Vina Subbasin GSAs Demand Reduction Strategies: Extend Orchard Replacement Pilot Study Final Report

Prepared for
Vina Subbasin GSAs

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ATTACHMENTS

LIST OF ACRONYMS

ac – acres

ac-ft – acre-feet

DWR – Department of Water Resources

EOR – Extend Orchard Replacement

ET – Evapotranspiration

ft - feet

GSA – Groundwater Sustainability Agency

GSP – Groundwater Sustainability Plan

lb - pounds

NDVI – Normalized difference vegetation index

PI – Precision Irrigation

PMA – Project and Management Actions

SGMA – Sustainable Groundwater Management Act

SIMS – Satellite irrigation management system

SSURGO – Soil survey geographic database

EXECUTIVE SUMMARY

The Extend Orchard Replacement (EOR) Pilot Study is a Vina GSA implementation project and demand-side intervention aimed at conserving groundwater by extending the fallowing period an additional year depending on orchard management practices during orchard replacement (i.e., one to two years). The objectives of the study are to 1) Quantify the potential water savings and required incentivization costs for implementing EOR; 2) Quantify costs ($/acre) and benefits (AF/acre) though an economic evaluation.

The technical approach for the EOR Pilot relies on the collection and analysis of spatial data that has been compiled on a field-by-field basis throughout the Vina Subbasin. The steps of the technical approach are summarized in Figure ES-1. Pilot orchards informed the focus of analysis on specific land use types typically used between orchard removal and replant.

- Step 1 • **Preparation** - Install field stations to measure field data for ET remote sensing modeling and review current knowledge on potential sources of non-beneficial ET.
- Step 2 • **Preliminary analysis** - Use spatial crop/age map data to Identify orchard crop type and age, condition, and removal status
- Step 3 • **Pilot orchard selection** - Select pilot orchards that represent different former crop type (almonds or walnuts), fallow periods, and/or fallow interim practices.
- Step 4 • **Field data collection** - Collect information on fallow period and practices from growers.
- Step 5 • **Consumptive use data collection** - Process consumptive use (ET) data on all orchards in basin using remote sensing modeling.
- Step 6 • **Data analysis** - Analyze historical and current year ET data and interpret using grower information.
- Step 7 • **Economic analysis** - Evaluate costs, benefits, return on investment and other economic considerations.
- Step 8 • **Conclusions** - Estimate costs, water savings, and co-benefits of extending orchard replacement using different practices throughout the Subbasin.
- Step 9 • **Recommendations** - Recommend strategies and show results of potential scenarios to reduce non-beneficial consumptive use in the subbasin

Figure ES- 1. Extend Orchard Replacement Pilot Study technical approach

Extending the period between orchard plantings can reduce ET, resulting in measurable water savings between 0.91 and 2.62 acre-feet of ET per year. Winter cover crops and spring sudan grass have potential agronomic benefits such as breaking disease cycles and improving soil physical and chemical properties as well as saving substantial consumed water. Summer cash crops can mitigate the revenue lost by not replacing an orchard right away but consume more water than other alternative land uses and have little or no co-benefits to soil. Fallowed idle land has potential for deleterious environmental effects even though it saves the most amount of water consumed. Abandoned orchards pose financial and agronomic risks and use more consumed water than idle ground or cover crops.

Extended replanting incentives vary depending on how the land is used during the idle period. Cover crops and spring-seeded grasses generate agronomic benefits but only modest economic returns, resulting in annual incentive payments up to $790 per acre, depending on the practice and crop transition.

Implementation decisions—such as program duration, enrollment structure, and payment mechanisms—will affect participation rates, program costs, and the magnitude and timing of groundwater savings achieved. Incentive payments are a central component of program implementation because they determine grower participation and overall program cost. Establishing payment levels that reflect the opportunity cost of delaying orchard replanting—while remaining financially reasonable—is critical to achieving meaningful, cost-effective enrollment and groundwater savings.

The economics and financial implications of EOR, potential water savings, and implementation findings provide a foundation for the Vina Subbasin and partners to consider how EOR and related projects and management actions (PMAs) could be implemented. Moving from analysis to implementation will require further program development.

1 PREFACE

The Vina Subbasin (DWR Basin No. 5-021.57) covers approximately 289 square miles—roughly 185,000 acres—on the western side of Butte County in the Northern Sacramento Valley. The subbasin includes the City of Chico, the communities of Nord and Durham, and the surrounding rural residential and agricultural lands. Approximately 110,000 people reside in the subbasin, with the majority of residents in Chico.

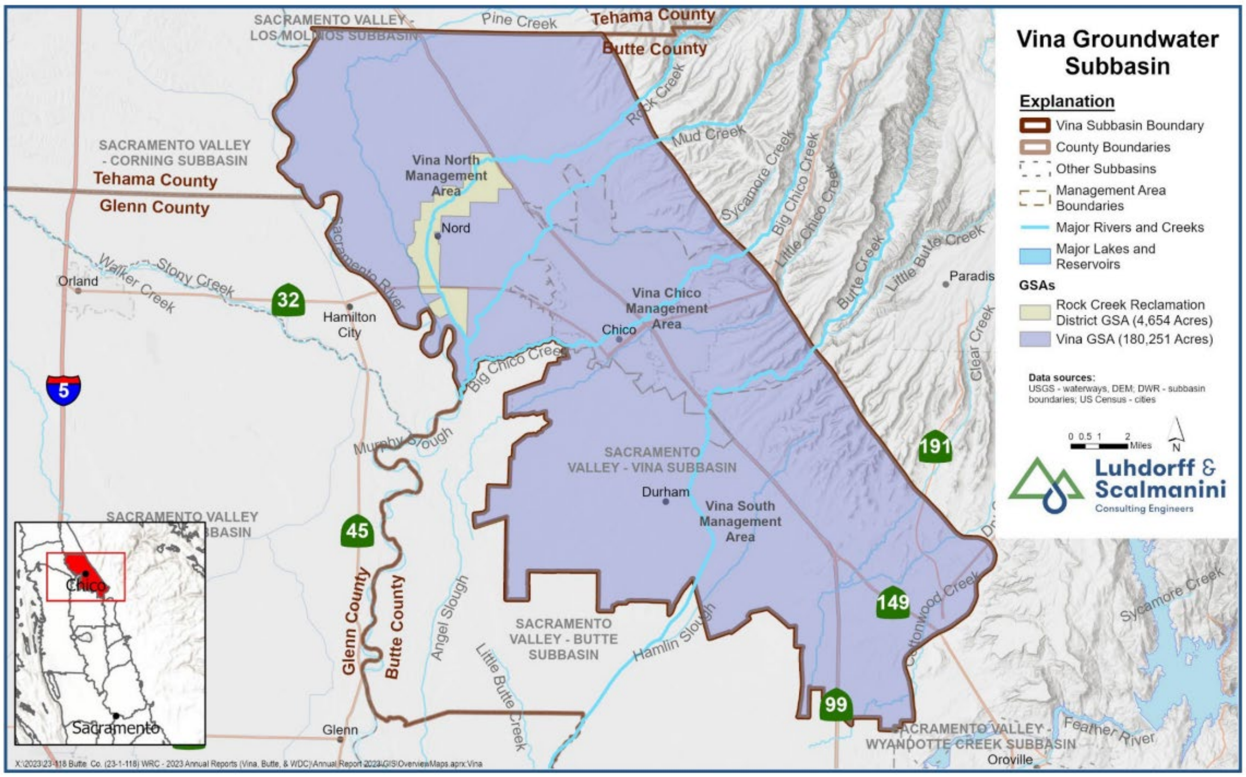

Figure 1. Vina Groundwater Subbasin.

The Vina Subbasin is predominantly groundwater dependent. Approximately 89 percent of its water supply comes from groundwater, with the remaining 11 percent from surface water. Agricultural irrigation accounts for 91 percent of total water use, supporting orchards, rice, row crops, vineyards, and grazing. Municipal and domestic uses account for the remaining 9 percent.

Groundwater Conditions and the GSP

There are two Groundwater Sustainability Agency's (GSAs) within the Vina Subbasin, the Vina GSA and the Rock Creek Reclamation District (RCRD) GSA that have entered into a cooperative agreement to prepare a single Groundwater Sustainability Plan (GSP). The GSP was submitted in January 2022 (Geosyntec, 2021; GSP), and the California Department of Water Resources (DWR) approved it in July 2023. The GSP estimates the subbasin's sustainable yield at 233,500 acre-feet per year (AFY), based on historical pumping of approximately 243,500 AFY and an annual storage decrease of approximately 10,000 AFY. Subsequent analysis by Butte County in developing the Recharge Action Plan suggests the annual deficit may be as high as 20,000 AFY, based on observed longer-term downward trends in groundwater levels. Although recent wetter years have stabilized groundwater levels, action is still needed to address these longer-term declines and prepare for the next drought. Under SGMA, the subbasin must achieve sustainability by 2042.

Approach to Sustainability

Closing the gap between current groundwater use and sustainable yield requires a portfolio of actions. No single project will likely be sufficient. Grant funds from the California Department of Water Resources (DWR) Sustainable Management grant program (SGM grant) funded a suite of feasibility studies and pilot projects conducted in 2024-2026. The Vina and Rock Creek GSAs and their partners—including Butte County, the City of Chico, Durham Irrigation District, Tuscan Water District, and the Agricultural Groundwater Users of Butte County—are advancing a coordinated strategy across four categories:

Demand Reduction and Conservation

Pilot programs for extended orchard replacement and precision irrigation were investigated with SGM grant funds (to be completed March 2026) to explore approaches for reducing agricultural water demand. Results of the pilot studies will provide information on potential water savings and costs of the programs.

Groundwater Recharge

The Butte County Recharge Action Plan, adopted by the Board of Supervisors in February 2024, establishes a recharge target of at least 20,000 AFY and prioritizes the Vina Subbasin. The SGM grant funded Recharge Feasibility Analysis identifies potential recharge sites and assessed site feasibility and multi-benefit opportunities throughout the subbasin. Additionally, the Feasibility of Enhanced Recharge in the Lindo Channel study will produce a recharge feasibility and alternatives report.

Increasing Surface Water Supplies

This strategy reduces the reliance on groundwater for water uses in the subbasin by identifying and refining surface water supply projects. This Surface Water Feasibility Study evaluates opportunities to deliver surface water to farms that currently rely entirely on groundwater, directly offsetting pumping through conjunctive use.

Planning and Partnerships

Interbasin coordination, partnerships with water districts (e.g., Western Canal Water District, Paradise Irrigation District), engagement with state and federal agencies, and collaboration with local entities such as Tuscan Water District enable the other strategies to succeed.

Potential for Demand Reduction through Extended Orchard Replacement and Precision Irrigation

Because agricultural irrigation accounts for 91 percent of total water use in the subbasin, and almonds and walnuts represent the majority of cropped acreage, both studies focused primarily on these permanent crops. The full results and analyses of each pilot study are documented in the accompanying technical memoranda: the Extend Orchard Replacement Pilot Study Final Report and the Precision Irrigation Pilot Study Final Report.

The EOR Pilot Study examined whether extending the fallowing period by one to two additional years during orchard replacement could produce meaningful water savings. The study sought to answer three core questions: What types of practices are used on idle orchard ground during the replant period, and how much water do they consume? What are the costs, co-benefits, and water savings of an extended replacement period over the life of an orchard? And how can this knowledge guide the GSA in designing implementable programs? The PI Pilot Study focused on the supply side of on-farm water management, asking: How and where is non-beneficial evapotranspiration (ET) occurring in almond and walnut orchards, and how can it be addressed using precision irrigation? What is the potential for demand reduction using precision irrigation? And how can this knowledge guide the GSA in implementing demand reduction programs?

Both studies relied on the collection and analysis of field-by-field spatial data compiled throughout the Vina Subbasin—including crop type, crop age, consumptive use (ET), soils, and remotely sensed data—combined with on-the-ground data collection from pilot orchards.

The EOR study found that extending the period between orchard plantings can reduce ET by 0.91 to 2.62 acre-feet per acre per year, depending on how the land is managed during the idle period. Winter cover crops and spring sudan grass consumed only 33 to 47 percent of the water used by established orchards, while also providing agronomic co-benefits such as improved soil health and reduced disease pressure. Idle ground produced the greatest water savings but posed risks of dust, erosion, and soil degradation. The study also developed an economic framework showing that incentive payments of up to $790 per acre per year may be needed to encourage grower participation, depending on the practice adopted during the extended replant period.

The PI study found that medium to large almond and walnut farms in the Vina Subbasin generally have good on-farm irrigation efficiency, with approximately 75 percent of pilot growers already using at least two data sources to inform irrigation decisions. As a result, the study found little evidence that precision irrigation alone would substantially reduce consumptive use on these operations. However, the study identified promising areas for further investigation: walnut orchards using pressure chambers to guide irrigation scheduling applied less water while maintaining or improving yields; small farms may have greater potential for improved water management; and shifting irrigation to nighttime hours could reduce the evaporation component of ET by an estimated 350 acre-feet per 1,000 acres of participation. Both studies provide a foundation for the Vina Subbasin GSAs and their partners to develop implementable demand reduction programs as part of the broader portfolio of actions needed to achieve sustainability.

2 INTRODUCTION

The Sustainable Groundwater Sustainability Act (SGMA) legislation passed in 2014, establishes a new structure for managing groundwater resources in California at the groundwater basin/subbasin level. Groundwater basins and subbasins are defined in the Department of Water Resources (DWR) Bulletin 118 document. SGMA requires Groundwater Sustainability Agencies (GSAs) to manage groundwater at the local level through the development and implementation of Groundwater Sustainability Plans (GSPs). The GSPs must ensure sustainable conditions by 2042.

The SGMA compliance process in the Subbasin started with the formation of the Vina GSA and subsequent development and submittal of the Vina Subbasin GSP. The Vina GSA was established in 2019 to meet SGMA requirements on behalf of landowners in the Vina Subbasin. Vina GSA manages GSP development and updates, GSP implementation, administration, and SGMA compliance. The Vina GSA is composed of three member agencies (City of Chico, Butte County, Durham Water District). The Vina GSA is governed by a 5-person board including a representative from each member agency and two community stakeholders.

2.1 VINA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

The Vina Groundwater Subbasin is a portion of the larger Sacramento Valley Groundwater Basin covering approximately 184,917 acres. The Vina Subbasin is a portion of the larger Sacramento Valley Groundwater Basin and is bounded by Tehama County to the north, the county line along the Sacramento River to the west, the foothills to the east (as defined by Bulletin 118), and the Western Canal Water District to the south.

Designated as a high-priority basin by the California Department of Water Resources (DWR), the Vina Subbasin is jointly managed by two Groundwater Sustainability Agencies (GSAs): the Vina GSA and the Rock Creek Reclamation District GSA. The Vina GSA was established through a Joint Powers Agreement (JPA) between the County of Butte, the City of Chico, and the Durham Irrigation District (DID). This collaborative governance structure ensures diverse representation and comprehensive management of the subbasin's groundwater resources.

The Vina GSP serves as the Subbasin's strategic roadmap for achieving and maintaining sustainable groundwater management. Developed through an inclusive and publicly engaged process, the GSP incorporates input from all beneficial uses and users of groundwater in the Subbasin. After being submitted to the DWR for review in January 2022, the GSP was officially approved in July 2023.

2.2 Grant Funding for Demand Reduction Strategies

The Vina Subbasin received a grant from California Department of Water Resources: Vina Subbasin GSP projects and Management Actions Implementation (Project). This Project is intended to make progress on GSP implementation actions that advance groundwater sustainability in the Vina Subbasin. The Project includes three categories of activities that will work toward monitoring and eliminating the 10,000 acre-feet (AF) of estimated overdraft per year. Activities include: 1) required GSP implementation tasks such as reporting, responding to DWR GSP determination, continued stakeholder outreach, groundwater model updates, financing strategies, and filling data gaps; 2) improving the monitoring network and developing a domestic well inventory; and 3) implementation of pilot projects for recharge, agricultural irrigation efficiency, and reduced groundwater demand. The Work Plan for the Project includes seven Components:

- Component 1: Grant Agreement Administration
- Component 2: GSP Updates, Data Gaps, and Outreach
- Component 3: Demand Reduction Strategies in the Vina Subbasin
- Component 4: Lindo Channel Surface Water Recharge
- Component 5: Surface Water Supply and Recharge Feasibility Study
- Component 6: Inter-basin Coordination, Modeling and Reporting
- Component 7: Outreach Program

The work documented in this report fulfils the requirements of tasks related to Component 3: Demand Reduction Strategies in the Vina Subbasin, Category b, Extend Orchard Replacement Pilot Program.

Component 3 will improve subbasin sustainability related to groundwater levels and groundwater storage by decreasing consumptive use (*i.e.*, evaporation and transpiration or ET) by applying ET-based water management principles of precision irrigation and ET monitoring. This component will leverage education and outreach, a feasibility study involving the piloting of innovative irrigation technologies, and the development of a precision irrigation implementation plan to improve ET-based water management at a broader scale in the Vina Subbasin. Additionally, a program for demand-side intervention aimed at extending the fallowing period of an orchard from one to two years during orchard replacement will reduce consumptive use (i.e., evapotranspiration or ET) of groundwater. The reductions in ET are obtained by having one or two additional low ET years at the beginning of the orchard life cycle. The former pilot study is called Precision Irrigation (PI) and is documented in a separate report, *Vina Subbasin GSAs Demand Reduction Strategies: Precision Irrigation Pilot Study Final Report.*

2.3 Extend Orchard Replacement Pilot Study Background

The Extend Orchard Replacement (EOR) Pilot Study is a demand-side analysis aimed at conserving groundwater by extending the fallowing period an additional year depending on orchard management practices during orchard replacement (i.e., one to two years). This practice will reduce the average annual consumptive use (i.e., evapotranspiration or ET) of groundwater by extending the fallowing cycle and reducing the total water use of the orchard over one extra year. This fallowing extension causes the average annual ET over the life of the orchard to be commensurately reduced.

2.4 Extend Orchard Replacement Pilot Study Goals and Objectives

Presently, the Vina Subbasin is almost entirely dependent on groundwater to meet crop water demands. To achieve long-term sustainability, the Vina GSP suggests the need to address a 10,000 AF per year groundwater budget deficit. Moreover, if water managers and stakeholders within the subbasin desire to recover some of the 300,000 to 400,000 AF cumulative reduction in storage that has occurred over the last 20 years, a change greater than 10,000 AF per year is required. This can be achieved by either reducing groundwater demands or increasing availability of surface water supplies.

With this in mind, the overall goal of this component is to improve subbasin sustainability related to groundwater levels and groundwater storage by decreasing consumptive use (i.e., evaporation and transpiration or ET).

The goal of EOR is to reduce overall groundwater pumping demand from the Vina Subbasin through increased land fallowing. The objective of the EOR Pilot Study is to implement a demand-side intervention aimed at extending the fallowing period an additional year (i.e., from one to two years) during orchard replacement, thereby reducing the average annual ET of groundwater. To realize these benefits, the following needs must be met:

1. Quantify the potential water savings and required incentivization costs for implementing EOR.

2. Quantify costs ($/acre) and benefits (AF/acre) though an economic evaluation.

3 Study Questions and Approach

The questions the EOR Pilot aimed to address included the following:

1. What types of practices (e.g. interim or cover crops) are used on idle orchard ground and how much water do they consume?
2. What are the costs, co-benefits and water savings of an extended orchard replacement period over the life of an orchard?
3. How can this knowledge be used to guide the GSA in implementing programs that realize the benefits of extended orchard replacement?

The technical approach for the EOR Pilot relies on the collection and analysis of spatial data that has been compiled on a field-by-field basis throughout the Vina Subbasin. Spatial data is information that is tied to a specific location. This data can be managed and analyzed in a spreadsheet, or it can be viewed on a digital map.

While traditional agricultural field studies run experiments on a few field plots or fields and then measure and interpret the results of those experiments, the approach to the EOR Pilot study leverages information related to orchard condition and removal that is already available for every field in the subbasin. This spatial data includes crop type, crop age, consumptive use by field (or ET), and other remotely sensed data such as soil type. This information can be analyzed across the Vina Subbasin to find orchards that have been removed and may have other fallow treatments ongoing.

The steps of the technical approach are summarized in Figure 2 and are explained in detail in the following sections.

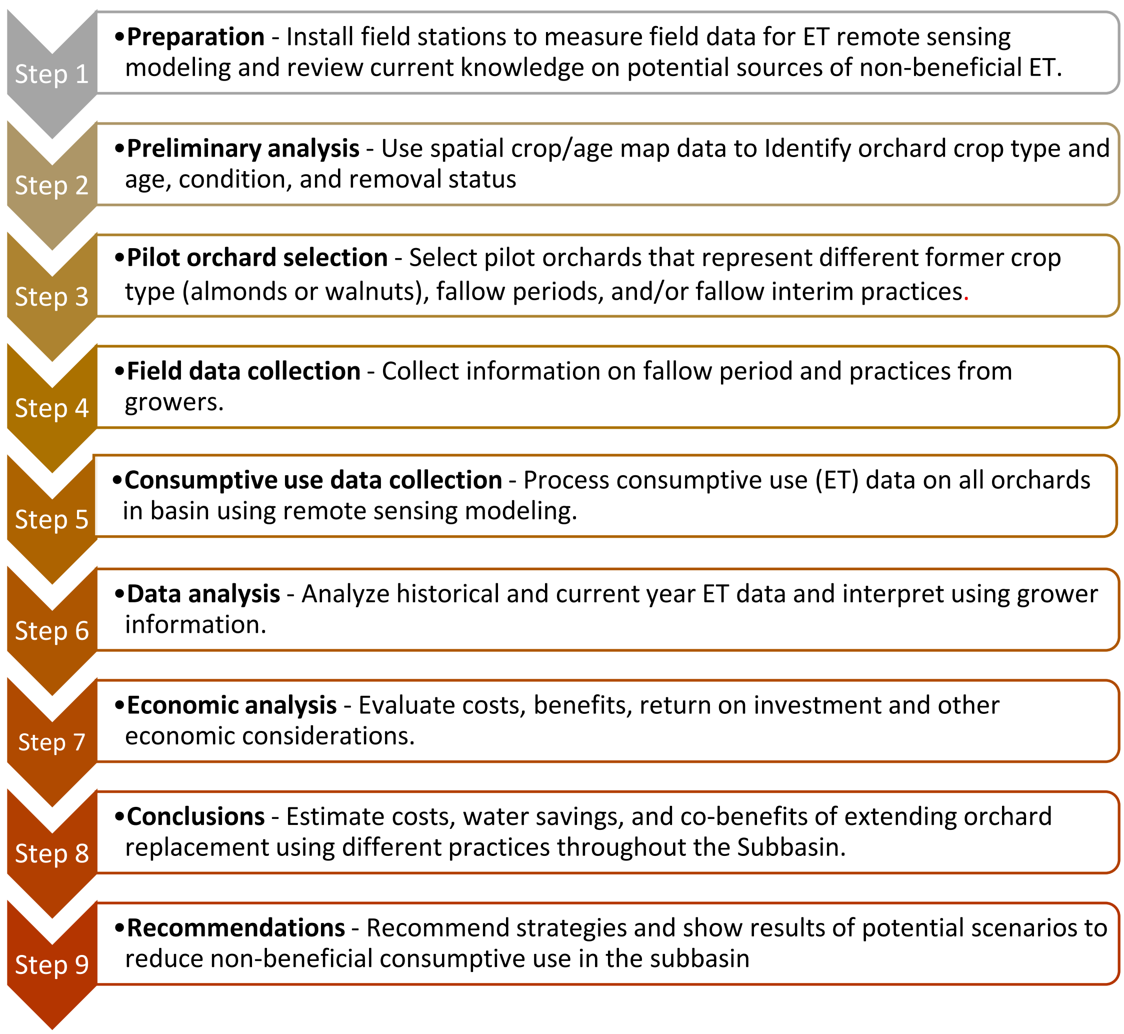

Figure 2. Extend Orchard Replacement Pilot Study technical approach

4 METHODS

4.1 STEP 1 – PREPARATION

Preparation included selecting appropriate sites for field stations in the Vina Subbasins, contacting growers, and installing the stations. Details about how ET data is collected from field stations and used to calibrate remote sensing modeling is provided in Section 3.5 on Consumptive Use Data Collection. Field stations were installed in fall and early winter 2024.

During this time, a review of literature and extension materials on consumptive use in almonds and walnuts and potential benefits of extending orchard fallow periods was completed. The purpose of the review was to understand what benefits and barriers to adoption are associated with extending orchard fallow periods.

4.2 STEP 2 - PRELIMINARY ANALYSIS WITH SPATIAL DATA

Land IQ compiled spatial data, including:

- Soil texture data from SSURGO
- Crop type data from DWR's land use data set
- Crop age data from DWR's land use data set
- Crop condition (stressed, abandoned) from Land IQ's land use data set
- Historical ET data modeled using SIMS

<u>Soil Data</u> - Digitally mapped soil survey data for the Vina Subbasin is available through Soil Survey Geographic Database (SSURGO) that has been collected by field work throughout the last 100 years by the National Cooperative Soil Survey. This database includes soil map units and several other soil attributes such as soil physical and chemical properties (e.g. soil depth, texture, drainage class, available water holding capacity, pH, salinity), topographical information (e.g. slope), and agricultural suitability.

The purpose of compiling soils data was to understand the distribution of soil texture throughout the Vina Subbasin, so that pilot orchards could be selected that were representative of all soil types. Soil texture is a key soil physical property that governs fertility, water holding capacity, and drainage class, which are factors in irrigation management.

<u>Crop Type, Age and Condition Data</u> - Land IQ has been mapping land use in California for the Department of Water Resources (DWR) since 2014. Since 2018, Land IQ has updated the spatial database of land uses, including agriculture (irrigated and fallow fields) and urban footprint annually. Farmed area in fields at least 2 acres in area, excluding roads, buildings and berms, is mapped to achieve an overall accuracy of 97.6%. The database represents 98% of all irrigated cropland. In addition to crop type, Land IQ also maps perennial crop age (planting year), perennial crop planting density, and condition (stressed, short-term abandoned, and long-term abandoned).

The spatial data was used to identify walnut and almond orchards along with their age and condition. Condition analysis identifies orchards that are stressed or abandoned.

<u>Historical ET Data</u> – Satellite Irrigation Management Support (SIMS) ET data was used to analyze historical ET (and its components) as described in the steps below. Use SIMS to calculate monthly ET from 2019 to 2024 for each field. SIMS is an open-source model for estimating ET. Though it is not calibrated with field station data like the Land IQ method, SIMS provides a way to calculate historical ET

data where and when field station data is not available. The SIMS ET data provides informative relative comparisons.

4.3 Step 3 – Pilot Orchard Selection

From the selection of almond and walnut orchards within the peak production age range, Land IQ consulted with Subject Matter Experts to prioritize features of pilot orchards. The prioritized features include:

- Orchards that have been removed and fallowed
- Ownership (owners who own single or multiple orchards and/or large acreage)
- Orchard size (minimum acreage threshold, mix of small and large)
- Geographical distribution (representing all areas of subbasin)
- Soil type (representing diverse soil textures in the Subbasin)

A target minimum number of 9 to 10 pilot fallowed orchards was determined based on the estimated level of effort needed to gather data from growers in the 2025 field season and representation of various practices used in the interim orchard replacement period.

4.4 Step 4 – Field Data Collection

The Subject Matter Experts for the EOR Pilot communicated with growers to attain permission for land access and willingness to participate in the EOR Pilot. All information from pilot orchard growers was collected by the Subject Matter Experts in a standardized form and kept confidential for the intent of performing analysis. Field data included:

- Quantitative
  - Removal date and Length of fallow period.
  - Planting and/or removal dates of crops grown in the interim period, if applicable
- Qualitative
  - Cultural practices such as orchard removal techniques
  - Fallow field management such as bare soil, winter annuals, cover cropped, or shorter season crop before replanting an orchard.
  - Production challenges and/or field conditions such as soil limitations and variability

4.5 Step 5 – Consumptive Use Data Collection

In the autumn of 2024, Land IQ installed four ET field stations in the Vina Subbasin in the following locations (Figure 3):

1. 20-year old walnut orchard in the northwest part of the Subbasin,
2. 9-year old walnut orchard in the northwest part of the Subbasin,
3. 8-year old almond orchard on the east side of the Subbasin and SE of Durham,
4. 15-year old almond orchard in the southwest part of the Subbasin,
5. Short season crop (such as beans or winter cereals) ET for comparison to removed orchard.

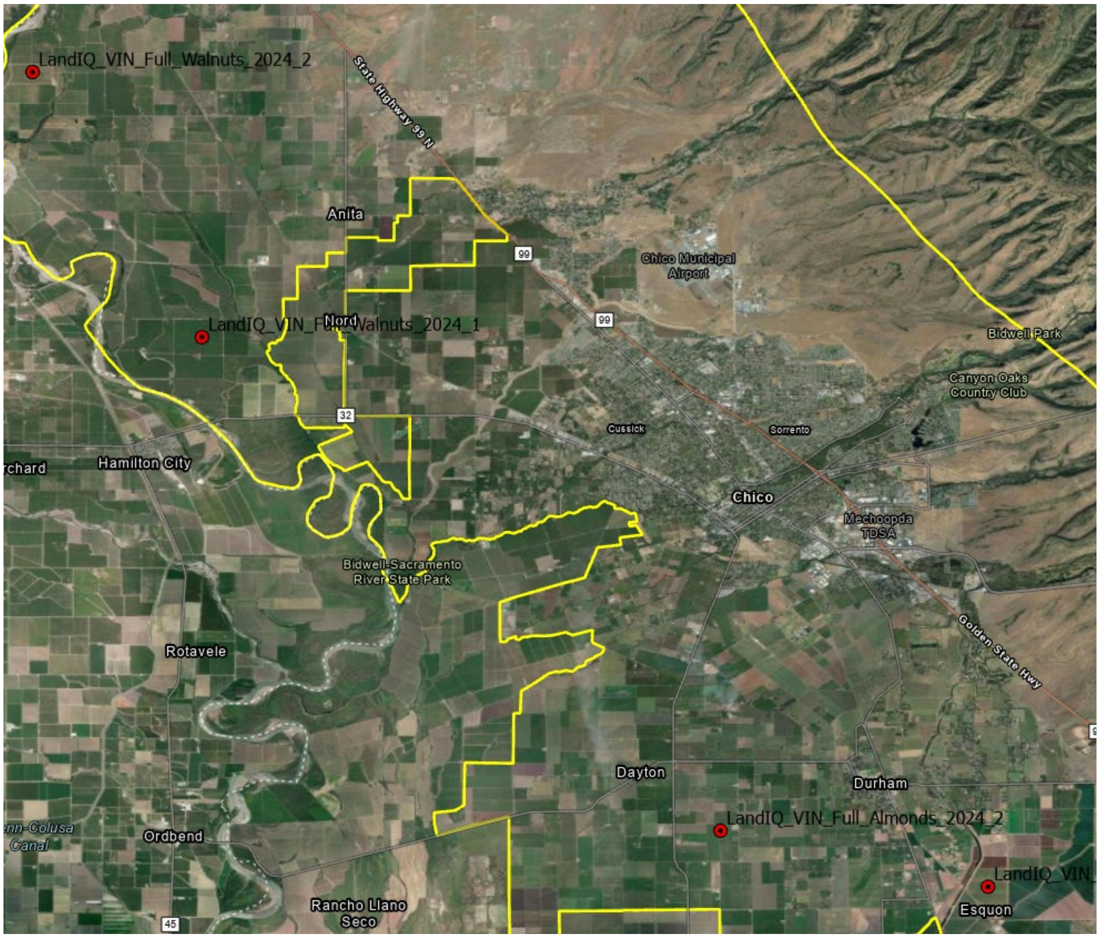

Figure 3. Land IQ ET Field Stations in the Vina Subbasin

Land IQ uses meteorological data from these stations to develop a model for calculating ET for each field. The Land IQ data-driven model uses a combination of meteorological data and analysis of remotely sensed imagery in a surface energy balance approach to estimate field by field ET. Inputs to this model include field station data, remotely sensed imagery, and spatial crop data. Outputs include ET by field and precipitation by analyzed area.

The data collected by the field stations is used to calibrate remote sensing models for ET and to extrapolate ET measurements across all fields to produce a complete estimate of monthly ET by crop type by field. Station data is also used to validate results and quantify accuracy. Data stations are fully telemetered (remotely logged) by cellular communication systems to Land IQ servers.

Accuracy assessment with an independent validation dataset (from stations) that were removed from the modeling dataset showed that the modeling coefficient of determination (R^2) was 0.95, meaning 95% of the model result was accounted for by the station data. The mean absolute error, another measure of accuracy, was a 0.48 inch difference between the station monthly measurement and the model monthly prediction. Non-statistical checks on the Land IQ ET data using applied water data showed that the model results are generally less than irrigation plus precipitation, which is expected. This high accuracy in ET modeling results is achieved on fields with actively growing crops; however, ET estimation models are not as accurate on non-irrigated or deficit-irrigated fields, and may have 10% error or more.

Land IQ uses a data-driven model to interpret remotely sensed image data. This approach can employ Landsat 8 and Sentinel 2 satellite imagery (freely available) as well as Planet imagery. Satellite data are screened for cloud cover and corrected for the effects of terrain, or different topographic positions, on reflectance. Remotely sensed satellite imagery of the area is collected on all available cloud free overpass dates within each month to estimate monthly, field by field ET.

Ground measurements from field stations are used to generate hourly ET results correlated to satellite imagery (Figure 4). The results are then used as a dependent variable in the modeling process. The analysis includes data-flagging protocols to identify any inconsistencies in data collection or outages. A thorough QA/QC effort is conducted on all field collected data prior to remotely sensed analysis.

Figure 4. ET field station in orchard

4.6 STEP 6 – DATA ANALYSIS

Data exploration on ET data from the entire Vina Subbasin including the removed or abandoned EOR pilot orchards was carried out to understand the differences in water use between actively growing orchards, fields where orchards have been removed, and abandoned orchards (where irrigation has ceased). Field and farm qualitative information was used to interpret differences in ET results between pilot orchards removed or between historical ET (2019-2024) and 2025 growing season ET on fallowed fields.

5 SUPPORTING INFORMATION

5.1 CO-BENEFITS OF USING COVER CROPS ON IDLE ORCHARD FALLOW

5.1.1 COVER CROPS AND SOIL HEALTH

Cover crop benefits to soil health and orchard ecology are well documented.

Bruno et al. (2020) reviewed the costs and benefits of winter cover cropping in California and developed a calculator to assess changes to baseline farm profits. Their study included almonds and assumed a cover crop of clover mix. Using average values for all the benefit and cost components, they found benefits are likely to exceed costs in almond systems when considering a 30-year time horizon. They concluded that winter cover cropping is an investment in the long-term viability of agricultural operations, and the value of cover cropping is greatest for California farmers with a longer time horizon and willingness to manage a cover crop as carefully as their cash crop.

They noted that the potential for cover crops to affect the irrigation requirements of cash crops is debated in the scientific literature. Cover crops may lead to higher water infiltration (resulting from improved porosity of the top soil), which can lead to increased capture of winter and spring rainfall, increased soil-water storage, which in turn can delay irrigation start and eventually reduce spring/summer irrigation requirements slightly; however, these effects are soil-specific and difficult to quantify and generalize and were not included in their model. Other potentially valuable aspects of cover cropping that were not included were reduced soil sealing and compaction, better soil oxygen concentration and diffusion rates, as well as increased effectiveness of salt-leaching practices. Benefits and costs of cover crops were listed by Bruno et al. (2020) as shown in Table 1.

Table 1. Potential Benefits and Costs of Winter Cover Cropping in California's Specialty Crop Systems (Bruno et al. 2020)

Benefits	Costs
• Increase in yields (from improved soil quality, fertility, and soil water relations) • Reductions in expenses associated with soil erosion control, nutrient cycling, weed control, and mycorrhizal fungi colonization • Improved ecosystem services (soil organic matter, runoff, soil-carbon storage) • Reduced tillage needs • Lower beehive prices (almonds only) • Reduced spring/summer irrigation requirements	• Seeds • Labor associated with planting & termination • Potential cash crop harvest complications • Depreciation of machinery • Time spent learning about cover cropping and disseminating instructions to crew • Irrigation for germination, if needed during dry fall-winter period

DeVincentis et al. (2022) found no significant differences in soil moisture between cover cropped and control fields throughout or at the end of the winter seasons, while evapotranspiration losses due to winter cover crops were negligible relative to clean-cultivated soil. Their results suggested that winter cover crops in the Central Valley may break even in terms of consumptive water use. California growers of high-value specialty crops can likely adopt winter cover cropping without altering their irrigation plans and management practices. This study included sites in Orland, Chico, and Durham. They noted that cover crops can improve the effectiveness of applying water during the dormant season to refill the soil profile and leach salts, and that natural vegetation used as a cover crop can enhance rhizosphere (root zone) ecology without incurring costs, but importantly, timing of winter cover crop termination is key to having these benefits realized, avoiding delays in normal farming operations, and preventing soil moisture depletion due to extra ET when the temperature increases. Other potential benefits of cover crops include increase of soil carbon storage and species diversity, climate change resiliency, economic benefits through financial incentives from USDA programs, and potential decrease over time of fertilizer and pesticide inputs.

