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Planning for the "new normal": Farmworker support organizations' experiences of climate change impacts and adaptation

Karie L. Boone, [a] Sonia A. Hall,[b] Chad E. Kruger,[c] Bernardita Sallato C.,[d] and Georgine G. Yorgey [e] *
Washington State University

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Abstract

Farmworker support organizations (SOs) in central Washington state are experiencing climate change–related impacts. To understand the challenges these organizations are facing, how they observe tree-fruit farmworkers navigating these impacts, and what gaps exist in farmworker support, we carried out a multimethod qualitative case study, interviewing 24 staff from community health clinics and centers, community-based organizations, and research and training organizations. The analysis found that SOs are providing essential support related to climate change, and that need for these services in increasing. Several factors converge to make it challenging for SOs to effectively contribute to long-term, sustainable solutions: limited capacity, staff burnout and, in some cases, the fact that staff do not make the connection between increasing heat and smoke events and climate change. We propose that three principles could strengthen efforts to agree upon and implement long-term climate resilience strategies for the benefit of farmworkers' health and safety and the sus-

[a] Karie L. Boone, PhD, Research Associate, Center for Sustaining Agriculture and Natural Resources, Washington State University, Wenatchee, WA 98801 USA.
Dr. Boone is now a Stewardship Manager with the Payette Land Trust, McCall, Idaho, USA.

[b] Sonia A. Hall, PhD, Agricultural Climate Resilience Specialist, Center for Sustaining Agriculture and Natural Resources, Washington State University, Wenatchee, WA 98801 USA; sonia.hall@wsu.edu; https://orcid.org/0000-0002-3442-814X

[c] Chad E. Kruger, MS, Director, Center for Sustaining Agriculture and Natural Resources, Washington State University; 1100 North Western Avenue, Wenatchee, Washington 98801 USA; cekruger@wsu.edu; https://orcid.org/0000-0002-9722-0143

[d] Bernardita Sallato C., MS, Tree Fruit Extension Specialist, Extension, Washington State University; 24106 North Bunn Road; Prosser, WA 99350 USA; b.sallato@wsu.edu; https://orcid.org/0000-0003-0970-3434

[e] * *Corresponding author:* Georgine G. Yorgey, MPA, Associate Director, Center for Sustaining Agriculture and Natural Resources, Washington State University; 2606 West Pioneer Avenue; Puyallup, WA 98371 USA; yorgey@wsu.edu; https://orcid.org/0000-0002-3053-4674

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tainability of tree-fruit production: (1) addressing the systemic inequalities that contribute to farmworkers' vulnerability, rather than focusing narrowly on individual preparedness and reducing exposure; (2) bringing together diverse players to propose solutions for protecting workers within the context of farm economic viability, so as to reduce the potential for unintended consequences to the tree-fruit production system; and (3) incorporating adaptive strategies that attend to how climate change impacts people differently, unevenly, and disproportionately.

Keywords
farmworkers, climate change, support organizations, climate adaptation, tree fruit, farmworker health, farmworker safety

Introduction

Increasing temperatures across the globe are leading to more very hot days and greater wildfire activity across the western U.S., increasing the risk of co-occurring heat and smoke (Abatzoglou et al., 2021; Marvel et al., 2023; Rosenthal et al., 2022). Farmworkers who work outdoors are increasingly at risk from climate change–related impacts, with profound potential implications for both worker well-being and food production systems. Recent heat and smoke events have led to revisions or implementation of heat rules and the development of smoke rules for outdoor workers in some U.S. states (e.g., Oregon Occupational Safety and Health [OR OSHA], 2023, 2024; State of Nevada Department of Business and Industry, 2025). The ongoing and anticipated impacts of climate change on conditions for farmworkers are beginning to be researched (e.g. Fenske & Pinkerton, 2021; Marlier et al., 2022; Pagán-Santana et al., 2023), yet little has been documented about implications for the network of governmental and nongovernmental organizations that support them.

Farmworkers of varying backgrounds rely on an extensive but underresourced network of governmental and nongovernmental support organizations (SOs) that provide direct services, and in some cases indirect services such as advocacy. These SOs may or may not be thinking consciously of how their own roles are shifting in the face of climate change. They also have an important view of how farmworkers experience adverse conditions, and whether they need additional support. While SOs have the potential to support adaptation, such social organizations are not always resourced to prioritize adaptations to increasing environmental and socioeconomic risks such as those posed by climate change (Boone et al., 2018; Folke et al., 2005; Gallaher et al., 2013; Pahl-Wostl et al., 2012).

Our work focused on understanding how these roles and issues play out in tree-fruit production systems in central Washington State, U.S., a large, labor-intensive agricultural system in a region already seeing effects on people and production from increasing temperatures and more frequent and pervasive wildfire smoke. Washington accounted for 76% of the nation's apples in 2024, more than 90% of its organic fresh apples, 38% of pears, and 52% of its sweet cherry production (Northwest Horticultural Council [NHC], 2024; U.S. Department of Agriculture, National Agricultural Statistics Service [USDA NASS], 2025). Tree-fruit orchards have fluctuating labor needs and employ both year-round and seasonal laborers, estimated at 68,400 individuals annually in Washington (Gallardo et al., 2024; NHC, 2024). Farmworkers' experiences differ depending on their background, employers, legal and migration status, and many other factors. Labor issues are a highly contested space.

The purpose of this case study is twofold. The first is to improve our understanding of how farm-

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worker SOs are experiencing climate-related impacts and how they observe tree-fruit farmworkers navigating these impacts. The second is to identify gaps in the farmworker social infrastructure that need attention, as a first step toward supporting climate adaptation. This work aims to complement other existing sources of information, including surveys of, and conversations with, farmworkers (Luciano et al., 2025; Parker et al., 2024), and farm employers and managers (Parker et al., 2025; Postma et al., 2025).

Background and Context

Governmental and nongovernmental farmworker SOs play critical roles in providing farmworkers with access to social and health care services, legal counsel, training, and basic needs such as food and educational opportunities (Erwin, 2022a; Kim et al., 2016; Madrigal, 2023; Sbicca, 2020). Some of these diverse organizations focus on service provision, others on advocacy, and some blur these traditional boundaries to provide both (Posada, 2025). They include community health centers, legal services organizations, labor unions and advocacy organizations, community-based organizations, faith-based organizations, and state institutions such as departments of health and agriculture. Many, but certainly not all, of the individuals working within these organizations share similar language, culture, or socioeconomic circumstances with farmworkers and have a long history of engaging in ways that are culturally and linguistically appropriate (Marcom et al., 2020; Olaniran et al., 2017; Thompson, 2021). Some organizations are farmworker-organized (Madrigal, 2023), and many other organizations utilize a participatory approach, though this has been criticized at times for failing to adequately address the structural inequalities and power imbalances that contribute to farmworker challenges (Erwin, 2022b; Thompson, 2021).

