

Research on N_2O Emissions from Agricultural Soils in California

California Air Resources Board
May 21, 2008

Presentation Outline

- Background
- Current California N₂O inventory
- Critical research gaps
- Ongoing and proposed research efforts
 - State Agencies
 - Industry
- Discussion

AB 32 Implementation

- Signed into law on September 27, 2006
- Mandating sweeping strategies to curb GHGs
- Early Action items
 - 44 Early Action measures
 - *Measure 31: Collaborative Research to Understand How to Reduce GHG Emissions From Nitrogen Land Application*
- Scoping Plan
 - Additional measures for GHG reductions

What is N₂O?

-A Kyoto Greenhouse Gas (GHG)

- The Kyoto six: CO₂, CH₄, N₂O, HFCs, PFCs and SF₆

-Global Warming Potential

- 310 (IPCC, 2001); 298 (IPCC, 2007);

-Produced both naturally and artificially:

- Natural processes: nitrification/denitrification, and combustion
- Artificial reaction: catalytic chemical oxidation (chemical manufacturing)

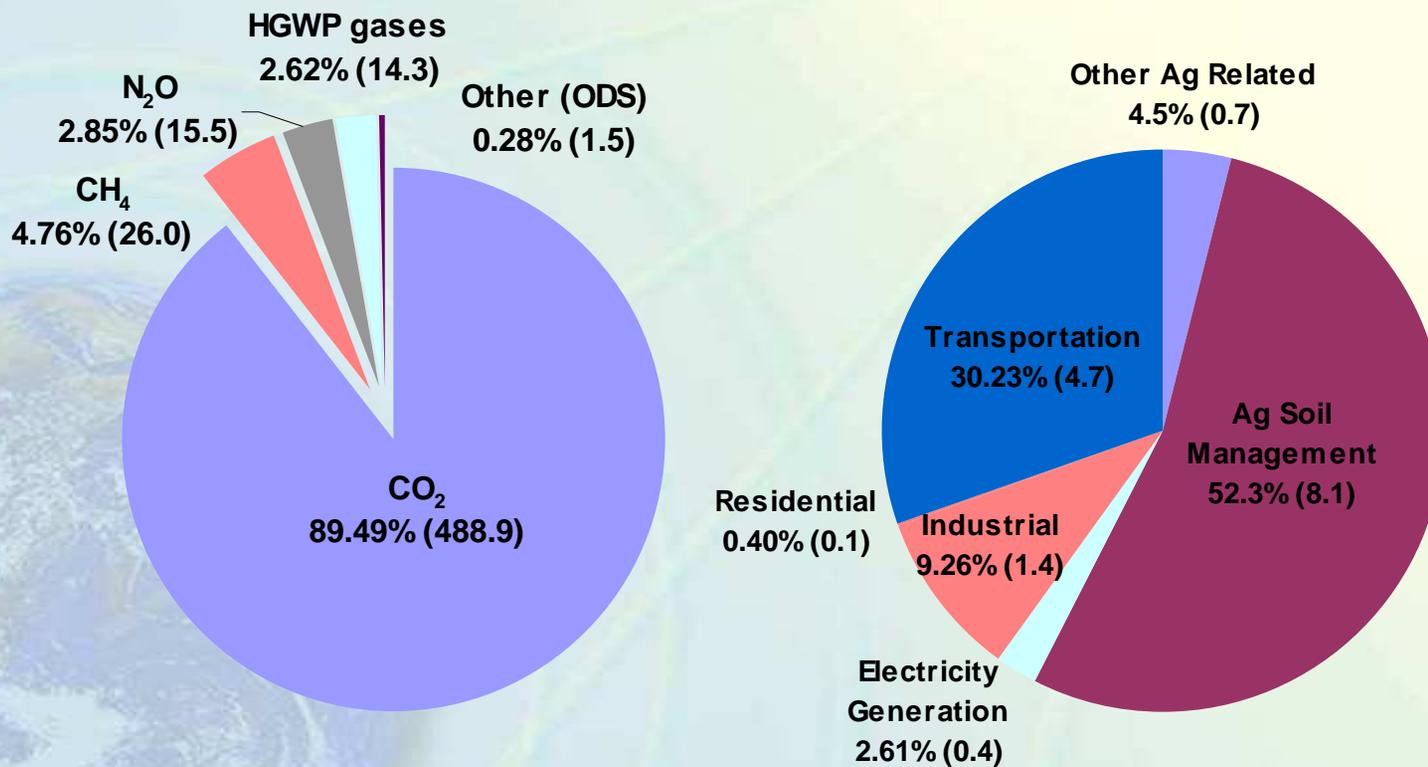
-Background concentration in the atmosphere: ~310 ppbv

