



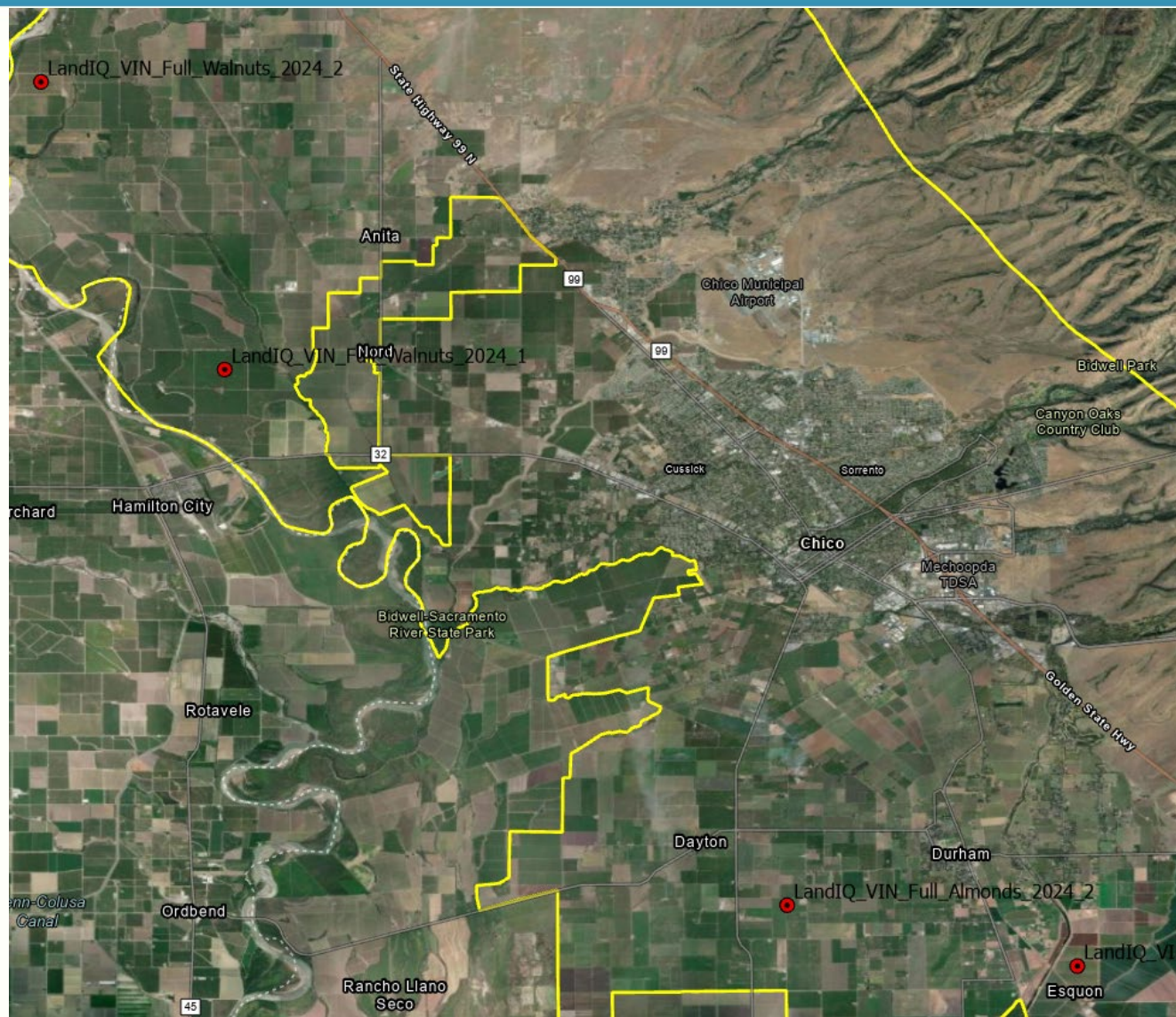
Demand Reduction Strategies

Extend Orchard Replacement (EOR) Pilot Study
Precision Irrigation (PI) Pilot Study

