State of California
AIR RESOURCES BOARD

Improving DNDC Modeling Capability to Quantify Mitigation Potential of Nitrous Oxide from California Agricultural Soils

RESEARCH PROPOSAL

Resolution 14-12

May 22, 2014

Agenda Item No.: 14-4-1

WHEREAS, the Air Resources Board (ARB) has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2773-278, entitled "Improving DNDC Modeling Capability to Quantify Mitigation Potential of Nitrous Oxide from California Agricultural Soils," has been submitted by the University of New Hampshire; and

WHEREAS, the Research Division staff has reviewed Proposal Number 2773-278 and finds that in accordance with Health and Safety Code Section 39701, research is needed to improve ARB's capability to quantify nitrous oxide (N_2O) emission reductions under a variety of agricultural management practices. The results of this project will inform ARB policy makers about the most effective strategies for reducing agricultural N_2O emissions. Research Division staff recommends this proposal for approval;

WHEREAS, in accordance with Health and Safety Code section 39705, the Research Screening Committee recommends for funding:

> Proposal Number 2773-278, entitled "Improving DNDC Modeling Capability to Quantify Mitigation Potential of Nitrous Oxide from California Agricultural Soils," submitted by the University of New Hampshire, for a total amount not to exceed $199,797.

NOW, THEREFORE BE IT RESOLVED that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendations of the Research Screening Committee and Research Division staff and approves the following:

> Proposal Number 2773-278 entitled: "Improving DNDC Modeling Capability to Quantify Mitigation Potential of Nitrous Oxide from California Agricultural Soils," submitted by the University of New Hampshire for a total amount not to exceed $199,797.

BE IT FURTHER RESOLVED that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed $199,797.

I hereby certify that the above is a true and correct copy of Resolution 14-12 as adopted by the Air Resources Board.

Tracy Jensen

Tracy Jensen, Clerk of the Board

ATTACHMENT A

"Improving DNDC Modeling Capability to Quantify Mitigation Potential of Nitrous Oxide from California Agricultural Soils"

Background

Agricultural soils are a major source of nitrous oxide (N_2O), a potent greenhouse gas (GHG) contributing to global warming, in California. Because N_2O is produced in soil by microbial activities which are affected by numerous environmental factors, process-based modeling incorporating site-specific conditions is considered a better approach characterizing N_2O emissions from agricultural crop land. Previous studies have indicated that significant mitigation of N_2O emissions from agricultural soils is possible through various management practices; however, a quantitative tool would be required to estimate emission reductions from these practices.

Objective

The objective of the project is to develop and deliver to ARB a California-specific modeling tool that can be used to calculate mitigation potential of N_2O emissions from a variety of mitigation practices for major California cropping systems.

Methods

The project will build upon a recently completed DeNitrification-DeComposition (DNDC) modeling system that has been evaluated and validated against California-specific crop growth and N_2O emissions data focusing largely on business-as-usual management scenarios for baseline emission assessment. Additional N_2O emission data are being collected from several key projects investigating mitigation strategies from major cropping systems in California as well as fundamental mechanisms leading to N_2O emissions from soils.

The proposed project will refine the DNDC model based on this newly acquired information. The project will incorporate into the DNDC model new and emerging research on N_2O formation mechanisms (such as Zhu et al., 2013) and field N_2O emission data, including an ongoing mitigation study sponsored by ARB and a paired study sponsored by USDA. Both projects are tasked to assess emission mitigation potentials for a variety of mitigation options such as use of nitrification inhibitors, dripping irrigations, cover crops, nitrogen fertilizer types and application methods. This project will also improve the flexibility and robustness of the DNDC model in deriving N_2O estimates through additional DNDC model development, calibration and validation for the selected mitigation scenarios to ensure that the model captures the impact of alternative management on crop growth and yields. Any new findings of N_2O formation pathways will be incorporated into the model improvement.

