AGUBC
Agriculture Groundwater Users of Butte County

BUTTE COUNTY Farm Bureau
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Butte County
WATER & RESOURCE CONSERVATION

June 6, 2022

Dear Reader:

We are pleased to present the attached report, ***Vina Subbasin Farmer Survey Report***, which was recently prepared by Mark Lubell and Liza Wood of Environmental Social Research Analysis (ESRA) for the Butte County Farm Bureau ("BCFB") and the Agricultural Groundwater Users of Butte County ("AGUBC"), in conjunction with the Butte County Water and Resource Conservation Department ("BCWRCD").

Development of the ***Vina Subbasin Farmer Survey Report*** has coincided with one of the most severe and extensive droughts that has ever gripped the western United States. Drought conditions throughout most of California, including the Vina Subbasin are classified as "exceptional", the most extreme classification defined by the U.S. Drought Monitor. In fact, the region is now considered to be in the worst "megadrought" in 1,200 years and some believe the drought in the western U.S. could last until 2030[1].

Fortunately, Butte County is in a relatively unique and enviable position given its location, natural resources and farmer efforts to conserve water over the years. According to a recent report by Land IQ, ***20-Year Land and Water Use Change in Butte County (1999-2019),*** agriculture in Butte County uses roughly 17% less groundwater than in 1999 and new orchards are being installed with modern and more efficient irrigation systems. Yet, this report identifies areas of opportunity for continued improvements and the possibility of reducing future water usage through changed irrigation practices.

In this report, the researchers conducted an extensive survey of farmers in the Vina Subbasin and the results provide a snapshot of farmer practices and perspectives on water management and water policy. Several key recommendations from the report to increase farmer adoption of sustainable groundwater management practices and participation and support for Sustainable Groundwater Management Act (SGMA) include:

1. Engage in research and programs that reduce the costs of individual irrigation practices and the uncertainty involved with practice implementation.
2. Focus SGMA policy tools on voluntary and incentive-based practices rather than more mandatory practices that directly regulate groundwater pumping behavior.
3. Provide opportunities for farmers to learn from each other about how they are thinking about groundwater management and SGMA.

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[1] https://www.ppic.org/blog/californias-21st-century-megadrought/ and https://www.nationalgeographic.com/environment/article/the-drought-in-the-western-us-could-last-until-2030

4. Train Pest Control Advisors (PCAs) about groundwater issues being encountered in the Vina Subbasin.
5. Develop programs targeting small farms, which tend to have less information, be less connected to policy discussions, and less likely to adopt practices.

Project partners from University of California Cooperative Extension and ESRA worked collaboratively with the BCFB, AGUBC, and the BCWRCD to develop a survey tool which was distributed by the BCFB via email to 95 farming operations in the Vina Subbasin. After the initial survey invitation in April 2021, farmers were sent four reminders over the following two months. Completion of the survey by 49/95 farmers provides a 52% response rate, which is high relative to other farmer surveys in the Central Valley which typically receive about a 30% response rate.

Notwithstanding our progress in Butte County, SGMA will require more from all of us and there is still room for improvement. Groundwater in Butte County, and particularly the Vina Subbasin, is essential for life and growth – for the food we eat, the families we raise, and the regional economy it supports. This data will contribute to a better understanding of the baseline condition in Butte County relative to farmer practices and perspectives on water management and water policies, and helps identify the opportunities for improvement, particularly as we move toward implementation of SGMA in the years to come.

Sincerely,

Kamela K Loeser

Kamie Loeser, Director
Butte County Water and Resource
Conservation Department

Walt Stile, President
Butte County Farm Bureau

Richard McGowan

Rich McGowan, Board Member
Agricultural Groundwater Users of Butte County

About the Authors

Liza Wood is PhD Candidate in the Center for Environmental Policy and Behavior at UC Davis. Liza's research focuses on the social dimensions of sustainable agricultural management, from nitrogen management to seed innovation, particularly how policies can facilitate transitions towards improved social and environmental outcomes.

Mark Lubell is a Professor of Environmental Science and Policy at UC Davis who studies decision-making in agricultural and environmental policy. He has done extensive research on farmer practice adoption and program participation throughout California. He also runs a research consulting firm, Environmental Social Research Analysis, which completed the Vina Subbasin project.

Vina Subbasin Farmer Survey Report

Liza Wood and Mark Lubell

Environmental Social Research Analysis

Executive summary

A survey of farmers in the Vina subbasin provides a snapshot of farmer practices and perspectives on water management and water policies. We provide summary statistics of the survey responses, and selected correlations related to factors that research has shown to influence farmer decisions. We interpret the findings in light of our broad experience in agricultural and farmer research in the Central Valley, as well as the broader scientific literature.

- **Farm system & irrigation methods:** The farmers surveyed grow almonds, walnuts, and rice with an average plot size of 356 acres, representing larger farms in comparison to the population of growers in Butte County, but generally representing the diversity of crops in the subbasin. Hence, the results of this survey cannot be fully generalized to all small farms, although from our previous agricultural research many of the results from the Vina subbasin are common across the Sacramento and San Joaquin Valley. The most common form of irrigation is solid-set sprinklers.
- **Water management practices:** Water management practices used by more than half of the farmers were soil moisture sensors, ET-based measurements, soil health practices, and pressure chambers. Cost and uncertainty about yields are the most common challenges identified for adopting new water management practices.
- **Groundwater use:** Farmers in the survey rely heavily on groundwater (92% of farmers use it exclusively) and make pumping decisions based primarily on availability and reliability of groundwater and their livelihood and well-being.
- **Water concerns:** Regulations around groundwater pumping are the deepest and most proximate concern to farmers, rather than groundwater depletion or quality decline. Climate change is proximate in the sense the many growers are experiencing the effects of climate change, but not concerning, most likely because growers are confident in their ability to "adapt" to changing weather.
- **Information sources:** Pest Control Advisers are heavily used sources of specialized knowledge who can be targeted for train-the-trainer programs with respect to sustainable groundwater management. Information from the Agricultural Groundwater Users of Butte County and the Butte County Farm Bureau are among the most widely received and trusted sources of these farmers. These trusted and commonly used channels are the most important communication pathways for broadcasting information about groundwater management and SGMA. If these communication sources encourage more sustainable groundwater practices and the reasons for participating in SGMA, farmers are more likely to listen.
- **SGMA perceptions:** 80% of farmers have participated in the Sustainable Groundwater Management Act (SGMA) and the vast majority of participants find the process to be local, inclusive, and necessary. The most common form of SGMA participation is meetings, rather than taking a formal role in governance. Farmers underestimate the extent to which their peers believe SGMA is necessary, which is a barrier to the emergence of social norms that support SGMA implementation at the community-level.
- **Groundwater extraction methods:** In response to water scarcity, farmers are most likely to deepen wells to extract more groundwater and least likely to change to a less water intensive crop. These are the basic drought management strategies that are used throughout the Central Valley, and have been observed for many decades.
- **Policy preferences:** Farmers most strongly support voluntary water policies that put decisions in the farmers hands, such as adoption of new practices and incentives for water saving, and most strongly oppose strict regulations including groundwater pumping fees and fixed quotas for pumping.
- **Drivers of decision making:** As seen with most agricultural research, farmers with larger acreage operations are more likely to adopt most practices, actively respond to water scarcity, and believe SGMA is fair and engaged. However, larger farms are less likely to support a range of proposed SGMA policy tools. With the exception of perceptions of the SGMA process, the number of information sources used by farmers does not affect their decision-making. This is different from a lot of agricultural research, where the number of information sources is a key driver of innovation. Groundwater concern has an interesting and important mixed results. On the one hand, farmers who are taking individual actions to reduce groundwater use are less concerned about the problem, most likely because they believe they are taking steps to solve it. On the other hand, farmers who are concerned about groundwater are more likely to believe SGMA is necessary and support proposed SGMA policy tools.

Recommendations:
We offer the following recommendations about how to increase farmer adoption of sustainable groundwater management practices and participation and support for SGMA.

1. Engage in research and programs that reduce the costs of individual practices and the uncertainty involved

with practice implementation. Farmers need a better understanding of how different practices will influence their agricultural productivity and economic outcomes.

2. Use trusted information sources such as the Butte County Farm Bureau and Agricultural Groundwater Users of Butte County to communicate about groundwater management and SGMA.
3. Focus SGMA policy tools on voluntary and incentive based practices rather than more mandatory practices that directly regulate groundwater pumping behavior.
4. Provide opportunities for farmers to learn from each other about how they are thinking about groundwater management and SGMA, because the overall community support for SGMA is more widespread than individual farmers believe.
5. Train PCAs about groundwater issues being encountered in the Vina subbasin. Even if PCAs are not being hired to manage groundwater or irrigation, their high level of communication with farmers is a opportunity for outreach and education.
6. The role of climate change in influencing groundwater availability is something that farmers are concerned about, and may be effectively framed as changes in weather or extreme events like drought.
7. Develop programs targeting small farms, which tend to have less information, be less connected to policy discussions, and less likely to adopt practices.

Introduction

Motivation: How farmers manage water, and the changes they are willing to make to management in times of water scarcity, have important implications for the development of new groundwater institutions under the Sustainable Groundwater Management Act (SGMA) and the sustainability of water in California. Farmers' management decisions are a product of multiple factors, including their farm operation, information and social networks, attitudes and beliefs, and participation in different activities that inform their thinking about farm management. This report summarizes the profile of farmers in the Vina subbasin, specifically their 1) farm systems and irrigation methods, 2) water management practices, 3) groundwater use, 4) concerns about groundwater management, 5) information resources, 6) perspectives on SGMA, and 7) willingness to adopt different water management and extraction methods and their support for water management policies. We also investigate the relationships between farmer profiles and their willingness to adopt irrigation and water management practices and preferences for various water management policies.

Butte County and the Vina Subbasin: The Vina Subbasin is a portion of the Sacramento Valley Groundwater Basin, located in Butte County (Figure 1, Vina Subbasin Fact Sheet 2019). Agricultural data available at the level of Butte County indicates that this region is home primarily to rice (74,115 acres, 34% of cropland), walnuts (52,655 acres, 24% of cropland), almond (42,835 acres, 20% of cropland), and prunes (7,716 acres, 4% of cropland) which account for 82% of all cropland acreage (177,321/215,946 per USDA 2017 Census). The average farm size in Butte County is 182 acres. The agricultural acreage in Vina Subbasin accounts for about 34% of the county's cropland (73,315/215,946) and represents a higher portion of orchard crops compared to the rest of the County. For example, Vina Subbasin has considerably more acreage in almonds (42% in Vina vs. 16% in Butte County) and walnuts (35% in Vina vs. 24% in Butte County), and fewer acres in rice compared to the County (8% in Vina vs. 43% in Butte County) (LandIQ 2021).

