Production challenges in forage systems: Needs assessment in northeast California

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A thorough understanding of the local farming challenges and needs is critical for the success of agricultural extension services. A survey of predominately farmers and ranchers was conducted to identify the key challenges and demands of irrigated forage systems of the Pit River Watershed of California. Overall, the survey results underscore the need for (a) local needs assessment and (b) increasing the extension personnel to address the efficient water and soil management in forages while reducing the input costs in forage production areas in the U.S.

California agriculture's combined commodities represent 10.4% of the U.S. cash farm receipts, led by the dairy industry producing 18.2% of the total U.S. share of milk (California Department of Food and Agriculture, 2022). Hay production in California exceeded the value of $1 billion in 2022, making it into the top 15 commodities in California (California Department of Food and Agriculture, 2022).

The University of California Cooperative Extension (UCCE) serves farmers facing a multitude of issues due to changing agricultural and environmental regulations, unpredictable weather patterns, frequent droughts, and water shortages. It is important to understand the most important farm-related issues of producers and stakeholders to steer extension programs in the right direction. Knowledge about local farming practices and existing barriers to adoption (Rudnick et al., 2023) could assist with resource allocation, focusing on high-priority areas and providing research and extension vision (Martins et al., 2019).

Each region of California is different from another in terms of agricultural commodities, geographic conditions, weather patterns, cropping seasons, cultural and social practices, market access, etc. The northeast corner of California (Modoc, Lassen, and Shasta counties) is an important agricultural region producing about 12% of the hay crop (alfalfa and other dry hay) and >80% of the wild rice crop in California (USDA-NASS, 2022).

The Pit River Watershed (PRW), originating from Warner Mountains, is the primary source of agricultural water in a large part of the forage-producing regions of Modoc, Lassen, and Shasta counties (Figure 1). The intermountain counties of Modoc, Lassen, and Shasta are known to produce high quality hay due to their short growing season and cool night temperatures (Orloff, 1997). Rising nut crop prices and increasing water pumping costs have driven a shift from field crops to nut crops in California's Central Valley, creating pressure on other regions—such as the PRW area—where forage production has recently increased as well to support California dairies (Gebremichael et al., 2021).

Efforts have been made to conduct needs assessment surveys to help set priorities from the county level to the national level. As the scope (region) widens for a survey, the overall response rate typically plummets in each county. Understanding current needs and resource allocation for specific counties or localities requires local surveys. Such surveys are generally not conducted throughout the state, leading to state-wide surveys with low local response rates guiding state-wide priorities that might not represent the local issues.

The primary goal of this study was to conduct a local needs assessment of the agricultural community for the forage production region of the Pit River Watershed in California (Figure 1). The objectives of the study were to (i) identify the major agricultural issues and management challenges faced by growers and (ii) identify major needs/demands of the agricultural industry from UCCE. This study assessed the needs of local agronomic industry stakeholders to strengthen local research and extension efforts and efficient resource allocation.

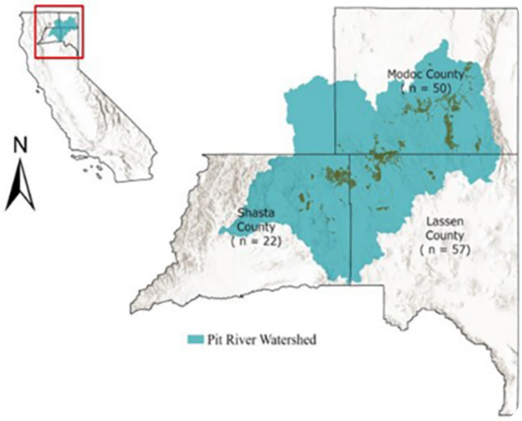

Figure 1. *Map of California highlighting the study region in a red rectangle. The study region consists of the Pit River Watershed (blue), irrigated agricultural areas (green), and three counties (Modoc, Lassen, and Shasta) with the number of respondents (n) from each county.*

Materials and methods

The survey questionnaire consisted of 11 closed-ended questions (multiple choices, rank order) and one open-ended question to identify major commodities, farm challenges/issues, irrigation systems, interests in specific topics, and preferred education and outreach methods for the local agricultural stakeholders.