Winter cover crops can also be part of a strategy to reduce disease and pest problems in replanted orchards.

5.1.2 Orchard Replacement Pests and Disease

Researchers identify three problems in replanted orchards (Caprile and Henry 2006):

1. Replant problem or rejection component
2. Nematodes
3. Crown gall

The replant problem (Figure 5) is not associated with a single pathogen; nematodes or other soil pests or microbes feed off the roots of mature trees and build up in orchard soils, then overwhelm the small root mass of the young trees. The replanted orchard frequently grows poorly exhibiting stunting and yellowing in an uneven pattern across the field. It is difficult to predict whether the “rejection” will occur in a certain location except by past history. It is less common in the Sacramento Valley than the San Joaquin Valley, and is more likely to be a problem on walnuts than on stone fruit and almonds in Northern California. The replant problem is often more severe on sandy soils prone to nematodes than on fine-textured soils but the clay loam soils in our area can also have problems. Killing the roots of the old orchard and rotating in a non-orchard crop for a year is effective at addressing this problem.

Figure 5. **Almond trees affected by Prunus Replant Disease (right); healthy almond tree (left).**

Photo source: Greg Browne, USDA-ARS UC Davis https://www.thealmonddoctor.com/blog/replant-disease-of-almond

The root-lesion nematode of concern in California is Pratylenchus vulnus. English walnut, seedling Paradox hybrid, and black walnut rootstock are all highly susceptible, with each root tip capable of supporting thousands of nematodes per gram of root. Any previous tree crop planting is likely to have hosted P. vulnus. UCCE estimates 85% of walnut orchards have nematode levels that are too high to replant without taking some measures to address them.

Crown gall, caused by the bacterium Agrobacterium tumefaciens, can be a serious problem in some old orchards. Inoculum built up in the soil can infect through wounds or natural openings (e.g. where lateral roots develop). Once A. tumefaciens is introduced into a field site it can survive for at least two years in the orchard soil and at least 1.5 years in non-irrigated fallow soil and still induce crown gall formation. Research found chloropicrin and 1,3-dichloropropene together in Telone® C-35 dramatically reduced A. tumefaciens populations in soil, but not in buried gall tissue. When applied alone, 1,3-dichloropropene (Telone® II) was not effective at controlling A. tumefaciens.

If fumigation is deemed necessary, based on nematode and/or crown gall pressure, a fallow period is critical to dry down the soil to 12% moisture, the level necessary for optimal fumigant efficacy. Fumigants move through air, not water. Soil aggregates with films of liquid can act as a secret hideout for the nematode you've paid so much money to try to kill. For most of the finer textured soils in the Sacramento Valley, a spring-summer crop of Sudan grass or safflower may be needed to pull out deep soil moisture. These crops also have the benefit of decreasing nematode populations. Ripping and reworking the soil in the summer can also dry down the soil but is not always sufficient.

Biofumigation is the process of growth, maceration and incorporation of a cover crop with the goal of releasing compounds that suppress nematodes (and possibly other diseases or weeds). Cover crop species that contain high concentrations of glucosinolates (GSLs) are chosen for this strategy. The practical process of biofumigation is straightforward. A seedbed is prepared and an appropriate cover crop (e.g. Brassica) is planted and managed to produce a high biomass. Preferably at the beginning of flowering, the cover is shredded and incorporated into the soil, where the effective compounds are released. There are knowledge gaps in this process, such as:

- Cover crop selection and harvest time: Which crops have the highest levels of GSLs and are not hosting orchard nematode pests?
- Phytotoxicity risk: if the effective compounds are potent enough to kill nematodes, will they also damage tree roots?
- Incorporation process: How should biomass be incorporated without damaging tree roots? Is soil sealing with plastic or irrigation required to achieve an ideal soil moisture and seal?
- Appropriate site selection: What aged orchards would benefit the most from biofumigation – preplant, nonbearing or mature?

Biofumigation cover crops not only suppress soilborne pathogens and pests but also attract pollinators with their abundant, nectar-rich, vibrantly colored flowers. These blooms provide a critical source of nectar and pollen, especially when other floral resources are scarce, supporting the health and diversity of bees, butterflies and other pollinators. Additionally, the habitat enhancement created by these crops fosters biodiversity and ecosystem stability, offering shelter for beneficial insects while potentially boosting yields of nearby pollinator-dependent crops (Sekaran et al. 2025).

The timing and method of cover crop termination are critical to biofumigation's success. Terminating biofumigation crops like mustard or radish at the flowering stage or just before seed set is crucial because it maximizes the concentration of glucosinolates within the plant. These are the key compounds responsible for producing the volatile, pest-suppressing compounds when the plant tissue is chopped and incorporated into the soil, thus achieving the most effective biofumigation action against soilborne pathogens and pests. Terminating mustard at early flowering can result in up to 40%–60% higher pest suppression compared to termination at later stages. To harness the maximum biofumigant potential, termination should be carefully timed — preferably at the flowering stage — to ensure optimal glucosinolate availability. Rapid soil incorporation of biofumigant crops immediately after termination is essential to minimize the volatilization and loss of compounds to the atmosphere. Irrigating the night before increases soil moisture, which enhances biofumigation success but likely has to be balanced with the challenges in terms of soil compaction and field accessibility.

Biofumigation crops should be selected as part of a long-term management practice. For example, allelopathic chemicals produced by black and brown mustard suppress wheat germination (SAREP undated).

UCCE recommends waiting 12 to 24 months between orchard removal and planting new trees (Pope 2017; Lightle 2017) and following a protocol to ensure replanted orchard health:

- Sample for nematodes
- Kill the old tree roots
- Wait at least 12 to 18 months before replanting the orchard. During the wait:
- Correct any physical (hard pan, plow pan, compaction, etc) or chemical (salt, pH, nutrient, herbicide residue) problems.
- Fumigate in the fall if you have high nematode counts.
- Plant an annual, non-nematode host crop.
    - Sudan grass or a sorghum x sudan hybrid is a good choice to begin to reduce nematode populations while improving soil tilth. These non-irrigated crops will also help to dry the soil if a fall Telone fumigation is necessary.
- If the soil does not need to be dried for fumigation most of our irrigated annual crops (except beans) won't host P. vulnus but they can host ring and root-knot nematodes.

The longer the idle period between orchards, the less likely there will be a need to fumigate. After a period of one year, chemical fumigation will likely be necessary, whereas after an extended period of two to three years, fumigation may not be necessary at all which may represent a significant cost savings.

The type of crop being removed and replanted also influences whether an idle period is sufficient to reduce nematodes and disease pressure to acceptable levels. Walnuts replanted on walnut ground are more likely to need fumigation, whereas walnuts following almond are less likely to need fumigation.

5.1.2.1 Barriers to Adoption

The main barriers to adopting fumigant alternatives include the continued availability of effective fumigants (because of regulatory phasing out), challenges related to the implementation, performance and economic feasibility of the alternatives, and an incomplete understanding of their environmental and unintended human health effects (Simmons and Broome 2025).

5.2 Undesirable Interim Practices

5.2.1 Idle Ground

Fallowed agricultural lands dominate human-caused dust sources in California and have expanded in recent years because of water shortages. These dust emissions are associated with public health issues and impacts on regional climate. In addition to increasing risk of respiratory and cardiovascular diseases, dust can carry infectious soil-dwelling fungal spores. Dust impacts regional climate by absorbing radiation and influencing winds, exacerbating heat waves, and affecting water resources availability (precipitation, snow melt timing) (Adebiyi et al. 2025).

Idle land is also susceptible to land degradation from soil erosion. The severity of soil erosion caused by wind depends on soil type and fetch, or the distance that wind has to blow or pick up before being obstructed. Soil erosion by water is also problematic because pesticides and nutrients can adhere to sediments and be carried to waterways. Soil erosion results in reduced fertility and soil microbial diversity. In turn, these impacts reduce agricultural productivity and resilience to extreme climate events by decreasing infiltration and buffering against other changes in soil physical and chemical conditions.

5.2.2 Abandoned Orchard

Abandoned orchard blocks have increased in California statewide because of water scarcity and low market prices. These blocks can harbor pests like navel orangeworm, rodents, and weeds that can spread to neighboring orchards. Assembly Bill 732 was signed into law in October 2025 to provide county agricultural commissioners with authority to issue civil penalties up to $500 per acre, and up to $1,000 if landowners fail to take action on abandoned orchards. The bill requires counties to issue a notice before penalties are levied. Landowners who take action based on resources such as UC Cooperative Extension and the UC Statewide Integrated Pest Management Program can void fines. The bill will remain in effect until 2035, allowing a decade for counties to assess its impact.

5.3 Current Orchard Fallow Period Practices in the Vina Subbasin

5.3.1 Fall-seeded Cover Crops or Resident Annual Vegetation

Fall seeded cover crops are planted in the fall (primarily October/November) and are harvested in the spring, such as winter grains such as wheat and triticale. They can protect topsoil from erosion, thereby protecting soil fertility. They may also guard surface water quality by reducing off-farm sediment and nutrient load into waterways. A grower has the option of harvesting and selling them as forage (hay, silage) or in the case of very wet years perhaps harvesting grain. In either case, production costs are relatively low for ground preparation and seeding, the crop is rainfed or receives minimal irrigation and may have the potential to generate positive cash return. Resident annual vegetation species that naturally germinate and grow in area orchards have some of these same benefits without the planting or harvest costs and returns.

If fall seeded crops are turned back into the soil before they mature and become lignified, they may act as a trap crop and green manure crop. They uptake important nutrients such as N, P, and K and when turned back into the soil they decompose and release these nutrients in the spring to the next crop whether it be a newly planted annual crop or a perennial crop that is emerging from dormancy. Trap crops or green manure crops can protect groundwater quality from leaching nitrogen and may partially address the fixation of other nutrients like potassium or phosphate. If fall seeded crops are harvested, they will not be as effective as a trap crop or green manure crop for recycling nutrients because some of the nutrients will be transported from the field with the harvested portion of the crop. Plus, residual plant matter that can be turned into the soil after harvest will be more lignified, less nutrient rich, and slower to decompose.

When more mature and lignified residual plant material is incorporated into soil, it can contribute to short term nutrient deficiencies (usually limited to nitrogen) in the following crop. The plant material is much higher in carbon content relative to nitrogen and soil microbes consume nitrogen during plant decomposition and temporarily create deficiencies in plant-available forms of nitrogen. This can be remedied with addition of organic or synthetic fertilizers at an extra cost or possibly avoided by waiting longer to plant the following crop and allow plant decomposition to reach completion.

5.3.2 Spring-seeded Cover Crops

Spring seeded cover crops such as Sudan grass and safflower offer value in the form of hay sales or oil seed harvest. Other spring seeded crops such as Brassica (mustards) are considered as well but cannot be harvested for forage. The cash value of spring seeded crops may be secondary to their role in preparing land for replanting second or third generation orchards, particularly in the case of walnuts that need dry soil in the fall for more effective pre-plant fumigation.

Spring planted cover crops that grow through the summer have high water demand and help dry out the soil profile. The efficacy of applying fumigants in dry soil profiles is superior to wet soils, especially in finer textured silt loam, and clay loam clay soils with high water holding capacity. In general, the deeper and the drier the soil profile resulting from growing a spring planted cover crop, the more effective the fumigation will be at controlling soil-borne pests. Properly selected spring seeded cover crops that are non-hosts to the pathogens and nematodes help reduce their populations in the soil by means of starvation. However, starvation alone is not likely to reduce the risk of replant problems, especially in walnut, so fumigation remains important.

5.3.3 Short-season Summer Annuals/Irrigated Cash Crops

Short season summer annual, irrigated cash crops such as dry beans, processing tomatoes, vine seeds, pumpkins, etc. are options for orchard fallow periods. However, they may be limited or not appeal to everyone. They have the advantage of offering more immediate cash returns but caution needs to be exercised to make sure the returns exceed costs. Generally, they require signing leases before planting with a tenant grower because the landowner does not have the farming experience of farm equipment needed to grow these crops and a contract with a buyer and processor of the crop. This practice may also involve implementing new irrigation methods such as subsurface drip. These may represent new risks or uncharted waters for many growers.

5.3.4 Conservation Cover Crops

Conservation cover crops (i.e. native perennial species) or banker cover crops that provide habitat (i.e. for bees or other species) are not likely to interest growers. The native perennial species may interfere, disrupt, or delay plans for new orchard plantings. For example, suppose a banker crop successfully supports bees or a threatened or endangered species but the grower desires to terminate it for financial or other reasons and replant the orchard or another higher value cash crop, will this be met with resistance to the change?

5.4 Potential Agronomic Benefits of EOR

Many growers have emphasized the importance of establishing a young, uniformly growing orchard. Some have experienced it being so important that they have torn out young two-year old orchards with poor uniformity and replanted again rather than invest further into a non-uniform orchard that will not grow and produce well for the next 20 to 35 years. Replanting a new walnut orchard after removal of a walnut orchard is most likely to be problematic. Replanting almonds after removal of an almond orchard is less likely to pose problems but it can occur. Changing orchard types (i.e. replant almonds after removal of walnuts or vice-versa) further reduces the risk of replant problems.

5.4.1 Barriers to Adoption

During interviews in 2025, growers expressed some hesitation with EOR and may be motivated to replant orchards in a timely manner, even when markets are uncertain or poor. Growers are typically heavily capital invested in mowers, shakers, sweepers, blowers, harvesters, bank-out wagons, driers, hullers, and, for those who are vertically integrated, processing and product packaging plants. The equipment is specialized and not easily adapted for use in other crops. Harvesting crops and operating hullers, driers, and processing plants during poor markets likely minimizes losses in comparison to if they did not harvest and operate at all. Though this approach is not sustainable long-term, it may be in the short term until poor markets can improve.

In addition to the issue of capital investment in harvest equipment and crop handling and processing, California almond and walnut producers are leaders in a competitive world-wide market. These two industries are steadily working to manage previous year's production inventories and current year production to sustain their position and capacity to sale their product in a worldwide market.

5.5 Spatial Data Collection

5.5.1 Orchard Type and Age

In 2025 there were 51,801 standing acres of almonds and walnuts (including standing abandoned orchards) divided fairly equally between the two crop types (Figure 6). Of the 25,668 ac of almonds, 46% (11,822 ac) are established (7-20 years old). About 20 percent are young and 35% are 21 years old or older. Of the 26,133 ac of walnuts, 57% are between 9 and 25 years old while about 16% are young and 26% are 26 years old or older.

Figure 7 focuses on the stressed, abandoned and removed orchards. This map includes almonds and walnuts that were removed in 2023, 2024 or 2025 and not replanted. Currently, (using 2025 mapping), there are 2,877 ac of removed orchards that have not been replanted. 1,986 of those ac were previously almonds and 892 ac were previously walnuts.

Abandoned orchards refers to those that are not irrigated but have not been removed. These orchards represent 254 ac of almonds and 106 ac of walnuts.

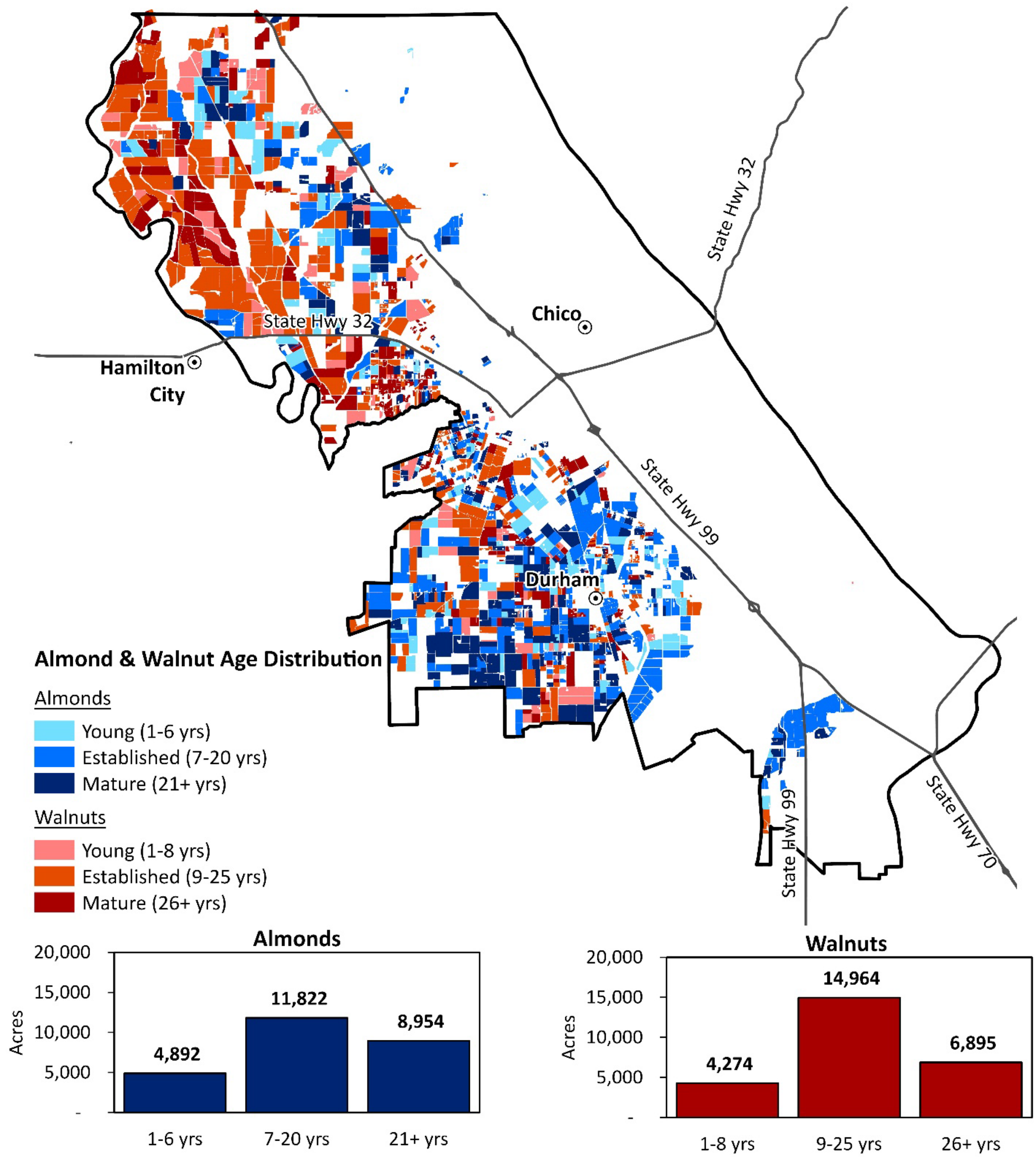

Figure 6. 2025 Almond and Walnut Age Distribution in the Vina Subbasin

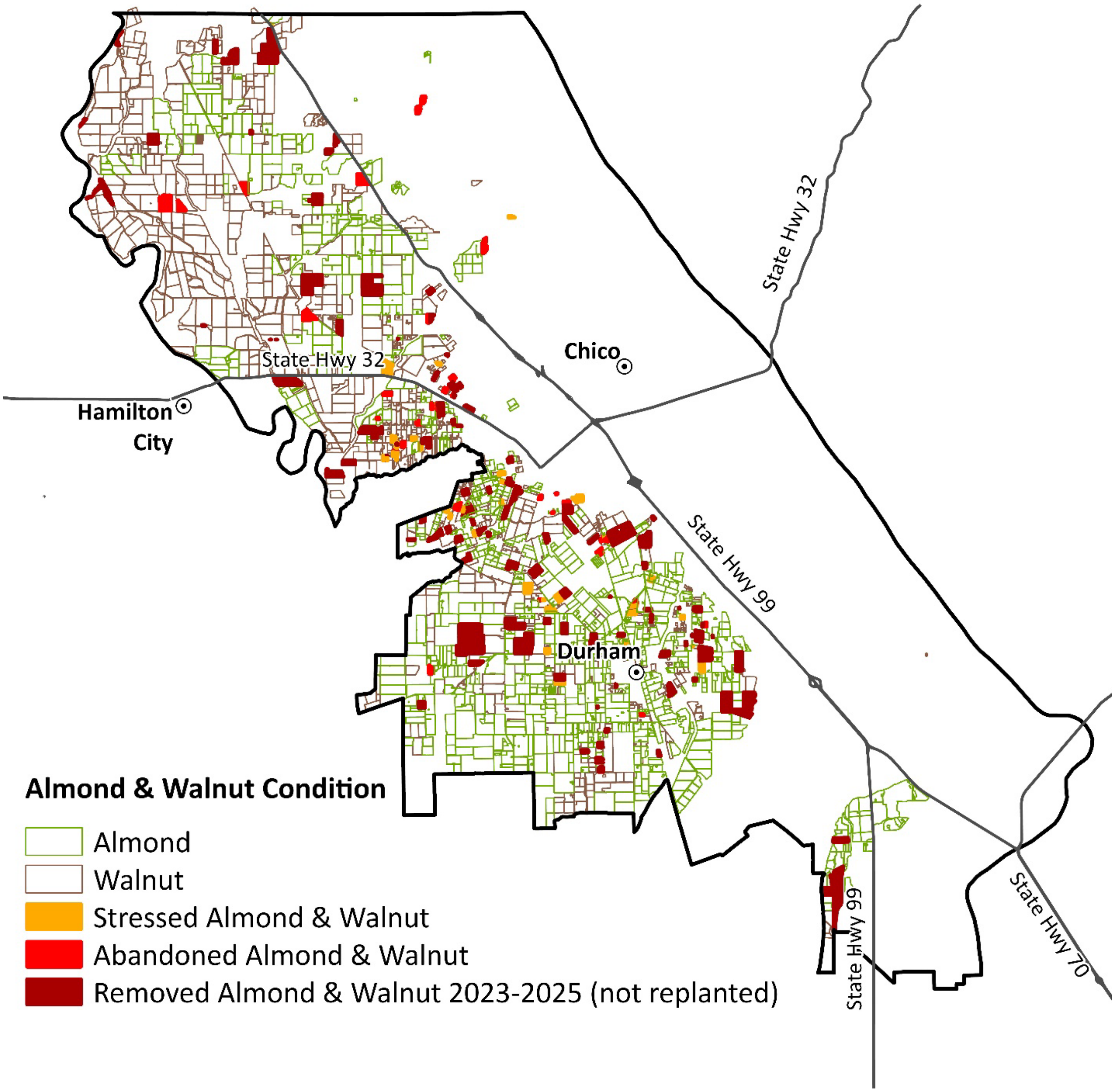

Figure 7. 2025 Almond and Walnut Condition in the Vina Subbasin

5.5.2 Consumptive Use (ET) and Precipitation Data

Consumptive use (ET) and precipitation data was collected in 2025 using Land IQ's data driven method. For 2019-2024 consumptive use data, the SIMS model was used as described.

Both consumptive use and precipitation datasets were calculated and summarized monthly during 2025. Though this data was originally anticipated to be delivered on a quarterly basis, it was not used in an incentivized pilot study and therefore was only needed for final analysis. Therefore, work was prioritized and four reports of data were modeled and delivered to the Vina GSA on the following schedule:

- January-April 2025 – delivered June 2025
- May-September 2025 – delivered November 2025
- October 2025 – delivered December 2025
- January-February 2026 – delivered March 2026

Both consumptive use and precipitation data were delivered in two forms: raster and vector data, which are the two forms of geographic information system (GIS) data. Raster data is a grid of cells (pixels) where each cell holds a value like elevation or temperature. Vector data is points, lines and polygons that represent discrete features like roads and fields. The raster datasets of both ET and precipitation cover the whole Vina Subbasin and were delivered in units of mm in a 30m-pixel resolution dataset. The vector data uses Land IQ field boundaries and has a zonal statistic result for each field. Zonal statistics calculate statistics (e.g., mean, sum, maximum) on a raster dataset based on defined zones in these cases, a field. They are used to summarize (e.g. calculate an average) pixel values within each field boundary. Therefore, field boundaries and crop type as mapped by Land IQ are included in these datasets, summarized as follows:

- ET raster - 30m pixel in mm
- Precipitation raster – 30m pixel in mm
- Field boundaries with zonal statistics of ETa (mm)
- Field boundaries with zonal statistics of precipitation (mm)

Each monthly dataset was accompanied by an html ET map that visualizes ET by field throughout the Vina Subbasin.

Precipitation maps are included in Appendix A. Four maps visualizing raster data are provided that represent one month from each quarter. One map representing the annual accumulation of precipitation by field is also included.

5.6 Pilot Orchard Selection and Data Collection

The selected pilot orchards are summarized in Table 2 and include five almond fields and six walnut fields. These fields were used to inform the EOR pilot study on what crops and practices are used in the idle period.

Table 2. Pilot Study Orchards and Site Conditions

#	Crop Type	Size (ac)	Interim Fallow Treatment	Date Orchard Was Removed
1	Almond	119.0	None provided	Abandoned
2	Almond	32.1	Beans; to be planted 4/15/26 and end 4/25/26	8/31/2025
3	Almond	328.4	Sudangrass; planted in sundangrass early April and harvested first of July.	2/15/2025
4	Almond	92.6	Fallow (2023) Wheat/Dry Beans (2024)	11/1/2022
5	Almond	54.4	Hay Crop (2022 & 2023) Cover Crop Mix (2024) Trees (2026)	10/2022
6	Walnut	183.0	Abandoned	NA
7	Walnut	34.3	Abandoned	NA
8	Walnut	71.6	Rainfed wheat; planted Nov. 24 and harvested June 25. No irrigation	10/31/2024
9	Walnut	78.0	None provided	7/16/2025
10	Walnut	23.6	New almond trees; planted on 2/10/25 and Bean Crop; planted 6/24/25	10/2023
11	Walnut	100.0	Tomatoes; planted 5/1/25, harvested 8/30/25	2024

6 EOR Consumptive Use Analysis and Results

6.1 Differences in Consumptive Use between Orchards and Alternative Land Uses during the Extended Replant Period

Consumptive use of alternative land uses that are likely to be used during the extended replant period are compared in Figure 8. These values were averaged using data from across the Vina Subbasin.

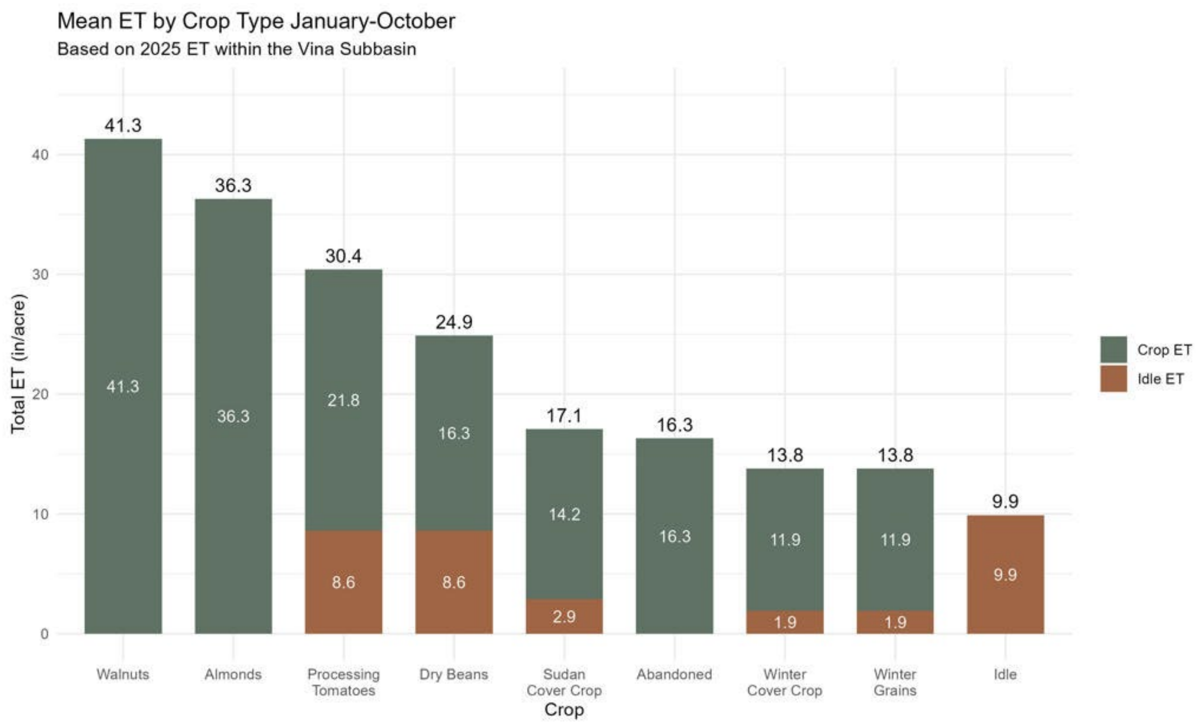

Figure 8. Consumptive use of walnut and almond orchards compared to alternative land uses during the extended replant period.

Figures 9-15 show consumptive use of each scenario for the same period, including ETc for the crops during their growing season and ET of idle land when the crop is not in the ground. Idle ground ET mostly occurs during March, April and May. Therefore, idle ground ET increases the consumptive use of summer crop scenarios substantially when it is included.

- The consumptive use of idle land depends on the vegetative cover and the type of precipitation year. Idle land in the Vina Subbasin used about 9.9 inches of water, on average, from January to October 2025. This value takes into account different water year types and various levels of vegetative cover (Figure 9).
- Abandoned almond orchards in the Vina Subbasin consumed about 16.5 inches of water and abandoned walnut orchards used about 16.1 inches of water from January to October, 2025 (Figure 10).
- Winter mix cover crops consumed 11.9 inches of water during their growing season in 2025. For months when the land was idle, another 1.9 inches of water was consumed, for a total of 13.8 inches of consumed water for this land use January to October 2025 (Figure 11).

- Winter grain crops consumed 11.9 inches of water during their growing season in 2025. For months when the land was idle, another 1.9 inches of water was consumed, for a total of 13.8 inches of consumed water for this land use January to October 2025 (Figure 12).
- Spring Sudan grass consumed 14.2 inches of water during their growing season in 2025. For months when the land was idle, another 2.9 inches of water was consumed, for a total of 17.1 inches of consumed water for this land use January to October 2025 (Figure 13).
- Processing tomato crops consumed 21.8 inches of water during their growing season in 2025. For months when the land was idle, another 8.6 inches of water was consumed, for a total of 30.4 inches of consumed water for this land use January to October 2025 (Figure 14).
- Summer dry bean crops consumed 16.3 inches of water during their growing season in 2025. For months when the land was idle, another 8.6 inches of water was consumed, for a total of 24.9 inches of consumed water for this land use January to October 2025 (Figure 15).

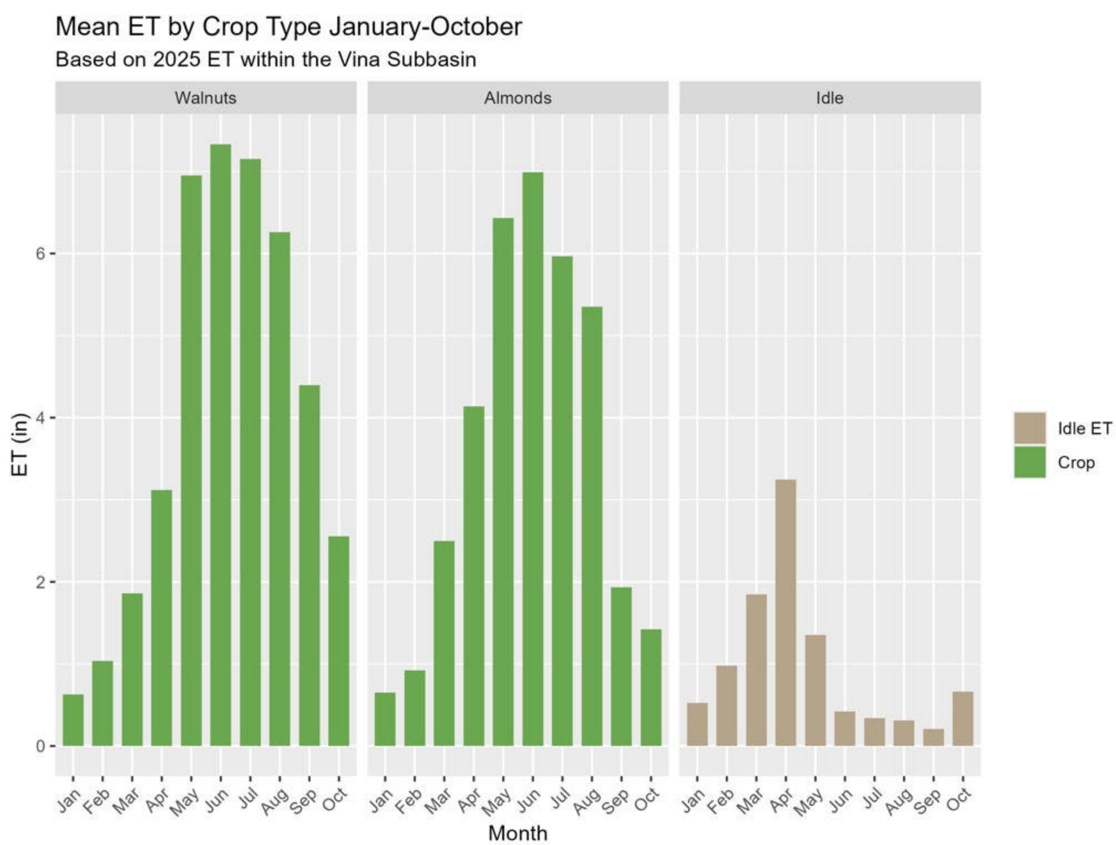

Figure 9. Consumptive use of established walnut and almond orchards compared to the idle land uses during the extended replant period.

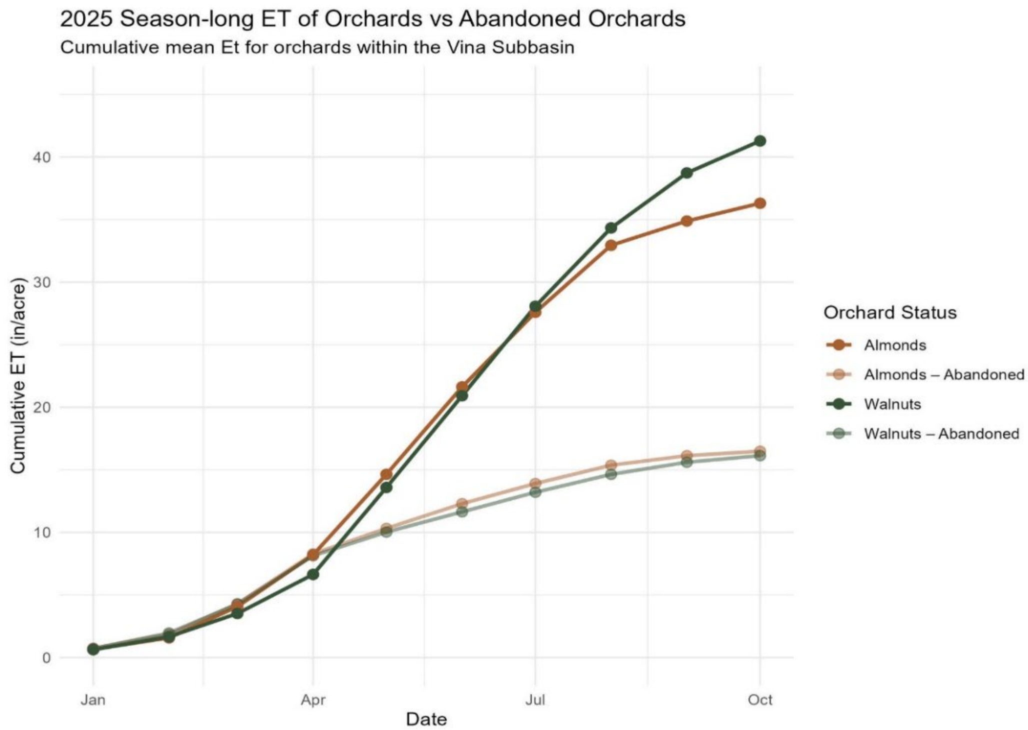

Figure 10. Consumptive use of abandoned almond and walnut orchards compared to established almond and walnut orchards.