Methods: The results shared in this report are based on survey responses from 49 farmers in the Vina subbasin. A survey tool was developed with the Butte County Farm Bureau, Butte County Department of Water Resources and Conservation, Agricultural Groundwater Users of Butte County, and University of California Cooperative Extension of Butte and Tehama Counties between November-December 2020. Online surveys were distributed via email by the Butte County Farm Bureau to 95 farmers in the Vina subbasin. After the initial survey invitation in April 2021, farmers were sent four reminders over the following two months, the survey closing in early June. Completion of the survey by 49/95 farmers provides a 52% response rate. This is a very good response rate relative to other farmer surveys in the Central Valley, which typically receive about a 30% response rate. The higher survey response is due to the partnerships and support from the agricultural sponsor organizations. However, even with this strong response rate we do expect some response bias towards larger, more innovative, and more involved farmers.

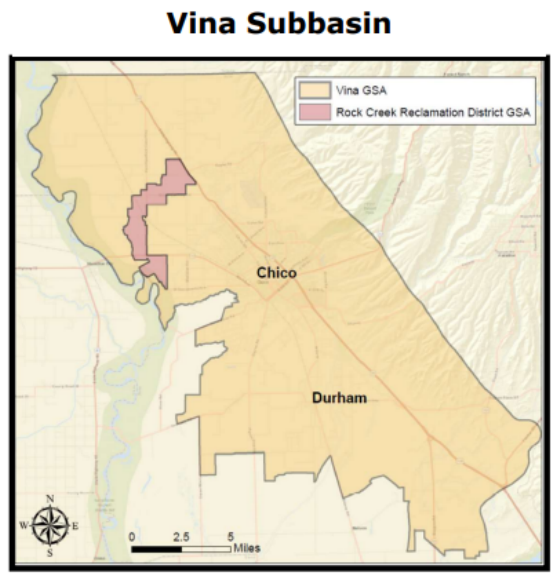

Figure 1: Vina subbasin map

Farm systems & irrigation methods

Farm systems are complex enterprises in which farmers manage multiple plots, crops, and irrigation systems. The complexity of a farm system – the number of crops and plots it includes, the different management roles farmers play on those plots, and the multiple management practices they use – are foundational to farmer decision-making.

Farm systems

To understand farmers' operations, farmers were asked to list all of the plots that they manage, and for each plot, identify the crop, acreage, and management role that they play. The 49 farmers who took the survey reported a total of 123 plots, making the average number of plots per farmer 2-3 plots. Only 14% (n=1) of farmers had one plot, 40% (n=17) had two plots, 21% (n=10) had three plots, 17% (n=8) had four plots, 4% (n=2) had five plots, and 2% (n=1) had six plots. These plots range in size, with 17% (n=20) of the plots having less than 50 acres, 35% (n=44) of the plots having between 50-179 acres, 26% (n=32) of the plots having between 180-499 acres, and 22% (n=27) of the plots having 500 acres or larger. Of the crops planted to these plots, 45% (n=55) are planted to almonds, 38% (n=47) are planted to walnuts, 5% (n=6) are planted to rice, 4% (n=5) are planted to prunes, and 8% (n=10) to other crops.

When evaluated by crop and acreage together (Figure 2), plots with acreage below 180 acres are planted primarily to walnuts, plots with acreage between 180-1000 acres are planted primarily to almonds, and rice accounts for only a small percentage of the plots but is more common in higher acreage plots. Put another way, the average acreage of plots planted to walnuts are 252 acres, the average acreage of plots planted to almonds are 421 acres, and the average acreage of plots planted to rice are 1,121 acres. The average acreage of plots planted to prunes are 120 acres, and for other crops, the average acreage of these plots is 146 acres. The average plot size is approximately 356 acres.

The sample of farmers surveyed represent a larger farm enterprise than the county's average (USDA 2017 Census). According to 2017 USDA data for Butte County, 66% of farms had less than 50 acres, 16% of farms had 50-179 acres, 12% of farms had 180-499 acres, and only 7% had 500+ acres. By comparison, medium and large-sized farmers are over-represented in these data. However, the crop acreage reported in the survey is generally representative of the Vina Subbasin, where almonds and rice are slightly overrepresented, and walnuts and prunes are slightly underrepresented. LandIQ data indicates that almonds account for 42% of cropland acreage in the subbasin compared to 53% of the acreage reported in the survey. Rice accounts for 8% of subbasin acreage compared to 15% of acreage reported in the survey. Walnuts account for 35% of subbasin acreage compared to 27% of acreage in the survey data. And prunes account for 4% of subbasin acreage compared to 1% of acreage in the survey data.

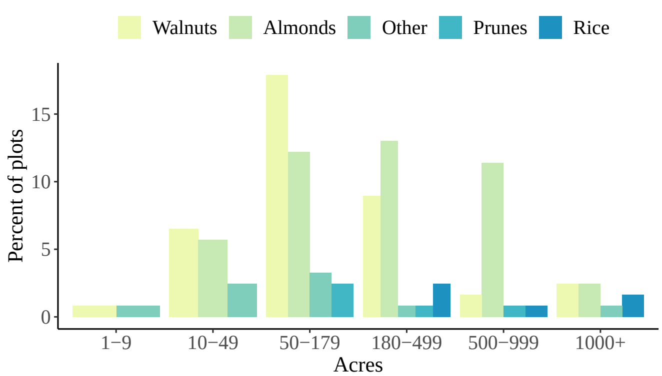

Figure 2. How many acres of the following agricultural crops you manage in a typical year?

Largest acreage plot

Given the number and diversity of plots that farmers manage, respondents were asked to identify their largest acreage plot (Figure 3) about which to answer a series of irrigation and water management questions. Five farmers identified rice as their largest acreage crop, ranging from 250 to 4,000 acre plots with an average of 1,752 acres, 28 farmers identified almonds as their largest acreage crop ranging from 42 acres to 5,995 acre plots with an average of 679 acres (acreage > 4,000 was omitted from Figure 3), 13 farmers identified walnuts as their largest acreage crop, ranging from 60-1000 acre plots with average of 398 acres, and prunes and olives each had one farmer identify these crops as their largest acreage plot. It is about these plots that farmers respond regarding irrigation methods, water management practices, and groundwater use.

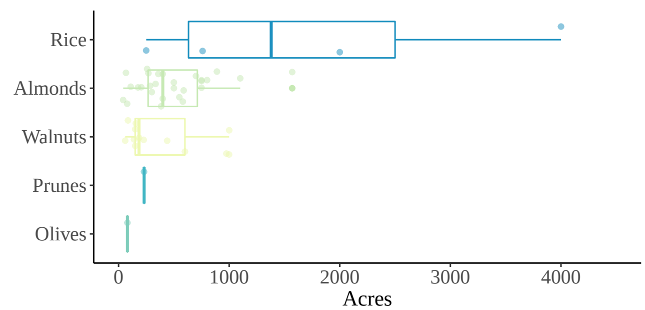

Figure 3. What is the acreage of the largest plot and what crop is it planted with? Each box represents the distribution of acreage for each plot, where the left−most line is the first, lower quartile, the left side of the box is the second quartile, line in the middle of the box is the median acreage, the right side of the box this the third quartile, and the right−most line is the fourth, upper quartile.

Irrigation methods

Farmers were provided a list of irrigation methods and asked what percentage of their largest acreage crop is managed with each method. Methods included surface drip irrigation, sub-surface drip irrigation, furrow/flood irrigation, micro-sprinklers, and solid set sprinklers. Responses to questions about irrigation methods are represented in Figure 4. Of the 49 farmers who responded to the survey, 46% (n=22) use more than one irrigation method on their largest field, signaling a that irrigation methods are not uniform across plots. Solid-set sprinklers are the most common irrigation method, with 52% (n=25) of farmers using solid set irrigation for over 75% of the acreage on their largest plot and another 28% (n=24) using it on 25-75% of their largest acreage plot. Micro-sprinklers are the next most common practice, with 45% (n=17) of farmers reporting using micro-irrigation on some amount of their largest acreage plot, mostly on 25% or less of its acreage. Furrow/flood is used by 10% (n=5) of farmers, and always covers more than 75% of their largest acreage. Surface drip irrigation is used by 23% of farmers, and subsurface drip by 10%, but again usually on less than half of the largest plot acreage. This suggest that micro-sprinklers and drip irrigation are often used a complement to more traditional irrigation methods such as solid-set sprinklers. Of the growers who use solid-set sprinklers, 38% (n=15) also use micro-sprinklers, 21% (n=8) also use surface drip irrigation, and 13% (n=5) also use sub-surface drip irrigation.

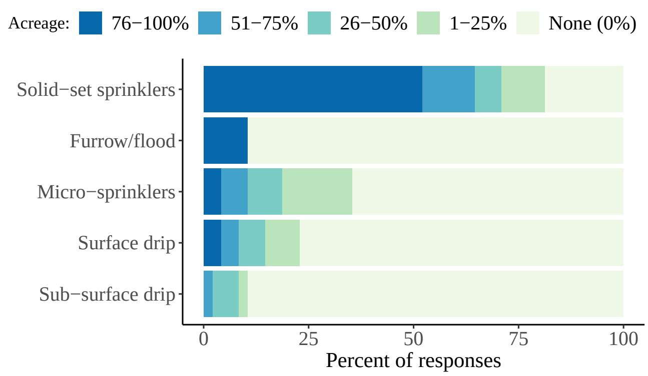

Figure 4. What percentage of your largest plot's acreage is managed with the following irrigation methods?

Water management

Multiple types of management practices can be implemented on-farm to improve water management, including tools and methods for measuring plant water needs, monitoring irrigation flows and distribution, and managing soil for improved water needs. However, farmers often face barriers to adoption of these practices, ranging from unawareness and uncertainty of the technology's effect on farm productivity to concerns over cost and labor. Identifying such barriers, and how they interact with farmers' adoption of these practices, provides a first step to understanding how to increase adoption of sustainable water management practices.

Current water management practices

Farmers were provided with a list of common water management practices and asked to identify the percentage of their largest plot's acreage they used the practice on. Practices included: Evapotranspiration (ET)-based methods to schedule irrigation, plant water status measurements to time irrigation (e.g. pressure chambers), soil moisture sensors, irrigation systems tests for distribution uniformity, use of flow meter to measure applied water, regulated deficit irrigation (i.e. purposefully withholding water when crop would benefit or be affected minimally), and soil health practices to improve water holding capacity and infiltration. Except for flow meter measurements, farmers who used a practice used it on the majority of their field (75-100% of its acreage).