Vina GSA Board of Directors – March 11, 2026

Joel Kimmelshue, PhD, Land IQ

Spatial Data for Pilot Studies - ET



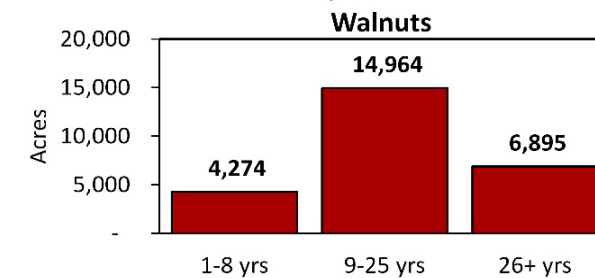
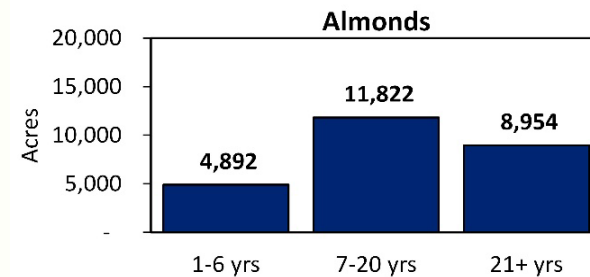
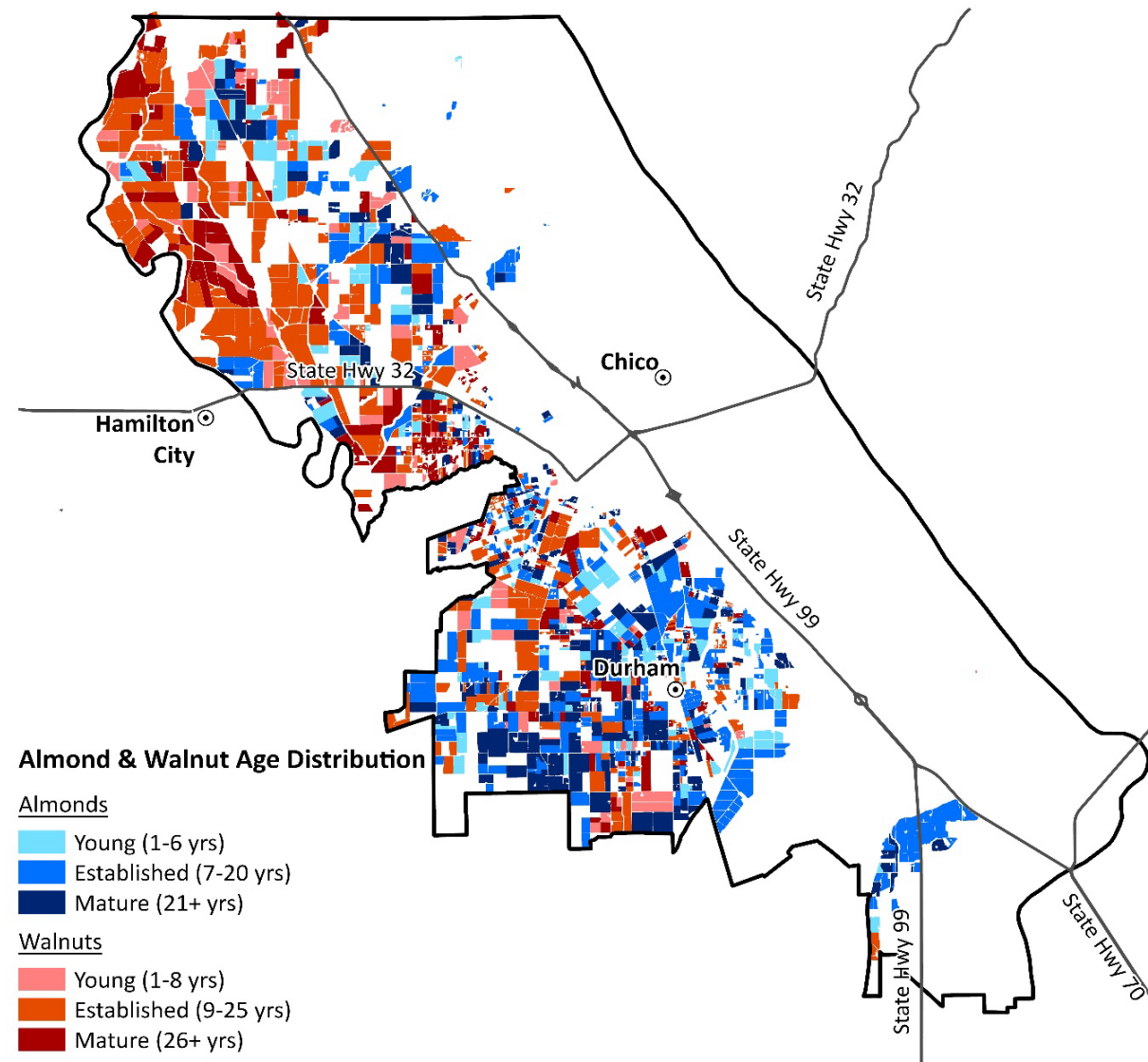
Spatial Data