Climate-Related Impacts and Projections

Eastern Washington's tree-fruit production region has a temperate, semi-arid climate with hot, dry summers. The number of very hot nights (minimum temperature of 18.3° C/65° F or higher) has generally been higher than long-term averages since 1990, while the number of very hot days (maximum temperature of 35° C/95° F or higher) has been variable, but above average since 2015 (Frankson et al., 2022). Future projections indicate that Yakima, Benton, and Okanogan counties—counties with high numbers of tree-fruit workers—are expected to experience a 35-day increase in the number of days with a heat index greater than 32.2° C (90° F) by mid-century, compared to 1971–2000 averages (Abatzoglou, 2013; Climate Toolbox, 2025). Figure 1 provides relevant projections for Benton County, Washington.

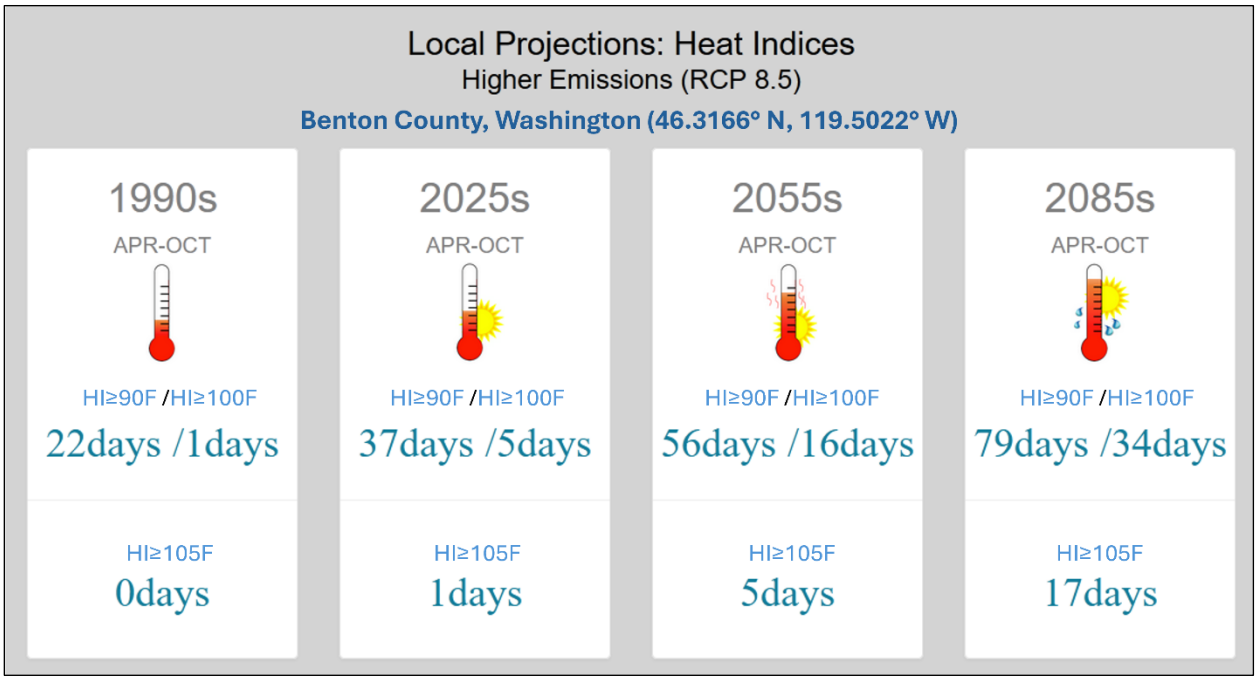
Wildfires have become larger, hotter, and more frequent over the last several decades, due to a suite of factors including climate change (Abatzoglou & Williams, 2016; Halofsky et al., 2020). This trend is expected to continue where fuels are sufficient (Holden et al., 2018; Parks & Abatzoglou, 2020), increasing air pollutants and risks for outdoor workers. There is also evidence that smoke events will increasingly co-occur with heatwaves (e.g., Kalashnikov et al., 2022; Rosenthal et al., 2022), compounding health threats (Ebi et al., 2021; Rahman et al., 2022).

Climatic changes are also likely to impact workers by affecting tree-fruit crop cycles, with accelerated development, earlier crop maturity, and a shorter growth season (Rajagopalan et al., 2018). Weather events in recent years compressed the windows for labor-intensive thinning and harvest, reducing potential worker income. This has likely economic and social implications, including reduced labor demand and layoffs (El Khayat et al., 2022; Fenske & Pinkerton, 2021; Pan et al., 2021).

Frontline Farmworkers and Their Exposure to Heat and Smoke-Related Impacts

Farmworker populations in the U.S. are diverse and changing. An increasing number come temporarily from another country (largely Mexico or Central American countries) through the federal H-2A Temporary Agricultural Workers Program (Gallardo et al., 2024). In Washington State, H-2A workers are the primary labor force in the tree-fruit sector, and usage of the H-2A program increased 513% from 2013 to 2023, from 6,303 to 38,664 workers (Washington State Employment Security

Figure 1. Anticipated Increases in the Number of Very Hot Days in Benton County, Washington, 1990s to 2085s



Source: Figure generated using the Climate Toolbox, 2025.

Department [ESD], 2024). Washington ranked third nationally in 2023 (after California and Florida) in the number of H-2A workers. Other tree-fruit workers in Washington include U.S. citizens, legal residents, and those without legal documentation. The H-2A workers tend to be males in their early 20s to mid-40s, whereas non-H-2A migrant and resident workers include more families, and ages that stretch into the 60s. Undocumented worker numbers are not well defined at the state level, but nationally it is estimated that 44% of farmworkers are not legally authorized to work in the U.S. (Gold et al., 2022).

Farmworkers are disproportionately affected by a changing climate, partly because of the places where they live and work (Frank et al., 2004), and partly due to institutionalized inequality (Heine et al., 2017; Rodman et al., 2016). These disadvantages persist alongside the fact that, in Washington, farmworkers have legal protections around health and safety, working conditions, minimum wage, overtime, collective organizing and bargaining, and workers' compensation (Washington State Department of Labor and Industries [WA L&I], 2018, 2023a, 2023b, 2023c, 2025). There is substantial evidence relating exposure to heat and wildfire smoke to farmworker occupational injuries, including heat-related illness, kidney injury, adverse pregnancy and birth outcomes, and mental health effects (Ebi et al., 2021; Rahman et al., 2022; Spector et al., 2016, 2019). Smoke exposure can also cause respiratory and otolaryngological irritation; chest aches; increased heart rate; and aggravations of underlying asthma, emphysema, and chronic bronchitis (Austin et al., 2021; Riden et al., 2020; Yao et al., 2016). High heat and wildfire smoke tend to occur from July through September, when farmworker numbers are at their highest (Austin et al., 2021).