Farmers use multiple water management practices, with an average of nearly four practices per farmer. As displayed in Figure 5, the most common type of water management practice is using a soil moisture sensor, with 70% (n=32) farmers using it on some portion of their field, followed by evapotranspiration-based measurement to schedule irrigation, used by 67% (n=31) of farmers. Soil health practices for improving water holding capacity are used by 65% (n=30) of the farmers, and plant water status measurements via pressure-chambers are used by 55% (n=25) of farmers. Slightly less popular are regulated deficit of irrigation, used by 46% (n=21) farmers, and tests for distribution uniformity and flow meter measurements, both of which are used by 43% (n=20) farmers.

These top four methods are largely plant and soil health focused to meet plant water needs. These are practices that involve directly assessing how water is applied to the crop. Less popular are methods that involve monitoring the amount and distribution of irrigation system itself, which is a more indirect and less visible practice operating at the system level. Similar patterns have been found in nitrogen management, where the most common practices involve the direct application of fertilizer while the less common practices are related to indirect management of the system such as the amount of nitrate in applied irrigation water.

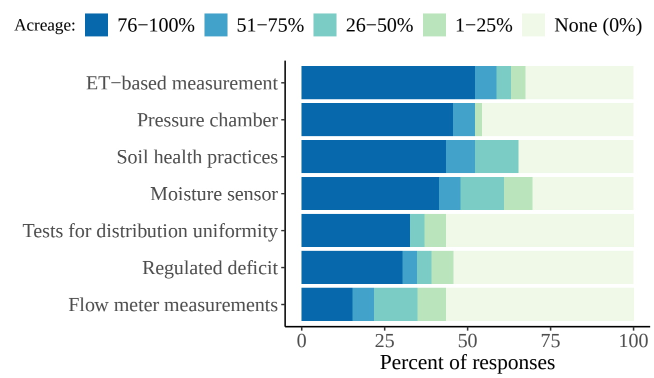

Figure 5. For your largest plot, what percent of your largest plot's acreage is managed with the following water management practices?

Challenges for adopting water management practices

Farmers were asked about the challenges they perceive when considering the previously listed water management practices. They could respond that they adopted with no challenges, or select all relevant challenges from a list: cost, labor intensity, technical knowledge, and uncertainty of impacts to crop yields. On average across all seven water management practices, cost and uncertainty about yields were the two most commonly identified challenges, with 23% of farmers naming each of these as a challenge. The challenge of labor intensity was named by 16% of farmers and technical knowledge by was named by 13% of farmers, on average across the seven practices.

The prevalence of challenges differ across practices (Figure 6). Cost is the primary challenge identified for flow meter measurements, moisture sensors, and soil health practices. Uncertainty is the challenge identified most for using regulated deficit irrigation and ET-based measurement methods. Labor intensity is the dominant challenge for using pressure chambers and testing for distribution uniformity. Interestingly, there is a pattern that practices with high cost barriers tend to have lower uncertainty, while practices with lower cost barriers tend to have high uncertainty. For none of the water management practices is technical knowledge the primary challenge. Together, the practice with the highest percent of farmers identifying challenges is the pressure chamber (87% of farmers identify at least one of the challenges, n=41). For soil health practices 61% (n=30) of farmers identify at least one of the challenges. Flow meter measurements, moisture sensors, and regulated deficit, each had 49% (n=24) of farmers identify at least one challenge. ET-based measurement 47% (n=23) of farmers identify at least one of the challenges, and for testing for distribution uniformity 40% (n=20) of farmers identify at least one of the challenges.

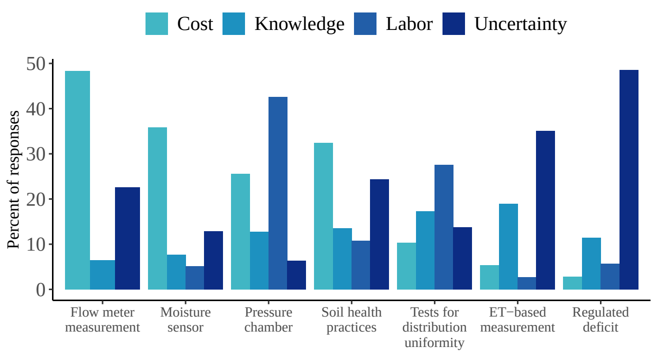

Figure 6. When considering these irrigation management practices, which of the following issues do you consider a challenge for implementation?

Likelihood of adopting water management practices

For the water management practices identified in the previous sections, farmers were asked to indicate the likelihood that they would adopt each practice "to ensure reliability of the water supply." Farmers scored likelihood on a six-point scale, ranging from very unlikely to very likely. This survey question was conditionally formatted so that farmers were provided a custom list of practices, including only those practices that they *do not already use* for at least a portion of their largest plot acreage. As a result, the total number of responses for each practice differs. For instance, only 14 farmers were asked about their likelihood of using moisture sensors, given that the remaining farmers in the survey indicated that they already use this practice on some portion of their largest acreage plot, while 26 farmers were asked about their likelihood of using flow meter measurements.

The likelihood of non-adopters selecting a future practice is shown in Figure 7. Adopting the pressure chamber to measure soil moisture levels is the practice that farmers identified as having the highest adoption potential, with 10% (n=2) of farmers very likely to adopt and another 20% (n=4) likely to adopt. The practice with the second highest adoption potential is flow meter measurements, with 8% (n=2) of farmers very likely to adopt and another 20% (n=5) likely to adopt. However, in line with their current frequency of use, flow meter measurements also have a split response with nearly half of the respondents saying they are unlikely or very unlikely to adopt. Next, testing for distribution uniformity has 8% (n=2) and 12% (n=3) of farmers very likely and likely to adopt, respectively. Using soil health practices for improving water holding capacity, regulated deficit, use of moisture sensors, and ET-based measurements all have small samples where fewer than 5 farmers are very likely or likely to adopt. As with flow meter measurements, farmers have as split opinion about regulated deficit irrigation with over 50% of respondents saying they are at least somewhat unlikely to adopt.

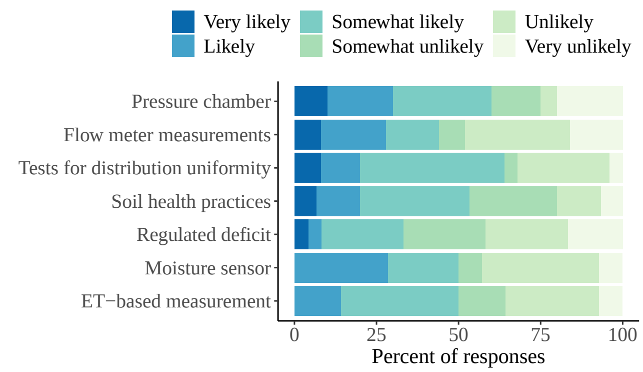

Figure 7. For your largest plot, what is the likelihood that you will consider using the following practices in the future to ensure reliability of the water supply?

Groundwater use and pumping motivations

Across California, farmers strike different balances of using surface water and groundwater to irrigate their crops, and have different motivations for pumping groundwater. Surface water users generally have some type of riparian or prior appropriation right, or purchase water from an irrigation or water management district. Groundwater users usually rely on their own wells, and if they have surface water rights, will rely more on their groundwater during dry years when surface water is scarce. Sustainable water management entails the conjunctive use of surface and groundwater as a portfolio of water management options, including enhancing groundwater recharge.

Groundwater use and measurement

Farmers were asked about the percentage of their water that comes from ground vs. surface water on their largest acreage plot. Figure 8 shows that 98% of farmers in this survey use some amount of groundwater in a typical year, with 92% of of farmers indicating that this is their primary source of water (i.e. use groundwater on 76-100% of their largest acreage plot). This signals a strong reliance on groundwater in the Vina subbasin. Counties across the Central Valley tend to use a mix of surface and groundwater, for instance, the percentage of farmers using only groundwater is 71% in San Luis Obispo County, 38% in Fresno County, and 35% in Madera County (2019 Farmer Perspectives on SGMA: San Luis Obispo County, Fresno County, Madera County). Of the farmers who use groundwater in this survey, 10% (n=5) measure groundwater more than once a year, 41% (n=20) measure groundwater levels annually, and 41% (n=20) do not measure their groundwater levels (Figure 9). While the greatest number of farmers only measure groundwater levels annually, the survey did not collect information about when in the year or season they measure groundwater, and a single annual measurement cannot adequately identify season patterns. Four farmers did not respond to this question.

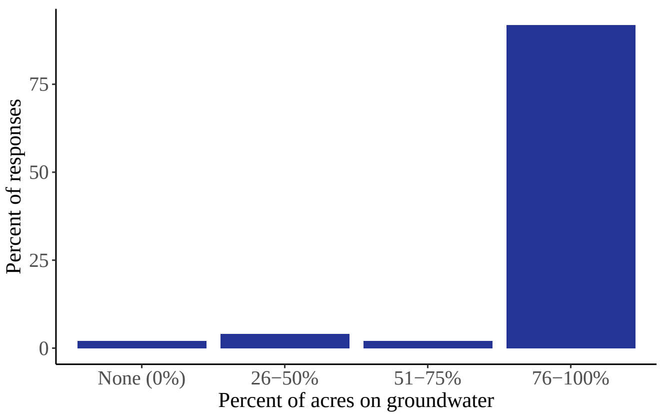

Figure 8. For your largest plot, approximately what percentage of your water comes from groundwater in a typical year?

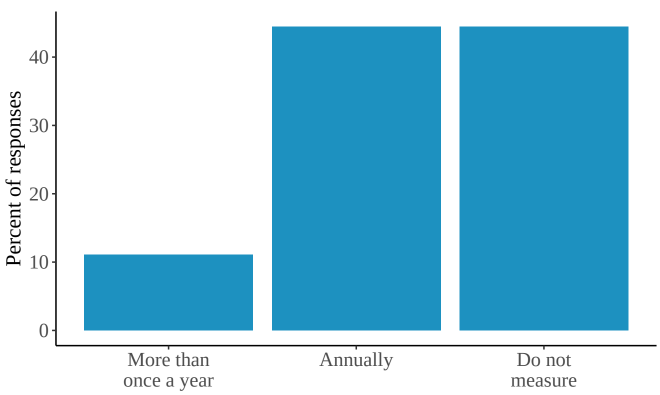

Figure 9. For your largest plot, how often you measure groundwater elevations or levels?

Motivations for pumping groundwater

When considering the pumping of groundwater, farmers were asked to rank the importance of different factors in their decision-making. Farmers were provided with the following factors: Availability and reliability of groundwater, affordability of food, on-farm autonomy, society/community well-being, labor and time requirements, access to food, economics/cost of production, policy/regulatory compliance, potential impact on future generations, sustainability of food supply chain, and family/self livelihood and well-being. They ranked each factor between 1-11, where 1 was the most important and 11 was the least important. Each rank could only be assigned once.