Crop type and age

25,668 acres of Almonds

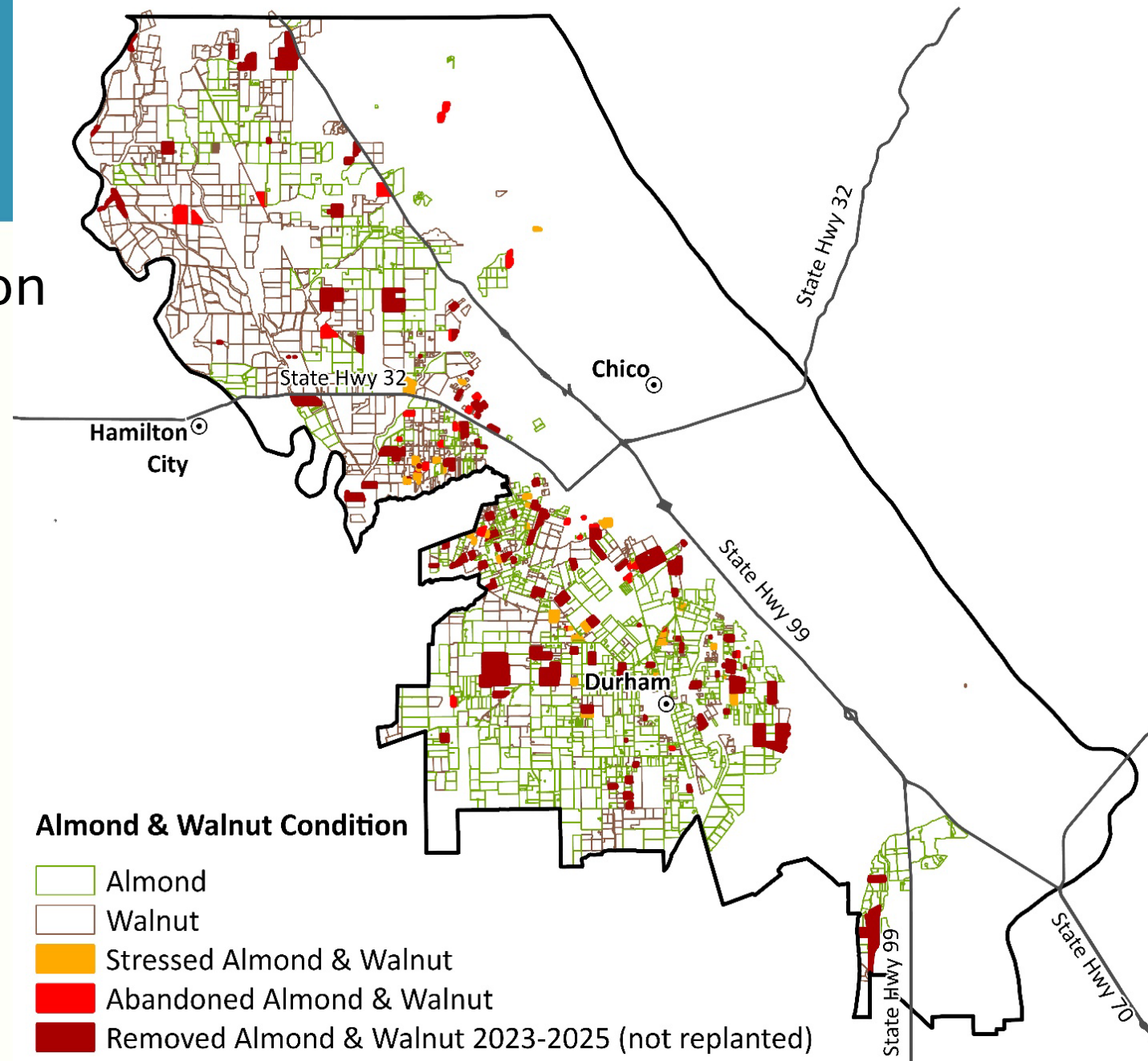
26,133 acres of Walnuts



Spatial Data



Crop type and condition





EOR – Pilot Study Questions

1. What types of practices/systems (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?

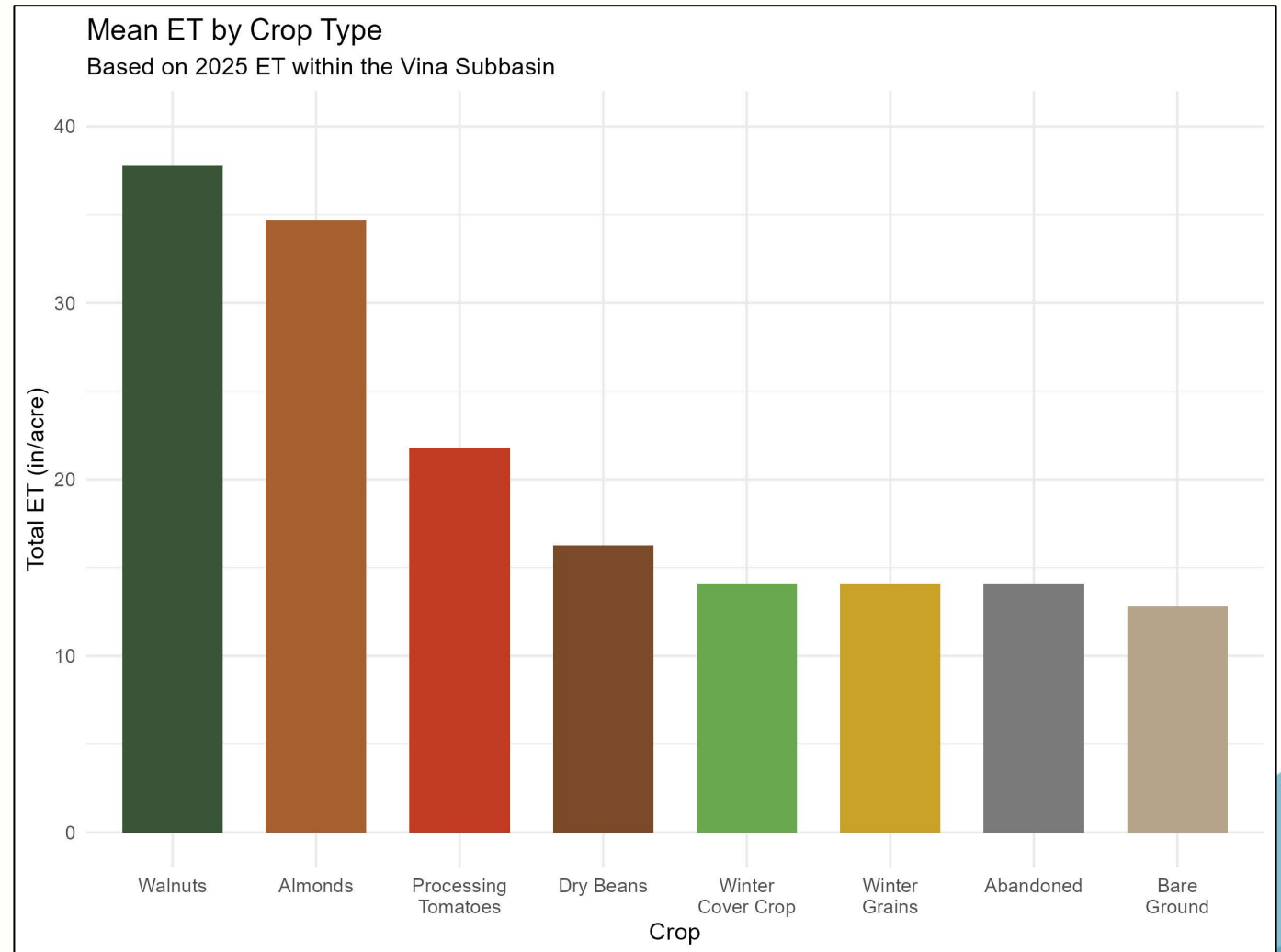


EOR – Analysis

- Pilot Orchards provided guiding information
 - ET
 - Idle period options – fallow, cover crop, summer cash crop, etc.
- ❖ Analysis focused on the whole basin.
- All orchards in Vina Subbasin were used for analysis
 - Condition – bearing, abandoned
 - ET

EOR – ET Analysis by Land Use

- Different crops have different consumptive use
- Growing lower water use crops still saves water
- Some crops rely solely on precipitation as their water source





PI – Pilot Study Questions

1. What are the irrigation scheduling approaches and technologies in use?
2. What is the potential for demand reduction using precision irrigation?
3. How can this knowledge be used to guide the GSA in implementing demand reduction programs?