- ~275 ppbv in 1750, ~290 ppbv in 1950, currently >310 ppbv
- Increase rate since 1950: 0.6 ppbv or 0.2% per year
- Largely caused by increased nitrogen fertilizer use

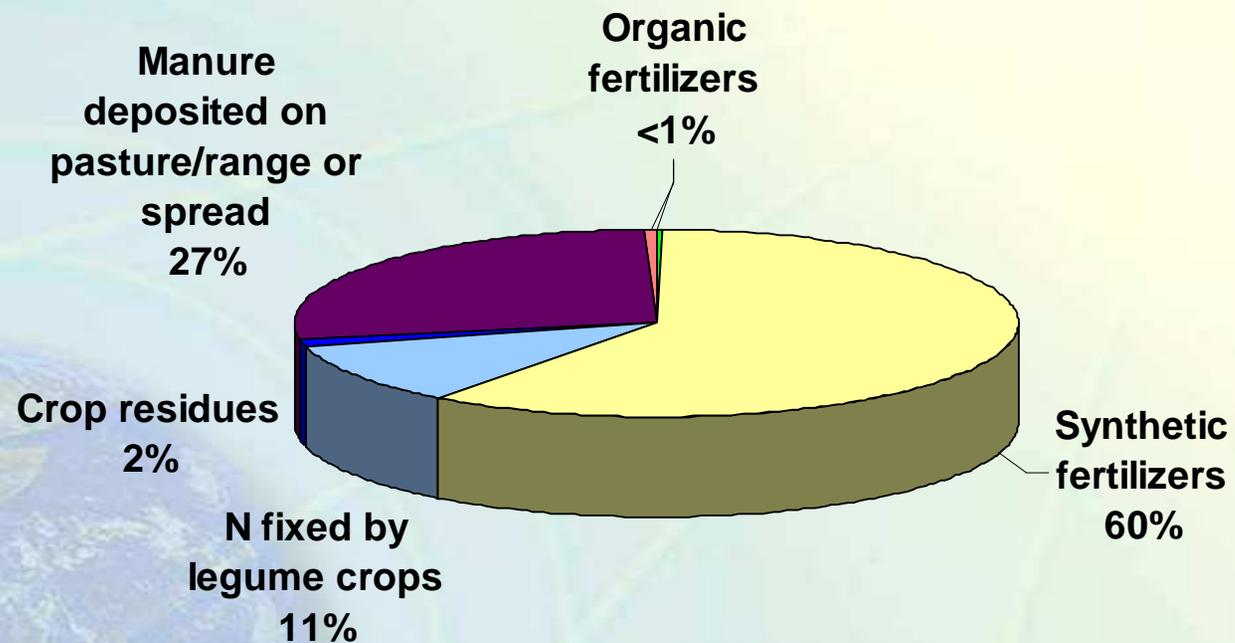
- Half-life ($t_{1/2}$) in the atmosphere: 114 years