Farmers' rankings of groundwater pumping factors are displayed in Figure 10, in which each box represents the distribution of ranking responses and the line in the middle of the box is the median rank. The most important factor for farmers' pumping is the availability and reliability of groundwater (mean rank = 2.4, median rank = 2), followed by their livelihood and well-being (mean rank = 3.6, median rank = 3), potential impact on future generations (mean rank = 4.5, median rank = 4), the cost of production (mean rank = 4.7, median rank = 5), on-farm autonomy (mean rank = 6.1, median rank = 5.5), labor and time requirements (mean rank = 6.9, median rank = 7), regulatory compliance (mean rank = 7.7, median rank = 8.5), affordability of food (mean rank = 7.4, median rank = 8), food access (mean rank = 7.4, median rank = 8), supply chain sustainability (mean rank = 6.9, median rank = 7), and society/community well-being (mean rank = 7.8, median rank = 8). Overall, farmers weigh the economic benefits/costs and reliability of groundwater more than broader system or social considerations including regulatory compliance.

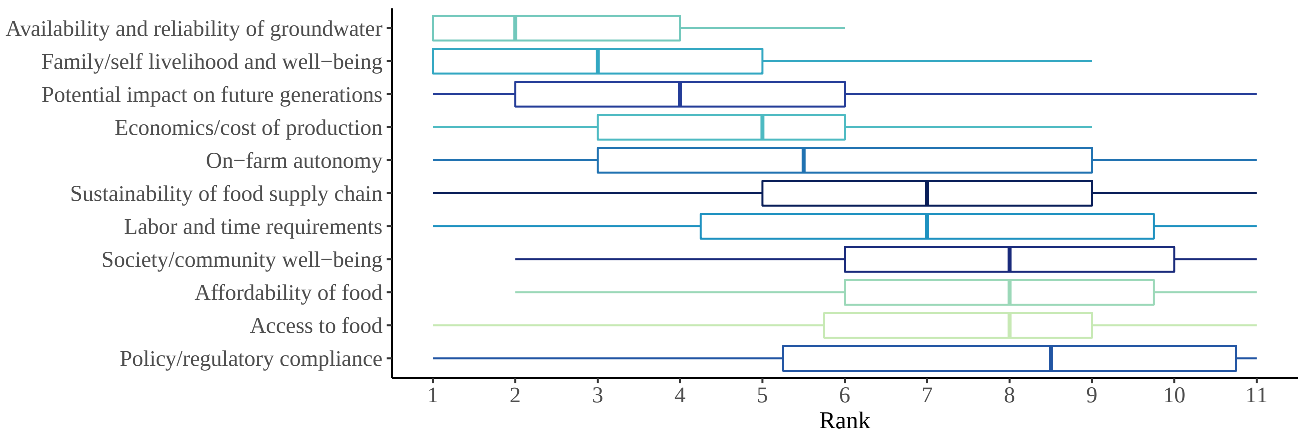

Figure 10. When pumping groundwater, rank the importance of the following factors (1 = most important, 11 = least important) Each box represents the distribution of rank responses for each factor, where the left−most line is the first, lower quartile, the left side of the box is the second quartile, line in the middle of the box is the median acreage, the right side of the box this the third quartile, and the right−most line is the fourth, upper quartile.

Watern concerns

A farmer's awareness of and concern for social and environmental problems related to water can influence how they view water management efforts. As with all human decision-making, farmers are more likely to expend resources to address what they perceive as a problem, versus expending resources on issues they perceive as not a problem.

Concern for groundwater conditions

Farmers were provided a list of regulatory and environmental conditions related to water management in the Vina subbasin and were asked to rank their level of concern on a six-point scale, from deeply unconcerned to deeply concerned. The conditions included: Chronically lower groundwater levels, reduction in groundwater storage, water quality degradation, local subsidence, depletion of stream and river flows, the negative affect of climate change on water availability, regulatory reduction of agricultural access to water, and increased cost of regulation.

Farmers' concerns for the different conditions are presented in Figure 11. Across the eight conditions, farmers are most deeply concerned with the consequences of regulation on groundwater costs and availability. Namely, 80% (n=35) are deeply concerned about the increased cost in regulation and 68% (n=30) are deeply concerned about the regulatory reduction in agricultural access to water. For these two conditions, every farmer that responded had some level of negative concern – there were no unconcerned farmers. Deep concern for other groundwater conditions were substantially less. Chronically lower groundwater levels prompted deep concern from only 28% (n=12) of farmers, though another 42% (n=18) express concern. Groundwater storage reduction prompted deep concern from only 23% (n=10) of farmers, though another 49% (n=21) express concern. Flow depletion in streams and rivers has 21% (n=9) of farmers deeply concerned and 36% (n=15) of farmers concerned. Climate change has also has 21% (n=9) of farmers deeply concerned and 16% (n=7) concerned. For water quality degradation, 14% (n=6) of farmers are deeply concerned and 37% (n=16) are concerned, and local subsidence deeply concerns 12% (n=5) and concerns 34% (n=14) of farmers. Across the eight conditions, between 5-8 farmers did not respond to these questions. In terms of the biophysical and hydrological aspects of groundwater management, farmers are more concerned about issues related directly to the conditions of the basin versus indirect effects on water quality, stream flow, or climate change.

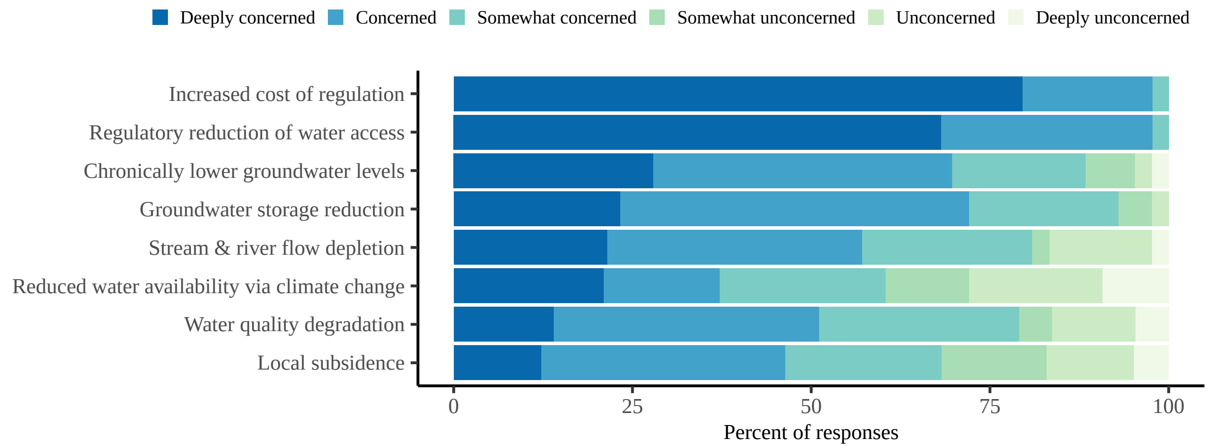

Figure 11. Please indicate your level of concern about the following potential conditions related to groundwater management in the Vina subbasin.

Likelihood of groundwater conditions occurring

For the same list of groundwater conditions, farmers were asked when they feel that each condition was likely to occur: Occurring now, likely to occur in 5, 10, or 20 years, or not likely to occur in the next 20 years. This survey question captures the idea of "psychological distance", which argues that farmers are more likely to respond to concerns that are more proximate in time. Farmers' ranking of proximate conditions are displayed in Figure 12. Farmers' deepest concern, increased cost of regulation, is perceived as already occurring by 59% (n=23) farmers. Climate change is the next most proximate occurrence, with 33% (n=12) of farmers reporting that climate change is happening now. Next, farmers concern with regulatory reduction in groundwater availability is perceived as occurring now by 28% (n=11) of farmers, stream and river flow depletion by 27% (n=10) of farmers, groundwater storage reduction by 21% (n=8) of farmers, chronically lower groundwater levels and water quality decline each by 18% (n=7) of farmers, and local subsidence by only 3% (n=1) of farmers. Across the eight conditions, between 10-13 farmers did not respond to this question.

Farmers' perceptions of how proximate groundwater conditions are generally matches with their concern for the issue, though there are exceptions. Increased regulation is perceived as deeply concerning and happening most imminently. However, climate change is low among the rankings of farmers concerns but considered one of the most proximate conditions. This is likely because farmers feel experienced adapting to changing climates (e.g. farmers have always had to adapt to "weather") and perceive it as less of a risk. So despite the recognition that climate change is having a negative effect on water availability, it is less concerning that other regulatory or hydrological changes to groundwater. In addition, there is substantial concern about reductions in groundwater levels and storage, with nearly half the farmers worried it will occur within the next 5 years.

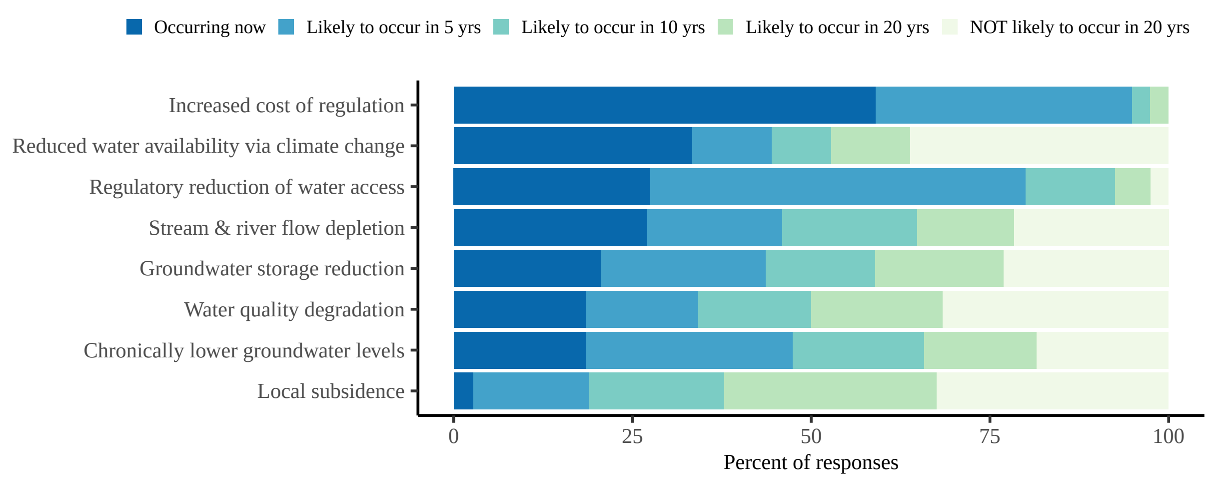

Figure 12. If the Vina subbasin does not implement any interventions, when do you feel the following consequences are likely to occur?

