

**Annual Update Summary**  
Southern San Joaquin Valley  
Management Practices Evaluation Program

Prepared for:  
**Southern San Joaquin Valley MPEP Committee**

Prepared by:



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# 1 INTRODUCTION

Through the Irrigated Lands Regulatory Program (ILRP), the Central Valley Regional Water Quality Control Board (Water Board) requires producers to implement management practices that are protective of groundwater quality and to document the effectiveness of those practices. The Southern San Joaquin Valley Management (SSJV) Final Management Practices Evaluation Workplan was approved by the Water Board to address requirements related to the Management Practices Evaluation Program. Program activities of the SSJV MPEP span workplanning and fundraising, assessments, investigations, and outreach. Highlights and accomplishments to date are described herein. Additional information for all program activities is available at <https://agmpep.com>.

## 2 WORKPLANNING AND FUNDRAISING

Workplanning included preparation of the Final Management Practices Evaluation Workplan. The Workplan included components indicated in the Order, along with others specifically requested by Water Board staff. Components included 1) a rigorous assessment of the effects of management of irrigated agricultural (crops not irrigated with dairy effluent) lands on underlying groundwater, including an initial prioritization of cropping systems relative to their potential influence on groundwater, 2) studies/research related to management practice performance, and 3) outreach to growers regarding management practices and their potential influence on underlying groundwater.

Two explicit strategies were identified to enable rapid acceleration and ultimate achievement of this aggressive program. The first was outreach to and partnership with large, established organizations already heavily engaged in these activities, to support, complement, focus, and expand their activities relative to Workplan components. The second was procurement of funding with potential project partners to expand near-term resources available to the MPEP Team and project partners, and by extension to growers. Multiple grants were pursued with our project partners. Over \$2.5M in grant funds have been awarded to support MPEP implementation. Several additional grants are currently pending award determinations. A summary of all grants pursued is included in Appendix A.

## 3 ASSESSMENTS

Several assessments have commenced, including the following:

- *Initial Crop Prioritization.* Crops on irrigated lands are to be prioritized based on factors such as acreage, position on the landscape, and intensity of nitrogen (N) use. Accordingly, several factors were assessed for their potential to inform an initial crop prioritization. These factors included total crop acreage, soil hydraulic characteristics (as they affect leaching of nitrate), and relationship to groundwater quality. The effect of crop class acreage had by far the strongest influence on the potential mass of nitrate-N leaching. Initial results identify 12 crop classes for prioritization, comprising about 90% of the total acreage in the SSJV. Crops classes include: 1) Almonds, 2) Grapes, 3) Corn, Sorghum and Sudan, 4) Alfalfa and Alfalfa Mixtures, 5) Pistachios,

6) Citrus, 7) Cotton, 8) Walnuts, 9) Wheat, 10) Peaches/Nectarines, 11) Tomatoes, and 12) Plums, Prunes and Apricots. This prioritization is applied to research, monitoring, and outreach.

- *Landscape Level Performance Assessment with the Soil and Water Assessment Tool (SWAT)*. SWAT is being developed to support a landscape-scale performance assessment of N losses under current conditions and alternative management practice scenarios. The most up-to-date digital land cover, soil, climate, hydrologic, topographic, and crop management information available are employed as input data. Output is being processed into formats that facilitate systematic comparison of suites of management practices (e.g., N rates, irrigation efficiency) as they are affected by factors such as the type of soil on which they are implemented, and incorporation into models that consider how they effect changes in sub-root-zone vadose and saturated (aquifer) zones. Model development is complete and four management scenarios (variation of N rates, irrigation efficiency) are being assessed.
- *Agronomic assessment of Nitrogen Management Plan (NMP) Data*. The Water Board requires growers to report NMP data to their water quality coalition, including crop type, acreage, N applied, yield, and N removed. An agronomic assessment of the 2016 NMP data was completed to understand the distributions of yield, N applied to the crops, and the N balance (N applied minus N removed). Results are being shared with commodity groups and growers so that they can incorporate the information and lessons learned into outreach, research, and annual N management planning.