Management and Policy Changes to Address Heat and Smoke-Related Impacts

In Washington State, recent impacts of heat and smoke on outdoor workers and new information suggesting the occurrence of illnesses below prior policy "trigger temperatures" contributed to increased attention and action, including policy changes, altered schedules to reduce heat exposure

(for fruit as much as for workers), employer and employee education, establishment of cooling centers, air quality monitoring, and better access to protective equipment and health care (Austin et al., 2021; Chicas et al. 2021; Ramos & Schenker, 2021; Riden et al., 2020).

Washington is one of seven U.S. states that have workplace heat stress rules in place, along with California, Colorado, Maryland, Minnesota, Nevada, and Oregon (Natural Resources Defense Council [NRDC], 2025). Only Washington, Oregon, and California have year-round rules pertaining to occupational exposure to wildfire smoke (Yaniz, 2023). In Washington, the updated Outdoor Heat Exposures rules (Washington Administrative Code 296-62-095 through 09560 and 296-307-097 through 09760; WA L&I, 2023a) include requirements for shade, rest, and acclimatization (WA L&I, 2023b, 2023d). At or above 90° F (32.2° C), a 10-minute cool-down period every 2 hours is mandatory, increasing to 15 minutes every hour at 100° F (37.8° C). Washington's smoke rules, effective since January 2024, require employers to prepare a written response plan, train employees, monitor fine particulate matter (PM2.5) conditions and forecasts, establish a two-way communication system, provide protective equipment as air quality thresholds are exceeded, and make provisions for prompt access to medical care if needed (WA L&I, 2024).

Several factors make central Washington a useful location for exploring our study questions, including the increasing heat and smoke exposure and impacts on farmworkers as the climate changes, the management and policy changes being implemented in the state, and the existence of a diverse networks of SOs serving tree-fruit farmworkers in the area.

Applied Research Methods

This study's questions were conceptualized after an extensive literature review and informal interviews with practitioners and include: How do farmworker SOs in central Washington experience and respond to climate-related impacts in the communities they serve? How do SOs describe gaps or unmet needs in climate adaptation for the communities they serve? To shed light on these questions, we carried out a multi-method case study analysis (Brewer & Hunter, 2006; Creswell, 2015; Yin, 2018) focused on farmworker SOs in central Washington. We selected the case of farmworker SOs because (1) SOs may be in a position (or could be enabled, with greater capacity) to support more effective climate adaptation; (2) we are unaware of other work focused specifically on farmworker SOs; and (3) SOs have direct connections with farmworkers and can observe changes in farmworker needs and gaps in service.

Data gathering included semi-structured interviews with SO staff to gain a deeper understanding of these complex issues; meeting notes from a monthly Farmworker Health Coalition composed of SO entities discussing on-the-ground needs and policy change; and three recent farmworker needs assessment reports from central Washington, California, and Oregon, to learn more about how topics of interest were experienced in nearby regions with labor-intensive fruit and vegetable crops. All three data sources were coded and triangulated to identify common themes.

Data Collection

Details of data collection from interviews with SO staff, analysis of meeting notes, and review of assessment reports are discussed below.

Semi-Structured Interviews

We identified interviewees using a combination of purposive and snowball sampling, strategically accessing a specific and difficult to reach population through trust-based referrals. We mitigated potential sampling bias by following a specific set of inclusion criteria to capture a diversity of experiences: years of experience in their professional field, level of staff position within organizational hierarchy, and experience with, or participation in, related policy development. Staff from the three most common categories of SOs were targeted for interviews: community health clinics and centers (clinics), community-based organizations (CBOs), and research and training organizations (RTOs). Inclusion criteria and SO categories were defined with participant observation during the Farmworker Health Coalition meetings, informal interviews with practitioners, and a review of SO web-

sites to capture the greatest diversity of experiences while also ensuring a sampling of respondents who could speak directly to our study questions. The interview guide was designed to uncover SO staffs' views with respect to our study questions, while respecting the way they framed and structured their responses (Marshall & Rossman, 2014). Table 1 provides the interview topics, and some sample questions within each category.

We interviewed 24 staff members from different types of farmworker SOs active in central Washington (fall 2022 through early 2024, halting during the busy growing season). During interviews, we asked about the services provided, breadth and depth of climate-related impacts, and potential pathways toward climate adaptation (Table 1). We did not assess compliance with policy or action thresholds in our interviews, as updates were implemented midway through our study. While all respondents work directly with farmworkers, there are important distinctions between the three categories (Table 2). Clinics and CBOs can speak to worker needs and to service provision impacts. Clinics have a public health focus so can speak to clinically relevant heat and smoke impacts. The CBOs have a stronger focus on advocacy, policy change, and community-based support mechanisms and therefore speak to a broader array of potential impacts. Research and training organizations are generally industry-associated, occupying a social space between management and farmworkers, understanding worker training norms and needs, and offering a unique perspective not otherwise captured.

Interviews concluded once saturation was reached across respondent categories, or when new data no longer provided new insights or themes and the existing patterns were consistently

Table 1. Example Interview Topics and Questions from Interview Guide

Topics	Sample Question
Changing needs	Have you observed changing (i.e., increasing/decreasing) client needs related to environmental threats such as hotter or colder temperatures, wildfire smoke or other climate-related impacts?
Support gaps	Are there service needs that you have observed that neither you nor other organizations can provide?
Organizational capacity	How would increasing frequency and duration of these environmental threats impact your capacity to respond (e.g., extreme heat for more consecutive days)?
Solutions	How have you been able to adjust to meet these changing needs? From your vantage point, what would an ideal response look like?

Table 2. Farmworker Support Organization (SO) Services and Scope and Number of Interviews by Respondent Category

Respondent Category	Services and Scope	# of Respondents
Community Health Clinics and Centers (Clinics)	Provide culturally competent primary and preventative healthcare with an emphasis on occupational health and safety. Staff at Clinics often connect workers to nonmedical social services.	6
Community-based Organizations (CBOs)	Nonprofits that address specific worker community needs by providing or connecting farmworkers to social, legal, and economic support services.	10
Research and/or Training Organizations (RTOs)	State and federal agencies and industry associations that study (tree-fruit) agriculture, labor, and provide occupation-related training to farmworkers.	8
Total		**24**

repeated. Interviews were virtual, recorded and transcribed using the Zoom virtual meeting platform to extend recruitment reach and inclusivity for disparately located SO staff (Archibald et al., 2019; Oliffe et al., 2021), and covered a range of relevant topics (Table 1). The full interview instrument is provided in the Appendix.