Information sources and programs

Farmers are guided in their management decisions by a range of actors and programs, such as consultants, voluntary programs organized by various governmental and non-governmental organizations, and seek information from agencies, organizations, and peers. The networks through which farmers get information is known to be an important driver of behavior, with better connected farmers typically adopting more innovative practices and participating more in outreach and education programs.

Consultants

Farmers were provided with a list of three consultant types and asked whether or not they hire any of these consultants to help manage their farm. Nearly all of the farmers (96%, n=47) use Pest Control Advisers (PCAs) as consultants on their farm (Figure 13). PCAs are a widely popular and influential source of information for farm behavior, and PCAs are themselves organized as a profession. As specialized experts, just like doctors prescribing medicine, PCAs recommend specific pesticide practices. If PCAs recommend more sustainable practices, or provide additional information about water management or programs like SGMA, they may also influence farmer behavior. For this reason, PCAs are excellent targets for "train-the-trainer" programs that subsequently spread knowledge to the grower level. Certified Crop Advisers (CCAs) are also popular, being used by 30% (n=19) of farmers, and irrigation specialists are used by 20% (n=10) of farmers.

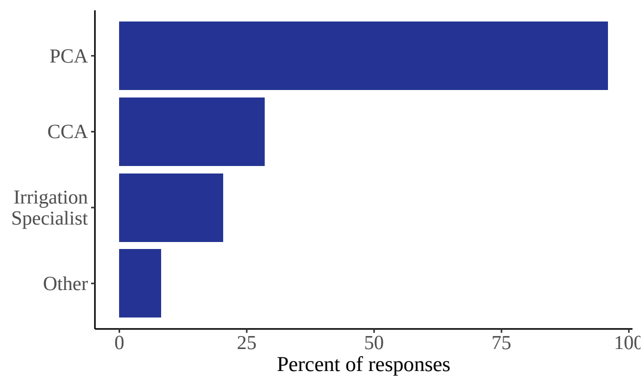

Figure 13. Do you hire any of the following types of consultants to help you manage your farm?

Program participation

Voluntary programs include local, state, and federal programs that support farmers' best management practices. Farmers were asked if they participate in a range of farm management programs. These included federal programs: USDA's Environmental Quality Improvement Program (EQIP), Agricultural Conservation Easement Program (ACEP), Conservation Stewardship Program (CSP), and Conservation Reward Program (CRP); California state programs: State Water Enhancement and Efficiency Program (CA SWEEP), Healthy Soils Program (Healthy Soils), and the Landowner Incentive Program (LIP); and regionally, the Mobile Irrigation Lab of Tehama County Resource Conservation District (Irrigation Lab). The survey also asked about sustainability and organic certification programs.

Participation in voluntary programs is relatively low (Figure 14). While 47% of farmers participate in at least one voluntary program, no single program is widely popular. The most popular is the Tehama County Mobile Irrigation Lab, used by 16% (n=6) of farmers, followed by sustainability certifications, USDA EQIP, and California SWEEP, each used by 10% (n=5) of farmers. California's Healthy Soils Program is used by 8% (n=4), USDA's CSP is used by 6% (n=3), and USDA ACEP is used by 4% (n=2). One farmer each participates in organic certification, USDA CRP, and other programs. The percent of farmers in our sample that are certified organic, 2% of responses, is below the County's 2017 report that 5% of Butte Country farmers were certified organic. No farmers participation in California's Landowner Incentive Program.

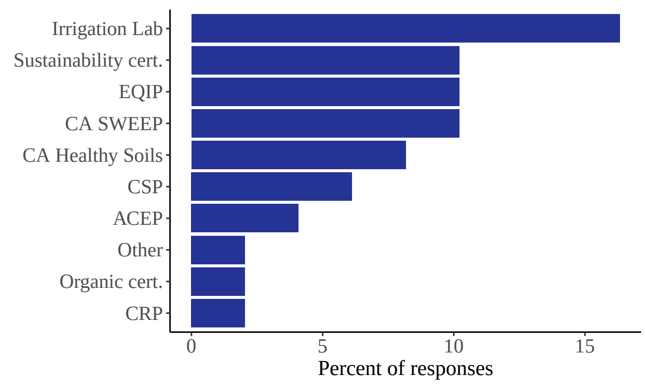

Figure 14. Does your farm participate in any of the following voluntary programs?

Information and trust

Farmers were provided with a list of information sources and asked to select whether they a) receive information from this source and b) trust information from this source. The idea here is that even if a farmer receives information from a source, they may not trust the source and therefore would not incorporate the information into their decision-making. However, we know from previous research that trust and receiving information is correlated, because farmers tend to seek out trusted sources. The sources listed included local sources: Agricultural Groundwater Users of Butte County (AGU BC), Butte County Department of Water and Resource Conservation (BC DWRC), Butte County Farm Bureau (BC FB), and Vina Groundwater Sustainability Agency (Vina GSA); Statewide sources: California Department of Water Resources (CA DWR), University of California Cooperative Extension (UC Extension). The survey also listed commodity organization/grower cooperatives (Commodity orgs.) and other farmers as information source options, without specifying any particular name.

Farmers receive information from an average of four sources, and Figure 15 displays the percentage of farmers who receive information from each source. The most popular are the Butte County Farm Bureau and the Agricultural Groundwater Users of Butte County, each accounting for 63% of farmer (n=31), UC Extension (61% of farmers, n=30), CA Department of Water Resources (55% of farmers, n=27), the Vina Groundwater Sustainability Agency and the Butte County Department of Water Resource Conservation, both accounting for 53% of farmers (n=26). Last, 45% (n=22) of farmers report getting information from other farmers and commodity organizations.

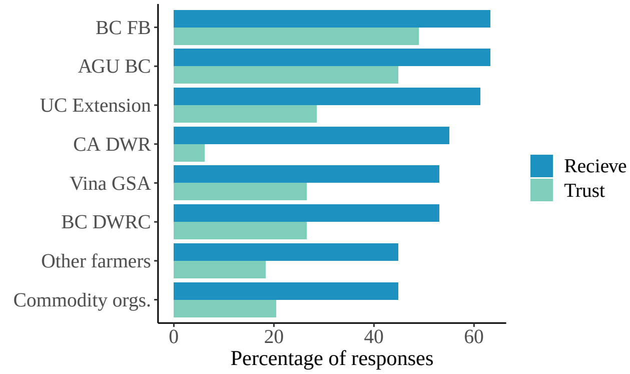

Figure 15. Which of the following are sources that you receive information from a information from with regard to water management?

Whether information is trusted, however, differs across the sources that farmers seek out. Figure 15 displays the percentage of farmers who indicate trusting the information sources that they receive information from. There is a tight coupling of receiving and trusting information for the most popular information sources. For the Butte County Farm Bureau, 24 of the 31 information users (77%) trust this source. For the Agricultural Groundwater Users of Butte County, 22 of the 31 information users (71%) trust this source. Of the 30 farmers that use UC Extension for information, only 14 (47%) trust them. For CA Department of Water Resources, only 4 of the 27 information users (15%) trust them. This most likely reflects the fact that DWR is sending out information about SGMA and water management to all growers, but the growers do not trust the information they are receiving. For the Vina GSA, 13 of the 26 information users (45%) trust this source and for the Butte County Department of Water Resource Conservation, 13 of the 26 information users (45%) trust this source. Other farmers are trusted by 9 of the 22 farmers (41%) who use peers for information and commodity organizations are trusted by 10 of the 22 farmers (45%) who use them for information.

Across these sources, the least trusted is California's Department of Water Resources, with a trust rate of 15% by its users. On the other end of the spectrum the Agricultural Groundwater Users of Butte County and the Butte County Farm Bureau have the highest rates of trust, both with more than 70% trust from their users. These two frequently used and trusted sources have been advocating for farmers at the local level for many years. Organizations that have farmers' trust will be critical in guiding farmers' decisions. Trusted organizations may also need to endorse other programs that may have less trustworthy reputations if they wish for success of these other programs. For example, if the AGU of BC and BC Farm Bureau believe SGMA is an important and useful policy program, and that groundwater depletion is an important future challenge, then those organizations should be delivering that message to farmers.

SGMA

The Sustainable Groundwater Management Act (SGMA) is a policy passed by the California legislature and signed by the governor in 2014, which requires the development of groundwater sustainability agencies and plans. The Vina Groundwater Sustainability Agency and the Rock Creek Reclamation District Groundwater Sustainability Agency, formed in 2017, are responsible for developing and implementing the plan for the Vina subbasin Vina Subbasin Fact Sheet 2019. SGMA is designed to be a participatory process, in which the voices of groundwater users are important in guiding water management decisions. Understanding farmer voices on the SGMA process is important for its development of management plans. Farmers need to be represented in SGMA decision-making in order for the groundwater sustainability plans to reflect their interests.

SGMA involvement

Farmers were asked to report their involvement in the SGMA process. They could indicate having never participated, attending a meeting, voting on GSA formation, served on a board, and/or testified on a SGMA issue.

A minority of farmers (20%, n=10) have not participated in the SGMA process, only one of which taking this survey had never heard of SGMA. Of the remaining 39 farmers who have participated in SGMA, farmers on average report participating in an average of two ways (Figure 16). The most popular form of participation is by attending SGMA meetings, which 53% (n=26) of farmers have done. SGMA meetings are the most basic form of information sharing, alerting farmers to compliance requirement, and providing a space for them to voice their concerns. Additionally, 33% (n=16) of farmers have voted on GSA formation, 20% (n=10) have served on a SGMA board, and 4% (n=2) have testified on a SGMA issue. These more formal methods of participation give farmers a more direct role in shaping the SGMA plans and decisions.

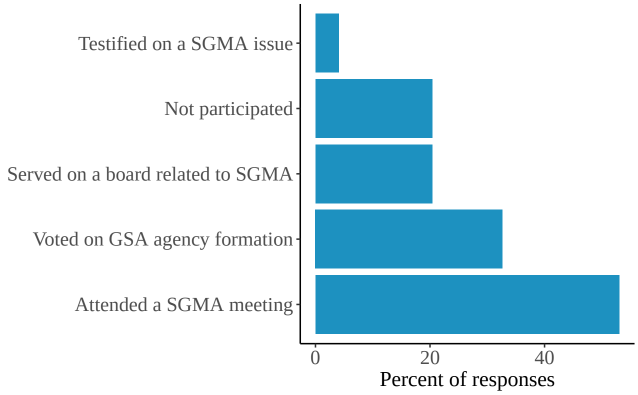

Figure 16. In which of the following ways have you participated in SGMA?

