2024 Arizona Farmworker Enumeration Profiles Study

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INTRODUCTION

Background and rationale

Farmworkers engage in time sensitive and labor-intensive tasks including crop cultivation and harvest, post-harvest production, animal husbandry, and animal product processing. These workers are essential to the $224 billion agriculture industry in the United States,[1] but enumeration of farmworkers presents multiple challenges.[2] Farmwork is often seasonal or temporary, and demand for farm labor shifts over time with changing agricultural practices, mechanization, immigration policy, regional demography, natural resource availability, and consumer demand. Nonetheless, pursuit of reasonable farmworker estimates by county is critical to provision of services, emergency and pandemic planning, policy setting, identification of underserved areas, and support of agricultural production. For example, migrant health and education programs need county level estimates of farmworkers for planning purposes. In 2020, the onset of the COVID-19 pandemic underscored the need for a rapid response to protect farmworker health, and by extension, food security and economic stability.[3] From a public health perspective, having reasonable farmworker estimates by county provides a basis for distribution of resources to support farmworkers and the agriculture industry during emergencies and for ongoing preventative health initiatives.[4] Other organizations can use county level estimates of farmworkers to secure resources for housing, employment, education, and other necessary assistance for farmworkers and their families. Individuals who may benefit from county level estimates of farmworkers include growers, shippers, researchers, government officials, industry experts, and media representatives.

In Arizona, where agriculture contributes $23 billion to the economy annually,[5] demand for farm labor is high in certain sectors of the agriculture economy. Specifically, during peak winter production of leafy greens, Arizona's Yuma County supplies over 90% of the nation's lettuce.[6] Yuma County also has the highest Medjool date acreage in the country and a date processing facility that serves Arizona and California producers.[7,8] In Pinal and Maricopa Counties, dairy production is growing and Arizona dairies have the largest average dairy herd size per farm of any state in the country.[9,10] In the climatically temperate southeast region of the state, Arizona produces wine grapes, pecans, and pistachios.[11,12] Farmworker hiring trends are influenced by Arizona's shared international border with Mexico, which facilitates access to a labor pool of individuals who live in Mexico and cross the border daily for work in the agriculture sector. In recent years, Arizona agriculture producers have increasingly relied on the H-2A program, which allows US employers who meet specific regulatory requirements to hire foreign nationals to fill temporary agricultural jobs that remain unfilled by domestic workers.[13] The H-2A workforce has been steadily rising in the US, with a six-fold increase from 2005 to 2022.[14] In Arizona, the number of H-2A visas certified in 2023 grew to over 10,000.[15] Reasons for the increase in H-2A hiring include an aging domestic agricultural workforce, decreased barriers to hiring H-2A workers, and the enduring need for timely crop harvesting.[16-21]

Since the beginning of the federal Migrant Health program in 1962, and its expansion to include seasonal farmworkers in 1968, the US Department of Health and Human Services (DHHS) has attempted to enumerate farmworkers at the county level. Challenges in estimation included a lack of reliable secondary data sources, the absence of a census to validate proposed survey-

based models, and no standard approach. Throughout the 1980s, the US Public Health Service (PHS) attempted to identify counties with high counts of migrant and seasonal farmworkers and their dependents to guide the provision of services, but these reports lacked specificity. In 1990, the DHHS published *An Atlas of State Profiles Which Estimate Number of Migrant and Seasonal Farmworkers and Members of Their Families* that yielded estimates for every state and county using demand for labor (DFL) methods, migrant health services data, and local review for validation.[22] This report was not updated, however, owing to complications with inconsistency in general approach and DFL factors used by region. In 1992, Dr. Alice Larson and Luis Placencia published statewide enumeration estimates using consistent DFL inputs, but this left a gap in enumeration by county. Subsequently, in the 2000s a new approach to estimating farmworkers at the county level was developed by Dr. Larson. It considered each component of the farmworker population separately (e.g., crop labor, nursery-greenhouse labor, and reforestation where relevant), incorporated a range of methodological techniques to develop estimates for each state, and used knowledgeable experts across disciplines to review the results. Instead of trying to apply uniform research techniques across all states, Dr. Larson considered each state as a separate unit, keeping a similar research framework but varying exact methodologies to meet the data sources available for that state. This approach and the resulting detailed estimates gained wide acceptance and utilization by researchers, service agency representatives, governmental agents, agricultural producers, and many others within the states where such studies were produced.

In 2008, with funding from Portable Practical Education Preparation (PPEP) Inc., Dr. Larson enumerated migrant and seasonal crop workers in Arizona using the interactive research approach she had designed to incorporate many different methodologies to examine components of the agriculture sector.[23] The 2008 Arizona Migrant and Seasonal Farmworker (MSFW) Enumeration Profiles Study (EPS) reported 67,704 MSFW in the state.[23] Subsequently in 2014, the National Center for Farmworker Health (NCFH) attempted a nationwide enumeration of farmworkers in every state, including Arizona, using an approach focused on labor expenses supplemented by data from an ongoing federal farmworker survey.[24] The 2014 NCFH study for Arizona reported 54,878 MSFWs in crop work and 6355 livestock workers. The 2014 report did not use DFL-based methods, used fewer data sources to inform estimates, and was not as extensive in terms of engagement with experts at the local level. Given the ongoing need for a farmworker enumeration estimate in Arizona and the lack of a DFL-based estimate since 2008, local stakeholders repeatedly called for an updated DFL-based enumeration with local input. In the wake of the COVID-19 public health emergency, resources were pooled across public health and non-profit agencies to fund the 2024 Arizona Farmworker Enumeration Profiles Study (AZ-FEPS) guided by the Larson method, which resulted in this report.

The 2024 AZ-FEPS was initially supported by the Centers for Disease Control and Prevention (CDC) COVID-19 disparities funding distributed to the state health department's Advancing Health Equity, Addressing Disparities in Arizona (AHEAD AZ) program in June 2023; funding was supplemented by PPEP, allowing completion of the project in August 2024. Consistent with previous reports using Larson's methodology, the 2024 AZ-FEPS enumerates Arizona workers in hand-labor intensive crops and nursery-greenhouse work by county with estimated counts of non-farmworker household members. In contrast to the 2008 report, this report also includes estimates of workers in animal agriculture.

Objectives

1. Enumerate reasonable estimates of farmworkers and their household members in Arizona, overall and by county, for those employed in hand-labor intensive crop commodities and nursery green-house agriculture.

2. Enumerate reasonable estimates of farmworkers in Arizona, overall and by county, for animal agriculture workers, including those employed in animal husbandry, aquaculture, animal slaughtering, and dairy product manufacturing.

