FINAL REPORT
Fertilizer Research and Education Program
California Department of Food and Agriculture

A. Project Information:

Project Title: ***Understanding Influences on Grower Decision-Making and Adoption of Improved Nitrogen Management Practices in the Southern San Joaquin Valley***

Grant Number: 18-0596

Project Team

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B. Abstract

Adoption of nitrogen (N) management practices is paramount to meeting the demand of regulatory agencies to reduce N loading into surface and groundwater of California. This project quantified the current use of practices and characterized drivers of grower behavior in order to enhance future research, education and outreach. Our approach included a mail survey of the Water Quality Coalitions in the Southern San Joaquin Valley (SSJV) Management Practices Evaluation Program (MPEP) and an online survey of the California Association of Pest Control Advisors (CAPCA) and the Western Region Certified Crop Advisors (WRCCA). Overall, we sent the mail survey to 3,010 SSJV growers across multiple coalitions for a total of 401 responses (13.3 % response rate) and 3,725 CAPCA and/or WRCCA members for a total of 567 responses (15.2% response rate).

Across all coalitions, there was higher adoption of split application, leaf and soil testing and testing for irrigation N practices compared to organic amendments, cover crops and pressure chambers, and there was higher adoption by very large (>1000 acres) compared to small (<50 acres) farms. These overall adoption results were similar to observations we made in our previous work in the North San Joaquin Valley. Growers across all SSJV coalitions reported multiple barriers associated with N management practice adoption. A range of barriers impact adoption such as cost, labor, practice efficacy, knowledge and uncertainty. These results collectively suggest efforts to increase grower adoption of N management practices must consider multiple barriers experienced by growers, and cater outreach and technical assistance to addressing these specific needs for specific practices.

Practice recommendations by PCA/CCAs are reported for the same practices in the SSJV grower survey. There were more recommendations by PCA/CCAs for split application, leaf and soil

testing and N budgeting compared to cover crops, distribution uniformity and use of the pressure chamber, and more overall recommendations for perennial crop compared to annual crops. These recommendations suggest practices with a direct connection to fertilizer N management are more readily recommended by PCA/CCAs. Soil health practices show a minor disconnect between growers and PCA/CCAs where PCA/CCAs recommend organic amendments and cover crops more readily than growers adopt these practices. These results suggest more information is needed for these practices to be adopted more readily, or specific unknown barriers still persist.

A range of perceived barriers by PCA/CCAs impact grower adoption such as cost, labor, practice efficacy, knowledge and uncertainty. The major perceived barriers are similar those reported by SSJV growers including uncertain impacts on yield, cost, but also technical knowledge. PCA/CCAs report the N budget as the practice with the most perceived barriers to adoption. This is an interesting result given the emphasis of N budgets within existing California state regulations. In general, on-farm information sources are the most used information sources for growers, specifically PCA/CCAs. However, PCA/CCAs also have their own information sources like UC Extension, PCA/CCA peers, WRCCA, CAPCA and Water Quality Coalitions.

The primary impact of this work includes providing a basis of information for the evolution of outreach and education within the important agricultural region of the SSJV as well as understanding the needs of of PCA/CCAs. The results from this work point to clear trends and consistent themes regarding the need to make policy, outreach and future research decisions within the context of farmer behavior and the needs of farm operations. Simple examples include practice adoption and recommendations being impacted by different crop types and farm sizes. However, more impactful examples include the need to consider barriers related to farmers' goals and operations, and to conduct outreach within the context of crop yield, quality and profitability.

C. Introduction

Adoption of N management practices by California growers is a required step in reducing N movement into surface and groundwater maintaining economically viable cropping systems, while satisfying the Irrigated Lands Regulatory Program (ILRP) requirements. Research over the past decade has identified many promising practices that can improve N management. These practices include the use of N budgets to balance N inputs and outputs for individual field units; implementation of the "4R's" (right rate, time, place, and source) to guide fertilization strategy; the use of leaf and soil N sampling for verification of crop nutrient status and residual soil N; appropriate integration of fertilizers with irrigation; enhancing soil health to improve nutrient retention; and careful deployment and management of micro-irrigation systems for efficient water use. Despite progress in the development of improved N management practices, there is insufficient understanding regarding the rate and barriers to practice adoption. This project aims to quantify the current use of N management practices and characterize barriers to adoption in order to enhance future research, education and outreach programs and to tailor policy recommendations specific to the SSJV. Our research findings will help guide practice, policy, investment and incentives necessary to meet agricultural and environmental challenges in California.

Recent research suggests a number of possible factors influence grower decision-making, including perceptions of risk, economic and labor constraints, social norms, sources of trusted information, social capital and networks, farm characteristics including size and income, and participation in local policy forums. However, we do not have a robust understanding how these factors relate to adoption rates of N management practices across the diverse geographies and grower demographics of the Central Valley, specifically the SSJV. Our efforts also include a targeted investigation into understanding the role of different types of information sources like PCA/CCAs on influencing farmer behavior and adoption of N management practices.

The general orders for the Irrigated Lands Regulatory Program require development of Management Practices Evaluation Plans (MPEPs) to evaluate and measure progress toward adoption of improved practices and reduced flow of N to surface and groundwater. Inherent in these MPEPs is the requirement to identify beneficial practices, to adapt these practices to specific site/crop/grower characteristics and to provide a strategy to measure progress toward achieving these goals. Currently, we have improved strategies to determine the rate of adoption of N management practices or to identify the constraints to adapting practices for given site or grower contexts based on our work in the North San Joaquin Valley. However, we do not have a baseline for the major growing region of the SSJV to extend our observations and draw conclusions.

This project aims 1) to develop an understanding of the status of grower adoption of improved N management practices in the SSJV; 2) to determine the key influences on grower decision making including the role of PCA/CCAs; and 3) to identify the key incentives and barriers to enhanced adoption of N management practices. The information developed will inform stakeholder groups including Water Quality Coalitions, UC Extension, consultants, State Water Boards, commodity groups to inform policy-making, improve N management and to reduce N loading to groundwater.

D. Objectives

1) To develop an understanding of links between adoption rates and barriers to adoption of N management practices in the coalitions of the SSJV MPEP;

2) To distribute, collect and aggregate survey data from growers and pest control/certified crop advisors (PCA/CCAs);

3) To analyze data to determine key motivations and barriers to grower adoption and PCA/CCA recommendations of N management practices;

4) To communicate these findings directly with the grower and PCA/CCA communities as well as academic and regulatory bodies;

5) To outline key variables linking adoption rates with barriers to adoption of N management practices within grower and PCA/CCA populations to tailor outreach, education and incentive programs.

E. Methods and Work Description

Objective 1: To develop an understanding of links between adoption rates and barriers to adoption of N management practices in the coalitions of the SSJV MPEP

Task 1.1: Identify relevant practices and barriers to test for the grower mail survey. This task will be informed by our work in the San Joaquin Delta and County and the East Joaquin.

Task 1.2: Identify relevant practices and barriers to test for the PCA/CCA survey. This task will be informed by partnership with CAPCA and WRCCA.

Results for Task 1: Both our mail survey for SSJV growers and the online survey used for technical advisors were adapted into unique surveys tools informed by our work in the North San Joaquin Valley as well as a pilot survey we completed in November 2019 in Reno, NV.

Objective 2: To distribute, collect and aggregate survey data from growers and PCA/CCAs

Task 2.1: Design a paper survey instrument based on experience drawn from FREP Project 16-0621-SA, to assess social, political and economic factors influencing decision making and adoption of N management practices. The survey will include questions regarding different levels of N management practice implementation, participation in available outreach/extension programs, communication with agricultural stakeholders, attitudes towards N management regulations, and basic operator/operation characteristics. Assemble survey advisory committees (SAC) from project supporters and representatives of key stakeholder groups.

Task 2.2: Design a survey instrument, based on results drawn from a CCA only pilot survey to assess social, political and economic factors influencing PCA/CCA recommendations and perceived grower adoption of N management practices. The survey will include questions regarding recommendations of N management practices based on crop choice and grower demographics, participation in education programs, communication with agricultural stakeholders, attitudes towards N management issues, and basic demographic and employment characteristics. Assemble separate SAC in partnership with CAPCA and WRCCA.

Task 2.3: SACs review first draft of surveys and researchers test second draft of survey instrument with a small group of growers and PCA/CCAs in order to test the efficacy of the question design.

Task 2.4: Develop strategy to identify grower sample size, finalize mail grower survey and PCA/CCA online survey and outreach activities by SSJV MPEP, CAPCA and WRCCA.

Task 2.5: Deliver survey to SSJV MPEP growers and PCA/CCAs using membership lists.

