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SmartProbe System for Improved IPM and Quality Control

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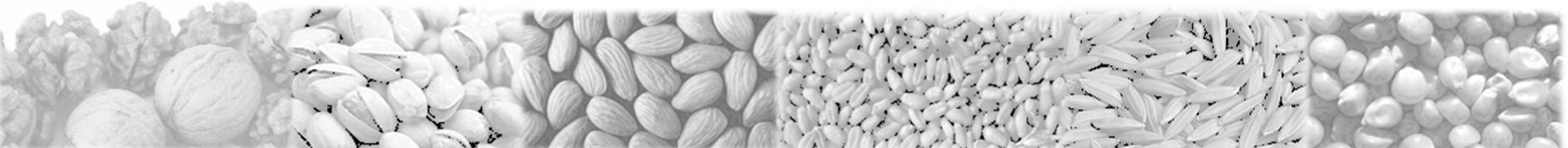
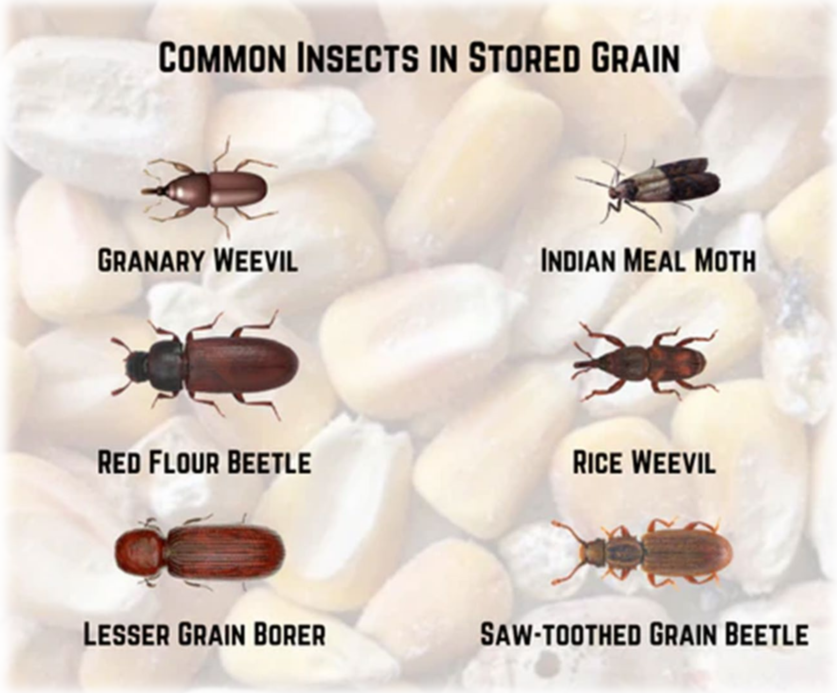


Insect Pests Related to Flour Mills

- Internal feeders (pests of whole grain)
  - Grain weevils
    - Granary weevil
    - Rice weevil
    - Maize weevil
  - Lesser grain borer
  - Angoumois grain moth
- External feeders
  - Indian meal moths
  - **Flour beetles**
  - Sawtoothed grain beetle
  - Flat grain beetle
  - Mealworms
  - Cadelle beetle

- Other pests
  - Psocids
  - Mites



Insect Infestation in Entire Supply Chain

Wheat storage and transportation

Flour mill, warehouse, and transportation

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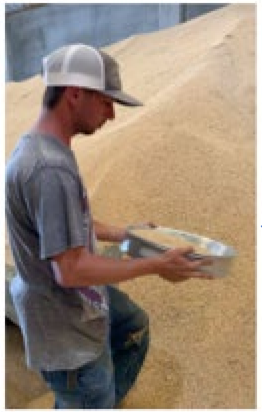
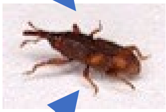
Problems of Insect Infestation

- Product loss
- Quality loss
- Food safety risk
- Economic loss
- Management cost
- Efficiency and profitability of operation
- Non-regulatory compliance
- Consumer/customer experience
- Liability

Current Insect Pest Control Practices – Human Inspection

Product sampling inspection



Trap inspection

Light trap

Protecta trapper

Sticky trap

Inaccuracy

Expensive

Health & Food Safety

Milling Quality Loss & Economic Effect

Storage Facility	Storage type	Rice category	Milling quality		
			TRY (%)	HRY (%)	WI
A	Metal (Bin 47)	Infested rice	64.81±0.32 a	58.12±0.18 a	40.10 ±0.20 a
		Clean rice	67.57±0.17 b	60.88±0.15 b	40.23±0.33 a
	Metal (Bin 48)	Infested rice	64.16±0.25 a	57.18±0.47 a	39.53±0.24 a
		Clean rice	67.57±0.17 b	60.88±0.15 b	40.23±0.33 a
B	Flat warehouse	Clean rice	66.02±0.69 a	59.88±0.62 a	39.63±0.36 a
		Clean rice	66.91±0.51 a	60.86±0.31 a	39.67±0.04 a