METHODS

Study design

The research team for the 2024 AZ-FEPS used a cross-sectional secondary data analysis approach. The study design and methods were adapted from previous farmworker enumeration profiles studies conducted by Dr. Alice Larson since 2000.[23-29] From June 2023 through August 2024, the research team for the 2024 AZ-FEPS followed this overall process:

1. Notification of stakeholders by deployment of mass email and optional online survey
2. Gathering and assembling of secondary data sources
3. Key informant interviews with stakeholders throughout Arizona
4. Preparation of estimates and initial draft
5. Review of initial draft by at least 10 knowledgeable experts in Arizona
6. Revision of initial draft based on knowledgeable expert input backed by related research
7. Issuance of the final 2024 AZ-FEPS report

Setting: geography and scope

The geographic scope of the 2024 AZ-FEPS included overall estimates of farmworkers for the state of Arizona and each of its counties (n=15). Enumeration estimates were not stratified by Arizona's 22 federally recognized tribes, but crop acreage data from tribal regions was incorporated into statewide and county-specific estimates.

This report contains estimates for the following types of farmworkers:

1. Crop workers in hand-labor intensive commodities, including those employed cultivation, harvest and immediate post-harvest production of fruits, vegetables, nuts, melons, and other hand-labor intensive crops;*
2. Nursery-greenhouse workers; and
3. Workers in animal agriculture, including animal husbandry, aquaculture, animal slaughtering, and dairy product manufacturing

*This report *does not* include those working exclusively in highly mechanized crop production such as cotton, wheat, and hay because the combination of data sources used did not allow for accurate estimation of this workforce.

For crop and nursery-greenhouse workers, household demographic analyses were included for the following groups:

1. Non-farmworkers present in the same household as farmworkers
2. Age distribution of children and youth under 20 years old in accompanied households

For crop workers only, migrant versus seasonal counts were estimated. No estimates of migrant versus seasonal workers were calculated for nursery-greenhouse workers or animal agriculture workers owing to the non-seasonal nature of tasks in these worker categories and lack of demographic data sources.

Definitions

The 2024 AZ-FEPS study used established definitions consistent with previous enumeration efforts and definitions specified by federally funded programs established to assist the farmworker population.

1. **Migrant and Seasonal Farmworkers (MSFW)** were defined as specified by the Health Resources and Services Administration (HRSA) in section 330 (g) of the Public Health Services Act.[30] *

   > Migrant definition: "Migratory agricultural workers are individuals whose principal employment is in agriculture, and who have been so employed within the last 24 months, and who establish for the purposes of such employment a temporary abode"
   >
   > Seasonal definition: "Seasonal agricultural workers are individuals whose principal employment is in agriculture on a seasonal basis and who do not meet the definition of a migratory agricultural worker"

   *By definition, those workers brought to Arizona on H2-A work visas were considered "Migrant"

2. **Industries included** in this report can be characterized by North American Industrial Classification System (NAICS) codes,[31] which were used when appropriate as a basis for extracting worker estimates from various databases. Broadly, jobs included under NAICS code 111 (Crop Production) and 112 (Animal Production and Aquaculture) were included in this report. Within crop production, the NAICS code 1114 (Greenhouse, Nursery and Floriculture Production) was used to distinguish nursery-greenhouse workers separately from those working in hand-labor intensive outdoor crop production. Additionally, NAICS code 115114 (Postharvest Crop Activities) was used to identify workers in facilities dedicated to postharvest cooling, packing, shelling and sorting activities. The NAICS codes for animal agriculture included beef cattle ranching and farming, cattle feedlots, dairy cattle and milk production, hog and pig farming, egg and poultry farming, sheep and goats farming, aquaculture, and other forms of animal production. Additionally, NAICS codes 3115 (Dairy Product Manufacturing) and 3116 (Animal

Slaughtering and Processing) were used to characterize off-farm animal agriculture jobs involving direct contact with animal parts or products.

Overview of Methodology

1. ***Demand for labor (DFL)*** was the primary methodology for enumerating hand-labor intensive jobs that employ farmworkers in the cultivation and harvest of fruits, vegetables, nuts, melons, and other hand-labor intensive commodities. The DFL is an econometric method for estimating full-time equivalent (FTE) jobs, which requires subsequent calculations to convert FTE jobs to worker estimates. This conversion accounts for duplication (i.e., when one worker has more than one job) and turnover (i.e., when one job is filled by more than one worker) as described below. One advantage of the DFL methodology is that it is agnostic to whether workers are direct hires, laborers supplied by farm labor contractors, or H-2A workers. Given the complexity in current hiring practices, which complicate the use of employer-reported data for enumeration, the DFL offers a method based on labor needed to cultivate and harvest crops. The method requires gathering data from a variety of sources and leverages acreage data reported to the Census of Agriculture (CoA) to estimate DFL.

2. **Non-DFL, employer-reported worker estimation methods** were used for workers in nursery-greenhouse, animal agriculture, and select postharvest processing categories. For these workers, the DFL methodology could not be employed because the inputs for the DFL are specific to seasonal outdoor crops. These non-DFL direct employer-reported worker counts were derived from several data sources (described below) in which NAICS codes were used to estimate the number of workers by agriculture category. When direct counts by county were unavailable for specific NAICS codes, multiple methods were employed, including indirect standardization by number of farms or establishments in each county.

3. **Demographic characteristics of crop workers and household composition** were estimated through compilation of data requested through government agencies and non-profit organizations serving farmworkers, including health, employment, education, and social services.

Limitations

Farmworker enumeration at the county level is not simple or straightforward owing to the dynamic nature of farmworkers and the agriculture industry. No database exists that provides a comprehensive picture of this population, and definitions used to characterize workers or determine eligibility for programs are in constant flux.[32] All enumeration studies to date have been limited by the necessary use of secondary data sources that were not prepared for the explicit purpose of enumerating farmworkers. The 2024 AZ-FEPS is an attempt to piece together available information concerning farmworkers in Arizona to make reasonable approximations with input from local key informants.

The estimates generated by this study should be considered reasonable estimates, distinct from surveillance data or statistical estimations derived from primary surveys. The use of secondary source material meant accessing reports and documents prepared for other purposes and assembling them, when possible and appropriate, for incorporation within the study. A challenge inherent to the DFL methodology is that calculations are based on the concept of jobs rather than individuals, making it challenging to discriminate between those casually employed in agriculture versus workers who rely on farmwork for the majority of their income. Utilization of client data from farmworker-serving organizations does provide a source that matches the specific worker definitions as most have similar eligibility criteria. However, information sought from organizations that work directly with farmworkers can be biased towards a particular segment of the population (i.e., those who know about or seeking services) and therefore may not represent the heterogeneity of the farmworker population at large. To address these challenges, the methodology emphasized combination of multiple sources to offset biases specific to any one source

Factors included in the DFL were derived from multiple databases and reports. The duplication and turnover factors required to convert FTE jobs to workers were derived from a singular farmworker service organization work history database, which could bias the generalizability of these factors. The research team acknowledges that despite efforts to locate all sources of data on this population, there may be sources unknown to the research team that were not considered. In several instances, the lack of detailed documents or other data required the utilization of key informant interviews to fill in blanks.