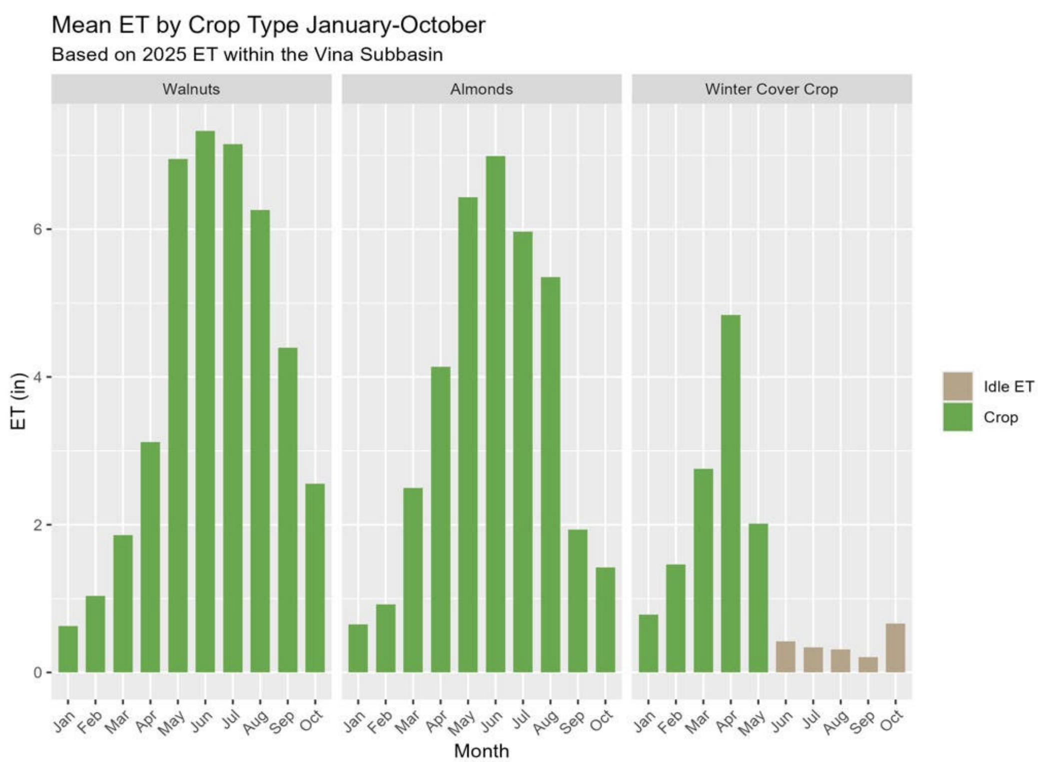

Figure 11. Consumptive use of abandoned almond and walnut orchards compared to established almond and walnut orchards.

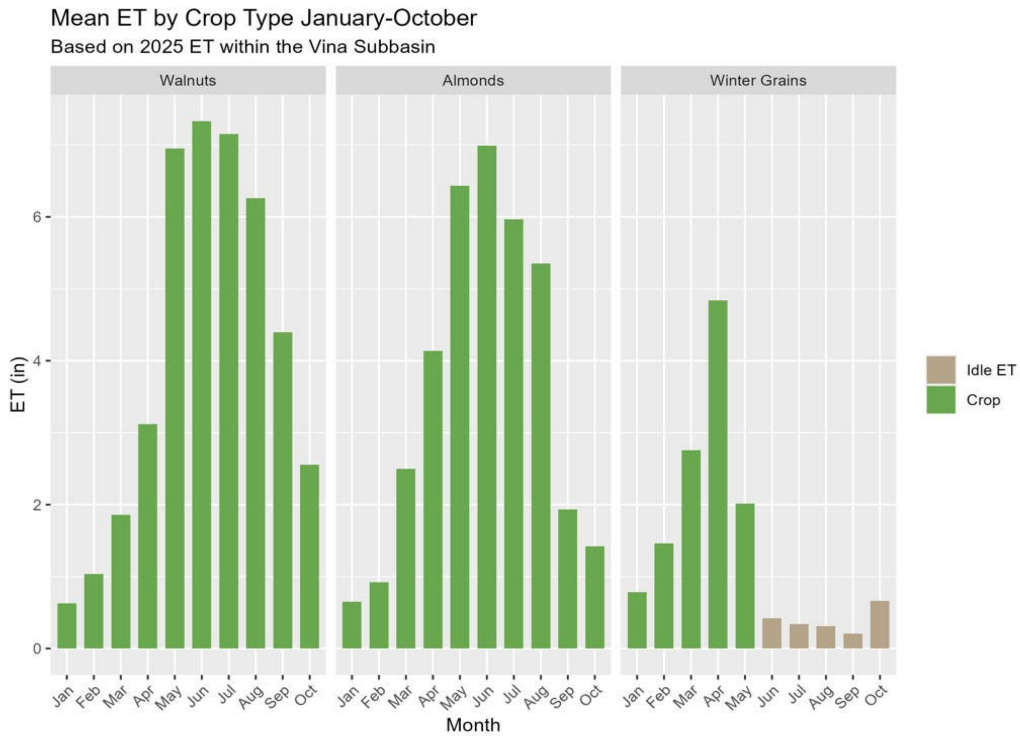

Figure 12. Consumptive use of winter grains compared to established almond and walnut orchards.

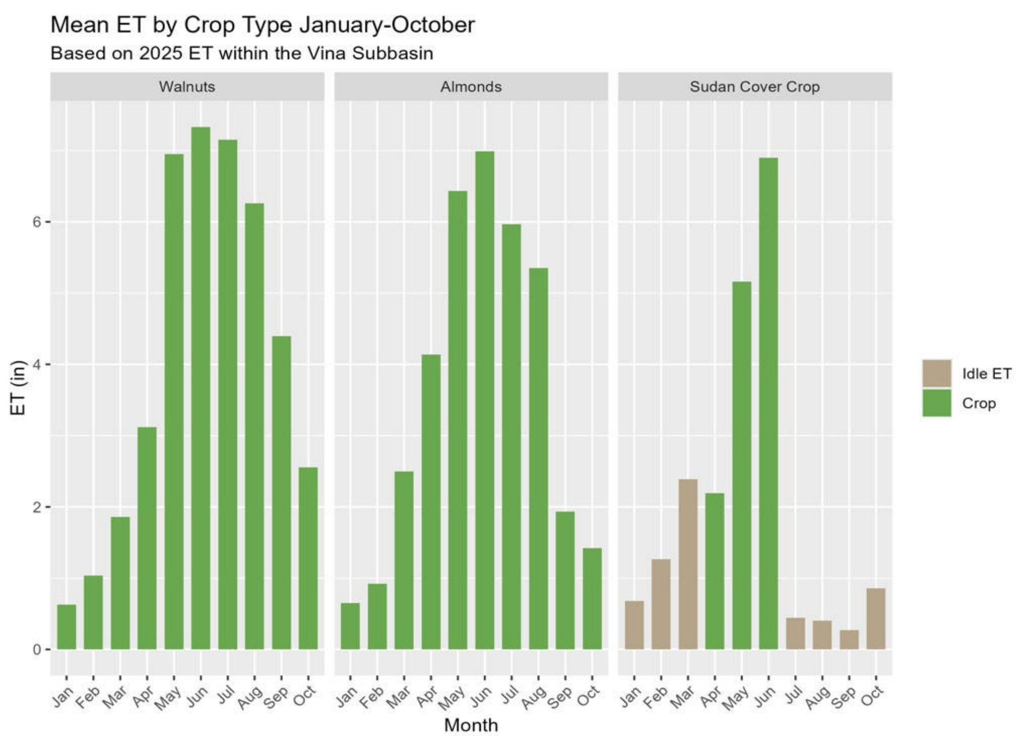

Figure 13. Consumptive use of Sudan grass compared to bearing almond and walnut orchards.

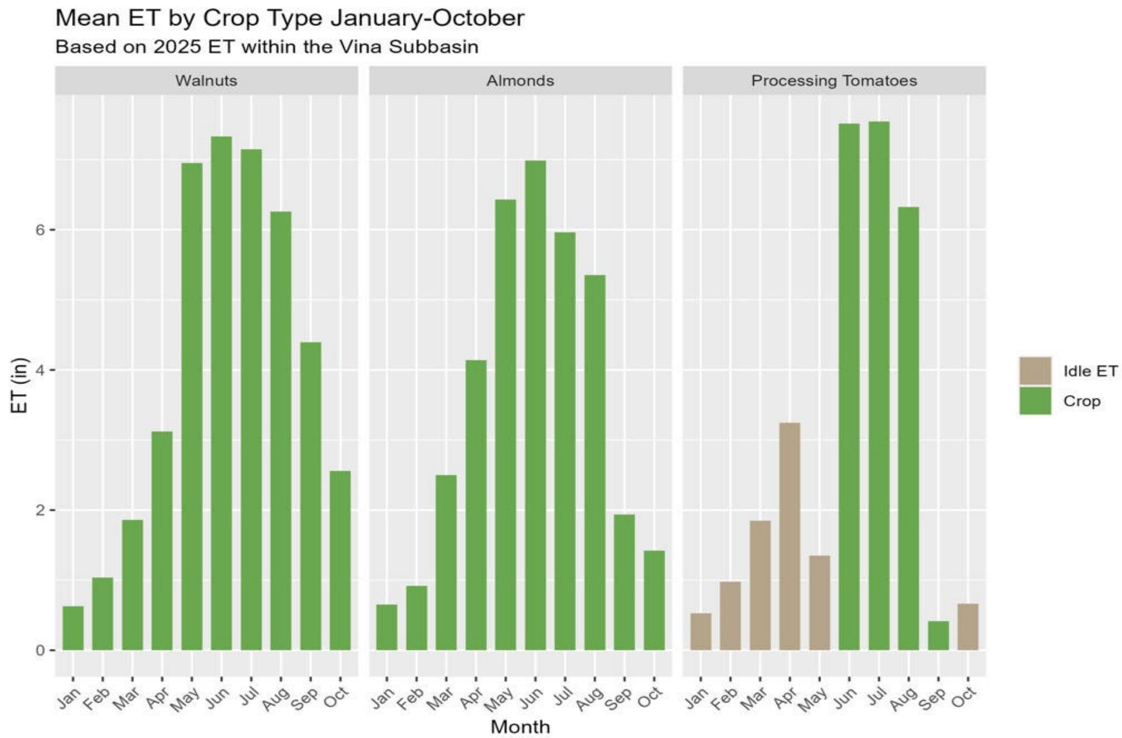

Figure 14. Consumptive use of processing tomatoes compared to bearing almond and walnut orchards.

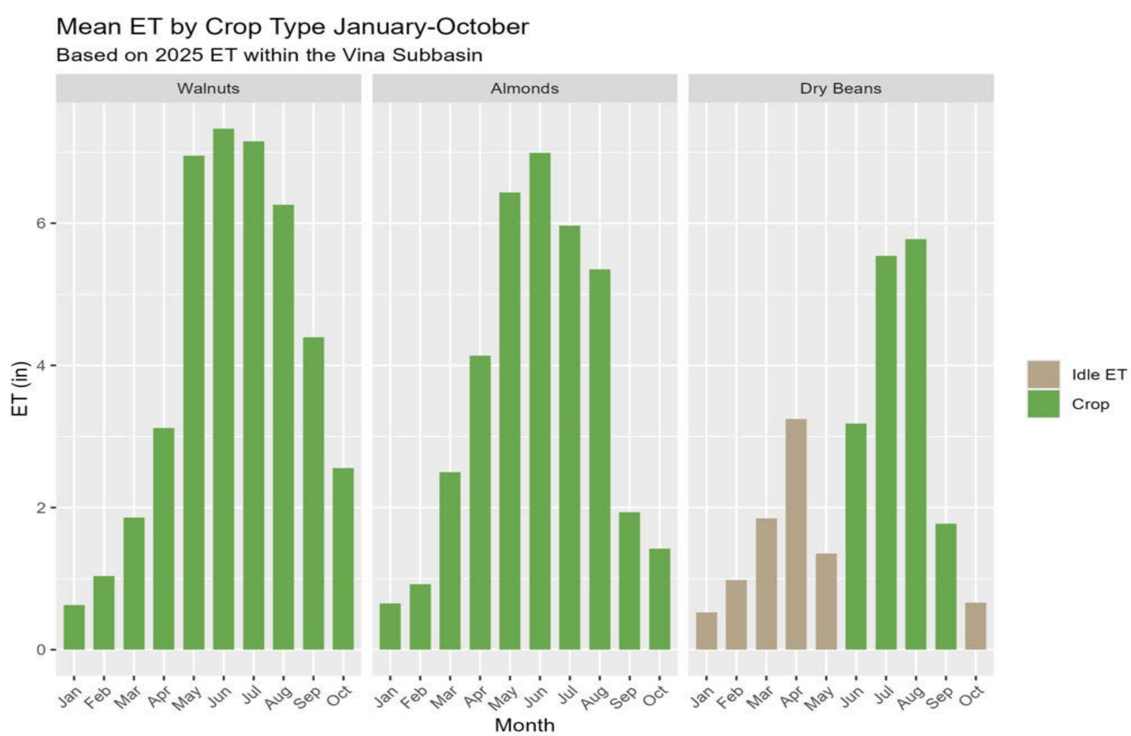

Figure 15. Consumptive use of dry beans compared to bearing almond and walnut orchards.

6.2 Water Savings Calculator

An EOR Calculator was developed to model expected water savings from extending orchard replacement with the land uses included in the EOR scenarios. The GSA can view almond and walnut removals (by acreage) in the Vina Subbasin in 2024 and 2025 for reference and select an acreage to be removed. The user can then select a percentage of that acreage that is assumed to be practicing EOR. From there, the user estimates the percent of acres that will be used by each alternative land use (idle, winter mix cover crop, Sudan grass, etc.). The calculator outputs the expected acreage of land dedicated to each land use under the selected proportions of land uses and the associated water use and water savings.

As an example, using average removal acreages and assuming half of removals are left as idle ground and the other half are equally distributed between the other modeled land uses (winter mix cover crop, winter grain, spring Sudan grass, processing tomato, dry beans), with no orchards left abandoned, results in about 2,900 ac-ft of consumed water savings compared to average orchard consumption (Figures 16 and 17). In that scenario, most of the consumed water comes from processing tomatoes (78 percent) and dry beans (64 percent).

Footprint

	Acres Removed Per Year	Percent Practicing EOR	Percentage of 2025 Acerage	Historical 2024 Acres	Historical 2025 Acres
Almonds	1000	95%	4%	977	2,214
Walnuts	700	95%	3%	582	917
Total Acres in EOR	1615				

EOR Land Utilization

	Historical 2024 Acres	Historical 2025 Acres	Percent of Total Fallow Acres	Acres
Abandoned	181	284	0%	0
Idle			50%	808
Dry Beans	281	628	10%	162
Processing Tomatoes	650	463	10%	162
Sudan Cover Crop			10%	162
Winter Cover Crop			10%	162
Winter Grains	2,965	2,049	10%	162
Total			100%	

Overall Use and Expected Water Savings Compared to an Average Orchard

	Overall Use		Savings Compared to an Orchard (walnut and almond average)		
	ET (ac-ft)	Applied Water (ac-ft)	ET (ac-ft)	Applied Water (ac-ft)	Orchard Use Percent
Abandoned	0	0	0	0	0%
Idle	666	0	1,945	1,844	25%
Dry Beans	335	335	187	34	64%
Processing Tomatoes	409	450	113	-81	78%
Sudan Cover Crop	230	0	292	369	44%
Winter Cover Crop	186	0	336	369	36%
Winter Grains	186	0	336	369	36%
Total	2,012	785	3,209	2,903	

Figure 16. EOR Water Savings Calculator Inputs

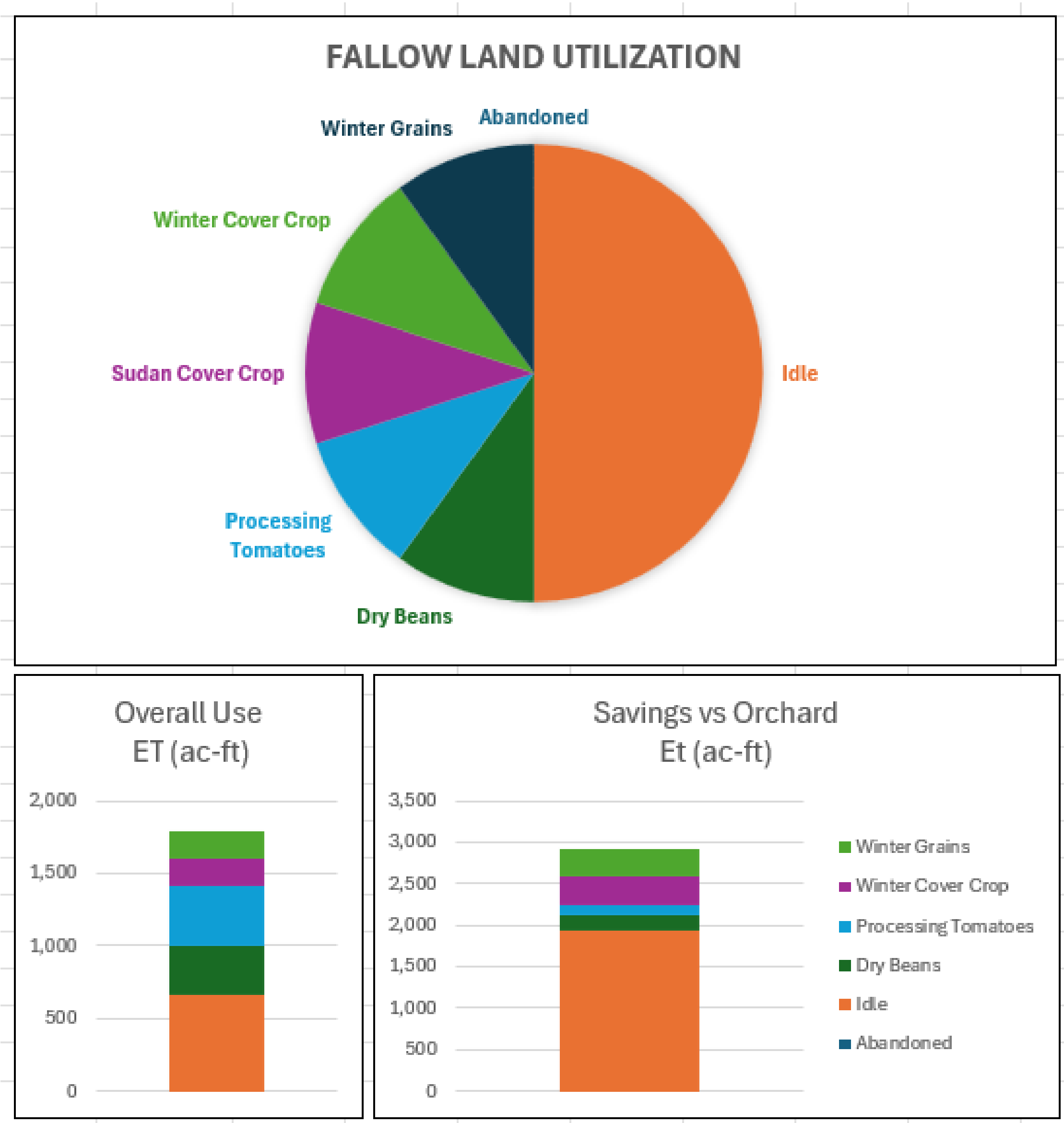

Figure 17. EOR Water Savings Calculator Results

Modeled ET for minor tree crops in the Vina Subbasin can be compared to ET for walnuts and almonds to determine approximate water savings. Consumptive use modeled from January to October in 2025 was 35.1 inches for prunes and 40.5 inches for pistachio. Olive uses less water and its ET for the same period was 27.6 inches. In 2025 there were 2,722 acres of prunes, 915 acres of pistachios, and 817 acres of olives. There were also very small acreages of other minor tree crops such as pecans and peaches (ET not modeled).

7 WATER SAVINGS ANALYSIS CONCLUSIONS

Abandoned orchards are not a desirable alternative land use for EOR. They consume 39 to 45 percent of water compared to established almond and walnut orchards, which is more than idle ground or winter cover crops consume. They also pose risks as pest havens and are now regulated in California.

The summer processing tomatoes land use consumes 74 to 84 percent of water compared to established almond and walnut orchards, including idle ground ET when the crop is not in the ground. This land use represents the least amount of consumed water savings modeled in the EOR scenarios. No soil health or agronomic benefits are associated with this land use.

The summer dry beans land use consumes 60 to 69 percent of water compared to established almond and walnut orchards, including idle ground ET when the crop is not in the ground. No soil health or agronomic benefits are associated with this land use, though legumes fix atmospheric nitrogen and can help reduce applied nitrogen fertilizer.

The spring Sudan grass land use consumes 41 to 47 percent of water compared to established almond and walnut orchards, including idle ground ET when the crop is not in the ground. Biofumigation, which breaks the disease cycle and helps to prevent the orchard replant problem, is a benefit associated with this land use.

The winter cover crop land use consumes 33 to 38 percent of water compared to established almond and walnut orchards, including idle ground ET when the crop is not in the ground. In addition to being a substantial consumed water savings, cover crops can provide numerous soil health and crop production benefits.

The idle ground land use consumes 24 to 27 percent of water compared to established almond and walnut orchards. Though this land use represents the most consumed water savings modeled in the EOR scenarios, problems such as dust emissions, soil erosion, water runoff and sediment loading, and soil degradation are potential disadvantages of this land use.

8 ECONOMIC EVALUATION SUMMARY

The full report documenting the EOR economic evaluation is provided in Attachment A and a summary is provided here.

The Vina Subbasin GSP specifies a mix of PMAs that may be developed and implemented to achieve and maintain sustainable groundwater conditions, including the EORP and PI programs. The economic analysis evaluated how alternative practices during an extended replanting period—ranging from harvested cover crops to short-season cash crops—affect the cost of delaying orchard replanting and the corresponding incentive payments that would be necessary to encourage voluntary participation in a program like EOR. These analyses provide additional data and context for future program design and implementation of future programs.

The analysis focuses on the costs and returns to the grower under representative scenarios. These values reflect conditions in the Vina Subbasin only and cannot be translated to other regions or programs. The EOR economic framework evaluates a selection of land management scenarios during the extended replanting period and assesses the costs for water savings. It also estimates the potential cost savings from changes in irrigation timing under time-of-use electricity rates. Agronomic effects—such as changes in ET, soil health, pest pressure, and long-term yield impacts—are only partially monetized or remain outside the scope of this study. As the EOR program concept is refined and additional field data become available, further analysis should be developed to refine incentive payments and support long-term program design.

8.1 Key Findings

Six scenarios for land management were developed that show potential benefits and incentive payments during an extended orchard replanting period. The incentive payments reflect the minimum willingness-to-accept for participation in a EOR program. Key findings include:

1. Extended replanting incentives vary depending on how the land is used during the idle period. Cover crops and spring-seeded grasses generate agronomic benefits but only modest economic returns, resulting in annual incentive payments up to $790 per acre, depending on the practice and crop transition.
2. Harvested cover crops partially offset idling costs by creating a (modest) revenue stream. Winter wheat harvested for grain or forage reduces grower costs relative to unmanaged idle land, lowering required incentive payments compared to other cover crops.
3. Short-season cash crops can substantially reduce or eliminate required incentive payments under certain market conditions. Processing tomatoes and dry beans can generate sufficient net revenue during the idle period to offset much of the cost of delaying replanting; however, outcomes are highly sensitive to commodity prices, contract terms, irrigation requirements, and operational feasibility.
4. As an alternative to removal, some growers have been abandoning orchards. Under AB 732, owners of abandoned orchards may be subject to substantial fines. The new law requires minimal management practices to avoid nuisance pest and disease pressure.
5. Extending the period between orchard plantings can reduce ET, resulting in measurable water savings between 0.91 and 2.62 acre-feet of ET per year. Of the scenarios considered for EOR, idle land and cover crops may provide the greatest water savings.

9 EOR Program Planning

The Vina Subbasin GSA could use an EOR framework to develop a specific target for demand reduction by increasing the number of acres in temporary fallow each year. Crop age data, historical orchard removal data, and information from the EOR pilot study can be considered to develop an EOR program that would meet these goals. However, forecasting how much water can be saved each year in the future by EOR would require an estimate of how many orchards are typically removed without an EOR program. This estimation is difficult for a variety of reasons, but especially because of market influences on planting and removal decisions.

The land use dataset provides data on age to determine the age distribution of walnuts and almonds in the Vina Subbasin (Figure 6). This age distribution illustrates variable annual planting rates. High planting years for walnuts included 2003, 2009-2011, 2013 and 2015. About twice as many almonds were planted in 2008 than in other high planting years for almonds, such as 2009 and 2018. This high variability in planting rates is not exactly correlated with removal rates because drivers for removal have their own set of influencing factors.

Removal age is not consistent from year to year. In 2023, 2,826 ac of almonds were removed and 1,200 ac of walnuts were removed. The average removal age was 32 and 35 for almonds and walnuts, respectively. But in 2024, only 563 ac of almonds were removed and only 36 ac of walnuts were removed. Similarly, in 2025 only 551 ac of almonds were removed and 260 ac of walnuts were removed. Similar to planting rates, removals also respond to markets; the cost of removal can disincentivize removal in a down market. Orchards may be removed or left standing for a diversity of reasons not explained by their attributes such as age. Orchards may be removed when they are nearing the end of the production life, their economic life, or kept in for other reasons (e.g. aesthetic) even though they may not be commercially optimal. Orchard economic productivity expectations differ between farming entities and their dependance on that asset to be profitable.

In the Vina Subbasin, many of the oldest orchards belong to small farming entities. Only 9 percent of the oldest almonds (over 35 years old) and walnuts (over 40 years old) are owned by farming entities over 500 acres, and 16 percent of the oldest orchards belong to farming entities 100 to 500 acres. Farming entities up to 100 ac have 45% of oldest orchards. Orchard removal data from 2023, 2024, and 2025 indicates that the removal age for almonds varies between 27 and 32 years, and between 32 and 35 years for walnuts.

The EOR pilot study provides data to determine the acreage of orchards that would need to be removed (annually) to achieve a specific water savings target. The water savings calculator shows the associated water savings with a specific number of removed orchard acres and how those water savings change when EOR practices change. The GSA could use this tool to determine how many acres it needs to incentivize for EOR and pursue funding to implement those incentives. The EOR pilot study economic analysis provides data to develop incentives, by acre, for EOR (see Attachment A). If GSA funding is known, the GSA could target a specific acreage to be removed each year, knowing the cost of incentivizing those removed orchards and how the water savings from those removals would reduce demand. This target might depend on known funding available for incentivizing extending the orchard replant period. However, both these approaches require a “moving target” because removals can’t be predicted.

From this perspective, an EOR program focusing on keeping orchards out of production once they are removed rather than targeting specific acreage or water savings targets will necessarily achieve different water savings and incur different costs each year. Table X provides an example of information from the water savings analysis and the economic analysis (incentive costs) using almond and walnut removal acreage data for 2023, 2024 and 2025. In other words, if an EOR program was in place during these years, this summary shows how much water would be saved (not consumed) and how much it would cost the GSA in incentives to keep these removed orchards out of production one extra year if there was 100% enrollment. Table X also shows how removals can vary substantially from year to year. An EOR program would need to take this variability into account. This summary provides an example of the water savings and the cost of each scenario; however, the water savings calculator can be used to determine water savings and costs of different orchard removal scenarios.

The first few years of an EOR program would yield data on rates of incentivized adoption, which may be applied to future years and provide the GSA with estimates of both water savings from and cost of EOR. For example, if 30 to 40 percent of growers enrolled in EOR in the first three years of implementation, these adoption rates might give the GSA insight into future enrollment acreage, regardless of removal acreage, to improve estimates of water savings and cost of implementation in coming years. Tracking removal data would aid in this process.

Table 3. EOR Water Savings and Economic Cost

Crop	Year	Removed Orchards (ac)	Estimated Consumptive Use Savings (AF/year)		Estimated Cost to Incentivize Removals ($/year)	
			Idle	Cover Crop	Idle	Cover Crop
Almonds	2023	2,826	6,416	5,495	$ 1,805,814	$2,232,540
	2024	563	1,278	1,095	$ 359,757	$ 444,770
	2025	551	1,251	1,071	$ 352,089	$ 435,290
Walnuts	2023	1,200	3,276	2,885	$ 759,600	$ 939,600
	2024	36	98	87	$ 22,788	$ 28,188
	2025	250	683	601	$ 158,250	$ 195,750

Note: Estimates are based on 2025 Land IQ modelled ET and not the measured ET in 2023 and 2024. Idle land and cover cropped land are precipitation-based systems and the ET of these systems is expected to fluctuate based on the precipitation amount and period of accumulation each year. Incentive payment costs represent the minimum costs of compensating growers based on average commodity prices.

10 RECOMMENDATIONS

The following recommendations were developed for a Vina Subbasin EOR program. More detailed recommendations for expanded economic analysis are provided in Attachment A.

1. Promote winter and spring cover crops as an EOR practice, which has high water savings and numerous agronomic co-benefits.
2. Collect data on almond and walnut annual removals, which will inform the implementation of an EOR program over time. Crop age is not a reliable indicator of orchard removal potential overall.
3. Use the EOR calculator to estimate water saved and incentives needed under various scenarios to understand how variability in annual removal acreage affects the benefits and costs of EOR implementation.
4. Develop draft eligibility criteria, enrollment procedures, incentive payment structure and monitoring requirements and implement an initial limited-scale EOR program. Develop a bidding or selection process to allocate program funds efficiently. These procedures can then be tested through the limited-scale EOR program to evaluate administrative feasibility and grower participation.
5. Use initial adoption rates and annual removal data to inform EOR expectations, understand adoption rates relative to annual orchard removal rates, and estimate and track EOR demand reduction.
6. Update scenario budgets and incentive payments periodically to reflect commodity prices, input costs, and contract terms for cover and cash crops. In general, EOR program payments should be updated annually. All the results of the economic analysis are sensitive to prices, costs, and farming practices and should be updated over time. Incentive payments reflect representative averages and do not capture farm-level heterogeneity; integrating site-specific agronomic performance will be critical for refining program design and evaluating cost-effectiveness across scenarios.