PI – Analysis

Pilot orchards used for analysis

- Pruning practices
- Irrigation types
- Irrigation scheduling technologies
- ET
- NDVI
- Yield
- Applied Water

All orchards in Vina Subbasin used to explore potential relationships between

- Crop type and age
- Irrigation methods
- ET
- NDVI

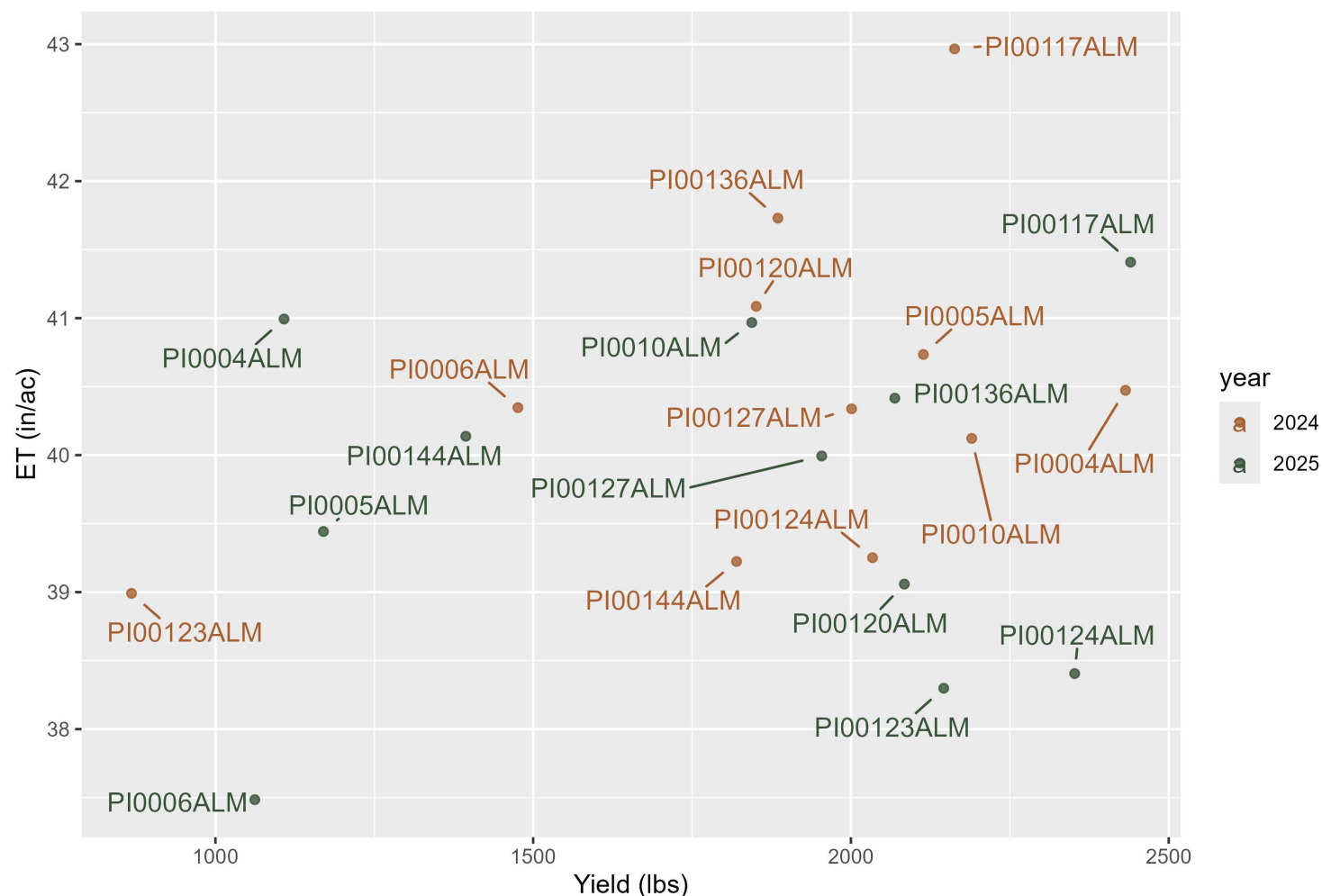
❖ Analysis focused on the pilot orchards.



PI – Conclusion 1: Using ET and Yield to Identify Non-beneficial Consumptive Use

- Almonds:
 - No correlation between yield and ET.
 - Few, if any orchards are purposely deficit irrigated
 - Yields are affected by many factors