- $5.5 loss per ton of paddy rice due to 2.5% milled rice reduction*
- Chemical fumigation cost: $2.5 per ton
- $770 for each 100t storage

California Rice Research Board (CRRB) Report- 2016

*based on the rice price in 2021

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SmartProbe Technology: Insect early detection, temperature, RH and moisture management

Sensors

Insect entry

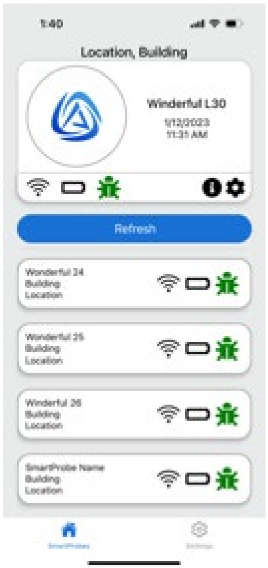
Camera and Insect collecting chamber

For detection in product

For detection in air

SmartProbe

Cloud Data and Computing



Application User Interface

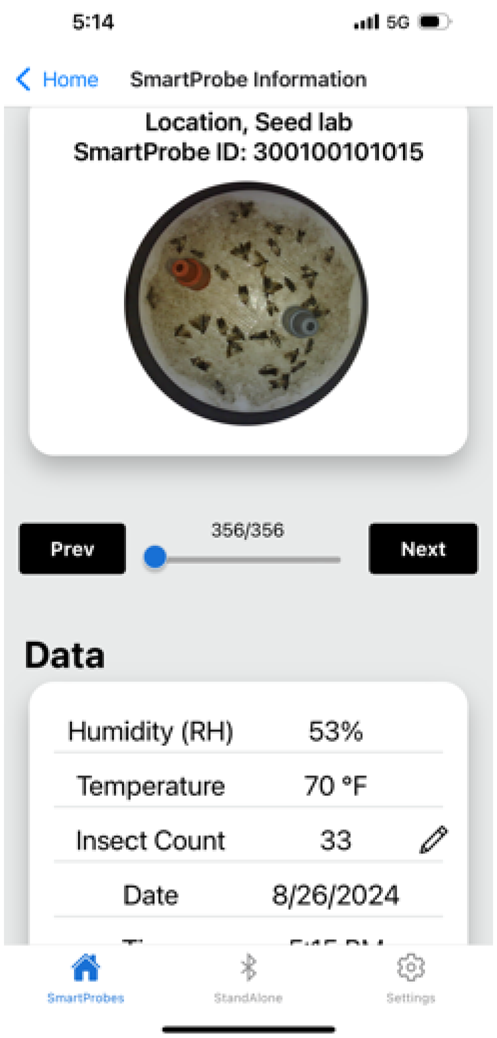
Patented technology

SmartProbe technology: Insect early detection, temperature, RH and moisture management