Results for Task 2: In January 2020, our research team reviewed the survey designed for growers in the SSJV MPEP, which was largely developed and tested in Fall 2019. Edits were made for clarity, length, and language. In February 2020, the draft final survey was vetted by John Dickey, the technical coordinator for the SSJV MPEP as well as the executive committee of the SSJV MPEP led by Donald Ikeimaya. In January 2020, for the online technical advisor survey edits and

adjustments were made to the pilot survey conducted in November 2019, based on the feedback and results from the technical advisers who took the survey. In March 2020, test questions related to the links between irrigation timing and nitrogen management were piloted with PCA/CCAs completing UC Nitrogen Management Training in Fresno. Furthermore, in March 2020, all executive directors of the SSJV MPEP (Kings River, Kern River, Kaweah Basin, Buena Vista, Cawelo, and Westside) provided verbal feedback on the survey tool, and their comments were incorporated. From May 1st to the 15th 2020, mailing lists were received by third-party printer from the SSJV coalitions for distribution. In April 2020, we discussed with CAPCA to delay the timing of survey distribution to PCAs. We were advised to wait until Fall 2020 to distribute the survey during the annual conference, which had been switched to an online format.

Following the Dillman approach, starting on May 22nd 2020, an introductory cover letter was mailed, announcing that survey was impending. On June 5th 2020, survey packet 1 was mailed, including a cover letter from UC Davis introducing the project, the survey booklet, and a pre-paid, pre-addressed business return envelope. The survey was sent to ~3,087 growers operating on irrigated agricultural lands in the SSJV. The survey asked growers about their nitrogen management practices, barriers and motivations to adopting those practices, thoughts on the links between irrigation and nutrient management, opinions toward nitrogen management challenges and policies, and opinions on the Water Quality Coalitions who implement the ILRP. On June 26th a postcard reminder was mailed to all recipients. Due to the proximity to harvest and the general election, our team decided to wait until October 30th, 2020 when we commenced with the second round of the grower mail survey by sending an introductory cover letter. On November 10th 2020, survey packet 2 was mailed and on December 2nd 2020, a postcard reminder 2 was mailed.

Grower survey response rates were calculated using the American Association for Public Opinion Research (AAPOR) Response Rate Calculator V4.0 for Mail Surveys. Total returned questionnaires from the first wave was 270 surveys and 194 surveys for the second wave. Non-responses including refusal or implicit refusal were 31 responses from the first wave and 43 responses from the second wave. Total eligible survey responses were 401 surveys for a raw response rate of 401 / 3084 = 13.0%. An adjusted response rate adjusts the denominator by the estimated proportion of unknown eligibility cases that are eligible. For this survey the non-responses rate was 74 / 3087 = 2.40% with an adjusted denominator of (1 – 0.024 = 97.6% * 3084 = 3010) 3010 for an adjusted response rate of 401/ 3010 = 13.3%.

On November 9th 2020, CAPCA initiated the online survey by sending an e-blast to all members totaling 2,486. On November 23rd, December 7th and December 21st 2020 reminder emails were sent. The total number of returned usable surveys was 368 being for a response rate of 368/ 2486 = 14.8%. On January 4th 2021, WRCCA initiated the online survey by sending an e-blast to all members totaling 1,239. This list excluded the email addresses provided by the CACPA responses to deter duplicate responses. On January 18th, February 1st and February 15th 2021 reminder emails were sent. The total number of returned usable surveys was 199, for a response rate of 199/ 1239 = 16.0%, and an overall response rate of 567/ 3725 = 15.2%

Objective 3: To analyze data to determine key motivations and barriers to grower adoption and PCA/CCA recommendations of N management practices

Task 3.1: Develop descriptive analysis of compiled results and emerging trends from survey response data for both SSJV growers and PCA/CCAs

Task 3.2: Use multi-level hierarchical modeling with random effects and factor analysis on survey response data to determine key variables influencing grower decision making and adoption of N management practices in the SSJV.

Task 3.3: Develop policy briefs that address key factors influencing grower adoption and PCA/CCA recommendation of N management practices and advise actions to overcome barriers to adoption. Distribute reports to project collaborators and supporters.

Results for Task 3: Descriptive statistics from both SSJV and PCA/CCA surveys are presented below. Policy briefs distributed to SSJV, CAPCA and WRCCA are appended to this report.

Objective 4: *To communicate these findings directly with stakeholder groups*

Task 4.1: Organize and conduct outreach activities, including workshops to present trends of adoption of N management practices in each water quality coalition, comparison between of Sacramento and North San Joaquin Valleys (See FREP Project 16-0621-SA) and the SSJV, comparison of perceived costs/benefits of practices, and introduce resources (i.e. technical advisory services and financial incentive programs) to assist in adapting management practices. Workshops hosted in collaboration with coalitions and UC Extension.

Results for Task 4: Outreach activities during the period of this proposal are listed below.

Objective 5: *To outline key variables populations to tailor outreach, education and incentive programs*

Task 5.1: Outline and recommend programs and policy incentives that address unique barriers experienced by different subsets of grower and PCA/CCA populations.

Results for Task 5: Outreach activities during the period of this proposal are listed below.

F and G. Results and Discussion

Successful execution of our work plan led to a variety of results with corresponding discussion points. Results are organized based on the response to our survey and includes discussion of 1) Grower practice adoption, 2) Grower barriers to adoption; 3) PCA/CCA practice recommendations; 4) Perceived barriers by PCA/CCAs and; 5) PCA/CCA information sources.

Grower practice adoption
Practice adoption by coalition are reported for split application, leaf and soil testing, irrigation N testing, N budget, moisture probe, evapotranspiration testing, organic amendments, distribution uniformity, cover crops and pressure bomb. Differences by coalition include higher overall adoption by Kern River compared to Kaweah Basin and Kings River (Fig. 1). Despite the higher overall adoption by Kern River, Kings River showed a higher rates of cover crop adoption.

Practice adoption for all regions for the same set of practices is also reported. Across all coalitions, there was higher adoption of split application, leaf and soil testing and testing for irrigation N compared to organic amendments, cover crops and pressure chamber (Fig. 2). These overall adoption results were similar to observations we made in the NSJV. This result suggests practices with a direct connection to fertilizer N management are more readily adopted by growers. Irrigation and soil health practices show a greater cognitive disconnect in the relationship with N management outcomes and may contribute to lower overall adoption.

Across all coalitions, there was higher adoption by very large (>1000 acres) compared to small (<50 acres) farms (Fig. 3). Higher adoption by larger farms suggest the role of economies of scale on practice adoption, where the costs associated with practice adoption can be more readily distributed over larger farm sizes. These adoption results were similar to observations we made in the NSJV as well as other agricultural regions worldwide.

Grower barriers to adoption

Growers across all coalitions in our mail survey reported multiple barriers associated with N management practice adoption. A range of barriers impact adoption such as cost, labor, practice efficacy, knowledge and uncertainty (Fig. 4). The major barriers include uncertain impacts on yield, cost, and technical knowledge. In general, those practices with lower adoption rates also showed more barriers to adoption. This results in the SSJV were similar to observations in the NSJV. Furthermore, multiple practices showed either no challenges or growers were not familiar with the practice (Fig. 5). These results collectively suggest efforts to increase grower adoption of N management practices most consider multiple barriers experienced by growers, and cater outreach and technical assistance to addressing these specific needs for specific practices. Additionally, initial exposure to practices such as pressure chambers, estimating ET, and calculating distribution uniformity may be beneficial, given the large number of growers with no experience.

PCA/CCA practice recommendations

Practice recommendations by PCA, CCA or both (PCA/CCA) are reported for the same practices in the SSJV grower survey. Differences include higher overall recommendation by the PCA/CCA for practices with higher adoption rates, while the PCA only showed higher recommendation for practices with lower adoption rates (Fig. 6). Despite the higher overall recommendations by the PCA/CCA, the CCA only showed a higher rate of recommendation for ET scheduling.

Recommendations for the same set of practices is reported. There were more recommendations of split application, leaf and soil testing and N budgeting compared to cover crops, distribution uniformity and use of the pressure chamber (Fig. 7). These overall recommendation results were similar to observations we made for SSJV growers. This result suggests practices with a direct connection to fertilizer N management are more readily reported by PCA/CCAs. Soil health practices show a minor disconnect between growers and PCA/CCAs where PCA/CCAs recommend organic amendments and cover crops more readily than growers adopt these practices. In tandem with the high reported barriers by growers for these practices, the results suggest that more information is needed for these practices to be adopted more readily.

Across all regions, there was more recommendations by PCA/CCAs for grower of perennial crops compared to annual crops (Fig. 8). Higher recommendations to perennial crop growers suggest these effects may be the result of higher crop values from perennial crops such as fruits and nuts, compared to agronomic crops, which affords greater capacity to invest in new technologies. Furthermore, the longer term nature of perennial crop production yield greater returns on investments realized over time. These results are consistent with our work in the NSJV.

