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Telephone: 530.754.7700
Facsimile: 530.752.0333
E-Mail: proposals@ucdavis.edu

April 15, 2015

Barzin A. Moradi
California Department of Food and Agriculture
Fertilizer Research and Education Program (FREP)
2800 Gateway Oaks Drive
Sacramento, CA 95833

Proposal Entitled:
"Online fertilizer guidelines for agricultural crops in California"
UC Davis Principal Investigator: Dr. Daniel Geisseler
Amount Requested: \$149,003
Project Period: 07/01/2015 – 06/30/2017

Dear Dr. Moradi:

On behalf of The Regents of the University of California, Davis Campus it is our pleasure to present for your consideration the above-referenced proposal.

Please contact Shanna Nation Jose at snation@ucdavis.edu with any administrative questions. We request correspondence pertaining to this proposal be sent via email to proposals@ucdavis.edu or mailed to the Office of Research Sponsored Programs Office, 1850 Research Park Drive, Suite 300 Davis, CA 95618-6153.

We look forward to working with you on this important project.

Sincerely,

A handwritten signature in blue ink, appearing to read "Chris D. Dye-Hixenbaugh".

Chris D. Dye-Hixenbaugh
Contracts and Grants Officer

Phone: (530) 754-8034

**Please refer to SPO #201503398 on all future correspondence.*

Send Award Notice to:

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PO BOX 989062
West Sacramento, California 95798-9062

A. Cover Page

1. Project Title

Online Fertilization Guidelines for Agricultural Crops in California

2. Project Leaders

Daniel Geisseler, CE Nutrient Management Specialist, University of California, Department of Land, Air and Water Resources, One Shields Ave., Davis, CA, 95616. (530) 754 9637, djgeisseler@ucdavis.edu

William R. Horwath, Prof. Soil Biogeochemistry, 1111 Plant and Environmental Sciences Building, Dept. Land, Air and Water Resources, University of California, Davis, CA, 95616. (530) 754-6029, wrhorwath@ucdavis.edu

3. CDFA Funding Request Amount/Other Funding

	CDFA Funding Request	Other Funding
07/2015-06/2016:	\$ 74,220.74	\$ 0
07/2016-06/2017:	\$ 74,782.60	\$ 0
Total:	\$ 149,003.34	\$ 0

4. Agreement Manager

Randi L. Jenkins, Associate Director, The Regents of the University of California, Sponsored Programs. 1850 Research Park Drive, Suite 300, Davis, CA 95618-6153. (530) 754 7700, awards@ucdavis.edu

B. Executive Summary

1. Problem

California growers are facing increasing pressure to improve nutrient use efficiency in crop production. For many crops, however, a comprehensive overview and synthesis of the current research on fertilizer use and management is missing. The Department of Land, Air and Water Resources at the University of California Davis and the California Department of Food and Agriculture Fertilizer Research and Education Program (FREP) have been working collaboratively since spring 2012 to create an online database for FREP-funded projects and to develop fertilization guidelines for major crops grown in California.

The overall goal of the proposed project is to expand the information accessible through the database and guidelines and make the guidelines more interactive and user-friendly.

2. Objectives, Approach, and Evaluation

Objectives

1. Keep database and guidelines up to date by entering new information.
2. Develop web-based nutrient management guidelines for an additional twelve crops grown in California.
3. Make the guidelines more interactive and user-friendly.
4. Increase the awareness level of the guidelines among potential users.
5. Write final report.

Approach

Final reports of FREP funded projects will be summarized and entered into the database. The available literature about nutrient management of major crops grown in California shall be summarized and made available online in the form of user-friendly guidelines.

Evaluation

The database and guidelines will be presented at a number of meetings. Feedbacks from the audience and users will be used to increase their usefulness. Use of the web-sites will be monitored using Google-Analytics. We expect that the number of users will increase by 20% each year.

3. Audience

The primary audience of the guidelines and database are growers and crop consultant. They are also a valuable resource for college students taking classes in agronomy or nutrient management. In addition, potential users include industry, government agencies and other entities.

C. Justification

1. Problem

For many crops, a comprehensive overview and synthesis of the current research on fertilizer use and management is missing. The FREP project 11-0485-SA, which started in spring 2012, has been closing this gap for some major crops. A user-friendly, web-based, database of FREP-funded research was created and crop-specific fertilization guidelines for 16 major crops grown in California have been written. These two products provide information on past funded research and summarize nutrient management practices in a web-based, user-friendly design to growers and other stakeholders. With the proposed project, the fertilization guidelines shall be expanded by an additional 12 major crops in California, the contents of the database shall be updated with new projects information and the website interface made more interactive and user-friendly.