Sleeve tube prevents debris
from getting into probe

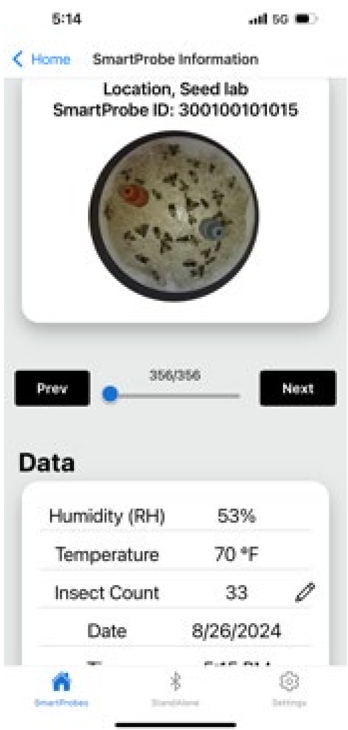
For both flying and crowing
insects

SmartProbe APP

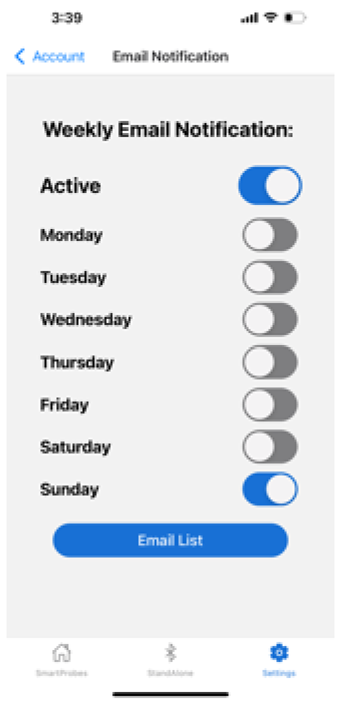


SmartProbe Technology - Features

- WiFi and Offline operation capabilities
- Flexible scheduling for photo and data collection
- Provide notification based on schedule or when insect activity is detected
- AI identify the numbers of insects
- Predict product moisture based on temperature and RH
- Able to fumigate with SmartProbes in product
- Data gathered can be downloaded into a spreadsheet



AI identify the numbers of insects



Flexible scheduling of data report

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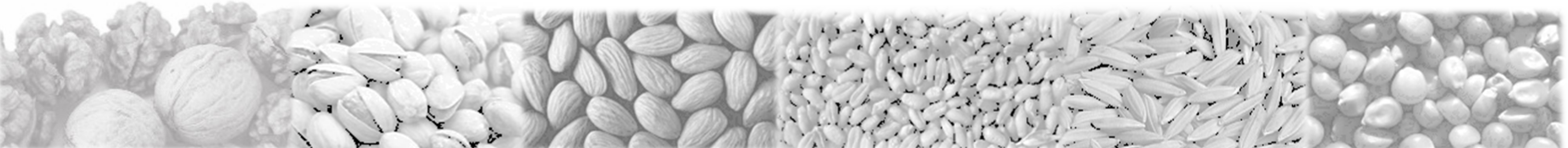
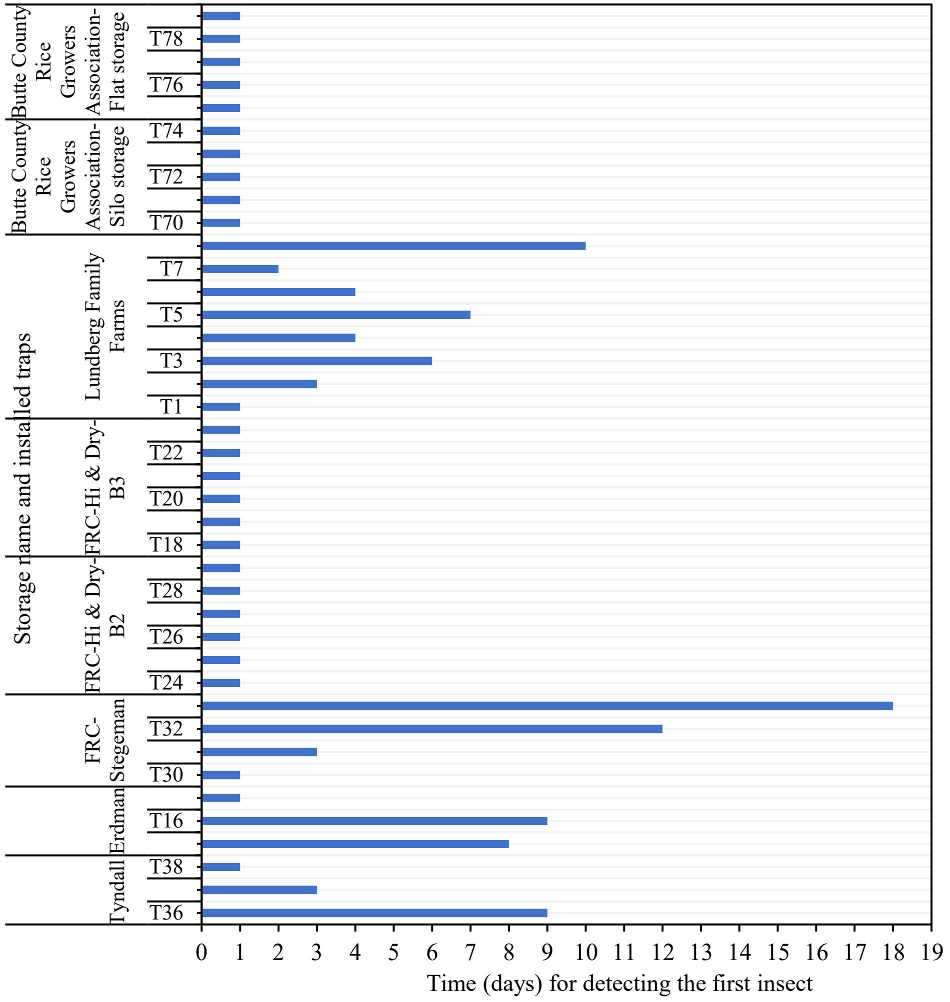
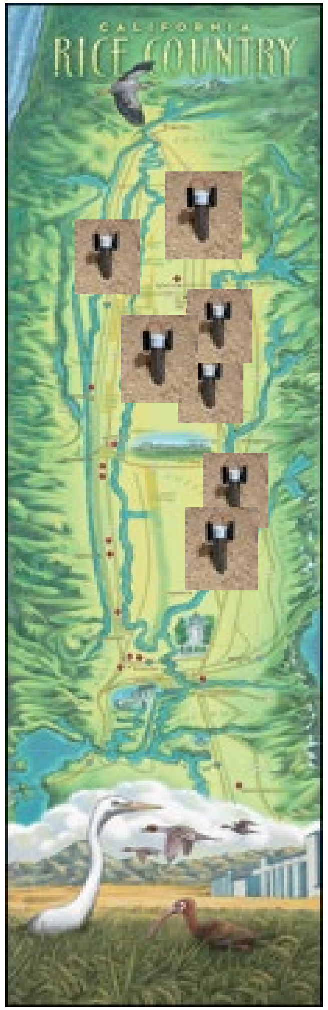
Can insects be detected early in raw materials before milling?