Finally, it is critical to note that this report does not include farmworkers working exclusively in highly mechanized crop commodities such as wheat, cotton, hay and other crops (Supplemental Table 2b). While these crops comprise a high proportion of all crop acreage in Arizona, harvest and post-harvest activities do not require intensive hand-labor and therefore do not require substantial numbers of farmworkers to accommodate seasonal crop demands. Most workers in these highly mechanized crop commodities are year-round employees. When temporary labor crews are hired for these highly mechanized crop commodities, they frequently have jobs in hand-labor intensive crops as well, which would mean they would be counted in the enumeration of those other crops (for which the DFL methodology was employed). However, those who work in highly specialized tasks, such as year-round operation of technical equipment or irrigation, would not be included in estimates. The research team attempted to enumerate these workers separately but were unable to agree on a valid method given limitations to reliably identifying these workers.

Community Engagement

Notification Email and Optional Survey. At the outset of the 2024 AZ-FEPS effort in Summer 2023, the research team sent a mass email for the purposes of notifying stakeholders of the project and gathering tips on additional secondary data sources. The email was sent via REDCap to 248 stakeholders in Arizona including: Arizona industry contacts published in the National Center for Farmworker Health directory; contacts from University of Arizona Cooperative Extension directories; directories compiled by the Arizona Interagency Farmworkers Coalition (AIFC); government agency directories including departments of agriculture, public health, and

employment; academic partners, community health providers, and non-profit agencies serving farmworkers. The email described the project and gave respondents the option to complete a survey on trends in Arizona agriculture over the past 10 years, knowledge of potential data sources, and interest in engaging with researchers. Within 90 days of sending the email and optional survey, 24 respondents replied with insight and suggestions for contacts and potential data sources.

Community Advisory Board (CAB). In Fall 2023, the research team solidified a CAB for the project, which was assembled in close collaboration with the AIFC. The AIFC was formed in the early 2000s to link various organizations from around the state involved with farm labor. Their mission is to meet the needs of farmworkers, their families, and their communities. Given their long-standing relationships and forums for gathering stakeholders in farm labor on a regular basis, the AIFC served as the backbone of the 2024 AZ-FEPS CAB. The CAB included AIFC board members from PPEP Inc., Arizona Alliance for Community Health Centers, Arizona Department of Agriculture, Arizona Department of Employment Services, Community Legal Services, Arizona Department of Education/Migrant Education, and Adelante Healthcare. In addition to the standing members of the AIFC Board, the research team invited representatives from state and local health departments as well as the University of Arizona to join the CAB. The AIFC meets monthly and allowed the 2024 AZ-FEPS research team to assemble the CAB on a quarterly basis during their regularly scheduled Zoom calls. During these quarterly meetings, members of the AZ-FEPS CAB who were not members of the AIFC were invited to attend the AIFC meetings during those meetings with CAB updates and discussion forums.

Internet Searches and Follow-Up. Members of the research team engaged in a thorough search of academic literature, gray literature, and websites. Web searches involved identifying and reviewing sites maintained by Arizona government agencies, academic institutions, trade associations, companies related to agriculture or farmwork and others. Relevant notifications, publications and reports were examined. Additional data sources or contacts for key informant interviews were sought as a result of these searches.

Key Informant Interviews. After collecting and arraying initial data, research team members arranged key informant interviews to help assess methodologic assumptions, get advice on how to fill in missing information, and gain perspective on the internal and external validity of data sources. Between 5/20/2024 and 7/17/2024, the research team interviewed 42 knowledgeable experts over the course of 31 interviews with individuals from Arizona's cooperative extension programs, agriculture industry, Department of Agriculture, Department of Employment Services, Community Legal Services, agriculture and economic researchers, and non-profit health and social services agencies serving farmworkers.[7,10,12,17,18,20,21,33-57]

Initial Draft Review. After generating preliminary estimates and completing a full draft report, 11 knowledgeable experts in Arizona reviewed the draft report to provide critical input. Based on input from draft reviewers, the research team considered each response from reviewers and made adjustments accordingly. The following is a summary of changes made in response to reviewer feedback.

1. Recalculation of turnover rates by county. Multiple reviewers of the draft report commented that a singular turnover rate should not be applied to all counties. Their primary concern was that the data source used for this calculation was biased towards workers in Yuma County. They commented that certain crops had a greater turnover rate given the high volume of jobs available at certain times of year which would draw workers from over the border or from California (e.g., lettuce harvest in Yuma County) where the same could not be said for tasks in other crops and locations. Based on the advice of an agricultural economist on the reviewer panel, the research team considered adjustments to this rate based on type of crop and amount of acreage grown in each county (details below). One reviewer commented that the PPEP data used to calculate turnover was a good representation of all farmworkers in the state. Another reviewer noted that clients seeking PPEP services were less likely to turnover than others, which could potentially produce an underestimate of overall farmworkers. We noted the limitation of using a single data source for turnover in the final report and applied weighted turnover rates as suggested, which allowed turnover to vary by county.

2. Reassessment of acreage in La Paz County. In the initial report, La Paz County had fewer than 20 workers in hand-labor intensive crops, which reviewers found unlikely. Several reviewers mentioned that they had seen workers harvesting melons in 2024. The research team rereviewed data from the 2022 Census of Agriculture (CoA), which was the primary source of data for county-specific DFL estimates and found no melon acreage reported in La Paz County. After speaking with local experts, the research team concluded this crop began production after 2022 COA acreage data were collected, and that currently there were 250 melon acres under production in La Paz. New DFL calculations were made based on this updated information resulting in the higher farmworker estimate in La Paz County utilized in the final report.

3. Clarification of methodology and terminology. Based on reviewer concerns about clarity of inclusion and exclusion criteria, the research team eliminated the use of "field workers" throughout the report. Instead "crop" workers are specified throughout as "those employed in the cultivation, harvest and immediate postharvest production of fruits, vegetables, nuts, melons, and other hand-labor intensive commodities." Throughout the narrative and tables, the exclusion of workers who work in highly specialized year-round tasks for mechanized crops was emphasized. Based on reviewer comments. Reviewers suggested additional citations to provide context for interpretation, all of which were incorporated into the final report.