N₂O Inventory

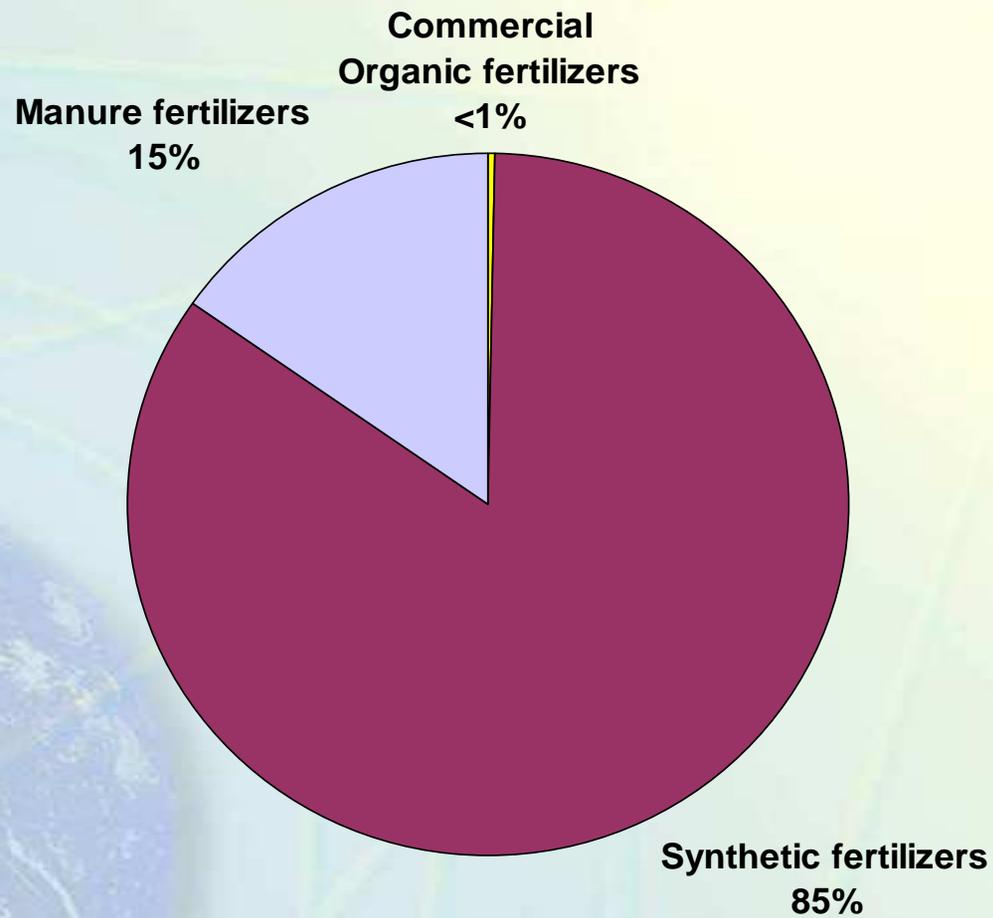
- Contributes ~ 3% to California's overall inventory
- Agricultural soil management is the largest source (>50%)