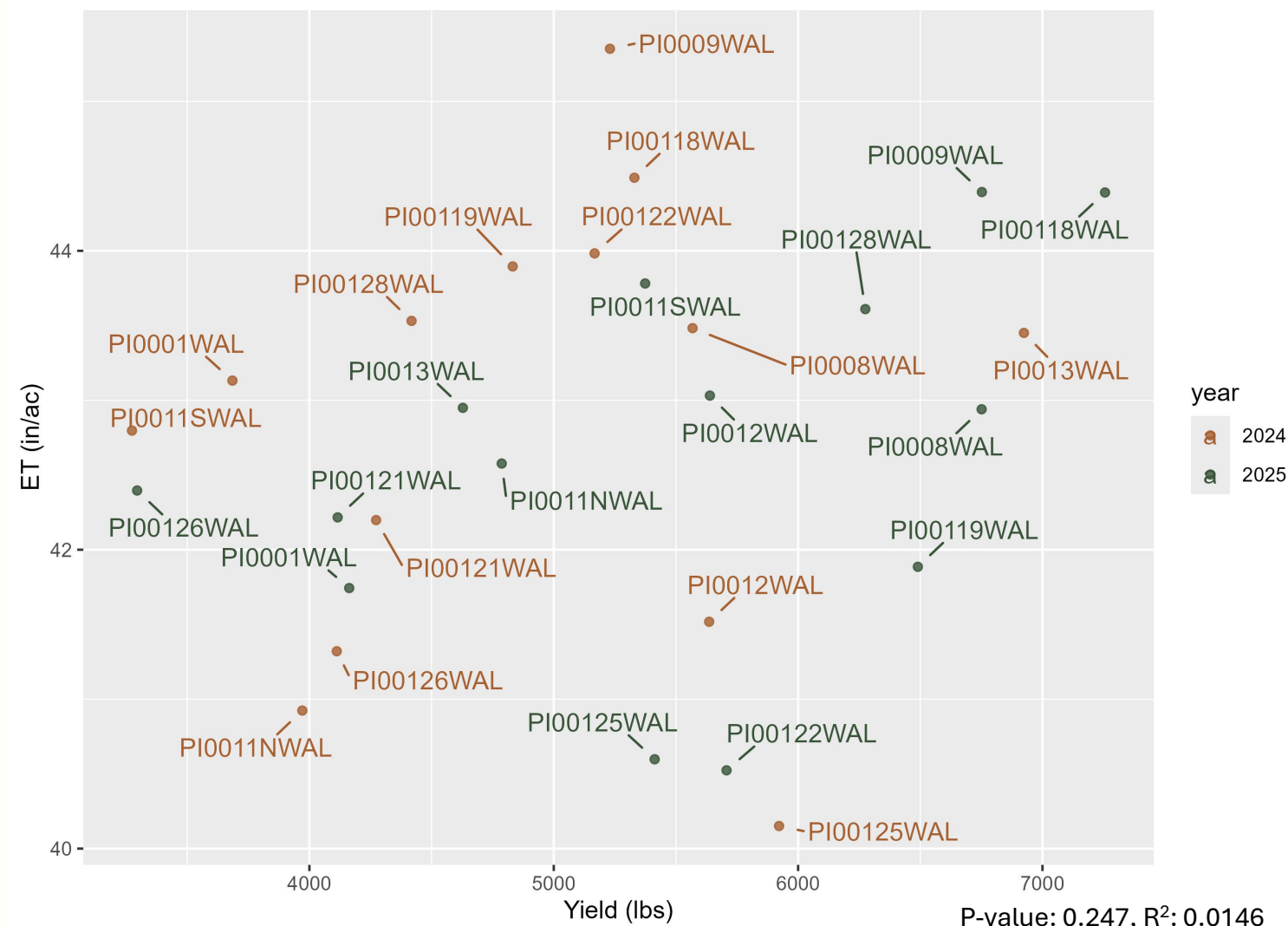
Vina Pilot Study Almonds: ET vs Yield (2024 and 2025)



PI – ET and Yield in Walnuts

- Walnuts:
 - No correlation between yield and ET.
 - Few, if any orchards are purposely deficit irrigated
 - Yields are affected by many factors

Vina Pilot Study Walnuts: ET vs Yield (2024 and 2025)



