

From Silicon Valley to Salad Bowl: Innovations Transforming Central Coast Vegetable Production

Presented by
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Outline

- Background
- Weeding & Thinning: Successful field applications
- Harvest Technologies: Road from Hybrid to Fully automation
- Automated insect pest management
- Expanding use of Drone Technology
- AgTech Innovation Hub



Central Coast California: A Unique Agricultural System

Salad Bowl of the World: Year-round cool-season production driven by coastal microclimates

National Production Hub

>80% of U.S. broccoli

~90% of U.S. lettuce (with Arizona)

Major producer of strawberries, spinach, cauliflower

Extreme Cropping Intensity

Double-cropping common (lettuce, broccoli)

Up to 3 crops/year for short-cycle crops (e.g. spinach)

High Land Value & Pressure

Row-crop rents: ~\$500–\$4,000 per acre

High production costs



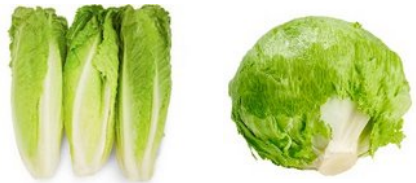
Central Coast California: A Unique Agricultural System

Per Acre (2023–2024)

Crop	Total Cost
Broccoli Bunched 14s	\$13,920
Broccoli Crown Cut	\$ 12,364
Lettuce Iceberg	\$ 17,203
Lettuce Romaine	\$16,793
Strawberries	\$112,694

Main cost drivers

Harvest Cost	Cultural Labor Cost	Material Cost
40 %	6 %	13%
36 %	6 %	14 %
42 %	5 %	13 %
40 %	6 %	14 %
38 %	7 %	23 %





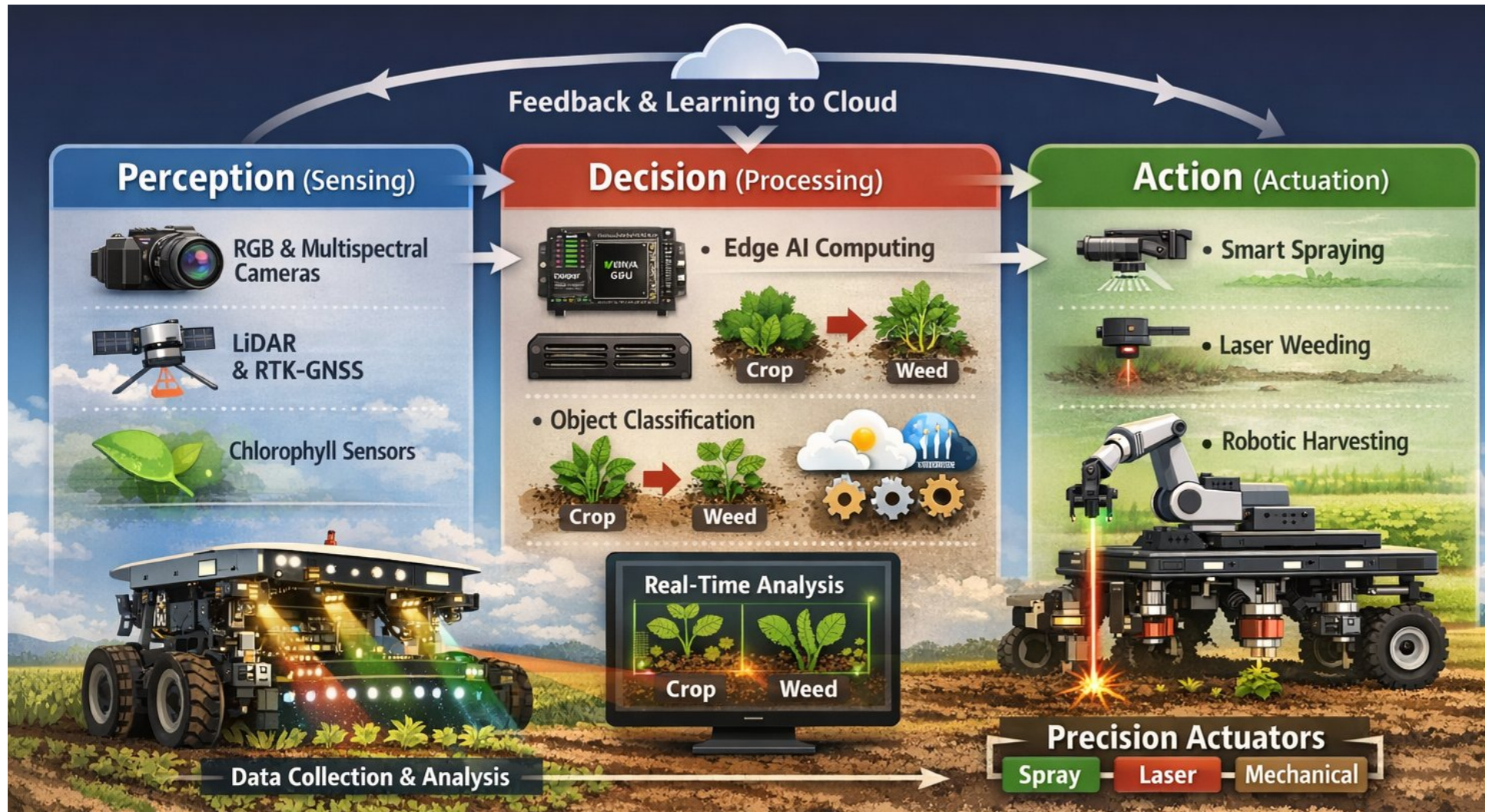
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Innovation: NextGen Farm Machinery



