RESEARCH ARTICLE

Farmers share their perspectives on California water management and the Sustainable Groundwater Management Act

Focus groups with Yolo County farmers demonstrate that farmers' perceptions of and responses to the regulation are important to its success.

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Abstract

Agriculture is the largest human use of water in California, which gives farmers a critical role in managing water to meet the goals of the Sustainable Groundwater Management Act (SGMA). To explore farmers' perspectives on SGMA, we held focus groups with 20 farmers in Yolo County, where the groundwater basin has been given a high/medium priority under SGMA. The farmers had varying perspectives about the factors that led to SGMA and varying responses to the regulation. They suggested that drought, competing agricultural and urban uses, and an increase in perennial crops were factors in recent water use, resulting in changes to water quality and quantity. Impacts of those changes included variable well levels, increased infrastructure costs, and ecosystem impacts, which farmers had responded to by implementing multiple management strategies. Additional research in other regions is imperative to provide farmers' viewpoints and strategies to policymakers, irrigation districts, farmer cooperatives, and the agricultural industry and give farmers a voice at the table.

In 2014, the California legislature passed the Sustainable Groundwater Management Act (SGMA), the state's effort to achieve the sustainable use and management of groundwater by 2040. The act requires the establishment of local and regional governance structures, known as groundwater sustainability agencies (GSAs), to develop and implement groundwater sustainability plans (GSPs) by 2022. The legislation sent into action a process in which, basin by basin, local communities are identifying who they would like to govern groundwater (GSA formation) and how they would like groundwater to be governed (GSP development).

The role of farmers is critical in achieving water sustainability because agriculture is the largest human use of water in the state, especially of groundwater in

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Groundwater pump and filtration equipment sit adjacent to a tomato field in Yolo County.

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dry years (CA DWR 2014). Agricultural production in California surpassed $20 billion in 2016, with California farmers producing more than 400 commodities (CDFA 2016). Much of the state's agricultural production feeds a global population, with 44% exported out of the state, representing 15.6% of total U.S. agricultural exports (CDFA 2016). Agricultural production relies on both surface water and groundwater, depending on farm location and water access.

At this early stage, much remains to be seen in terms of how the SGMA will be interpreted and implemented locally. Thus far, the process has primarily revolved around the forming of the GSAs. The deadline for that was June 30, 2017, for the 127 medium- and high-priority basins; low- and very-low priority basins are encouraged, though not required, to form a GSA and write a GSP (Water Education Foundation 2015). Recent research from Conrad et al. (2016) highlights through case studies, based on interviews with regional stakeholders, that GSA formation looked very different from region to region.

Kiparsky (2016) suggests that a number of the unanswered questions on SGMA implementation revolve around the social acceptance of policy definitions and mechanisms by different groundwater users. Social acceptance issues involve users' perceptions of fairness, efficacy and other value-based dimensions that can raise tensions and lack clear, unambiguous solutions. Social acceptance is likely to become increasingly important as the emphasis now shifts to writing GSPs, which must include measurable objectives and detailed planning for achieving sustainable groundwater use within 20 years. The deadline for completing the GSPs is Jan. 31, 2020, for critically overdrafted basins and Jan. 31, 2022, for the remaining medium- and high-priority basins (Water Education Foundation 2015).

Despite the significance of farmers in the SGMA process, only a little empirical research has examined their perceptions of SGMA implementation, which may be of critical importance for the functioning of GSAs and the implementation of GSPs. In a snapshot of three farmers' perspectives on SGMA, Rudnick et al. (2016) brought attention to the burden different farm sizes and systems may face under the new regulation and called for better understanding of stakeholder needs to facilitate the SGMA process.