Perceived barriers by PCA/CCAs

A range of perceived barriers by PCA/CCAs impact grower adoption such as cost, labor, practice efficacy, knowledge and uncertainty (Fig. 9). The major perceived barriers are similar to those reported by growers including uncertain impacts on yield, cost, and technical knowledge. Similar to the grower survey, those practices with lower adoption rates also showed more perceived barriers to adoption. However, PCA/CCAs report the N budget as the practice with the most perceived barriers to adoption. This is an interesting result given the emphasis of the IRLP. Furthermore, PCA/CCAs report a lower frequency of barriers for organic amendments and cover crops compared to growers. These results for soil health practices collectively suggest efforts to increase grower adoption may include others barriers experienced by growers, and future work is needed to cater outreach and technical assistance to addressing these specific soil health practices.

PCA/CCA information sources

In general, on-farm information sources are the most used information sources for growers, specifically PCA/CCAs. However, PCA/CCAs also have their own information sources (Fig. 10). Interestingly, the information sources for PCA/CCAs include many of the secondary information sources identified in our NSJV grower survey like UC extension. Other information sources of importance include PCA/CCA peers, WRCCA, CAPCA and Water Quality Coalitions.

H. Challenges

N/A

I. Project Impacts

The primary impacts of this work include: (i) providing a basis of information for the evolution of policy decisions related to the development of the ILRP, (ii) on-going outreach and education within the important agricultural region of the SSJV, and (iii) understanding the needs of primary grower information sources of PCA/CCAs. The results from this work point to clear trends and consistent themes regarding the need to make policy, outreach and future research decisions within the context of farmer behavior and the needs of farm operations. Simple examples include practice adoption and recommendations being impacted by different crop types and farm sizes. However, more impactful examples include the need to consider barriers related to farmers' goals and operations, and to conduct outreach within the context of crop yield, quality and profitability.

Other examples of the impact of this work include 1) supporting the need for a better understanding of grower benefits associated with soil health practices; 2) stimulating participation in education for PCA/CCAs within the missions of CAPCA and WRCCA; and 3) a greater appreciation for PCA/CCA influence over management outcomes leading to higher rates of adoption.

J. Outreach activity summary

Policy briefs – appended below
SSJV Grower Views on Nitrogen Management Survey Summary
Pest Control Adviser Views on Nitrogen Management Survey Summary
Certified Crop Adviser Views on Nitrogen Management Survey Summary

Blog Posts
Nitrogen Management Adoption Rates. Blog post for CDFA FREP. April 14, 2020. https://blogs.cdfa.ca.gov/FREP/index.php/research-update-nitrogen-management-adoption-rates/

Webinars
2021 Western Region CCA Webinar – Uncovering barriers to grower adoption and technical advisor recommendation of nitrogen management practices

Conferences
2021 CDFA/FREP Conference – Understanding grower and technical advisor decision-making on the adoption of nitrogen management practices. San Luis Obispo, CA.

2019 CAPCA Annual Conference – Research advances in nitrogen management for fruit and nuts crops. Reno, NV

2018 CDFA/FREP Conference – Barriers to adoption of nitrogen management practices. Seaside, CA

Products

Completed works
Wood L, MN Lubell, JM Rudnick, MV Sears, SDS Khalsa and PH Brown (2022) Information-based policy tools facilitate California farmers' learning about nitrogen management. Land Use Policy 114: 105923.

Rudnick JM, MN Lubell, SDS Khalsa, S Tatge, BL Wood, M Sears and PH Brown (2021) A farms systems approach to the adoption of sustainable nitrogen management practices in California. Agriculture and Human Values, 38 (3): 783-801

SDS Khalsa, JR Rudnick, MN Lubell and PH Brown (2019) Understanding decision-making of citrus and raisin grape growers and adoption of nitrogen management practices. Report to the Southern San Joaquin Valley Management Practices Evaluation Program Committee: 1-12.

Tatge S (2019) Potential spatial accessibility as a proxy for self-reported accessibility in Californian agricultural knowledge and information systems. M.S. Thesis in International Agricultural Development U.C. Davis; 88 pages.

Rudnick, J. 2020. Drivers of Individual and Institutional Change to Achieve of Improved Agricultural Nitrogen Management in California. Dissertation for PhD in Ecology. University of California Davis.

Manuscripts submitted/in prep

SDS Khalsa, Rudnick JM, MN Lubell, M Sears and PH Brown (Submitted) Linking agronomic and knowledge barriers to adoption of conservation practices for nitrogen management.

Rudnick, J. et al. *(In Prep)* Understanding causes and implications of uncertainty in farmer decision-making on nitrogen management.

Rudnick, J., Khalsa, S.D.S., Lubell, M., Leinfelder-Miles, M., Gould, K., and P. Brown. Understanding farmers' reported barriers to adoption of sustainable nitrogen management practices in California (*In Prep)*

Jäger, F., Rudnick, J., Lubell, M., Kraus, M., and B. Müller. (2022) Using Bayesian belief networks to investigate farmer behavior and policy interventions for improved nitrogen management. *Environmental Management*, https://doi.org/10.1007/s00267-022-01635-6

Conference abstracts

2021 ASA CSSA SSSA Conference – The role of technical advisors in fostering adoption of conservation practices. Salt Lake City, UT

2020 ASA CSSA SSSA Conference – Integrating crop, soil and grower research to improve environmental quality – the case of nitrogen in California almond.

2019 ASA CSSA SSSA Conference – Adoption of N management practices by permanent crop growers in the San Joaquin Valley, California. San Antonio, TX

A Portfolio Approach to Sustainable Nitrogen Management: Understanding Farmer Adoption of Multiple Best Management Practices in California. Panel Presentation. Soil and Water Conservation Society Annual Conference 2020. Online. July 29, 2020.

Understanding Grower Decision-Making on Nitrogen Management and Water Quality in California**.** Invited Brownbag Presentation. Almond Board of California. May 15, 2020. Online.

Understanding California Grower Barriers to Adoption of Nitrogen Management Best Practices. Panel Presentation. California Climate & Agriculture Network (CalCAN) Biennial Summit. Davis, CA. March 5, 2019.

Nitrogen Course

2022 Barriers to Adoption Module in UC Nitrogen Course for CCAs. Online module https://ucanr.edu/sites/nitrogencourse/coursemodules/

Brown Invited Talks
Cal Agronomy Society Plant and Soil Conference
Presentation title: Talks and Panel discussion
Location and date: Virtual, February 3rd, 2021
CCA/Grower Continuing Education Units (CEUs) offered: 2
Number of participants 125

Pomology Extension Conference
Presentation title: Update on Nutritional Challenges in Almond
Location and date: Virtual, March 25, 2021
Attendee demographics: Farm advisors, research faculty, industry representatives, CCA/PCA
Number of participants: 25

International Symposium on Mineral Nutrition of Fruit Crops
Presentation titles:
(1) Nitrogen regulations and changes in California agriculture - a case study (Patrick H. Brown)
(2) Heterogeneous saline and nutritional conditions in the root-zone and its effect in water and nutrient uptake (Francisco Valenzuela-Acevedo)
(3) Panel discussion I: Management of N and P to Meet Regulatory Requirements and Environmental Protection (Patrick H. Brown)
Location and date: Virtual, 28-30 June 2021
CCA/Grower Continuing Education Units (CEUs) offered:
Attendee demographics: Researchers, CCA and industry, growers
Number of participants: 525

Tri Society Meeting of America Society of Soil Science, Agronomy and Crop Science
Leo M Walsh Distinguished Fellow in Soil Fertility Address
Presentation Title: From physiological principles to fertilizer management and the determinants of grower practice adoption: A perspective on the steps needed to achieve sustainable fertility management in California.
Location and date: Salt Lake City, November 9th, 2021
Attendee demographics: Students, research faculty, industry representatives, CCA/PCA
Number of participants: 350

International Fertilizer Association
Presentation Title: From physiological principles to fertilizer management and the determinants of grower practice adoption: A perspective on the steps needed to achieve sustainable fertility management in California.
Location and date: Dubai, Nov 15thth, 2021
Attendee demographics: Industry representatives, Researchers
Number of participants: 50