2. FREP Mission and Research Priorities

The proposed project addresses the FREP Priority Research Area “*Developing Integrated Water and Nutrient Management Tools*”.

3. Impact

The guidelines and database are the most comprehensive online source of crop-specific information about nutrient management for crops grown in California. They are freely available to growers and crop consultants.

The guidelines and database give growers an overview of the results of the most recent nutrient management research. Using these resources will help growers and crop consultants plan nutrient management, improve N fertilizer use efficiency and reduce the risk of nitrate leaching.

4. Long-Term Solutions

The guidelines and database have the potential to increase N use efficiency in crop production, resulting in lower risks of nitrate leaching to the groundwater. They also provide growers with background information that help them better understand the processes and factors affecting nutrient use efficiency in the field. Being based on the same research results, the guidelines are complementary to decision support tools, such as CropManage and the almond N model. While decision support tools make site-specific in-season recommendations, the guidelines provide the background to better understand these recommendations and help growers plan their nutrient management.

5. Related Research

The proposed project builds on the work done in FREP project 11-0485-SA, which will be completed on April 30, 2015.

Database

Since the early 1990s, the Fertilizer Research and Education Program (FREP) of the California Department of Food and Agriculture (CDFA) has funded more than 160 projects. Project 11-0485-SA, which has been a collaborative effort between the Department of Land, Air and Water Resources at the University of California, Davis and FREP, made the wealth of technical research data and findings from these projects readily available through a user-friendly, web-based, database (<http://www.cdfa.ca.gov/is/frep/Default.aspx>). So far, key information from all projects for which a final report has been submitted to FREP (close to 150 projects) has been entered into the database.

The proposed project aims to ensure that the database remains a valuable source of information, reflecting past and present research, by adding summaries of recently completed FREP projects to the database.

Fertilization guidelines

Results from research projects, including FREP-funded studies, have been synthesized to create web-based fertilization guidelines for specific crops. The guidelines present accurate and timely crop nutrient information in a user-friendly, visually interactive interface. Information about application rates, time of application, fertilizer placement and types of fertilizers is included. The guidelines provide information about nitrogen, phosphorus, and potassium fertilization. In addition, deficiency symptoms are described and the use of soil and plant tissue analysis is discussed and instructions for representative sampling are provided. An extensive list of references and links to sites with additional information complement the guidelines. By spring 2015, guidelines for 16 crops will be freely available online (<http://apps.cdfa.ca.gov/frep/docs/guidelines.html>).

Based on grower and crop adviser demand, we added a series of webpages where data on nitrogen uptake during the growing season, nitrogen partitioning in the plant and nitrogen removed with the harvested plant parts are presented (http://apps.cdfa.ca.gov/frep/docs/N_Uptake.html). Most of the data included is from studies carried out in California. The webpages are linked with the guidelines and are a valuable resource for the preparation of nitrogen budgets.

The guidelines are the most comprehensive online source of crop-specific information about nutrient management for crops grown in California. To increase the reach of the guidelines, the proposed project aims to create guidelines for additional crops.

6. Contribution to Knowledge Base

The guidelines and database are the most comprehensive online source of crop-specific information about nutrient management for crops grown in California. They are freely available

to growers and crop consultants. A large proportion of the information summarized in the guidelines is from publications that are not available online and from scientific articles published in journals which require subscription. Therefore, the guidelines summarize information to which most growers and crop consultants do not have access to otherwise.

7. Grower Use

The guidelines and database are freely available online. They are easy to navigate, metric units are converted to US units and they are written in a clear and concise way intended for a non-scientific audience.

D. Objectives

The overall goal of the proposed project is to expand the amount of information accessible through the database and guidelines and make the guidelines more interactive and user-friendly.

1. Keep database and guidelines up to date by entering new information.
2. Develop web-based nutrient management guidelines for an additional twelve crops grown in California.
3. Make the guidelines more interactive and user-friendly.
4. Increase the awareness level of the guidelines among potential users.
5. Write final report.

E. Work Plans and Methods

1. Work Plan

The objectives shall be met by completing the following tasks by June 30, 2017:

Task 1 (addressing Objective 1): Enter key information of FREP-funded projects into the existing database when their final reports are submitted.