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AI-guided Weeding and Thinning

One of the most successful Ag Tech use cases

Weeding and Thinning Crop Fields

- Earliest success of tech integration was seen in thinning by Blue River Technology in US
- It was eventually bought by John Deere in 2017
- Automated weeders, cultivators, and smart sprayers from Europe such as Robovator from Denmark, Garford from UK
- Multiple startups have gone into commercialization and adoption by growers across the US.



 **ROBOVATOR**

Domestic Automated Smart Weeders, Thinner and Sprayer



Domestic Automated Smart Weeders, Thinner and Sprayer

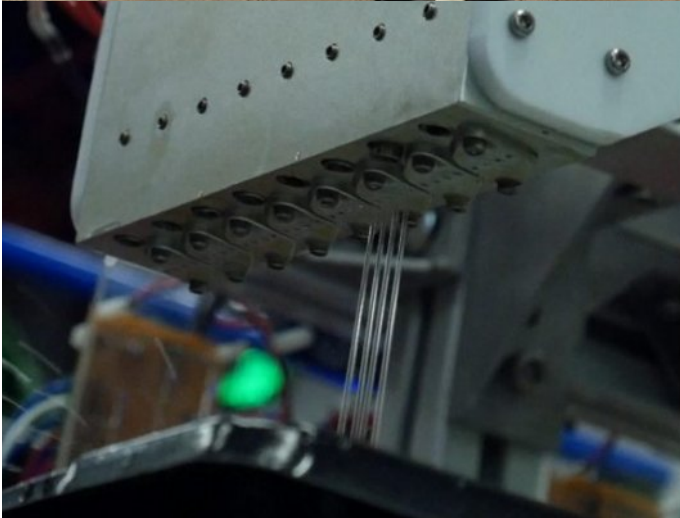


 **MANTIS™** AG TECHNOLOGY
SMART THINNER



 **MANTIS™** AG TECHNOLOGY
SMART SPRAYER

Automated Weed Control options for Organic Production



BHF Robotics



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Automated Weed Control: What Was Evaluated & How It Performed

Technologies Tested

Mechanical (blades/knives): FarmWise, Stout, Robovator, Steketee, Garford

Mechanical (finger weeders): Naio Dino

Spray-based: Blue River “See & Spray”, Verdant Robotics

Thermal / Laser: Carbon Robotics (laser), Tensorfield (hot oil)

Key Performance Results

Weed removal ranged from **~30% to ~99%**, averaging **~70%**

Automated weeders removed **~2× more weeds** than standard cultivation

Best results in **transplanted crops**



Labor Savings, Crop Safety, and the Evolution of the Technology

Labor & Cost Impacts

- **35–45% reduction** in follow-up hand weeding
- **~4 hours per acre** of labor saved
- Higher weed pressure = **greater economic benefit**

Crop Safety

- No significant yield loss in lettuce trials
- Mechanical systems generally crop-safe
- Spray systems risk **collateral crop contact**