To help fill the gap in empirical literature, we collected the perspectives of farmers in Yolo County, California. Our work presents an early view of their perspectives on the factors that influence water availability and management and of the approaches they propose for SGMA implementation. With a groundwater basin that has been categorized under SGMA as high/medium priority, Yolo County provides an opportunity to examine the GSA process in context. Located on alluvial plains in the Sacramento Valley region of the Northern Central Valley, it supports vibrant and diverse agricultural production, including rice, cattle grazed in summer-dry grasslands and savannas, and perennial, vegetable, and row crops (Jackson et al. 2012; Niles et al. 2013). In 2015, the top 10 commodities in Yolo County (by dollar amount) were processing tomatoes, almonds, wine grapes, organic production, walnuts, sunflower seed, rice, alfalfa hay, cattle and nursery products. The county had more than 90 direct export partners, indicating its importance in a global agricultural system (Yolo County 2016). Of the 653,449 acres in the county, 531,902 (81%) are agricultural land, including grazing land (CA DOC 2015).


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The Sustainable Groundwater Management Act mandates the formation of basin-level agencies charged with achieving sustainable groundwater management by 2040.

To explore farmers' perceptions, we used the drivers, pressures, states, impacts and responses (DPSIR) framework (Kristensen 2004). In particular, we asked for farmers' perspectives on (1) drivers of recent water use, (2) pressures current water users faced, (3) changes in the state of water, (4) impacts of these changes and (5) responses they had implemented and how they wanted SGMA implementation to be designed.

Focus groups

Focus groups took place in October 2016 in Yolo County. With assistance from the Yolo County Flood Control and Conservation District, we used an organizational recruitment strategy, relying on the district as a key stakeholder in the GSA process with significant local connections to identify and recruit farmer participants (Krueger and Casey 2015). Farmers were selected to represent a diversity of different farm systems (conventional, organic, small, medium and large, different irrigation technologies, mix of surface water and groundwater) and agricultural products (diversified vegetable production, tree nuts, fruit, olives, row crops such as corn and alfalfa, rice, animal production).

We designed 10 questions (see technical appendix, ucanr.edu/u.cfm?id=184) for the focus groups and recruited 20 farmers into four focus groups (four to six farmers per group). Focus groups were audio recorded, and the recordings were professionally transcribed to facilitate analysis. Using the framework approach for qualitative research (Ritchie and Lewis 2003), we drew upon the DPSIR framework (Kristensen 2004) and

coded using NVivo qualitative data analysis software (version 10, QSR International Pty Ltd, Melbourne, Australia). We organized a set of codes (see technical appendix) into emergent categories. Then, using a systematic approach, we double-coded transcripts using the framework categories and assessed coding agreement. Overall coding agreement for all categories and all focus groups was 95%; researchers discussed coding disagreements and recategorized as necessary. Results presented here represent dominant themes in the analysis, grouped by DPSIR codes and subcodes (table 1).

Drivers of water use

Farmers stated that both agricultural and nonagricultural uses are important drivers of water use in Yolo County and California. Agricultural water uses stem from a diversity of farm sizes, cropping patterns and livestock types. Despite agriculture's long history in the region, many farmers reported that new drivers are changing the landscape, including an increase in permanent crops, urbanization and new agricultural development of previously uncultivated areas.

Most farmers reported using a mix of surface water and groundwater, although in certain parts of the region (e.g., Zamora) farmers have access to only groundwater. Farmers expressed that there had been an increasing reliance on groundwater irrigation, driven by drought in the past several years and new agricultural development, which was served by new wells and the lowering of existing wells. As one farmer said,

> *We have a classic tragedy of the commons when you have groundwater down there, and we can't all pump, pump and pump forever.*

Pressures water users face

Most farmers expressed that land-use change and irrigation technologies were exerting pressure on groundwater. In particular, farmers felt that the price of almonds was driving agricultural development in Yolo County, and developers with access to capital were planting permanent crops in new areas and drilling deep wells. One farmer said,

> *I actually call this California's second gold rush, because everyone is so driven by that shining gold — that in this case is a nut.*

Some farmers said that developers were in many cases developing marginal land with highly erodible soil, which might result in unexpected development impacts. Some farmers who had been in Yolo County prior to the recent agricultural development stated they did not believe they could compete with the rising costs of land and with developers. There was a sense amongst many focus group participants that nonlocals did not have the same sense of stewardship or responsibility.