SGMA perceptions

How farmers perceive regulatory programs may influence their willingness to cooperate with policies. The survey provided farmers with a series of statements about SGMA and the SGMA process. The survey questions were based on other surveys of groundwater users across the West. Farmers to were asked to indicate their agreement with these statements on a six-point scale, from strongly disagree to strongly agree. The statements were as follows:

- The SGMA process is being managed at the local level
- Farmers have been involved in the SGMA process
- I feel the process for engaging farmers in the SGMA process has been fair
- I know how to participate in the SGMA process and have my opinions heard
- I clearly understand the SGMA process for establishing groundwater sustainability in the Vina subbasin
- I believe SGMA is necessary to achieve groundwater sustainability locally
- I believe SGMA is necessary to achieve groundwater sustainability in California
- The majority of farmers think that SGMA is necessary for achieving groundwater sustainability locally
- The majority of farmers think that SGMA is necessary for achieving groundwater sustainability in California

Farmers' agreement with these statements is displayed in Figure 17. The statements farmers most strongly agree with are that SGMA is necessary to achieve groundwater sustainability at the local level (14% (n=5) strongly agree and 33% (n=12) agree), that it is being managed at the local level (13% (n=5) strongly agree and 45% (n=17) agree), and that farmers have been involved in the SGMA process (13% (n=5) strongly agree and 42% (n=16) agree). Next, 5% (n=2) of farmers strongly agree and 38% (n=14) agree that they clearly understand the SGMA process for establishing groundwater sustainability in the Vina subbasin, and 5% (n=2) of farmers strongly agree and 32% (n=12) agree that SGMA is necessary to achieve groundwater sustainability locally. 3% (n=1) strongly agree and 42% (n=5) agree that SGMA is a process in which they know how to participate and have their voices heard, and 3% (n=1) strongly agree and 25% (n=9) agree that SGMA is a fair process for engaging farmers. 24% of farmers agree that SGMA is **perceived by other farmers as necessary** to achieve groundwater sustainability locally and similarly, 23% of farmers agree that SGMA is **perceived by other farmers as necessary** to achieve groundwater sustainability in California. Across the nine statements, between 11-14 farmers did not respond to this question.

Positive perceptions of SGMA and the SGMA process outweigh negative perceptions considerably. Only 16% (n=6) of farmers in this survey disagree, at some level, that SGMA is necessary at both the local and statewide levels. However, when asked about the perceptions of other farmers, 36% (n=14) think SGMA is unpopular among peers locally. They consider SGMA's popularity to be even lower across California, where 49% (n=17) of farmers in the survey project a negative sentiment on to other farmers across the state. Surveys from multiple counties in California find this trend: the vast majority of farmers agree that SGMA is necessary, but they perceive it to be unpopular among their peers, which makes it harder to implement SGMA because individual farmers do not perceive support from their peers (2019 Farmer Perspectives on SGMA: San Luis Obispo County, Fresno County, Madera County, Yolo County). To the extent SGMA requires farmer cooperation, the perception that peers believe SGMA is necessary will help develop social norms across farmer communities.

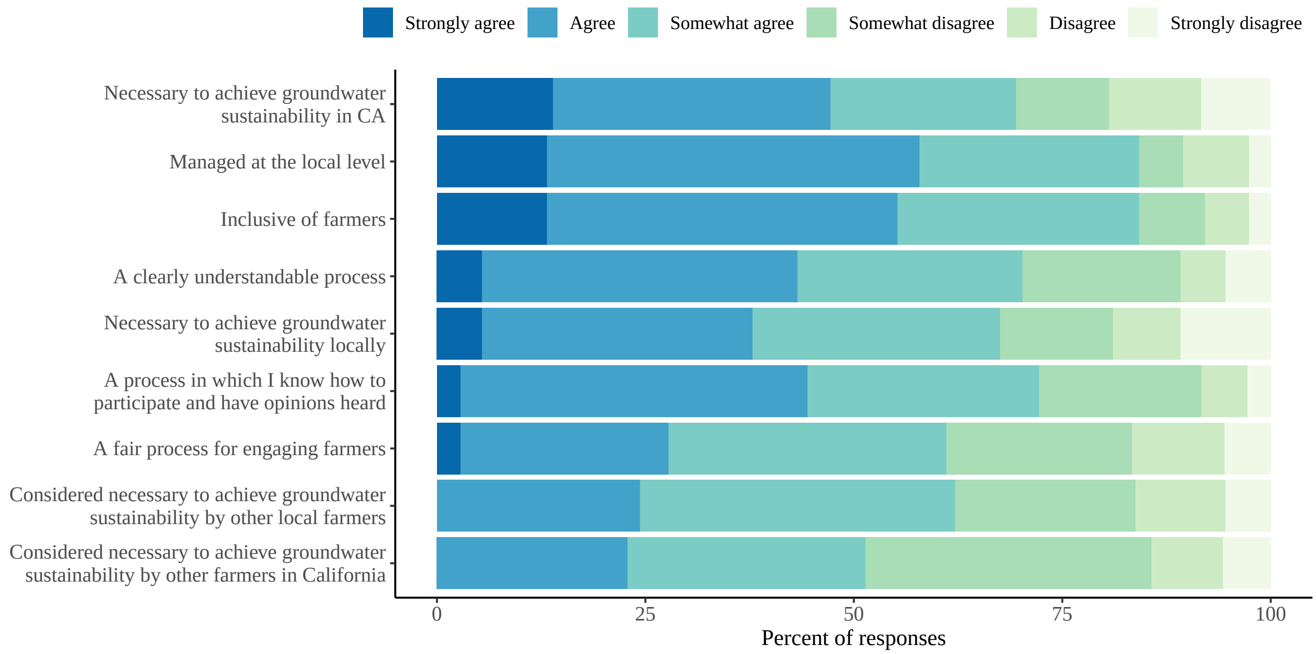

Figure 17. Please rate your level of agreement with the following statements related to SGMA. SGMA is...

Management and policy change

Groundwater users across the West are reflecting on their water use and in some cases, considering different management strategies and policy approaches to guide management. With SGMA's Groundwater Sustainability Plans in development and the state experiencing record droughts over the past decade, new strategies are under consideration. SGMA plans are considering many of these strategies as part of their overall policy portfolio. Farmers' preferences can be used to guide researchers and policy-makers as they develop strategies for dealing with water demand in the West.

Groundwater management strategies

Farmers were presented with five different approaches to changing their groundwater extraction and use on their fields in response to water scarcity: Deepening existing wells, pumping more groundwater, drilling new wells, fallowing fields, and changing to a less water intensive crops. Farmers were asked to rank the likelihood of adopting each of these practices in a six-point scale, from very unlikely to very likely.

The likelihood of farmers using different groundwater management strategies is presented in Figure 18. The most likely response of farmers to water scarcity is to deepen their existing wells, where 12% (n=5) are very likely to do so and another 17% (n=7) are likely. Similarly, 7% (n=3) are very likely to pump more and 20% (n=8) are likely to pump more groundwater. Drilling more wells is a very likely option for 5% (n=2) and a likely option for 15% (n=6) farmers. Fallowing fields is a very likely option for 5% (n=2) and a likely option for 5% (n=2) farmers. And changing to a less water-intensive crop is a very likely option for 2% (n=1) and a likely option for 5% (n=5) farmers. Together, farmers prefer practices that maintain their production through increasing extraction rather than using less water. As seen in other surveys, farmers prefer to adjust their inputs as a response to change and scarcity, rather than shift outputs such as changing crops.

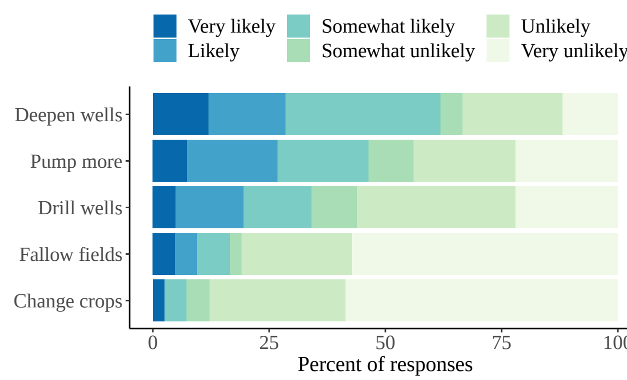

Figure 18. In response to water scarcity, what is the likelihood you would use the following practices in the future?

Policy preferences

We provided farmers with a list of policy options that have been used in the West for agricultural water management, and asked them to rank their support on a six-point scale, ranging from strongly support to strongly oppose. These are also groundwater management strategies being considered in many SGMA plans. These management and policy options include:

- Farmer adoption of improved water management practices
- Fixed quota for water pumping allocated to each

farmer
- Incentives for water saving practices
- Moratorium on new wells
- Site-specific well construction requirements when issuing new well permit
- Groundwater pumping fees
- Groundwater trading credits within the Basin
- On-field recharge
- Recharge off field
- Government investment in surface water supplies
- Government investment in resilient well infrastructure
- Land ordinances or rezoning to manage future water demand

Farmers' policy preferences are displayed in Figure 19. Farmers show the strongest support for farmer-driven solutions. 42% (n=17) of farmers strongly support farmer adoption of improved water management practices as the first policy option, followed by 40% (n=16) of farmers strongly supporting incentives for water saving practices. The second tier of preferred policies is government investment in water infrastructure. 36% (n=14) of farmers strongly support government investment in surface water supplies and 21% (n=8) strongly support government investment in well infrastructure. A third tier of policy preferences is for off and on-field recharge, which are strongly supported by 18% (n=7) and 10% (n=4) of farmers, respectively. A fourth and lowest tier of preferences includes market options and government regulation around groundwater use. Moratoriums on new wells and land ordinances to manage water demand are strongly supported by 10% (n=4) of farmers and groundwater trading credits are strongly supported by 3% (n=1) of farmers. Least popular on this lowest tier are fixed quotas for water pumping, supported by only 5% (n=2) and opposed in some form by 90% of farmers, and groundwater pumping fees, supported by no farmers. Across the 12 policy options, between 9-11 farmers did not respond to this question.

These preferences are consistent with farmer responses to these policy options across the state of California. Farmers' top preferences are for policies that put farmers in charge through their own voluntary adoption of practices and incentives for doing so. The next set of preferences focuses on infrastructure supported through government spending, putting the government in control but without any restrictions on farmers. The third and fourth tier preferences lay out programs and regulations that limit farmer autonomy and their ability with use groundwater as they see fit. One surprising finding, given the ubiquitous statewide discussion about groundwater markets in SGMA, is very low farmer support for groundwater trading.