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APPENDIX A

Precipitation Maps

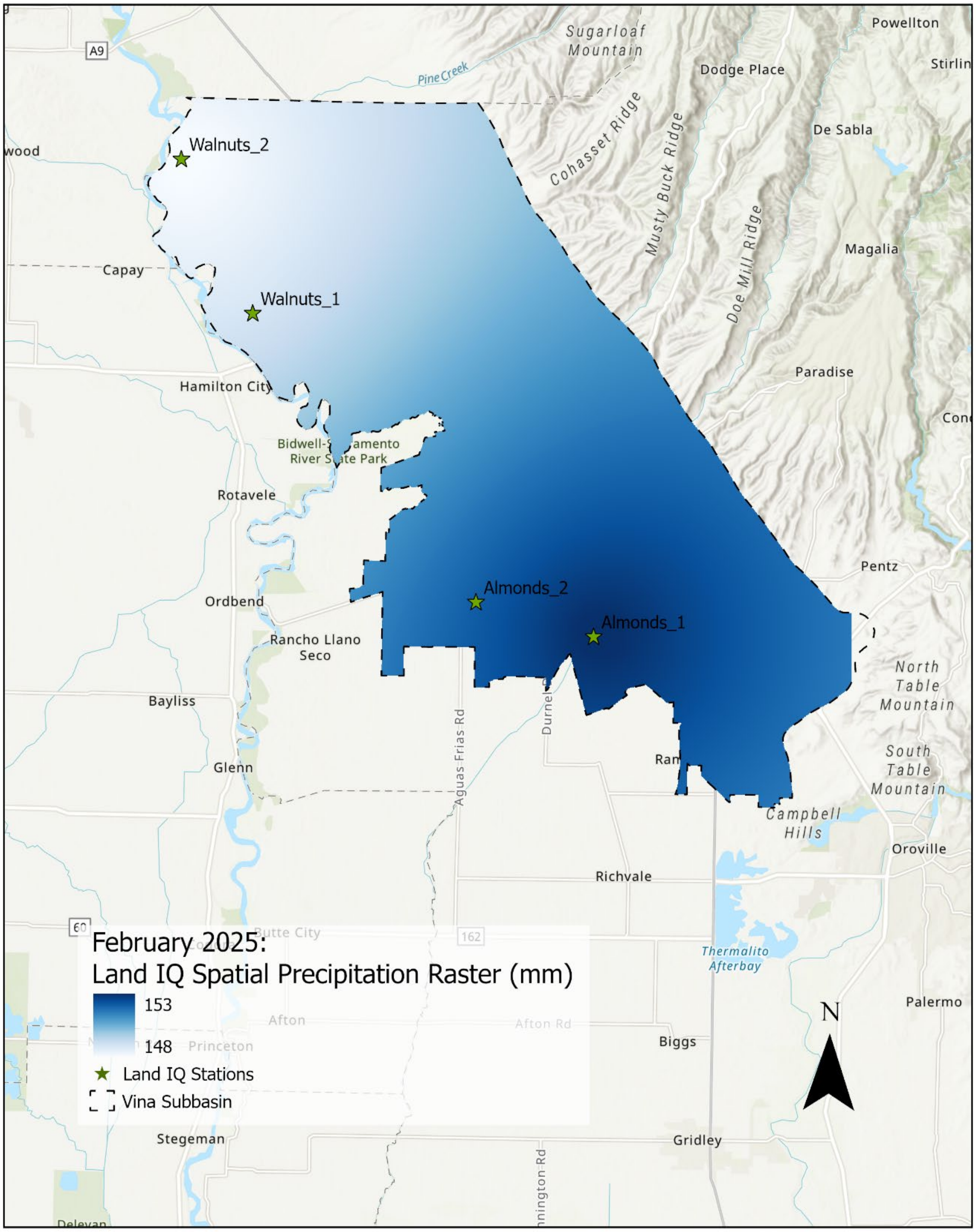


Figure A-1. Cumulative precipitation in the Vina Subbasin during February 2025

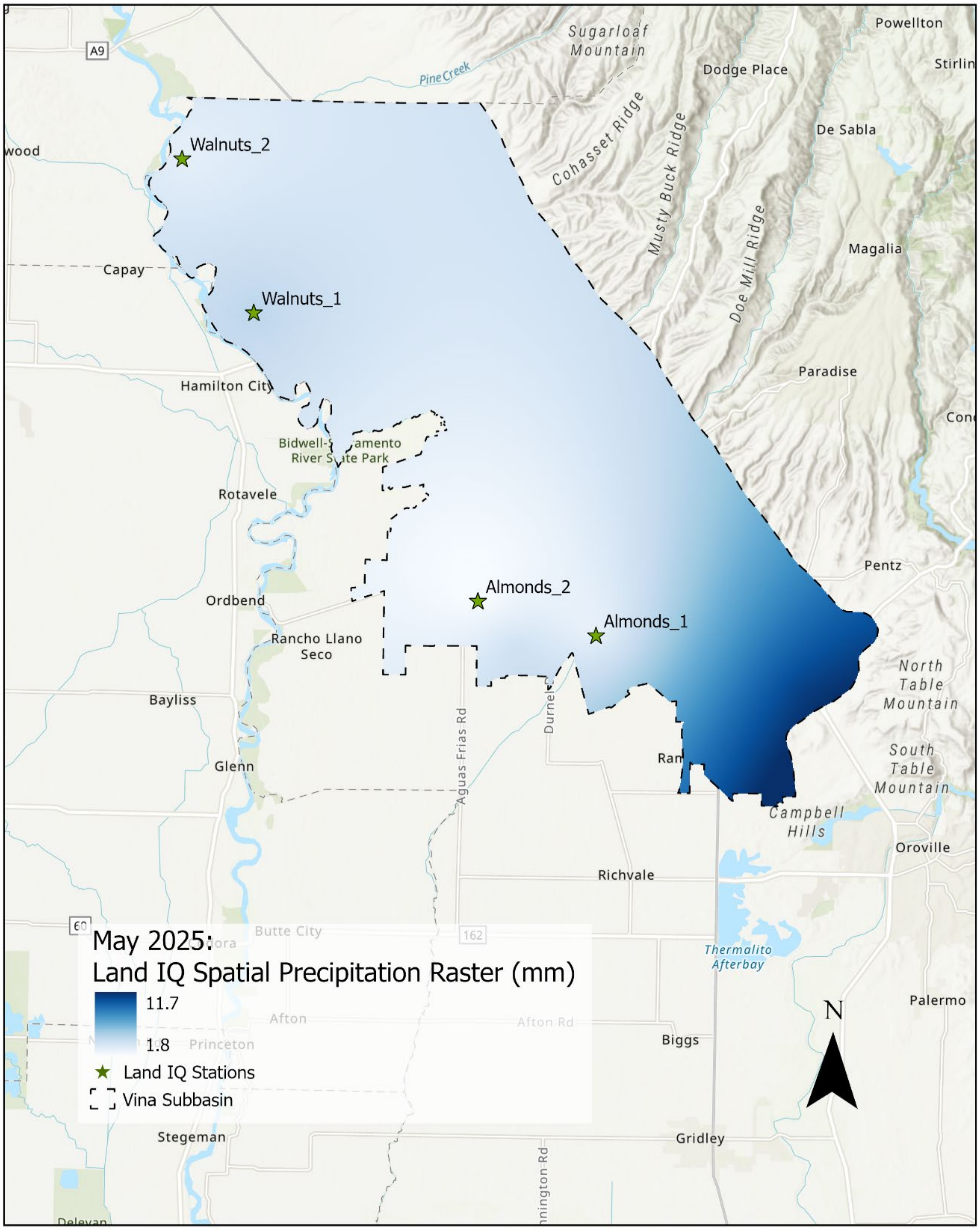


Figure A-2. Cumulative precipitation in the Vina Subbasin during May 2025

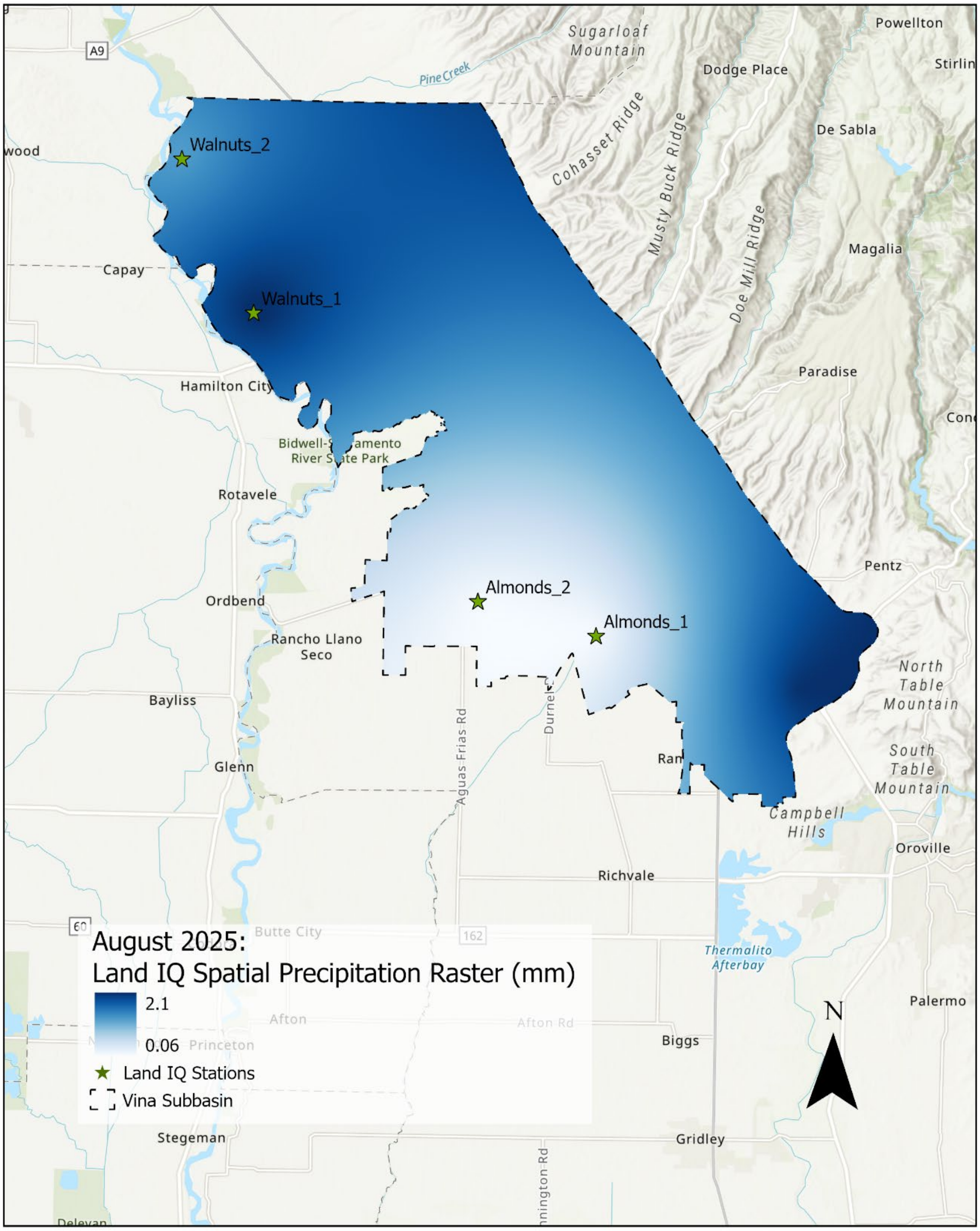


Figure A-3. Cumulative precipitation in the Vina Subbasin during August 2025

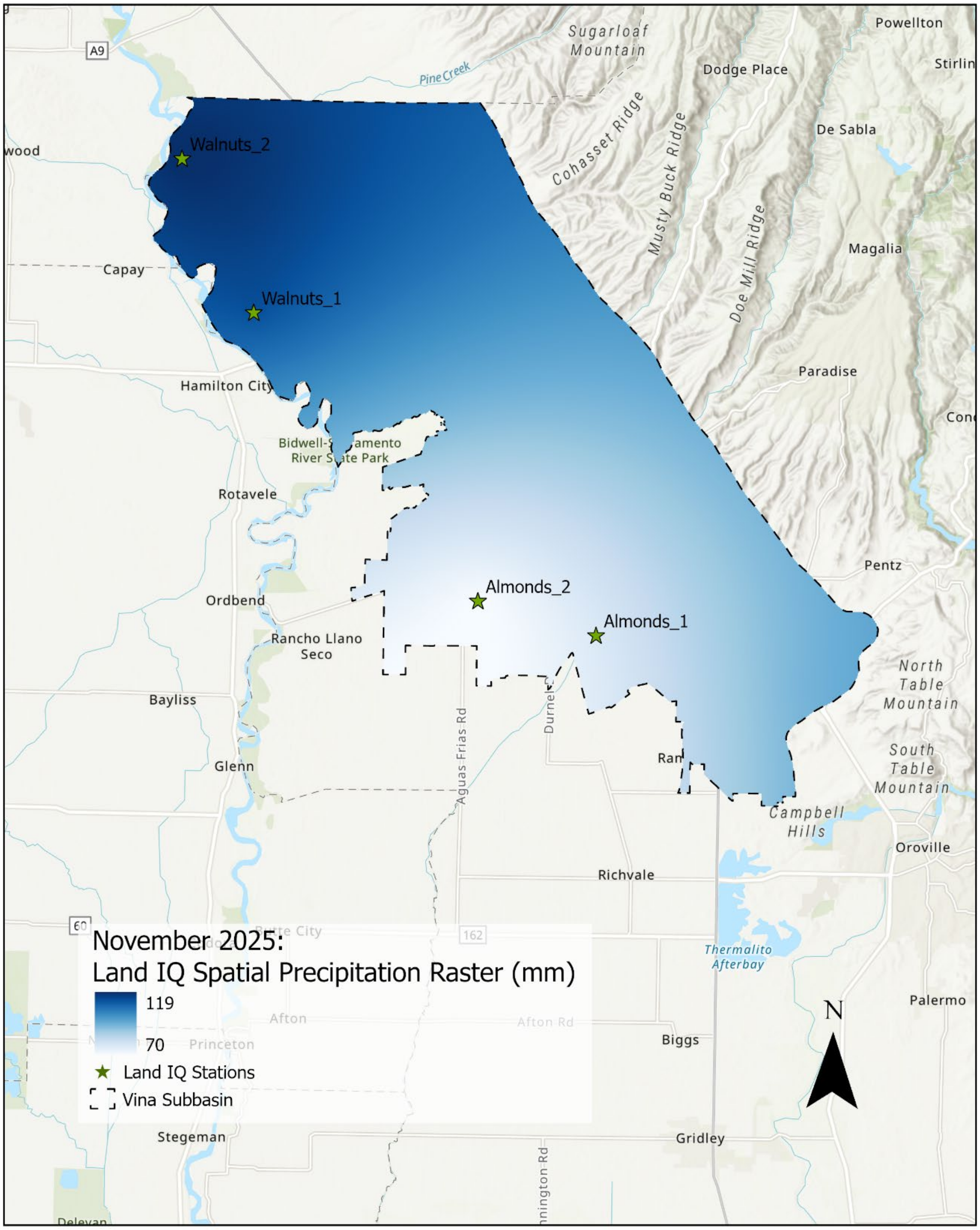


Figure A-4. Cumulative precipitation in the Vina Subbasin during November 2025

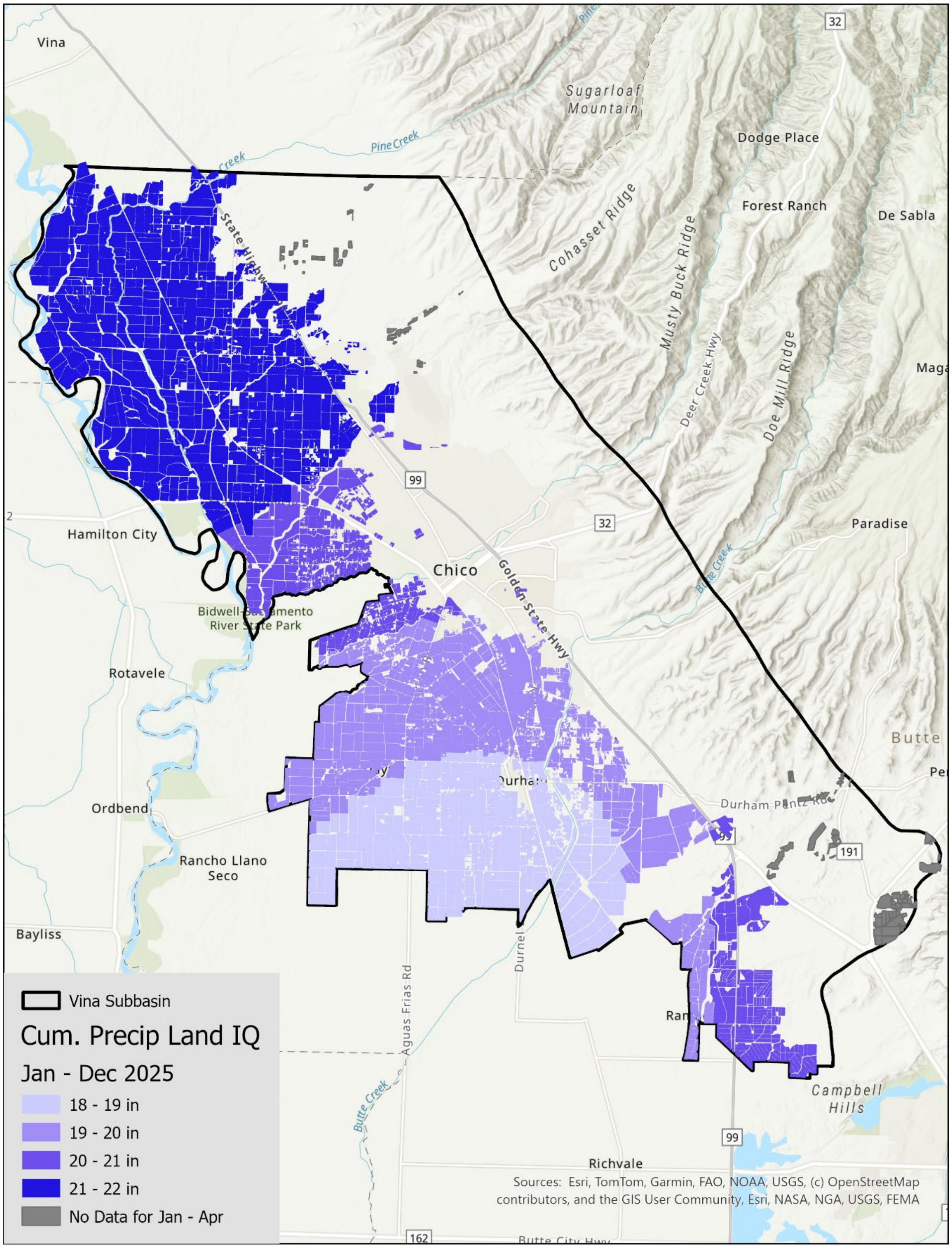


Figure A-5. Cumulative precipitation in the Vina Subbasin during 2025

Note: Precipitation data for Jan. – Apr. 2025 was not evaluated for fields at higher elevation east of hwy-99 due to lack of ground truthing stations and potential for higher precipitation than the valley floor.

ATTACHMENTS

ATTACHMENT A

Vina Subbasin Economic Analysis for Extend Orchard Replacement Program

Vina Subbasin Economic Analysis for Extended Orchard Replacement Program

April 2, 2026

Prepared by:
ERA Economics, LLC

Prepared for:
Tovey Giezentanner, Vina Subbasin / AGUBC

ERA Economics
Environment • Resources • Agriculture

Table of Contents

List of Tables

List of Figures

1. Purpose and Background

The Vina Subbasin encompasses approximately 185,000 acres within Butte County and is designated as a High Priority Subbasin by the Department of Water Resources (DWR). The Subbasin is managed by the Vina Groundwater Sustainability Agency (GSA) and the Rock Creek Reclamation District GSA. It is split into three Management Areas that reflect regional differences in groundwater and water users across the Subbasin. A Groundwater Sustainability Plan (GSP) was developed, submitted, and ultimately approved by DWR in July of 2023.

The Vina Subbasin GSP specifies a mix of projects and management actions (PMAs) that the GSAs will develop and implement to achieve and maintain sustainable groundwater conditions in the Subbasin. These include but are not limited to:

- A Precision Irrigation (PI) program would evaluate, incentivize, and design mechanisms to encourage wider adoption of precision irrigation practices by agricultural water users in the Subbasin. These include approaches such as switching irrigation methods, technology, timing, and crops.
- An Extend Orchard Replacement Program (EOR) would reduce groundwater demand by providing an incentive payment (or payments) to voluntarily forgo orchard replanting, or potentially switching to an alternative crop, for a defined period. The Program will quantify water saving benefits and provide a range of co-benefits to the region.

ERA Economics was engaged to analyze components of the PI program as well as EOR incentive payments for six (6) land management "scenarios", representing different farming practices during the period between removal and replanting. These practices are intended to realize other co-benefits in soil and nutrient management and other agronomic factors, affecting program incentives.

This technical memorandum (TM) summarizes:

- A description of the EOR concept, and the design and implementation considerations for components of the program.
- Six (6) potential EOR scenarios and the results of a series of economic analyses to establish incentive payments for the EOR for each scenario. Program incentive payments are presented for each scenario in addition to the average amount from the economic analysis of the baseline replanting scenario (bare ground). The values presented in this report do not translate or apply to other regions or program; they are specific to the Vina Subbasin only.
- A series of sensitivity analyses was developed to illustrate potential program costs and incentives under different market conditions (e.g., high/low crop prices and returns).
- Description of EOR scenarios, potential water savings, other potential co-benefits.

- An additional analysis for the EOR program of the impact of Assembly Bill 732 on orchard abandonment, which imposes fines on landowners for nuisance orchards.
- A summary of EOR and PI program considerations and next steps for program design and additional analysis.

2. Extend Orchard Replacement Concept in the Vina Subbasin

One way to reduce groundwater pumping is to decrease irrigated land through extending a permanent or temporary idle period. As a rotational fallowing concept, an extended orchard replacement approach increases the duration between removal and replanting of perennial crops (e.g., almonds, walnuts, grapes) by one or more growing seasons. By delaying replanting and leaving land idle for a specified period on lands that have historically have relied on groundwater for irrigation, groundwater pumping is reduced, which provides a benefit to the subbasin. The landowner incurs some costs in this period and delays net returns from the new orchard stand, but there are substantial co-benefits to using this approach for demand management purposes.

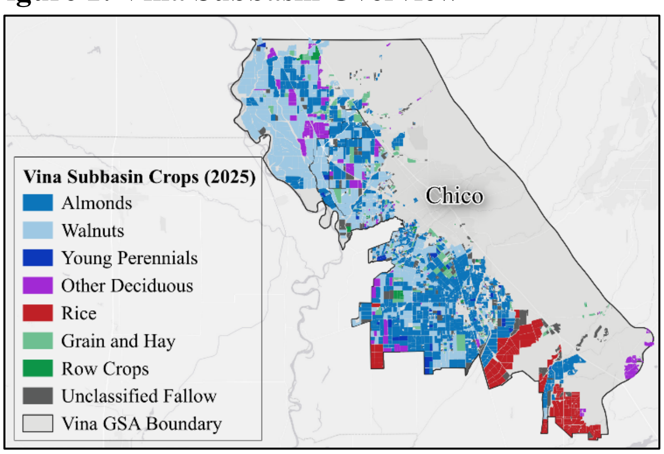
The Vina GSA has considered utilizing this program concept under the Extend Orchard Replacement Program (EOR), which is designed to accommodate permanent crops that are longer-term capital investments. The following sections examine the various factors and considerations necessary to the successful development and implementation of this program.

2.1 Agriculture in the Vina Subbasin

While annual cropping systems can skip planting for one or more seasons with relatively modest impacts to costs and returns, idling permanent perennial crops can take considerable planning and impact cash flow in future years. The Vina Subbasin is predominately permanent crops.

Based on 2025 data provided by LandIQ, Figure 1 illustrates the crop mix and includes a table summarizing acreage by major crop group in the Vina Subbasin. Irrigated agriculture in the Vina Subbasin is dominated by almonds (37% of acreage) and walnuts (36%), with other deciduous crops (e.g., prunes, other stone fruit) (6%) and rice (10%) generally in the southern part of the subbasin. A small share of the subbasin's irrigated acreage (~6%) is planted to field, grain, and row crops. In short, over 80 percent of agricultural land is planted to permanent crops.

Figure 1: Vina Subbasin Overview



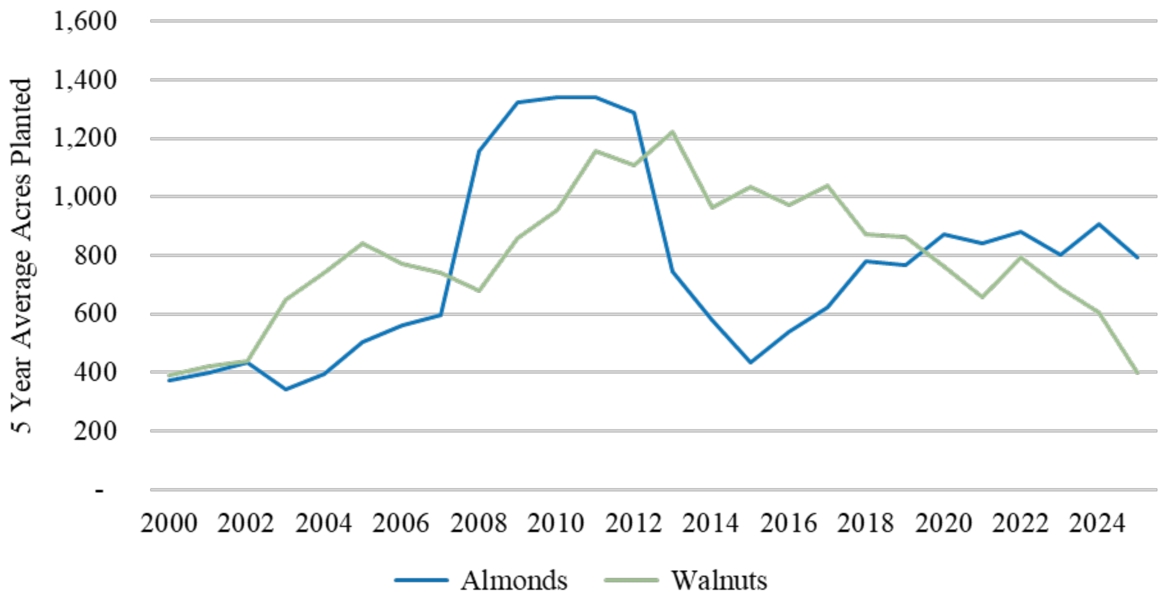
Crop	Acres	Share of Total
Almonds	27,820	37%
Walnuts	27,170	36%
Young Perennials	1,300	2%
Other Deciduous	4,890	6%
Rice	7,540	10%
Grain and Hay	3,020	4%
Row Crops	1,300	2%
Irrigated Acres	73,030	

Almonds and walnuts are the dominant permanent crops in the region at nearly 80 percent of the total acreage. Orchards have a typical economic lifespan, and since older orchards are closer to replacement, extending replanting is more suitable to regions with a higher percentage of acreage that is likely to be replaced soon. Almonds typically have a 25-year lifespan, while walnuts have a 40-year estimated lifespan. In aggregate, Vina almond and walnut plantings are older than the average orchard age in other parts of California.

Figure 2 illustrates the 5-year rolling annual average of new acres planted for both walnuts and almonds:

- Almond planting 5-year rolling average peaked in 2011 at 1,360 acres and has since fallen to 795 acres per year as of 2025.
- Walnuts peaked slightly later, at 1,257 acres per year in 2013, and have since fallen to 399 acres per year as of 2025.

Figure 2: 5-Year Rolling Average Annual Almond and Walnut Plantings



An extended orchard replanting program was considered for almonds and walnuts, the two prominent crops in the Vina Subbasin.

2.2 Program Structure and Considerations

EOR is a type of demand management program to reduce or manage groundwater pumping. A landowner would be offered an incentive payment to increase the duration between removing and replanting an orchard by one or more growing seasons. The program can be offered for one or more replanting cycles on a rolling basis (similar to an annual crop fallow bank) or in perpetuity. By delaying replanting, groundwater pumping is reduced by shifting (delaying) that pattern of water application and consumptive use over the life of the orchard. The EOR program would be voluntary, and participation would be encouraged by offering fair incentive payments that compensate the landowner/grower[1] for the direct costs of idling land.

Key components of such a program include:

- The program is paying to delay replanting for a defined period (one or more years). Replanting is an activity that will occur on all lands eventually as permanent crops reach the end of their productive economic life. Economic life depends on a range of factors including but not limited to variety, agronomic factors (e.g., disease, block productivity), market conditions (e.g., prices and costs), and farm management practices/preferences. A typical economic life for orchards is between 25 and 40 years.
- Program incentive payments are not based on the full value of a productive acre of an orchard. Rather, it is paying for an incremental delay in the typical replanting cycle.
- The program saves water by shifting the entire water use pattern of the orchard. A newly established orchard applies and uses very little water. The water savings of the program must account for the entire stream (time path) of water application and use over the economic life of the orchard. In effect, the total water use over the life of an orchard is spread over, for example, 26 years instead of 25 years.
- The EOR program can be tailored to local conditions. In addition, EOR can also be combined with other water conservation programs (such as PI) or supply augmentation projects and scaled to reach specific groundwater goals in the region.

To design a successful program, the general technical approach includes:

- Design general program concepts, technical studies to support development (e.g., agronomic feasibility, scale, location, timing, duration of contracts, etc.)
- Evaluate potential incentive payments (and sensitivity range) for extending replanting under the program (this TM).
- Integrate grower/stakeholder outreach throughout to inform program technical and policy design.
- Evaluate program potential water savings.
- Develop preliminary program rules and contract design.
- Design program co-benefits, if applicable (e.g., targeted to lands in specific areas, increase the scale of the program in drier years).

[1] This report uses the terms grower and landowner interchangeably, recognizing that a range of contractual arrangements exist between landowners and farming operators (e.g., owner-operators, cash rent, share rent, or custom farming agreements). An EOR concept would be offered to and administered through the landowner with and appropriate agreement with the GSA. Implementation may also require modifications to any agreement between the landowner and the grower or lessee to allocate responsibilities, costs, and revenues associated with delayed replanting and interim land management practices. These landowner-grower lease agreement considerations are beyond the scope of this initial economic assessment and would be considered as part of program design.

- Run a pilot program and/or test program to gage interest and improve design.
- Implement the broader program and secure long-term funding sources.

Other program design considerations include:

- To yield sustained groundwater savings, an extended replant program must ensure that acreage held out of production does not move elsewhere, effectively transferring water use and eliminating potential water savings. A program is most effective if it continues in perpetuity, which requires stable funding sources, but this is not a prerequisite for program benefits. Even a pilot program operating for a single year generates immediate and future water savings by shifting the time path of the replanting cycle.
- An extended replanting program focuses on the retention of groundwater in the aquifer, managing consumption to stretch across additional years. The program could be coupled with a program to expand on-farm recharge, in areas where it is feasible to do so.
- A sustainable funding source may include a mix of grants and other local funding. Program incentive payments need to be carefully adjusted to be consistent with the source(s) of funding. The analysis summarized in this report assumes that external grant funding is applied to the pilot program. Incentive payments would need to be revisited/revised if local funding sources were applied in the future.

In addition, the program would consider the wider implications of the program. Idling land imposes direct costs on the landowner/grower and potential indirect economic effects in the regional economy. These can include the following:

- For the grower, every year that replanting is delayed pushes back first leaf, non-bearing years and ultimately full production, which means forfeiting near-term gross margins while fixed costs and land carrying costs keep accruing. In practical terms, postponing an orchard replanting defers positive net cash flow in the future, which affects the net present value of the block through a real opportunity cost from lost production, ongoing costs (e.g., property taxes, fees, other overhead), delayed revenue streams, and foregone reinvestment capital.
- At the regional level, a contraction in farming may also affect other businesses and communities. For example, less walnut acreage reduces throughput across the downstream supply chain, including hulling and drying facilities, shellers, handlers, and distribution. Fewer walnuts moving through the system also affects demand for local farm inputs and services—custom harvest crews, trucking, ag chemical and fertilizer suppliers, equipment dealers, and other services. The EOR concept is intended to

minimize these effects[2] by extending the period between removal and replanting rather than permanently reducing the footprint of the industry.

A critical component of EOR is designing fair, appropriate incentive payments to encourage participation. The EOR program, and similar rotational fallowing programs, are highly local. Program design and incentive payments are specifically tailored to conditions in a specific GSA/subbasin (in this case, the Vina Subbasin). What applies in the Vina Subbasin will not generally apply in other regions. Incentive payments in other regions will differ because the opportunity cost of rotational fallowing differs in those areas, both due to market conditions and variation in crop mix.

[2] Regional effects (also called third party effects) are an important consideration for agricultural land idling programs. These are beyond the scope of this preliminary economic assessment that focuses on the direct costs to the landowner. Third party effects could be quantified and considered as part of EOR program implementation.

3. Benefits of Extended Replanting

Extending the period between removal and replanting a crop provides opportunities to realize a range of benefits. These may include but are not limited to groundwater savings, savings on farming input costs, and land management benefits.

3.1 Water Savings

An extended replanting program saves water through idling land for a defined period, which reduces applied irrigation water and potential consumptive water use. This is effectively a "demand management" action/approach then leads to a benefit to the subbasin.

The timing and duration of the extended replanting period determines when and how much water saving is realized. By not irrigating ground that would have otherwise been irrigated the EOR reduces applied water and potentially ET of applied water (depending on the alternative land use). This is no different than an annual, rotational fallowing program. However, an orchard is a capital asset with a typical life of 25 years or more and it can be helpful (but not necessary) to consider annual water savings and water savings over the life of the orchard.

Consider an acre of almonds that applies a total of 87.5 acre-feet of groundwater during its 25-year life, which is an average of 3.5 acre-feet of applied water per acre per year. The orchard would be replanted every 25 years. EOR groundwater savings is illustrated with the following scenarios:

- **Adding one additional year before replanting.** The one-year savings is a reduction of 3.5 AF of applied water. Equivalently, the same 87.5 acre-feet would be applied over 26 years rather than 25 years, resulting in an average of 3.36 acre-feet per year, or a 4 percent reduction in average annual applied water for that acre over the economic life of one orchard.
- **Removing an orchard early and keeping the orchard out for a year before replanting.** For example, if an acre of almonds is removed in year 23, rather than the typical economic life of 25 years, this acre avoids full irrigation for the remaining 2 years of the orchard, in addition to the extended replanting period of 1 year. The replanting cycle was shortened, and no irrigation was applied for one year.
- **Adding an additional year before replanting in perpetuity.** The same 87.5 acre-feet would be applied over 26 years rather than 25 years, resulting in an average of 3.36 acre-feet per year, or a 4 percent reduction in average annual applied water for that acre over the economic life of the current orchard, and all future orchards.

The timing of water savings is critical for estimating the economic cost of EOR participation. As described in subsequent sections of this TM, orchards are long-lived capital assets, typically with productive lives of 25 years or more, requiring substantial upfront investment before trees reach bearing age. Cash outlays occur in the early years, positive net cash flow generally begins in years four or five, and the grower realizes a return on investment only later in the orchard life.

By delaying replanting, the EOR shifts this entire stream of costs, revenues, and water use farther ahead in time across the current and all subsequent orchard cycles. The per-acre-foot cost of EOR water savings must be evaluated based on when those savings occur, with the delayed income stream discounted (or compounded) to the appropriate point in time.

As illustrated in the examples above, the program is most effective if it continues in perpetuity, but this is not a prerequisite for realizing water savings. Even a pilot program operating for a single year generates immediate and future water savings by shifting the time path of the replanting cycle, applied water, and consumptive water use.

3.2 Agronomic Benefits

In addition to water savings, idling land for a year or more can provide a variety of agronomic benefits. These may support orchard productivity by enhancing yields and crop resiliency in future stands, leading to increased revenue or reduced costs for the landowner/grower. LandIQ has been evaluating the potential benefits of EOR in the Vina Subbasin, including:

- **Soil health.** Resting ground allows soils to recover and replenish essential nutrients, improving the nutrient profile to support the establishment of a new crop. In addition, this can also reduces soil disturbance and allows for existing crop residues and cover crops to break down, enhancing soil structure, organic matter, and moisture retention over time. These practices not only help establish a new stand more quickly but can also lead to greater yields overtime.
- **Pest management.** By removing a crop and not immediately replacing it, pests and diseases no longer have a host vector in the field. The idle period breaks the life cycle for pests that rely upon the crop for survival, which reduces pressure and improves productivity as a new stand is established. For example, removing nut orchards and allowing the ground to remain idle for a year can help reduce nematode populations through drying of soil and starvation.
- **Weed management.** Under certain conditions, idling is also an opportunity to control the weed population without interfering with a crop. Growers can use methods and practices during the idle period that might otherwise injure or be more difficult to employ with an orchard in the ground. For example, weeds can be allowed to germinate on bare soil and then be terminated through cross-cultivation before going to seed. This reduces the seed bank in future stands.

Agronomic considerations associated with EOR—such as those listed above as well as potential effects on nutrient management and yield potential—are not fully evaluated in this economic assessment. Some of these factors may generate meaningful on-farm benefits (i.e., revenues) or costs that affect the grower’s bottom line; these were not monetized in the present analysis. Future iterations of this work could evaluate these agronomic effects to provide a more complete assessment of the net benefits and costs of EOR concepts.

3.3 Land Management

When idling land, there are opportunities to employ practices that would otherwise be more difficult to incorporate with a permanent crop. The bare ground can be planted to a cover crop, switched to another crop temporarily, or incorporated with other practices to realize even greater, more specific benefits, such as:

- **Reduced fertilizer use.** Cover crops and crop residue can be incorporated into the soil to provide additional nutrients through composting or green manure. The improvements are significant enough that in some cases, landowners and growers can reduce their fertilizer use in the first few years upon replanting.
- **Broken pest cycle.** As described above, removing a crop and either idling the land for a period or rotating to a different crop eliminates the host for various pests. This breaks the pest's life cycle and leads to reduced pressure in future plantings. For example, growers may plant a non-host cover crop in spring after removing a nut orchard to control nematodes through starvation and moisture loss in the summer.
- **Soil drying & easier fumigation.** Due to their high-water demand, some cover crops naturally dry out the soil profile, which can inhibit some pests and diseases from thriving during the idle period. This has implications for whether fumigation is necessary.
- **Weed suppression.** Adding a cover crop during an extended replanting period can suppress weed population. Many cover crops grow rapidly, outcompeting weeds through nutrient competition and shading. This can help reduce weed pressures in future stands when incorporated with other management practices. In addition, some species utilized in the region, such as certain varieties of sorghum-Sudangrass, can inhibit weeds.
- **Revenue source.** In addition to the benefits described above, some cover and cash crops can be harvested and sold, generating revenue for the operation. This revenue can offset the costs incurred during the idling period. For example, wheat planted as a winter cover crop can be harvested in early summer for grain, which provides some revenue.
- **Groundwater Recharge.** Idling land with or without land management is also compatible with a wide range of groundwater recharge approaches. For example, temporary recharge basins and stormwater capture can be implemented during an extended idling period for additional groundwater and co-benefits to the region.
- **Livestock system support.** If available, landowners and growers can integrate livestock into an idle rotation, leveraging the acreage while minimizing water use. Many cover crops make excellent forages through either grazing or harvested hay/silage, and well-managed livestock can improve soil fertility and structure (in addition to other related benefits beyond the scope of this report).

- **Ecosystem services.** Idling land can also offer benefits to the wider ecosystem. A range of complementary practices can provide habitat, promote biodiversity, and reduce machinery and input use.

Some land management considerations associated with EOR were not evaluated in this economic analysis. Many of these effects generate public or regional benefits that accrue beyond the individual grower and could be incorporated into future EOR program design (e.g., a funding framework for EOR).

4. Extending Replanting Scenarios

An EOR can provide specific benefits for potential water savings and agronomic practices implemented during the extended replanting period. The Land IQ team and the GSA have been exploring concepts for EOR in the Vina region.

Six (6) scenarios were developed based on feedback from local growers and preliminary analysis of water savings that define additional practices for the land during the replanting period. This includes traditional cover crops, harvested cover crops, and short-season cash crops. The analysis of the scenarios summarized in this report focuses on economic considerations for each scenario to assess how alternative practices affect grower opportunity costs. See Land IQ technical memoranda for additional details.

One baseline and six land management scenarios are presented in this report, described below:

- **Baseline Scenario: Idle Ground.** The land is idled as bare ground for one or more years following orchard removal. There are no other land management practices incorporated into this scenario except for minimal weed control measures. This is the baseline scenario that the other six scenarios are compared to.
- **Cover Crop, Winter Mix.** A cool-season grass and legume mixture is planted in fall, which is then mowed and disced in late in spring. This scenario provides soil benefits over the winter. In addition, it also contributes nitrogen from the resulting green manure, which provides minor reductions in fertilizer costs for the first few years after replanting. The cover crop is not harvested in this scenario.
- **Cover Crop, Winter Forage for Hay.** Winter wheat, oats, or triticale is planted as a cover crop in fall and harvested for hay the following year. This provides erosion control and improves soil health through root and stubble decomposition. The cover crop is harvested in this scenario, and hay sales generate modest revenue.
- **Cover Crop, Winter Wheat for Grain.** Winter wheat is planted as a fall cover crop. The grower harvests the crop at maturity for grain the following year. This approach offers winter soil benefits from the cover and field residue. In addition, the cover crop is harvested in this scenario, and the grain crop produces modest revenue.
- **Cover Crop, Spring Grass.** A grassy cover crop (a sorghum-Sudangrass hybrid) is planted in the spring and terminated through mowing and discing at the end of the growing season. It is not a host for some pests and diseases that impact nut orchards (i.e. nematodes, scale). The cover crop dries out the soil. it can interrupt the life cycle of major pests and may eliminate the need for fumigation prior to planting. Additionally, the incorporated residue provides soil benefits, which provides minor reductions in fertilizer costs for the first few years after replanting. The cover crop is not harvested in this scenario.