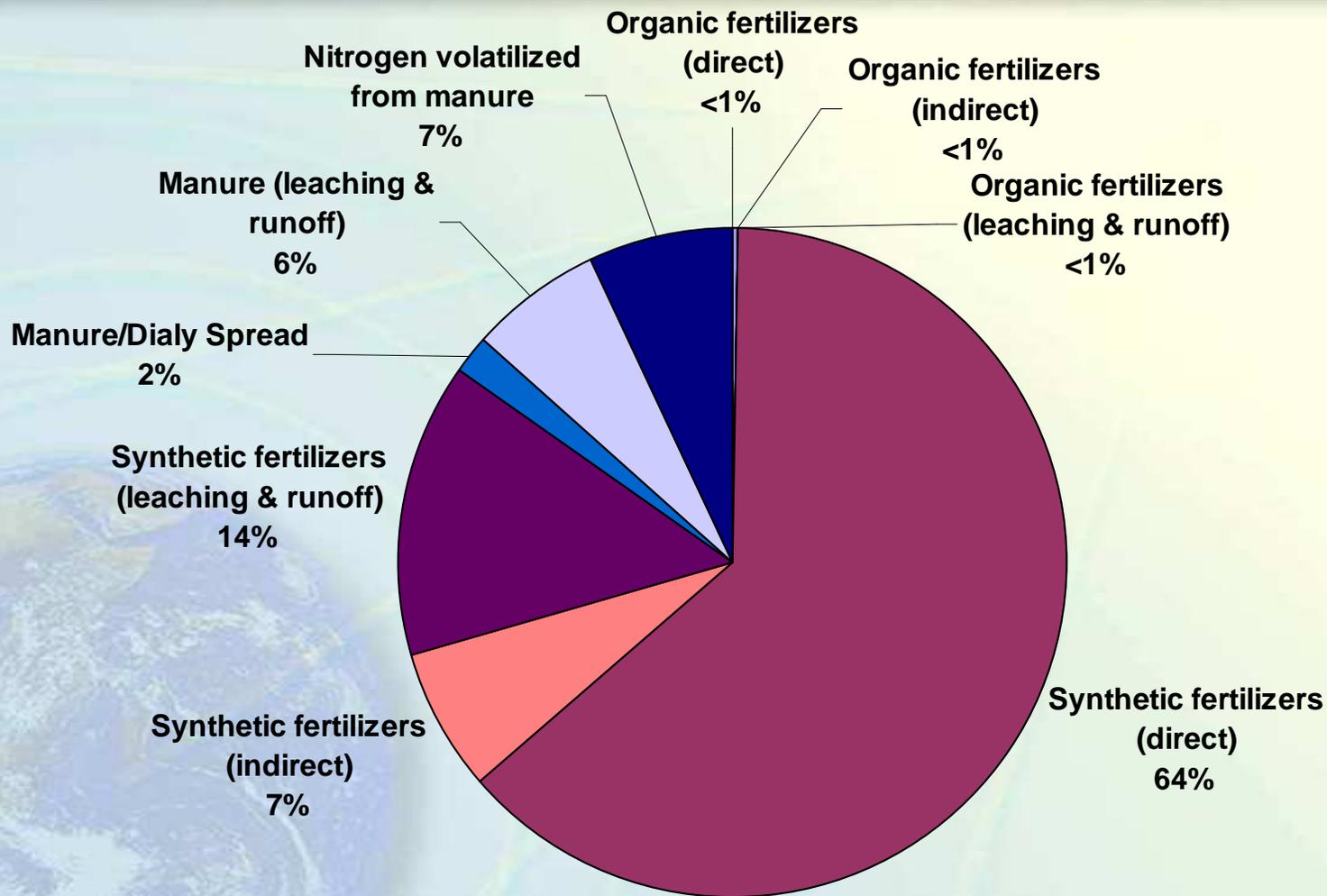
N₂O From Agricultural Soils



2004 Emissions from N Application



2004 Emissions from N Application



N₂O Inventory Estimation Methods

-IPCC Tier 1 approach (Emission Factor = EF)

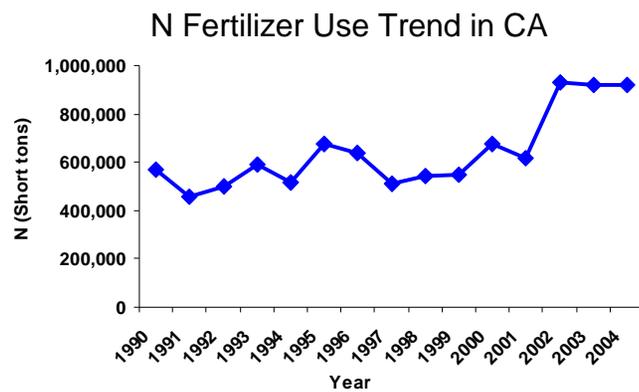
- Current California method for estimating agricultural soil N₂O emissions
- **N₂O Emissions = Activity x EF = Soil N Inputs x EFs**

-IPCC Tier 2 approach (disaggregated EFs)

Considering site specific information

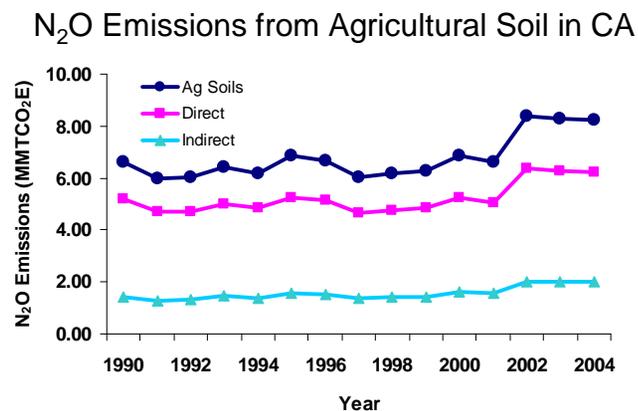
-IPCC Tier 3 approach: modeling/measurement