Data Sources

National Datasets

The AZ-FEPS team assembled information from multiple data sources, some of which were publicly available for download. Other datasets were provided upon direct request to service agencies. All datasets were either de-identified individual-level datasets or aggregate data. Subsets of Arizona-specific data were extracted from the most current versions of the following national databases:

1. Census of Agriculture (CoA). The United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) conducts a direct survey of agriculture producers every five years. This survey collects information on acreage by county. This study used the most recent data from the 2022 CoA for Arizona to inform acreage inputs for DFL estimations by crop and county.[58] Previous versions of the CoA from 2017,[59] 2012,[60] and 2007[61] were used in specific instances where county level suppression of 2022 CoA data prohibited the allocation of crop acreage by county.

2. Quarterly Census of Employment and Wages (QCEW). The US Department of Labor (DoL) Bureau of Labor Statistics publishes counts of workers by month and by county reported to be employed by NAICS codes. The QCEW includes reports of hired employees and wages paid by individual Social Security Number, which is compiled from information submitted to the DoL by each state for workers covered by the state Unemployment Insurance System. Summaries of workers by county are published online with suppression of county level counts that are small or that would allow for identification of a specific establishment based on data reported. For this study, peak monthly employment was pulled from quarterly QCEQ data downloaded for the years 2021-2023 for Arizona overall and by county according to NAICS codes specified above.[62]

3. Census of Horticulture (CoH). The USDA NASS collects data on the nursery and greenhouse industry every five years for establishments with over $10,000 annual sales. This study used data from the most recent such report, the 2019 Census of Horticulture.[63]

4. National Agricultural Workers Survey (NAWS). The NAWS database provides employment, demographic, and health data on a random sample of farmworkers from every state. Results are reported by region, where most single-state regions are not publicly available due to privacy considerations. California is an exception due to its size and large share of the farmworker population, so state-level reports are published. The NAWS began in 1989, and over the following 30 years generated interview data from over 76,000 crop workers. The survey includes questions concerning employment, work history, household composition, general health, and access to services. The survey does not include H-2A workers in its sampling frame. The Southwest region contains Arizona, New Mexico, Texas and Oklahoma, while California is its own region.[64] The research team decided to use California NAWS data since California grows many of the same crops as Arizona, and workers travel between the two states, most frequently for leafy green harvesting. Ultimately, researchers used the data aggregated from the most recent five years of reports (2016-2020) from the California region to estimate the demographic factors described below.

5. Farm Labor Report. The USDA NASS, on a quarterly basis, collects and reports information submitted by agricultural employers on the number of weekly hours worked and wages paid to their farm labor force. This information is grouped into regions. The Mountain Region III area includes Arizona, Colorado, Montana, New Mexico, Utah and Wyoming. This information was incorporated into the factors needed for the DFL estimates pertaining to hours worked per day and per week using data from 2018-2023.[65]

6. H-2A Certification Database. The US Department of Labor's Office of Foreign Labor Certification publishes applications and certifications for H-2A visas for work in agriculture. Data were downloaded for H-2A requests and certifications for Arizona worksites for 2023.[66] A summary of certified H-2A applications by Arizona county and agriculture category is listed in Supplemental Table 3. These workers would be included in the estimates in Table 1 since H-2A workers are included in DFL estimates.

Reports Containing DFL Factors: The University of California, Davis Department of Agricultural and Resource Economics produces enterprise crop budgets offering guidance to agricultural producers on the costs and production methods for individual crops. These budgets were available online by crop.[67] Crop budget narratives and budget lines were mined to extract factors for understanding specific tasks requiring hand labor and the hours per acre needed and season length for each task. Various crop calendars were considered to estimate peak season length by crop.[68-70]

Arizona Health or Service Agency Datasets: Researchers requested and arrayed data from health services agencies and other non-profit agencies in Arizona to inform various estimation factors. Data were obtained from federally qualified health centers with Migrant Health programs (e.g., Sunset, Adelante, Chiricahua, and Mariposa Community Health Centers); migrant education programs (e.g., Chicanos por la Causa), and other service agencies serving farmworkers (including PPEP and Campesinos Sin Fronteras). Data from these sources was weighted and arrayed to inform household composition and other demographic factors.

Estimation Methods

In this report, crop workers are defined as hand-labor intensive crop workers involved in the cultivation, harvest, or immediate post-harvest production of fruits, vegetables, nuts, melons, and other hand-labor intensive commodities. These workers comprise the majority of agriculture workers in Arizona and were estimated via the DFL methods. Nursery-greenhouse workers, off-farm postharvest workers, and animal agriculture workers were estimated using non-DFL methods described below.

1. Crop workers. The primary method used for estimating hand-labor intensive crop workers was demand-for-labor (DFL) by crop, which generates the number of jobs needed to complete agricultural production tasks (e.g., harvest, pruning, weeding, thinning irrigation, and sorting). The concept was to delineate the task where most workers were likely to be engaged. For lettuce, an examination of a database that included farm labor work histories revealed that workers employed for cultivation activities were different from those working the lettuce harvest. For this reason, DFL estimates were made for two lettuce work tasks. For potatoes, most hand labor involved cultivation tasks. Accordingly, DFL estimates were made for this activity rather than harvest. Note, the DFL estimates do not include workers in highly mechanized crop harvesting (for a full list of excluded crops, see Supplemental Table 2).

   Key informants in Arizona indicated that individuals involved in other pre-harvest activities (e.g., moving pipe, planting, weeding, thinning) were usually employed in harvesting as well,

so to prevent counting a single individual worker more than once, separate estimates were not made for these activities. Further, individuals involved in highly technical aspects of crop cultivation (e.g., remote sensing and programming of irrigation) were not enumerated unless they were also directly engaged in other forms of hand-labor intensive activities.

The assumption in using jobs to estimate workers is that one DFL-defined FTE job is equivalent to one worker. This is not necessarily the case. To compensate, two factors were applied to make the conversion from job to worker. The first one, duplication rate, considers the fact that one worker might hold more than one defined DFL job. The second factor, turnover rate, accounts for the reality that a single job defined by the DFL might be performed by more than one person. Once the DFL was calculated, duplication and turnover factors were applied.

Arizona, particularly the Yuma area, proved challenging for estimating the duplication and turnover rates as a large number of farmworkers come and go through the area in a variety of ways. An individual can work directly for an agricultural producer or can be employed by a farm labor contractor or by a company that contracts with growers to produce a specific crop. In addition, casual labor is used to fill out work crews from each of these sources as needed (i.e., when more regular employees are absent). Lastly, individual workers and farm labor contractors can travel back and forth between Arizona and California depending on harvest season. More details on the use of job history data to estimate duplication and turnover factors are provided below.

DFL estimates involve the application of a formula composed of four elements for each crop included. (The resulting factors used for each crop are provided in Supplemental Table 1):

$$DFL = \frac{A \times H}{W \times S}$$

Where:
A = crop acreage
H = hours needed to perform a specific task on one acre of the crop
W = work hours per farmworker per day during maximum activity
S = season length for peak work activity

A (crop acreage): The 2022 CoA was the base source for crop-specific acreage by county in Arizona. Crops with less than 10 acres reported to the CoA were excluded under the assumption that most hand labor would be performed by family members or other unpaid individuals. Also excluded were crops that were highly mechanized (e.g., mechanically harvested, requiring minimal-to-no hand labor). Supplemental Tables 2a and 2b provide lists of these excluded crops.

