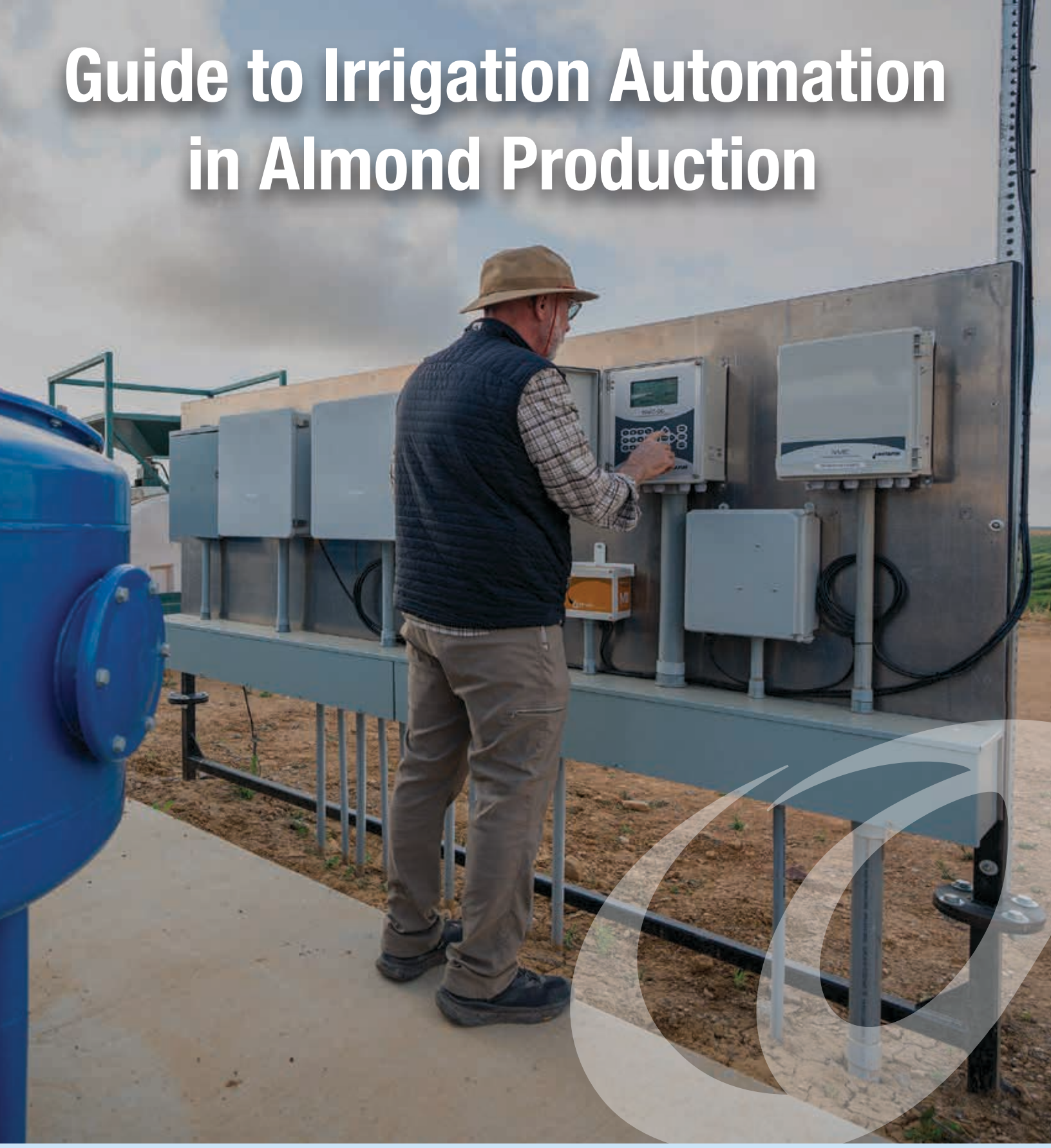
Guide to Irrigation Automation in Almond Production