During spring 2024, the paper survey was disseminated through various local agricultural workshops and meetings organized by UCCE in McArthur (Shasta Co.), Alturas (Modoc Co.), Susanville (Lassen Co.), and Cedarville (Modoc Co.). An email was sent to an extension email list of Modoc (232 contacts) and Lassen County (133 contacts) to participate in the survey through Qualtrics with a reminder email sent later. A survey questionnaire was also mailed out to 48 stakeholders in Shasta County via the U.S. Postal Service. No incentives were provided for survey completion. All the responses, including in-person surveys, were recorded in Qualtrics at the end of the survey, and the complete data set was downloaded in the Microsoft Excel program to run descriptive statistics.

Results and discussion

A total of 102 responses were collected for the local needs assessment survey. The respondents worked in one or more counties with 49% in Modoc County, 56% in Lassen County, and 22% in Shasta County, respectively (n = 102) (Figure 1). The total number of producers in Modoc, Lassen, and Shasta Counties are 833, 865, and 2078, respectively (USDA-NASS, 2022). Most survey respondents were in contact with UCCE, which might skew the results, considering the late responders may not have attended the in-person workshops and meetings.

In this study, respondents were categorized as producers (84%), followed by governmental agencies (12%), irrigation managers (7%), Pest Control Advisers/Certified Crop Advisers (5%), professional agronomists (5%), and allied industry (1%). Most respondents worked with hay production [grass (76%) and alfalfa (63%)], followed by irrigated pasture (62%), small grains for both hay and forage (47%), and rice production (21%) (Figure 2). The spike in producers' participation in local needs assessments helps the local extension personnel serve better.