N₂O Emission and N Fertilizer Use



- Annual use trend (*California Department of Food and Agriculture, 2006*)

- 1990-2001: Relatively stable between ~500,000 - 600,000 tons
- 2002-2004: >900,000 tons



- Total N₂O emission from agricultural soil amounts to ~8.1 mmtCO₂e in 2004

- N₂O emissions were dominated by N fertilizer use (~60%)

- Direct emissions contribute about three times more N₂O than indirect emissions

Overview of N₂O Research

- Nitrogen fertilizer management has been an important research topic
 - Nitrogen fertilizer efficiency
 - Leaching/runoff controls
- Direct field observations on N₂O emissions are limited in USA, especially for California
- Process models (DNDC, DAYCENT) predict trends, are less reliable on events due to unknown localized parameters
- Major regulating factors on N₂O emissions
 - Inorganic N sources (practice dependent)
 - Soil water content (practice dependent)
 - O₂ sources
 - Carbon sources
 - Temperature

Critical Research Gaps

- Need crop-, practice-, and local-specific N₂O emission data for California
 - ✓ Baseline emissions inventory estimates
- Need to improve model applicability, validity, and reliability
 - ✓ Monitoring data for model calibration/validation
 - ✓ Improved spatial and temporal resolution

CDFA Sponsored N Fertilizer Related Research

California Department of Food and Agriculture

- FREP (Fertilizer Research and Education Program)

- Established in 1990
- Funds fertilizer, education, and environmental research
- Funding level: Typically 3 years at \$50,000/year
- Funded 139 projects to date
- More than 55% of funded projects directly relate to N fertilizer use

- Past project focus

- N fertilizer use under diversified cropping and irrigation systems and regions
- Best Management Practices (BMPs)
- Other environmental concerns (air and water)
- Outreach/Education

- <http://www.cdfa.ca.gov/is/fflders/frep.html>

CEC-Sponsored N Fertilizer Related Research

Quantifying Carbon Dynamics and Greenhouse Gas Emissions in Agricultural Soils of California: A Scoping Study

C. Li, W. Salas, M. Los Huertos

Objectives

- DNDC was used to estimate recent CO₂ & N₂O emissions at the county scale for CA

Results

- CA agricultural soils are sequestering C and have the potential to reduce N₂O emissions
- Large uncertainties due to uncertainties in initial soil conditions and crop residue management.

Recommendations

- Establish a program to collect data on residue and manure management.
- Further validate the DNDC model, over a range of California

CEC-Sponsored N Fertilizer Related Research

Integrated Assessment of the Biophysical & Economic Potential for GHG Mitigation in CA Agricultural Soils

De Gryze, S., R. Catala, R.E. Howitt, and J. Six

Objectives

- DayCent used to estimate GHG emissions and mitigation in CA agriculture under alternative and conventional management
- Evaluate financial incentives to stimulate adoption of alternative cropping practices