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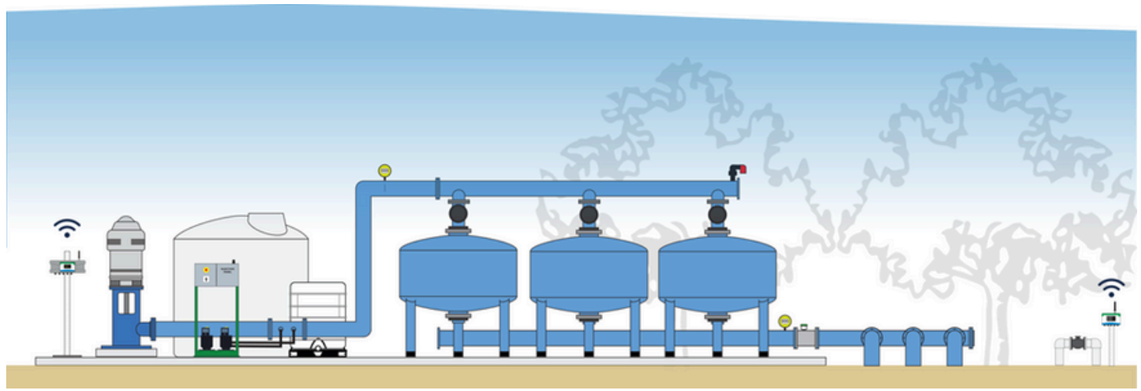
INTRODUCTION

Irrigation automation is revolutionizing almond orchard management by improving efficiency, optimizing water use, and reducing labor demands. By integrating automated control systems with real-time monitoring, growers can make data-driven decisions that enhance productivity and sustainability. This guide explores various irrigation automation technologies, their components, and key considerations to help almond growers select and implement the most effective solutions for their operations.



ADVANCEMENTS IN ORCHARD IRRIGATION:
FROM MANUAL TO AUTOMATED SYSTEMS

Throughout the history of agricultural irrigation, several key advancements have significantly improved water use efficiency. Early irrigation relied on flood systems, which, while effective, resulted in high water loss. The transition to hand-move sprinkler systems and later to buried solid-set systems marked an important shift toward more controlled water distribution. The introduction of micro-sprinklers and drip irrigation further revolutionized the industry by delivering water directly to the root zones of trees, minimizing evaporation and runoff.

Automation represents the next major advancement in irrigation technology. By enabling precise control over irrigation timing, automated systems can dynamically adjust water applications based on real-time plant demand, soil moisture levels, and weather conditions. This ensures that water is applied efficiently, aligning with the trees' changing needs throughout the growing season while reducing labor requirements and resource waste.

In orchard irrigation, the most common system still relies on manually controlled valves to regulate water flow to different orchard blocks. These valves can be located at the pumping station or at remote valve stations positioned at the heads of various field blocks. While this method is straightforward and effectively manages irrigation, it is also one of the most cost-effective options for installation.

For many growers, a manually controlled irrigation system has traditionally been effective in getting the job done. However, it often comes with higher labor costs, inconsistent water application, and reduced irrigation efficiency.

Switching to an automated irrigation system enables precise adjustments to irrigation timing, informed by monitoring systems that analyze remote imagery, soil moisture levels, local weather conditions, and plant-stress sensors. Automation eliminates the need for staff to manually adjust valves for each irrigation cycle, ensuring consistent water application. Additionally, it allows for accurate tracking of irrigation runtimes and applied water, with options to integrate fertilizer applications and blending for improved efficiency.

Common Options for Irrigation Automation Systems

- **Timer-Based Systems:** Simple scheduled irrigation controllers
- **Fully Integrated IoT Systems:** Cloud-based automation with remote control and data analytics

TIMER-BASED SYSTEMS

Similar to the controllers used for home lawn irrigation, these systems represent the most basic form of irrigation automation, operating on pre-set schedules to turn irrigation on and off. Some timer-based systems also incorporate local ET forecasts, allowing for weekly adjustments to irrigation schedules based on predicted weather conditions.