When the 2022 CoA had directly reported acreage at the county level, that data was used for DFL calculations. However, a substantial amount of county level crop acreage data was suppressed in the 2022 CoA. Data suppression can happen for two reasons: the number of farms in a particular county is so small that the acreage data could easily be attributed to a particular farm or a small number of farms if published, or a particular farm is identifiable because data from other farms has been suppressed. For these reasons, substantial amounts of crop acreage by county data were not available in the 2022 CoA. Data suppression was more likely in the 2022 CoA than in previous iterations of the CoA.

Although crop acreage was suppressed for some counties, the number of farms producing a given crop was consistently reported by the county. When less than 50% of acreage for a particular crop was suppressed, researchers used the distribution of the number of farms by county to estimate acreage by county. When certain counties had suppressed data and other counties had reported data for a given crop, the total acreage reported for a specific crop was subtracted from the statewide total acreage (statewide acreage was reported for every crop, which included data that was suppressed at the county level); the remaining unallocated acreage was then estimated for each county based on the distribution of farms by county.

When more than 50% of acreage data for a particular crop was suppressed, study researchers examined older versions of the CoA and where these provided unsuppressed crop acreage, this information was used to generate an acreage distribution which was then applied to the total unallocated acres reported in the 2022 CoA. A decision was made on which past year to use based on the following considerations: percent of acreage unallocated (lower was prioritized), similarity of total acreage to 2022 (closer was prioritized), and most recent (closer to 2022 was prioritized).

These methods had the potential to lead to distorted acreage distribution particularly where unreported crop acreage in one county might be caused by one very large producer. Key informants familiar with agriculture industry trends and CoA reporting told study researchers that more small farms were participating in the 2022 CoA than had in previous years, which means that the methods for allocating suppressed data by distribution of farms could be biased by the assumption of average acreage by farm. The research team checked with key informants to verify acreage distributions where such data was not directly reported in the CoA. For particular crops where acreage was suppressed or unavailable across CoA iterations (e.g., dates) or for crops where knowledgeable experts told researchers there had been recent mergers and acquisitions, manual adjustments were made based on expert input and research into the location of specific farms.

H (Hours for Task): The number of manual labor hours required to complete specific tasks for each crop was determined using various sources, primarily enterprise crop budgets developed by University Extension programs. Researchers used the most current information available. During the project period, Enterprise Crops Budgets were not being produced by the University of Arizona's College of Agriculture Life and Environmental Sciences (CALES) as they had been in the 1990s and early 2000s. However, recent crop budgets were available from the University of California, Davis.[71] Key informants familiar with Arizona agriculture consulted for this study agreed that such budgets would be relevant to Arizona

crop production and provided guidance on their use. Additional sources for the hours per task factor came from what had been used in the 2008 Arizona Migrant and Seasonal Farmworker (MSFW) Enumeration Profiles Study (EPS) and the 2013 Oregon MSFW EPS Update.[23,28] In cases where multiple sources were referenced for a particular crop, the average number of hours per acre was calculated and utilized for estimation purposes (Supplemental Table 1). When estimates diverged, key informants familiar with crop production were consulted.

W (Work Hours): The W factor was derived from weekly work hours reported in the USDA NASS Farm Labor Report. These quarterly figures were averaged over five years. Information from the NAWS, H-2A work order requests (which specified days those requested would be required to work), and key informants suggested a six-day work week.[65,72] The averaged Farm Labor Report weekly hours figure was divided by 6 to determine daily work hours. The resulting factor of 7.41 was utilized in the DFL equation for the W factor.

S (Season Length): Information sought for the DFL S factors related to peak activity and not necessarily the entire season length. Sources used included previous enumeration reports from Arizona (2008) and Oregon (2013),[23,28] University of California Davis Crop Budgets,[71] Research Designed for Agriculture (RD4AG) Field Crops and Citrus Harvest Calendar,[69] Barkley Company of Arizona Growing Calendar,[71] and the 2018 Arizona Department of Agriculture Guide to Agriculture.[68] Where multiple estimates were available and close in range, estimates were averaged. To make decisions about season length, the preference for certain sources was determined by the following criteria: most current, specific to Arizona, and verification through key informant interviews. Where season length was provided in calendar days, these were converted to workdays for the DFL equation by dividing by seven (determine number of weeks) and multiplying by six (determine number of actual workdays). The S used for each crop is provided in Supplemental Table 1.

Duplication Rate. The DFL method for workers in crop agriculture estimates FTE jobs rather than individual workers, which assumes one "job" equals one worker. An adjustment was made to account for those employed in more than one agricultural job. For example, a single individual might work in both broccoli and lemon operations. If the estimates for workers employed in each of these crops were simply added, the results would overestimate the number of individual farmworkers within any one county or statewide. A duplication rate was applied to account for these multiple jobs completed by a single worker.

To estimate the duplication factor, the research team examined records of individuals served by PPEP in the last five years which included work history information for a 12-month period as a means to determine client eligibility. This database contained information on 1397 non-H-2A farmworkers. Researchers coded work history data on the number of distinct jobs held by each worker over a one-year period. The collective jobs total was then divided by the number of individuals in the dataset. The result was 1.72 jobs per worker. Each county's total DFL estimate was divided by this factor.

Turnover Rate. The DFL estimates also needed to be adjusted by a turnover rate to account for the fact that multiple farmworkers work a single "job" as defined by DFL estimates. The

research team defined turnover by comparing the length of time needed to perform a particular crop job (described by the S factor in the formula) to the amount of time a worker actually spent performing that job. The PPEP work history database was used to determine actual time spent working on a particular task throughout one year. For example, if an individual employed harvesting lettuce reported multiple such jobs during a 12-month period, the time spent on all these similar jobs was added together. The results were compared to the DFL season length for that same task (Supplemental Table 1) to determine if the time the worker was employed in a particular crop was less than or greater than the DFL season-length. The findings by crop were added, and then a ratio of over-to-under season length was calculated. This factor was determined to be the turnover rate. The only source used to make this calculation was from PPEP (a farmworker assistance program) where 90% of the data was from clients in Yuma. In preliminary analyses, a factor of 2.88 was utilized for every county. In response to expert review comments that the turnover rate should be adjusted by county, the research team used the PPEP work history data base to create crop-specific turnover rates, and then calculated a turnover rate for each county based on distribution of crop acreage in the 2022 CoA. Ultimately, the highest turnover rate was applied to Yuma County (3.01) and all other counties had a turnover rate of 2 or lower. This adjustment was consistent with the general observation shared by interviewees and reviewers that Yuma County likely had a higher turnover rate compared to other counties given the high volume of seasonal workers living in the county and commuters crossing the border daily for agriculture jobs. The rate in other counties is consistent with, or slightly lower than, a "two workers per job" rule applied by UC Davis researchers using different methods to estimate agriculture jobs in California counties.[73,74]

Note that duplication and turnover rates were not applied to nursery-greenhouse workers or animal agriculture workers. While turnover is likely in these agriculture job categories, the research team did not have data to inform turnover rates for nursery-greenhouse or animal agriculture workers. Further, these jobs are less seasonal in nature, so potentially less subject to turnover than seasonal crop work.

