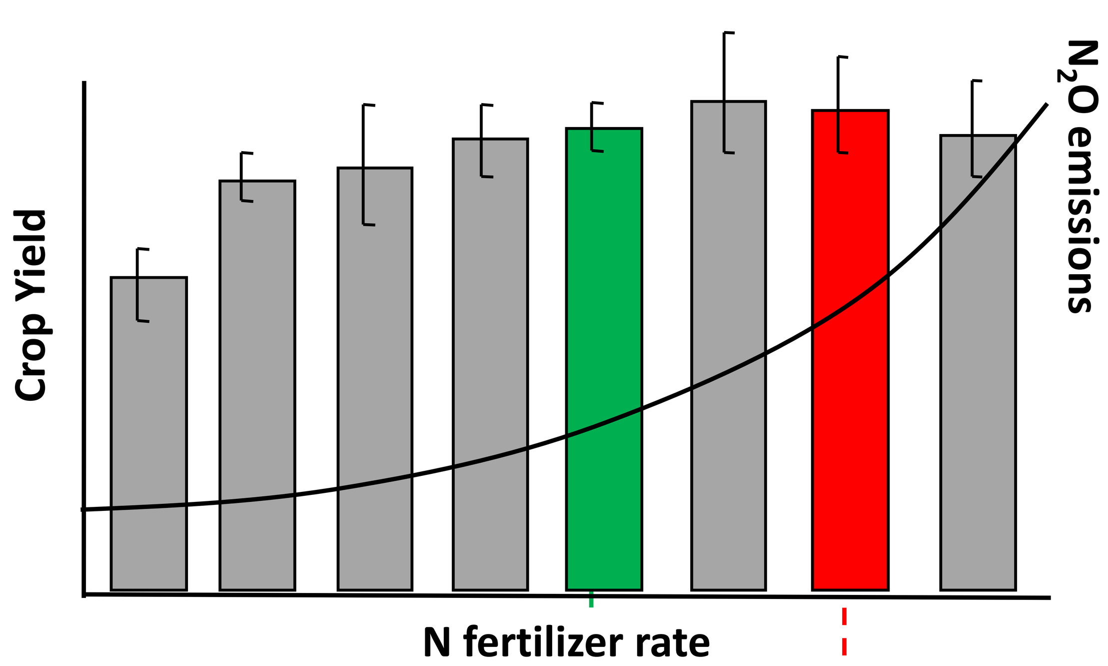
Why we care about nitrous oxide

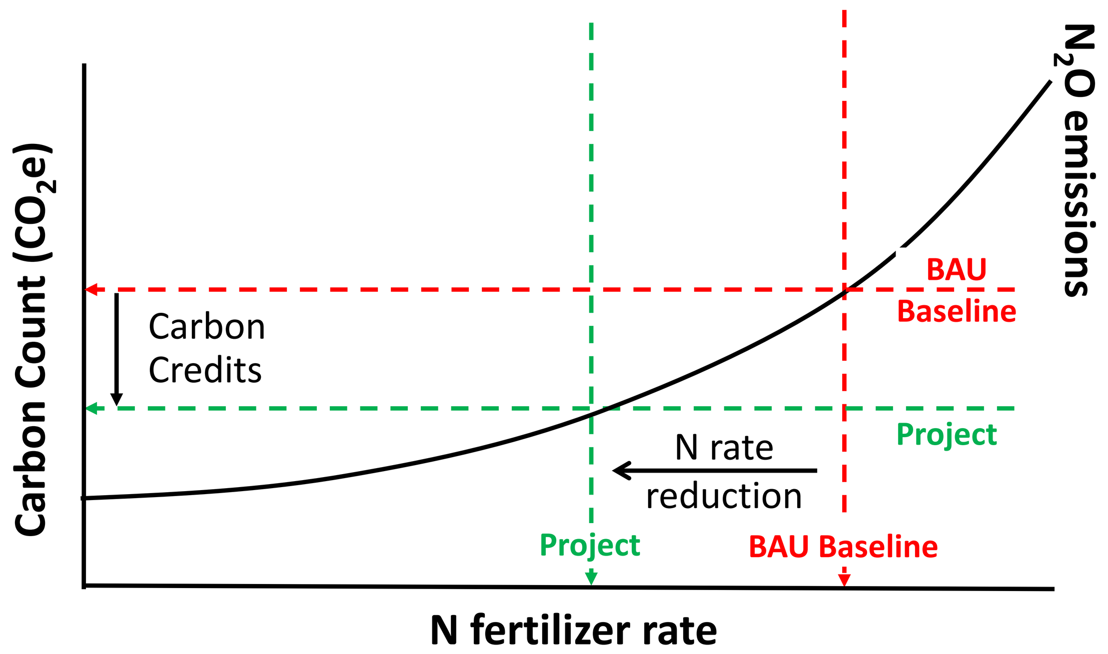
- Nitrous oxide (N_2O) is a potent greenhouse gas (GHG) with a Global Warming Potential (GWP) ~ 300 × CO_2
- Nitrous oxide is the most important precursor of atmospheric gases that deplete stratospheric ozone
- About two thirds of global anthropogenic N_2O emissions and more than three quarters of total U.S.A. N_2O emissions are from agriculture, predominantly from cropping systems with external N inputs to the soil
- Nitrogen fertilizer rate is a very good predictor of nitrous oxide emissions