- **Short Season Cash Crop, Processing Tomatoes.** A contract is entered into with a tenant to plant processing tomatoes, planted in spring and harvested in summer or fall (depending on timing of planting). A crop rent contract is applied where the landowner receives a percentage of gross revenues and is responsible for overhead costs and water supply. Tomatoes provide some revenue through the lease agreement. The tomatoes require irrigation at around 2.2 acre feet per acre.
- **Short Season Cash Crop: Dry Beans.** A contract is entered into with a tenant to plant dry beans (pinto, kidneys, lima, etc.) in the spring and harvest the crop in the fall. A crop rent contract is applied, with the landowner receiving a percentage of gross revenues and is responsible for overhead costs and water supply. The cash crop provides some revenue through the lease agreement. Dry beans applied water is estimated as 1 acre foot per acre.

Table 1 summarizes the key characteristics and benefits for the scenarios.

Table 1: Scenarios for Management During the Replanting Period

Scenario	Cover Crop	Cash Crop	Soil Protection	Soil Health Benefits	Pest Benefits	Additional Operating Costs	Additional Crop Revenue	Cash Rent (Contract)	Additional Irrigation
Baseline idle land									
With Cover Crop (Winter Mix)	■		■	■		■			
With Cover Crop (Winter Forage for Hay)	■		■			■	■		
With Cover Crop (Winter Wheat for Grain)	■		■			■	■		
With Cover Crop (Spring Grass)	■		■	■	■	■			
With Cash Crop (Processing Tomatoes)		■				■	■	■	■
With Cash Crop (Dry Beans)		■				■	■	■	■

These practices generate additional costs and returns to the grower beyond the baseline extended replanting scenario, which affects program incentive payments. The following section summarizes the results of the economic analysis to establish the potential EOR incentive payments for each scenario.

5. Incentive Payment Analysis

A fair incentive payment for an EOR program includes compensation for two components or considerations for the grower during the replanting period:

(1) The opportunity cost of foregone and delayed net returns from extending replanting, which also accounts for income from the cover or cash crop (if any) during the replanting period.

(2) Any costs incurred during the replanting period for selected crop or other agronomic practices under each scenario.

An economic analysis was developed to analyze these factors and estimate an appropriate incentive payment for each scenario. A sensitivity analysis was developed to present a range. The analysis applies representative average costs and returns developed from a series of grower interviews, budgets, and other representative market data. Any single individual operation will vary from these averages. A sensitivity range for program incentive payments is included in the analysis, and any incentives for a specific program should be evaluated annually to adjust for evolving market conditions.

5.1 Parameters and Approach

For this analysis, the incentive payments are estimated by developing representative farm budgets for each scenario to capture the costs incurred to the grower. The analysis applies data from Vina growers, UC Cooperative Extension (UCCE), USDA, and ERA for both almonds and walnuts orchards. Key considerations driving the incentive payment calculation are summarized below.

5.1.1 Cost to Delay Replanting

Foregone and delayed net returns are an important component of EOR incentive payments. When a grower delays replanting an aging orchard, they defer the future income stream from new and future productive stands. The incentive must include compensation for this cost to the grower. Returns depend upon prevailing market prices and the marketable yield in addition to the production costs required to produce a crop each year.

5.1.2 Market Conditions - Almonds

Almond prices in California peaked in 2014 at $5.28 per pound (inflation-adjusted to 2024 dollars) and have since steadily declined to a 20-year low at $1.49 per pound in 2022 before rebounding modestly through 2025. Data and grower outreach indicate that prices rose above $2 per pound mark as of the 2025 season and prices are expected to approach the long-term average within five years. Based on historic prices, a price of $2.25 per pound is applied for the EOR analysis. (See Appendix A, Figure A.1 for historical price trends.)

The typical lifetime average yield is around 1.1 tons (2,200 pounds) per acre for Sacramento Valley. Local growers reported yields of 1.3 tons per acre during peak production years (7-16) and 1.0 tons per acre for older orchards. A yield schedule mirroring these changes is applied in this analysis.

5.1.3 Market Conditions - Walnuts

Walnut prices are recovering from a historic low. The 2024 average reported price of $0.43 - $0.70 per pound is roughly one-third of the period's average price of $1.25 per pound. Given these soft conditions, applying the same methodology as almonds would underestimate the incentive. Instead, the walnut analysis develops an incentive payment that incorporates orchard removal costs and potential net returns from almond production after replant, appropriately representing the capital value of the land. (See Appendix, Figure A.2 for historical walnut price trends.)

5.1.4 Costs for Orchard Replanting and Production

Representative orchard replanting and production costs were developed from local supplier and grower interviews. For replanting, key costs include orchard removal costs (including pulling, burning/recycling, ripping discing, leveling), fumigation (if needed), planting, and irrigation systems. Total replanting costs range from approximately $5,960 to $9,340 per acre, depending on practices selected. Almond and walnut removal are roughly equivalent, with an additional $200 per acre applied to walnuts for ripping after removal. For production, representative annual operating costs for almonds and walnuts are applied. Growers emphasized recent inflationary pressure on costs, with labor and ag chemicals highlighted as key cost drivers in recent years. (See Appendix, Table A.1 for additional details on replanting costs.).

5.1.5 Cost to Extend Replanting

Overhead costs for idling irrigated agricultural land in the region include general office expenses, liability insurance, property insurance, the GSA fee, and property taxes (roughly 1.1% in the Vina Subbasin for non-Williamson Act land). Representative overhead costs range from $239 to $554 per acre annually. (See Appendix, Table A.2 for details on overhead costs.)

5.1.6 Costs for Land Management Scenarios

The analysis evaluates one baseline idled land scenario and six (6) land management scenarios (winter mix, winter forage for hay, winter wheat for grain, spring grass, processing tomatoes, dry beans). The baseline scenario assumes no cover crop and average revenues and yields (using historic price of $2.25 per pound for almonds), in addition to average costs for removal ($2,800 per acre for almonds, $3,000 per acre for walnuts), establishment ($11,077 per acre for almonds), and management. Under the six land management scenarios, a grower may also incur additional production costs, estimated between $129 and $460 per acre. Wheat, hay, and other cash crop revenue is between $169 and $826 per acre. Some cover crops also provide modest soil amendment savings (estimated at $15 per acre as a placeholder). (See Appendix, Table A.3 for the full scenario parameters.)

5.2 Results

The analysis shows potential incentive payments for delaying production of both almonds and walnuts for a duration of 1, 2, or 3 years. Payments are reported on an annual and one-time (lump sum) basis. The appropriate value depends on the final EOR program design. Since the analysis applies representative average costs and returns, an individual operation will vary from these averages. Due to recent soft market conditions for walnuts, the analysis assumes walnuts are removed and almonds are replanted.

The incentive payments reflect all costs, returns, capital expenditures, and the opportunity cost of delaying replanting of a capital asset. This reflects the net loss to the grower, which is the minimum willingness-to-accept to participate in a EOR program. Typically, a premium above this amount would be required to encourage substantial participation.

Table 2 summarizes the results of the analysis for the incentive payment for delaying replanting for a period of 1, 2, or 3 years for an almond orchard that is replanted to almonds. Delaying replanting for one year shows incentive payments between $107 and $790 per acre. The low value ($107) reflects the processing tomatoes scenario, where crop income substantially offsets losses from delaying replanting. Cover crops generate a more modest return (if any), and incentive payments are higher to reflect this difference.

Table 2: Total Almond Incentive Payment Analysis

Scenario	1-Year	2-Year		3-Year	
		Annual	Total	Annual	Total
	$/ac	*$/ac*	*$/ac*	*$/ac*	*$/ac*
Baseline idle land	$639	$639	$1,253	$639	$1,844
With Cover Crop (Winter Mix)	$790	$790	$1,551	$790	$2,282
With Cover Crop (Winter Forage for Hay)	$658	$658	$1,291	$1,899	$1,904
With Cover Crop (Winter Wheat for Grain)	$531	$531	$1,042	$531	$1,533
With Cover Crop (Spring Grass)	$758	$758	$1,487	$758	$2,187
With Cash Crop (Processing Tomatoes)	$107	$107	$210	$107	$309
With Cash Crop (Dry Beans)	$600	$600	$1,178	$600	$1,733

Table 3 summarizes the results of the analysis for the incentive payment for delaying replanting for a period of 1, 2, or 3 years for a walnut orchard that is replanted to almonds under each scenario. Delaying replanting for one year shows incentive payments between $102 and $785 per acre, reflecting the similar per-acre cost structure after adjusting for walnut removal.

Table 3: Total Walnut to Almond Incentive Payment Analysis

Scenario	1-Year	2-Year		3-Year	
		Annual	Total	Annual	Total
	$/ac	*$/ac*	*$/ac*	*$/ac*	*$/ac*
Baseline idle land	$633	$633	$1,243	$633	$1,828
With Cover Crop (Winter Mix)	$783	$783	$1,537	$783	$2,261
With Cover Crop (Winter Forage for Hay)	$653	$653	$1,280	$653	$1,884
With Cover Crop (Winter Wheat for Grain)	$526	$526	$1,031	$526	$1,517
With Cover Crop (Spring Grass)	$753	$753	$1,476	$753	$2,172
With Cash Crop (Processing Tomatoes)	$102	$102	$200	$102	$294
With Cash Crop (Dry Beans)	$595	$595	$1,167	$595	$1,717

It is important to note that the processing tomato scenario reflects production under a cash rent arrangement, under which a tenant manages production and harvest activities while the landowner receives a share of gross revenues and remains responsible for land-related overhead and water supply costs. In addition, the analysis does not include intrinsic market volatility of the tomato sector that transforms risk. As a result, the profitability of this scenario—and the corresponding incentive payment—depends heavily on prevailing crop prices, contract terms, yields, and farming costs. These should be considered as part of program development for all scenarios.

The analysis intentionally focuses on the economic implications of alternative land management scenarios during the idling period following replanting. It does not evaluate the full range of benefits from incorporating these practices on idle land (soil health, pest management, ecosystem services, economic development), beyond the explicitly quantifiable fertilizer cost savings. An extension of this analysis would evaluate these factors to better quantify their impact.

5.3 Sensitivity Analysis

The analysis results are sensitive to key cost and market factors applied in the analysis, particularly commodity price and net returns from alternative uses/crops during the replanting period. To better understand how these factors affect the incentives across different scenarios, a sensitivity analysis incorporates alternative prices, replanting costs, and yields into the payment calculations. Key findings are summarized below, while the full results are presented in the Appendix (Tables A.4 through A.10).

5.3.1 Commodity Prices

To capture the impact of prevailing market prices on the analysis, a price sensitivity analysis includes alternative high ($2.50 per pound) and low ($2.10 per pound) almond market prices. It found that high crop prices can make annual cash crops more profitable than replanting almonds or walnuts, with one-year almond incentive payments range from roughly $260 to $1,250 per acre. For example, when low almond prices are applied, processing tomatoes during the idle year can be more profitable than immediately replanting, substantially reducing or eliminating the incentive. Conversely, high almond prices increase the incentive required encourage a grower to switch to tomatoes. (See Appendix, Tables A.4 and A.5.)

5.3.2 Replanting Costs

Since farming costs impact incentive payments, a cost sensitivity analysis applies the average, low, and high replant costs (ranging from $2,300 to $4,000 per acre) to the baseline scenario. Lower replant costs increase the incentive payment necessary for a 1-year delay between plantings, while higher costs reduce the incentive payment. Including fumigation ($1,200 per acre) adds roughly $44 per acre to the incentive payment across scenarios. (See Appendix, Tables A.6 through A.9.)

5.3.3 Almond Yields

Anecdotal evidence from grower interviews suggests that when replanting is delayed, the new stand displays more vigorous orchard growth and better production over its lifetime, leading to additional revenues. Growers would need to realize a 0.16 to 1.23% increase in yield (0.04 to 0.32 tons per acre) over the 25-year lifetime of the new almond orchard to compensate for the cost of delaying replanting. If measured and proven, even minor increases in yield can cover the costs to the grower for delaying replanting. (See Appendix, Table A.10.)

6. Abandoned Orchards Analysis

Abandoned orchards are orchards that are not irrigated or managed to produce a commercial crop but have not been removed. These orchards may still access water from stored soil moisture, shallow groundwater, or capillary action from connected sources such as rivers or canals. These blocks can become a public nuisance, harboring pests like navel orangeworm, rodents, and weeds that can impact the productivity of neighboring orchards.

Due to water scarcity and low market prices, orchard abandonment has increased in California. Assembly Bill 732 was signed into law in October 2025. It provides county agricultural commissioners with authority to issue civil penalties up to $500 per acre for abandoned orchards, and up to $1,000 if landowners fail to take action to rectify the issue. The bill requires counties to issue a notice before penalties are levied. Landowners who take action based on resources from UC Cooperative Extension and the UC Statewide Integrated Pest Management Program can void fines. The bill will remain in effect until 2035, allowing a decade for counties to assess its impact.

To understand the financial implications of this fine on orchards in the Vina Subbasin, this analysis considers an almond or walnut orchard that is abandoned after its term of 25 or 40 years. Once abandoned, the orchard is not irrigated, managed, or removed. The producer chooses when to incur removal costs. Pursuant to the passage of AB 732, the county agricultural commissioner may levy penalties ranging from $500 to $1,000 per acre for orchards that are left abandoned.

An analysis was developed to compare the revenues and costs over the post-production period of 1, 2, or 3 years following the decision to abandon the orchard. An enterprise farm budget was developed that includes all costs and revenues for this scenario, including removal, cash costs, capital costs, and overhead.

- **Revenues**. Since the orchard is abandoned, the model assumes it is not replanted or harvested. There is no revenue generated in the subsequent production cycle.
- **Costs**. The only costs associated with the abandoned orchard scenario are the overhead costs. This analysis assumes minimal overhead costs to cover property taxes and insurance at $190 per acre. There are no irrigation, removal, or management costs.
- **Other considerations**. Leaving the orchard abandoned poses a threat to soil and agronomic health, especially for neighboring orchards and fields. Abandoned orchards foster the growth and spread of pests, including navel orangeworm, rodents, and weeds. To avoid fines, landowners can employ minimal management methods to control pests but not bring the orchard back into production (known as mothballing).
- **Water savings**. Almond orchards have an average annual evapotranspiration (ET) of 2.89 acre-feet per acre over a 25-year orchard. Since abandoned orchards have an average ET of 1.18 acre-feet per acre each year, water savings are estimated at 1.71 acre-feet per acre for each year of abandonment.

The financial analysis shows the additional cost to delay orchard removal. The timing of income removal costs and penalties to the grower changes. Under the abandoned orchard scenario, civil penalties are levied against producers that are in violation of AB 732. This means they have left an orchard neglected or abandoned, and it poses a public nuisance due to the presence of pests. The policy states that growers must first receive notice of the nature of their violation and then have thirty (30) days to rectify the issue. This may include implementing minimal management practices, removing the orchard, or bringing the orchard back into production. If it is fixed within this period, the penalty is removed. If the grower does not take good faith action within forty-five (45) days, the penalty amount is authorized to increase to up to $1,000 per acre, as shown in Table 4.

Table 4: Penalties for the Abandoned Orchard Scenario

	30 Days *$/ac*	**45 Days** *$/ac*
Penalty Cost	$0 - 500	$1,000

This scenario assumes the orchard remains abandoned under this operation cycle; therefore, there are no incentive payment or yield sensitivity analysis considerations. Instead, Table 5 summarizes a comparison of the payoffs between several management decisions a producer could make at the end of the previous orchard's productive life (Year 0). Without the fine, abandonment is the most economical approach to orchard maintenance, but once it is imposed, it is cheaper to implement minimal management methods and avoid the fine.

Table 5: Selected Cost Comparison by Management Scenario in Year 0

Cost	**Abandoned Orchard** *$/ac*	**Minimal Management** *$/ac*	**Idle Ground** *$/ac*	**Replanting** *$/ac*
Removal	$0	$0	$2,800	$2,800
Overhead	$190	$364	$364	$364
Management	$0	$200	$0	$430
Irrigation	$0	$0	$0	$4,000
Replanting	$0	$0	$0	$2,300
Subtotal	$190	$564	$3,164	$9,894
Penalty Fine*	$500-$1,000	$0	$0	$0
Total	$690 to $1,190	$564	$3,164	$9,894

* The penalty fine is only imposed if the producer is in noncompliance; the amount depends on the timeline and grower response following notice of violation.

7. Water Savings Analysis

A benefit of extending the period between removal and replanting is water savings. The following section reviews potential water savings from delaying replanting of almond and walnut orchards in conjunction with land management practices. This report generally refers to water savings – this can be measured in terms of applied water, or ideally, in terms of ET of applied water. Land IQ provided estimates of ET for crops and land use alternatives that were applied to this economic analysis. Water savings benefits may be refined as additional data are developed. In addition, an effective EOR program (or any similar program) should be developed to prevent new acreage from being developed that would offset the idle land (e.g., idle an orchard, but develop a new orchard on previously undeveloped lands). These are standard considerations for any rotational fallowing program.

For this analysis, estimated water use of each scenario (baseline and land management) is compared to the water use with no extended replanting period, or immediate replanting. Water savings are calculated on a per acre basis. LandIQ provided evapotranspiration (ET) data for the crops and scenarios. For this analysis, almonds have a 25-year economic life and average ET of 3.44 acre-feet per acre annually. Walnuts have a 40-year economic life and average ET of 3.03 acre-feet per acre annually. For each scenario, the difference between the ET from not idling (immediately replanting to an orchard crop) and the ET associated with practices employed for that scenario was calculated. For cash crops, tomatoes have an average ET of 2.53 acre-feet per acre, while dry beans have an average ET of 2.08 acre-feet per acre. Cover crops have an estimated ET of 1.15 acre-feet per acre, except for spring grass at 1.43 acre-feet per acre.

Table 6 and Table 7 present the one-time ET water savings per acre for almonds and walnuts, respectively, realized from delaying replanting by 1, 2, or 3 years. Of the scenarios analyzed, maintaining idle ground or cover cropping offers the greatest ET water savings. For both almonds and walnuts, the lowest water savings are realized from planting tomatoes during the idle period.

Table 6: ET Water Savings per Acre During Delayed Replanting, Almonds

Scenario	1-Year	2-Year	3-Year
	AF/ac	*AF/ac*	*AF/ac*
Baseline idle land	2.62	5.23	7.85
With Cover Crop (Winter Mix)	2.29	4.58	6.87
With Cover Crop (Winter Forage for Hay)	2.29	4.58	6.87
With Cover Crop (Winter Wheat for Grain)	2.29	4.58	6.87
With Cover Crop (Spring Grass)	2.02	4.03	6.05
With Cash Crop (Processing Tomatoes)	0.91	1.82	2.72
With Cash Crop (Dry Beans)	1.37	2.73	4.10

Table 7: ET Water Savings per Acre During Delayed Replanting, Walnuts

Scenario	1-Year	2-Year	3-Year
	AF/ac	*AF/ac*	*AF/ac*
Baseline idle land	2.20	4.40	6.60
With Cover Crop (Winter Mix)	1.88	3.75	5.63
With Cover Crop (Winter Forage for Hay)	1.88	3.75	5.63
With Cover Crop (Winter Wheat for Grain)	1.88	3.75	5.63
With Cover Crop (Spring Grass)	1.60	3.20	4.80
With Cash Crop (Processing Tomatoes)	0.49	0.98	1.48
With Cash Crop (Dry Beans)	0.95	1.90	2.85

The cost of the EOR water conservation can be calculated as the difference in the discounted present value of the stream of net returns with versus without the delayed replanting. Dividing the difference by acre-feet saved for each scenario provides the cost per acre-foot.

The ET results are presented in Table 8 and Table 9. For both almonds and walnuts, the scenario with the lowest cost per acre-foot saved is planting tomatoes during the replanting period, at $113 to $207 per acre-foot. While this scenario has the lowest ET water savings, it also results in the lowest cost to encourage a landowner to participate in the program. The next lowest value per acre-foot is winter wheat for grain, at $223 to $281 per acre-foot of ET saved. The dry bean cash crop scenario has the highest cost per acre-foot of water saved.

Table 8: Cost of ET Water Savings, Almonds

Scenario	1-Year	2-Year	3-Year
	$/AF	*$/AF*	*$/AF*
Baseline idle land	$244	$239	$235
With Cover Crop (Winter Mix)	$345	$338	$332
With Cover Crop (Winter Forage for Hay)	$287	$282	$277
With Cover Crop (Winter Wheat for Grain)	$232	$227	$223
With Cover Crop (Spring Grass)	$376	$369	$361
With Cash Crop (Processing Tomatoes)	$118	$116	$113
With Cash Crop (Dry Beans)	$439	$431	$423

Table 9: Cost of ET Water Savings, Walnuts

Scenario	1-Year	2-Year	3-Year
	$/AF	*$/AF*	*$/AF*
Baseline idle land	$288	$283	$277
With Cover Crop (Winter Mix)	$418	$410	$402
With Cover Crop (Winter Forage for Hay)	$348	$341	$335
With Cover Crop (Winter Wheat for Grain)	$281	$275	$270
With Cover Crop (Spring Grass)	$471	$461	$453
With Cash Crop (Processing Tomatoes)	$207	$203	$199
With Cash Crop (Dry Beans)	$626	$614	$602

Another approach calculates water savings based on the amount of applied water saved in delaying replanting. For this analysis, the difference between the applied water from not idling (immediately replanting to an orchard crop) and the applied water associated with practices employed for that scenario was calculated. Both almonds and walnuts receive an average of 3.5 acre-feet of applied water per acre annually over a 25-year and 40-year lifetime, respectively. For cash crops, tomatoes receive an average of 2.29 acre-feet of applied water per acre annually, while dry beans receive on average 1 acre-foot per acre. Cover crops receive no applied water.

Table 10 presents the one-time applied water savings per acre for both almonds and walnuts from delaying replanting by 1, 2, or 3 years. Again, maintaining idle ground or cover cropping offers the greatest applied water savings, due to the lack of applied water. At over 2 acre-feet of applied water per acre, processing tomatoes provide the least amount of applied water savings.

Table 10: Applied Water Savings per Acre During Delayed Replanting

Scenario	1-Year	2-Year	3-Year
	AF/ac	*AF/ac*	*AF/ac*
Baseline idle land	3.50	7.00	10.50
With Cover Crop (Winter Mix)	3.50	7.00	10.50
With Cover Crop (Spring Grass)	3.50	7.00	10.50
With Cover Crop (Winter Forage for Hay)	3.50	7.00	10.50
With Cover Crop (Winter Wheat for Grain)	3.50	7.00	10.50
With Cash Crop (Processing Tomatoes)	1.21	2.42	3.63
With Cash Crop (Dry Beans)	2.50	5.00	7.50

Tables 11 and 12 provide the cost per acre-foot saved in each scenario. Under current market conditions, processing tomatoes provide the lowest cost per acre-foot of applied water saved, at $81 to $88 per acre-foot, followed by winter wheat for grain at $179 to $152 per acre-foot. The highest cost per acre-foot is the dry beans scenario; each acre-foot of applied water saved costs between $229 and $240 per acre-foot.

Table 11: Cost of Applied Water Savings, Almonds

Scenario	1-Year	2-Year	3-Year
	$/AF	*$/AF*	*$/AF*
Baseline idle land	$183	$179	$176
With Cover Crop (Winter Mix)	$226	$222	$217
With Cover Crop (Spring Grass)	$217	$212	$208
With Cover Crop (Winter Forage for Hay)	$188	$184	$181
With Cover Crop (Winter Wheat for Grain)	$152	$149	$146
With Cash Crop (Processing Tomatoes)	$88	$87	$85
With Cash Crop (Dry Beans)	$240	$236	$231

Table 12: Cost of Applied Water Savings, Walnuts

Scenario	1-Year *$/AF*	2-Year *$/AF*	3-Year *$/AF*
Baseline idle land	$181	$178	$174
With Cover Crop (Winter Mix)	$224	$220	$215
With Cover Crop (Spring Grass)	$215	$211	$207
With Cover Crop (Winter Forage for Hay)	$187	$183	$179
With Cover Crop (Winter Wheat for Grain)	$150	$147	$144
With Cash Crop (Processing Tomatoes)	$84	$83	$81
With Cash Crop (Dry Beans)	$238	$233	$229

These water savings estimates may be updated as additional data is available, and the analysis can be extended to incorporate how changes in input costs, yields, and other market factors can influence the cost of water savings. Additionally, this analysis of water savings does not consider other potential agronomic co-benefits. An extension of this analysis would evaluate these factors to better quantify their impact. These metrics could then be directly compared to other groundwater supply augmentation projects or demand management approaches to inform prioritization of groundwater sustainability projects and management actions.

8. EOR Implementation Considerations

The analyses presented in the preceding sections evaluate the economic costs, water savings, and operational characteristics associated with elements of EOR. The analysis provides estimates of incentive payments and potential groundwater benefits under a range of scenarios. Translating the analysis/findings into an effective program requires additional design and administrative considerations.

Implementation decisions—such as program duration, enrollment structure, and payment mechanisms—will affect participation rates, program costs, and the magnitude and timing of groundwater savings achieved. The following sections outline key considerations for how these concepts could be implemented, scaled, and adapted over time.

Key program design considerations include but are not limited to:

- **Administration**. Evaluate the staffing, data systems, and technical expertise required to implement and manage the program.
- **Program duration**. Determine whether the program will operate as a short-term pilot, annual program, or long-term demand management strategy. Specify how many years participants are expected to delay replanting (this may allow participants to select from 1 or more years).
- **Scale**. Establish the total acreage target or number of participants the program seeks to enroll annually. This should be tied to groundwater demand reduction targets.
- **Eligibility**. Define what types of orchards or parcels are eligible (e.g., age of orchard, crop type, groundwater-dependent lands, location within priority management areas).
- **Payment structure**. Determine what incentive payments will be offered as annual payments, lump-sum payments, or a hybrid structure tied to contract length.
- **Payment mechanism**. Decide whether payments will be fixed (set administratively) or determined through a competitive bidding or reverse auction process.
- **Funding sources and budget**. Identify sustainable funding sources such as grants, groundwater sustainability fees, or other public funding to support incentive payments and administration.
- **Verification and compliance**. Develop “rules” and procedures to confirm orchard removal, verify land management practices during the idle period, and ensure replanting timelines are followed.
- **Permitted activities**. Establish rules regarding allowable practices during the idle period (e.g., cover crops, cash crops, grazing) and whether irrigation is allowed. Ensure that practices are tied to the incentive payments.

- **Water accounting**. Define how groundwater savings will be measured or estimated and how those savings contribute to GSP sustainability targets. This includes identifying total pumping (applied water) or net water use (ET or ET of applied water). Ensure that idled acreage is not offset by new groundwater-dependent plantings elsewhere in the subbasin
- **Coordination with other PMAs**. Consider integrating EOR or PI with complementary PMAs.
- **Stakeholder outreach**. Conduct outreach with growers, landowners, and agricultural businesses to refine program design and encourage voluntary enrollment.
- **Adaptive management**. Establish a process to periodically update incentive payments and program rules based on market conditions, participation rates, and groundwater outcomes.

In short, EOR (or PI) program design includes multiple steps and elements that should be carefully developed to ensure the program is effective. The following sections provide additional details for key program design elements. A more detailed assessment of program design could be developed in the future.

8.1 Administration

Program administration includes planning, implementation, and oversight of EOR activities. Administrators are responsible for establishing EOR operational procedures, ensuring compliance, and adjusting the program over time. This includes but is not limited to developing work plans, EOR incentive payments, budgeting, and coordinating communication among stakeholders. Importantly, the administrator develops, publishes, and updates clear rules/guidelines that govern how the program operates.

A key component of program administration is continuous monitoring and evaluation. The administrator tracks program performance (water savings), collects data on outputs and outcomes, and applies this information to improve the EOR. The administrator is typically the GSA but could include other partners such as the local Farm Bureau or other organizations.

8.2 Program Timeline

The length of time over which the EOR operates is an important consideration for both program effectiveness and grower participation. One approach is to begin with a pilot program that enrolls a limited number of acres for a short period, such as one to three years. A pilot allows the GSA and program partners to test procedures, payments, confirm grower interest, and evaluate real-world costs and outcomes (water savings and accounting) before expanding the program. Even a small pilot can generate measurable water savings by delaying orchard replanting and shifting the timing of groundwater use across the orchard life cycle.

Over time, longer-term implementation can provide more durable groundwater conservation benefits. Programs that operate for multiple years or on a rolling basis can maintain reductions in groundwater demand by continuously enrolling orchards approaching the end of their productive life. Sustained implementation also provides greater certainty for both growers and program administrators, allowing participation decisions and funding commitments to be made with a longer planning horizon. However, this requires a stable funding source for the program.

A longer-term program makes the most sense if there is significant buy-in from landowners or the need for significant reductions in groundwater use to meet GSP goals. As noted above such a program requires stable funding sources and commitments from partners, which can be challenging. The EOR could be rolled out in phases, where the GSA begins with a pilot that is extended as resources and partnerships become available or conditions change (e.g., in response to grant opportunities). The program could also be tailored to groundwater conditions and scaled up in response to those conditions.

8.3 Incentive Payments

An important consideration for program implementation is how incentives are offered. There are a number of different approaches, but two main alternatives: (i) offer a fixed price payment, or (ii) establish a bidding system to allow growers to apply and make an "offer" to the program. This could be through a standard reverse auction approach, or other auction mechanisms can be applied. An evaluation of these options was beyond the scope of this analysis. There are examples of fallow bank programs that use variations of one or both approaches.

A brief summary of the tradeoffs between each approach and other considerations for setting payment amounts through an auction approach is presented below. Additional analysis is warranted if the EOR (or a pilot) program is implemented in the future.

Some considerations for a fixed price approach include:

- **Certainty.** By knowing the exact value growers will be paid, program participants can more easily evaluate the decision to participate.
- **Simplicity.** A fixed price reduces the labor for growers to estimate bids. It also reduces the labor required by the program administrator to implement an auction approach.
- **Financial Certainty.** A firm price can be established in the first year of the program, adjusted over time to reflect conditions, and used to estimate a firm annual program cost.
- **Equity.** This approach typically increases the cost of the program because all growers are paid the same amount, even though the program would (ideally) target less productive (e.g., older) orchards that would remove and extend a replant period at a lower cost.

Considerations of an auction approach include:

- **Efficiency.** Through an auction approach, the program can select the participants with the lowest willingness to accept (e.g., lower incentive payments), reducing the per acre program cost and potentially generating greater water savings. Lower bids tend to indicate less productive or higher-cost orchards.

- **Flexibility.** As noted throughout this TM, business conditions vary across operations. Agronomic factors affecting this variability include but are not limited to soil quality and pest pressures. Operational factors include but are not limited to farming experience, access to labor, equipment, business structure (e.g., vertical integration), and farm size. A biding system lets interested growers submit offers that reflect individual considerations for each block.
- **Risk preferences**. In addition to factors that directly impact net returns, grower expectations and risk preferences impact a grower's willingness to accept payment for a program such as the EOR. Even small changes in the expected average price significantly affect the costs of delaying replanting. Opinions among growers about what prices will be over the 25 years varied even among the small outreach group. This is typical. Further, the time value of money may vary greatly between growers. For growers with immediate cash flow constraints, receiving a payment while delaying the cost of replanting by one to three years may be attractive. For other growers, such as those with larger operations or other sources of income, the cost of delaying replant may be greater than a fixed program payment. In summary, each grower will have different price expectations, costs, operating conditions, risk tolerance, and business practices that affect program incentive payments – a bid system allows growers to make an offer that reflects these individual characteristics.
- **Market power**. In markets with few participants, growers may be able to work together to coordinate bidding. In cases where markets have one or two large bidders, these bidders may be able to influence or set the price. Therefore, it is useful for program administrators to make their own estimate of fair compensation even in a reverse auction or other bidding approach. This can be accomplished through annual reports.

Other considerations that affect program incentive payments include:

- Decisions about what is permissible during the idle season impact program payments. Allowing non-irrigated cover crops has the potential to increase soil quality, but cover crops use some water during the idle season. Off-season activities should be monitored to ensure the program is generating the benefits it is designed to.
- Future program design considerations that involve a self-financing approach may consider the effect that program fees will have on a grower's willingness to accept program payment. For example, an assessment per acre will reduce the expected value of future orchards, meaning the necessary incentive payment to forgo that future stream would also be reduced.

Incentive payments are a central component of program implementation because they determine grower participation and overall program cost. Establishing payment levels that reflect the opportunity cost of delaying orchard replanting—while remaining financially reasonable—is critical to achieving meaningful, cost-effective enrollment and groundwater savings.

8.4 Coordination with Other PMAs

Implementation of the EOR should be considered within the broader set of PMAs identified in the GSP. A portfolio of PMAs can be implemented to achieve sustainability goals. To support effective decision-making, it is important to evaluate and standardize the estimated costs and expected benefits of each PMA using comparable metrics (e.g., lifecycle cost per acre-foot of groundwater conserved or new supplies).

A portfolio of PMAs can be selected that collectively provides the most cost-effective way to achieve sustainability. EOR may serve as one component of a implementation strategy, complementing other PMAs such as PI programs, recharge projects, or other water management initiatives. Considering EOR alongside other PMAs helps ensure that program investments are aligned with overall basin management objectives and that resources are directed toward the most efficient combination of actions.

This approach can be developed through a funding strategy that evaluates the cost-effectiveness of individual PMAs and establishes funding needs. A funding strategy would be structured around a portfolio of PMAs. This allows programs such as EOR to be developed with other demand management and recharge initiatives. It also positions the GSA to pursue grant funding opportunities when they are available.

9. Summary and Next Steps

The Vina Subbasin GSP specifies a mix of PMAs that may be develop and implemented to achieve and maintain sustainable groundwater conditions, including the EOR and PI programs. This report evaluated how alternative practices during an extended replanting period—ranging from harvested cover crops to short-season cash crops—affect the cost of delaying orchard replanting and the corresponding incentive payments that would be necessary to encourage voluntary participation in a program like EOR. For PI, an irrigation timing analysis was also developed to estimate potential cost savings in new or existing orchards by changing the timing of irrigation to use off-peak electrical rates under representative agricultural time-of-use rate structures. These analyses provide additional data and context for future program design and implementation of future programs.

The analysis focuses on the costs and returns to the grower under representative scenarios. These values reflect conditions in the Vina Subbasin only and cannot be translated to other regions or programs. The EOR economic framework evaluates a selection of land management scenarios during the extended replanting period and assesses the costs for water savings. It also estimates the potential cost savings from changes in irrigation timing under time-of-use electricity rates. Agronomic effects—such as changes in ET, soil health, pest pressure, and long-term yield impacts—are only partially monetized or remain outside the scope of this study. As the EOR program concept is refined and additional field data become available, further analysis should be developed to refine incentive payments and support long-term program design.

Six scenarios for land management were developed that show potential benefits and incentive payments during an extended orchard replanting period. The incentive payments reflect the minimum willingness-to-accept for participation in a EOR program. Key findings include:

- Extended replanting incentives vary depending on how the land is used during the idle period. Cover crops and spring-seeded grasses generate agronomic benefits but only modest economic returns, resulting in annual incentive payments up to $790 per acre, depending on the practice and crop transition.
- Harvested cover crops partially offset idling costs by creating a (modest) revenue stream. Winter wheat harvested for grain or hay reduces grower costs relative to unmanaged idle land, lowering required incentive payments compared to other cover crops.
- Short-season cash crops can substantially reduce or eliminate required incentive payments under certain market conditions. Processing tomatoes and dry beans can generate sufficient net revenue during the idle period to offset much of the cost of delaying replanting; however, outcomes are highly sensitive to commodity prices, contract terms, irrigation requirements, and operational feasibility.
- As an alternative to removal, some growers have been abandoning orchards. Under AB 732, it is more expensive to abandon an orchard, and minimal management practices are required to avoid nuisance pest and disease pressure.

- Extending the period between orchard plantings can reduce ET, resulting in measurable water savings between 0.91 and 2.62 acre-feet of ET per year. Of the scenarios considered for EOR, idle ground and cover crops may provide the greatest water savings.
- Switching irrigation to off-peak periods yields modest but measurable cost savings. It may also provide water savings by reducing incidental ET. Under selected agricultural time-of-use rate plans, growers can reduce electricity costs by up to roughly $65 per acre per year, with additional, though currently unquantified, benefits from reduced incidental ET.