Rules of Thumb. Alternative methods for calculating the number of workers needed for specific crops and tasks were obtained directly from individuals who were familiar with or were producing a specific crop (e.g., so many workers necessary to harvest one acre of a specific crop). These "Rules of Thumb," if incorporated into DLF estimates, were included in Supplemental Table 1. Sources for this information included key informant interviews, UC Davis Crop Budgets and the previously completed Arizona and Oregon enumeration studies. When a Rule of Thumb was available, a final estimate was developed by averaging these results and the DFL estimate.

2. Postharvest workers in cooling, packing, shelling and sorting. Key informants indicated there were a significant number of workers employed in off-farm indoor facilities for cooling and packing leafy greens, sorting and shelling dates and nuts, or packing produce coming across the US-Mexico border. These workers would not be included in DFL estimates because these activities were not included in specific crop budgets, which were based on costs per farm acre of land. One source of information for these postharvest workers was determined to be QCEW data reported under 115114 (postharvest activities). A

postharvest crop worker estimate was derived from the average peak employment month for this NAICS code over three years, and the results were added to worker crop estimates for each county.

3. Nursery-greenhouse workers. Nursery-greenhouse workers and those employed in crops grown under cover engage in tasks on a variety of crops including plants, cut flowers, florist greens, floriculture, flower seed crops, foliage plants, greenhouse vegetables, mushrooms, potted flowering plants, sod, and vegetable seed crops. Some products are grown in covered structures while others are raised in open acreage. Tasks differ with product type and production needs.

   To estimate nursery-greenhouse workers by county, three data sources were used: the Quarterly Census of Employment and Wages (QCEW, years 2021-2023), the 2019 Census of Horticulture (CoH), and the 2022 Census of Agriculture (CoA). These databases were analyzed to enumerate nursery-greenhouse workers in five different ways. The county level estimates generated by each of the five methods below were averaged for the final estimates for nursery-greenhouse workers presented in Table 1.

   Method 1. Subsets of QCEW Arizona data for 2021-2023 were pulled for NAICS code 1114, defined as workers in the industry "Greenhouse, Nursery and Floriculture Production." The month with the maximum employment under this code was identified for each of the three years, 2021-2023, by county. Results were averaged.

   Method 2. A statewide Arizona employment number for nursery-greenhouse workers was extracted from the 2019 CoH dataset. The three-year average maximum employment for each county calculated from Method 1 was used to determine the statewide percent share of workers in each county. This percentage was then applied to the CoH statewide figure to estimate county-specific totals.

   Method 3. The 2022 CoA reports acres of "open growing" and "square feet under glass," which was pulled for Arizona. The square feet figure was converted to acres and added to the figure for acres of open growing. County level acreage data was arrayed where reported, and where suppressed, acreage was allocated based on the distribution of farms. The percentage of statewide acreage in each county was then applied to the CoH statewide employment figure to generate county level estimates.

   Method 4. A statewide Arizona employment number for nursery-greenhouse workers was extracted from the 2022 CoA dataset. The three-year average maximum employment for each county from Method 1 was used to calculate the percent share of workers in each county and then multiplied by the statewide 2022 CoA figure to estimate county-specific totals.

   Method 5. The county level percent distribution of acreage data determined in Method 3 using the 2022 CoA was applied to the state total of workers specified in the 2022 CoA dataset. This calculation resulted in a fifth estimate of nursery-greenhouse workers by county.

Demographics. Estimates were made for other members residing in the same household as workers, defined in this report as "accompanied" households. These estimates relied on a set of demographic factors that were applied to worker estimates (Table 1 and 2). Household members were only estimated for crop and nursery-greenhouse workers. Data were obtained from a variety of sources (described below) from which these factors were derived. Calculations were made by multiplying the number of workers by the percent of accompanied, dividing the results by the average number of farmworkers per accompanied household (to determine number of accompanied households), then multiplying by the number of non-farmworkers per household (after first determining the average household size of accompanied households). Household member estimates are included in Table 1.

Additionally, for crop workers only, information was obtained that allowed for an estimate of the percent of workers who could be defined as "migrant" versus "seasonal" (Table 2). Age distributions for children and youth under 20 years old were calculated for accompanied households (Table 3).

a. Migrant/Seasonal. Seven estimates of the migrant and seasonal proportion (i.e., "split") of crop workers were considered when generating the migrant/seasonal split to apply to final estimates.[42,75-80] Three of the sources contained Yuma data only, which indicated a different migrant/seasonal split than the sources with statewide data. Two sources indicated a different split for Maricopa County. Accordingly, different percentage distributions were used for Yuma and Maricopa Counties, with a singular "statewide" distribution used for all other counties. For Yuma, 24% were estimated to be migrant and 76% seasonal. For Maricopa, 49% were estimated to be migrant and 51% seasonal. For all other counties, 47% were estimated to be migrant and 52% seasonal. These estimates reflect weighted averages across the seven datasets used.

b. Accompanied. Four estimates of accompanied versus unaccompanied were considered.[42,75,76,79] A weighted average from the five data sources yielded an accompanied rate of 73% and an unaccompanied rate of 27%.

c. Farmworkers and Non-Farmworkers per household. Four data sources provided information which yielded a weighted average household size of 4.16.[3,76,79,81] Two sources were used to estimate farmworkers per accompanied household at 1.82.[76,82] By subtracting 1.82 from 4.16, the estimated number of non-farmworkers per household is 2.34.

d. Children and youth by age groups. Two data sources were averaged to generate the percentage of children and youth (See Table 3).[75,79]

4. Animal Agriculture Workers. Estimates for Arizona workers in animal agriculture, including aquaculture, dairy product manufacturing, and animal slaughtering were based on information from three years of QCEW data (2021-2023) and the 2022 CoA. These estimates are in Table 4. Animal agriculture workers were estimated using NAICS codes exclusively because the DFL methodology could not be applied. All jobs under NAICS codes 112 and select jobs under 311 were included in animal agriculture worker estimates. This included beef cattle ranching and farming, cattle feedlots, dairy cattle and milk production, hog and pig farming, egg and poultry farming, sheep and goat farming, aquaculture, and other forms of animal production such as apiculture (beekeeping).[11]

   Two sources for animal worker numbers were found: QCEW and 2022 CoA. Peak month employment figures for NAICS 112 (animal agriculture) were pulled for a three-year period and averaged for each county. Since the CoA animal worker numbers were only available at the state level, the statewide proportional share of QCEW animal workers for each county was applied to the CoA statewide figure. Final animal worker estimates were derived by averaging the results from these two sources.