Meeting Notes and Farmworker Needs Assessment Reports

To cross-check and enrich interview findings, we gathered data from two years of call meeting notes from a regional farmworker SO coalition and three geographically relevant farmworker assessments. The Farmworker Health Coalition was originally initiated by farmworker-serving organizations across the Pacific Northwest and California to share information and provide support in response to the COVID-19 pandemic. Meetings have continued and aim to center the experiences of both farmworkers and the community health workers who serve them, share challenges, pool resources, and improve coordination to address ongoing and emergent threats to farmworker health and safety (Guild, 2024). These have included smoke, heat, and other impacts of climate change, as well as the lingering effects of COVID-19. Starting in January 2023, we were invited to participate in Coalition meetings. Coalition members included individuals from our three categories of interviewees (Guild, 2024), which helped ensure our analysis was contextualized and relevant to the SO community. Farmworker coalition meeting organizers also allowed us to analyze two years of call meeting notes (20 monthly meetings from January 2022 through December 2023, with four meetings canceled by organizers).

To further understand SO experience of unmet needs for climate adaptation, we searched for publicly available farmworker needs assessment reports from nearby regions with similar labor-intensive fruit and vegetable crops, published between 2015 and 2025. Documents were located using strategic Google search techniques with targeted keywords to find credible, relevant, and high-quality assessment reports (Bowen, 2009). We searched within specific domains (.org, .gov, .edu, .com) and structured queries using relevant word combinations: "climate adaptation" or "climate change" and "farmworker" and "needs assessment." Reports were included if they (1) addressed farmworker populations in the targeted states; (2) were issued by credible sources (e.g., SOs partnered with government or academic institutions); and (3) contained empirical or narrative data on climate-related farmworker health, labor conditions, or social needs. Three documents from central Washington (Rivera & D'Evelyn, 2023), California (Brown et al., 2022), and Oregon (O'Connor et al., 2022)) were selected based on their relevance, recency, and representativeness across the region.

We additionally examined organizational documents—annual reports, presentation materials, websites, other public-facing information—from SOs that participated in interviews to better understand organizational goals, services provided, climate-related impacts to workers, policy recommendations, and other contextual information. The reviewed documents provided additional detail and clarification to interviewees' responses, though they were not explicitly coded and analyzed.

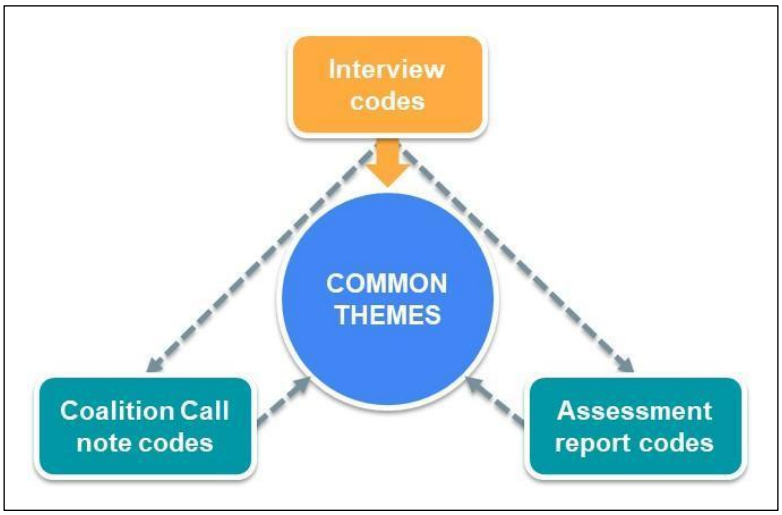
Data Analysis

The first author carried out data analysis, beginning with uploading transcripts from 24 interviews, 20 Coalition call meeting notes, and the three assessments into NVivo qualitative coding software (Lumivero, Denver, CO). Interview analysis took place using a three-step coding process: (1) open coding to condense data into preliminary analytic categories, (2) axial coding to identify key concepts, and (3) selective coding to identify the data that would support conceptual coding categories and final themes (Neuman, 2020). Assessments and call notes were coded deductively using a code book generated from interview questions. Example codes include 'heat impacts,' 'climate-related support gaps,' 'organizational capacity,' 'response needed,' and 'blacklisting,' among others. We coded assessments and call notes to identify similar or divergent instances of farmworker and SO experiences of climate change, to improve the replicability, credibility, validity, and richness of our findings (Neuman, 2020). Analytical memos systematically documented reflections and emergent patterns that formed the basis for themes (Charmaz,

2006). Where codes triangulated across all three data sources, a theme was generated (Figure 2) and is presented as a key finding in the Results section, below. Triangulating interview data with Coalition call meeting and assessment report data provided a richer understanding of the research topic compared to relying on a single data source and increased the validity and credibility of findings (Neuman, 2020; Noble & Heale, 2019; Yin, 2018).

Preliminary themes were shared during two Coalition calls (June 2023 and April 2024) and at the Western Forum on Migrant and Community Health Conference in Seattle, Washington (February 2024) to solicit feedback on the accuracy of findings. We did not receive any feedback contrary to the findings presented but rather reinforcing commentary that the themes captured SO staffs' lived experiences.

Figure 2. Triangulated Analysis with Initial Interview Coding, and Subsequent Confirmation with Coalition Call Notes and Assessment Reports



Results

Four key findings arose that shed light on how farmworker SOs in central Washington are experiencing changing weather- and climate-related impacts, their observations of how frontline farmworkers are navigating climate-related impacts, and their insights into the gaps in farmworker support infrastructure.

Key Finding 1: SO capacity is being stretched as they respond to an increasing number of climate change–related heat and smoke events affecting frontline farmworkers.

Support organization staff emphasized the difficulty of meeting needs relating to increasingly frequent heat and smoke events, especially while they are already stretched thin. They are observing increased demand for SOs to fill emergency response roles during wildfires and have observed spikes in need for personal protective equipment, such as face masks, sometimes beyond their capacity to meet. Heat and smoke have important physical and psychological health dimensions they are trying to mitigate. They also see increased needs for information and regulatory and legal advising related to managing work during heat and smoke. One community health worker shared that:

> When workers are picking, cutting, they're up and down ladders, it's hot, they're doing a lot of cardio and it's humid inside orchards. To wear a mask to protect from the smoke—they're suffocating inside masks. … We have more cases to deal with where workers think they're having [a] heart attack, that they're dying, because they can't breathe inside masks under these conditions, workers have anxiety.

Other climate-related impacts noted less frequently included increased stress among farmworkers due to reduced income resulting from extreme weather impacts on crop productivity, and the compression of harvest during particularly warm seasons. When asked, respondents noted that compressed harvests contribute to the loss of worker income, as harvest represents a time of higher wages from piece-rate pay.