Researchers will conduct statistical analysis to assess DNDC model uncertainty. This will entail performing statistical analysis of modeled versus measured residuals and quantifying model uncertainty by using Monte Carlo and Bootstrapping approaches to ensure that model estimates of GHG emissions reduction are realistic and conservative. This project will provide estimates of mitigation potential in terms of N_2O, carbon dioxide, and methane reductions for all of California agricultural land using the newly

improved DNDC modeling tool, including the updated GIS databases and crop models developed from the recently completed DNDC modeling project. Ultimately this project will produce a DNDC interface that would facilitate model inputs, including automatic links to the USDA's Soil Survey Geographic database and climate data from the California Irrigation Management Information System and other meteorological networks, and post-modeling data processing, for mitigation potential calculations.

Expected Results
The project will further develop the DNDC model into a rigorous mitigation calculation tool for prevailing mitigation measures in California at the field scale, and produce a DNDC interface to facilitate model inputs and data processing.

Significance to the Board
This project will improve ARB's capability to quantify N_2O emission reductions under a variety of agricultural management practices. The results of this project will inform ARB policy makers about the most effective strategies for reducing agricultural N_2O emissions.

Contractor:
The University of New Hampshire

Contract Period:
24 months

Principal Investigator (PI):
Changsheng Li, Ph.D.

Contract Amount:
$199,797

Basis for Indirect Cost Rate:
The University of New Hampshire has agreed to a ten percent indirect cost rate.

Past Experience with this Principal Investigator:
The Principal Investigator, Dr. Changsheng Li, recently completed a contract with ARB using DNDC to assess baseline N_2O emissions under business-as-usual management scenarios. The new project will build upon this earlier project to further develop the DNDC into a rigorous mitigation assessment tool for California-specific agro-ecosystems.

Prior Research Division Funding to the University of New Hampshire

Year	2013	2012	2011
Funding	$ 0	$ 0	$ 249,688

BUDGET SUMMARY

Contractor: The University of New Hampshire, Durham, NH

"Improving DNDC Modeling Capability to Quantify Mitigation Potential of Nitrous Oxide from California Agricultural Soils"

DIRECT COSTS AND BENEFITS			
1.	Labor and Employee Fringe Benefits	$ 86,131	
2.	Subcontractor(s)/Consultant(s)	$ 87,559	
3.	Equipment	$ 0	
4.	Travel and Subsistence	$ 7,944	
5.	Electronic Data Processing	$ 0	
6.	Photocopying & Printing	$ 0	
7.	Mail, Telephone & Fax	$ 0	
8.	Materials & Supplies	$ 0	
9.	Analyses – Service Provider (W. Salas)	$ 0	
10.	Miscellaneous	$ 0	
	Total Direct Costs		$ 181,634
INDIRECT COSTS			
1.	Overhead	$ 0	
2.	General and Administrative Expenses	$ 18,163	
3.	Other Indirect Costs	$ 0	
4.	Fee or Profit	$ 0	
	Total Indirect Costs		$ 18,163
TOTAL PROJECT COSTS			**$ 199,797**

ATTACHMENT B

SUBCONTRACTORS' BUDGET SUMMARY

Subcontractor: Applied GroSolutions LLC, Durham, NH 03824

Description of subcontractor's responsibility: Perform DNDC model structural and database-induced uncertainties and develop a California-specific modeling interface for GHG mitigation calculation.

DIRECT COSTS AND BENEFITS			
1.	Labor and Employee Fringe Benefits	$ 87,559	
2.	Subcontractors	$ 0	
3.	Equipment	$ 0	
4.	Travel and Subsistence	$ 0	
5.	Electronic Data Processing	$ 0	
6.	Reproduction/Publication	$ 0	
7.	Mail and Phone	$ 0	
8.	Supplies	$ 0	
9.	Analyses	$ 0	
10.	Miscellaneous	$ 0	
	Total Direct Costs		$ 87,559
INDIRECT COSTS			
1.	Overhead	$ 0	
2.	General and Administrative Expenses	$ 0	
3.	Other Indirect Costs	$ 0	
4.	Fee or Profit	$ 0	
	Total Indirect Costs		$ 0
TOTAL PROJECT COSTS			**$ 87,559**