Benefits of lowering nitrous oxide emissions

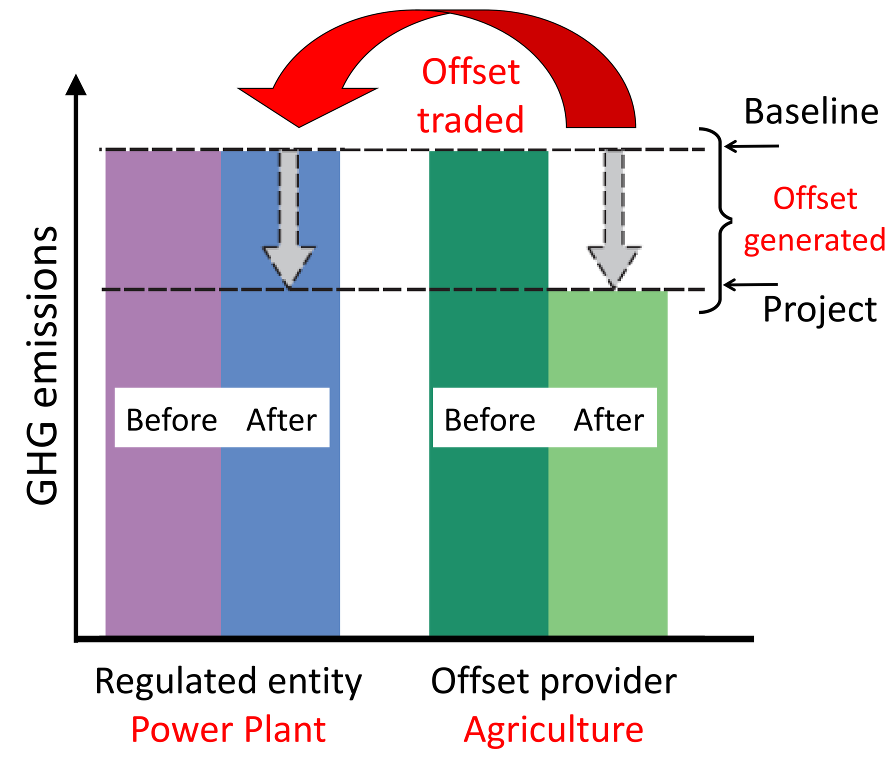
- Fertilizer costs can be lowered without a yield loss
- Other N losses (e.g., nitrate leaching) can be reduced
- Nitrogen (N) will be used more efficiently by the crop
- Agriculture's global warming impact will be reduced