Technology Evolution

- **Standard Cultivation**
Large untreated band → heavy hand labor
- **Intelligent Mechanical (“Buffer Zone”)**
Camera-guided blades, but weeds near crops remain
- **Precision Kill (“Zero Tolerance”)**
Lasers, hot oil, eclectic zapping treat weeds *right next to crops*
Goal: **minimal or no hand weeding**



Harvest Automation

The Holy Grail

Harvest: The Holy Grail of Automation

- **Speed & Dexterity Gap**
 - Humans: 1 berry every **2–3 seconds**
 - Robots: **7–19 seconds per berry**
- **Low Harvest Efficiency**
 - Robots capture **40–90%** of ripe fruit
 - Missed fruit requires costly human “clean-up”
- **High Capital, Low Utilization**
 - Robotic harvesters are expensive
 - Seasonal yield limits machine uptime
- **Operational & Safety Constraints**
 - Unpredictable picker demand (logistics robots)
 - Safety buffers reduce productivity



Delbridge, T. (2021). Robotic strawberry harvest is promising but will need improved technology and higher wages to be economically viable. *California Agriculture*, 75(2). <https://doi.org/10.3733/ca2021a0009>

Peng, C., Vougioukas, S., Slaughter, D., Fei, Z., & Arikapudi, R. (2022). A strawberry harvest-aiding system with crop-transport collaborative robots: Design, development, and field evaluation. *Journal of Field Robotics*, 1–27. <https://doi.org/10.1002/rob.22106>

Harvest: The Holy Grail of Automation

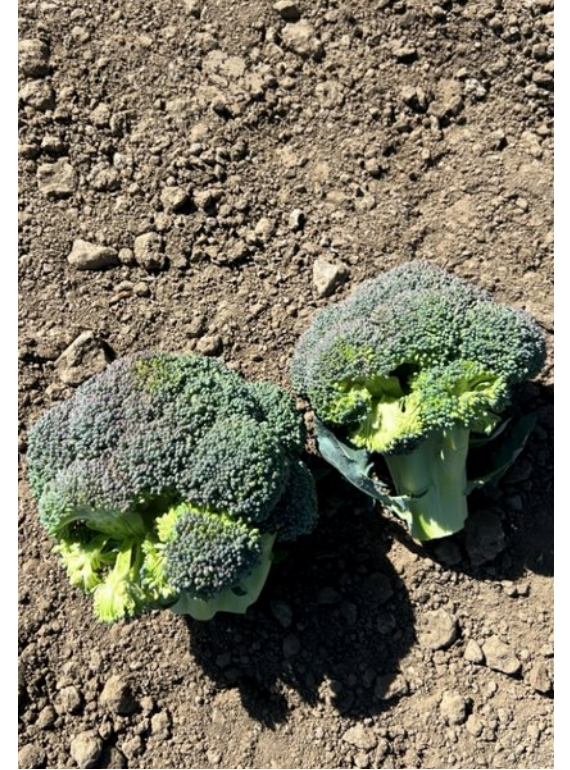
Where Harvest Automation Is Headed

- **Not Yet Economically Viable**
 - Manual harvest still cheaper under current wages
 - Viability requires **≤ 10 sec/berry** and **$\geq 70\%$ efficiency**
- **Rise of Collaborative Robots**
 - Transport “co-bots” reduce walking time
 - Field trials show **$\sim 10\%$ crew efficiency gains**
- **Hybrid Human–Robot Future**
 - Robots handle logistics or first-pass harvest
 - Humans manage complex, delicate picking

Delbridge, T. (2021). Robotic strawberry harvest is promising but will need improved technology and higher wages to be economically viable. *California Agriculture*, 75(2). <https://doi.org/10.3733/ca2021a0009>

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A Generalized Categorization of the robot image recognition levels



Disease and Insect Pest Management

From Lab to Field

Automated Pest and Disease Control

Treatment Tech

- **UV-C light arrays** for non-chemical pest & pathogen control (night operation)
- **High-powered electric vacuums** (45–50 mph airflow) targeting lygus & SWD

Scaling from Pilot to Platforms

- \$5.5M seed round
- 600 acres booked for the 2026 season
- Fleet expansion from ~10 units to 40–50 units
- Santa Maria → Oxnard & Watsonville
- Biologicals: Automated dispersal of beneficial insect

TRIC Robotics



Drone Technology

Expanding use areas

Agriculture Taking a Flight



- Around mid 2000s, commercial drones became available for capturing imagery, marking a shift toward more accessible aerial data collection.
- Over two decades, the use case of drones have expanded to other agricultural uses such as
 - Applying chemicals
 - Spreading seeds, fertilizers
 - Release of beneficial insects.