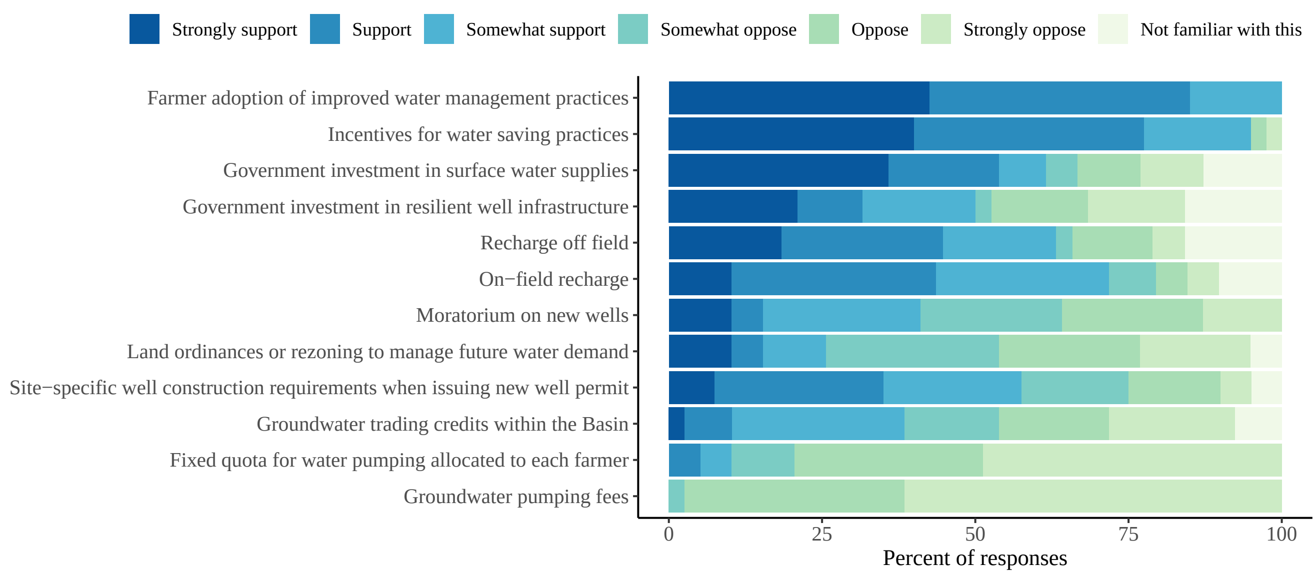

Figure 19. The following are a list of agricultural water management that have been used in the West. Please provide your level of preference for each.

Analyzing drivers of farmer perceptions and preferences

How farm operations, farmer attitudes, and information sources affect their decisions to adopt or support different programs and policies can be analyzed using statistical methods that assess the correlation between attitudes and behaviors. Such methods generally select some type of outcome variable of interest, such as the likelihood of adopting a particular practice. That outcome variable is then related to a predictor or "driver" variable expected to influence the outcome. Correlations (indicated by the letter "r" in the figures) are a simple measure of a bivariate relationship; they range from -1 to 1 where negative number indicates a negative or inverse relationship and positive number indicates a positive relationship, with larger numbers being stronger. In survey research, we generally consider correlations above 0.20 as evidence of a possible relationship between two concepts. The correlations can be visualized a linear relationship that cuts through a scatterplot of the datapoints.

Here, we selected three main variables to consider as drivers of farmer perceptions and preferences. These variables are commonly considered in research on farmer behavior, and are of then the first variables people think about when brainstorming about how farmers make decisions. These include farm size, the number of information sources, and concerns for changes to groundwater quality and quantity. We measured the concern variable by aggregating and averaging responses to the question about farmers' level of concern about potential conditions related to groundwater management in the Vina subbasin. We reduced concern for groundwater conditions into two groups: regulatory concern and natural concern, and focus on natural concern in this summary. Description of this aggregation can be found in Table 1 of the Appendix.

We then selected four main variables to think of as farmer perceptions and preference outcomes. These outcomes include 1) already adopting or expressing strong likelihood of adoption of certain water management strategies, 2) agreement with statements about SGMA, 3) likelihood of using groundwater extraction methods in times of scarcity and 4) level of preference for agricultural water management policies. Outcomes 2-4 were aggregated and averaged into larger groupings for easier summaries (detailed in Table 1 of the Appendix).

The figures provided (Figures 20-23) express the relationship between the drivers and the outcomes, with trend lines showing the relationship. Upward trending lines indicate a positive relationship, signaled by correlation "r" values greater than zero.

Adoption of water management strategies

The first set of figures (Figure 20) summarizes the relationship between acreage, information sources, and groundwater concern and the likelihood of adopting individual management practices. As seen in other research, the most common finding is that larger farmers are more likely to adopt individual practices. An interesting deviation from this trend is a strong negative correlation between farm size and adoption of regulated deficit irrigation. The number of information sources does not have any systematic relationship to practice adoption. However, concern for groundwater scarcity has a negative relationship with many practices. This is slightly surprising, and may reflect the idea that farmers who adopt many practices believe the problem is being solved. If they are taking steps to reduce water use, they become less concerned about groundwater management.

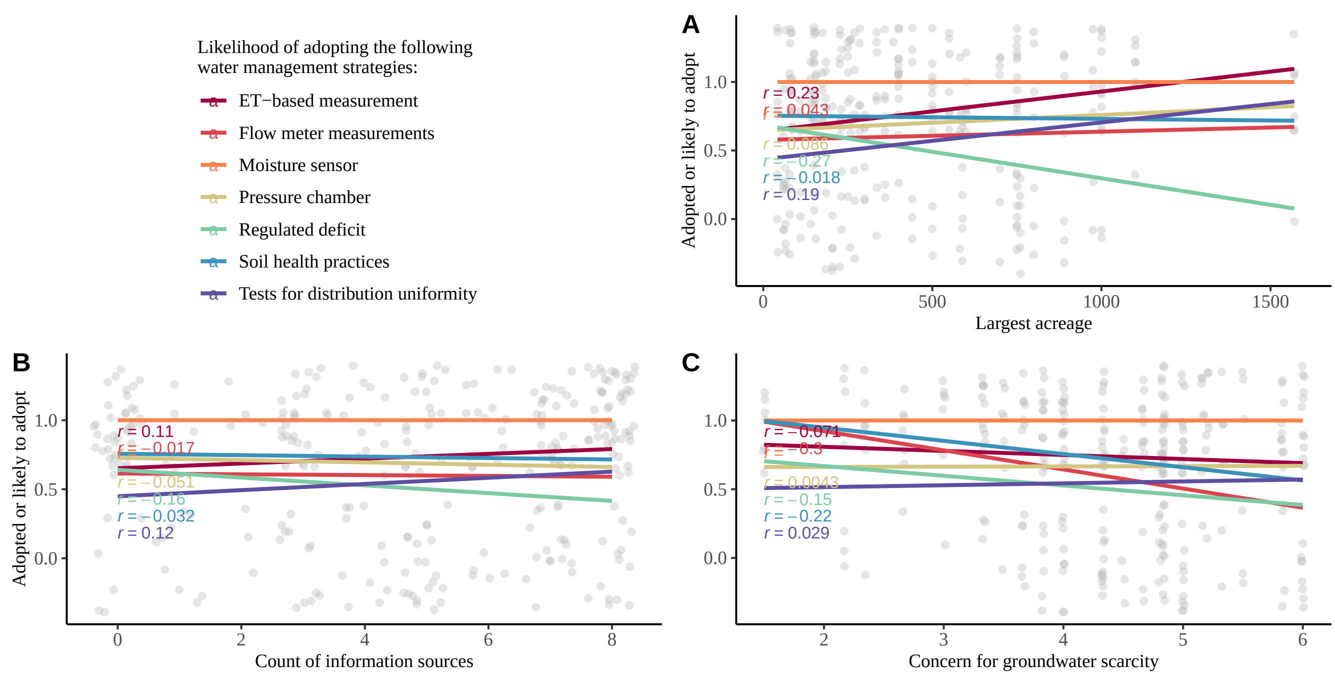

Figure 20. Correlations between the likelihood that a farmer adopts (or is willing to adopt) water management strategies, as a binary choice (0 = not adopt, 1 = adopt) and A) size of their largest acreage plot size, B) the number of information sources they use, and C) their concern for groundwater scarcity

Groundwater use and extraction strategies

We summarize responses to water scarcity in terms of the likelihood to change inputs related to groundwater pumping, versus outputs related to crops. Larger farms are more likely to engage in both types of responses, but they are especially more likely to take steps to maintain groundwater supplies. Information sources have no effect. As concern for groundwater scarcity in increases, farmers are less likely to consider changing crops or fallowing. This may be a similar effect as seen in practice adoption, where farmers who are changing crops or fallowing are less concerned about groundwater scarcity because they are taking steps to reduce their reliance on groundwater.

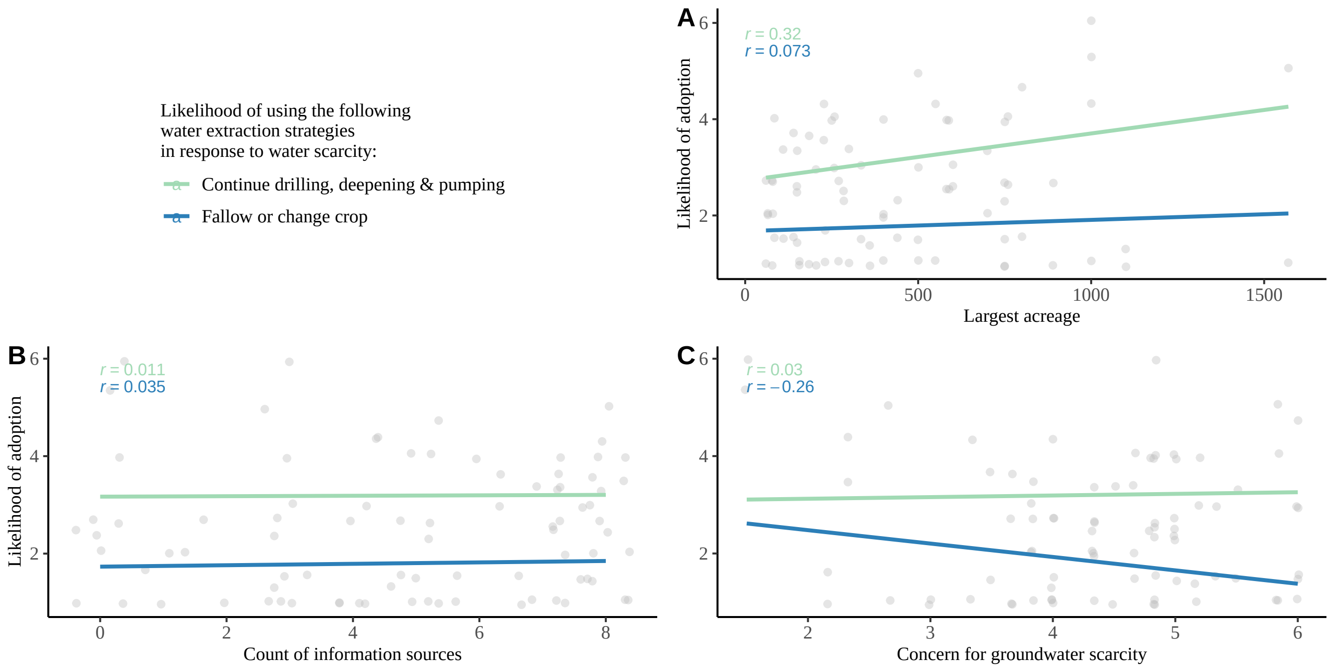

Figure 21. Correlations between farmers' likelihood of adopting water extraction strategies in a time of water scarcity (1 = very unlikely, 6 = very likely) and A) size of their largest acreage plot size, B) the number of information sources they use, and C) their concern for groundwater scarcity

Perceptions of SGMA

The drivers of agricultural decision-making show some interesting patterns with respect to perceptions of SGMA, which we divide into process-based perceptions of the fairness versus the necessity of SGMA (Figure 22). Larger farms with more information and who are concerned about groundwater all believe SGMA is more fair and engaged. Only concern for groundwater scarcity has a strong positive relationship with attitudes related to the necessity of SGMA. This reinforces the idea that farmers need to understand or believe that groundwater scarcity is a current or future problem before they will perceive SGMA as necessary.