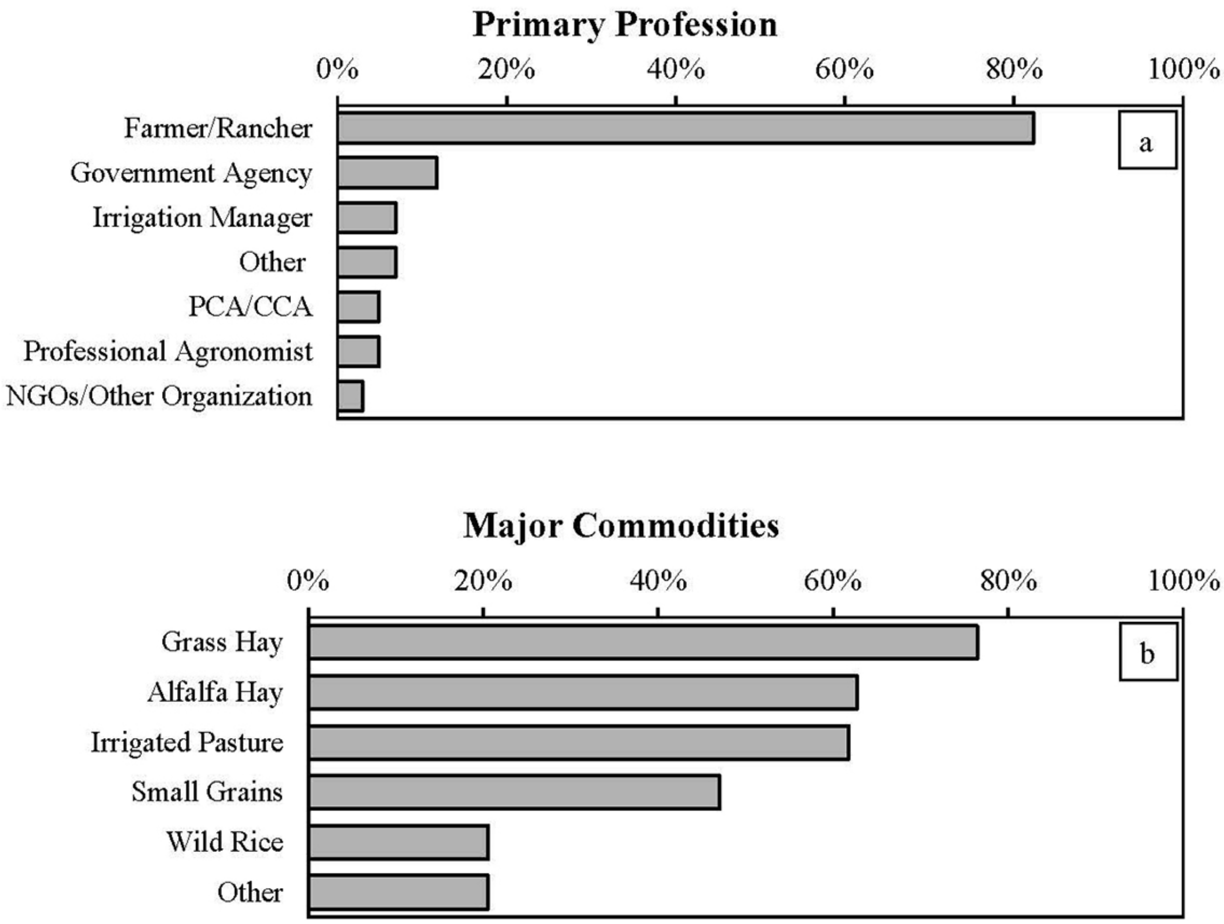

Figure 2. *Survey respondents' profession and association with agricultural production (a) and commodities produced (b).*

Challenges in contemporary farm practices

The survey listed 10 options to identify challenges or concerns prevalent in the crop production sector, along with an option to mention any other challenge besides the listed options. Production cost and irrigation management were the top two concerns chosen by 73 and 53% of respondents (n = 99), respectively (Figure 3). These results are similar to the statewide needs assessment that documented water use regulations and costs as top concerns (Kanter et al., 2024, 2021). The factors beyond the farmer's control, such as international trade and export markets, can lead to unstable hay prices that are concerning for growers (Carter et al., 2023). The unprecedented formation of local agencies to comply with regulatory requirements in California is mainly driven by farmer funds, such as local Groundwater Sustainability Agencies (GSAs) (Harter, 2020). Moreover, California's frequent drought events greatly impact agricultural economics by reducing water availability and increasing crop water demands, hence increasing production costs (Escriva-Bou et al., 2022; Lund et al., 2018).

Irrigation management was ranked second in the farm challenges or concerns by 53% of respondents. Water-related concerns were ranked highest in the recent statewide needs assessment surveys, reflecting the challenge in agricultural water management (Ikendi et al., 2024; Kanter et al., 2024, 2021). Irrigation water management becomes a priority for riparian water and groundwater in drought-prone Californian landscapes (Liu et al., 2022), especially in the alfalfa-producing Western U.S. (Putnam & Orloff, 2016) when groundwater regulations are being imposed, other sectors compete for water supply (Hrozencik, 2021), and high variability of precipitation and shifts in its patterns occur (Pathak et al., 2018).

Furthermore, 45% of respondents were concerned about nutrient management, 39% about pest management and commodity price, and 32% about labor availability/regulations (Figure 3). Nutrient management is necessary for optimizing crop yields, increasing nutrient use efficiencies, reducing environmental losses, and being economically profitable (Singh et al., 2024b; Yadav et al., 2019) depending upon existing soil conditions (Singh et al., 2025b). Coupled nutrient and irrigation management further reduces environmental losses while maintaining crop yields, resulting in increased economic profitability and resource (water and nutrient) use efficiencies (Di Paolo & Rinaldi, 2008; Kamran et al., 2022; Singh et al., 2025a). The studies performed in Northern California for nitrate-contaminated water excluded the PRW region due to no or little availability (<10%) of data points (Burrow et al., 2013), leading to less focus on nutrient management in the PRW region.