Agriculture Taking a Flight



- Health & Safety
 - Labor Constraints
 - Environmental & Terrain
- Limitations**

Crop Duster Crashes into Lettuce Field Aug 4, 2013

No one was hurt when the helicopter went down while doing doing aerial agricultural spraying Wednesday morning.

Helicopter spraying pesticides crashes near Gonzales July 20, 2011

Pilot walked away with no injuries

Agriculture Taking a Flight



REMOTE OPERATIONS

Supervised Drone Flights for Continuous Bird Mitigation

Skysense drones launch from automated docks and fly along pre-planned routes under the supervision of certified remote pilots. These patrols deter birds before and after they land, protecting vulnerable crops without the need for on-site labor.

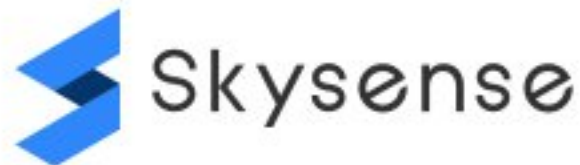
Agriculture Taking a Flight



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Salinas: Silicon Valley of AgTech

Private VC, Local Farmers & Stakeholders

Local Stakeholders, and Public Institutes



GROWER-SHIPPER
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HARTNELL
COLLEGE

AgTech Incubator: Reservoir Farms



08/28/25

The Reservoir Launches First On-Farm AgTech Innovation Hub for Specialty Crops

Startups Taking to the Field this Spring



CropMind



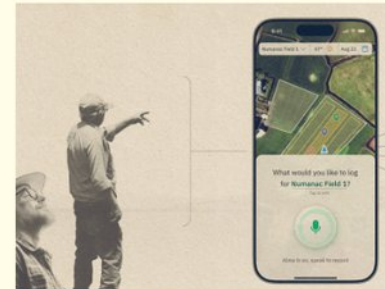
Budbreak



Beagle Tech



Agtom



Numanac



TRIC Robotics



UCCE Ag Tech Program

- Evaluating emerging agricultural technologies such as drones, biological chemistries.
- Field days, workshops.
- Collaborative effort