Carbon markets provide financial incentives to lower N rate



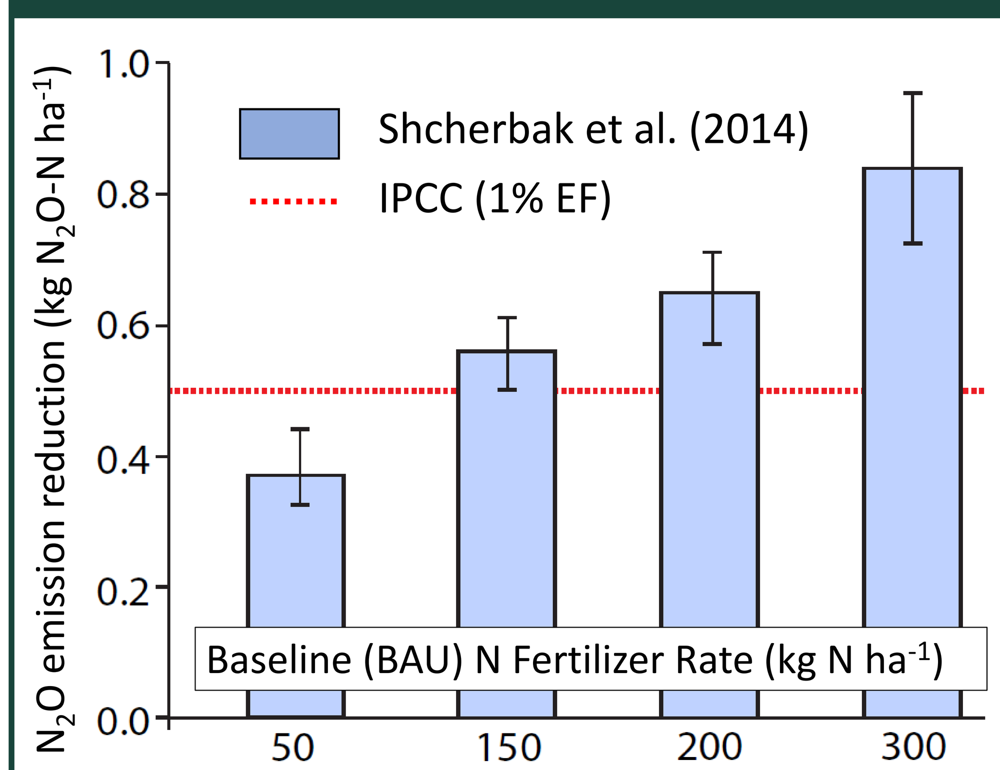


Mechanism for trading a Carbon Offset



- N rate reduction
  - Example of a practice change
- Baseline (BAU) GHG emissions
  - Before practice change
- Project GHG emissions
  - After practice change

How much nitrous oxide mitigation can be achieved?



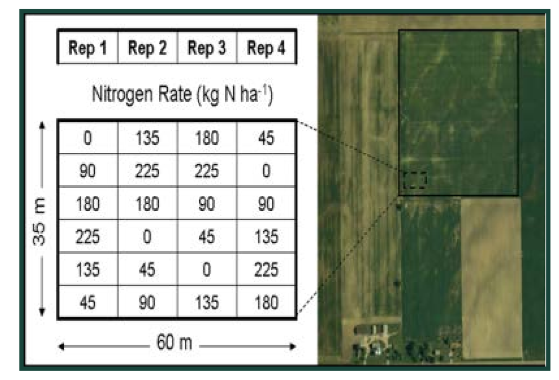
Effects of a 50 kg ha^{-1} reduction in N rate

BAU fertilizer rate	Reduced fertilizer rate	N_2O emissions reductions	Carbon units generated
kg N ha^{-1}		kg N_2O-N ha^{-1}	kg CO_2e ha^{-1}
300	250	0.84	393
200	150	0.65	304
150	100	0.56	262
50	0	0.37	173

The incentive to reduce N fertilizer rate is increased as baseline N fertilizer rate increases