All the results presented in this report are sensitive to prices, costs, and farming practices and should be updated over time. Incentive payments reflect representative averages and do not capture farm-level heterogeneity; integrating site-specific agronomic performance will be critical for refining program design and evaluating cost-effectiveness across scenarios. Cost-effectiveness evaluations could additionally be extended to evaluate other demand management measures (such as precision irrigation/efficiency improvements) and other supply projects, which could be integrated into a broader GSA funding strategy to minimize costs to landowners/growers.

Based on the current findings and outreach, recommended extensions of this analysis include:

- Update scenario budgets and incentive payments periodically to reflect commodity prices, input costs, and contract terms for cover and cash crops. In general, any EOR program payments should be updated annually.
- Evaluate and monetize the economic/financial benefits from specific practices during the extended replanting period, such as soil health, amendments, water use, and other agronomic practices. Monetize these benefits and integrate into the program. Identify ways to leverage grant funding opportunities for such programs.
- Gather data from pilot sites and analyze the potential yield/productivity benefits growers realize after delaying replanting and/or integrating land management practices. Update analysis to reflect these benefits and disseminate findings to support further adoption of practices.
- Improve water use and ET estimates and apply to the cost-per-acre-foot-saved analysis for EOR participation. This could be extended to other programs (e.g., PI / water use efficiency programs) and GSA funding and implementation strategies.

The analyses presented in this report provide an initial evaluation of the economics and financial implications of EOR and PI, potential water savings, and implementation considerations. These findings provide a foundation for the Vina Subbasin and partners to consider how EOR and related PMAs could be implemented. Moving from analysis to implementation will require further program development. Based on the results of this analysis, several next steps are recommended to support program development and implementation:

- Apply economic and financial analysis to standardize PMA costs. Expand the analytical framework developed in this study to evaluate and compare the costs of EOR, PI, and other PMAs using consistent metrics (e.g., cost per acre-foot of groundwater conserved or supplied). Standardizing these cost estimates will support evaluation of a cost-effective portfolio of projects and management actions for GSP implementation.
- Develop draft program guidelines and implement a pilot EOR program. Prepare draft EOR program guidelines, including eligibility criteria, enrollment procedures, incentive payment structure, and monitoring requirements. A bidding or selection process should be developed to allocate program funds efficiently. These procedures can then be tested through a limited-scale pilot program to evaluate administrative feasibility and grower participation.
- Use pilot results to integrate EOR with other PMAs. Information from the pilot program, combined with continued economic and financial analysis, can be used to refine incentive payments, evaluate participation levels, and assess water savings outcomes. These results can then inform how EOR may be integrated with PI and other PMAs as part of a coordinated implementation portfolio designed to support long-term groundwater sustainability in the Vina Subbasin.

These steps provide a pathway for transitioning from conceptual program analysis to practical EOR and PI implementation.

10. Appendix A: Incentive Payment Analysis Supporting Tables

The following tables provide the detailed cost, revenue, and sensitivity data underlying the incentive payment analysis in Section 5.

Figure A.1: Historical Average Almond Prices per Pound (Inflation-adjusted 2024 dollars)

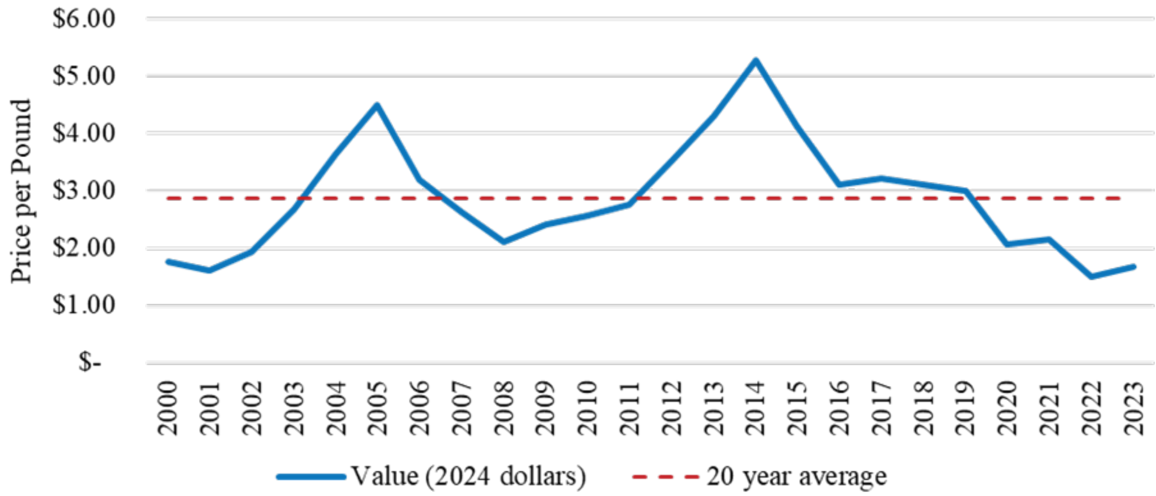


Figure A.2: Historic Walnut Prices per pound (Inflation-adjusted 2024 dollars)

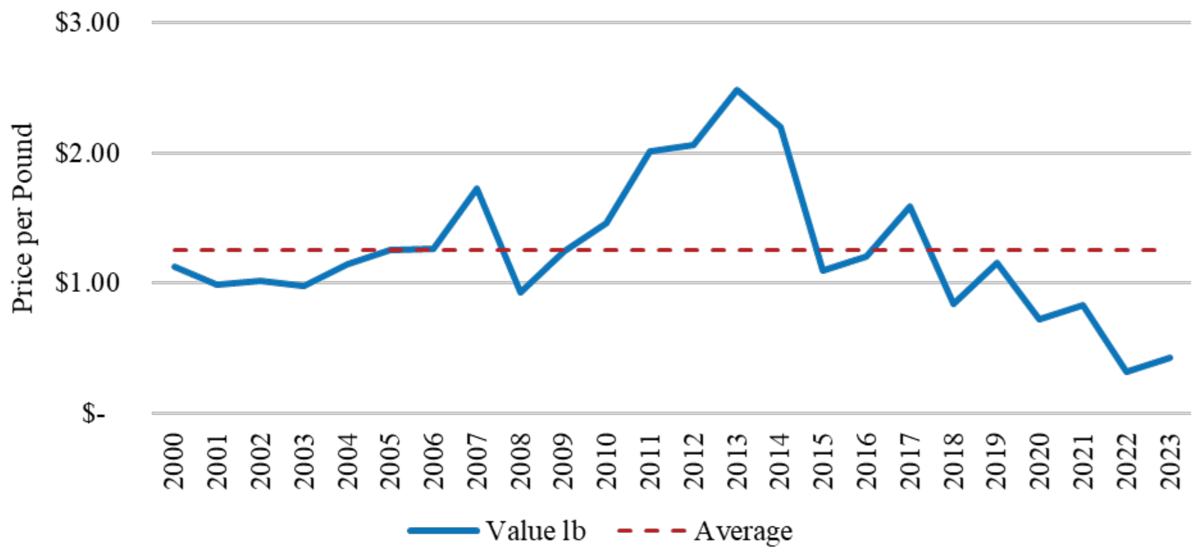


Table A.1: Example Replant Cost Summary, Selected Items

Orchard Replacement Costs	Low *$/ac*	High *$/ac*
Orchard Removal	**Burning**	**Recycling**
Pulling Trees	$1,000	$1,000
Grinding Trees		$700
Burning	$500	
Spreading		$300
Ripping	$600	$600
Discing/Plow	$80	$210
Leveling/berms	$130	$130
Subtotal	**$2,310**	**$2,940**
Fumigation (if needed)	$0	$1,200
Planting	$1,650	$1,700
Irrigation System (capital only)		
Double Line Drip	$2,000	
Micro Sprinkler		$3,500
Total	**$5,960**	**$9,340**

Table A.2: Almond Orchard Idle Season, Example Selected Expenses

Category	Expense	Low *$/ac*	High *$/ac*
Overhead	Office Overhead	$50	$100
	Other Insurance	$8	$8
	Property Tax/Insurance/Other	$126	$241
	Other/Repairs	$55	$55
Total		$239	$554

Table A.3: Summary of Selected Scenario Budget Parameters

Scenario	Cover or Cash Crop		Soils Amendment Cost Savings *$/ac*
	Costs *$/ac*	Revenues *$/ac*	
Baseline idle land	-	-	-
With Cover Crop (Winter Mix)	$156	-	$15
With Cover Crop (Winter Forage for Hay)	$400	$380	-
With Cover Crop (Winter Wheat for Grain)	$460	$572	-
With Cover Crop (Spring Grass)	$122	-	$15
With Cash Crop (Processing Tomatoes)	$273	$826	-
With Cash Crop (Dry Beans)	$129	$169	-

Table A.4: Almond Incentive Payment Almond Price Sensitivity Analysis

Scenario	1-Year Low	1-Year High
	$/ac	*$/ac*
Baseline idle land	$366	$1,094
With Cover Crop (Winter Mix)	$488	$1,246
With Cover Crop (Winter Forage for Hay)	$385	$1,114
With Cover Crop (Winter Wheat for Grain)	$258	$987
With Cover Crop (Spring Grass)	$485	$1,214
With Cash Crop (Processing Tomatoes)	-	$563
With Cash Crop (Dry Beans)	$327	$1,056

Table A.5: Walnut to Almond Incentive Payment Almond Price Sensitivity Analysis

Scenario	1-Year Low	1-Year High
	$/ac	*$/ac*
Baseline idle land	$360	$1,089
With Cover Crop (Winter Mix)	$510	$1,239
With Cover Crop (Winter Forage for Hay)	$379	$1,108
With Cover Crop (Winter Wheat for Grain)	$252	$981
With Cover Crop (Spring Grass)	$479	$1,208
With Cash Crop (Processing Tomatoes)	-	$557
With Cash Crop (Dry Beans)	$322	$1,051

Table A.6: Almond Baseline Replant Cost Range and Incentive Payment

Scenario	Replant Cost	1-Year Payment
	$/ac	*$/ac*
Baseline idle land	$2,800	$639
Low replant cost	$2,300	$650
High replant cost	$4,000	$612

Table A.7: Walnut to Almond Baseline Replant Cost Range and Incentive Payment

Scenario	Replant Cost	1-Year Payment
	$/ac	*$/ac*
Baseline idle land	$3,000	$633
Low replant cost	$2,500	$645
High replant cost	$4,200	$607

Table A.8: Almond Incentive Payment Fumigation Cost Sensitivity Analysis

Scenario	1-Year Without Fumigation	1-Year With Fumigation
	$/ac	*$/ac*
Baseline idle land	$639	$683
With Cover Crop (Winter Mix)	$790	$835
With Cover Crop (Winter Forage for Hay)	$658	$702
With Cover Crop (Winter Wheat for Grain)	$531	$576
With Cover Crop (Spring Grass)	$758	$802
With Cash Crop (Processing Tomatoes)	$107	$152
With Cash Crop (Dry Beans)	$600	$645

Table A.9: Walnut to Almond Incentive Payment Fumigation Cost Sensitivity Analysis

Scenario	1-Year Without Fumigation	1-Year With Fumigation
	$/ac	*$/ac*
Baseline idle land	$633	$678
With Cover Crop (Winter Mix)	$783	$830
With Cover Crop (Winter Forage for Hay)	$653	$697
With Cover Crop (Winter Wheat for Grain)	$526	$570
With Cover Crop (Spring Grass)	$753	$797
With Cash Crop (Processing Tomatoes)	$102	$146
With Cash Crop (Dry Beans)	$595	$639

Table A.10: Almond Yield Requirement Analysis

Scenario	1-Year Yield increase	1-Year Yield increase
	%	*tons/ac*
Baseline idle land	0.99	0.25
With Cover Crop (Winter Mix)	1.23	0.32
With Cover Crop (Winter Forage for Hay)	1.03	0.26
With Cover Crop (Winter Wheat for Grain)	0.83	0.21
With Cover Crop (Spring Grass)	1.18	0.30
With Cash Crop (Processing Tomatoes)	0.16	0.04
With Cash Crop (Dry Beans)	0.94	0.24

Attachment B

Case Study – Idle Land

Extended Orchard Replacement (EOR) Case Study

Idle Land

DEFINITION

Idle land is any land where an orchard has been removed and not replaced with another crop. Depending on how it is managed, idled land can be bare or weeds or other vegetation can proliferate to various degrees.
Land is mapped as idle if it presents as a field that has been managed in the past as an agricultural field but does not currently have a crop growing on it. The Land IQ land use dataset classifies idle as fallow in the current year, and idle lands as short-term (idle for two or three consecutive years) and long-term (idle for four or more years). For example, idle can include:

- Bare field, tilled so that little/no vegetation grows during the water year
- Winter/spring weed growth that is tilled in or mowed, with field bare after
- Field not tilled or mowed the entire water year or multiple water years, covered in vegetation

Therefore, land classed as "idle" can be in various conditions, and land condition and its associated water use may be difficult to determine from land use and evapotranspiration data alone.

WATER USE

The consumptive use of idle land depends on the vegetative cover and the type of precipitation year. Idle land in the Vina Subbasin used about 9.9 inches of water, on average, from January to October, 2025. This value takes into account different water year types and various levels of vegetative cover.

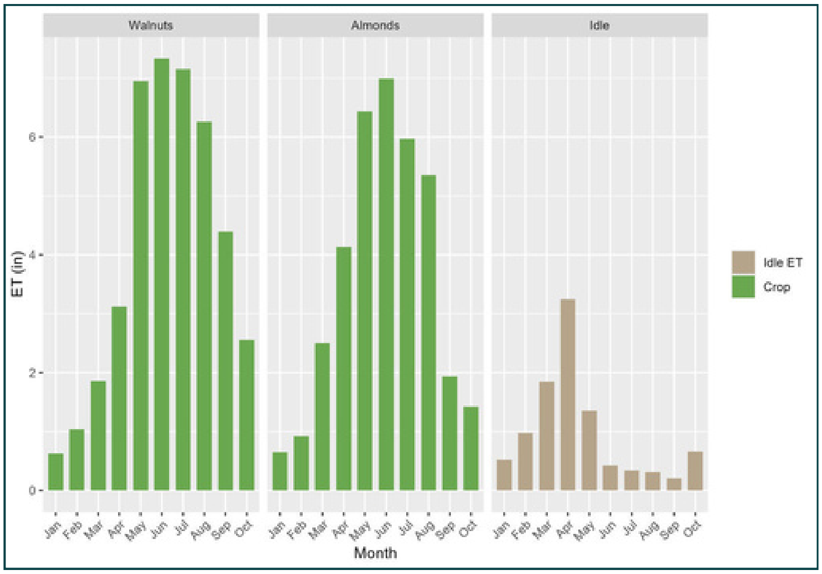


Figure 1. Mean ET by Crop Type January - October

Extended Orchard Replacement (EOR) Case Study

Idle Land

CONSIDERATIONS

Idled agricultural lands dominate human-caused dust sources in California (causing over 80% of total emissions) and has expanded in recent years because of water shortages. These dust emissions are associated with public health issues and impacts on regional climate. In addition to increasing risk of respiratory and cardiovascular diseases, dust can carry infectious soil-dwelling fungal spores. Dust impacts regional climate by absorbing radiation and influencing winds, exacerbating heat waves, and affecting water resources availability (precipitation, snow melt timing) (Adebiyi et al. 2025).

Idle land is also susceptible to degradation from soil erosion especially when it is unirrigated during periods of high evaporative demand. The severity of soil erosion caused by wind depends on soil type and fetch, or the distance that wind has to blow or pick up before being obstructed. Soils with high water infiltration capacity and/or organic matter are less prone to soil erosion. Silts, fine sands, and some clays are more susceptible. The longer the fetch, Soil erosion results in reduced fertility and soil microbial diversity. In turn, these impacts reduce agricultural productivity and resilience to extreme climate events by decreasing infiltration and buffering against other changes in soil physical and chemical conditions.

FINANCIAL ANALYSIS

The financial analysis considers an almond orchard that is removed and the land is idled for a period of 1, 2, or 3 years prior to replanting to almonds. During the idle period, idle land falls under the idle land strategies described in the definition section. This creates water savings and may also provide soil or other agronomic benefits.

An analysis was developed to compare the net income (revenue minus costs) to the grower when immediately replanting versus delaying replanting by 1, 2, or 3 years.

- **Revenues.** The almond orchard is removed in Year 0. If it is immediately replanted to almonds the next season (Year 1), it will produce the first viable crop in Year 3 (3rd leaf). It would generate positive net cash flow in Year 6. Delaying replanting by 1 year means the block produces its first crop in Year 4 and generates positive net cash flow in Year 7. Similar logic applies to delaying replanting by 2 or 3 years. For delayed replanting, the land is idled as bare soil.

- **Costs.** The almond orchard is removed in Year 0 at a cost of approximately $2,800 per acre for tree removal, grinding trees, composting, ripping for root removal, disc, and roll. Replanting costs include trees, spraying, and field establishment. These costs are incurred in Year 1 if the block is immediately replanted, and they are incurred in Years 2, 3, or 4 if replanting is delayed. The only costs associated with idling land are overhead costs.

- **Other considerations**. Delaying replanting in the idle land scenario may or may not provide additional soil and pest management benefits. There are potential negative effects including soil erosion, increased dust emissions, and declines in soil fertility. However, anecdotal reports from growers report more vigorous orchard growth and better production when replanting is delayed at least one year

Extended Orchard Replacement (EOR) Case Study

Idle Land

FINANCIAL ANALYSIS

- **Water savings.** Almond orchards have an average evapotranspiration (ET) of 3.03 acre-feet per acre over the lifetime of a 25-year orchard. The idle land ET is assumed to be 0.83 acre-feet per acre. Total ET savings are 2.20, 4.40, and 6.60 acre-feet per acre in the 1-year, 2-year, and 3-year replanting delay scenarios. The corresponding cost of water savings are $309, $303, and $297 per acre-foot of water saved, respectively.

The analysis illustrates representative costs, yields, and returns. Actual costs and returns will vary by farming operation. A grower, or a grower that is also a handler, will have different access to cash and borrowing that may affect operations and outcomes. Almond prices fluctuate based on market conditions and would affect the values in this analysis. The analysis applies to representative almond yields and a price of $2.25/lb. for almonds.[1]

An enterprise farm budget was developed for this scenario that includes all costs and revenues: removal and replanting, cash costs, capital costs, and overhead. Table 1 summarizes the costs (excluding all overhead) for expenses that would be incurred under each option. By delaying replanting, the grower defers the outlay for stand establishment and instead incurs lower costs to maintain the idle land. Delaying replanting postpones the initial bearing years and break-even net cash flow.

Table 1. Summary of Selected Almond Orchard Replanting Costs for the Winter Wheat-Grain Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Year 0	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)
Year 1	Replant ($6,300)	-	-	-
Year 2	1st leaf	Replant ($6,300)	-	-
Year 3	2nd leaf	1st leaf	Replant ($6,300)	-
Year 4	3rd leaf	2nd leaf	1st leaf	Replant ($6,300)
Orchard Cash Flow Break Even	Year 6	Year 7	Year 8	Year 9

[1]Additional analysis, discussion, and sensitivity scenarios are available in the full Vina Subbasin Extend Orchard Replacement Program Report.

Extended Orchard Replacement (EOR) Case Study

Idle Land

FINANCIAL ANALYSIS

The financial analysis shows the cost implications of delayed replanting; the timing of income (revenues) and costs to the grower changes based on the delay interval. A financial model was developed to calculate the break-even payment that would be required to make the grower indifferent between immediately replanting, or delaying replanting by a period of 1, 2, or 3 years. A program offering incentive payments for delayed replanting would offer a payment equal to or greater than this amount.

Almond Incentive Payment (per acre)
Idle Land

1-year	$639
2-year	$1,253
3-year	$1,844

Incentive Payment Sensitivity (per acre)
Idle Land

Low Almond Incentive Payment

$366/ac

High Almond Incentive Payment

$1,094/ac

The results presented are sensitive to key cost and market factors applied in this analysis, particularly commodity price and net returns from alternative uses/crops during the replanting period. To better understand how these factors affect the incentives across different scenarios, a sensitivity analysis incorporates alternative prices, replanting costs, and yield into the payment calculations. These are presented as a range of low and high for one-year payments.

The idle land scenario may or may not provide soil benefits. For example, yield may decline if erosion had a severe impact on soil health. However, anecdotal reports from growers report more vigorous orchard growth and better production when replanting is delayed at least one year. An additional financial analysis was developed to calculate the break-even yield or production increase for the grower, where the greater yields for the future orchard offset the initial cost of delaying replanting. Figure 1 summarizes the results from this analysis.

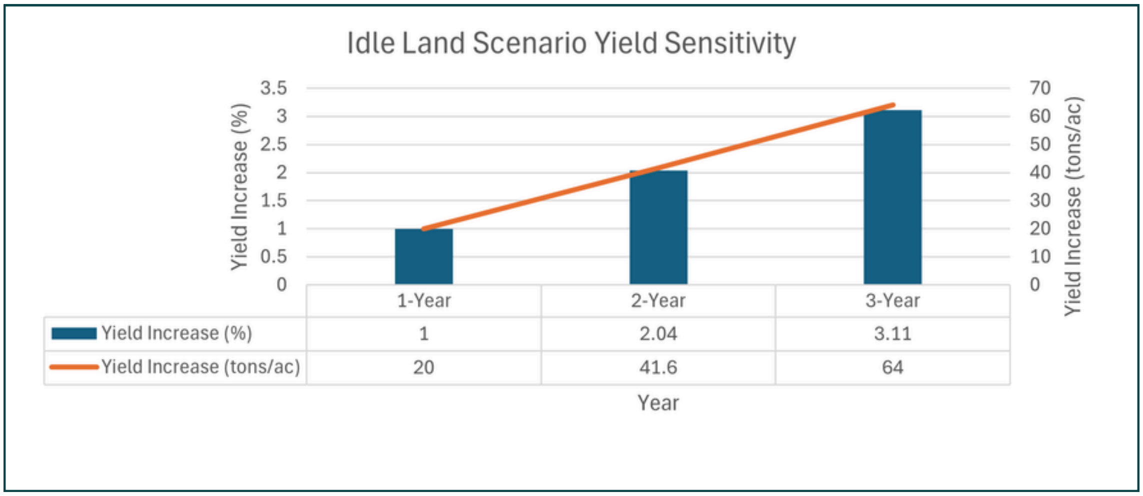


Figure 2. Yield Impact Sensitivity Analysis for the Idle Land Scenario

Extended Orchard Replacement (EOR) Case Study

Idle Land

FINANCIAL ANALYSIS

For the idle land scenario, yield for a one-year delay would need to be 1% higher throughout the 25-year life of the orchard to offset the upfront expense of delayed replanting. This corresponds to a ~20 tons per acre yield increase. This required yield increase rises with the number of years delayed due to the higher overhead expenses and orchard production delay.

Table 2 presents a complete financial outlay including revenue, cost, and yield impacts. Assuming yield is unchanged, there is a cost to delay replanting, and additional idle land year costs, which are captured by the declining value measure. The financial model then calculates the Breakeven Yield Factor, which is the yield increase necessary for value to be equal between the No delay scenario, and the corresponding number of years of delay. That is, the cost of delaying replanting is offset by the benefits of increased yields by the factors shown in Table 2 (between 0.997% and 3.113%, depending on the scenario).

Table 2. Breakeven Analysis for the Idle Land Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Value at Yield Factor = 1.00	$4,818	$4,179	$3,565	$2,974
Annual Costs				
Cover crop planting cost	$0	$0	$0	$0
Basic idle year costs	$0	$364	$364	$364
Cover crop revenue	$0	$0	$0	$0
Net Revenue	$0	($364)	($728)	($1,092)
One-Time Costs				
Removal	$2,800	$2,800	$2,800	$2,800
Replant	$6,300	$6,300	$6,300	$6,300
Breakeven Yield Factor	1	1.00997	1.02035	1.03113

ATTACHMENT C

Case Study – Abandoned Orchards

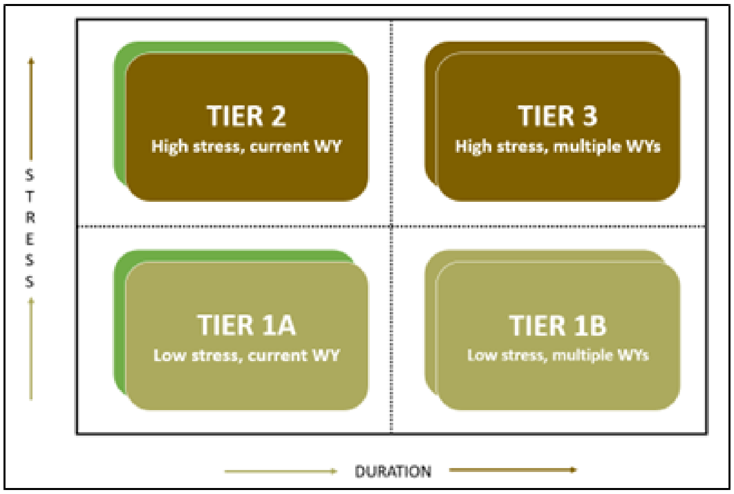
Extended Orchard Replacement (EOR) Case Study

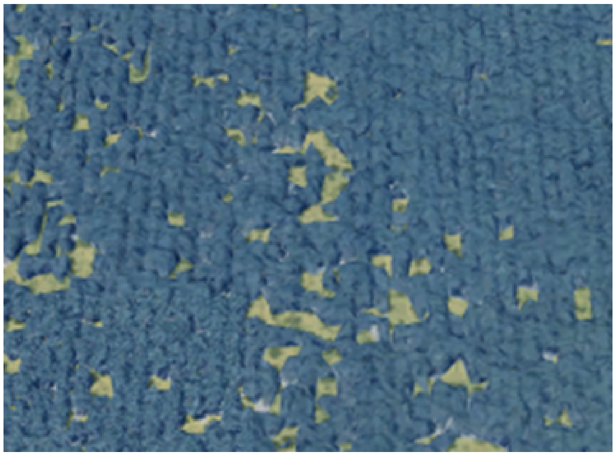
Abandoned Orchards

DEFINITION

Abandoned orchards are orchards that are not irrigated or managed to produce a commercial crop but have not been removed. These orchards may still access water from stored soil moisture, shallow groundwater or capillary action from connected sources such as rivers or canals.

In the Land IQ land use dataset, stressed and abandoned orchards are classified into four categories depending on the level and duration of stress. Therefore, orchards classified as abandoned can represent a range of conditions. For this analysis, orchards were considered abandoned if they were in Tier 3.





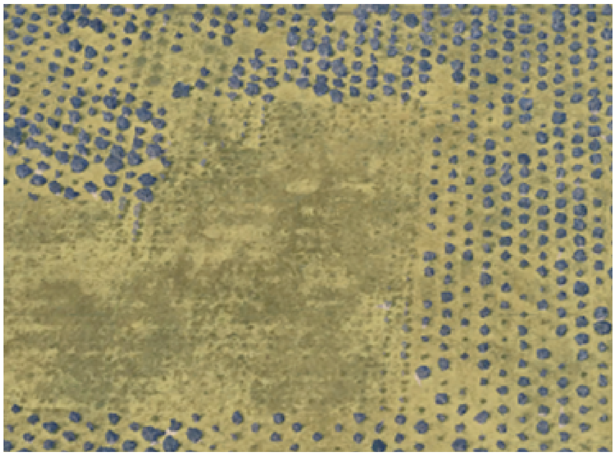
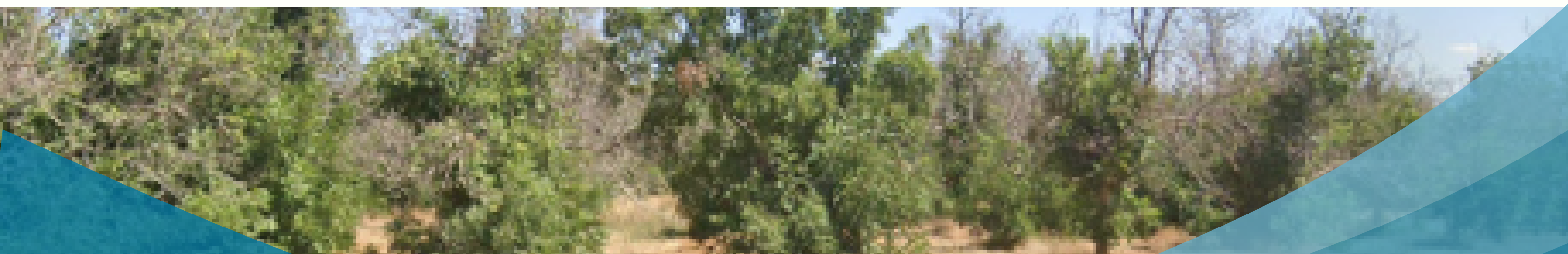


Figure 1. Examples of Tier 1A Abandoned Orchard (Left) and Tier 3 Abandoned Orchard (Right)



Abandoned Orchards

WATER USE

Abandoned almond orchards in the Vina Subbasin consumed about 16.5 inches of water and abandoned walnut orchards used about 16.1 inches of water from January to October, 2025.

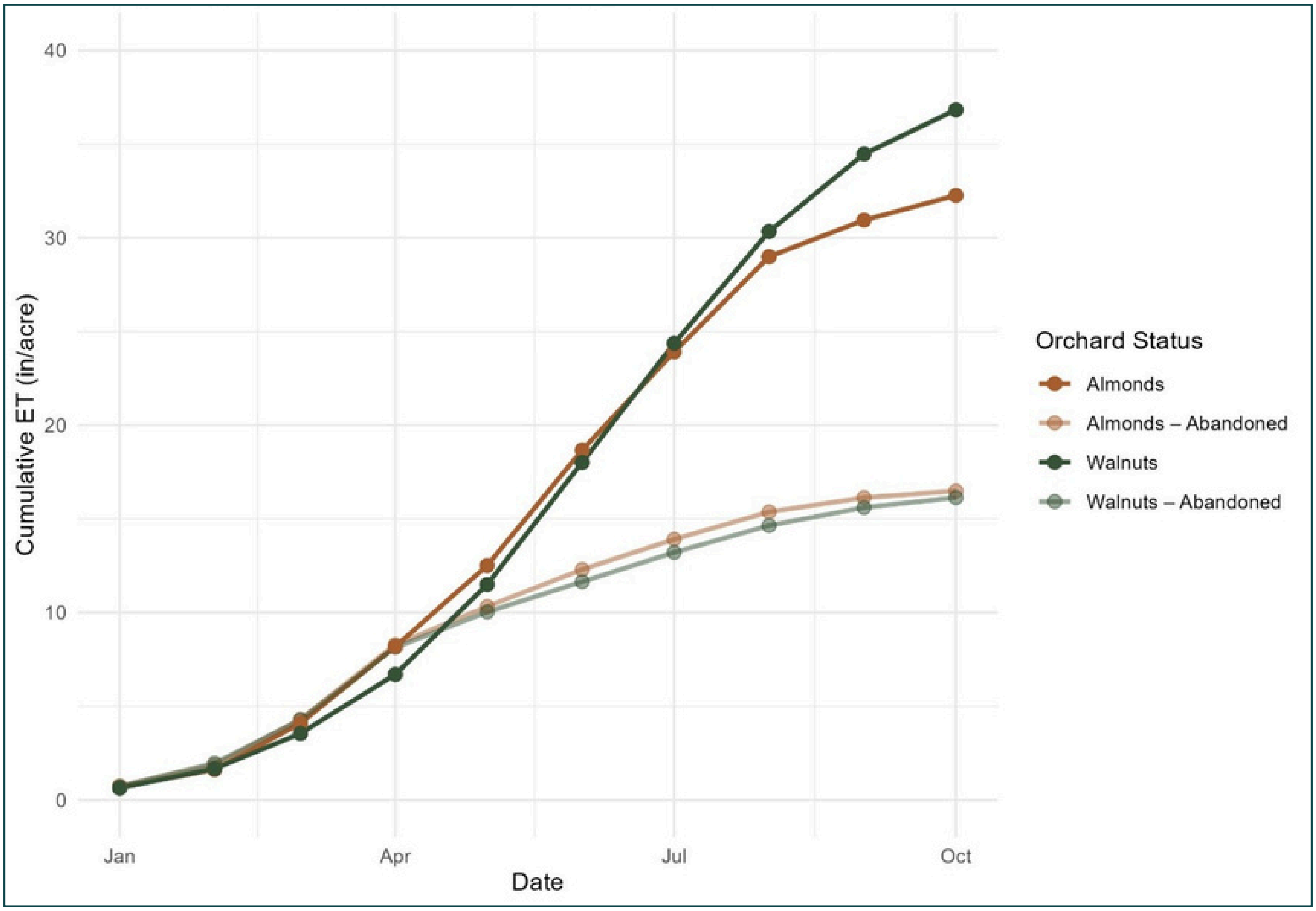
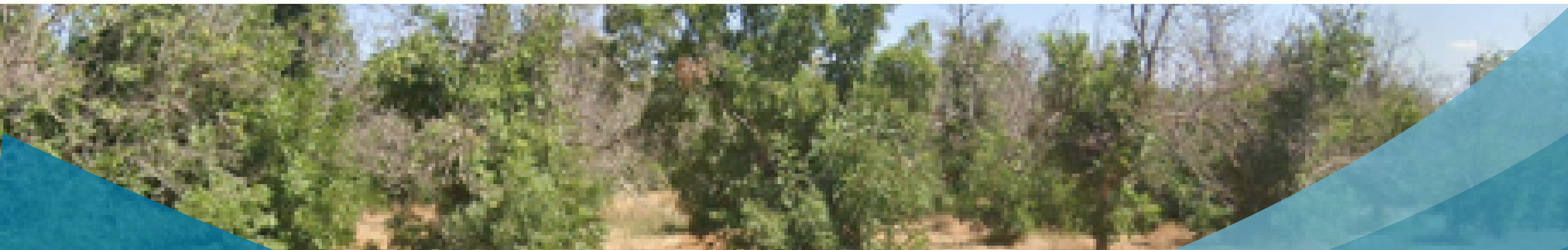


Figure 1. 2025 season-long ET of orchards vs abandoned orchards.



Extended Orchard Replacement (EOR) Case Study

Abandoned Orchards

CONSIDERATIONS

Abandoned orchard blocks have increased in California statewide because of water scarcity and low market prices. These blocks can harbor pests like navel orangeworm, rodents, and weeds that can spread to neighboring orchards. Assembly Bill 732 was signed into law in October 2025 to provide county agricultural commissioners with authority to issue civil penalties up to $500 per acre, and up to $1,000 if landowners fail to take action on abandoned orchards. The bill requires counties to issue a notice before penalties are levied. Landowners who take action based on resources such as UC Cooperative Extension and the UC Statewide Integrated Pest Management Program can void fines. Th bill will remain in effect until 2035, allowing a decade for counties to assess its impact.

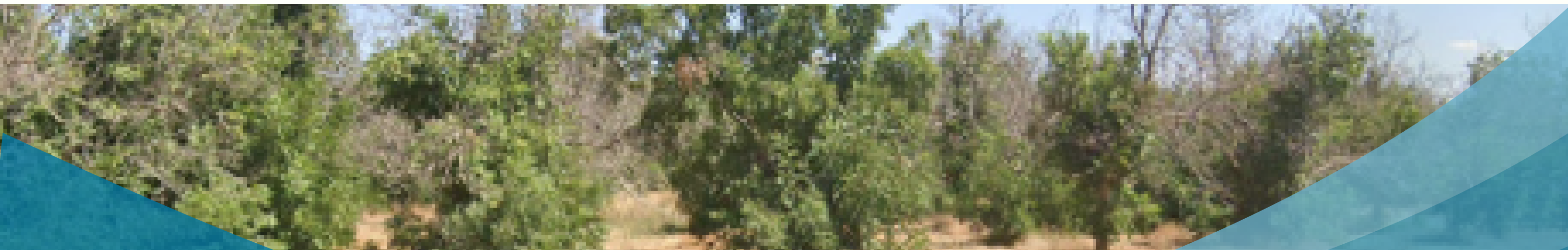
FINANCIAL ANALYSIS

The financial analysis considers an almond orchard that is abandoned after its term of 25 years. Once abandoned, the orchard is not irrigated, managed, or removed. Pursuant to the passage of AB 732, the county agricultural commissioner may levy penalties ranging from $500 to $1,000 per acre for orchards that are left abandoned.