PI – Conclusion 2: Potential for Demand Reduction using PI on Mid-Large Farms

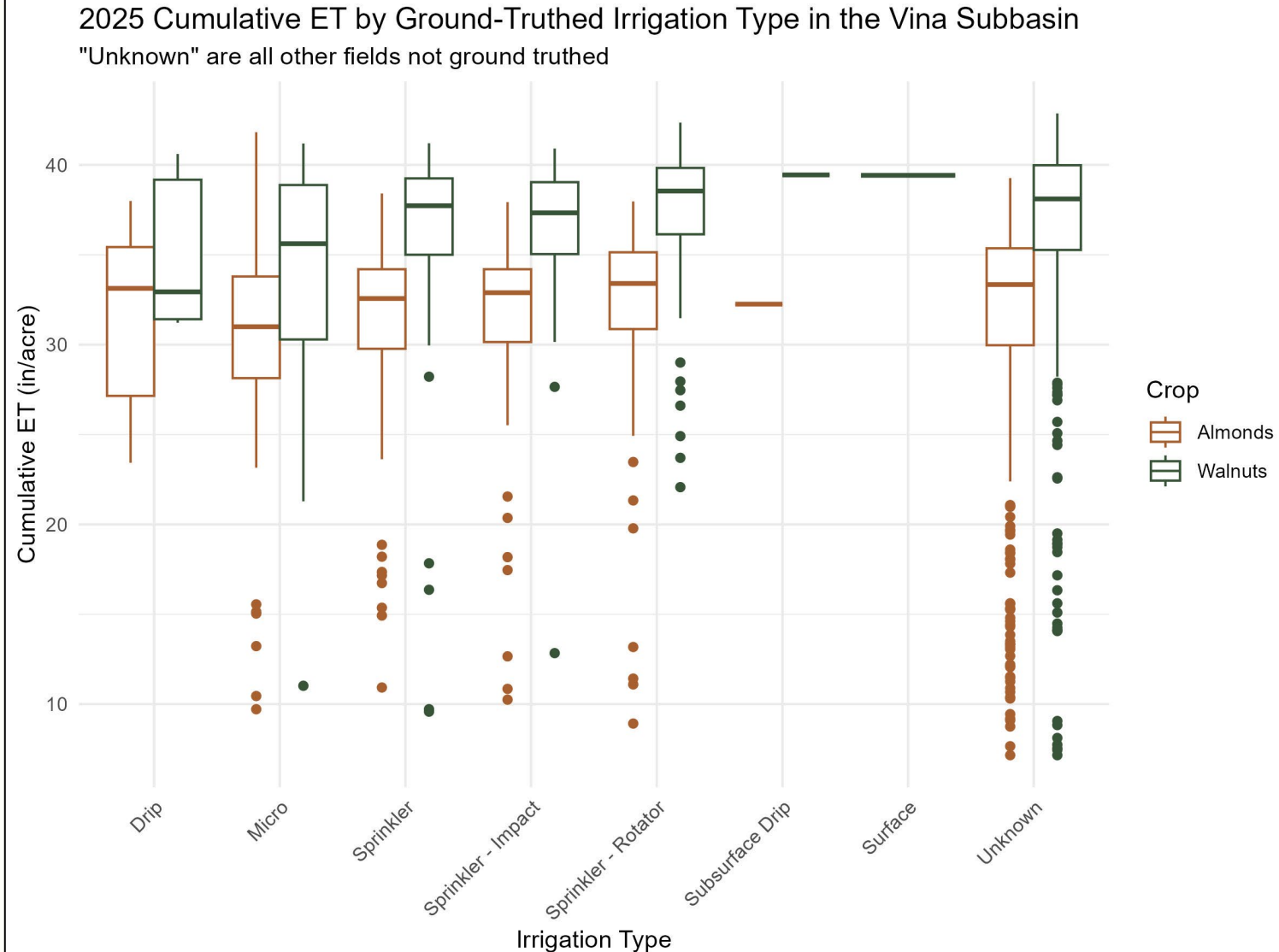


- There is likely little opportunity to reduce crop evapotranspiration (ETc) with irrigation scheduling in medium to large size almond and walnut orchards.
- PI Technical Bulletins and Case Studies
 - Methods for Determining When and How Much to Irrigate – growers are optimizing irrigation with technology
 - Minimizing Midday Irrigation – water savings potential comes with “heavy lift” on farms

PI – Conclusion 3: Irrigation Systems



Irrigation system management was more important than irrigation type in maximizing water use and water productivity (water use as a function of yield).



PI – Conclusion 4: Pressure Chambers

No Pressure Chamber Used

$ETc = 3.25$ ac-ft



 2437 in-shell lbs
LAND IQ


$n=5$

Pressure Chamber Used

$ETc = 3.37$ ac-ft



21.7% Less Applied Water

 2580 in-shell lbs (+5.9%)

$n=7$

Walnuts appeared to respond to less irrigation while improving production, though this trend was not the same in almonds.

PI – Conclusion 5: Potential for Demand Reduction using PI on Small Farms



- Butte County Survey (2021) - these technologies are not used as much on small farms.
- 70% of farms are <100 ac and account for 30% of acreage.
- Highest barrier to pressure chamber adoption overall is labor.