K. References

L. Appendix

Figures

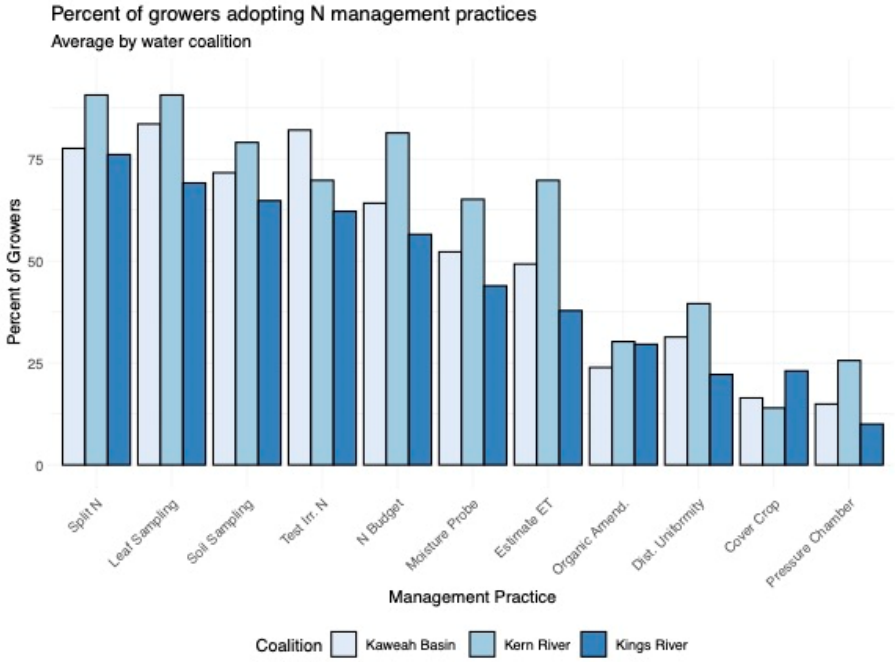


Figure 1. Practice adoption for Kaweah Basin, Kern River and Kings River. Practices include split application, leaf and soil testing, irrigation N testing, N budget, moisture probe, evapotranspiration testing, organic amendments, distribution uniformity, cover crops and pressure bomb.

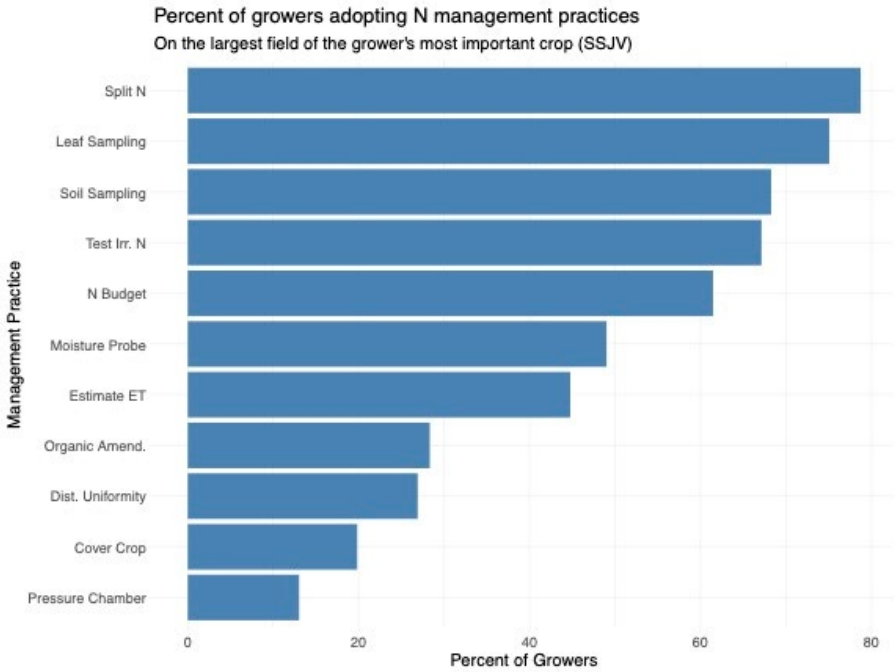


Figure 2. Practice adoption across the entire SSJV. Practices include split application, leaf and soil testing, irrigation N testing, N budget, moisture probe, evapotranspiration testing, organic amendments, distribution uniformity, cover crops and pressure bomb.

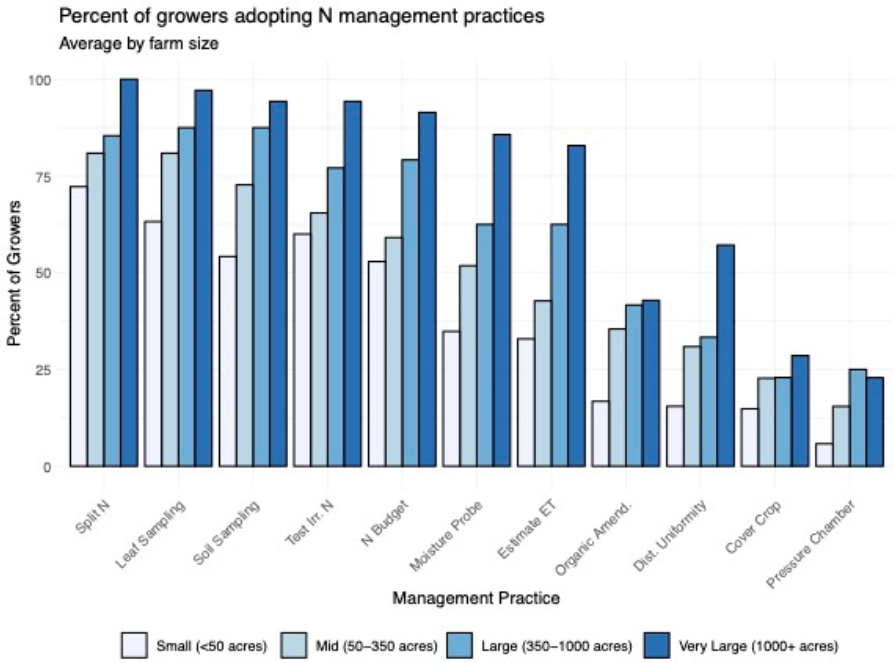


Figure 3. Practice adoption by farm size from small to very large. Practices include split application, leaf and soil testing, irrigation N testing, N budget, moisture probe, evapotranspiration testing, organic amendments, distribution uniformity, cover crops and pressure bomb.

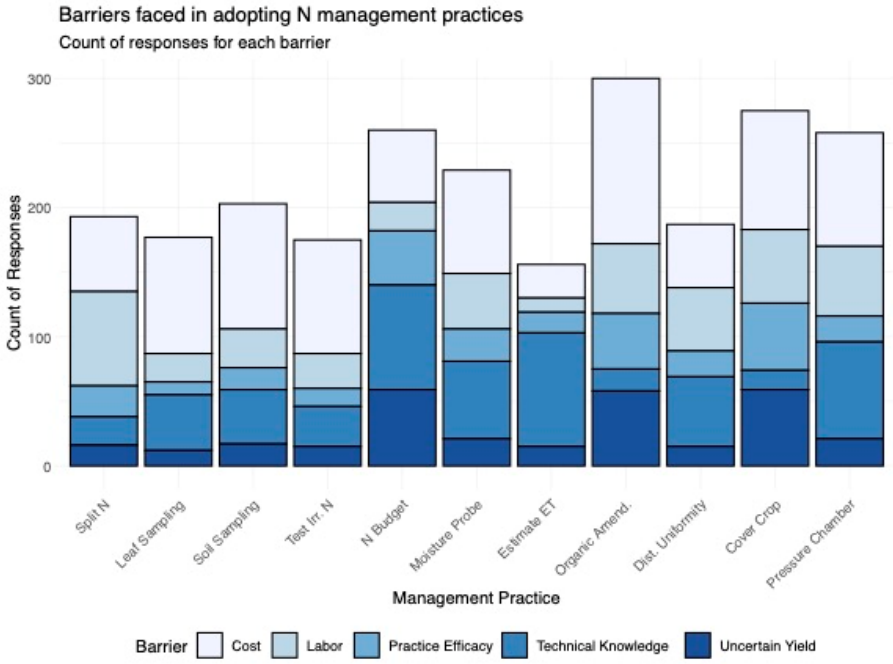


Figure 4. Frequency of barriers for N management practices by all SSJV growers. A range of barriers impact adoption such as cost, labor, practice efficacy, knowledge and uncertainty.