An analysis was developed to compare the revenues (none) and costs over a period of 1, 2, or 3 years following orchard abandonment against those of other management options.

- **Revenues.** Since the orchard is abandoned, the model assumes it is not replanted or harvested. There is no revenue generated in the subsequent production cycle.
- **Costs.** The only costs associated with the abandoned orchard scenario are the overhead costs. This analysis assumes minimal overhead costs to cover property taxes and insurance at $190 per acre. There are no irrigation, removal, or management costs.
- **Other considerations.** Leaving the orchard abandoned poses a threat to soil and agronomic health, especially for neighboring orchards and fields. Abandoned orchards foster the growth and spread of pests, including navel orangeworm, rodents, and weeds. Another practice a grower might engage in is ‘mothballing’, which is defined as maintaining a non-producing orchard with minimal, critical inputs to allow for a rapid return to production in the future. This practice accomplishes objectives including a reduction in per-acre cost, and lowering pest and disease pressure, but is not considered for this case study.
- **Water savings.** Almond orchards have an average annual evapotranspiration (ET) of 3.03 acre-feet per acre over a 25-year orchard. Abandoned orchards have an average ET of 1.36 acre-feet per acre each year. Water savings are estimated at 1.67 acre-feet per acre per year.

The financial analysis shows the additional cost to delay orchard removal. Depending on the length of orchard removal delay, the timing for when removal costs and penalties (if applicable) realized by the grower changes. Under the abandoned orchard scenario, civil penalties are levied against producers who are in violation of AB 732. This means they



Extended Orchard Replacement (EOR) Case Study

Abandoned Orchards

FINANCIAL ANALYSIS

have left an orchard neglected or abandoned, and it poses a public nuisance due to the presence of pests. The policy states that growers must first receive notice of the nature of their violation and then have thirty (30) days to rectify the issue. If it is fixed within this period, the penalty is removed. If the grower does not take good faith action within forty-five (45) days, however, the penalty amount is authorized to increase to up to $1,000 per acre. Examples of actions that would rectify the issue include removal and fallowing, a minimal management scenario, or a return to full production.

Penalties for Abandoned Orchard Scenario

30-days

$0 - 500

45 days

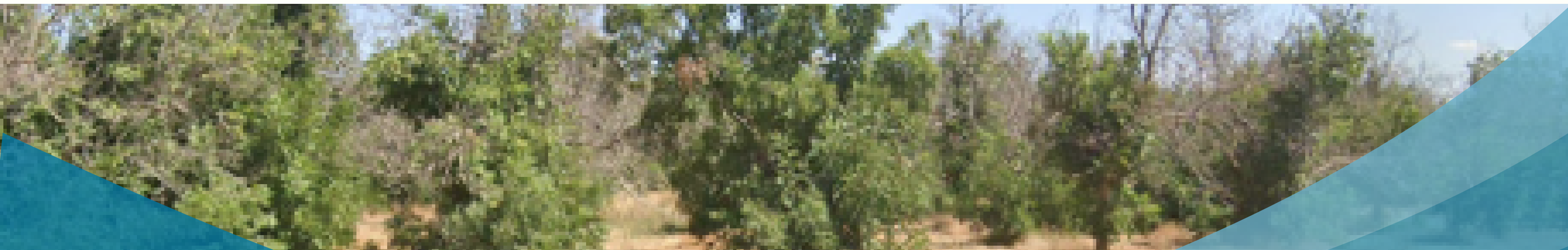
$1,000

The analysis illustrates representative costs, yields, and returns. Actual costs and returns will vary by farming operation. A grower, or a grower that is also a handler, will have different access to cash and borrowing that may affect operations and outcomes. Almond prices fluctuate based on market conditions and would affect the values in this analysis. The analysis applies to representative almond yields and a price of $2.25/lb. for almonds.[1] Table 1 compares the financial outlay between several management decisions a producer could make at the end of the previous orchard's productive life (Year 0).

Table 2. Selected Cost Comparison by Management Scenario in Year 0

Cost	Abandoned Orchard $/ac	Minimal Management $/ac	Bare Ground Idle* $/ac	Replanting $/ac
Removal	$0	$0	$2,800	$2,800
Overhead	$190	$364	$364	$364
Management	$0	$200	$0	$430
Irrigation	$0	$0	$0	$4,000
Replanting	$0	$0	$0	$2,300
Subtotal	$190	$564	$3,164	$9,894
Penalty Fine**	$500-$1,000	$0	$0	$0
Total	$690 to $1,190	$564	$3,164	$9,894

[1]Additional analysis, discussion, and sensitivity scenarios are available in the full Vina Subbasin Extend Orchard Replacement Program Report.
*The penalty fine is only imposed if the producer is in noncompliance; the amount depends on the timeline and grower response following notice of violation.
**For more information, refer to the Bare Ground Fallow Case Study



ATTACHMENT D

Case Study – Winter Cover Crop

Extended Orchard Replacement (EOR) Case Study

Winter Cover Crop - Winter Mix

DEFINITION

Here an EOR winter cover crop is assumed to be a cool-season grass and legume mixture that is planted in the fall, terminated in the spring and incorporated for green manure.

WATER USE

Winter mix cover crops consumed 11.9 inches of water during their growing season in 2025. For months when the land was idle, another 1.9 inches of water was consumed, for a total of 13.8 inches of consumed water for this land use January to October 2025.

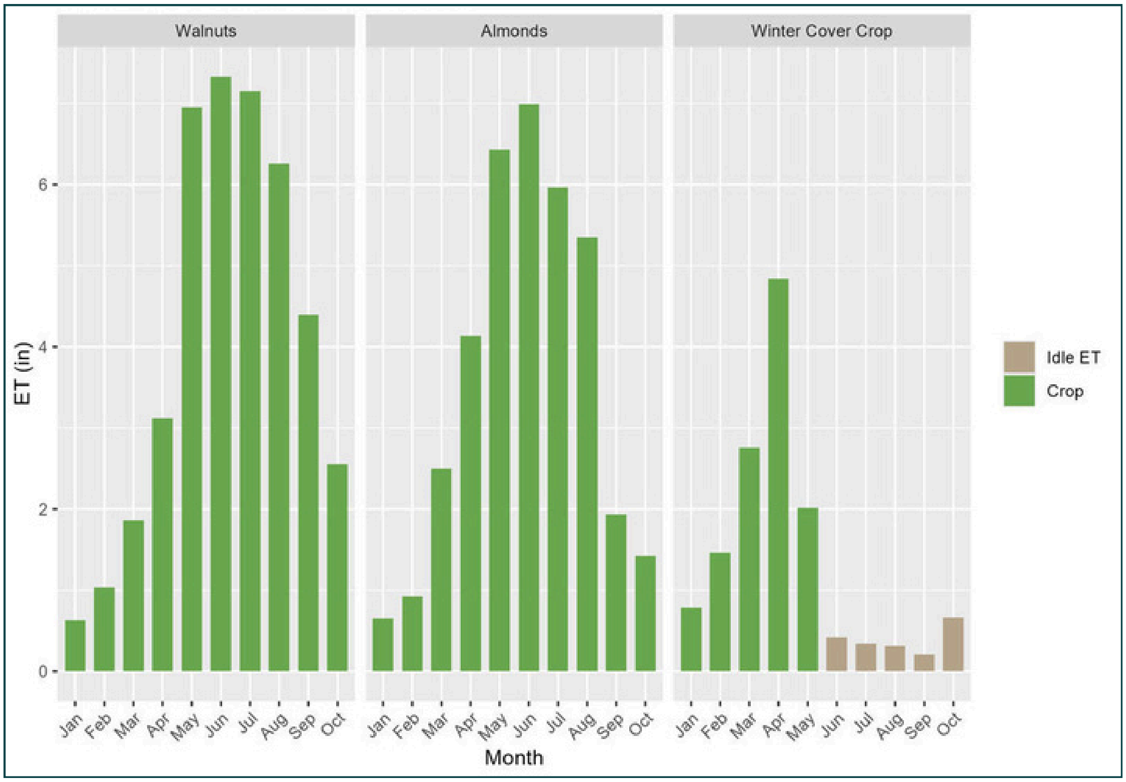
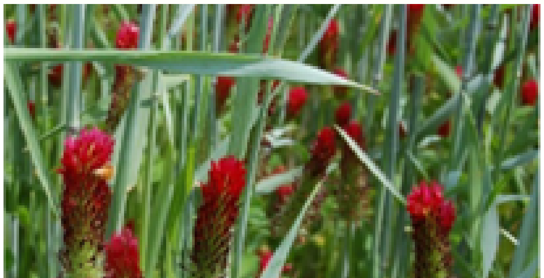


Figure 1. Mean ET by Crop Type January - October



Extended Orchard Replacement (EOR) Case Study

Winter Cover Crop - Winter Mix

CONSIDERATIONS

Potential benefits from cover crops include:

Reduced :

- Compaction and cracking
- Soil erosion
- Nitrogen losses
- Pest nematodes

Improved :

- Pollinator forage
- Beneficial insects and other organisms
- Water infiltration
- Orchard access during rainy periods
- Salt management (including sodium)
- Soil nitrogen
- Carbon and organic matter content
- Weed management (especially brassicas)

In orchards where whole orchard recycling has been used, cover crops may help regulate soil moisture and prevent nitrogen getting tied up in orchard residue.

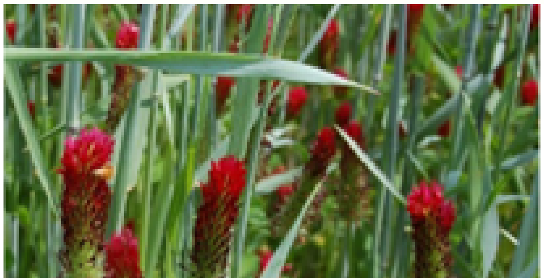
Challenges with cover crops include increased gopher populations (particularly in clover-heavy mixes) and the potential for cover crops to act as a pest vector for susceptible adjacent plantings.

Different cover crops can be used to accomplish different goals and no single cover crop can achieve all of them. Some cover crops might be better for nematode inhibition while others might be better suited for improving water infiltration. Importantly, fall-planted cover crops use winter rains as their main source of water, and once those rains stop in the spring, cover crops can compete with orchard crops for stored soil moisture and applied water if they are not terminated in a timely manner.

FINANCIAL ANALYSIS

The financial analysis considers an almond orchard that is removed and the land is left idle for a period of 1, 2, or 3 years prior to replanting to almonds. During the idle period, under this scenario, a winter wheat mix is planted as a fall cover crop. This creates water savings and provides some soil and other agronomic benefits. An analysis was developed to compare the net income (revenue minus costs) to the grower when immediately replanting versus delaying replanting by 1, 2, or 3 years.

- **Revenues.** The almond orchard is removed in Year 0. If it is immediately replanted to almonds the next season (Year 1) it will produce the first crop in Year 3 (3rd leaf). It would generate positive net cash flow in Year 6. Delaying replanting by 1 year means the block produces its first crop in Year 4 and generates positive net cash flow in Year 7. Similar logic applies to delaying replanting by 2 or 3 years. For delayed replanting, a winter wheat mix crop is planted, however not harvested. Although there is no harvesting or revenue generated from the sale of this cover crop, there is benefit in the form of reduced cost for soil amendment at $15 per acre in the first two years of orchard planting.


Extended Orchard Replacement (EOR) Case Study

Winter Cover Crop - Winter Mix

FINANCIAL ANALYSIS

- **Costs.** The almond orchard is removed in Year 0 at a cost of approximately $2,800 per acre for tree removal, grinding trees, composting, ripping for root removal, disc, and roll. Replanting costs include trees, spraying, and field establishment. These costs are incurred in Year 1 if the block is immediately replanted, and are incurred in Years 2, 3, or 4 if replanting is delayed. For delayed replanting, the winter mix cover crop is planted at cost of $156 per acre, excluding overhead.

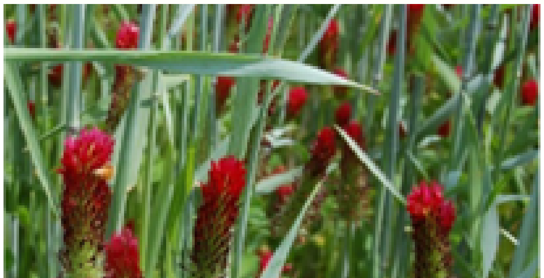
- **Other considerations.** Delaying replanting may provide additional soil and pest management benefits. Depending on the duration of the replanting period some growers may be able to avoid fumigation for nematode management. Other soil and crop productivity benefits may provide cost savings through reduced amendments or increased productivity.

- **Water savings**. Almond orchards average evapotranspiration (ET) of 3.03 acre-feet per acre over a 25-year orchard. The cover crop ET is assumed to be 1.15 acre-feet per acre. ET savings are 1.88, 3.76, and 5.64 acre-feet per acre in the 1-year, 2-year, and 3-year replanting delay scenarios. The corresponding cost of water savings are $423, $415, and $408 per acre-foot of water saved, respectively.

The analysis illustrates representative costs, yields, and returns. Actual costs and returns will vary by farming operation. A grower, or a grower that is also a handler, will have different access to cash and borrowing that may affect operations and outcomes. Almond prices fluctuate based on market conditions and would affect the values in this analysis. The analysis applies to representative almond yields and a price of $2.25/lb. for almonds.[1]

An enterprise farm budget was developed for this scenario that includes all costs and revenues: removal and replanting, cash costs, capital costs, overhead, and crop revenue from the orchard. Table 1 summarizes the expenses (excluding all overhead) that would be incurred under each option. By delaying replanting the grower defers the outlay for stand establishment and instead incurs lower costs to plant the winter mix cover crop. Delaying replanting delays the initial bearing years and break-even net cash flow.

[1]Additional analysis, discussion, and sensitivity scenarios are available in the full Vina Subbasin Extend Orchard Replacement Program Report.


Extended Orchard Replacement (EOR) Case Study

Winter Cover Crop - Winter Mix

FINANCIAL ANALYSIS

Table 1. Summary of Selected Almond Orchard Replanting Costs for the Winter Mix Cover Crop Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Year 0	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)
Year 1	Replant ($6,300)	Wheat ($156)	Wheat ($156)	Wheat ($156)
Year 2	1st leaf	Replant ($6,300)	Wheat ($156)	Wheat ($156)
Year 3	2nd leaf	1st leaf	Replant ($6,300)	Wheat ($156)
Year 4	3rd leaf	2nd leaf	1st leaf	Replant ($6,300)
Orchard Cash Flow Break Even	Year 6	Year 7	Year 8	Year 9

The financial analysis shows the additional cost to delay replanting. The timing of income (revenues) and costs to the grower changes. A financial analysis was developed to calculate the break-even payment that would be required to make the grower indifferent between immediately replanting, or delaying replanting by a period of 1, 2, or 3 years. A program offering incentive payments for delayed replanting would offer a payment equal to or greater than this amount.

Almond Incentive Payment (per acre)
Winter Mix Cover Crop

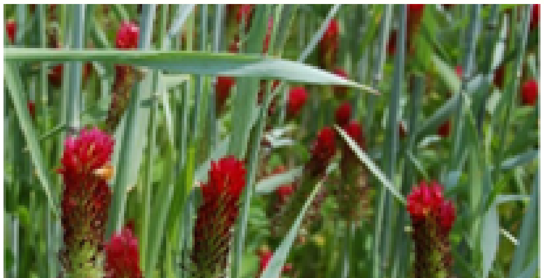
1-year	$790
2-year	$1,551
3-year	$2,282

Incentive Payment Sensitivity (per acre)
Winter Mix Cover Crop

Low Almond Incentive Payment
$327/ac

High Almond Incentive Payment
$1,056/ac

The results presented are sensitive to key cost and market factors applied in this analysis, particularly commodity price and net returns from alternative uses/crops during the replanting period. To better understand how these factors affect the incentives across different scenarios, a sensitivity analysis incorporates alternative prices, replanting costs, and yield into the payment calculations. These are presented as a range of low and high for one-year payments.


Extended Orchard Replacement (EOR) Case Study

Winter Cover Crop - Winter Mix

FINANCIAL ANALYSIS

The winter mix crop may provide soil benefits, which would potentially boost orchard yield. Anecdotal reports from growers report more vigorous orchard growth and better production when delaying replanting. An additional financial analysis was developed to calculate the break-even yield/production increase for the grower where the greater yields for the future orchard offset the initial cost of delaying replanting. Figure 1 summarizes the results from this analysis.

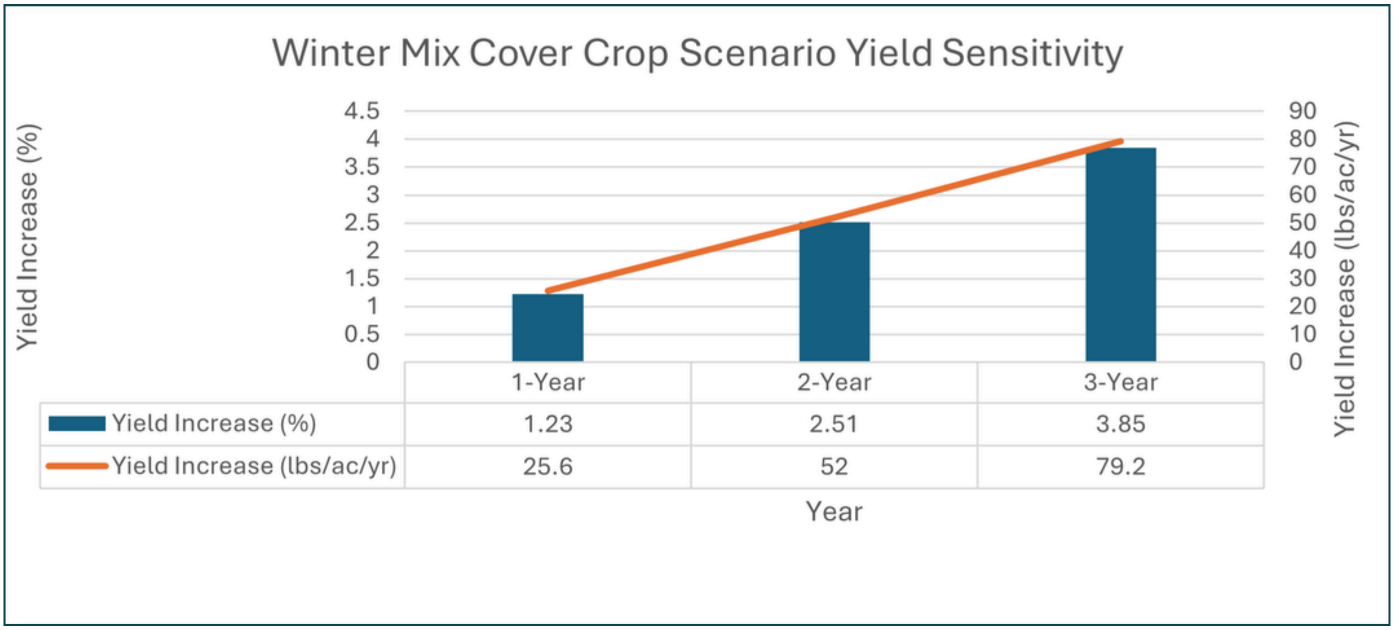
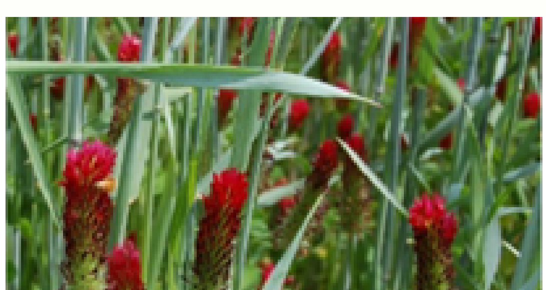


Figure 2. Yield Impact Sensitivity Analysis for the Winter Mix Cover Crop Scenario



Extended Orchard Replacement (EOR) Case Study

Winter Cover Crop - Winter Mix

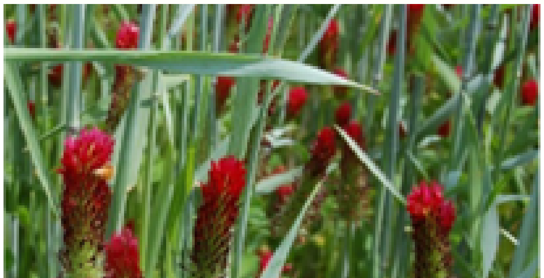
FINANCIAL ANALYSIS

For the winter mix, yield for a one-year delay would need to be 1.23% higher throughout the 25-year life of the orchard to offset the upfront expense of delayed replanting. This corresponds to a 25.6 lbs per acre yield increase. This required yield increase rises with the number of years delayed due to the higher overhead expenses and orchard production delay.

Table 2 presents a financial summary including revenue, cost, and yield impacts. Assuming yield is unchanged, there is a cost to delay replanting, and additional fallow year costs, which are captured by the declining value measure. The financial model then calculates the Breakeven Yield Factor, which is the yield increase necessary for value to be equal between the No delay scenario, and the corresponding number of years of delay.

Table 2. Breakeven Analysis for the Winter Cover Crop Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Value at Yield Factor = 1.00	$4,864	$4,073	$3,313	$2,582
Annual Costs				
Cover crop planting cost	$0	$156	$156	$156
Basic fallow year costs	$0	$364	$364	$364
Cover crop revenue	$0	$0	$0	$0
Cover crop benefit	$0	$30	$30	$30
Net Revenue	$0	($490)	($1,010)	($1,530)
One-Time Costs				
Removal	$2,800	$2,800	$2,800	$2,800
Replant	$6,300	$6,300	$6,300	$6,300
Breakeven Yield Factor	1	1.01234	1.02518	1.03853


ATTACHMENT E

Case Study – Winter Grain Crop

Extended Orchard Replacement (EOR) Case Study

Winter Grain Crop

DEFINITION

Winter wheat is planted as a fall cover crop in October/November. The grower harvests the crop at maturity for grain in July the following year. This approach offers winter soil benefits from decomposing roots and field residue. In addition, the grain crop produces modest revenue.

WATER USE

Winter grain crops consumed 11.9 inches of water during their growing season in 2025. For months when the land was idle, another 1.9 inches of water was consumed, for a total of 13.8 inches of consumed water for this land use January to October 2025.

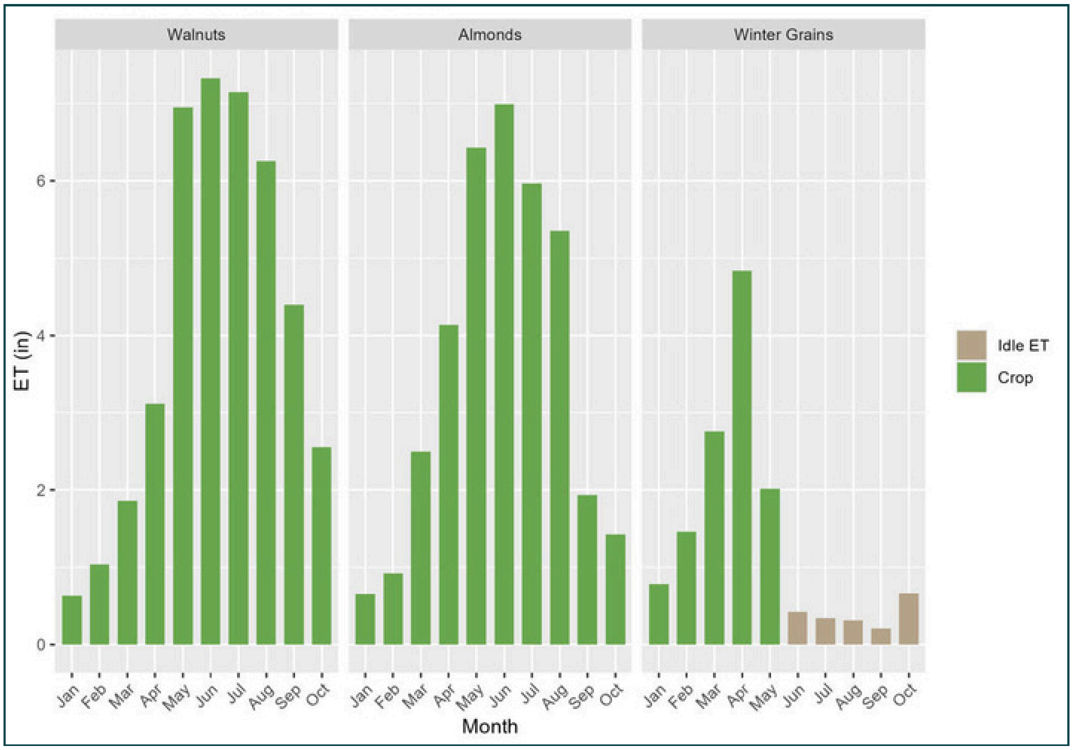


Figure 1. Mean ET by Crop January - October

Extended Orchard Replacement (EOR) Case Study

Winter Grain Crop

CONSIDERATIONS

Potential benefits from cover crops include:

- Improved:
  - Pollinator forage
  - Beneficial insects and other organisms
  - Water infiltration
  - Orchard access during rainy periods
  - Salt management (including sodium)
  - Soil nitrogen
  - Carbon and organic matter content
  - Weed management (especially brassicas)
- Reduced:
  - Compaction and cracking
  - Soil erosion
  - Nitrogen losses
  - Pest nematodes

In orchards where whole orchard recycling has been used, cover crops may help regulate soil moisture and prevent nitrogen getting tied up in orchard residue.

Challenges with cover crops include increased gopher populations (particularly in clover-heavy mixes) and the potential for cover crops to act as pest vectors for susceptible adjacent plantings.

Different cover crops can be used to accomplish different goals, and no single cover crop can achieve all of them. Some cover crops might be better for nematode inhibition while others might be better suited for improving water infiltration. Importantly, fall-planted cover crops use winter rains as their main source of water, and once those rains stop in the spring, cover crops can compete with orchard crops for stored soil moisture and applied water if they are not terminated in a timely manner.

Extended Orchard Replacement (EOR) Case Study

Winter Grain Crop

FINANCIAL ANALYSIS

The financial analysis considers an almond orchard that is removed and the land is left idle for a period of 1, 2, or 3 years prior to replanting to almonds. During the idle period, under this scenario, winter wheat for grain is planted as a fall cover crop. This creates water savings, provides a harvestable crop, and provides some soil and other agronomic benefits. An analysis was developed to compare the net income (revenue minus costs) to the grower when immediately replanting versus delaying replanting by 1, 2, or 3 years.

- **Revenues**. The almond orchard is removed in Year 0. If it is immediately replanted to almonds the next season (Year 1) it will produce the first crop in Year 3 (3rd leaf). It would generate positive net cash flow in Year 6. Delaying replanting by 1 year means the block produces its first crop in Year 4 and generates positive net cash flow in Year 7. Similar logic applies to delaying replanting by 2 or 3 years. For delayed planting, a winter wheat crop is planted and harvested for grain generating around $570 per acre in revenue.

- **Costs.** The almond orchard is removed in Year 0 at a cost of approximately $2,800 per acre for tree removal, grinding trees, composting, ripping for root removal, disc, and roll. Replanting costs include trees, spraying, and field establishment. These costs are incurred in Year 1 if the block is immediately replanted, and are incurred in Years 2, 3, or 4 if replanting is delayed. For delayed replanting, winter wheat is planted at cost of $460 per acre, excluding overhead.

- **Other considerations.** Delaying replanting may provide additional soil and pest management benefits. Depending on the duration of the replanting period some growers may be able to avoid fumigation for nematode management. Other soil and crop productivity benefits may provide cost savings through reduced amendments or increased productivity.

- **Water savings.** Almond orchards average evapotranspiration (ET) of 3.03 acre-feet per acre over a 25-year orchard. The cover crop ET is assumed to be 1.15 acre-feet per acre. ET savings are 1.88, 3.76, and 5.64 acre-feet per acre in the 1-year, 2-year, and 3-year replanting delay scenarios. The corresponding cost of water savings are $341, $335, and $328 per acre-foot of water saved, respectively.

The analysis illustrates representative costs, yields, and returns. Actual costs and returns will vary by farming operation. A grower, or a grower that is also a handler, will have different access to cash and borrowing that may affect operations and outcomes. Almond prices fluctuate based on market conditions and would affect the values in this analysis. The analysis applies to representative almond yields and a price of $2.25/lb. for almonds.[1]

[1] Additional analysis, discussion, and sensitivity scenarios are available in the full Vina Subbasin Extend Orchard Replacement Program Report.

Extended Orchard Replacement (EOR) Case Study

Winter Grain Crop

FINANCIAL ANALYSIS

An enterprise farm budget was developed for this scenario that includes all costs and revenues: removal and replanting, cash costs, capital costs, overhead, and crop revenue from the orchard or winter wheat-grain. Table 1 summarizes the expenses (excluding all overhead) that would be incurred under each option. By delaying replanting the grower defers the outlay for stand establishment and instead incurs lower costs to plant the winter wheat-grain cover crop. The grain harvest offsets some of these costs. Delaying replanting delays the initial bearing years and break-even net cash flow.

Table 1. Summary of Selected Almond Orchard Replanting Costs for the Winter Wheat-Grain Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Year 0	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)
Year 1	Replant ($6,300)	Wheat ($460)	Wheat ($460)	Wheat ($460)
Year 2	1st leaf	Replant ($6,300)	Wheat ($460)	Wheat ($460)
Year 3	2nd leaf	1st leaf	Replant ($6,300)	Wheat ($460)
Year 4	3rd leaf	2nd leaf	1st leaf	Replant ($6,300)
Orchard Cash Flow Break Even	Year 6	Year 7	Year 8	Year 9

The financial analysis shows the cost implications of delayed replanting; the timing of income (revenues) and costs to the grower changes based on the delay interval. A financial model was developed to calculate the break-even payment that would be required to make the grower indifferent between immediately replanting, or delaying replanting by a period of 1, 2, or 3 years. A program offering incentive payments for delayed replanting would offer a payment equal to or greater than this amount.

Almond Incentive Payment (per acre)
Winter Grain Crop

1-year	$531
2-year	$1,042
3-year	$1,533

Extended Orchard Replacement (EOR) Case Study

Winter Grain Crop

FINANCIAL ANALYSIS

Incentive Payment Sensitivity (per acre)
Winter Grain Crop

Low Almond Incentive Payment

$258/ac

High Almond Incentive Payment

$987/ac

The results presented are sensitive to key cost and market factors applied in this analysis, particularly commodity price and net returns from alternative uses/crops during the replanting period. To better understand how these factors affect the incentives across different scenarios, a sensitivity analysis incorporates alternative prices, replanting costs, and yield into the payment calculations. These are presented as a range of low and high for one-year payments.

The winter wheat-grain cover crop may provide soil benefits, which would potentially boost orchard yield. Anecdotal reports from growers report more vigorous orchard growth and better production when delaying replanting. An additional financial analysis was developed to calculate the break-even yield/production increase for the grower where the greater yields for the future orchard offset the initial cost of delaying replanting.

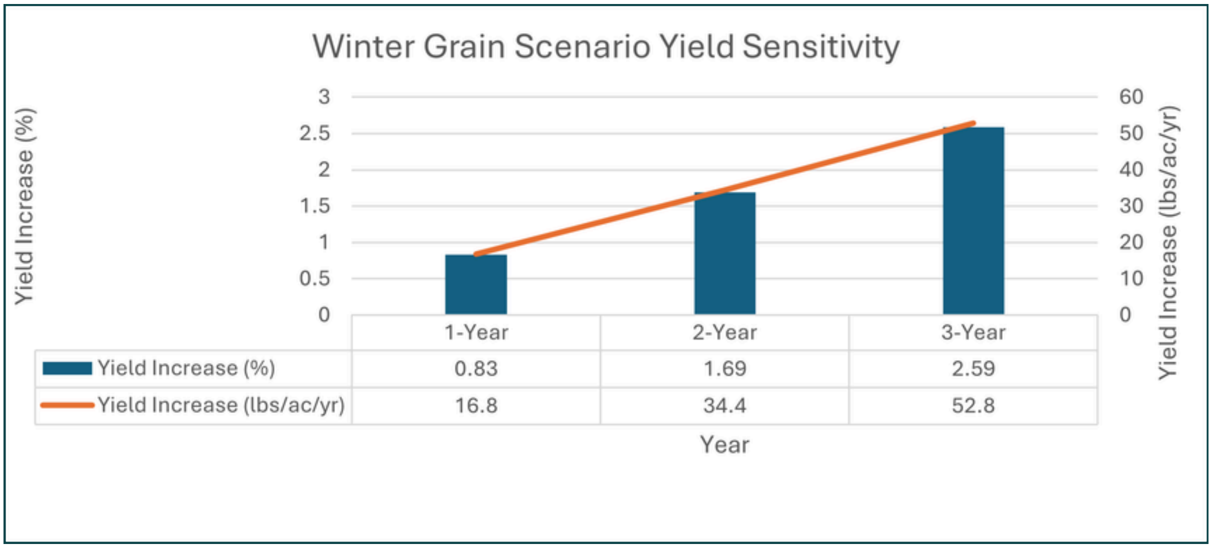


Figure 2. Yield Impact Sensitivity Analysis for the Winter Wheat-Grain Scenario

For the winter wheat-grain scenario, yield for a one-year delay would need to be 0.83% higher throughout the 25-year life of the orchard to offset the upfront expense of delayed replanting. This corresponds to a 16.8 lbs per acre yield increase. This yield increase rises with the number of years delayed due to the higher overhead expenses and orchard production delay.

FINANCIAL ANALYSIS

Table 2 presents a financial summary including revenue, cost, and yield impacts. Assuming yield is unchanged, there is a cost to delay replanting, and additional fallow year costs, which are captured by the declining value measure. The financial model then calculates the Breakeven Yield Factor, which is the yield increase necessary for value to be equal between the No delay scenario, and the corresponding number of years of delay.

Table 2. Breakeven Analysis for the Winter Wheat-Grain Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Value at Yield Factor = 1.00	$4,818	$4,287	$3,776	$3,285
Annual Costs				
Cover crop planting cost	$0	$460	$460	$460
Basic fallow year costs	$0	$364	$364	$364
Cover crop revenue	$0	$572	$572	$572
Net Revenue	$0	($252)	($504)	($756)
One-Time Costs				
Removal	$2,800	$2,800	$2,800	$2,800
Replant	$6,300	$6,300	$6,300	$6,300
Breakeven Yield Factor	1	1.00829	1.01691	1.02588

ATTACHMENT F

Case Study – Spring Sudan Grass Crop

Extended Orchard Replacement (EOR) Case Study

Spring/Summer Sudan/Sorghum Cover Crop

DEFINITION

Here an EOR grassy cover crop (a sorghum-Sudangrass hybrid) is planted in the spring and terminated through mowing and discing at the end of the growing season.

WATER USE

Spring sudan grasses consumed 14.2 inches of water during their growing season in 2025. For months when the land was idle, another 2.9 inches of water was consumed, for a total of 17.1 inches of consumed water for this land use January to October 2025.