Respondents spoke about how the sheer numbers of workers means that SOs are overwhelmed providing health and safety trainings and basic resources such as medical care, water, face masks, and food. In addition, they described how the increasing numbers of H-2A workers are pro-

foundly impacting SOs' work, as they tend to have higher levels of need and experience greater barriers to engagement and access. Respondents viewed the effect of an increased number of H-2A workers on demand for SO services as compounded by an increased length of stay, as many H-2A workers are staying for six to nine months instead of the once-typical three months. They also described challenges in reaching H-2A workers, given they often live in farm-supplied housing outside of towns, have little control over their time, less access to transportation, and are culturally distinct from local workers.

Respondents indicated that their SOs are finding it harder to meet workers during their shifts to provide resources, given the occurrence of more night shifts and more, smaller farm crews. Increased night shifts are designed to avoid high heat, preserve fruit quality, and extend the harvest window. While this practice can reduce heat-related issues among farmworkers, respondents highlighted additional complications and other negative impacts associated with night shifts: it is harder for workers to see, making the workplace potentially more hazardous; it is also more difficult to obtain childcare.

In addition to these practical challenges, respondents pointed to persistent and systemic inequalities that make it more difficult to meet both climate- and non–climate-related needs of farmworkers, including poverty, living in housing that may increase rather than reduce exposure to high heat, and inconsistent access to physical and mental healthcare. Respondents indicated that heat and smoke illness prevention training is sometimes lacking or inadequate; these trainings are often one of an extensive list of health and safety training topics delivered in a short amount of time. One farmworker trainer that works for the tree-fruit industry highlighted an example from H-2A worker training, sharing that:

> [There is] inconsistency in training [of H-2A workers] because that's up to each company that brings workers. Some companies do an amazing job with them and bring them a week or more prior to work for training. Other companies, on the other hand, bring them just one day before work, and I don't see how one day is enough for all the training they need to receive.

Respondents indicated that collectively, these changes have stretched SOs' capacities to meet workers during their shifts to provide both climate change–related and other resources. The importance of these interacting factors was reflected in the issues the Farmworker Health Coalition identified as needing network support. The top priorities they collaboratively identified in the winter of 2022–23 were, in order of importance: (1) supporting the needs of H-2A workers, including getting them information about local rules and regulations, encouraging them to apply for health insurance, and assessing the impacts of their increasing numbers on local worker populations; (2) circulating information about occupational health, safety, and work availability impacts from year-round climate extremes (e.g., heat stress, wildfire smoke, and cold); (3) inviting grower associations into the conversation about worker health and safety; and (4) addressing chronic illness education.

Key Finding 2: SO staff varied in whether they connected support needs that arise during heat and smoke events with climate change; those who did were more likely to participate in support networks and policy efforts.

When asked if they had experienced an increase in climate change–related needs, some respondents initially indicated that they had not. It was only later in the interview that they connected the increasing heat and smoke service needs they were describing to climate change. For example, at the beginning of an interview, a staff member at a CBO that provides rent and paycheck support to farmworkers during financially difficult times did not connect the increased needs for food and rent support to compressed cherry harvests. Then, after being asked about the potential for increased frequency and duration of environmental threats, they realized the potential link to ongoing climate change and expressed concern that their organization did not have a plan in place for coping with such changes.

Other respondents described their organiza-

tions' responses to heat and smoke events as individual "one-off" emergencies, even while noting the increasing frequency and describing feelings of burnout. A state agency staff member commented during a support call that:

> [It] seems like we're always scrambling at the last minute. Whether a heat wave, wildfires, cold weather. The CBOs are the ones that get hit all the time. They're the ones that continue doing the work, [and are] expected to do more with minimal resources.

Respondents who recognized worker needs as persistent and related to climate change tended to be the same individuals who were engaged in developing resource and information support networks, such as the Coalition calls. They also tended to participate in shaping policy protections at the regional and state levels, including SOs engaged in forward-thinking climate policy work. For example, the Coalition spearheaded a proposal—the Western Smoke and Heat Protection Pact—for strong, consistent, protective rules for heat and wildfire smoke with similar thresholds for action across Washington, Oregon, and California. It recognized that farmworkers may work in multiple states, that they are primarily immigrants, people of color, low-wage, and non-union workers, and that they face disproportionate harms from climate change (Alliance Medical Center et al., 2021).

In discussing the question of how climate hazards have been changing, respondents noted that systemic difficulties make it hard to objectively track whether heat-related illnesses or other climate-related impacts to worker health have been increasing. They noted that the available public records on worker injuries and illness do not indicate the workers' occupations and thus they could not conclusively respond to the question of whether the frequency of climate-related injuries is changing.

Key Finding 3: Multiple factors contribute to farmworkers' vulnerability to heat and smoke events: (1) power differentials and cultural norms contribute to a lack of safe lines of communication through which farmworkers can advocate for their health and safety needs, (2) the development of new state heat and smoke rules did not include sufficient worker participation, and (3) in situations when workplaces are not in compliance, enforcement is inadequate.

All respondents discussed factors that increase farmworkers' vulnerability to heat and smoke events, beyond the physical conditions themselves. Three factors were mentioned repeatedly. First, during every interview, throughout the Coalition call notes and assessments, SO respondents discussed the many factors that prevent farmworkers from advocating for their health and safety needs. They described how workers who communicate safety-related needs are at risk of being blacklisted, or not being invited back to work at the orchard the following year:

> H-2As can't complain or [they] won't get hired next year, they get blacklisted.

The SOs shared that these practices are pervasive because there are few, if any, negative consequences for employers who blacklist. Workers thus tell SOs they do not often express feelings of physical or mental illness, or request water breaks or shade access, for fear of being labeled "weak" or "lazy" by supervisors. Respondents also indicated that they considered cultural norms among the farmworker community, valuing toughness and labeling those who speak about physical or mental illness as "weak," as a contributing factor. A discussion during the October 2023 Coalition call centered on how to support male workers from a culture where individuals who are vulnerable enough to express needs related to physical and mental health may be viewed as less competent, capable, and confident at work. In reference to reporting heat illness symptoms, a worker trainer shared that:

> It's a cultural thing, they don't tend to seek medical attention, they wait too long, this is one thing to get across to them.

Respondents indicated that without permanent immigration status, H-2A workers are even more

reluctant than resident workers to challenge unfair or dangerous working conditions because they fear retaliation, employer termination, and being sent back to their country of origin. The SOs indicated that H-2A workers are more vulnerable to a range of potential workplace hazards and abuses because they are less well informed of their rights than resident workers and are operating under contracts that leave them open to retaliation. The SOs shared that this may make H-2A workers more desirable for employers. One CBO staff member shared that employers

> can lock down H-2A [worker]s, they're more controllable, they have to stay with the grower, can't go shopping for the best price per bin. Why deal with locals who will go to the highest paying grower?