How They Work

Set irrigation timing manually based on estimated water needs. Systems operate on a fixed schedule, regardless of real-time soil moisture or weather conditions.

Timer-Based Systems	
Pros	**Cons**
Simple and inexpensive to install and maintain.	Inefficient if weather or soil moisture levels change unexpectedly.
Reduces labor compared to manual irrigation with irrigations starting and stopping based on schedule automatically.	Risk of overwatering or underwatering.
Does not require telemetry or connection to internet to operate.	No real-time adjustments based on plant needs and notifications.
Works well when water demand is predictable.	Requires valves to be at pump station or wired connection to field valves.

FULLY INTEGRATED IoT SYSTEMS

Overview: The most advanced option, these systems use cloud-based technology, real-time data, and remote automation for complete irrigation control.

How They Work

- In addition to providing irrigation control, these systems collect, record, and display real-time data from in-field **soil moisture sensors, weather stations, and flow meters** to monitor conditions accurately.
- Data is transmitted to the cloud, where software analyzes environmental and soil conditions to **automate irrigation decisions or provide recommendations** based on preset parameters.
- Users can **monitor, adjust, and control irrigation remotely** through mobile apps or web-based dashboards, ensuring flexibility and precision.
- Advanced systems can integrate with **fertigation management tools**, allowing for precise nutrient application alongside irrigation.
- Some platforms incorporate **AI-driven analytics**, learning from historical trends and current data to optimize irrigation timing and water use efficiency.

Fully Integrated IoT Systems	
Pros	**Cons**
Maximizes water efficiency by applying irrigation only when needed, reducing waste.	**High initial investment**, including hardware, software, and installation costs.
Optimizes yield potential by maintaining ideal soil moisture levels.	**Requires reliable internet or cellular connectivity** for seamless real-time operation.
Reduces labor costs by automating irrigation scheduling and adjustments.	**User training is necessary** to fully utilize system capabilities and avoid operational errors.
Allows remote access, enabling users to monitor and adjust irrigation from anywhere.	**Ongoing costs,** including cellular data fees, service visits, and software subscription costs for cloud-based services.
Integrates with AI-powered predictive analytics, improving long-term water management.	
Enhances record-keeping for regulatory compliance and farm management decisions.	

COMPONENTS OF AUTOMATION SYSTEM

Cloud-Based Software serves as the brain of the irrigation automation system, storing and analyzing real-time data to enable remote control and automated decision-making. Its effectiveness is critical to the system's overall success, making it essential to select a platform that aligns with the operation's needs.

A **comprehensive understanding of the software's features, functionality, and application** is crucial when choosing a solution. The evaluation process should involve all team members responsible for irrigation management, including those making scheduling decisions and those executing irrigation in the field.

If field teams are responsible for **adjusting settings, overriding irrigation events, or coordinating with other farm operations,** their input is essential during the selection and implementation process. Ensuring that all users are comfortable with the system will lead to a smoother transition, better adoption, and long-term success in maximizing water efficiency and operational effectiveness.

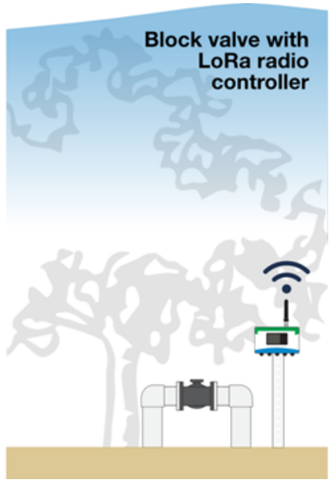
Mobile Applications – A key component that allows for use of system by staff while working in the field. Access to cellular will still be required to make changes and viewing current status of system.

IoT Connectivity Modules – Enable wireless communication between sensors, controllers, and cloud platforms (Wi-Fi, cellular, LoRaWAN, or Bluetooth).

Pump Station Controller – The **hub of the irrigation system,** the pump station controller plays a critical role in automating operations, optimizing water delivery, and reducing labor demands on field staff. It monitors and records key inputs, ensuring efficient and consistent irrigation events.