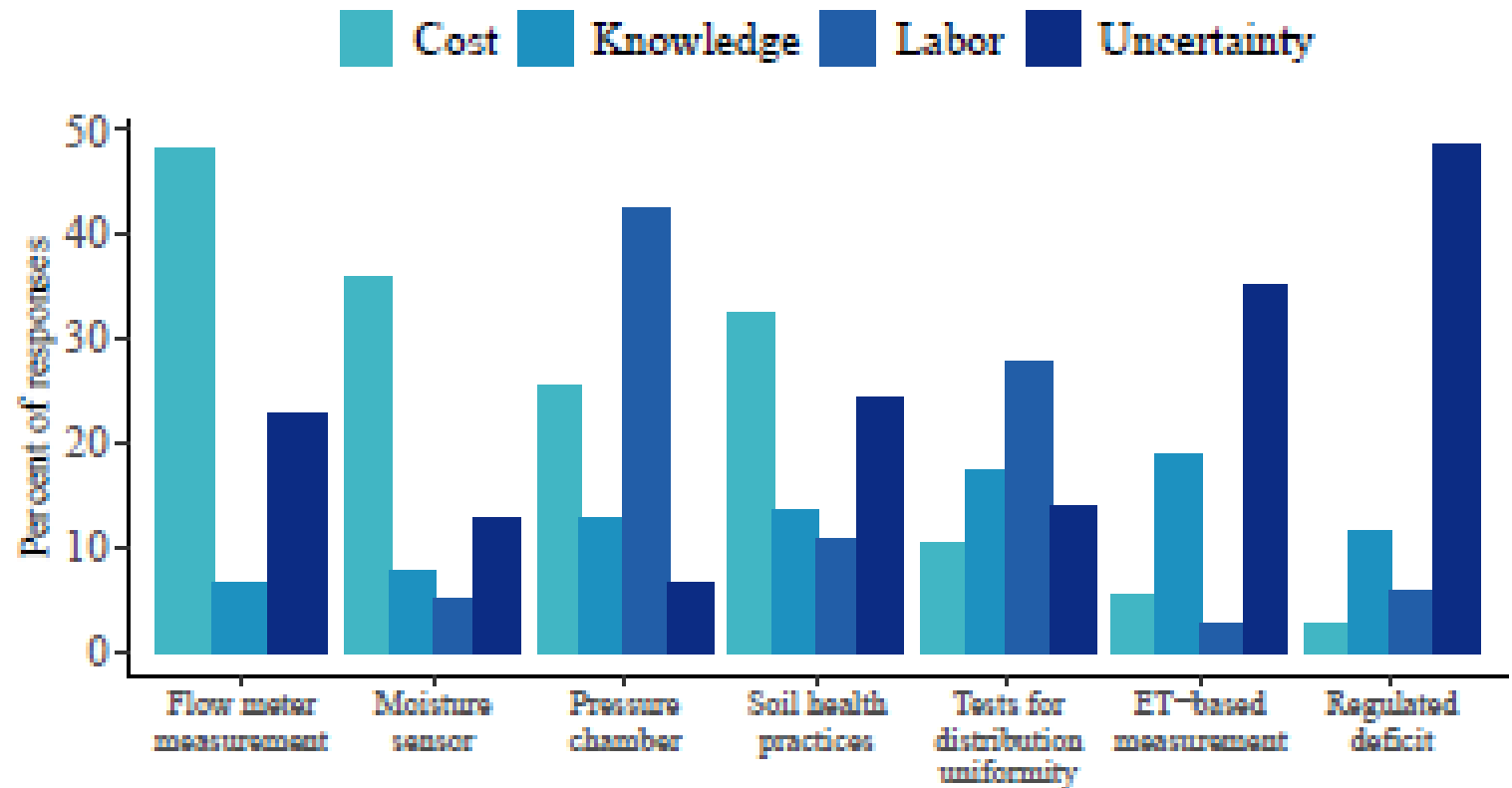


Figure 6. When considering these irrigation management practices, which of the following issues do you consider a challenge for implementation?

PI – Conclusion 6: Minimizing Midday Irrigation



- Values from literature that need to be locally validated
 - Potential for saving 7.6 inches of ET
 - 630 ac-ft of groundwater pumping per 1,000 irrigated acres lost to evaporation
- Target orchards with lower weekly water requirements of mature orchards, more barren soils than vegetation in middles
 - Micro or mini-sprinkler irrigation
 - 20 to 60 percent canopy cover (3 to 8 years old)

PI – Summary of Conclusions



1. The PI pilot study demonstrated how ET and yield *can* be used to determine orchards with non-beneficial ET.
2. There is little evidence from the PI pilot study that there is substantial opportunity to reduce ET with precision irrigation in medium to large almond and walnut farms.
3. Irrigation system management was more important than irrigation type in maximizing water use and water productivity (water use as a function of yield).

PI – Summary of Conclusions



4. Walnuts appeared to respond to less irrigation while improving production, though this trend was not the same in almonds.
5. There may be more potential for improved water management, including both irrigation efficiency and minimizing non-beneficial ET, on small farms. Farms <100 acres represent 30% of acreage.
6. There may be potential to reduce the evaporation portion of ET by using more nighttime irrigation and less daytime irrigation.

Recommendations



EOR

- Apply economic and financial analysis to standardize and compare EOR, PI and other PMA costs per AF
- Implement first with small-scale or pilot study

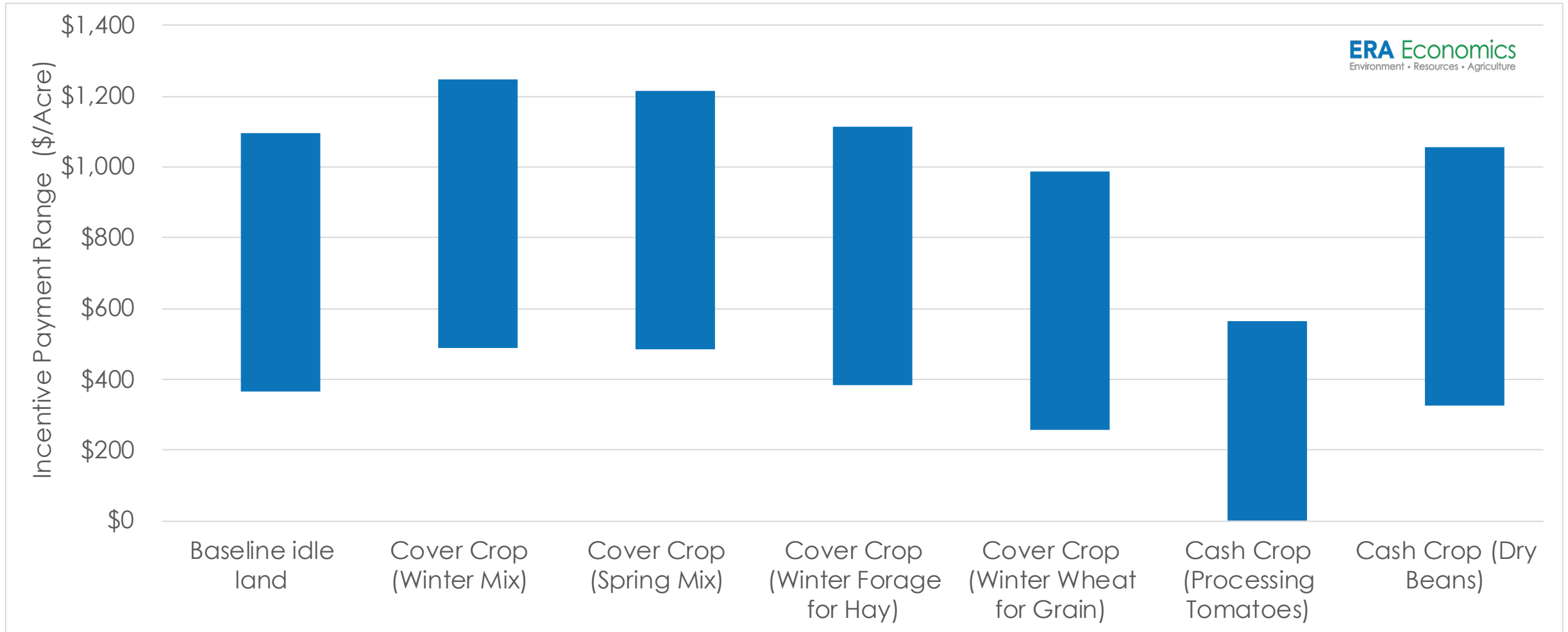
PI

- If the Vina GSA wishes to pursue identification of non-beneficial ET in almond and walnut orchards, it would need multiple years of yield and ET data from orchards to determine how non-beneficial ET occurs.
- To maximize demand reduction from efforts, the Vina GSA should investigate acreage and technology adoption by farm size, then determine potential demand reduction.
- The Vina GSA should focus its efforts related to specific irrigation management practices on the use of pressure chambers as components of an advanced technology approach to irrigation scheduling, either through outreach and education and/or incentivizing technology, particularly in walnut production.
- If the Vina GSA wishes to pursue a move away from midday irrigation, education and outreach would be needed on the associated financial savings, and potentially assistance in implementing automation.