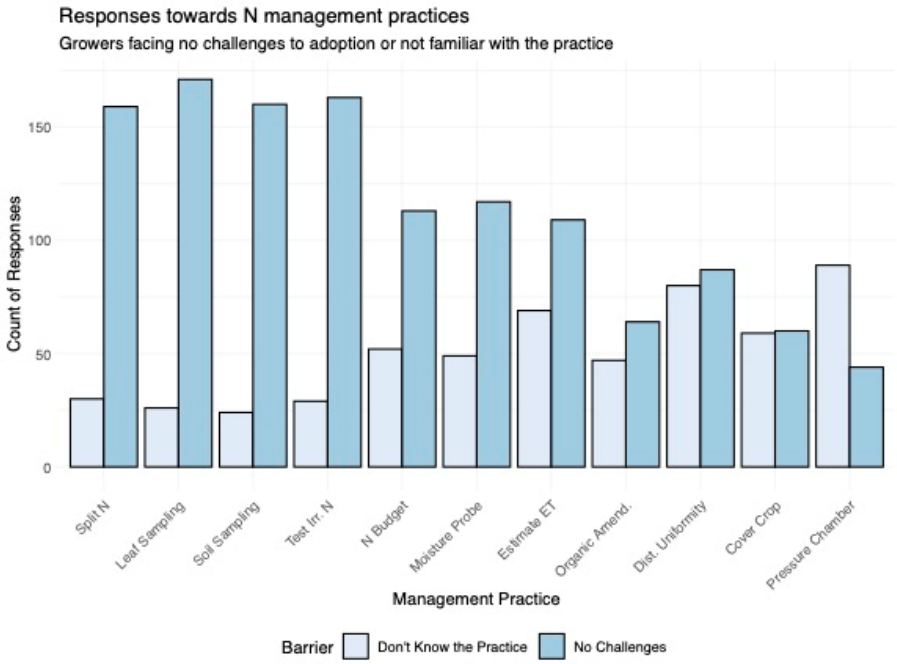


Figure 5. Growers with no challenges and those not familiar with the practice. Practices include split application, leaf and soil testing, irrigation N testing, N budget, moisture probe, evapotranspiration testing, organic amendments, distribution uniformity, cover crops and pressure bomb.

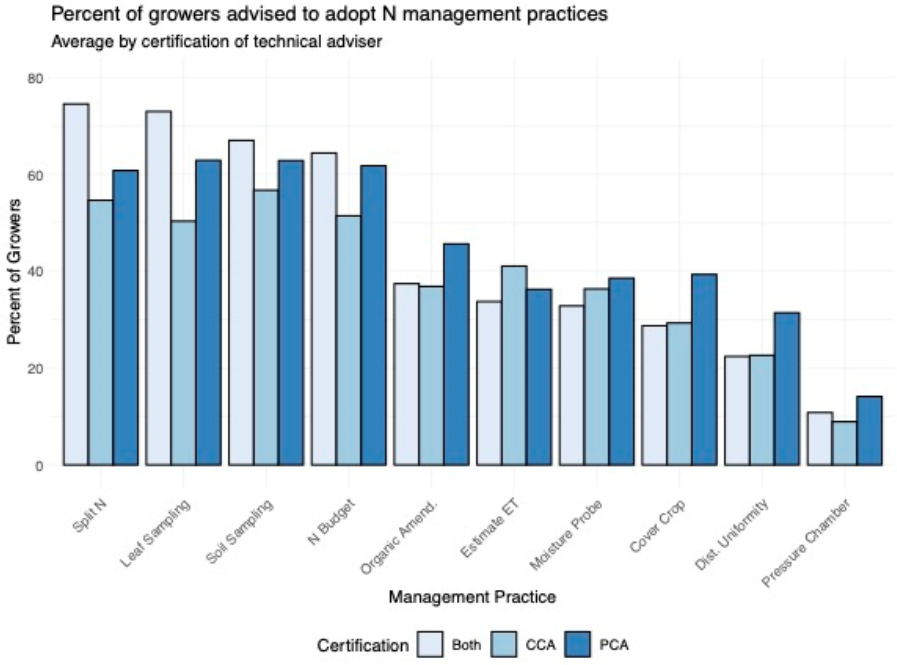


Figure 6. Practice recommendation by PCA, CCA or certified as both. Practices include split application, leaf and soil testing, irrigation N testing, N budget, moisture probe, evapotranspiration testing, organic amendments, distribution uniformity, cover crops and pressure bomb.

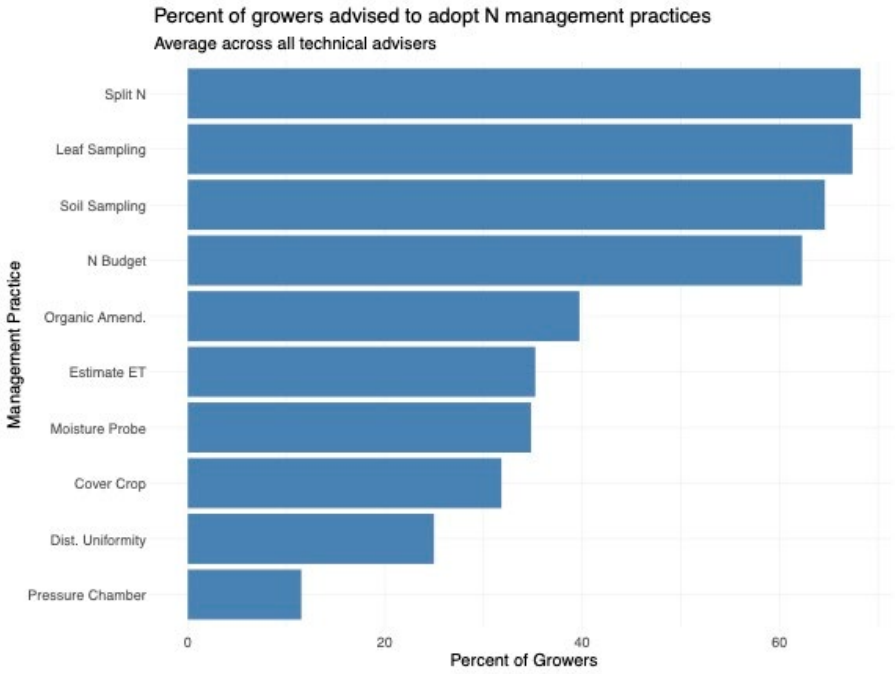


Figure 7. Practice recommendations for all PCA and CCAs. Practices include split application, leaf and soil testing, irrigation N testing, N budget, moisture probe, evapotranspiration testing, organic amendments, distribution uniformity, cover crops and pressure bomb.

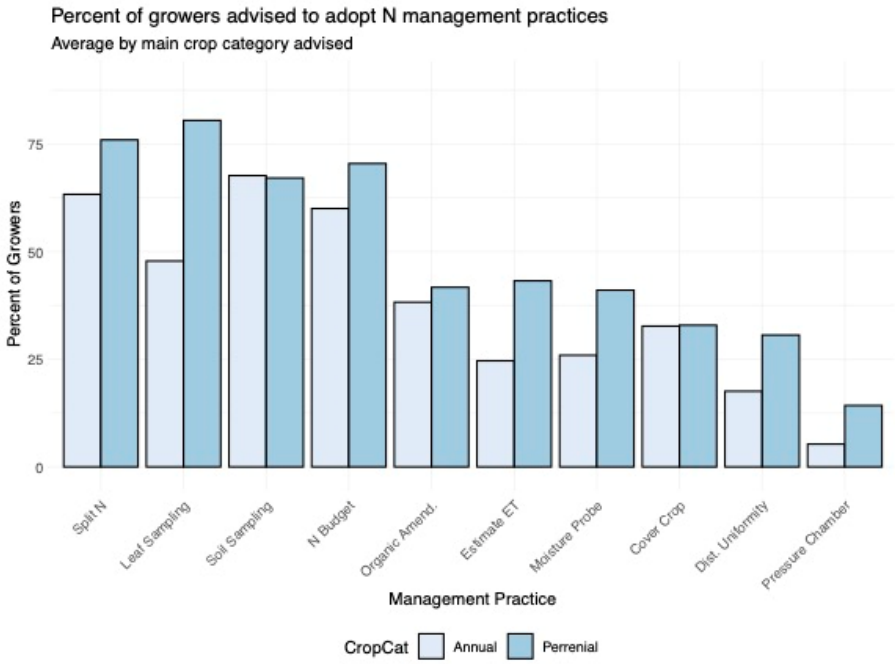


Figure 8. Practice recommendations by PCA and CCAs by crop type. Practices include split application, leaf and soil testing, irrigation N testing, N budget, moisture probe, evapotranspiration testing, organic amendments, distribution uniformity, cover crops and pressure bomb.