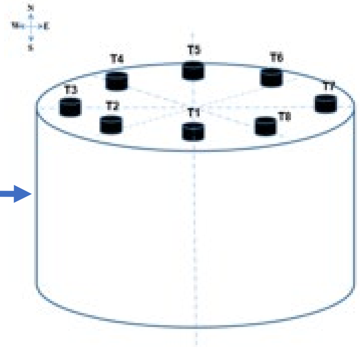


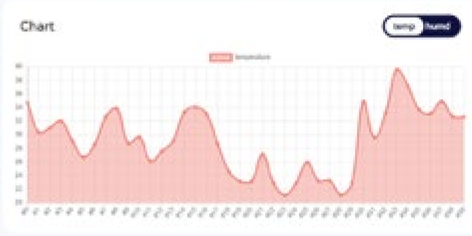
Case Study Results: Early Detection and Effectiveness in Rice Silos

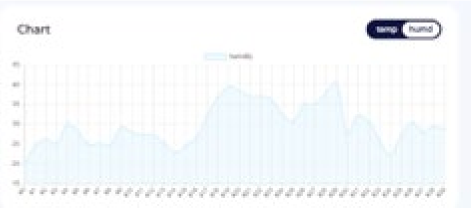


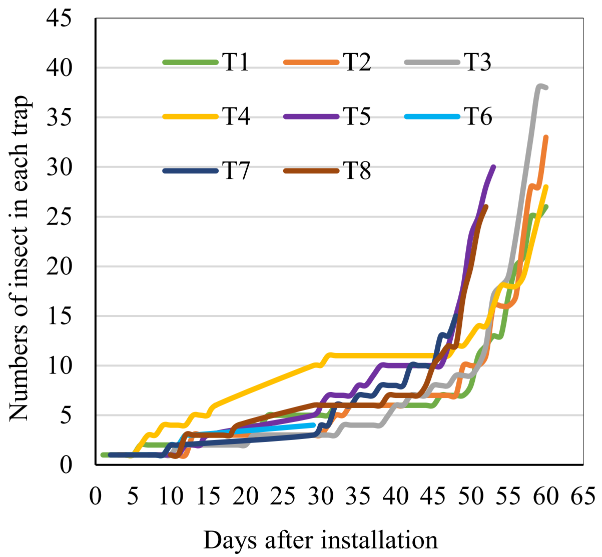


Case Study Examples - Insect Development during Storage









Installation Date:
4-28-2021

Example – Insects Develop Quickly during Storage

5/27

6/1

6/17