When selecting a controller, it's important to consider **both current and future operational needs.** Even if the system requirements are simple today, choosing a scalable solution can prevent costly upgrades down the line. Key factors to evaluate include:

- **Compatibility with automation systems** (e.g., sensors, weather stations, flow meters)
- **Remote monitoring and control capabilities for field valves & sensors**
- **Integration with fertigation and filtration systems**
- **Expansion potential for additional pumps or irrigation zones**
- **Energy efficiency and pump performance tracking**



Planning for future growth ensures that the system remains effective as the operation scales.

KEY CONSIDERATIONS FOR CONTROL AND MONITORING AT PUMP STATION

Automation and Control

- **Pump(s)** – Primary water delivery system, automate for efficiency.
- **Variable Frequency Drive (VFD)** – Adjust pump speed to optimize energy use and system performance.
- **Engines** – Control and automate engine-driven pumps where applicable.
- **Reservoir Fill** – Automate water replenishment to maintain consistent supply.
- **Filter Flush** – Ensure proper filtration system operation to prevent clogging and maintain efficiency.
- Prevent or reduce “On Peak” usage.

Monitoring

- **Power & Energy Use –** Track power and energy consumption for efficiency and cost management.
- **Engine Vitals** – Monitor engine performance, including RPM, temperature, fuel levels, and operational hours.
- **VFD Variables** – Observe motor frequency, torque, and power output for system optimization. The VFD panel also records a host of data points that can be used for regulatory and system performance reporting.
- **Flowmeter** – Measure water flow to track usage and detect inefficiencies or leaks.
- **Weather Station** – Provide real-time climate data to optimize irrigation scheduling.
- **Pressure** – Monitor system pressure to ensure consistent water distribution and prevent damage.
- **Fertigation** – Monitor fertigation tank levels & volumes of material injected.

STEPS TO IMPLEMENTING IRRIGATION AUTOMATION

Implementing an **irrigation automation** requires a well-thought-out plan to ensure efficiency, **effectiveness, and long-term success.**

There will be many different roles in the use of a system, and it is best to include all team members in the planning process. Each team member will have different needs and challenges to overcome. Including each role will drive the development of a plan better able to address these needs. It is also a good idea to select a project champion who can take the lead. A **Project Champion** plays a critical role in ensuring the successful implementation and operation of irrigation automation technology. They must be **fully trained** in all aspects of the system, gaining a deep understanding of both the **technology** and its practical application in the field. Additionally, they should have **strong knowledge** of the **irrigation and pumping systems**, allowing them to troubleshoot basic issues and optimize performance. The Project Champion also serves as the **primary point of contact** for field service needs, either being trained to handle service tasks or coordinating with the appropriate service providers. Beyond technical expertise, they act as the **key communicator** within the team, ensuring that knowledge is effectively shared and applied to improve overall system efficiency and effectiveness.

A well-developed plan ensures an irrigation system aligns with **orchard goals,** supports **regulatory compliance**, and maximizes **long-term productivity.** It helps **avoid costly mistakes** by preventing inefficiencies and ensuring scalability. Additionally, **training staff** ensures effective system use, leading to better adoption and long-term success.

Developing a comprehensive plan before implementation saves time, **reduces costs, and maximizes efficiency,** ensuring the irrigation and fertigation system meets the orchard’s needs both now and in the future.

Considerations for Implementation

- **Assess Orchard Needs –** Evaluate soil type, topography, and the current irrigation system to determine compatibility and identify any necessary upgrades.
- **Select an Automation System –** Choose a system that fits your orchard size, budget, and water availability. Consider scalability for future needs.
- **Install Controllers and Sensors –** Collaborate with the vendor during installation and provide guidance on field sensor placement based on on-the-ground knowledge.
- **Upgrade Existing Irrigation Infrastructure –** Be prepared to address limitations such as the need for extended pipe lengths, electrical panel upgrades, or other modifications to support automation.
- **Set Up Remote Monitoring & Alerts –** Work with the vendor to configure real-time alerts and notifications tailored to your operational goals.
- **Implement a Training Program –** Ensure all team members are trained on system operation and irrigation planning before the system goes live. Early preparation is key to long-term success.