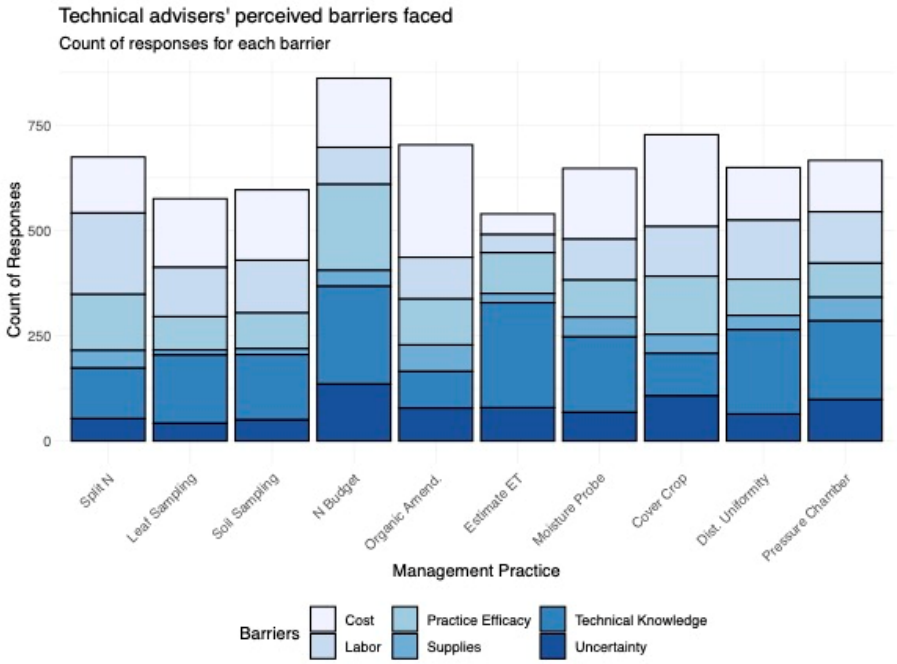


Figure 9. Frequency of perceived barriers for N management practices by PCA and CCAs. A range of barriers impact adoption such as cost, labor, practice efficacy, knowledge and uncertainty.

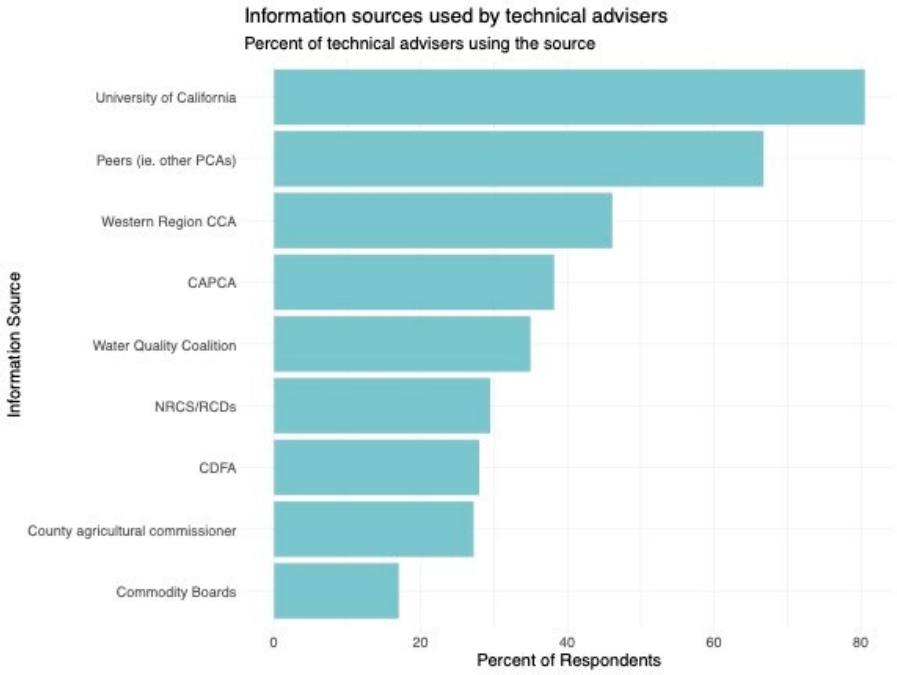


Figure 10. Percentage of PCA and CCAs using different information sources. Information sources include UC, peers, WRCAA, CAPCA, coalitions, NRCS/RCDs, CDFA and others.

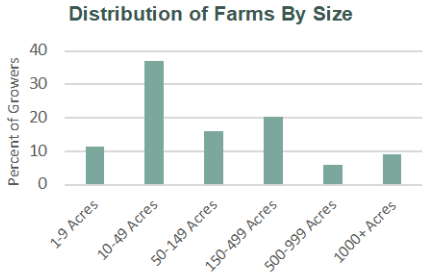
Grower Views on Nitrogen Management Survey Summary

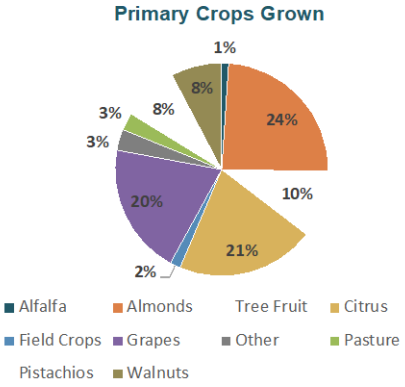
Survey region: South San Joaquin Water Quality Coalition (SSJWQC)

Sat Darshan Khalsa, Molly Sears*, Jessica Rudnick, Mark Lubell, Patrick Brown

Project Summary:

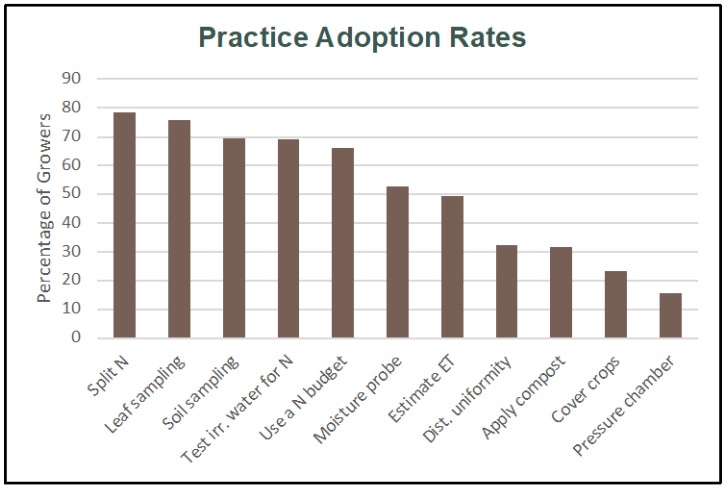
- UC Davis sent our Grower Views on Nitrogen Management Survey to SSJV MPEP growers to ask about their views on nitrogen management and better understand how the Coalition can provide support to growers in adopting nutrient management practices and complying with the Irrigated Lands Regulatory Program.
- The survey was sent to ~3000 SSJV MPEP growers between June and December 2020. We received 401 responses (13% response rate).
- Project objectives include: (a) providing feedback to SSJV MPEP outreach and extension programs on ways to continue assisting growers with adoption of nitrogen management practices; (b) providing feedback to the Coalition and Regional Water Board on what growers think about the Irrigated Lands Regulatory Program; (c) linking results from this survey to previous mail surveys to look at adoption behavior across the Central Valley.





Key findings on practice adoption:

- Split Nitrogen Application is readily adopted by growers of most crops. Sampling for nitrogen via tissue tests, soil probes, and irrigation water tests are also common.
- The application of compost, adoption of cover crops, and use of pressure chambers were the least popular. These practices were also the most frequently cited as having barriers to their adoption.



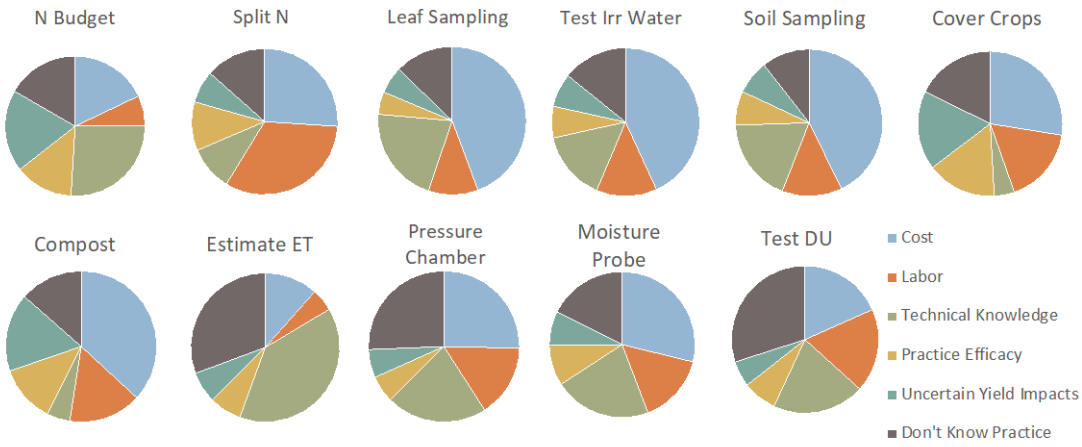
Key findings on adoption:

- Returns from implementing a practice, stewardship, and consideration for public health and safety are important factors considered in adoption.
- Costs, technical knowledge, and unfamiliarity with the practice are the most commonly cited barriers to adoption, as shown below.
- Uncertain yield impacts also plays a role influencing grower decisions about adoption.