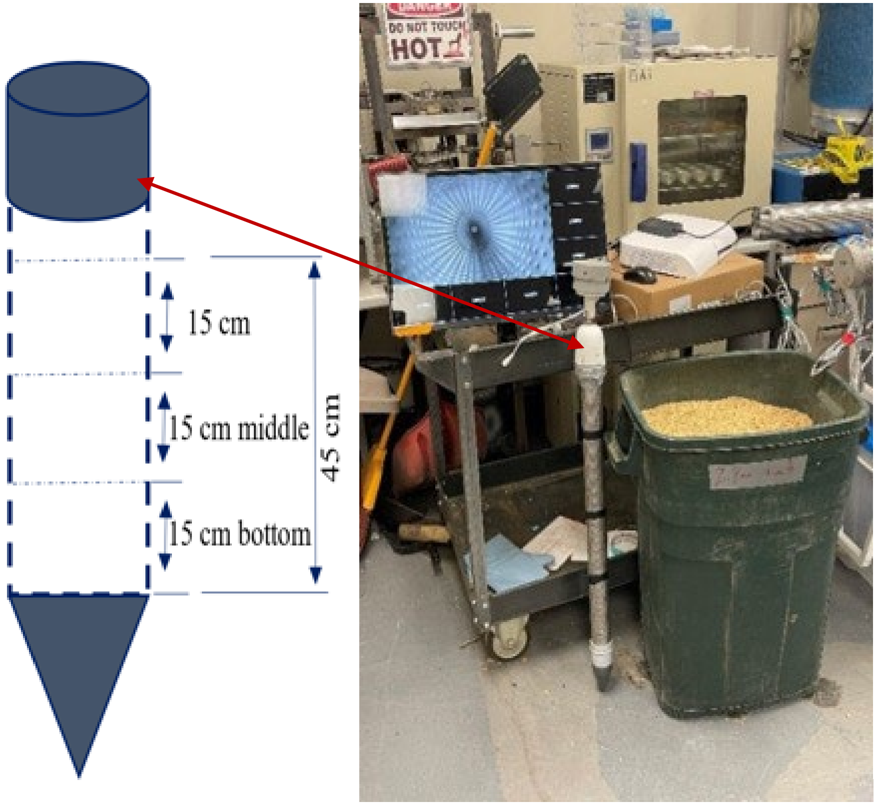
6/18

6/20

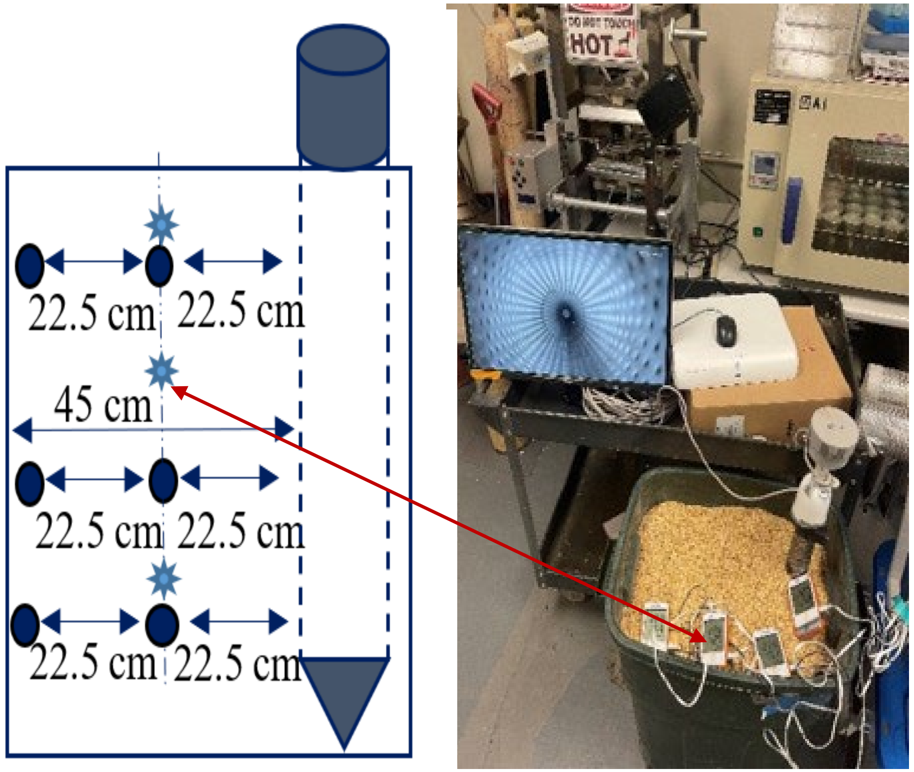
7/1

Movement Behavior of Insects - Laboratory Test

- Monitoring device
  - Length 45 cm
  - Diameter 5 cm
  - Three sections
  - Each 15 cm
  - Video camera
  - Temp & RH sensors
- Infestation GC analyze
  - Top
    - 22.5 cm
    - 45.0 cm
  - Middle
    - 22.5 cm
    - 45.0 cm
  - Bottom
    - 22.5 cm
    - 45.0 cm