Table of Departmental Needs			
Irrigation Automation for Almond Production			
Department / Role	**Responsibilities**	**Needs / Requirements**	**Benefits of Automation**
Project Champion	Acting as the lead user and internal advocate for system adoption.	Comprehensive training, authority to coordinate across teams, communication tools, service contact responsibilities.	Smooth implementation, better adoption, bridge between technology providers and farm staff.
Farm Management / Ownership	Strategic planning, budgeting, investment decisions.	ROI analysis, cost-benefit studies, system scalability, alignment with long-term orchard goals.	Reduced costs, improved yields, sustainable resource management, long-term profitability.
Irrigation / Water Manager	Overseeing irrigation schedules & water allocation.	Training on controllers, access to soil moisture/weather data, other monitoring tools.	Compliance with water restrictions, optimized scheduling & efficient water use.
Field Operations / Orchard Crew	Executing irrigation tasks, monitoring system operation, responding to field issues.	Training on valve/pump operations & easy-to-use interfaces.	Reduced manual labor, better coordination with farm activities.
Fertility / Nutrition Manager	Overseeing fertilizer applications & nutrient management.	Integration with fertigation systems, precise control of application rates, training on injection equipment.	Improved nutrient efficiency, reduced waste, consistent tree nutrition.
Maintenance / Service Team	Maintaining pumps, filters, valves, and sensors.	Notifications of system issues, diagnostic tools, training for troubleshooting and preventative care.	Less downtime, extended equipment life, reduced emergency repairs.
Finance / Administration	Managing budgets, reporting, and compliance with cost-share programs.	Usage reports for groundwater & surface water use, access to rebate/funding opportunities, system usage reports.	Improved financial planning, potential grant/rebate funding, measurable ROI documentation.

MAKING THE SWITCH: ANALYZING ROI AND PAYBACK PERIOD FOR AUTOMATION

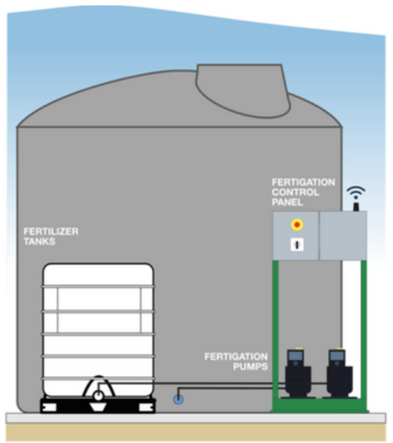
The initial investment in irrigation automation includes equipment, installation, and potential infrastructure upgrades like telemetry, sensors, and flow meters. While the payback period typically ranges from 3 to 7 years, depending on farm size, water savings, labor reduction, and yield improvements, the long-term benefits can include increased net revenue from higher yields and lower input costs. Additionally, more precise irrigation strategies help mitigate long-term orchard health risks.

Switching from manually controlled irrigation to an automated system in almond production can significantly impact **return on investment (ROI)** through cost savings, yield improvements, and resource efficiency. Here's a breakdown of the key ROI opportunities:

Cost Savings	**Increased Yield & Quality**
Labor Reduction	**Automated Labor Costs**
• Less need for manual valve adjustments and monitoring. • Lower labor costs over time, especially during peak irrigation periods.	• Consistent watering reduces plant stress, leading to higher yields. • Improved kernel quality due to steady nutrient uptake.
Water Savings	**Better Nutrient Delivery**
• Precision irrigation reduces overwatering and waste. • Potential reduction in water costs, especially in areas with tiered pricing.	• Automation improves fertigation efficiency, reducing fertilizer waste and increasing nutrient absorption.
Energy Efficiency	
• Reduced pump operation times lower electricity or fuel expenses. • Automation can optimize irrigation timing to avoid peak energy rates.	
Risk Reduction	**Sustainability**
Frost & Drought Protection	**Environmental Benefits**
• Automated systems can react faster to temperature extremes. • Reduced risk of yield loss due to drought stress or frost damage.	• Reduced runoff and leaching. • More sustainable farming practices improve industry reputation and may open up sustainability incentives or certifications.
Regulatory Compliance	
Improved reporting and tracking of water usage for compliance with SGMA and other regulations.	