University of California, Davis
*Project contact: molly_vandop@berkeley.edu

Grower Views on Nitrogen Management Survey Summary

Survey asked growers about barriers that affected their decisions to adopt N management practices.



Is there good enough information on N management and N regulations?

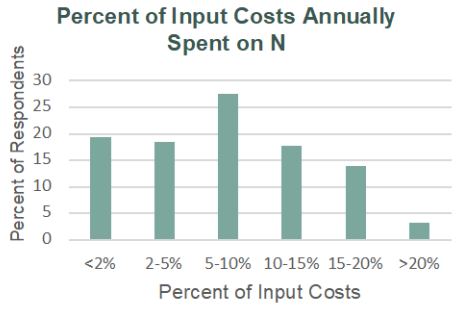
- Growers seek information from many sources to base their nitrogen management decisions, but the most important sources are other growers (cited by 76% of growers) and their own past experiences (94%).
- The Water Quality Coalition is also an important source, used by 69% of growers.

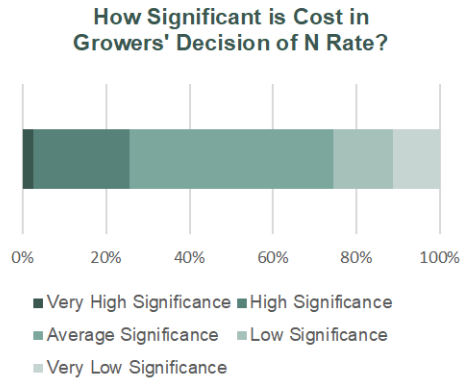
What is the importance of fertilizer cost in management decisions?

- As growers cited cost as the top priority and biggest barrier in practice adoption, we asked growers how much they were spending on fertilizer annually, and how it impacted their nitrogen application rate.
- Most growers cited that the cost of N played a somewhat significant role in their choice of application rate, and the cost of N relative to input costs varied substantially across growers.

Takeaways for Outreach:

- Water Coalitions are a highly valued information source and may be crucial partners to disseminating information about N management
- Emphasizing on-farm benefits of improved N management is key to motivating practice adoption,
- Uncertain yield impacts and cost of practice implementation are important barriers to adoption
- Cost of N fertilizer influence N application rates





Have ideas or questions the survey data? Please reach out to share! Contact Molly Sears: molly_vandop@berkeley.edu

Pest Control Adviser Views on Nitrogen Management: Survey Summary

Survey participants: Active PCAs in Fall 2020

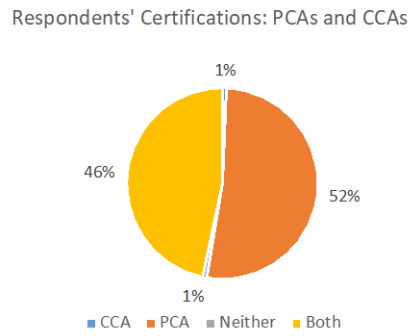
Sat Darshan S Khalsa and Molly Sears*

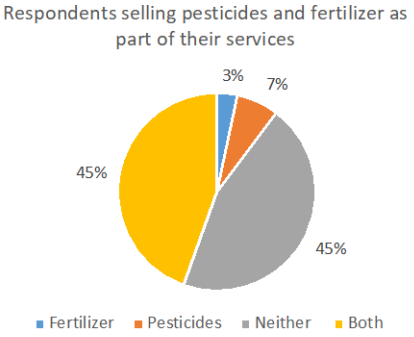
Project Summary:

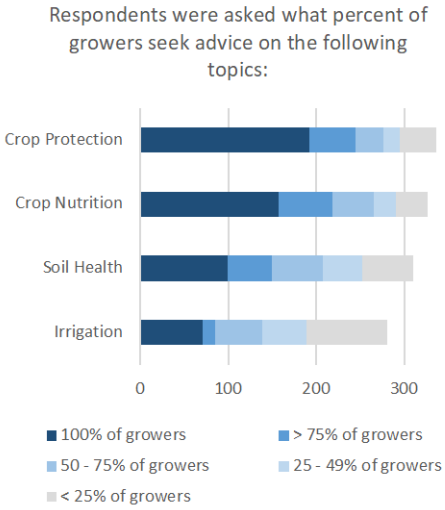
- The PCA population was surveyed to garner an understanding of their expertise in nitrogen management practices and how frequently they recommend these practices to farmers in California. The survey asked background questions about the crops and locations where the PCAs work, along with nutrient management practices they recommend, perceived barriers to the adoption of said practices, as well communication and expertise that they have on various topics.
- The survey was distributed online, following the 2020 CAPCA conference, targeting active PCAs.
- There were 438 responses to the survey, with a 78.5% completion rate.

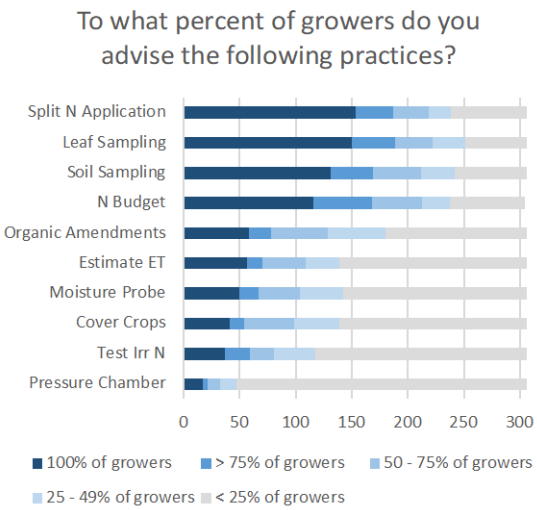
Key findings:

- Of PCAs who sell products as part of their services, 87% sell fertilizer.
- Respondents indicated that they provide advice on a variety of topics, including crop nutrition, crop protection, irrigation, and soil health, making it clear that PCAs are an important source of information for growers.
- Practices that are most recommended by PCAs include split nitrogen application, leaf sampling, soil sampling, and use of an N budget.





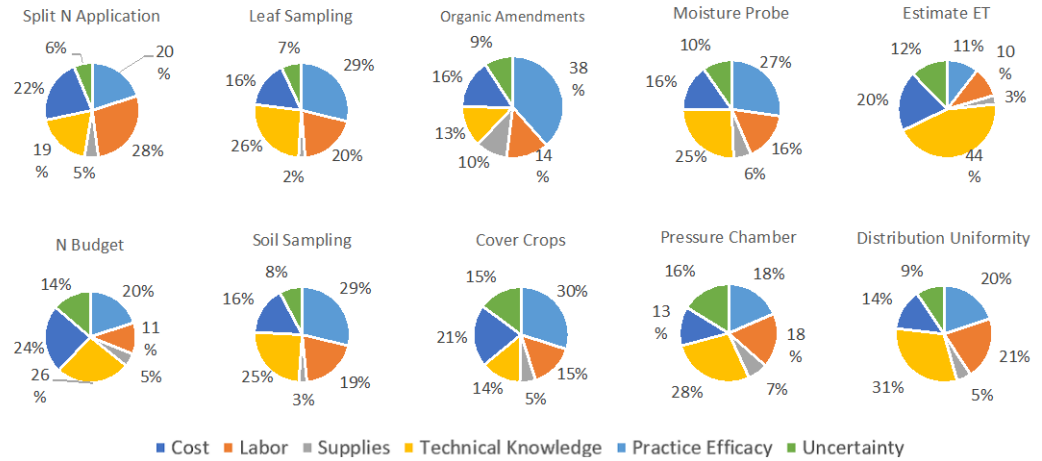


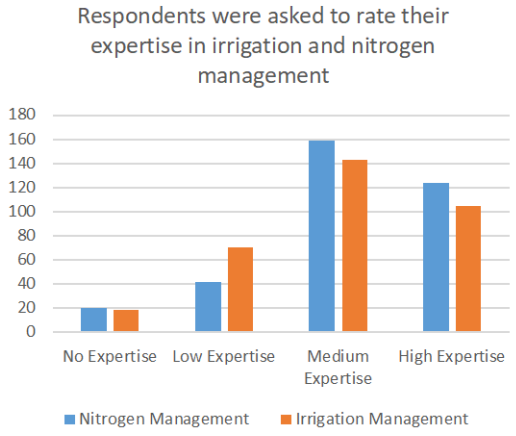


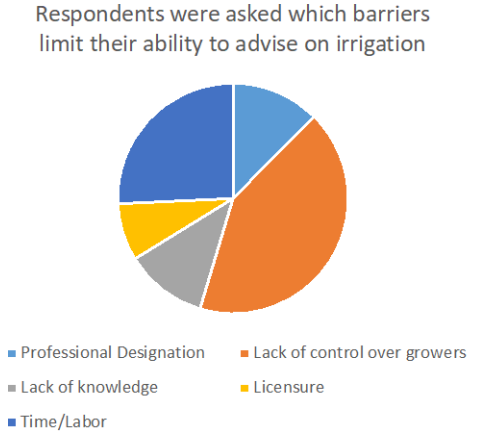
*Project Contact: molly_vandop@berkeley.edu