   Aquaculture workers are those employed in the controlled cultivation of aquatic organisms and plants, including breeding, growing, and harvesting. These activities are identified under NAICS code 1125 which includes finfish farming and fish hatcheries, shellfish farming, and other aquaculture.[11] No information on aquaculture workers was available from the CoA, so only data from the QCEW were used to estimate aquaculture workers. Peak employment month figures for a three-year period were averaged for each county and incorporated into the on-farm animal agriculture worker estimates in Table 4.

   Workers in off-farm animal agriculture were characterized for dairy product manufacturing (NAICS code 3115) and animal slaughtering (NAICS code 3116). Totals by county were merged for these two codes and presented in Table 4. No information on off-farm dairy product manufacturing or animal slaughtering workers was available from the CoA, so only data from the QCEW were used to estimate aquaculture workers. Peak employment month figures for a three-year period were averaged for each county and incorporated into Table 4.

TABLES

Table 1. Estimated counts and percentages of Arizona crop* and nursery-greenhouse workers, with estimated counts of non-farmworkers in farmworker households, by county.

County	Crop Workers* n (%)	Nursery-Green-house Workers n (%)	Crop* and Nursery-Greenhouse Workers n (%)	Non-Farm-workers in Households† n	Total People in Farmworker Households n
Apache	170 (0.2)	44 (1.6)	214 (0.3)	199	412
Cochise	4,816 (6.0)	24 (0.9)	4,839 (5.8)	4,509	9,348
Coconino	433 (0.5)	12 (0.4)	445 (0.5)	415	860
Gila	192 (0.2)	0 (0.0)	192 (0.2)	179	371
Graham	675 (0.8)	45 (1.6)	719 (0.9)	670	1,390
Greenlee	69 (0.1)	0 (0.0)	69 (0.1)	64	133
La Paz	45 (0.1)	1 (0.1)	46 (0.1)	43	89
Maricopa	4,529 (5.6)	1,442 (53.3)	5,971 (7.2)	5,564	11,535
Mohave	853 (1.1)	104 (3.8)	956 (1.2)	891	1,848
Navajo	136 (0.2)	4 (0.1)	140 (0.2)	131	271
Pima	374 (0.5)	119 (4.4)	492 (0.6)	459	951
Pinal	504 (0.6)	519 (19.2)	1,023 (1.2)	953	1,976
Santa Cruz	852 (1.1)	63 (2.3)	916 (1.1)	853	1,769
Yavapai	1,470 (1.8)	140 (5.2)	1,610 (1.9)	1,500	3,111
Yuma	65,320 (81.2)	188 (7.0)	65,508 (78.8)	61,042	126,550
Total State	**80,437 (100.0)**	**2,704 (100.0)**	**83,141 (100.0)**	**77,472**	**160,613**

*Crop workers are defined as those employed in the cultivation, harvest and immediate post-harvest production of fruits, vegetables, nuts, melons, and other hand-labor intensive commodities; workers in highly mechanized crops such as cotton, wheat, and hay are excluded

†Non-farmworker household members are estimated by assuming the following: 73% of farmworkers are accompanied; of these, the average household size is 4.16, including an average of 1.82 farmworkers and 2.34 non-farmworkers per household (see report narrative for detail on source data and estimation methods).

Table 2. Estimated counts and percentages of Arizona crop* workers by migrant or seasonal status and county.

County	Crop Workers* n (%)	Migrant Crop Workers† n (%)	Seasonal Crop Workers† n (%)
Apache	170 (0.2)	80 (0.3)	90 (0.2)
Cochise	4,816 (6.0)	2,263 (9.9)	2,552 (4.4)
Coconino	433 (0.5)	204 (0.9)	230 (0.4)
Gila	192 (0.2)	90 (0.4)	102 (0.2)
Graham	675 (0.8)	317 (1.4)	358 (0.6)
Greenlee	69 (0.1)	32 (0.1)	36 (0.1)
La Paz	45 (0.1)	21 (0.1)	24 (0.0)
Maricopa	4,529 (5.6)	2,219 (9.7)	2,310 (4.0)
Mohave	853 (1.1)	401 (1.8)	452 (0.8)
Navajo	136 (0.2)	64 (0.3)	72 (0.1)
Pima	374 (0.5)	176 (0.8)	198 (0.3)
Pinal	504 (0.6)	237 (1.0)	267 (0.5)
Santa Cruz	852 (1.1)	401 (1.8)	452 (0.8)
Yavapai	1,470 (1.8)	691 (3.0)	779 (1.4)
Yuma	65,320 (81.2)	15,677 (68.5)	49,643 (86.2)
Total State	**80,437 (100.0)**	**22,872 (100.0)**	**57,565 (100.0)**

*Crop workers are defined as those employed in the cultivation, harvest and immediate post-harvest production of fruits, vegetables, nuts, melons, and other hand-labor intensive commodities; workers in highly mechanized crops such as cotton, wheat, and hay are excluded

†County-specific migrant and seasonal proportions were applied as followed: Yuma County, 24%-76%; Maricopa, 49%-51%; and all other counties, 47%-53%

Table 3. Statewide distribution of children and youth under 20 years-old living in accompanied households of with Arizona crop* and nursery-greenhouse workers.

Age Group (years)	Percentage†
<1	2.2
1-4	14.8
5-12	43.7
13-14	11.6
15-18	22.8
19	4.9

*Crop workers are defined as those employed in the cultivation, harvest and immediate post-harvest production of fruits, vegetables, nuts, melons, and other hand-labor intensive commodities; workers in highly mechanized crops such as cotton, wheat, and hay are excluded

†Weighted average percentages were calculated from PPEP and Chicanos por la Causa data sources

Table 4. Estimated counts and percentages of Arizona animal agriculture workers including on-farm animal agriculture and aquaculture, and off-farm dairy product manufacturing and animal slaughtering, by county.