The close collaboration with FREP ensures that final reports are forwarded to us when they are submitted, allowing us to enter their key information into the database in a timely manner.

Task 2 (addressing Objective 1): Incorporate new research findings into the existing guidelines.

The guidelines shall represent a summary of the most recent information available from research projects. This goal shall be met by incorporating findings from recently published studies. Personal contacts with scientists, regular searches of scientific databases, attendance of meetings and field days shall ensure that we are aware of the latest research results.

Task 3 (addressing Objective 2): Write nitrogen, phosphorus and potassium fertilization guidelines for twelve additional crops.

By spring 2015, fertilization guidelines for 16 crops will be available online. The selection of these crops was mainly based on acreage in California with a focus on nitrate sensitive areas, which have been identified by FREP as being the Central Coast valleys and the east side of the San Joaquin Valley (see Interim Report, September 2013).

Applying the same criteria, we have identified twelve additional crops, which shall be added during the proposed extension of the project until summer 2017. These crops include (in alphabetical order): avocado, beans, carrots, celery, melons, olives, onions, peaches/nectarines, potatoes, prunes/plums, safflower, and sunflower. Based on USDA data, these crops have been harvested on 30,000 acres or more in 2012/13. If major shifts in acreage occur, some crops on this list may be replaced by others that are gaining in importance.

Task 4 (addressing Objective 3): Add quizzes about fertilization of specific crops

A set of five to ten multiple choice questions about nutrient management shall be added to the guidelines of specific crops (Figures 1 and 2). Users can test their knowledge about fertilization practices in an interactive way. After completing a quiz, the correct answers will be displayed together with prompts that point to information sources on the webpage that support the correct answers. Over time the pool of questions shall be increased, so that a random subset of the questions can be generated each time somebody takes a quiz allowing users to take the quiz multiple times with different questions.

These quizzes may be especially valuable for crop advisers preparing for an exam and undergraduate and graduate students taking a class in agronomy or soil science. The quizzes can also be used by undergraduate and graduate students, which are our future crop advisers. For example, the website is an exercise in Soil Science 109 Sustainable Nutrient Management taught by Professor W. R. Horwath at UC Davis.

Task 5 (addressing Objective 3): Add case studies of efficient N fertilizer use based on field trials.

The fertilization guidelines provide an overview of optimal nutrient management practices. For many crops little information about fertilizer management for specific regions of the state is available. Necessary adjustments to general guidelines may differ considerable for the same crop when grown in different regions of California.

To support growers when making field specific adjustment, we propose adding case studies to the guidelines. These case studies will highlight management practices that have been shown to work under specific conditions, such as soil types or crop rotations. They will be based on trials carried out in growers' fields. The case studies will include information about location, soil type, results from soil and plant tissue analyses, irrigation management, fertilizer management (including amount, time and mode of application, as well as type of fertilizer used), and crop yield (Figure 3). The nitrogen

budget of the case studies shall be presented in a format that closely resembles the nitrogen budgeting worksheet used by the Central Valley coalitions.

The case studies can be used as templates and, together with the discussion about field specific factors affecting nutrient management, which are discussed on the website (<http://apps.cdfa.ca.gov/frep/docs/Adjustments.html>), provide growers with a tool to make field-specific decisions. Furthermore, the case studies will facilitate the adoption of good management practices summarized in the guidelines.

Task 6 (addressing Objective 3): Javascript programs are most commonly used for dynamic and interactive features on websites. Using Javascript programs would make the nutrient guidelines more user-friendly: Currently, the boxes with detailed information open when the user moves the cursor over a field, and close when the cursor moves away. People not familiar with the page may move the cursor too fast and close the boxes before they have a chance to read the content. Javascript programs would allow opening and closing the boxes by clicking on them. To replace the current CSS commands with a Javascript programs, the code for each of the popup boxes needs to be changed on every page separately.

Task 7 (addressing Objective 4): The efforts to promote the guidelines and to encourage their use by decision makers in the field shall be intensified in different ways:

- Links on related sites: Webmasters of sites with related content shall be contacted and asked to add a link to the guidelines on their sites. Examples of websites with related content include UC Davis Research and Information Center webpages for vegetables, agronomic crops and tree crops, as well as websites of commodity groups.
- Presentations: We will continue presenting the guidelines at meetings and conferences. This will be done in collaboration with the FREP team.

Several presentations for early 2015 have already been confirmed, namely a Salinas Valley vegetable growers meeting, the California Plant and Soil Conference, and three CCA nutrient management trainings.