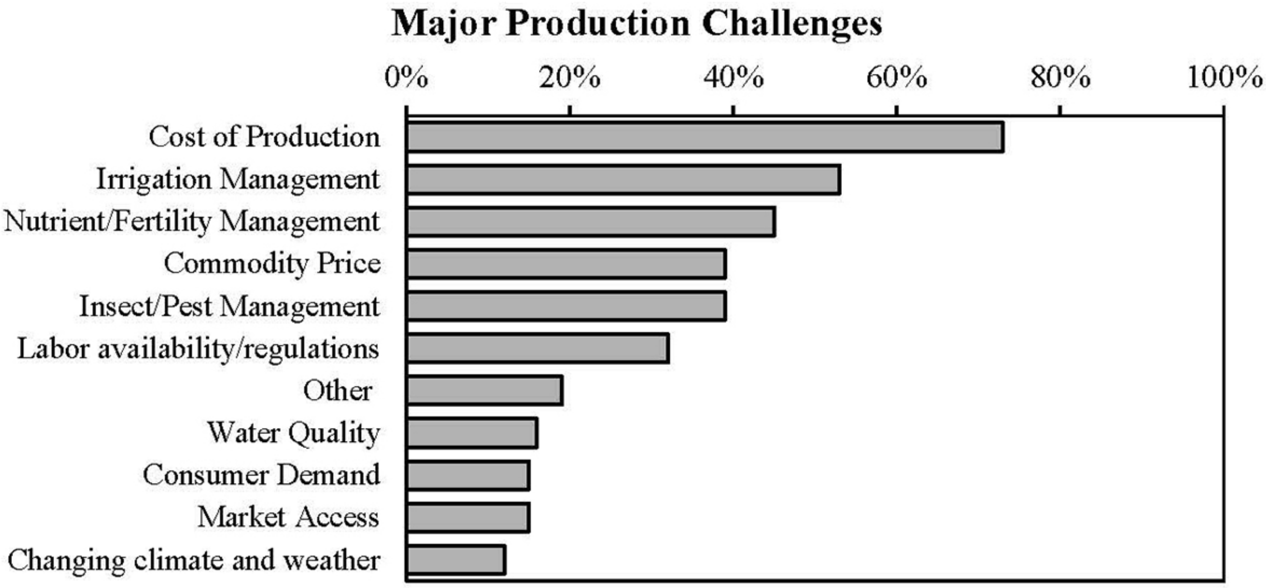

Figure 3. *Percentage of respondents highlighting major challenges and concerns.*

Pest populations are becoming increasingly resistant to management practices in California (Brunharo & Hanson, 2018; Rodbell et al., 2022), partially due to restrictions on the use of certain chemicals in pest control in the past (USEPA, 2021; Kanter et al., 2021). For example, the chlorpyrifos ban controlling alfalfa weevil and aphids, or glyphosate-resistant alfalfa in California, are major concerns in the alfalfa production system (Long et al., 2019; Loveland et al., 2023). Additionally, weeds are often the primary limitation to crop yields with considerable water consumption (Norris, 1996; Singh et al., 2022). Seasonal farm labor needs are mainly (>70%) compensated for by unauthorized farm labor (Martin, 2017; Goodhue & Martin, 2014), which reflects the desperate challenges of farm labor in the state.

"The chlorpyrifos ban controlling alfalfa weevil and aphids, or glyphosate-resistant alfalfa in California, are major concerns in the alfalfa production system."