Results

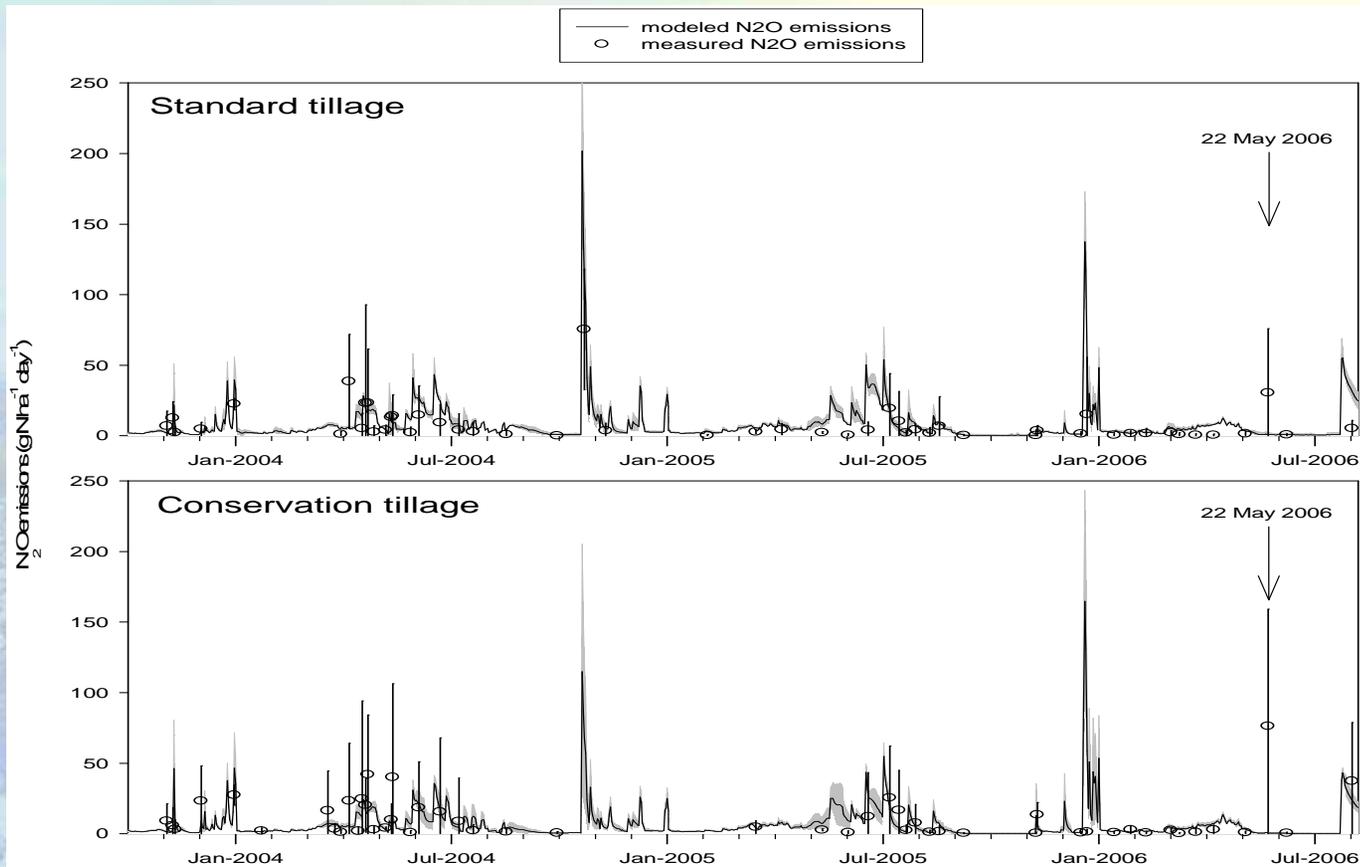
- Potential sequestration of 0.5 - 3.3 Mg CO₂-eq ha⁻¹ yr⁻¹ by combining alternative practices
- Daily N₂O fluxes were predicted fairly well. Variability of peak events inaccurate.

Recommendations

- Multi-year and multi-field contracts to reduce possible discount in C credit prices for agricultural mitigation
- Create a dataset of N₂O fluxes in CA agroecosystems
- Improve N₂O emission routines of existing models

CEC-Sponsored N Fertilizer Related Research

Modeled and measured N_2O emissions versus time for the standard and conservation tillage treatments at the Field 74 experiment (De Gryze et. al. 2008)



CEC PIER Request for Proposal

- Released March 17, 2008
- Due date May 20, 2008
- Projects will begin in November
- Total of up to \$2,900,000 for the six research topics
- Research Topic 2: N₂O Emissions from the Application of Fertilizers in Agricultural Soils (\$500,000; 3 yrs max)
- <http://www.climatechange.ca.gov/research/funding.html>