Many farmers expressed that the increase in orchards had put drip irrigation on lands that were previously unirrigated. Some of these farmers felt that drip might not be decreasing overall water use as expected, because it had facilitated this new development and did not allow for the capture and reuse of tailwater. However, other farmers acknowledged that drip was increasing yields, which meant that less water was producing more food overall, though the systems were expensive. Farmers are also using furrow and flood irrigation technology in the county.

TABLE 1. Drivers, pressures, states, impacts and responses identified by Yolo County farmers for sustainable groundwater management

Drivers	Pressures	States	Impacts	Responses
Agricultural • Diverse land uses • Drilling new wells, new irrigated lands • Permanent crops in new areas **Nonagricultural** • Urban areas and domestic use **Water source** • Mix of surface water and groundwater (only groundwater in some areas) • Reduced surface water allocations, typically from drought, increasing reliance on groundwater	**Development** • Outside developers converting land and drilling deep wells • Irrigation and perennial crops on highly erodible ground **Irrigation technologies** • Drip increasingly common • Furrow and flood still used	**Water quantity** • Less water leaves fields now • Even if reservoirs are full, farmers may not get water • Uncertainty in groundwater levels and flow **Water quality** • Salts • Boron **Soil quality** • Subsidence • Boron and salts in soil	**Access to water** • Well levels have varied, but generally held up • Drip irrigation has allowed for agricultural expansion • Wells positively affected when surface water is available **Economic** • Costly to pump • Significant investment in water infrastructure • Land values increasing **Ecosystem** • Efficient irrigation is decreasing water for habitat • Competition for water between fish, farms and waterfowl	**Farm management** • Crop insurance • Fallowing land • Changing crops • Purchasing water • Monitoring wells • Digging new wells **Regulation** • Competing regulations from different agencies • Support for Yolo County Flood Control and Water Conservation District

State of water quality and quantity

Farmers perceived these drivers and pressures to be affecting the state of water quality and quantity. New development of orchards and wells were taking place in erodible areas and subsidence was evident in regions that relied exclusively on groundwater for irrigation. Because of the transition by many to drip irrigation, farmers felt that less water leaves their fields now for use by downstream users or groundwater recharge. Also, farmers said that soil salts (i.e., increased soil salinity) and boron in the irrigation water were quality issues. Boron in the water was an issue in parts of the county, especially because of its toxicity in trees (Nable et al. 1997).

Farmers expressed that surface water was often challenging to pump and filter because of sediments and algae; they suggested cleaner surface water might alleviate pressures on groundwater. Surface water availability in the county ebbed and flowed, and farmers acknowledged that one rain event could change a whole season. However, sometimes even when lakes and dams were full, farmers, especially those near the Sacramento River, couldn't get access to surface water, which might occur when water was prioritized for environmental use and became unavailable to agriculture.

Impacts of water changes

Farmers reported the impact of the water quantity and quality changes on access to water, economic returns and the functioning of local ecosystems. Farmers felt that increases in irrigation efficiency with drip irrigation had allowed for agricultural expansion in the county. With respect to water quantity, recent good rain years had led to better water availability; however, some farmers felt surface water availability for agriculture was inconsistent even in wet years. When surface water was available, farmers reported that groundwater wells were positively affected. Most farmers expressed the opinion that groundwater use should be second to surface water use. While some farmers had dug deeper wells in recent years, others reflected that many wells had remained productive. New and deeper wells had also negatively affected some domestic wells. Given recent changes to water availability and shortages statewide, a small number of farmers were pumping groundwater to send south or trade out of the county.