## 4 PRIORITY INVESTIGATIONS

Several priority investigations have commenced, including the following:

- *Assessment of Harvested and Sequestered Nitrogen Content to Improve Nitrogen Management in Crops* (Yield to N Removed, or Y-to-R Study). On behalf of the Central Valley water quality coalitions, including those that comprise the SSJV MPEP Committee, the MPEP Team contracted and worked with Dr. Daniel Geisseler of UC Davis to complete and publish usable, literature-based yield-to-N-removed conversion factors for 72 crops, representing more than 98% of Central Valley irrigated lands. *Nitrogen Concentrations in Harvested Plant Parts - A Literature Overview* was prepared by Dr. Geisseler (2016). The report found that well-established coefficients are only available for a limited number of crops. Approximately \$220k in funding was awarded from CDFA FREP to assess N concentration of harvested material removed from fields for approximately 25 crops over several growing seasons. The MPEP Team coordinates crop yield sampling, and Dr. Geisseler's team processes samples, analyzes them, and interprets their implications relative to valley-wide N content of harvested materials. Work completed since the January 2018 grant award includes development of sampling protocols and coordination of year-1 sampling of 12 crops with grower/packer/shipper partners, along with initial lab analysis.
- *Assessment of Almond and Orange Irrigation and Fertilization by Combining Grower Operational Records, Actual Evapotranspiration, Soil, and Plant Tissue Data* (Irrigation/Fertilization

Assessment Study). The study is located on a medium-size fruit and nut production field near Fresno on the Kings River fan, on a site with 29 acres of oranges and 18 acres of almonds. Project objectives are to 1) quantify the yield, quality, water use efficiency, and nutrient use efficiency benefits of converting from a non-automated irrigation system (operated weekly) to widely available, replicable systems that provide more frequent and precisely timed irrigation and fertigation; 2) relate these management changes to reductions in the amount of nitrate transiting to groundwater, and 3) work with growers, commodities groups, and the NRCS to develop an initiative that would facilitate cost-share funding of these types of system upgrades, encouraging and enabling their broader adoption. The study has demonstrated that a) detailed information about the fate of water and N in the root zone, as determined by crop and soil measurements that growers can make, can be used to infer the amount of nitrate moving into groundwater, b) growers can respond to results of site-specific assessment with management shifts that they identify as feasible to simultaneously improve production and environmental performance, c) even in a well-managed, HFLR (drip or microspray) irrigated orchard, environmental performance can sometimes be significantly improved by modest shifts in management, and d) strategies that extend N residence time in and uptake from the root zone, even as other salts continue to move outward to avoid damaging levels of salinity.

- *Understanding Influences on Grower Decision-Making and Adoption of Nitrogen Management Practices in the South San Joaquin Valley* (Barriers to Adoption Study). The SSJV MPEP Committee contracted with project partners at UC Davis to quantify the current use of practices and characterize drivers of grower behavior. The specific study objectives are 1) to develop a quantitative understanding of key influences and barriers to adoption of N management practices for citrus and raisin grapes (crops that are concentrated in the regions represented by the SSJV water quality coalitions); 2) to distribute, collect and aggregate survey data from growers during focus groups and; 3) to analyze response data to determine key motivations and barriers to grower adoption of N management practices. Results are being used to understand the status of adoption of N management practices; determine the challenges and benefits on grower decision-making; and identify the key incentives and barriers to enhanced adoption of improved management practices. A final report is expected in April 2019. These results will be augmented by a newly funded, follow-on study.

## 5 OUTREACH

Outreach activities include development and publication of a website, development and publication of tools and calculators for growers and grower advisors, presentations at conferences and grower meetings, outreach to growers through their commodity organizations, and other outreach activities. Each is described below.