AUTOMATED FERTIGATION

An automated fertigation system, like irrigation automation, is a powerful tool for maximizing returns on high-value crops such as almonds. By precisely delivering nutrients through irrigation, they improve efficiency, reduce waste, and support healthier trees and higher yields—all while lowering labor and resource costs through real-time monitoring and remote control.



Automation and Control

Components

- Programmable controllers
- Flow meters and EC/pH sensors
- Remote access & telemetry
- Injection pumps for fertilizers and acids
- Software control interface

Key Benefits

Improved Efficiency & Precision

- Delivers exact nutrients and water needed by the tree at the right time and rate.
- Reduces waste and nutrient leaching.
- Supports variable-rate applications tailored to block/tree needs.

Labor Savings

- Reduces need for manual valve operation, fertigation setup, and monitoring.
- Especially valuable in tight labor markets and during peak demand periods.

Enhanced Tree Health & Yield Potential

- Consistent nutrient delivery = stronger root systems, better nut fill, and higher yields.
- Can lead to more uniform growth across orchards.

Remote Monitoring & Control

- Access system data and adjust via smartphone or computer.
- Faster response to environmental changes or system failures.

Record-Keeping & Compliance

- Automatically logs water and nutrient applications.
- Simplifies documentation for compliance with nitrate management plans, food safety, and processor requirements.

Return on Investment (ROI)

- Reduced input waste (fertilizer, water, labor).
- Improved yield and nut quality = increased revenue potential.
- ROI typically realized in 2–4 years, based on system size and usage.

Payback Period Drivers

- Size of operation.
- Frequency of fertigation.
- Existing infrastructure (retrofit vs. new install).
- Local water and fertilizer costs.

Limitations & Considerations

- Upfront capital investment.
- Need for system maintenance and calibration.
- **Training requirements** for optimal use.

ECONOMIC CONSIDERATIONS

- Upfront investment vs. long-term cost savings.
- Potential rebates and funding programs for water conservation technologies.
- ROI analysis: increased yield, reduced labor, and lower water costs.

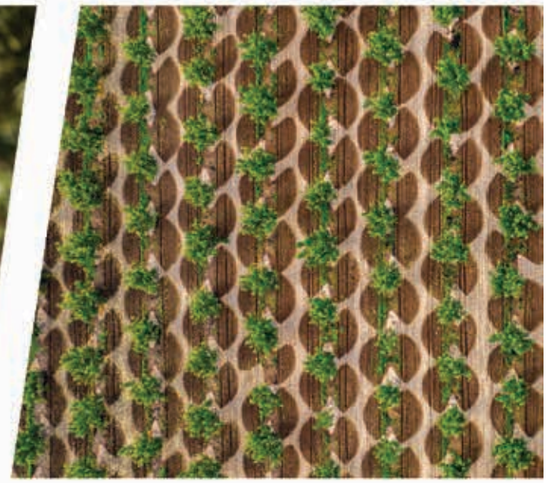
POTENTIAL INCENTIVES & COST-SHARING

- NRCS EQIP funding
- Utility or GSA rebates for water-saving tech
- SWEEP funding

Scan the QR code to learn more about incentives for almond growers:

CONCLUSION

Automation represents a strategic investment that enhances long-term profitability, sustainability, and resilience in almond production by aligning with industry goals of doing more with less—using less water, fertilizer, and labor while maintaining high-quality crop output. Additionally, these systems support accurate record-keeping to meet regulatory requirements, such as nutrient management and water use reporting, and can offer a potentially prompt return on investment through improved efficiency and yield.



NOTES

Vision

California almonds make life better by what we grow and how we grow.

Mission

Expand global consumption of California almonds through leadership in strategic market development, innovative research and accelerated adoption of industry best practices.

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