Monitoring device

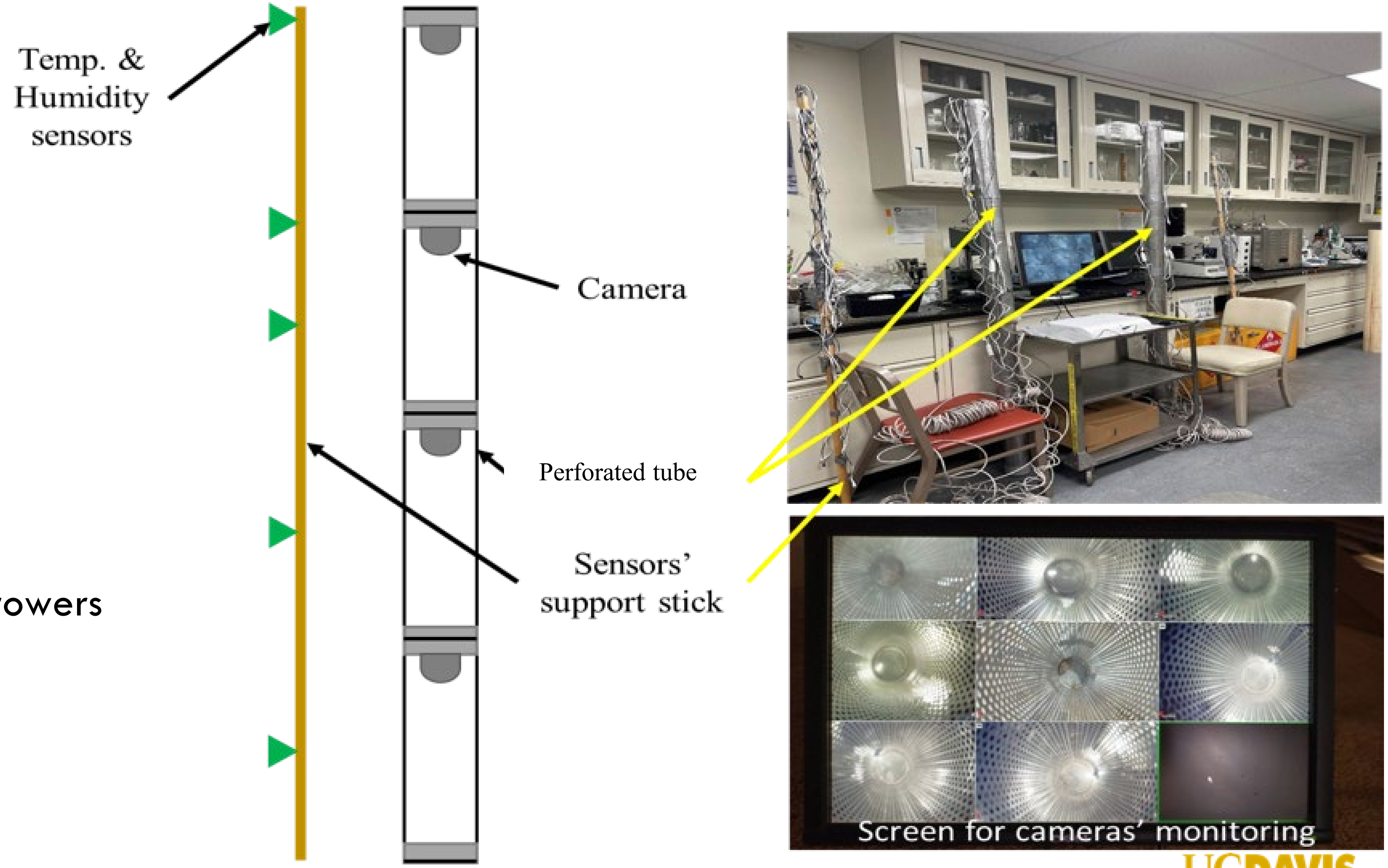


Test set-up

Movement Behavior of Insects - Silos

- Insect-catching device
  - Length 200 cm
  - Diameter 9 cm
  - Four sections
  - Each 50 cm
  - Video camera
  - Temp & RH sensors

- Installation
  - Framers Rice Co-Op (Hi&Dry)
  - Butte County Rice Growers Association