According to farmers, water quantity changes had also had economic and ecosystem impacts. Water was very expensive to pump, and too costly to let run off their fields, so farmers have been making significant investments in water infrastructure. Land was becoming a new limited resource in the county due to rising costs, which resulted in increasing land values. If farmers fallowed land because of lack of water, they believed the economic impacts to farming would reverberate across the county through dwindling income in support industries and other businesses and less demand for farmworkers. In terms of ecosystem impacts, many farmers mentioned that the lack of water had negative effects on habitat, fish and waterfowl (particularly because farmers had less access to water to create habitat) and that springs in the county were drying up. Farmers reported that increases in irrigation efficiency also result in less water for habitat.

Farmers' responses, strategies

Farmers said that a number of strategies had been used to respond to a lack of water, including buying crop insurance, fallowing land, growing crops that used less water, purchasing water, cover cropping, monitoring wells and digging new wells. Farmers mentioned that they were also responding to a range of other policy demands that affect agriculture.

Many expressed the perception that regulations were often a greater challenge than drought. Agencies had competing issues, which, according to farmers, resulted in heavy regulatory burdens for managing water, species and other environmental resources. One farmer said,

> *Well, I've become a resource manager, that's really what my job has boiled down to. So now I'm just a resource manager. I manage land resources, and water, and that's what I really do now.*

While farmers voiced frustration at heavy regulatory burdens, they also expressed support for the work and initiative taken by Yolo County Flood Control and Water Conservation District in working with them to manage water quantity and quality challenges.

Perspectives on SGMA

Farmers expressed a range of perspectives on the SGMA process (table 2). We grouped their opinions

Photo: Phil Hogan, USDA NRCS

Some farmers in the study expressed concern about an increase in high-value orchard crops in previously uncultivated areas, which they felt had increased overall water application in the region and contributed to increases in the price of agricultural land.

TABLE 2. Yolo County farmers' perspectives on SGMA

SGMA regulatory design	Definition of sustainability	Potential policy mechanisms	Farmer involvement
• Common sense • Locally relevant • Farmer involvement • Solutions oriented • Science of groundwater informed by farmer experience	• Capture and reuse • Transfers • Reasonable use	• Prioritize surface water over groundwater use • Drilling moratorium • Limit development • Incentives for farmers • Water trading • Investment in infrastructure	• Opportunity through districts • Involvement is critical • Lack representation in decisions

into four categories: regulatory design, defining sustainability, potential policy mechanisms, and farmer involvement.

Regulatory design

At the time of the focus groups, a GSA was forming in Yolo County. Farmers said that they would like to see a common sense design for SMGA, meaning that SGMA needed to make sense on the ground, not just on paper, with a long-term perspective for sustainable water use and a sustainable agricultural industry. One farmer reflected on the SGMA process and the future:

> *I would say, I have both hope and fear of SGMA. My hope is that some logic and common sense prevails in coming up with how things work and that the result of that will … produce [a] sustainable environment that enhances farming in Yolo County for decades to come. My fear is that the result will not be that! And my fear is that farming in California could be severally impacted in ways that will change the state as we really know it.*

Farmers also mentioned that they would prefer to see bottom-up processes, but they already felt written out of the process because they could not officially be part of the GSA. They suggested that there was not a one-size-fits-all solution to groundwater management in the state, so a focus on local context and needs was important.

Farmers expressed that they would like SGMA to take a solutions-oriented approach, integrating development and efficiency improvements. However, they acknowledged that the success of SGMA might be a challenge because it was difficult to regulate stewardship. Farmers also mentioned that SGMA success might require a new paradigm of water rights and water-use priorities. Finally, many said that sustainable management of groundwater required a better understanding of the groundwater systems in the county, which should include farmer intuition and experience combined with science.

Defining sustainability

SGMA seeks to create sustainable groundwater management for California. For farmers, sustainability has multiple meanings. As one farmer stated,

> *It's present. It's real. And whether we address it ourselves or — it will get addressed somehow. I mean, if we don't come up with something sustainable, then someone will for us. And we may like that even less.*

Farmers expressed that sustainable groundwater use involved thinking beyond single use to water capture, reuse, and transfer between users, and it involved emphasizing reasonable use and water balance. This could mean, as some suggested, a recognition that not all water uses are equal — for example, water use for food production and water use for lawns. Most farmers also suggested that the current planting of perennial crops on previously nonirrigated land in the county was most likely unsustainable and would be more so in the long term as trees matured. Finally, some farmers felt that sustainable groundwater use needed to be achieved much sooner than 2040.