County	On-Farm Animal Agriculture Workers n (%)*	Off-Farm Dairy Production and Animal Slaughtering n (%)†
Apache	33 (0.7)	0 (0.0)
Cochise	385 (7.6)	108 (1.8)
Coconino	78 (1.5)	298 (4.9)
Gila	28 (0.6)	0 (0.0)
Graham	70 (1.4)	0 (0.0)
Greenlee	53 (1.0)	0 (0.0)
La Paz	27 (0.5)	0 (0.0)
Maricopa	2,054 (40.5)	3,531 (57.7)
Mohave	160 (3.2)	94 (1.5)
Navajo	180 (3.5)	232 (3.8)
Pima	256 (5.0)	270 (4.4)
Pinal	1,217 (24)	1,001 (16.4)
Santa Cruz	239 (4.7)	0 (0.0)
Yavapai	173 (3.4)	305 (5.0)
Yuma	118 (2.3)	280 (4.6)
Total State	**5,071 (100.0)**	**6,119 (100.0)**

*Includes cattle ranching and farming, cattle feedlots, dairy cattle and milk production, hog and pig farming, poultry and egg production, sheep and goat farming, aquaculture, and other on-farm animal production

†Includes NAICS code 3115 (dairy product manufacturing) and 3116 (animal slaughtering and processing)

SUPPLEMENTAL TABLES

Supplemental Table 1. Demand for labor factors, including hours per acre and season length, by crop with notes on other methods integrated into calculations including rules of thumb (RoT)

Crop	Task	Task-specific hours per acre	Peak Season Length (Workdays)	Method Notes
Apples	harvest	131.94	49.96	
Apricots	harvest	96	51	Average 2 methods
		RoT:* 1 worker / acre		
Asparagus	harvest	59.59	85.71	Average 2 methods
		RoT:* 3 workers/acre		
Beans, snap	grade/clean/box/storage	35.95	32.86	
Broccoli	harvest	212.84	110.75	
Cabbage, head	harvest	102.35	103	
Cauliflower	harvest	150.25	101.54	
Celery	harvest	126	107.86	
Cucumbers	harvest	105.72	41.67	
	grade/pack	53.88	41.67	
Dates	harvest	130	54.29	Average 3 methods
		RoT: † 0.46 workers/acre		
		RoT: † 0.335 workers/acre		
	sort/pack	130	54.29	
Figs	harvest	2.67	43.57	
Garlic	harvest	115.73	87.86	
Grapefruit	harvest	133.57	160.29	
Grapes	hand harvest	200.83	17.14	Average 2 methods
		RoT:* 5 workers/acre		
Greens, collard	harvest	92	129	
Greens, kale	harvest	180	33.57	
Greens, mustard	harvest	171.43	26.43	
Herbs, fresh cut	harvest	293	103	
Lemons	sort/pack	219.14	65	
	pick/haul	176.3	65	
Lettuce	cultivation	7	69.29	Average 2 methods
		RoT: ‡ 1 harvest worker: 0.3046 cultivation workers		
	harvest/field pack	295.61	120.50	
Melons, cantaloup	harvest	50.64	34.40	
Melons, honeydew	harvest	120	17.14	
Melons, watermelon	harvest	65.8	50.28	
Olives	machine harvest	17.48	22.86	
Onions, dry	non-machine activity	37.33	152.14	

Crop	Task	Task-specific hours per acre	Peak Season Length (Workdays)	Method Notes
Oranges	pick & haul	44.44	58.22	
	wash/grade/sort/pack	131.68	58.22	
Parsley	harvest	293	33.57	
Peaches	harvest	22.93	96.44	Average 2 methods
		RoT:* 1 worker/acre		
Pears	harvest	**RoT:**§ 0.4 workers/acre		
Pecans	sort	15	34.75	
Peppers, chile	harvest	166.09	130.71	
Pistachios	sort	15	43.57	
Potatoes	non-machine labor	7	109.29	
Pumpkins	harvest	34	38.14	
Spinach	harvest/pack/palletize	80.75	120	
Squash	harvest	92.08	73.57	
Sweet corn	harvest	40.61	35.99	
Tangelos	harvest	55	49.71	
Tangerines	harvest	55	41.29	
Tomatoes, in the open	harvest	318	41.31	
Turnips	harvest	178.5	49.29	
Other citrus	harvest	92.86	74.9	
Other vegetables	harvest	132.76	81.27	

RoT=Rule of Thumb
*Source: 2013 Oregon Farmworker Enumeration Profiles Study
†Source: 2024 AZ-FEPS key informant interview
‡Source: PPEP work history data
§Source: UC Davis crop budget

Supplemental Table 2a. Crops excluded from demand for labor estimation calculation due to low acreage

Apricots	Okra, Fresh Market
Artichokes	Onions, Green
Brussel Sprouts	Pears, (Excl Bartlett)
Cherries, Sweet	Peas, Chinese (Sugar & Snow)
Cherries, Tart	Peas, Green, (Excl Southern)
Daikon	Peppers, Bell
Eggplant	Persimmons
Herbs, Dry	Plum-Apricot Hybrids, Incl Plumcots & Pluots
Kumquats	Plums & Prunes
Limes	Rhubarb
Nectarines	Sweet Potatoes

Supplemental Table 2b. Crops excluded from demand for labor estimation calculation due to mechanization

Barley	Haylage
Beans, Dry Edible, (Excl Chickpeas & Lima)	Jojoba
Corn, Grain	Legumes, Alfalfa, Seed
Corn, Silage	Oats
Corn, Traditional Or Indian	Sorghum, Grain
Cotton	Sorghum, Silage
Grasses & Legumes Totals, Seed	Wheat
Hay	

Supplemental Table 3. Certified H-2A worker applications in 2023 for crop,* nursery-greenhouse, animal agriculture, and other agriculture workers with worksites in Arizona

County	Crop* Workers n (%)	Nursery-Greenhouse Workers n (%)	Animal Agriculture Workers n (%)	Other Agriculture Workers n (%)
Apache	2 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Cochise	157 (1.5)	0 (0.0)	4 (2.9)	15 (3.0)
Coconino	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.6)
La Paz	0 (0.0)	0 (0.0)	0 (0.0)	103 (20.6)
Maricopa	2,141 (20.5)	287 (71.6)	28 (20.6)	144 (28.8)
Navajo	0 (0.0)	0 (0.0)	0 (0.0)	31 (6.2)
Pima	0 (0.0)	68 (17.0)	0 (0.0)	0 (0.0)
Pinal	504 (4.8)	0 (0.0)	89 (65.4)	154 (30.8)
Santa Cruz	10 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
Yavapai	11 (0.1)	46 (11.5)	15 (11.0)	0 (0.0)
Yuma	7,603 (72.9)	0 (0.0)	0 (0.0)	50 (10.0)
Total State	**10,428 (100.0)**	**401 (100.0)**	**136 (100.0)**	**500 (100.0)**

*Crop workers are defined as those employed in the cultivation, harvest and immediate post-harvest production of fruits, vegetables, nuts, melons, and other hand-labor intensive commodities; workers in highly mechanized crops such as cotton, wheat, and hay are excluded

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