- *SSJV MPEP Website*. The website, <http://agmpep.com>, was developed and published in early 2017. At a single, grower-owned location, it brings together links to management practice information and resources from experts throughout agriculture in academia, industry, government, and crop advisers. The site provides numerous resources for growers and advisers, including an interactive calendar of outreach events related to nutrient management, which was

developed in collaboration with FREP. Events are organized by field days, crop-specific seminars, professional association meetings, and other events. Users may search for events by crop, location, event type, and other criteria. The website also includes a directory of publicly available agricultural management practice tools and resources. The website continues to be improved and refined with more and more tools and links for use by growers and grower advisors.

- *Tools and Calculators.* Several tools and calculators are published to help growers make more informed nutrient management decisions.
  - **Irrigation N Calculator.** The N supply in irrigation water is a crucial component to consider in managing N fertility. This calculator allows users to calculate N supply from inches of applied water and N (nitrate and/or ammonium) content from surface and/or groundwater (accommodating two different water supplies to the same field). This peer-reviewed calculator is published at <https://agmpep.com/calc-irrn/>. Users may also download tools that provide identical functionality in alternative formats, including a) an offline Excel calculator, b) a single-page calculation guide (for those making their own calculations by any desired means), and c) a printable set of lookup tables that enable growers to determine N in applied water without using a computer or calculator. For even more flexibility, growers who do not customarily work in inches of applied water have the option to perform the calculation with pump run time or water volume readings from flow meters.
  - **Y to R Calculator.** The Crop Yield to Nitrogen Removed Calculator (also known as the Y-to-R Calculator) was developed based on conversion factors developed by Geisseler (2016). The calculator can be used by growers and advisers to use anticipated or actual yield data to estimate N removed (R) and the ratio of N applied (A) to N removed (A/R). Results are provided based on inputs for a single crop or for multiple crops. This peer-reviewed calculator is published at <https://agmpep.com/calc-y2r/>. Recent updates include clarification on reporting units and plant parts, as well as plant parts in which N removal is considered. Additional updates will be incorporated as results from the Y to R Project become available.
  - **Actual Evapotranspiration (ETa) Variability Viewer.** Management is often discussed at the field or block level, even though we know that individual fields or blocks may contain very distinct units due to soil, topographic, or management variation. Precision agriculture increasingly provides options to manage this variation, but a first step is to determine how much variation exists within a given area, and how it is patterned. This online mapping tool allows the user to zoom into specific fields, complete with field boundaries and reference maps and imagery, and view evapotranspiration variability at a density of 5 pixels/acre (e.g., 400 individual ET estimates in an 80-acre field) within each field. Data are aggregated over an irrigation season (May to October) and for July. The tool also quantifies variability in terms of distribution uniformity of the ETa within each field, as a way to assess the degree and importance of variability in one field

relative to others. Growers can access the Evapotranspiration Variability Viewer online through a portal on their coalition's website. The portal currently restricts the view to the grower's own fields.

- **Field Water Use Tool.** This tool is similar to the ETa Variability Viewer, but allows growers to view a 1) histogram of the Statewide ETa distribution for a selected crop and 2) annual total ETa, ETa95, and ETc. The portal is under development and for the time being will restrict the view to the grower's own fields.
- *Meetings and Conferences.* Events conducted by the water quality coalitions in the SSJV are summarized on their respective websites. The MPEP Team has presented (including poster and spoken/slide presentations) as part of the MPEP outreach program at over 30 events. Selected presentation are summarized at <https://agmpep.com/presentations/>.
- *Management Practice Handouts.* Three management practice handouts were developed to address abandoned wells and inactive wells; wellhead protection and well maintenance; and calculation of irrigation water nitrogen content. Each handout is available at <http://agmpep.com>.