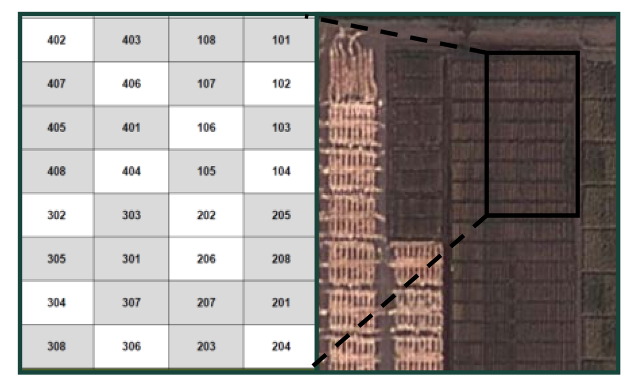
Measuring nitrous oxide emissions

Manual chamber technology used to sample for N_2O gas from soil surface. N_2O concentrations analyzed using gas chromatography. N_2O flux calculated from concentration change over time.



Michigan, USA

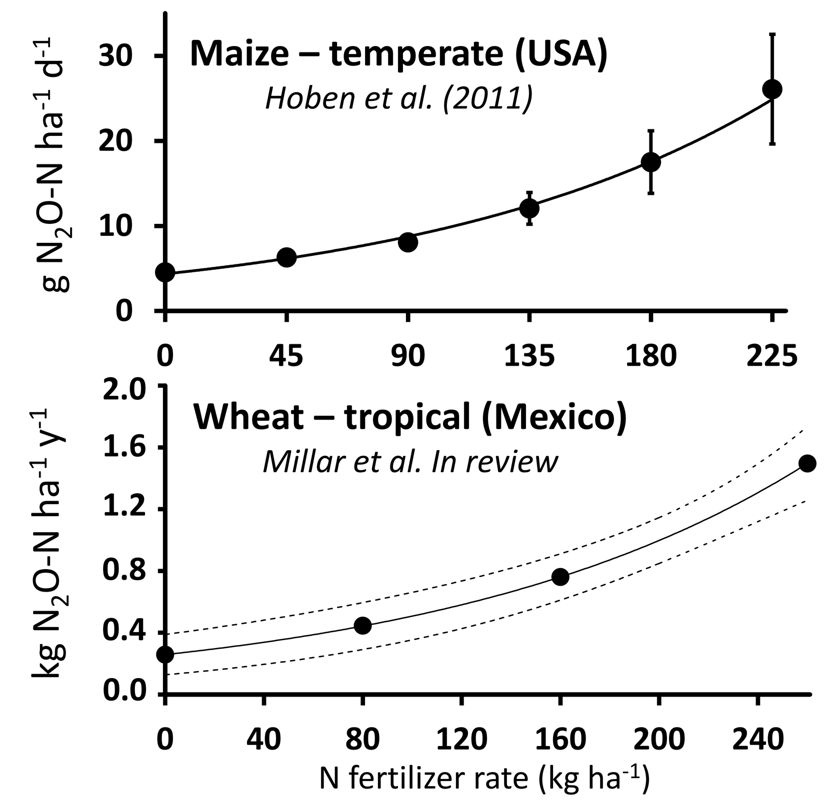
Location:	42.41-43.45 N; 83.64-85.37W
Rotation:	**Maize** - soybean
Design:	RCBD (4 replicates)
Plots:	15.2 × 5 m
N rates:	0, 45, 90, 135, 180, 225 kg ha^{-1}
Soil:	Fine loams
MAP:	800 – 1005 mm
MAT:	8.3 – 10.1 °C