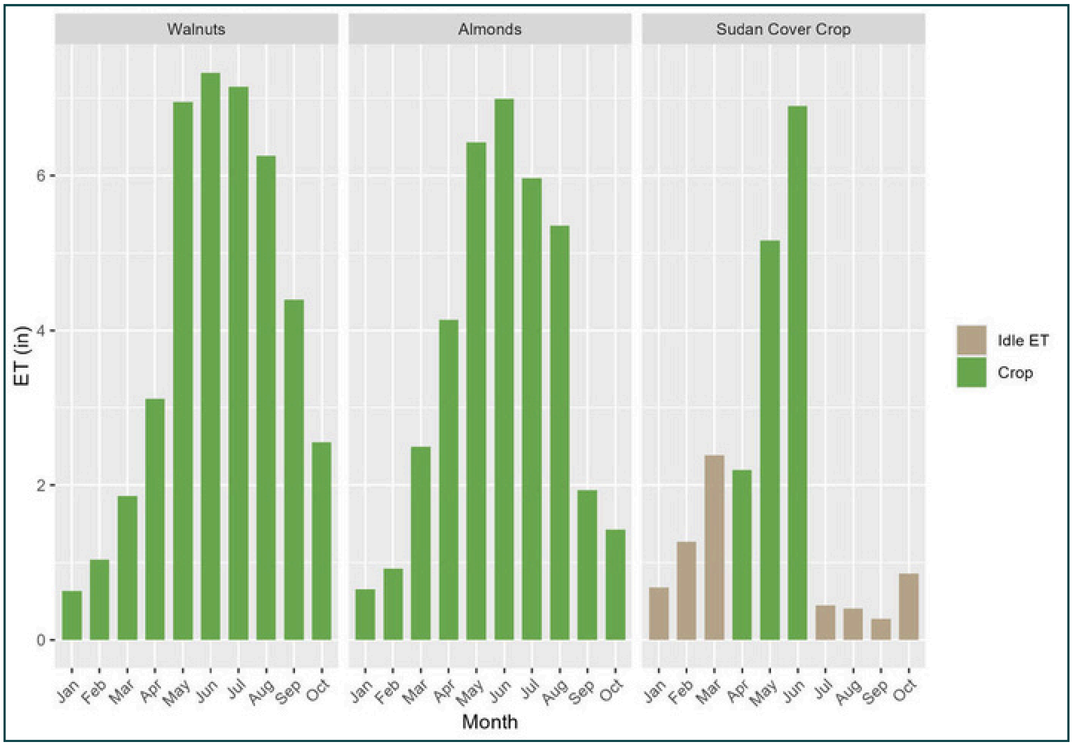


Figure 1. Mean ET by Crop Type January - October

Extended Orchard Replacement (EOR) Case Study

Spring/Summer Sudan/Sorghum Cover Crop

CONSIDERATIONS

Potential benefits from sudan grass include:

- Fast growing producing high biomass in 2-3 months
- Suppresses weeds
- Improves soil structure and water infiltration
- Organic matter addition, increasing carbon and soil fertility (high C:N ratio, so decomposes slowly)
- Nematode reduction, but can also harbor nematodes
- Can be harvested as forage (makes high quality forage or silage) with multiple cuttings or worked in to use as green manure; harvested with grain harvesting equipment, or flail chopped
- Some varieties harbor beneficial insects such as lady beetles, and lacewings
- Scavenges water from deep soil layers
- May be used in mixes
- Tolerates very high pH (8.0 to 9.0) and salinity
- Can grow with very little precipitation

FINANCIAL ANALYSIS

The financial analysis considers an almond orchard that is removed and the land is idled for a period of 1, 2, or 3 years prior to replanting to almonds. During the idle period, under this scenario, a grassy cover crop, such as sudan grass, is planted in the spring and removed at the end of the growing season. This creates water savings and provides some soil and other agronomic benefits.

An analysis was developed to compare the net income (revenue minus costs) to the grower when immediately replanting versus delaying replanting by 1, 2, or 3 years.

- **Revenues.** The almond orchard is removed in Year 0. If it is immediately replanted to almonds the next season (Year 1) it will produce the first crop in year 3 (3rd leaf). It would generate positive net cash flow in Year 6. Delaying replanting by 1 year means the block produces its first crop in Year 4 and generates positive net cash flow in Year 7. Similar logic applies to delaying replanting by 2 or 3 years. For delayed replanting, a spring sudan grass cover crop is planted, however not harvested. Although there is no revenue generated from the sale of this cover crop, there is benefit in the form of reduced cost for soil amendment at $15 per acre in the first two years of orchard planting.

- **Costs**. The almond orchard is removed in Year 0 at a cost of approximately $2,800 per acre for tree removal, grinding trees, composting, ripping for root removal, disc, and roll. Replanting costs include trees, spraying, and field establishment. These costs are incurred in Year 1 if the block is immediately replanted, and are incurred in Years 2, 3, or 4 if replanting is delayed. For delayed replanting, spring sudan grass is planted at cost of $122 per acre, excluding overhead.

Extended Orchard Replacement (EOR) Case Study

Spring/Summer Sudan/Sorghum Cover Crop

FINANCIAL ANALYSIS

- **Other considerations.** Delaying replanting may provide additional soil and pest management benefits. Depending on the duration of the replanting period some growers may be able to avoid fumigation for nematode management. Other soil and crop productivity benefits may provide cost savings through reduced amendments or increased productivity.

- **Water savings.** Almond orchards average evapotranspiration (ET) of 3.03 acre-feet per acre over a 25-year orchard. The cover crop ET is assumed to be 1.43 acre-feet per acre. ET savings are 1.60, 3.20, and 4.80 acre-feet per acre in the 1-year, 2-year, and 3-year replanting delay scenarios. The corresponding cost of water savings are $487, $478, and $469 per acre-foot of water saved, respectively.

The analysis illustrates representative costs, yields, and returns. Actual costs and returns will vary by farming operation. A grower, or a grower that is also a handler, will have different access to cash and borrowing that may affect operations and outcomes. Almond prices fluctuate based on market conditions and would affect the values in this analysis. The analysis applies to representative almond yields and a price of $2.25/lb. for almonds.[1]

An enterprise farm budget was developed for this scenario that includes all costs and revenues: removal and replanting, cash costs, capital costs, overhead, and crop revenue from the orchard. Table 1 summarizes the expenses (excluding all overhead) that would be incurred under each option. By delaying replanting the grower defers the outlay for stand establishment and instead incurs lower costs to plant the spring sudan grass cover crop. Delaying replanting delays the initial bearing years and break-even net cash flow.

Table 1. Summary of Selected Almond Orchard Replanting Costs for the Spring Sudan Grass Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Year 0	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)
Year 1	Replant ($6,300)	Spring Grass ($122)	Spring Grass ($122)	Spring Grass ($122)
Year 2	1st leaf	Replant ($6,300)	Spring Grass ($122)	Spring Grass ($122)
Year 3	2nd leaf	1st leaf	Replant ($6,300)	Spring Grass ($122)
Year 4	3rd leaf	2nd leaf	1st leaf	Replant ($6,300)
Orchard Cash Flow Break Even	Year 6	Year 7	Year 8	Year 9

[1] Additional analysis, discussion, and sensitivity scenarios are available in the full Vina Subbasin Extend Orchard Replacement Program Report.

Extended Orchard Replacement (EOR) Case Study

Spring/Summer Sudan/Sorghum Cover Crop

FINANCIAL ANALYSIS

The financial analysis shows the additional cost to delay replanting. The timing of income (revenues) and costs to the grower changes. A financial analysis was developed to calculate the break-even payment that would be required to make the grower indifferent between immediately replanting, or delaying replanting by a period of 1, 2, or 3 years. A program offering incentive payments for delayed replanting would offer a payment equal to or greater than this amount.

Almond Incentive Payment (per acre)
Spring Sudan Grass

1-year	$758
2-year	$1,487
3-year	$2,187

Incentive Payment Sensitivity (per acre)
Spring Sudan Grass

Low Almond Incentive Payment

$485/ac

High Almond Incentive Payment

$1,214/ac

The results presented are sensitive to key cost and market factors applied in this analysis, particularly commodity price and net returns from alternative uses/crops during the replanting period. To better understand how these factors affect the incentives across different scenarios, a sensitivity analysis incorporates alternative prices, replanting costs, and yield into the payment calculations. These are presented as a range of low and high for one-year payments.

The cover crop may provide soil benefits, which would potentially boost orchard yield. Anecdotal reports from growers report more vigorous orchard growth and better production when delaying replanting. An additional financial analysis was developed to calculate the break-even yield/production increase for the grower where the greater yields for the future orchard offset the initial cost of delaying replanting. Figure 1 summarizes the results from this analysis.

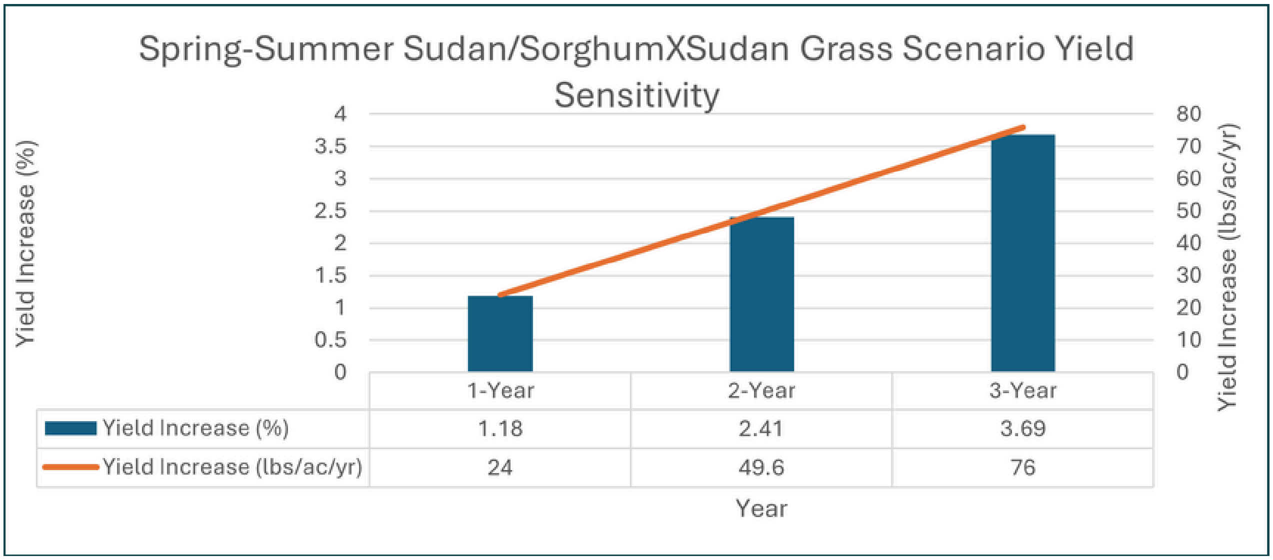


Figure 2. Yield Impact Sensitivity Analysis for the Spring Sudan Grass Scenario

Extended Orchard Replacement (EOR) Case Study

Spring/Summer Sudan/Sorghum Cover Crop

FINANCIAL ANALYSIS

For the spring sudan grass, yield for a one-year delay would need to be 1.18% higher throughout the 25-year life of the orchard to offset the upfront expense of delayed replanting. This corresponds to a 24 lbs per acre yield increase. This yield increase rises with the number of years delayed due to the higher overhead expenses and orchard production delay.

Table 2 presents a financial summary including revenue, cost, and yield impacts. Assuming yield is unchanged, there is a cost to delay replanting, and additional fallow year costs, which are captured by the declining value measure. The financial model then calculates the Breakeven Yield Factor, which is the yield increase necessary for value to be equal between the No delay scenario, and the corresponding number of years of delay.

Table 2. Breakeven Analysis for the Spring Sudan Grass Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Value at Yield Factor = 1.00	$4,818	$4,287	$3,776	$3,285
Annual Costs				
Cover crop planting cost	$0	$122	$122	$122
Basic fallow year costs	$0	$364	$364	$364
Cover crop revenue	$0	$0	$0	$0
Cover crop benefit	$0	$30	$30	$30
Net Revenue	$0	($456)	($942)	($1,428)
One-Time Costs				
Removal	$2,800	$2,800	$2,800	$2,800
Replant	$6,300	$6,300	$6,300	$6,300
Breakeven Yield Factor	1	1.01183	1.02413	1.03693

ATTACHMENT G

Case Study – Processing Tomatoes

Extended Orchard Replacement (EOR) Case Study

Processing Tomatoes

DEFINITION

Here an EOR summer cash crop of processing tomatoes includes the following assumptions:

- Spring or early summer planting
- Multiple-year lease with tenant grower
- Subsurface or surface drip irrigation

WATER USE

Processing tomato crops consumed 21.8 inches of water during their growing season in 2025. For months when the land was idle, another 8.6 inches of water was consumed, for a total of 30.4 inches of consumed water for this land use January to October 2025.

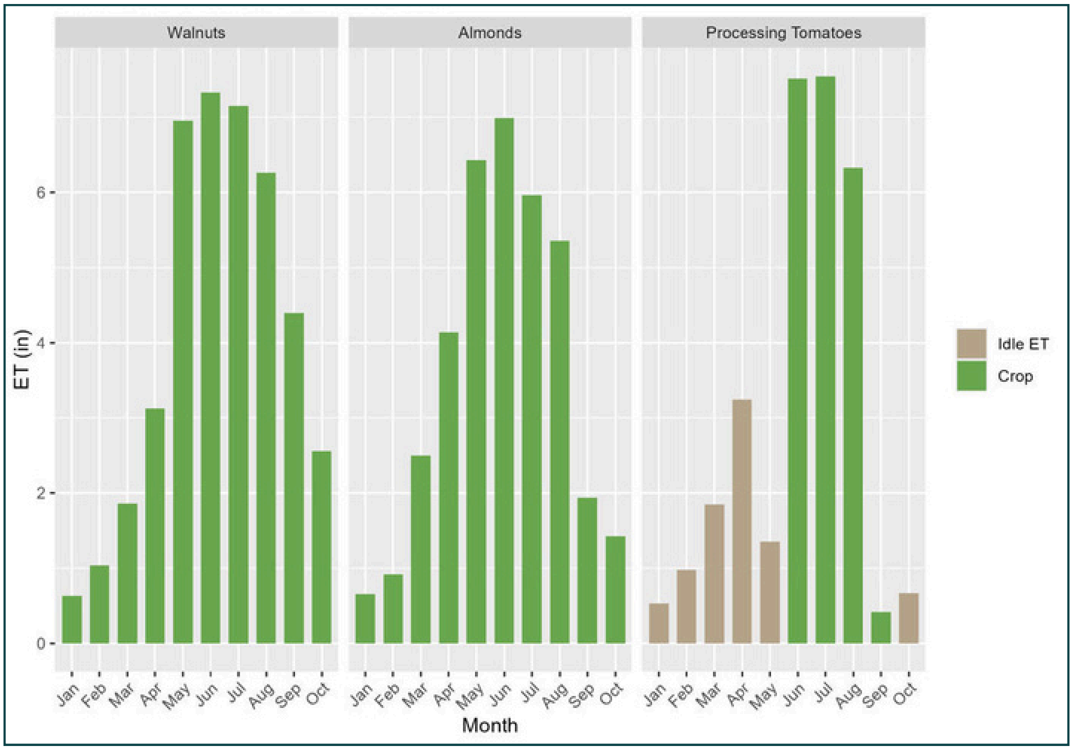


Figure 1. Mean ET by Crop Type January - October

Extended Orchard Replacement (EOR) Case Study

Processing Tomatoes

CONSIDERATIONS

- Must find somebody to lease
- Lease term
- Legacy effects of fertilizer or pesticides

FINANCIAL ANALYSIS

The financial analysis considers an almond orchard that is removed and the land is idled for a period of 1, 2, or 3 years prior to replanting to almonds. During the idle period, under this scenario, a contract is entered into with a tenant to plant processing tomatoes as a cash crop, planted in spring and harvested in late summer or fall (depending on timing of planting). A crop rent contract is applied with the landowner receiving a percentage of gross revenues and is responsible for overhead costs and water supply. This creates water savings and provides a harvestable crop.

An analysis was developed to compare the net income (revenue minus costs) to the grower when immediately replanting versus delaying replanting by 1, 2, or 3 years.

- **Revenues.** The almond orchard is removed in Year 0. If it is immediately replanted to almonds the next season (Year 1) it will produce the first crop in Year 3 (3rd leaf). It would generate positive net cash flow in Year 6. Delaying replanting by 1 year means the block produces its first crop in Year 4 and generates positive net cash flow in Year 7. Similar logic applies to delaying replanting by 2 or 3 years. For delayed planting, a tomato crop is planted and harvested generating $826 per acre in revenue.

- **Costs.** The almond orchard is removed in Year 0 at a cost of approximately $2,800 per acre for tree removal, grinding trees, composting, ripping for root removal, disc, and roll. Replanting costs include trees, spraying, and field establishment. These costs are incurred in Year 1 if the block is immediately replanted, and are incurred in Years 2, 3, or 4 if replanting is delayed. For delayed replanting, the tomato crop is planted at cost of $273 per acre, excluding overhead.

- **Other considerations.** Delaying replanting may provide additional soil and pest management benefits. Other soil and crop productivity benefits may provide cost savings through reduced amendments or increased productivity.

- **Water savings.** Almond orchards average evapotranspiration (ET) of 3.03 acre-feet per acre over a 25-year orchard. The processing tomato ET is assumed to be 2.53 acre-feet per acre. ET savings are 0.50, 1.0, and 1.50 acre-feet per acre in the 1-year, 2-year, and 3-year replanting delay scenarios. The corresponding cost of water savings are $299, $294, and $288 per acre-foot of water saved, respectively.

Extended Orchard Replacement (EOR) Case Study

Processing Tomatoes

FINANCIAL ANALYSIS

The analysis illustrates representative costs, yields, and returns. Actual costs and returns will vary by farming operation. A grower, or a grower that is also a handler, will have different access to cash and borrowing that may affect operations and outcomes. Almond prices fluctuate based on market conditions and would affect the values in this analysis. The analysis applies to representative almond yields and a price of $2.25/lb. for almonds.[1]

An enterprise farm budget was developed for this scenario that includes all costs and revenues: removal and replanting, cash costs, capital costs, overhead, and crop revenue from the orchard or processing tomatoes. Table 1 summarizes the costs (excluding all overhead) for expenses that would be incurred under each option. By delaying replanting the grower defers the outlay for stand establishment and instead incurs lower costs to plant the tomato crop. The tomato harvest offset some of these costs. Delaying replanting delays the initial bearing years and break-even net cash flow.

Table 1. Summary of Selected Almond Orchard Replanting Costs for the Processing Tomatoes Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Year 0	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)
Year 1	Replant ($6,300)	Tomato ($273)	Tomato ($273)	Tomato ($273)
Year 2	1st leaf	Replant ($6,300)	Tomato ($273)	Tomato ($273)
Year 3	2nd leaf	1st leaf	Replant ($6,300)	Tomato ($273)
Year 4	3rd leaf	2nd leaf	1st leaf	Replant ($6,300)
Orchard Cash Flow Break Even	Year 6	Year 7	Year 8	Year 9

The financial analysis shows the additional cost to delay replanting. The timing of income (revenues) and costs to the grower changes. A financial analysis was developed to calculate the break-even payment that would be required to make the grower indifferent between immediately replanting, or delaying replanting by a period of 1, 2, or 3 years. A program offering incentive payments for delayed replanting would offer a payment equal to or greater than this amount.

Almond Incentive Payment (per acre)
Processing Tomatoes

1-year	$107
2-year	$210
3-year	$309

[1]Additional analysis, discussion, and sensitivity scenarios are available in the full Vina Subbasin Extend Orchard Replacement Program Report.

Extended Orchard Replacement (EOR) Case Study

Processing Tomatoes

FINANCIAL ANALYSIS

Incentive Payment Sensitivity (per acre)
Processing Tomatoes

Low Almond Incentive Payment

($166)/ac

High Almond Incentive Payment

$563/ac

The results presented are sensitive to key cost and market factors applied in this analysis, particularly commodity price and net returns from alternative uses/crops during the replanting period. To better understand how these factors affect the incentives across different scenarios, a sensitivity analysis incorporates alternative prices, replanting costs, and yield into the payment calculations. These are presented as a range of low and high for one-year payments.

The payment range for tomatoes is an excellent illustration of the impact of these factors. When relatively low almond prices are applied, the analysis indicates that farming processing tomatoes during the idle year can be more profitable than delaying replanting without production, thereby substantially reducing (eliminating) the required incentive payment. On the other hand, high almond prices substantially increase the minimum incentive required to encourage a grower to switch to tomatoes for a fallow year instead of immediately replanting.

Delayed replanting may provide soil benefits, which would potentially boost orchard yield. Anecdotal reports from growers report more vigorous orchard growth and better production when delaying replanting. An additional financial analysis was developed to calculate the break-even yield/production increase for the grower where the greater yields for the future orchard offset the initial cost of delaying replanting. Figure 1 summarizes the results from this analysis.

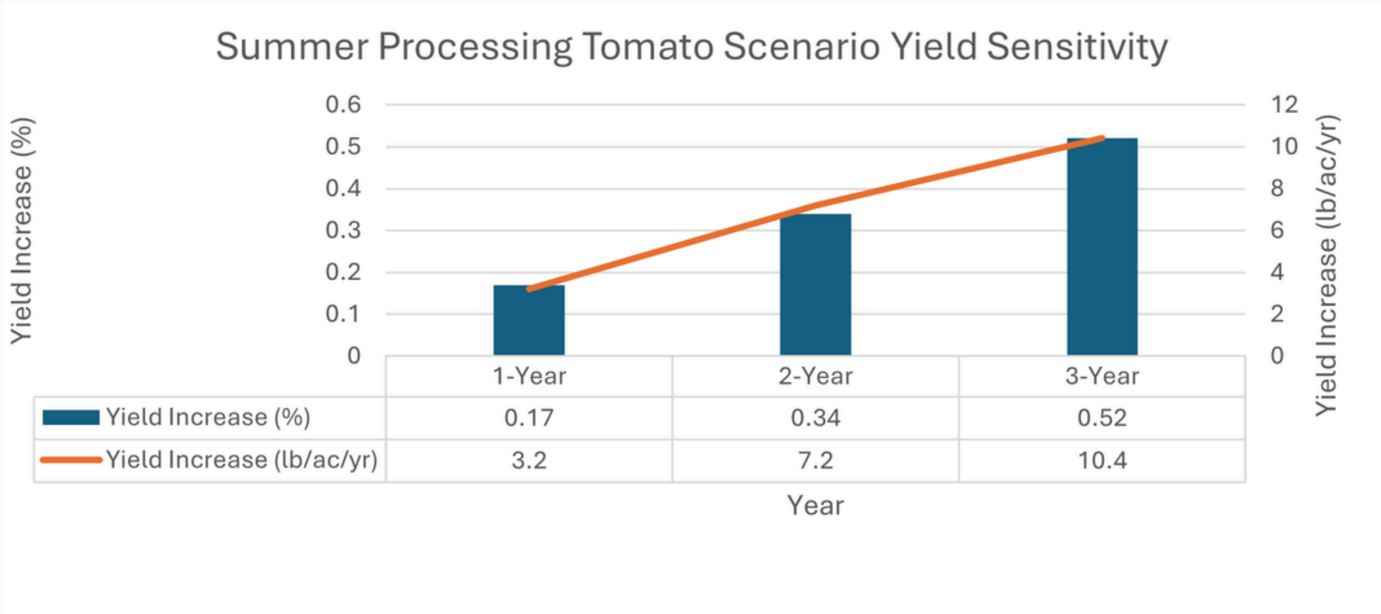


Figure 2. Yield Impact Sensitivity Analysis for the Processing Tomatoes Scenario

Extended Orchard Replacement (EOR) Case Study

Processing Tomatoes

Vina GSA

FINANCIAL ANALYSIS

For the summer processing tomato scenario, yield for a one-year delay would need to be 0.17% higher throughout the 25-year life of the orchard to offset the upfront expense of delayed replanting. This corresponds to a 3.2 lbs per acre yield increase. This yield increase rises with the number of years delayed due to the higher overhead expenses and orchard production delay.

Table 2 presents a financial summary including revenue, cost, and yield impacts. Assuming yield is unchanged, there is a cost to delay replanting, and additional fallow year costs, which are captured by the declining value measure. The financial model then calculates the Breakeven Yield Factor, which is the yield increase necessary for value to be equal between the No delay scenario, and the corresponding number of years of delay.

Table 2. Breakeven Analysis for the Processing Tomatoes Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Value at Yield Factor = 1.00	$4,864	$4,073	$3,313	$2,582
Annual Costs				
Cover crop planting cost	$0	$273	$273	$273
Basic fallow year costs	$0	$364	$364	$364
Cover crop revenue	$0	$826	$826	$826
Net Revenue	$0	$189	$378	$567
One-Time Costs				
Removal	$2,800	$2,800	$2,800	$2,800
Replant	$6,300	$6,300	$6,300	$6,300
Breakeven Yield Factor	1	1.01234	1.02517	1.03582

ATTACHMENT H

Case Study – Dry Beans

Extended Orchard Replacement (EOR) Case Study

Dry Beans

DEFINITION

Here an EOR summer cash crop of dry beans includes the following assumptions:

- Dry beans such as pinto, lima, kidney, canary
- Beans grown under crop rent contract
- Planted from May to early June
- Furrow irrigated

WATER USE

Summer dry bean crops consumed 16.3 inches of water during their growing season in 2025. For months when the land was idle, another 8.6 inches of water was consumed, for a total of 24.9 inches of consumed water for this land use January to October 2025.

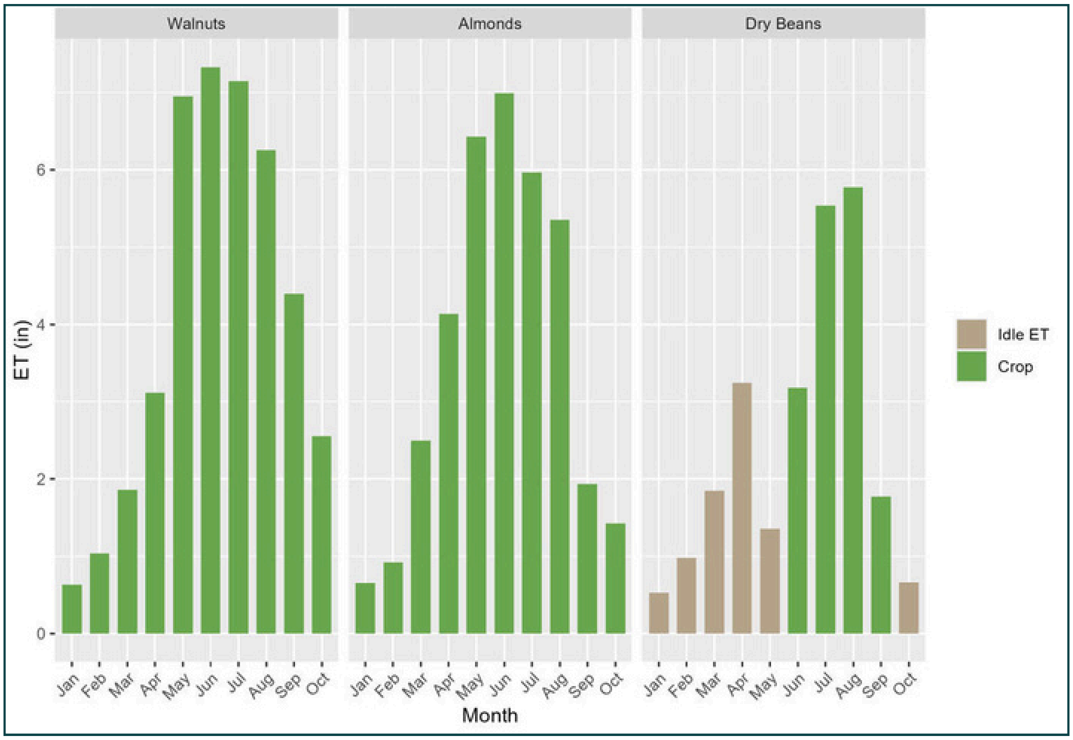


Figure 1. Mean ET by Crop Type January - October

Extended Orchard Replacement (EOR) Case Study

Dry Beans

CONSIDERATIONS

- Have to find somebody to lease
- Fix atmospheric nitrogen and may reduce nitrogen fertilizer application rates
- Break disease cycle associated with monocultures

FINANCIAL ANALYSIS

The financial analysis considers an almond orchard that is removed and the land is idled for a period of 1, 2, or 3 years prior to replanting to almonds. During the idle period, under this scenario, a contract is entered into with a tenant to plant dry beans (pinto, kidney, lima, etc.) in the spring and harvest the crop in the fall. A crop rent contract is applied, with the landowner receiving a percentage of gross revenues and responsible for overhead costs and water supply. This creates water savings, provides a harvestable crop, and provides some soil and other agronomic benefits.

An analysis was developed to compare the net income (revenue minus costs) to the grower when immediately replanting versus delaying replanting by 1, 2, or 3 years.

- **Revenues.** The almond orchard is removed in Year 0. If it is immediately replanted to almonds the next season (Year 1), it will produce the first crop in Year 3 (3rd leaf). It would generate positive net cash flow in Year 6. Delaying replanting by 1 year means the block produces its first crop in Year 4 and generates positive net cash flow in Year 7. Similar logic applies to delaying replanting by 2 or 3 years. For delayed planting, a dry bean crop is planted and harvested, generating $169 per acre in revenue.
- **Costs.** The almond orchard is removed in Year 0 at a cost of approximately $2,800 per acre for tree removal, grinding trees, composting, ripping for root removal, disc, and roll. Replanting costs include trees, spraying, and field establishment. These costs are incurred in Year 1 if the block is immediately replanted, and are incurred in Years 2, 3, or 4 if replanting is delayed. For delayed replanting, the dry bean crop is planted at cost of $129 per acre, excluding overhead.
- **Other considerations.** Delaying replanting may provide additional soil and pest management benefits. Other soil and crop productivity benefits may provide cost savings through reduced amendments or increased productivity.
- **Water savings.** Almond orchards average evapotranspiration (ET) of 3.03 acre-feet per acre over a 25-year orchard. The dry beans ET is assumed to be 2.08 acre-feet per acre. ET savings are 0.95, 1.90, and 2.85 acre-feet per acre in the 1-year, 2-year, and 3-year replanting delay scenarios. The corresponding value of water savings are $734, $720, and $707 per acre-foot of water saved, respectively.

Extended Orchard Replacement (EOR) Case Study

Dry Beans

FINANCIAL ANALYSIS

The analysis illustrates representative costs, yields, and returns. Actual costs and returns will vary by farming operation. A grower, or a grower that is also a handler, will have different access to cash and borrowing that may affect operations and outcomes. Almond prices fluctuate based on market conditions and would affect the values in this analysis. The analysis applies to representative almond yields and a price of $2.25/lb. for almonds.[1]

An enterprise farm budget was developed for this scenario that includes all costs and revenues: removal and replanting, cash costs, capital costs, overhead, and crop revenue from the orchard or dry beans. Table 1 summarizes the costs (excluding all overhead) for expenses that would be incurred under each option. By delaying replanting the grower defers the outlay for stand establishment and instead incurs lower costs to plant the dry bean crop. The dry bean harvest offsets some of these costs. Delaying replanting delays the initial bearing years and break-even net cash flow.

Table 1. Summary of Selected Almond Orchard Replanting Costs for the Dry Beans Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Year 0	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)	Removal ($2,800)
Year 1	Replant ($6,300)	Dry beans ($129)	Dry beans ($129)	Dry beans ($129)
Year 2	1st leaf	Replant ($6,300)	Dry beans ($129)	Dry beans ($129)
Year 3	2nd leaf	1st leaf	Replant ($6,300)	Dry beans ($129)
Year 4	3rd leaf	2nd leaf	1st leaf	Replant ($6,300)
Orchard Cash Flow Break Even	Year 6	Year 7	Year 8	Year 9

The financial analysis shows the additional cost to delay replanting. The timing of income (revenues) and costs to the grower changes. A financial analysis was developed to calculate the break-even payment that would be required to make the grower indifferent between immediately replanting, or delaying replanting by a period of 1, 2, or 3 years. A program offering incentive payments for delayed replanting would offer a payment equal to or greater than this amount.

Almond Incentive Payment (per acre)
Dry Beans

1-year	$600
2-year	$1,178
3-year	$1,733

[1]Additional analysis, discussion, and sensitivity scenarios are available in the full Vina Subbasin Extend Orchard Replacement Program Report.

Extended Orchard Replacement (EOR) Case Study

Dry Beans

FINANCIAL ANALYSIS

Incentive Payment Sensitivity (per acre)
Dry Beans

Low Almond Incentive Payment

$327/ac

High Almond Incentive Payment

$1,056/ac

The results presented are sensitive to key cost and market factors applied in this analysis, particularly commodity price and net returns from alternative uses/crops during the replanting period. To better understand how these factors affect the incentives across different scenarios, a sensitivity analysis incorporates alternative prices, replanting costs, and yield into the payment calculations. These are presented as a range of low and high for one-year payments.

The bean crop may provide soil benefits, which would potentially boost orchard yield. Anecdotal reports from growers report more vigorous orchard growth and better production when delaying replanting. An additional financial analysis was developed to calculate the break-even yield/production increase for the grower where the greater yields for the future orchard offset the initial cost of delaying replanting. Figure 1 summarizes the results from this analysis.

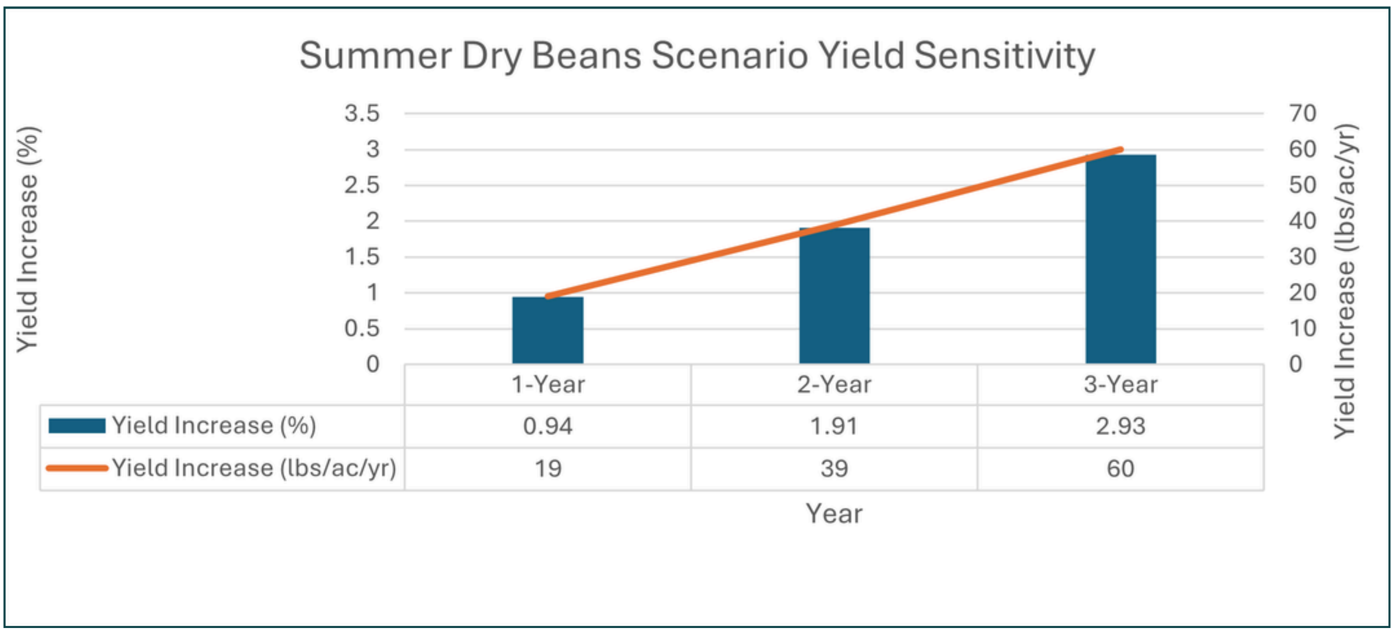


Figure 2. Yield Impact Sensitivity Analysis for the Dry Beans Scenario

Extended Orchard Replacement (EOR) Case Study

Dry Beans

FINANCIAL ANALYSIS

For the dry bean crop, yield for a one-year delay would need to be 0.94% higher throughout the 25-year life of the orchard to offset the upfront expense of delayed replanting. This corresponds to a ~18 lbs per acre yield increase. This yield increase rises with the number of years delayed replanting due to the higher overhead expenses and orchard production delay.

Table 2 presents a financial summary including revenue, cost, and yield impacts. Assuming yield is unchanged, there is a cost to delay replanting, and additional fallow year costs, which are captured by the declining value measure. The financial model then calculates the Breakeven Yield Factor, which is the yield increase necessary for value to be equal between the No delay scenario, and the corresponding number of years of delay.

Table 2. Breakeven Analysis for the Dry Beans Scenario

Metric	No Delay $/ac	1-Year Delay $/ac	2-Year Delay $/ac	3-Year Delay $/ac
Value at Yield Factor = 1.00	$4,818	$4,218	$3,641	$3,085
Annual Costs				
Cover crop planting cost	$0	$129	$129	$129
Basic fallow year costs	$0	$364	$364	$364
Cover crop revenue	$0	$169	$169	$169
Net Revenue	$0	($324)	($628)	($972)
One-Time Costs				
Removal	$2,800	$2,800	$2,800	$2,800
Replant	$6,300	$6,300	$6,300	$6,300
Breakeven Yield Factor	1	1.00937	1.01912	1.02926