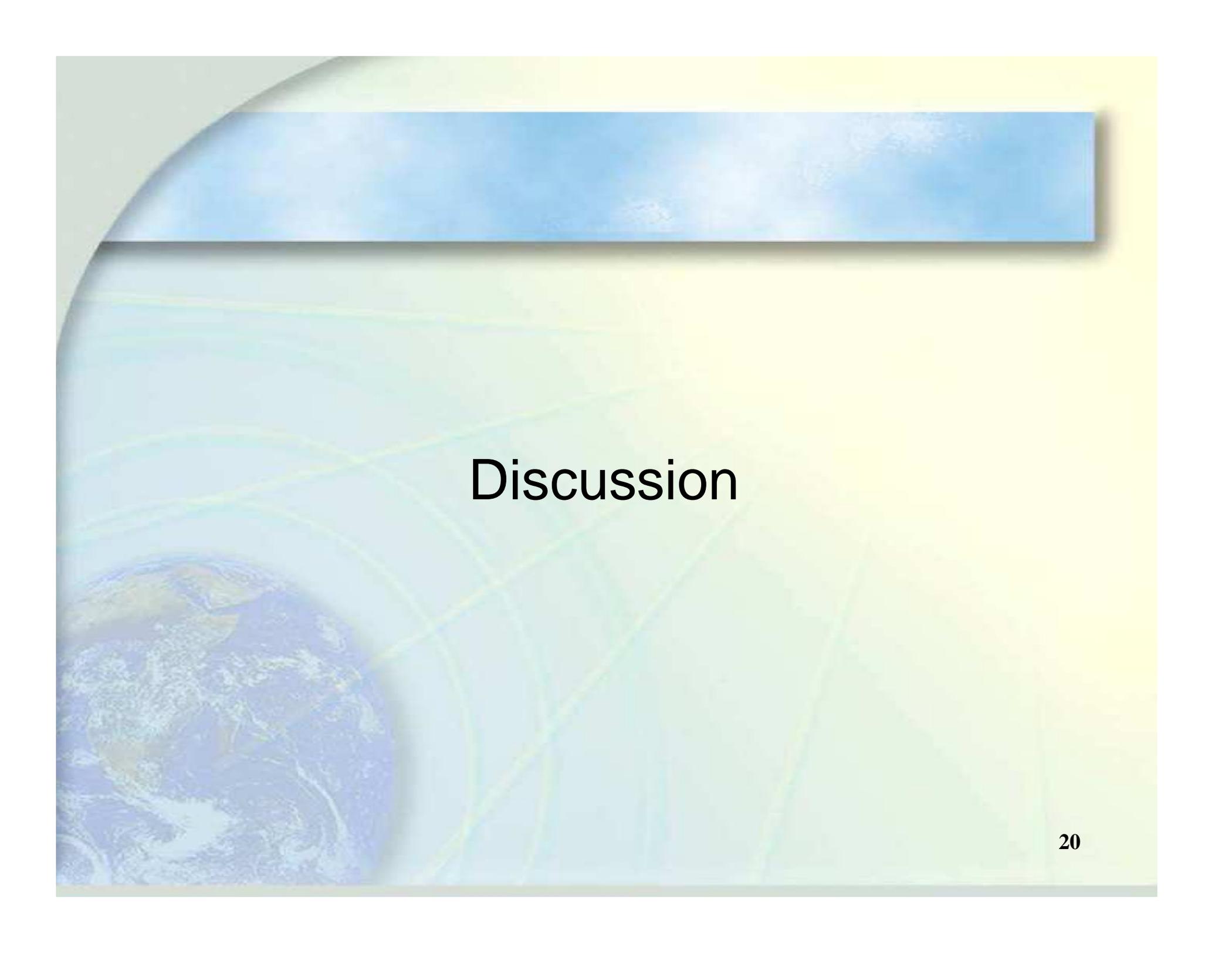
Suggested Research Project

Title: Establish baseline N_2O emissions from nitrogen fertilizer use based on California specific emission rates

Approach: Conduct field experiments to measure N_2O emission rates at multiple sites in key agricultural counties on major crops

Key considerations:

- ✓ N fertilizer type (NO_3^- , NH_4^+)
- ✓ Soil properties (organic matter content, texture)
- ✓ Irrigation practice
- ✓ Climate (temperature, precipitation)

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Discussion

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