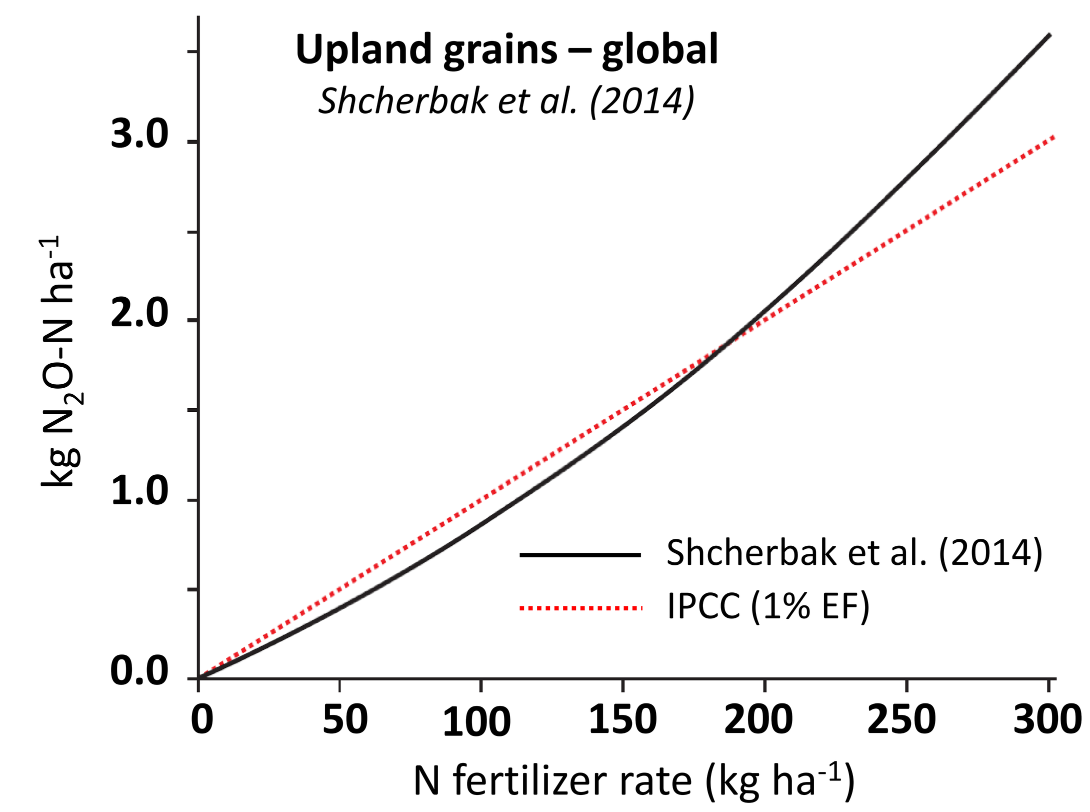


Yaqui Valley, Mexico

Location:	27°N; 109°W
Rotation:	**Wheat** - maize
Design :	RCBD (4 replicates)
Plots:	5.0 × 3.2 m
N rates:	0, 80, 160, 2600 kg ha^{-1}
Soil:	Coarse, sandy clay
MAP:	212 mm
MAT:	25.9 °C

Nitrous oxide response curves





How to manage for lower N rate

- 4R stewardship improves NUE
  - Should translate to lower N rate for same yield
- Precision N application
  - Variable rate lessens fertilizer need
- Precision estimation of N need
  - MRTN better predicts average
  - Real-time process modeling

Co-benefits

Reducing N fertilizer rate can:

- Lower loss of other reactive N species
- Provide financial savings to the farmer
- Generate offsets for the marketplace

Barriers to farmer participation

Institutional

- Lack of policy (direction)
- Low Carbon offset price (no incentive)

Agricultural

- Record keeping (availability and access)
- Technology (availability and access)

Project based

- Cost (validation and verification)
- Multiple protocols (uncertainty)

Personal

- Management legacy (inertia)
- Risk (averse)

Some potential next steps

- Combine complementary policies with an emissions trading program
- Test cropland N management protocols in compliance markets
- Allow projects to stack offset credits
- Credit multiple offset types separately

Globalize & harmonize N_2O mitigation protocols

MICHIGAN STATE UNIVERSITY | W.K. Kellogg Biological Station | KBS LTER | EPRI ELECTRIC POWER RESEARCH INSTITUTE | NSF | Michigan State University AgBioResearch

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