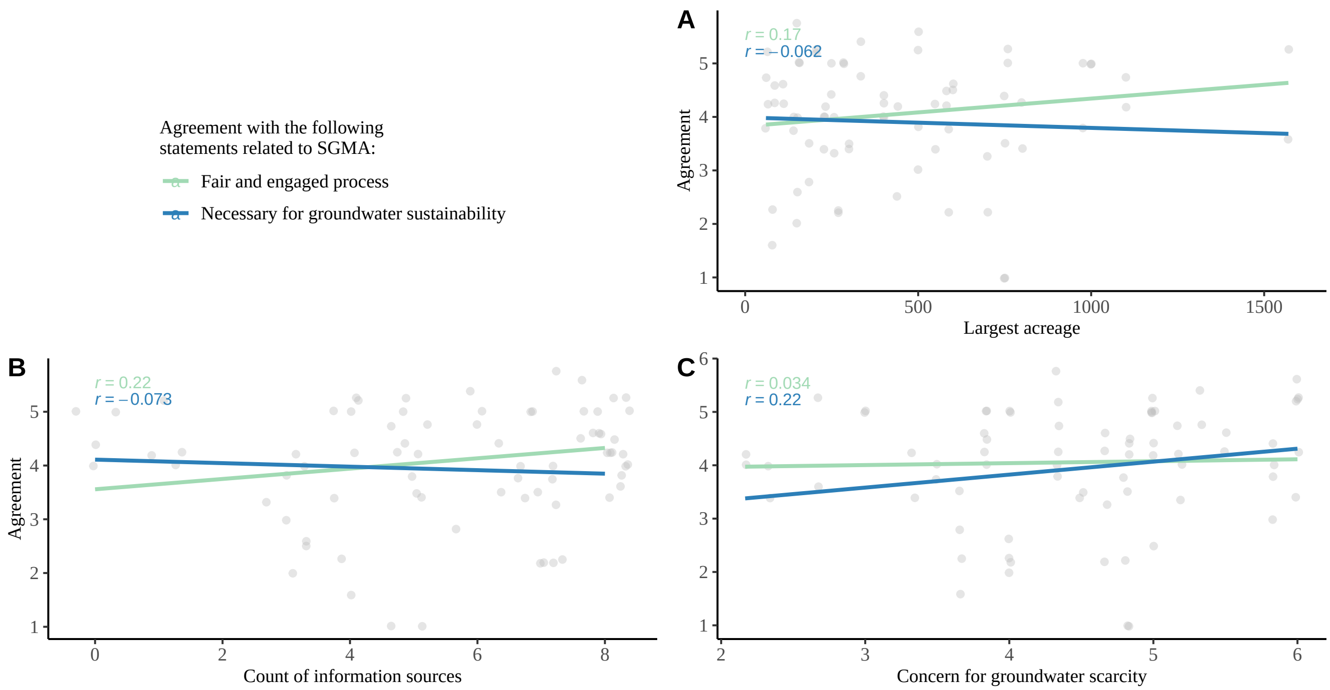

Figure 22. Correlations between farmers' agreement with sentiments about SGMA (1 = strongly disagree, 6 = strongly agree) and A) size of their largest acreage plot size, B) the number of information sources they use, and C) their concern for groundwater scarcity

Policy preferences

We summarize policy preferences in groups: support for government investment infrastructure, support for pumping quotas and fees, support for recharge and groundwater credits, and support for well regulation and incentives. With the exception of recharge, larger farms are less likely to support any of these groundwater management strategies. Larger farms may support recharge because they have enough acreage to develop recharge on their own land. Information sources do not make a difference. However, concern for groundwater has a consistent, positive relationship with three of the overall strategies (not recharge efforts). As with the other analyses, farmers who believe there is a groundwater problem are more likely to support taking action.

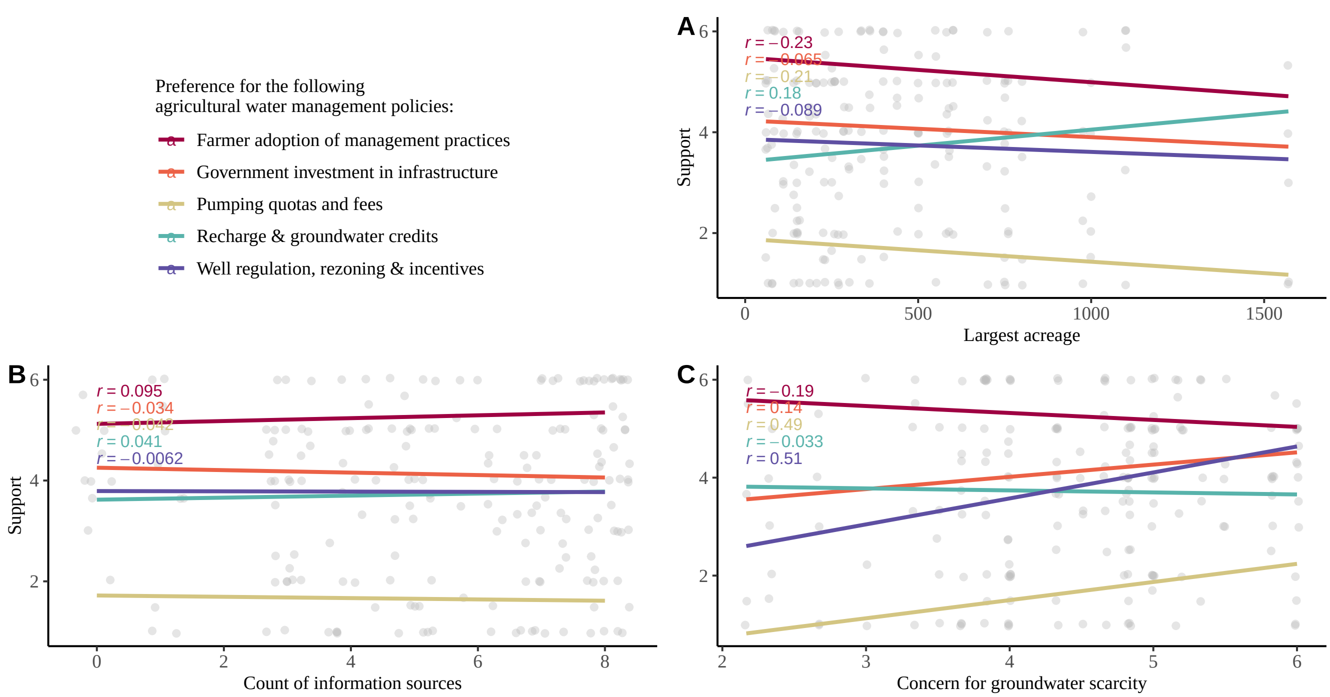

Figure 23. Correlations between the farmers' preferences for water managemenr policies (1 = strongly oppose to 6 = strongly support) and A) size of their largest acreage plot size, B) the number of information sources they use, and C) their concern for groundwater scarcity

Appendix

Table 1. Aggregated responses to key questions for describing correlations (Figure 20-23)

<table>
<tr><th>Question</th><th>Selections</th><th>Aggregated responses</th></tr>
<tr><td rowspan="2">Please indicate, in response to water scarcity, if you currently use the following water management strategies on your farm and your likelihood to use the following practices in the future.</td><td>Pump more groundwater
Deepen existing wells
Drill more wells</td><td>Continue drilling, deepening & pumping</td></tr>
<tr><td>Fallow fields
Change to a less water intensive crop</td><td>Fallow or change crop</td></tr>
<tr><td rowspan="2">Please indicate your level of concern about the following potential conditions related to groundwater management in the Vina subbasin.</td><td>Chronically lower groundwater levels
Reduction in groundwater storage
Water quality degradation
Local subsidence
Depletion of stream and river flows
The negative impact of climate change on water availability</td><td>Concern for groundwater scarcity</td></tr>
<tr><td>Regulatory reduction of agricultural access to water
Increased cost of regulation</td><td>Regulatory concern</td></tr>
<tr><td rowspan="2">Based on your knowledge and experience with SGMA please rate your level of agreement with the following statements related to SGMA.</td><td>The SGMA process is being managed at the local level
Farmers have been involved in the SGMA process
I feel the process for engaging farmers in the SGMA process has been fair
I know how to participate in the SGMA process and have my opinions heard
I clearly understand the SGMA process for establishing groundwater sustainability n the Vina subbasin</td><td>Fair and engaged process</td></tr>
<tr><td>I believe SGMA is necessary to achieve groundwater sustainability locally
I believe SGMA is necessary to achieve groundwater sustainability in California
The majority of farmers think that SGMA is necessary for achieving groundwater sustainability locally
The majority of farmers think that SGMA is necessary</td><td>Necessary for groundwater sustainability</td></tr>
<tr><td rowspan="5">Please provide your level of preference for the following types of management</td><td>Farmer adoption of improved water management practices</td><td>Farmer adoption of management practices</td></tr>
<tr><td>Groundwater trading credits within Basin
On-field recharge
Recharge off field</td><td>Recharge & groundwater credits</td></tr>
<tr><td>Incentives for water saving practices
Moratorium on new wells
Site-specific well construction requirements when issuing new well permit
Land ordinances or rezoning to manage future water demand</td><td>Well regulation, rezoning & incentives</td></tr>
<tr><td>Government investment in surface water supplies
Government investment in resilient well infrastructure</td><td>Government investment in infrastructure</td></tr>
<tr><td>Fixed quota for water pumping allocated to each farmer
Groundwater pumping fees</td><td>Pumping quotas and fees</td></tr>
</table>