The production challenges ranking below 17% were identified in the categories of water quality, consumer demand, changing climate, and market access. Our study found that 88% of the farmers in the region do not have concerns about climate change, which is considerably (almost four times) higher than the state-wide survey by Kanter et al. (2021). Another statewide survey focused on climate-smart agriculture documented that 67% of the farmers believe that climate change is happening, out of which 53% agree with acting against climate change (Ikendi et al., 2024) but had very low or negligible representation from the northeastern counties of California. The growers from Northern California (including the PRW region) attribute the changing climatic conditions to weather cycles and harsh geographies with a strong denial of anthropogenic climate change (Peterson-Rockney, 2022). In contrast, evidence suggests that climate change can impact forage yield and quality and soil conditions (Morgan et al., 2004; Singh et al., 2024a; Singh et al., 2025b; Thivierge et al., 2023).

Irrigation management

According to the survey responses for irrigation method, 71% of respondents utilize flood irrigation, making it the most common practice, followed by center-pivot systems at 53% of respondents, and wheel-line irrigation being used by 36% of respondents (n = 91). Dryland agriculture production is prevalent in the PRW region where 37% of the respondents have dryland production (Figure 4).

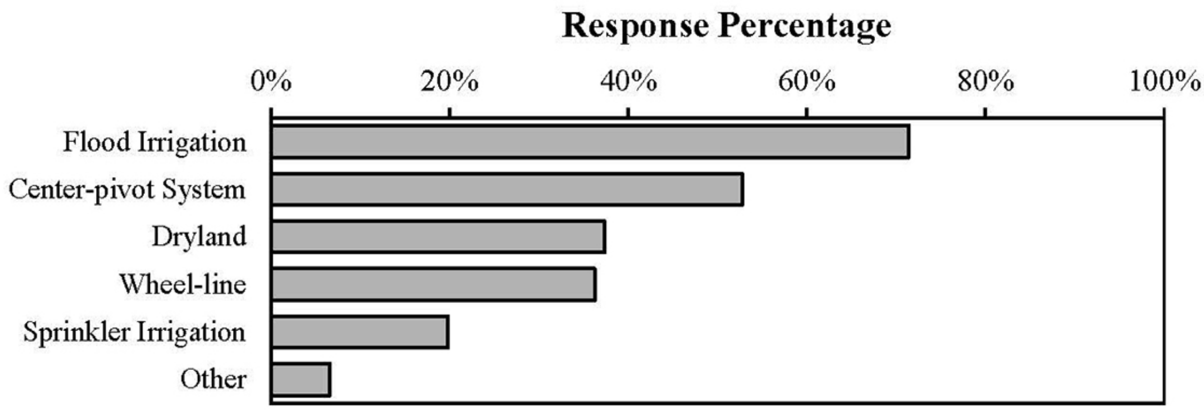

Figure 4. *Different irrigation practices utilized by respondents (n = 91).*

Efficient irrigation practices are necessary for agriculture as inefficient irrigation leads to economic losses in terms of both crop yield losses and energy costs. In terms of irrigation scheduling, personal experience ranked as the top metric used on when and how much to irrigate, i.e., 89% of the respondents (n = 89) (Figure 5). Soil moisture sensors (18%) and evapotranspiration (ET) data (16%) are used for irrigation decisions while only half of the respondents measured the irrigation volume. This survey suggests that flood irrigation and overhead sprinkler systems are the primary irrigation methods. Water use efficiency of these systems can be improved through technical assistance as (a) only half respondents measure irrigation volume and (b) the distribution uniformity of flood irrigation is low. Crop productivity is directly impacted by soil spatial variability, and lesser measurements might lead to overapplication of water (Anderson et al., 2023; Singh, 2021; Singh & Kukal, 2024).