During a Coalition meeting, a state agency staff member said:

> There are many reasons that employers are preferring H-2A workers. They are less informed about their rights as workers, and they are vulnerable since their contracts are tied to a single employer. Because of COVID regulations and wildfire heat and smoke protection [rules] that is why they are preferring H-2A workers.

The second factor contributing to farmworkers' vulnerability that respondents noted was procedural, relating to insufficient opportunity to give meaningful feedback on policy processes that affect farmworkers. Respondents considered the updated and new statewide heat and smoke protections (2023 and 2024, respectively) as important steps forward. However, they described how community input sessions occurred during the regular workday and far from places of employment, identifying these as common procedures when workplace rules are being developed or amended. They also pointed out that H-2A workers are not citizens, do not have "standing," and thus tend not to become involved in rule development. One respondent who has decades of experience advocating for farmworker rights and who grew up working in the agricultural fields of central Washington said:

> I don't think many people took farmworkers into consideration, and when it came to any kind of environmental or climate rulemaking or decisions, or any kind of conversation, you know; so I think that's been one of the more … revealing things around here that how often all these rules and policies are made without any input from farmworkers themselves. You know, it's all industry.

The third contributing factor discussed by respondents relates to insufficient enforcement of either longstanding or new protections for workers. This was widely mentioned, even though respondents generally felt that working conditions have improved over the last few decades. Without improvements in enforcement, SOs doubt that working conditions will continue to improve enough to truly protect workers' health and safety. Respondents discussed two contributing factors. First, noncompliance with previous rules such as access to clean, cool drinking water, adequate shade for breaks, and breaks themselves have not resulted in meaningful penalties, leaving respondents skeptical that new rules will be enforced any better. Second, there is a broad distrust of enforcement entities, encompassing a sense that they are both underfunded and, in the words of one respondent, "on the side of employers." The issue of health and safety rule enforcement arose during 22 out of 24 interviews, 5 out of 20 Coalition calls, and in all 3 farmworker assessments.

Respondents' experience with the state agency charged with developing and enforcing rules and policies that protect workers is that when a worker makes a complaint, agency staff usually communicate with employers before arriving at the worksite to check on a reported rule violation. They described examples of potential violations quickly fixed by the employer before the state Department of Labor and Industries (L&I) arrives, a pattern that has generated widespread distrust. The SOs also report that inadequate staffing and a lack of funding at L&I cause delays in response to reported violations and limit enforcement capacity.

Key Finding 4: More consistent and universal training and the creation of more effective enforcement mechanisms for existing and new policy protections could help improve climate adaptation.

Support organizations emphasized that education about heat and smoke illness prevention practices, rules, and policies should be improved and should be consistent for all employees (H-2As, residents, crew supervisors) and employers (management and owners). They saw this as an important pathway to improving working conditions and reducing climate-related impacts to farmworkers. A participant in the monthly support Coalition calls highlighted a need for:

> more training, in person. Employees and employers need to have the same information, mandate[d] breaks, and protective health and safety. Rules need to be enforced; accountability needs to be enforced.

Several respondents noted that crew supervisors play a key role as they are literally "in the field" ensuring that the rules are implemented, and so they need to be able to recognize the indicators for heat- and smoke-related illness so that they can act when workers need support. A respondent who has experience as a farmworker, trainer, and orchard owner shared that, in their broad experience, most field supervisors and labor managers do not have the needed leadership and soft skills to ensure worker well-being. Another respondent suggested that, if managers were supported to effectively manage delegation, team communication, and conflict resolution, farmworkers under their supervision would be more likely to have better health and safety outcomes. Soft-skill training could also increase supervisor empathy and mitigate blacklisting practices. They also suggested that upper-level managers' and tree-fruit production company leaders' roles are critical, too, as they oversee workflow and worker needs, set the tone for workplace culture around these issues, and ultimately have the power to ensure that protective rules are followed.

Respondents also spoke about the need for adequate implementation and enforcement of not only the new state heat and smoke rules but also prior existing protections such as rest periods, shade, and clean water access. Concerning the new heat rule in Washington, respondents suggested that evaluating preparedness during site inspections and performing true surprise inspections could aid its consistent implementation:

> Rules are great, but the monitoring and implementation has been bumpy. The preparedness should be able to be evaluated during a site inspection.

In addition, individual respondents noted a number of other possible solutions to address particular challenges relating to farmworkers' vulnerability to heat and smoke events (Table 3).

Discussion

Our study adds to the existing literature in several ways, bringing attention to the roles of farmworker SOs in the broader social ecosystem that includes farmworkers, managers, and employers—an ecosystem that modulates how farmworkers experience heat and smoke. Our work demonstrates that increasing exposure to heat and smoke not only negatively affects farmworkers' physical and psychological well-being, but also places additional stress on farmworker SOs and their staff (Key Finding 1). It also uncovers a potential connection between a climate change-informed view of these issues and the likelihood of pursuing systemic changes (Key Finding 2). This study therefore builds on existing work that examines labor issues and solutions as being social and systemic rather than individual problems (Allen, 2016). We also build on existing farmworker-centered scholarship in our region that indicates that farmworkers in the Pacific Northwest have long been navigating heat exposure (Hofmann et al., 2009), and that these risks are increasing (Luciano et al., 2025; Parker et al., 2024). Smoke is also an emerging concern (Parker et al., 2024, 2025; Zuidema et al., 2022). Our study focused on the lived experiences and observations of one set of actors—farmworker SOs—who play an important role in supporting farmworkers within a complex production system. These actors are very aware of the structural power

Table 3. Specific Challenges and Potential Solutions Respondents Mentioned to Contribute to Farmworkers' Preparedness and Resilience to Climate Change

Challenge	Potential Solution
Inadequate or inconsistent training across orchards and among management levels	Convening a coordinated, statewide, state-industry-SO partnership to develop and implement consistent trainings on climate-related impacts for employers, management, and workers alike Leadership training for field supervisors
Inconsistent access by farmworkers to cool indoor spaces	Investing in improvements in cooling of farmworker housing, promoting rest and recovery, which can reduce risk while minimizing impacts to productivity
Inconsistent farmworker access to health and other services	Developing and deploying mobile clinics to improve healthcare access for workers and reach more farmworkers with educational and social resources
Insufficient data to fully evaluate climate-related impacts to farmworkers	Collecting data on heat-related illnesses or other climate-related impacts to farmworker health and cataloguing worker's occupation in the collection of clinical data on work-related injuries and illness
Inadequate enforcement of health and safety including heat and smoke rules	Implementing randomized and unannounced screening of orchards to document health and safety practices and working conditions

differentials and cultural norms that make it difficult for farmworkers to advocate for their health and safety. The SOs also spoke about insufficient farmworker input in the development of rules meant to protect them, and inadequate enforcement in situations where workplace health and safety rules are not being followed (Key Finding 3). In this regard, our findings are broadly consistent with other studies in the western U.S. and elsewhere that have pointed to the power structures that contribute to farmworkers' vulnerability to weather hazards (Courville et al., 2016; Parker et al., 2024; Posada, 2025).