**APPENDIX A – FUNDRAISING ACTIVITIES**

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**TABLE A-1. SUMMARY OF GRANTS PURSUED FOR THE SSJV MPEP**

Applicant and Cooperator(s)	Status
<b>AWARDED GRANTS</b>	
<p>Project: <i>Increasing Implementation of Conservation Practices to Protect Groundwater Quality</i>            Grant: 2016 US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Conservation Innovation Grant (Federal)</p>	
<p>SSJV MPEP Committee (included 18 letters of support)</p>	<p>Awarded \$2M. The project has five main objectives: 1) to identify protective practices for Central Valley agriculture; 2) to adapt the USDA’s Soil and Water Assessment Tool (SWAT) for Central Valley agriculture; 3) to increase adoption of protective practices through intensive producer/advisor outreach and an online decision support tool; 4) to assess adoption of protective practices by comparing a 2016 benchmark assessment with practices implemented throughout the project duration; and 5) to quantify the reductions in nitrate leaching at the landscape-level using SWAT.</p>
<p>Project: <i>Assessment of Harvested and Sequestered Nitrogen Content to Improve Nitrogen Management in Crops</i>            Grant: 2017 CA Department of Agriculture (CDFA) Fertilizer Research and Education Program (FREP)</p>	
<p>SSJV MPEP Committee             Cooperator:            Daniel Geisseler, Assistant Nutrient Management CE Specialist, UC Davis</p>	<p>Awarded \$223,119. The project includes assessment of N concentration of harvested material removed from fields (N removed [R]) for approximately 25 crops over several growing seasons. Samples of harvested material will be collected and analyzed for twelve of those crops. Data for the remaining crops will come from existing sources.</p>
<p>Project: <i>Understanding Influences on Grower Decision-Making and Adoption of Nitrogen Management Practices in the South San Joaquin Valley</i>            Grant: 2018 CDFA FREP</p>	
<p>Patrick H. Brown, Professor, Department of Plant Sciences, University of California (UC) Davis             Mark N. Lubell, Professor, Department of Environmental Science and Policy, UC Davis.             Sat Darshan Khalsa, Assistant Project Scientist, Dept. of Plan Sciences, UC Davis             Cooperator:            Doug Parker, Director CA Institute for Water Resources</p>	<p>Awarded \$165,400. Project includes 1) to quantify the current use of improved practices and characterize drivers of grower behavior in order to enhance future research, education and outreach programs, and tailor policy recommendations and 2) to expand previous work conducted in the Sacramento and North San Joaquin Valleys to the SSJV. The findings will help guide practice, policy, investment and incentives necessary to meet agricultural and environmental challenges in California.</p>



Applicant and Cooperator(s)	Status
<p>Project: <i>Evaluation of Nitrogen Uptake and Applied Irrigation Water in Asian Vegetables Bok Choy, Edible Chrysanthemum, Garlic Chives, Moringa, and Lemongrass</i>  Grant: 2018 CDFA FREP</p>	<p>Awarded \$149,999. The project will provide detailed measurements of total N uptake and N uptake pattern of bok choy, edible chrysanthemum, garlic chives, moringa, and lemongrass. This project will also evaluate current irrigation management practices of these crops and compare them with the crops' water requirements and identify potential practices that may help reduce nitrate leaching. The proposed project also includes outreach activities, including workshops to train growers in nitrogen management.</p>
<p>Aparna Gazula, UCCE Farm Advisor  Ruth-Dahlquist Willard, UCCE Farm Advisor  Daniel Geisseler, Cooperative Extension Specialist</p>	
<b>AWARD DETERMINATIONS PENDING</b>	
<p>Project: <i>Increasing Grower Use of Statewide Actual Evapotranspiration and Soils Data to Improve Irrigation Uniformity and Efficiency</i>  Grant: CDFA Specialty Crop Block Grant  Applicant: SSJV MPEP Committee</p>	
<p>Project: <i>Irrigation and Nitrogen Management and Monitoring to Improve Nut Production While Minimizing Groundwater Nitrate Leaching</i>  Grant: CDFA Specialty Crop Block Grant  PI: Thomas Harter (Chair, Water Management and Policy; Groundwater Hydrology Specialist, UC Davis)</p>	
<p>Project: <i>Evaluating monitoring practices and fertigation management effects on production and on nitrate leaching to groundwater for nuts, citrus and vegetables</i>  Grant: The Fertilizer Institute – 4R Stewardship  PI: Thomas Harter (Chair, Water Management and Policy; Groundwater Hydrology Specialist, UC Davis)</p>	
<p>Project: <i>Alfalfa Production under Precision Overhead Sprinkler and Mobile Drip Irrigation for Improved Yield and Quality under Limited Water</i>  Grant:  PI: Isaya Kisekka (Assistant Professor of Irrigation and Water Management, Depts. Land, Air and Water Resources/ Biological and Agricultural Engineering) and Dan Putnam (Statewide Alfalfa &amp; Forage Extension Specialist)</p>	