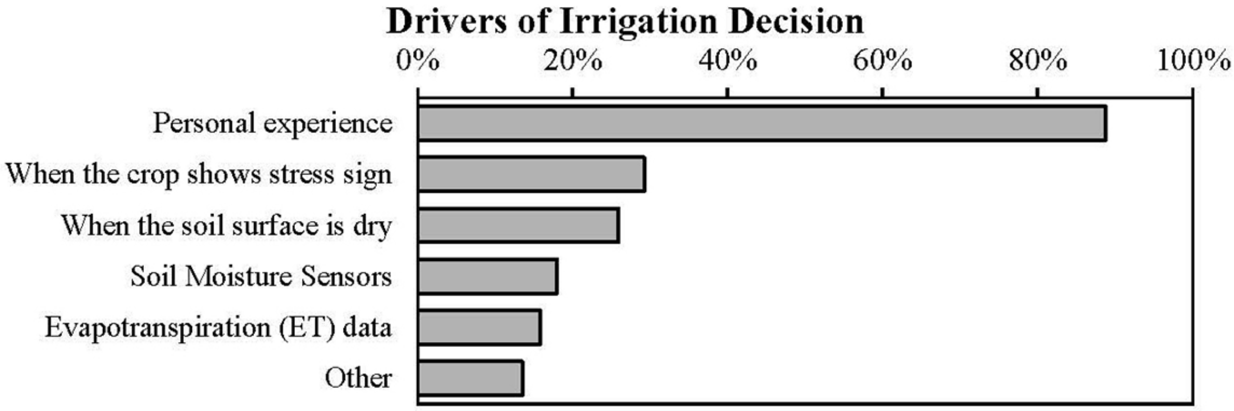

Figure 5. *Factors driving irrigation decision-making among respondents.*

Outreach demand

The respondents were interested in learning about better farm management; soil management ranked at the top with 57% of respondents wanting more educational and extension efforts in the region (n = 82) (Figure 6). Holistic soil management is necessary through regenerative management practices for improving crop productivity, water quality, and soil health (Singh et al., 2023). A recent survey in Utah reports that 52% of crop advisers do not have the required information and answers regarding soil health practices (Petrzelka et al., 2024), indicating the need for training and information. In California, the governmental incentive programs focused on soil health might serve as motivation for the growers to educate themselves about soil management (California Department of Food and Agriculture, 2025).

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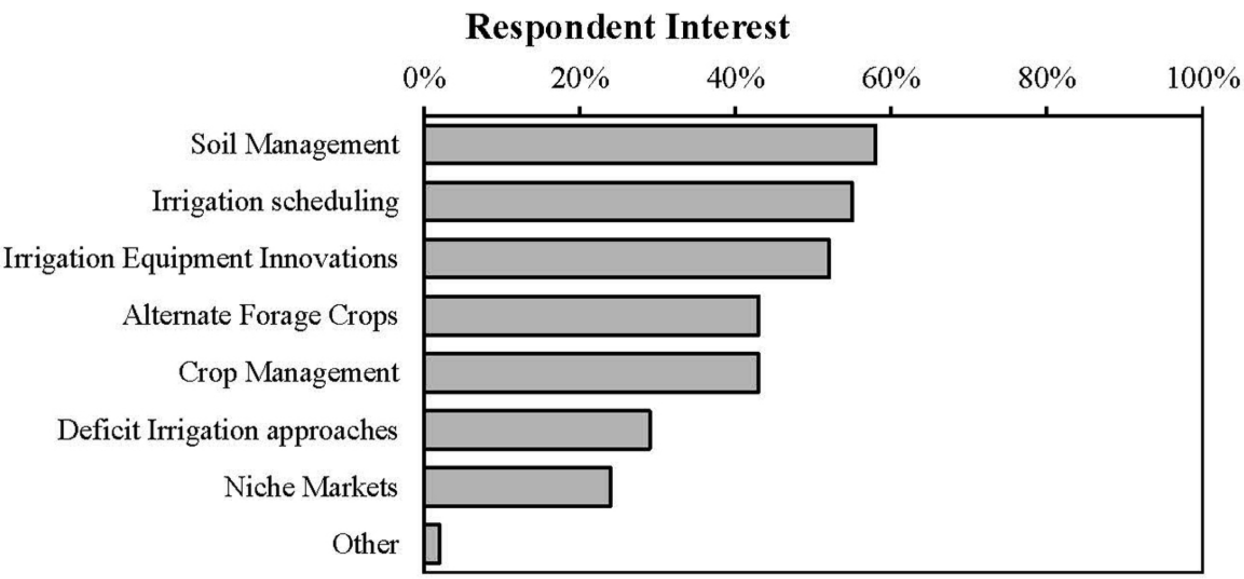