Climate-related risks are intrinsic to the outdoor jobs that farmworkers perform. However, our findings highlight how workers' vulnerabilities are not only a function of their exposure, but also of their sensitivity to impacts and their limited adaptive capacity (Dawson et al., 2011; Füssel & Klein, 2006). Increased sensitivities result from several factors that respondents discussed: the physical demands of their jobs, living in housing that may increase exposure to high heat, poverty and lack of access to healthcare that can increase the risk of pre-existing medical conditions, and in some cases, a lack of acclimation prior to working in the heat. Adaptive capacity is limited by the power dynamics at play, including farmworkers' relative status in the workplace, blacklisting practices, and inadequate compliance with workplace protection rules (Key Finding 3; Rodman et al., 2016; Wadsworth et al., 2022). The differences in effects on different types of workers suggest that flexible, diverse efforts, rather than one-size-fits-all solutions, are needed to address the factors that increase workers' vulnerability to climate or limit their adaptive capacity. These results also suggest that solutions should include a focus on climate justice (Newell et al., 2021; Sultana, 2022), including procedural justice so that farmworkers can meaningfully participate in policy processes that impact their livelihoods and well-being (Holland, 2017; Parker et al., 2024; Ryder, 2018; Zoodsma et al., 2022).

One notable finding was that many individuals working at SOs have not yet linked the increases in heat and smoke incidence with ongoing climate change (Key Finding 2). Heat and smoke events are still being treated as one-off emergencies, and SOs are experiencing burnout from more frequent and severe climate-related needs. This may be inhibiting efforts to build the long-term capacity needed to cope as conditions change. Whether it is through increased investment in SOs or also through investments in other entities, there is a

need to increase the adaptive capacity of farmworker support entities, who are a key element of the food production system.

Another notable theme across our key findings was that vulnerabilities and needs are different for different types of farmworkers (Key Finding 1; Key Finding 3). In particular, the increasing use of H-2A workers across the Washington tree-fruit industry (and likely in other agricultural sectors and areas as well) has had a large impact on the work of farmworker SOs. These workers have a distinct legal status as noncitizens who are formally recognized (as distinguished from U.S. citizens or farmworkers who are undocumented). Their schedules, on-farm living quarters, lack of knowledge about their rights, and their fear of being blacklisted all make them a more challenging population for SOs to reach.

Farmworker SOs play diverse and important roles across the U.S. (Kim et al., 2016; Madrigal, 2023; Sbicca, 2020). While our findings relate to farmworker SOs in central Washington and cannot be generalized broadly, they highlight the need to further explore these issues in other labor-intensive areas of U.S. agriculture, with both likely areas of congruent experience and regional differences due to climate, policy, culture, and other contextual factors. The specific dynamics depend on the baseline conditions and the levels of heat, humidity, and fire experienced in each region (Bolster et al., 2023; Burke et al., 2021). Changes in climate are being felt across the U.S., with increasing incidence of wildfire across the western U.S. and wildfire smoke events even beyond. Although Washington's policy context is more similar to Oregon and California, our findings related to nonregulatory approaches are likely applicable in other areas of the U.S. as well.

Given the limited existing research on SOs' responses under a changing climate, more investigation is needed. In our study area of central Washington, next steps include engaging with a wider range of actors in this complex human-agricultural ecosystem to support the identification and implementation of a range of solutions. Although limited to one geographic region, our study provides an example of the role SOs can and do play in highlighting the experiences of those not adequately supported by the rules and policies meant to protect them. Respondents pointed to the need for more robust enforcement to accompany rulemaking, and consistent training on these rules for farmworkers, managers, and employers (Key Finding 4). These suggestions point strongly to the need for (1) systemic approaches rather than reliance solely on individual action; and (2) a collaborative, comprehensive approach to address climate change impacts on the whole production system, including farmworkers, managers, employers, and the production system itself. Respondents also provided a wide range of other potential strategies to ameliorate specific challenges (Table 3). Other challenges noted by our respondents could be tackled with specific research, information, or tools (Table 4).

Such solutions need to be evaluated and designed in the context of the whole production system. For example, Tigchelaar et al. (2020) showed that increasing rest time or providing cli-

Table 4. Particular Challenges that Contribute to Farmworkers' Vulnerability that Could Be Improved Through Research, Information, and Tools

Challenge	Potential Solution
Inconsistent access to, and use of, accurate data to inform implementation of heat and smoke protections	• Increasing the number of local on-farm weather stations with air quality instruments • Developing a text alert system for high temperature and degraded air quality (similar to Amber Alerts)
Inadequate engagement of farmworkers and others in the tree-fruit industry during rule making	• Expanding the locations and times of public meetings to improve accessibility to farmworkers, growers and others with interests in the process • Establishing processes and funding for CBOs to represent the interests of workers without such access, at the workers' request

mate-controlled recovery areas could effectively eliminate risk even under future projected conditions, but could have strong negative effects on farm productivity, farmworker earnings, and labor costs. For an industry with slim or even negative production margins (Gallardo et al., 2025a, 2025b, 2025c), such additional costs could lead to unprofitable production environments and loss of family farms, consolidation of production, and other changes with unintended consequences to farmworkers' livelihoods. Industry leaders have said that labor costs have grown even more quickly than other costs, rising from an estimated 37% of the growers' returns for a bin of apples in 2013 to 70% in 2022 (Johnson & Prengaman, 2024). These increases threaten growers' ability to withstand market fluctuations, with labor representing an estimated 99% of returns in 2023 as apple prices dropped amid market fluctuations.

Given this unprecedented increase in labor costs, the most likely pathway to successful climate adaptation is one that is inclusive of both farmworkers' health and safety needs and of growers' economic viability, even if this may add challenging dynamics. While such "big tent" approaches can constrain the approaches used, for example, to avoid overly political stances, these efforts also provide new opportunities and have the potential to expand spaces for meaningfully advancing equity (Erwin, 2022b; Weiler et al., 2016). The Washington tree-fruit industry has already collaborated in this way in the area of pesticide education. In partnership with state agencies and university Extension services, the industry has made significant investments in worker health and safety training (including in Spanish) over the past few decades, achieving substantial reductions in pesticide exposure. A similar model is worth exploring to address heat and smoke exposure.