FCC Covered List Update: Two Temporary Exceptions for Drone Supply in 2026

January 12, 2026

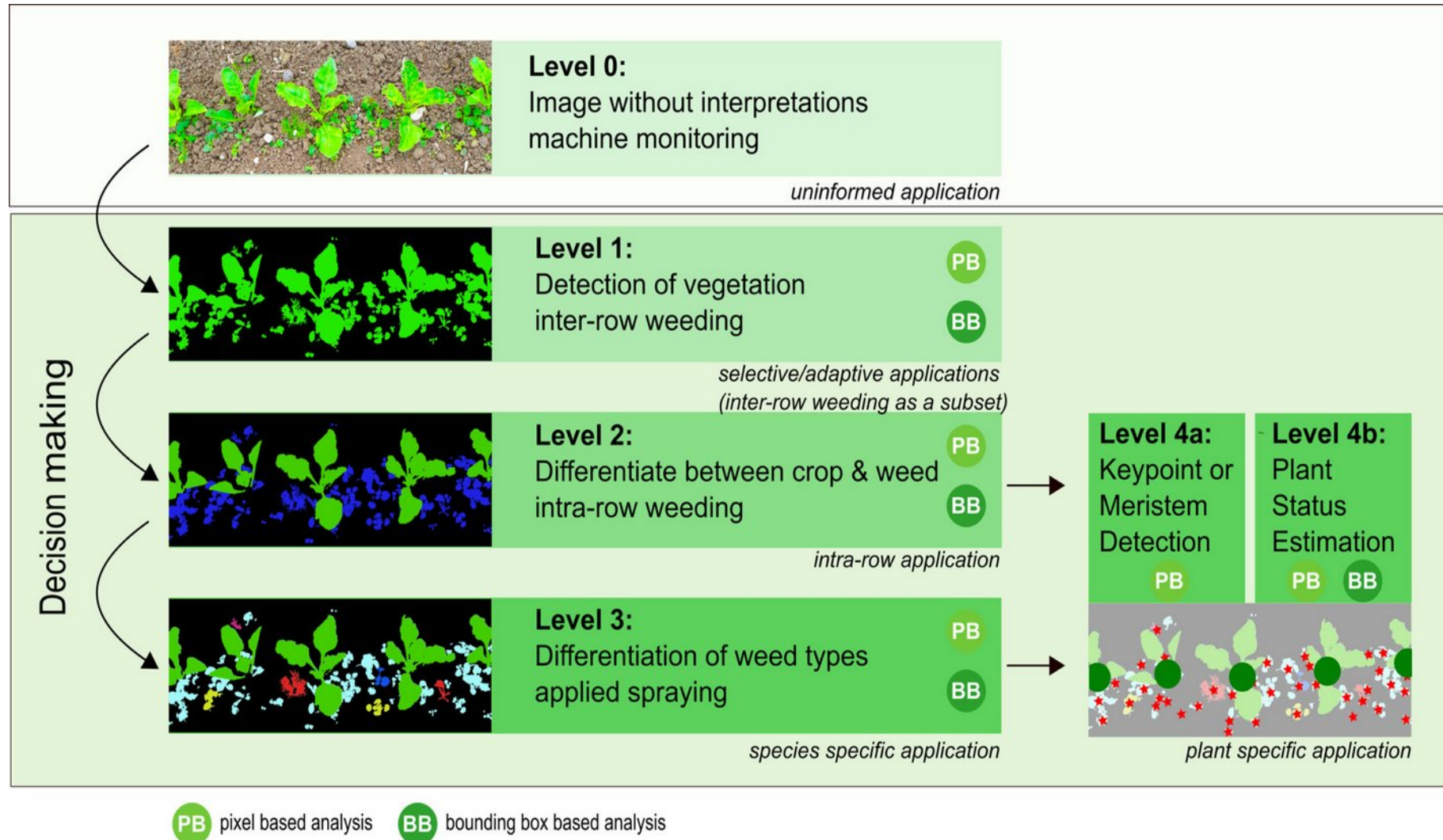
By Paramveer Singh



Questions ?



A Generalized Categorization of the robot image recognition levels



Journal of Field Robotics, Volume: 43, Issue: 1, Pages: 49-62, First published: 28 July 2025, DOI: (10.1002/rob.70030)

Automated Pest and Disease Control

Cal Poly Field Trials 2025: Key Findings on **TRIC Robotics**

Proven Lygus Control

- Organic fields: 36% population reduction
- Conventional fields: 39% reduction
- Maintained control even below economic thresholds

Improved Fruit Quality

- Significantly less Lygus damage
- No pollination-related damage observed

Strong Grower ROI

- Organic: ~\$90/acre/week (~180% ROI)
- Conventional: ~\$109/acre/week despite low pest pressure

Additional Insights

- SWD: 57–59% reduction (promising, more data needed)
- UV-C: Effective on mite eggs (up to 80%), ineffective on Lygus eggs.