As an extension specialist, Daniel Geisseler will not lack opportunities to hold presentations at meetings in the future. With the guidelines being an important part of his outreach activities they will be a topic of many of his presentations.

- Personal contacts: Daniel Geisseler will intensify contacts with farm advisors and representatives of commodity groups. The guidelines can be a useful tool for farm advisors for their work with growers. Discussions with farm advisors shall increase their awareness of the guidelines as a source of information for growers. Farm advisors shall also be asked for their feedback to make the guidelines even more useful for their work with growers.

Task 8 (addressing Objective 5): Write final report. The final report will be written and submitted by the end of April 2016.

Tomato fertilization quiz

1. When do tomatoes take up most of the seasonal N?

☐ During vegetative growth (before bloom)

☐ Between early fruit set and red fruit stage

☐ Between red fruit stage and harvest

2. True or false: Starter P should be applied to tomato transplants, even in fields with adequate P test values

☐ True

☐ False

Calculate my score

Figure 1: Example of a quiz for tomatoes. Between 5 and 10 multiple choice questions will be added to each crop.

Tomato fertilization quiz

1. When do tomatoes take up most of the seasonal N?

☐ During vegetative growth (before bloom)

☒ Between early fruit set and red fruit stage

☐ Between red fruit stage and harvest

Correct! Generally more than 60% of the seasonal N is taken up between early fruit set and red fruit stage.

2. True or false: Starter P should be applied to tomato transplants, even in fields with adequate P test values

☐ True

☒ False

Incorrect. Often nurseries do not P-fertilize and the transplants arrive deficient, so it is a good idea to apply some starter P even if soil test P is adequate. For more information see **Starter P-Application rate**

Calculate my score

Figure 2: After answering the questions, users can check how they performed and see the correct answers.

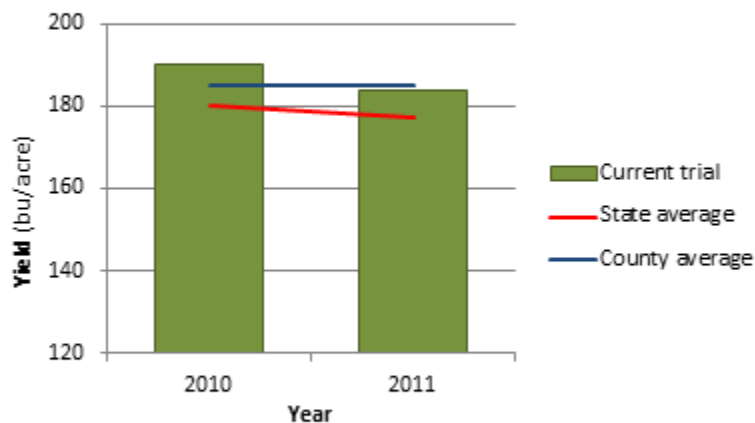
Grain corn

Variety 5H-515
 Location Davis, Yolo County
 Soil type Rincon silt loam
 Irrigation system Furrow irrigation



Nitrogen inputs				lbs N/acre
N fertilizer applications				
Preplant	Urea	Broadcast, incorporated		50
Starter	UN32	Band below seed		40
Topdress at 8-leaf stage	Urea	Banded in		100
Residual soil nitrate-N	top foot	5 ppm		17.5
	2 nd foot	3 ppm		10.5
Expected N mineralization from residues				small
Expected N mineralization from manure				none
Total available N				218

Yield



Comments:

The trial was carried out in a commercial field. The irrigation management was based on the growers practice.

Figure 3: Draft of the layout of case studies (the numbers in this draft are not actual data from a research trial).

F. Project Management, Evaluation, and Outreach

1. Management

Daniel Geisseler and William R. Horwath will supervise the creation of the guidelines. The guidelines will be written by Patricia Lazicki and possibly other people with a good background in nutrient management of specific crops. Daniel Geisseler will collaborate with CDFA-IT to upload new and improved content to the web sites, including the database and the guidelines.

2. Evaluation

The guidelines will be presented at a number of meetings. Feedbacks from the audience and users will be used to increase their usefulness. Use of the web-sites will be monitored using Google-Analytics. We expect that the number of users will increase by 20% each year.

3. Outreach

The entire project is an outreach activity for FREP. For specific outreach activities, see task 7 above.