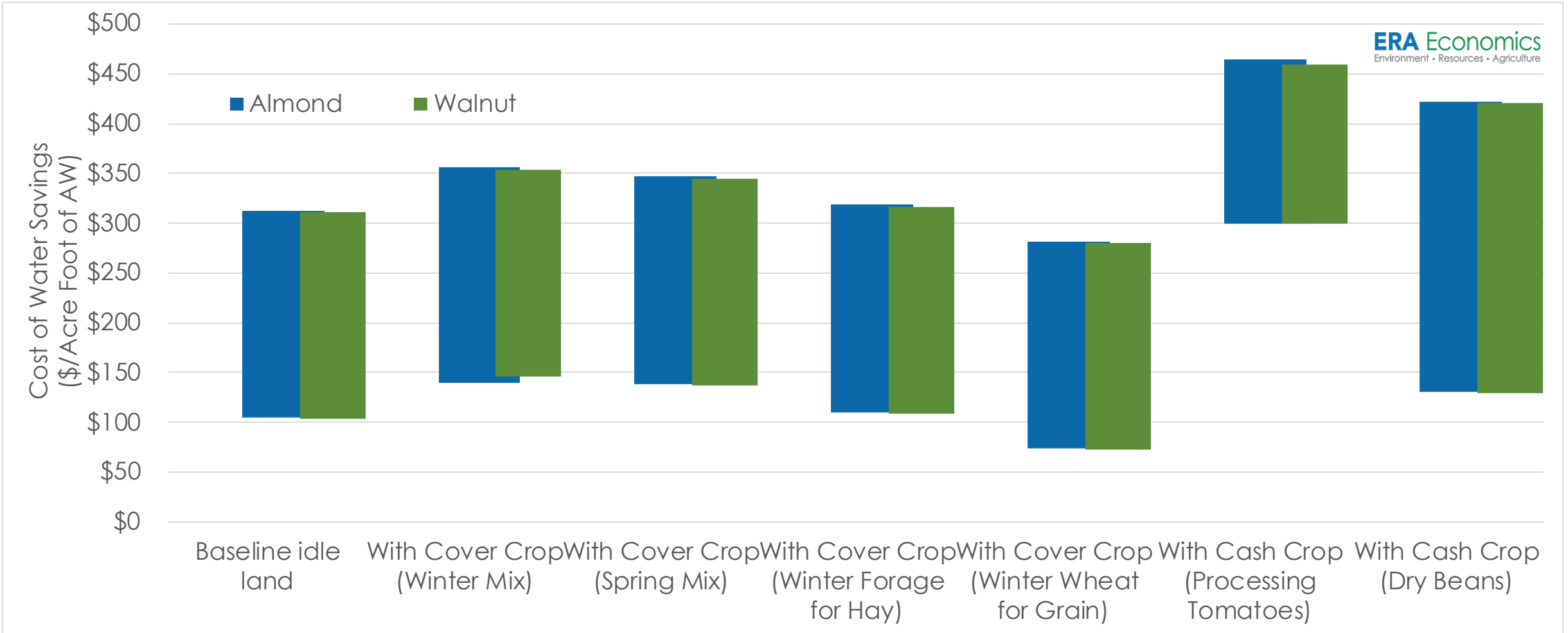
EOR Program Concepts

- Incentivize extended replanting period
 - Cover crop or other activities during idle period
 - Evaluated idle period 1 – 3 years
- Incentive payment compensates for the present value of forgone income during the idle period
 - Land costs, taxes, overhead; delayed replanting costs; delayed income
 - Range reflects different costs and prices
- Water savings
 - Measured as AW or ET
 - Measured as annual amount or amount over life of the orchard

EOR Incentive Payment Range (1 Year Idle)



Annualized Cost of EOR AW Savings (1 Year Idle)



Program Development

Program Element	Description
Administration	Staff, data, technical expertise to administer the program
Funding Strategy	Financial and economic analysis for the resources required to run the program
Program Rules / Guidelines	Clear program guidelines – eligibility, duration, scale, application periods, selection process, enrollment process, etc.
Incentive Payments	Amounts and process for establishing incentive payments – fixed price, bids, reverse auction, other approaches; tied to funding strategy and revisited annually
Contracts / Agreements	Agreement between participant and program administrator that defines responsibilities of the parties
Monitoring and Enforcement	Process for measuring water savings and ensuring compliance with program guidelines
PMA Integration and Adaptive Management	Process for review and integration with other PMAs, including ongoing financial analysis to evaluate least-cost implementation strategies; process for revising the program as new information is developed

Recommendations

1. Apply economic and financial analysis to **standardize** EOR, PI, and other PMA costs to support evaluation of a cost-effective GSP implementation portfolio
2. Develop draft EOR program guidelines, bidding/selection process, and monitoring process and test in a limited-scale **Pilot Program**
3. Use Pilot Program and economic/financial analysis to **integrate EOR with PI and other PMAs** for GSP implementation