Applicant and Cooperator(s)	Status
<p>Project: <i>Sustainable Salinity Management in Microirrigated Nut Tree Crop Production with Marginal Water Quality</i>            Grant: USDA National Institute of Food and Agriculture Specialty Crop Research Initiative            PI: Isaya Kisseka (Assistant Professor of Irrigation and Water Management, Depts. Land, Air and Water Resources/ Biological and Agricultural Engineering)</p>	
<b>GRANTS NOT AWARDED</b>	
<p>Project: <i>Increasing Implementation of Conservation Practices to Protect Groundwater Quality</i>            Grant: 2016 USDA NRCS Conservation Innovation Grant (State)</p>	<p>SSJV MPEP Committee</p> <p>Grant was selected for funding (\$75,000) through the state CIG program, but the SSJV MPEP Committee declined it to enable acceptance of the larger CIG grant through the federal program.</p>
<p>Project: <i>Increasing Implementation of Conservation Practices to Protect Groundwater Quality</i>            Grant: 2016 CDFA FREP</p>	<p>SSJV MPEP Committee</p> <p>Grant not awarded. Requested \$216,095 to help fast-track implementation of known protective practices by providing producers with quantifiable tools to support nutrient management planning, and provide guidance to shape future outreach efforts to effectively and efficiently inform producers.</p> <p>Cooperators:            Patrick H. Brown, Professor, Department of Plant Sciences, University of California (UC) Davis</p> <p>Mark N. Lubell, Professor, Department of Environmental Science and Policy, UC Davis.</p> <p>Daniel Geisseler, Assistant Nutrient Management CE Specialist, UC Davis.</p>
<p>Project: <i>Rapid Rate of Travel Evaluation of Connection between Nitrate in Root Zone and Groundwater as Affected by Crop and Soil Management</i>            Grant: 2017 CDFA FREP</p>	<p>SSJV MPEP Committee</p> <p>Grant not awarded. Requested \$224,370 to equip growers with information necessary to evaluate technology-based irrigation and fertigation management that can increase nitrogen use efficiency and water use efficiency in existing or new high-frequency low-rate irrigation systems.</p>

Applicant and Cooperator(s)	Status
<p>Cooperators:</p> <p>Thomas Harter, Chair, Water Management and Policy; Groundwater Hydrology Specialist, UC Davis</p> <p>Dan Munk, Farm Advisor, Cooperative Extension Fresno County, Dept of Agriculture and Natural Resources, UC</p> <p>Dr. Mae Culumber, Nut Crop Advisor, Cooperative Extension Fresno County, Dept of Agriculture and Natural Resources, UC</p> <p>Dr. David Cehrs, Grower, Geologist (retired)</p>	
<p>Project: <i>An Integrated Framework for Assessing Effects of Irrigation and Fertigation Management on Nitrate Movement in the Deep Vadose Zone</i> Grant: 2018 CDFA FREP</p>	
<p>Isaya Kisekka, Assistant Professor of Irrigation and Water Management, Depts. Land, Air and Water Resources/ Biological and Agricultural Engineering</p> <p>Thomas Harter, Professor and Specialist in Cooperative Extension of Groundwater Hydrology, Depts. Land, Air and Water Resources</p> <p>Jan Hopmans, Professor of Vadose Zone Hydrology, Depts. Land, Air and Water Resources</p>	<p>Grant not awarded. Requested \$225,000 to assess effects of irrigation and fertigation management practices on nitrate movement within and below the root zone in a commercial citrus production orchard and to develop an integrated model-driven decision support tool for predicting nitrate distribution in the vadose zone under different irrigation and fertigation management practices.</p>