G. Budget Narrative

Salaries and benefits

Assistant Specialist

Under the supervision of D. Geisseler and W.R. Horwath, an assistant specialist will write nitrogen, phosphorus and potassium fertilization guidelines for the crops identified in Task 3 and compile information needed for Tasks 4 and 5. The assistant specialist will complete the necessary review and synthesis of new FREP technical reports, which will be entered by Daniel Geisseler into the electronic database for use by growers and others at the field level.

Patricia Lazicki, who is already working on the guidelines since November 2011, will continue working on the project as an assistant specialist. The salary requested is predominantly for her. Part of the salary requested may be used to hire a web design specialist for a short period to help with Javascript development or a specialist with a strong background in nutrient management of some of the crops on our list. Her salary is currently \$ 44,904. An annual increase of 3% is projected for the first and again for the second year. Therefore, her salary for 2015/16 and 2016/17 will be \$ 46,251.12 and \$ 47,638.65, respectively. Benefits are based on federally approved composite benefit rates and projected to be 38.4% for the first year and 38.5% for the second year.

Student assistant III

In addition, the help of a student assistant majoring in IT/web design is requested to help with Javascript implementation. The student assistant will help develop and test Javascript

programs to ensure that they work on all major browsers as well as on tablets and smartphones with touchscreens before replacing the current CSS commands with Javascript programs. Once the code is developed, it needs to be changed for each of the popup boxes on every page separately. We request a salary for 12 weeks in the first year and 5 weeks in the second year. Student assistants generally work 20 h/week at a rate of \$ 10.5/h. A 3% increase is projected for the second year. Benefits are based on federally approved composite benefit rates and projected to be 1.3%.

Travel

To attend meetings with CDFA FREP personnel in Sacramento and professional meetings to present the database and guidelines to stakeholders (e.g. field days, annual FREP conference, California Plant and Soil Conference) we request \$ 1,000 per year for travel.

Indirect Costs: (Accounted for in the “Other Expenses” line)

Per a California Department of Food and Agriculture Memorandum (Dated April 10, 2014) all research and grant contracts with universities are subject to an F&A rate of 10% of personnel costs.

I. Appendices

1. Project Leader

Resume and list of recent publications from

- Daniel Geisseler
- William R. Horwath

2015 FREP Project Proposal Budget Template

Complete the budget template below by filling in the shaded cells. This template uses formulas to automatically calculate totals. **Do not** alter the formatting or formulas in unshaded cells. Rows may be added to accommodate additional personnel or funding sources, if necessary. An example is included on the next worksheet. Contact FREP staff at (916) 900-5022 or FREP@cdfa.ca.gov for help filling out this template.

Project Title: Online Fertilization Guidelines for Agricultural Crops in California

Project Leader(s): Daniel Geisseler and William R. Horwath

	07/15-06/16	07/16-06/17	Total
A. PERSONNEL (name, role, % based on full time salary)			
Salary			
Assistant specialist (1.0 FTE) Patricia Lazicki	\$46,251.12	\$47,638.65	\$93,889.77
Student assistant III	\$2,520.00	\$1,081.50	\$3,601.50
			\$0.00
			\$0.00
			\$0.00
<i>Salary Total</i>	\$48,771.12	\$48,720.15	\$97,491.27
Benefits			
Assistant Specialist, Patricia Lazicki	\$17,760.43	\$18,340.88	\$36,101.31
Student assistant III	\$32.76	\$14.06	\$46.82
			\$0.00
			\$0.00
			\$0.00
<i>Benefits Total</i>	\$17,793.19	\$18,354.94	\$36,148.13
Personnel Cost (A)	\$66,564.31	\$67,075.09	\$133,639.40
B. OPERATING EXPENSES			
Supplies			\$0.00
Equipment			\$0.00
Travel	\$1,000.00	\$1,000.00	\$2,000.00
Professional/Consultant Services			\$0.00
Other Expenses	\$6,656.43	\$6,707.51	\$13,363.94
Operating Cost (B)	\$7,656.43	\$7,707.51	\$15,363.94
TOTAL CDFA FUNDING REQUESTED (A+B)	\$74,220.74	\$74,782.60	\$149,003.34
C. OTHER FUNDING SOURCES			
			\$0.00
			\$0.00
			\$0.00
			\$0.00
			\$0.00
TOTAL OTHER FUNDING (C)	\$0.00	\$0.00	\$0.00
TOTAL PROJECT BUDGET (A+B+C)			
	\$74,220.74	\$74,782.60	\$149,003.34