Potential policy mechanisms

Farmers suggested a number of potential mechanisms for GSPs under SGMA. The sustainable groundwater plans could encourage the use of surface water over groundwater. The availability of cleaner surface water for irrigation use was one change farmers suggested could aid in facilitating the prioritization of surface water use over groundwater. Some farmers also mentioned that a change in electricity contracts, such as removing the contractual obligation to pump groundwater when surface water was available, could help farmers transition away from groundwater reliance.

Some farmers mentioned the potential of a drilling moratorium, but opinions on that were mixed. Some farmers saw it as a threat to their farm business; others saw it as a necessity to control developers from outside the county who were coming in and drilling new wells on marginal lands:

> *I'm not sitting here saying I want government in my life. I don't. But I also want water in the long term. And if it takes a little government regulation to force everyone to participate, as they well should … (then) it might take some of that.*

An alternative option was control mechanisms for overdrafting wells. Additionally, some farmers expressed that there could be restrictions on new acreage in water-intensive crops like almonds. Similarly,

some farmers mentioned that new developments could require some type of cost-benefit analysis or environmental impact assessment.

Farmers suggested that payments to farmers for saving water or some other acknowledgment of farmers' efforts to conserve groundwater, such as signs that identify a farm as a "good steward", as potential policy mechanisms. Some farmers also mentioned intracounty water exchange and trading. With water trading, there was fear expressed that cap and trade could turn into pay-to-play, with larger developers controlling water.

Finally, farmers enthusiastically supported infrastructure solutions to groundwater management. These included upgrades to existing infrastructure and new dams, pipes, winter storage and increased gate automation. Farmers wanted to see funding for local infrastructure projects through SGMA. However, farmers expressed that funding in the past for infrastructure improvements had been difficult to acquire because of regulatory red tape. One farmer said,

> *I think we can engineer our way out of a lot of problems, but then it becomes a money problem.*

Farmer involvement

Farmers saw themselves as important participants in the sustainable management of water. They anticipated that the transition to countywide sustainable use would be a painful process for farmers. They also expressed that it was imperative to be proactive and involved. One farmer said,

> *I don't want to get the state involved. I think that's why we need to be very proactive as locals to make it happen and to bring all the parts together.*

Farmers felt they were able to participate in the SGMA process through irrigation districts and with Farm Bureau representation. However, they felt outnumbered in the decision-making process. Most representatives were from cities or boards of irrigation districts that did not have a lot of farmer representation. They saw that as a real concern with consequences for their businesses. They suggested if someone was going to create a policy, farmers should be a key part of the process.

Agriculture's voice at the table

Our results demonstrate that farmers, even within one county in California, have varying perspectives about the factors that led to SGMA and varying responses to the regulation. Nevertheless, some key themes emerged — farmers acknowledged the role of agriculture in sustainable surface water and groundwater management and recognized that many strategies may be necessary across different actors to achieve sustainable water management. To our knowledge, this study is the first to detail farmer perceptions of sustainable water management and SGMA policy preferences and implementation using empirical research. As such, it is an important contribution to understanding farmer viewpoints necessary for policymakers, irrigation districts, farmer cooperatives, and the agricultural industry.

However, this study is limited in its geographic scope, which means it may not be representative of other California regions or all farmers. Given the potential for SGMA to transform water management in California, and the implications that such transformations could have for the agriculture industry, we think it is imperative that additional research — including interviews, focus groups and large-scale surveys — across multiple California regions explore the role of farmers in the GSA and GSP process, and document their behaviors and perspectives. This research could help ensure that one of the key players for water management — California agriculture — has a role in the process and a voice at the table. CA

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