Figure 6. *Percentage (%) of respondents interested in future educational and outreach efforts related to agricultural operations.*

Following soil management, water-related practices were the desired topic of interest for learning among the respondents. Crop water requirements and irrigation scheduling ranked second among the topics backed by 57% of respondents, whereas innovative irrigation equipment (51%) ranked third on the list (n = 82) (Figure 6). This is a positive sign for reducing irrigation water use in California as Arizona has reduced the quantity of water used by 5% while increasing its irrigated cropland by 10% from 2007 to 2017 (Mpanga & Idowu, 2021). Automated surface irrigation techniques can be beneficial in regions with flood irrigation as a primary distribution system to conserve water and reduce labor costs as compared with manual irrigation (Champness et al., 2023).

Other topics of interest included crop management and alternative forage crops; both being ranked as an important topic by 44% of respondents. From a crop management perspective, salinity and cultivar effects on alfalfa forage yield and nutritive value (Anderson et al., 2023; Singh, 2021) have been studied. Alfalfa decreases nitrate leaching potential and improves soil carbon but at the cost of soil water (Singh et al., 2023). Therefore, the need for research on alternate forage crops arises, which is limited in California, but there are few promising studies in the western U.S. to find alternate cropping practices due to the volatile crop prices of traditional systems (Wieme et al., 2020). Deficit irrigation techniques and niche markets ranked low on the list with <30% of the respondents showing interest in the region compared with other parts of California and the U.S. (Montazar et al., 2020, 2016; Singh et al., 2025) and needs more attention as deficit irrigation improves water use efficiency and is not costly to adopt.

As the producers are 40% more likely to adopt practices supported by on-farm research than research conducted in university trials (Pires et al., 2024), local producer engagement in research should be continued. With the advancement and desire to adopt technology, social media can become a source of information and influence.

According to Bagnall et al. (2020), mentoring from early adopters helps late adopters for easy adoption, as collaborative research is important for mutual learning among diverse stakeholder groups for adaptive management and efficient resource use (Hardie Hale et al., 2022).

Careful considerations should be taken into account when implying the results from this survey to other regions, such as different geographic conditions, commodities produced, and production factors that might be different than the region surveyed in this study. This study underscores the importance of assessing the local needs for any agricultural region.

Conclusions

Our survey demonstrated that production cost and irrigation management are among the major challenges in the forage production systems of the Pit River watershed of California. Nutrient and pest management are also seen as major farming concerns in the region. These challenges are reflected in the grower's desire to learn about soil management and water-related practices through local organizations. This survey covered ~6% of the total farmers in the region and found that locals do not prioritize water quality and climate change as the state-wise surveys suggest while agreeing with the need for regenerative management practices (water, nutrients, and pests) to increase resource use efficiency.

"Our survey demonstrated that production cost and irrigation management are among the major challenges in forage production systems in the Pit River Watershed of California."

In the face of ongoing farm challenges, need-based local education and extension outreach are necessary to provide growers with the required technical assistance for sustainable agricultural production. Local understanding of farming communities and industry is pivotal for efficient resource allocation and fruitful research and extension programs due to geographical diversity within state boundaries or regions. This study provides insights for the UCCE irrigated systems program in the PRW region to help improve resource (water and nutrient) management and soil health by collaborating with stakeholders (farmers, ranchers, industry, and others).

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