A Generalized Categorization of the robot image recognition levels

Level 1



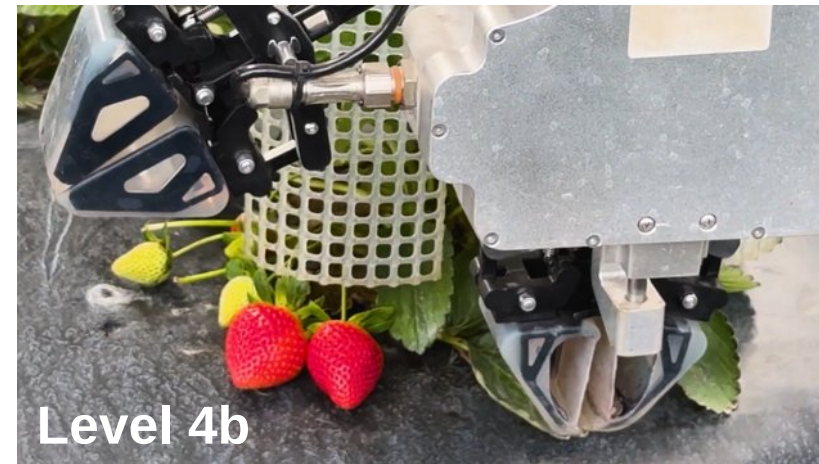
Level 4a



Level 2/3



Level 4b



Central Coast California: A Unique Agricultural System

Rising Labor Costs on California's Central Coast

- Labor costs rose far faster than crop prices or total production costs
 - Regulatory and compliance costs increased **1,366% per acre over last two decades**
 - Labor-related regulations now drive a major share of farm expenses, 1.24% (2006) → **12.6% (2024)**
-
- | | |
|---|--|
| ➤ Workers' Comp: \$428/acre (+627%) | ➤ Lettuce crew wages (2024): \$19–\$21/hour |
| ➤ Wage compliance & paid leave: \$425/acre | ➤ 10% drop in CA vegetable workers (2018–2021) |
| ➤ Affordable Care Act: \$334/acre (new cost) | ➤ Aging workforce; fewer new domestic entrants |
| ➤ H-2A labor: \$25–\$30/hour total | ➤ H-2A jobs grew from ~10,000 (2013) to |
| ➤ Overtime: More crews, higher admin costs | ~40,000+ (2024) |

Hamilton, L., & McCullough, M. (2025). *Two Decades of Change: Evolving Costs of Regulatory Compliance in the Produce Industry*. Cal Poly, San Luis Obispo. [Source 592]

Martin, P. (2022). *Farm Labor Issues in the 2020s*. California Polytechnic State University, San Luis Obispo. (Note: This source provided the data on the 10% decline in the domestic workforce and H-2A expansion statistics).



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Automated Pest and Disease Control

TRIC Robotics: Scaling from Pilot to Platform

- \$5.5M seed round
- Robots-as-a-Service (RaaS): Service pricing comparable to chemical sprays
- Commercial Scale-Up
- Fleet expansion from ~10 units to 40–50 units
- 600 acres booked for the 2026 season
- Santa Maria → Oxnard & Watsonville
- Targets California, ~90% of U.S. strawberry production
- Biologicals: Automated dispersal of beneficial insects
- New targets: Corn earworm, Botrytis in conventional fields, SWD validation

Break-even cost

1. Lettuce (Central Coast)

Wrapped Iceberg Lettuce (24-count carton)

- **Break-Even Price per Carton:** Approximately **\$19.11**
- **Break-Even Price per Pound:** Approximately **\$0.46**
- *Assumption:* Based on a yield of **900 cartons** per acre and a carton weight of **42 lbs.**

2. Romaine Hearts (12 count, 3-heart bags)

- **Break-Even Price per Carton:** Approximately **\$19.76**
- **Break-Even Price per Pound:** Approximately **\$0.90**
- *Assumption:* Based on a yield of **850 cartons** per acre and a carton weight of **22 lbs.**

Break-even cost

Broccoli (Central Coast)

Bunched Broccoli (14 count)

- **Break-Even Price per Carton:** Approximately **\$19.89**
- **Break-Even Price per Pound:** Approximately **\$0.95**
- *Assumption:* Based on a yield of **700 cartons** per acre and a carton weight of **21 lbs.**

Crown Cut Broccoli (Loose pack)

- **Break-Even Price per Carton:** Approximately **\$22.08**
- **Break-Even Price per Pound:** Approximately **\$1.10**
- *Assumption:* Based on a yield of **560 cartons** per acre and a carton weight of **20 lbs.**

Break-even cost

Break-Even Prices (2024 Data)

To cover all costs (cultural, harvest, and overhead), a grower needs a significantly higher price per tray than for vegetable crops.

- **Break-Even Price per Tray:** Approximately **\$12.52**
 - *Assumption:* Based on a yield of **9,000 trays** per acre.
 - *Tray Specs:* Standard tray with eight 1-pound clamshells (approx. 9.0–9.3 lbs per tray)

Automated Pest and Disease Control

Dual-Action Pest & Disease Control in Strawberries

UV-C Light Targets

Fungal diseases

- Powdery mildew (chemical replacement)
- Gray mold (Botrytis)

Mite eggs

- Two-spotted spider mite
- Lewis mite

Bug Vacuum Targets (Physical Removal)

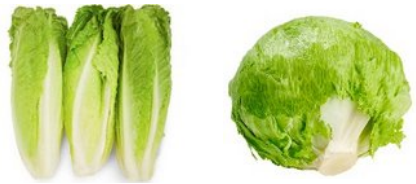
- Lygus bugs
- Spotted Wing Drosophila (SWD)

TRIC Robotics



Central Coast California: A Unique Agricultural System

Production and Harvest Costs Per Acre (2023–2024)



Crop	Total Cost
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