Study Limitations

Our case study focused on the experience of SOs, one type of entity within a complex system. It therefore does not comprehensively represent the full spectrum of perspectives of other actors in the tree-fruit production system. On the one hand, individuals working in SOs hear about the experiences of many different types of farmworkers and are often embedded in farmworker communities themselves; on the other hand, given their role of filling gaps in support, SOs likely represent most closely the view of farmworkers in need of that support, although the full spectrum of farmworker perspectives is likely broader. Further efforts exploring and comparing perspectives are therefore needed to fully understand the challenges and develop solutions.

In addition, this multimethod case study focused on farmworker SOs in central Washington and is not generalizable. Though it is possible, maybe even likely, that some of our key findings are true and relevant in other labor-intensive agricultural regions seeing similar climate trends, our study does not provide sufficient causal understanding of these factors to infer where they might have similar or different influence. Finally, this study does not isolate the climate change–related impacts to farmworkers from other factors that affect them. For instance, Washington State rolled out the updated heat and new smoke protection rules at roughly the same time as new agricultural worker overtime rules (WA L&I, 2025). This led to two different sets of rules influencing the system at the same time, effectively providing unplanned incentives for workers to ignore the health impacts as they tried to reduce the loss of income resulting from employers' responses to those new rules. As these rules fully come into effect, explicit evaluation of how they interact with climate change–related impacts will be needed.

Conclusion

Our aims were to improve understanding of how farmworker SOs are experiencing climate change–related impacts and to identify gaps in the farmworker social infrastructure that need attention, as a first step towards supporting strategies for more equitable climate adaptation. Our focus on SOs in central Washington allowed us to highlight underrepresented experiences in climate change adaptation dialogues and connect these perspectives into ongoing efforts in climate adaptation in tree-fruit production systems.

Based on the integration of this study's findings with the existing understanding of systemwide climate change impacts, we conclude that at least

three elements are needed to design and implement effective climate adaptation strategies. First, it is necessary to address the systemic inequalities that contribute to farmworkers' vulnerability, rather than focusing narrowly on individual preparedness and reducing exposure. Second, diverse players need to come together to propose solutions for protecting workers in the context of farm economic viability, in order to reduce the potential for unintended consequences to the tree-fruit production system as a whole; otherwise, those consequences, in turn, could undermine the sustainability of the solutions. Lastly, any adaptive strategies should attend to how climate change impacts people differently, unevenly, and disproportionately. These three elements are not solutions in and of themselves, but rather principles that would underlie efforts to agree on and implement sustainable solutions for the benefit of farmworkers' health and safety and the sustainability of tree-fruit production under a changing climate.



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Appendix. Interview Guide

Introductory Remarks: Thanks again for agreeing to the interview with me. I work with the Center for Sustaining Agriculture and Natural Resources, a research and education center of Washington State University. The purpose of this study is to identify tree fruit farm worker support services and agencies and assess their needs related to anticipated climate change impacts in central Washington.

We're interested in knowing more about the entities that provide support, what future needs are projected, and what questions you have relating to projected climate impacts on farm workers. In particular, we're interested in assessing if there is a need for collaboration, research and information relating to the increasing likelihood of drought, high heat or frost events, wetter springs and other climate-related environmental threats. We are also interested in exploring what information and resources might help you support workers, that would be more applicable considering changing environmental conditions in the future.

This study has been certified as Exempt by the WSU Human Research Protection Program. For questions about the rights of participants, you may contact the office: irb@wsu.edu. I ask all interviewees the same questions. Your name and responses will not be identified as pertaining specifically to you in anything I write to summarize interview findings. I'm asking to record the interview for internal reference purposes and to ensure I accurately capture your responses. Recordings will be kept on a password protected drive. If recording makes you uncomfortable, I'm happy to just take notes. Are you ok with being recorded?

If there is any question you do not feel comfortable answering, please just let me know and we'll move on to another topic.

Interview Questions

1. I understand that (organization/agency name) provides _____ services to tree fruit farm workers and their families. Are there other environmental health-related services that you offer?
    a. In what format do you provide these services? (I.e., one-on-one consultations, workshops, individual financial support, popular and/or social media?)
    b. Which are your most utilized services?
    c. Are there times of the year when your services are more utilized? For example, do you have a "busy season" and what are the most requested services during these times?
    d. Are there service needs that you have observed that neither you nor other organizations can provide?
2. How would you describe the demographics of your clientele?
    a. Age, sex, race/ethnicity, country of origin, work permit: H2A, seasonal, resident, undocumented or others.
3. Have you observed changing (I.e., increasing/decreasing) client needs related to environmental threats such as hotter or colder temperatures, wildfire smoke or other climate-related impacts? If so, how would you characterize these needs?
    a. How have you been able to adjust to meet these changing needs?
    b. If you've been challenged to meet these changing needs, what would you need to do so? From your vantage point, what would an ideal response look like?
4. We're curious about the potential changes in timing for worker needs since farm labor needs may be shifting in response to climatic changes. For example, increasing temperatures can lead to crops developing more quickly, which may mean a compressed amount of time for harvest and a shorter overall harvest season which may impact paychecks.
    a. Have you noticed any changes to the timing or the types of services needed related to changing environmental conditions?
    b. Probe: In addition to heat-driven changes, are there other timing and service changes related to environmental changes?

5. How would increasing frequency and duration of these environmental threats impact your capacity to respond (I.e., extreme heat for more consecutive days)?
    a. Is there a threshold where current responses would need to be adapted?
    b. Are there particular services that you're worried about being able to provide in the future?
    c. Are there gaps you see in training resources that prevent these threats from being adequately addressed?
6. Does your organization currently utilize research-based information in your programs? If so, how?
    a. From where do you usually get your researched information? (I.e., the University Extension service, agencies, other)
    b. What research or information needs, if any, does your organization have related to environmental threats such as heat, frost, and drought?

If more information is needed on climate-related topics, continue to question 7. If not, jump to question 8:

7. If there were an opportunity for you to access up-to-date and regionally specific information through research or educational programs on climate-related topics, how would you prefer to engage?
    a. What type of format (education, training, connections to research teams, connections to existing resources) would be most useful for you to serve your clients? Are you or have you been involved with climate adaptation or resiliency planning or projects? If so, which project and what is/was your role?
8. Are you or have you been involved with climate adaptation or resiliency planning or projects? If so, which project and what is/was your role?
    a. Can you tell me more about the process and who is/was involved?
    b. How, if at all, did the outcomes change (or do you expect to change) the services you provide to farm workers?
9. Do you have any questions for me?
10. If I have any further questions or need clarification of anything you said, would it be all right if I contacted you again?