Pest Control Adviser Views on Nitrogen Management: Survey Summary

Survey asked PCAs what barriers they perceived growers faced when considering implementing the following nutrient management practices:







Barriers to Adoption and Future Research:

- Technical knowledge and practice efficacy were broadly considered to be the largest barriers preventing adoption by growers. The practices that were considered to have the greatest number of barriers were the use of an N budget and the use of organic amendments, such as compost.
- In our pilot studies, PCAs recognized that many of the nitrogen management practices were closely linked to irrigation, but suggested that they often had limited influence with respect to irrigation management. Those views were consistent within this survey, where PCAs reported substantial irrigation knowledge, but a general lack of control over grower irrigation practices. Growers also rarely sought advice on the topic.
- The same survey was distributed to Western Region CCAs in January 2020, to compare and contrast views with the CCA population. We will also compare responses to a grower survey that was conducted in the South San Joaquin Valley in Fall 2020, asking similar questions about nutrient management practices and their respective barriers.

*Project Contact: molly_vandop@berkeley.edu

Crop Control Adviser Views on Nitrogen Management: Survey Summary

Survey participants: Active Western Region CCAs in January 2021

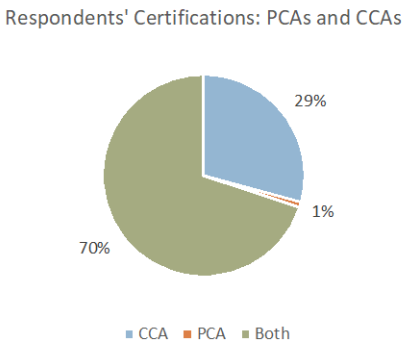
Sat Darshan S Khalsa and Molly Sears*

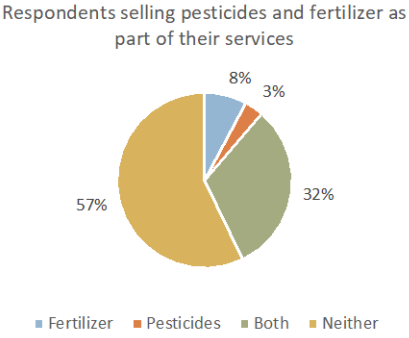
Project Summary:

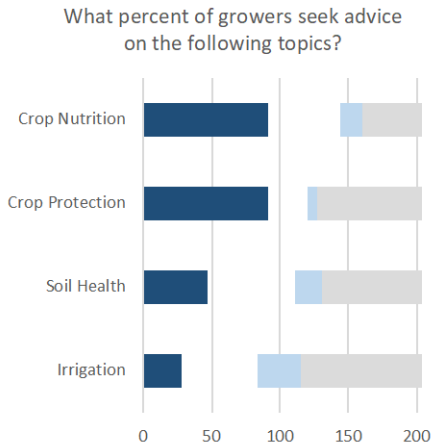
- The Western Region Certified Crop Adviser (WRCCA) population was surveyed on their expertise in nitrogen management practices and how frequently they recommend these practices to farmers in California. The survey asked background questions about the crops and locations where the CCAs work, along with nutrient management practices they recommend, perceived barriers to the adoption of said practices, as well communication and expertise that they have on various topics.
- The survey was distributed online in January 2021, to Western Region CCAs, excluding those who took the survey as part of the California PCA population in late 2020.
- There were 241 survey responses, with an 82.1% completion rate.

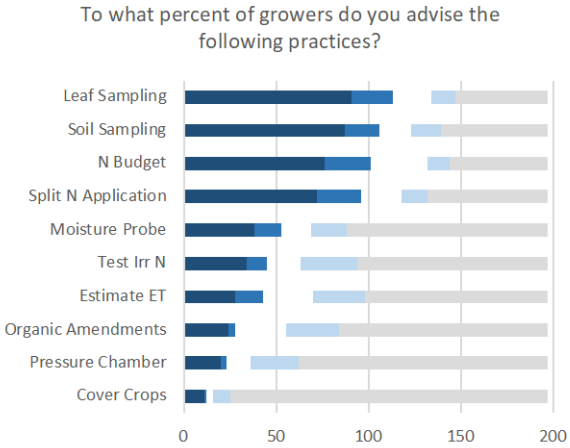
Key findings:

- 43% of CCAs surveyed sell fertilizer or pest control products as part of their services.
- Respondents indicated that they provide advice on a variety of topics, especially regarding crop nutrition, crop protection, and soil health, making it clear that CCAs are an important source of information for growers.
- Practices that are most recommended by CCAs include split nitrogen application, leaf sampling, soil sampling, and use of an N budget.





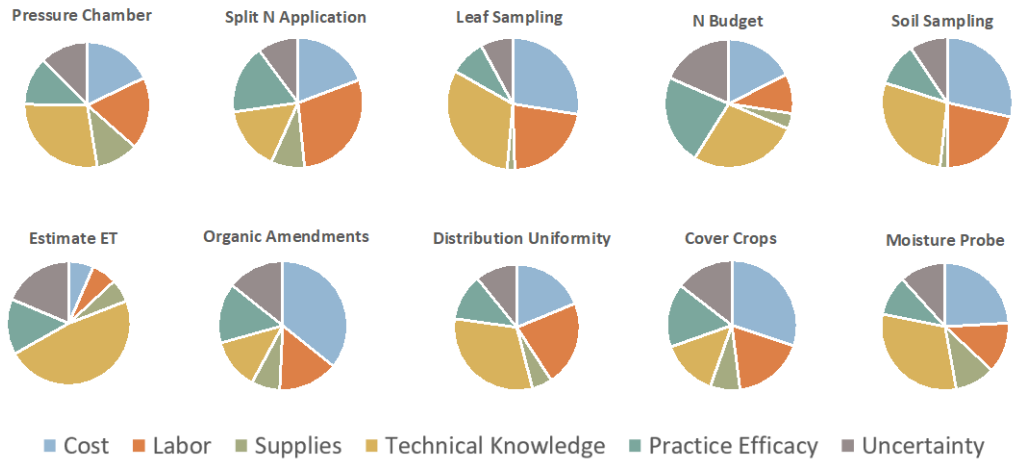




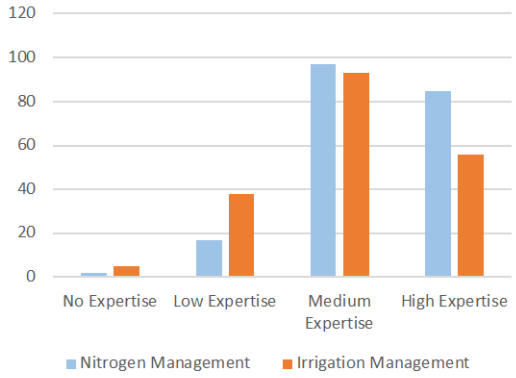
*Project Contact: molly_vandop@berkeley.edu

Crop Control Adviser Views on Nitrogen Management: Survey Summary

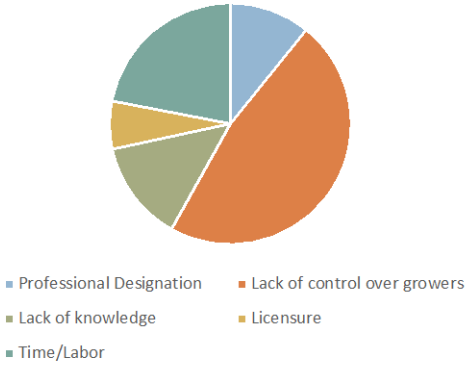
Survey asked CCAs what barriers they perceived growers faced when considering implementing the following nutrient management practices:



Respondents were asked to rate their expertise in irrigation and nitrogen management



Respondents were asked which barriers limit their ability to advise on irrigation



Barriers to Adoption and Future Research:

- Technical knowledge and costs were broadly considered to be the largest barriers preventing adoption by growers. The practices that were considered to have the greatest number of barriers were the use of an N budget and the use of cover crops
- In our pilot studies, CCAs recognized that many of the nitrogen management practices were closely linked to irrigation, but suggested that they often had limited influence with respect to irrigation management. Those views were consistent within this survey, where PCAs reported substantial irrigation knowledge, but a general lack of control over grower irrigation practices. Growers also rarely sought advice on the topic.
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