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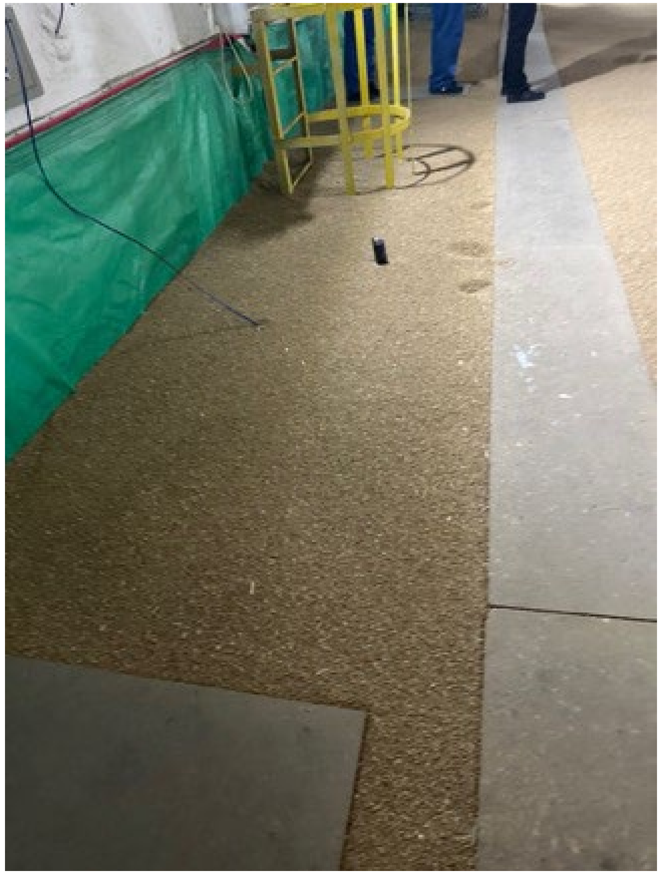
Reduction of Chemical Use and Cost by Early Detection and Treatment

74% chemical cost reduction for disinfestation treatment due to early detection and using insecticide Centynal.

Example – Insect Is Still Active at Low Temperature

Wheat storage



Example – Insects are Still Active at Low Temperature

Fumigated on July 1, 2024

7/25/2024
79ºF

9/5/2024
71ºF

9/16/2024
74ºF

10/10/2024
60ºF

Insects developed as unexpected

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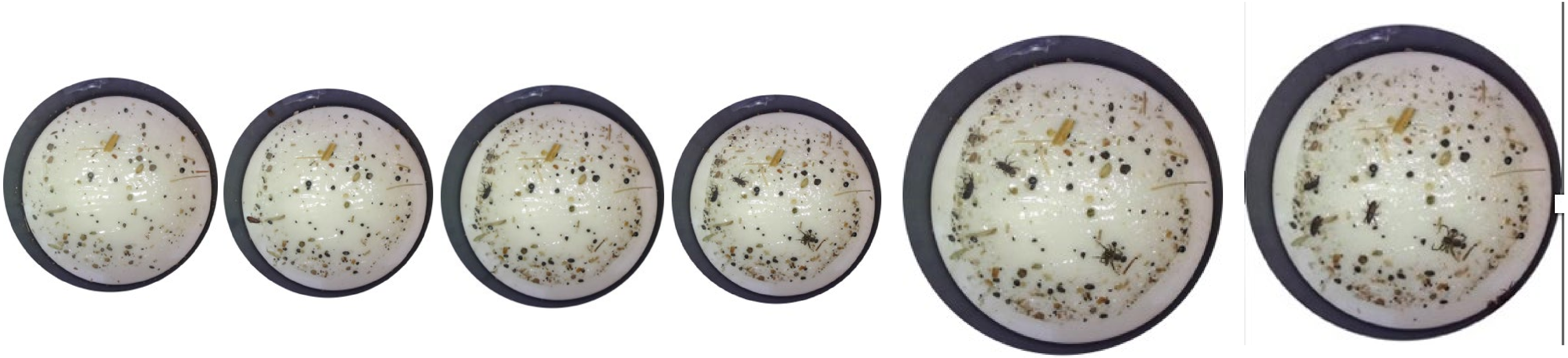
Example – Insect Is Still Active at Low Temperature

Fumigated on July 1, 2024



10/10/2024
64ºF

10/17/2024
62ºF

10/28/2024
55ºF

10/29/2024
55ºF

10/31/2024
57ºF

1/1/2024
59ºF

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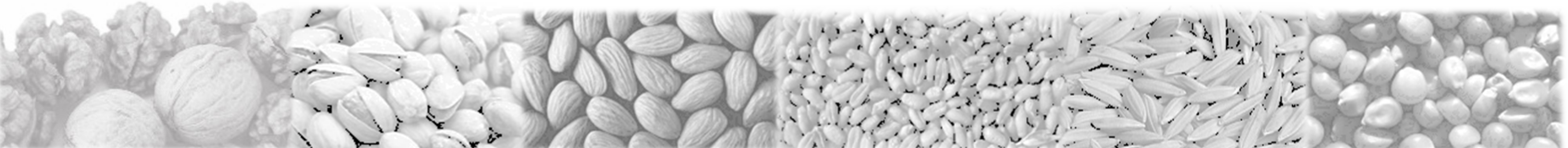
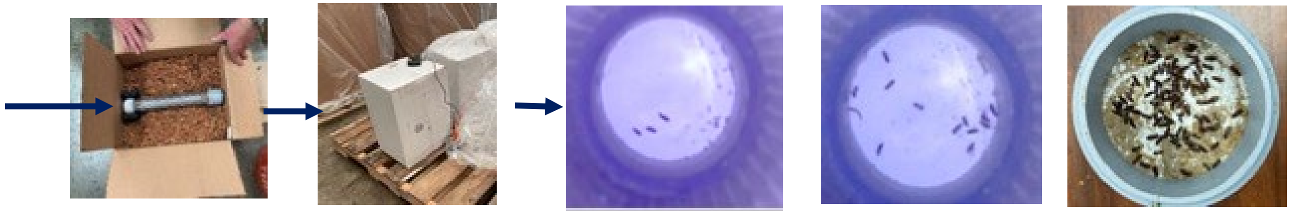
Is SmartProbe more effective than the current methods?



Insects in Almond Box and Bins

- Insect detection results
  - Detected in carton box without plastic liner, but no insect detected for the box with a plastic liner.
  - In one of the two fiber bins.
  - No insects were detected in the two bins of rejected kernels.
- Average temperatures: 32.7 - 31.9°C.
- Relative humidity: 41.8 - 40.7%.

SmartProbe



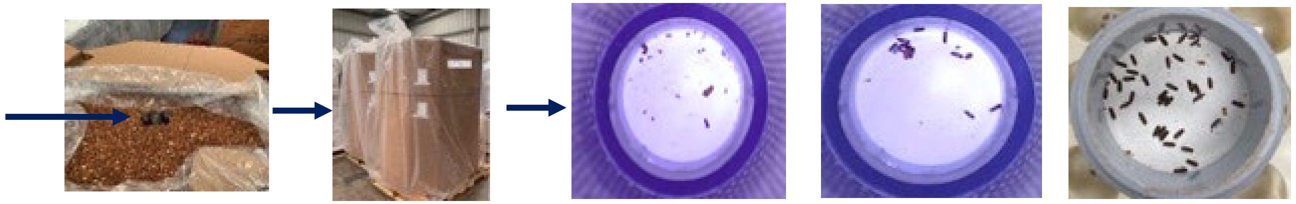
Carton box without plastic liner

3 days

7days

45 days

SmartProbe

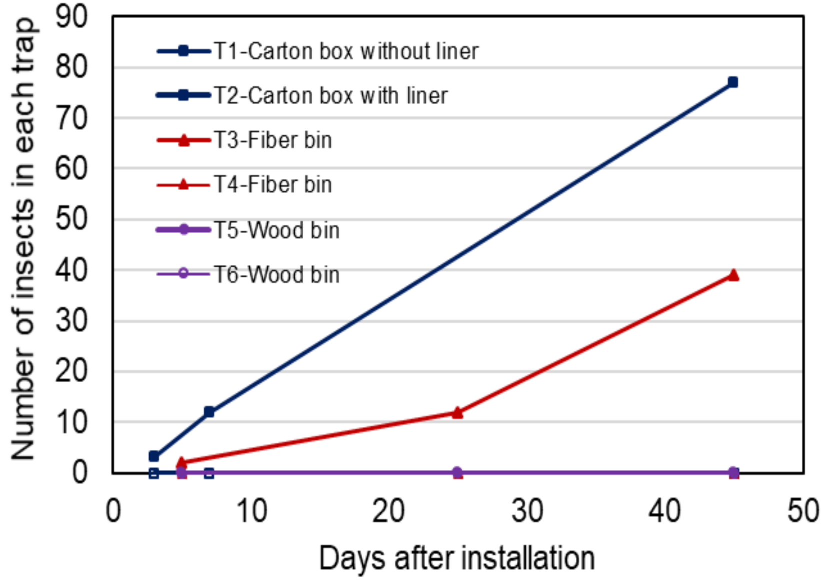


Fiber bin

5 days

25 days

45 days



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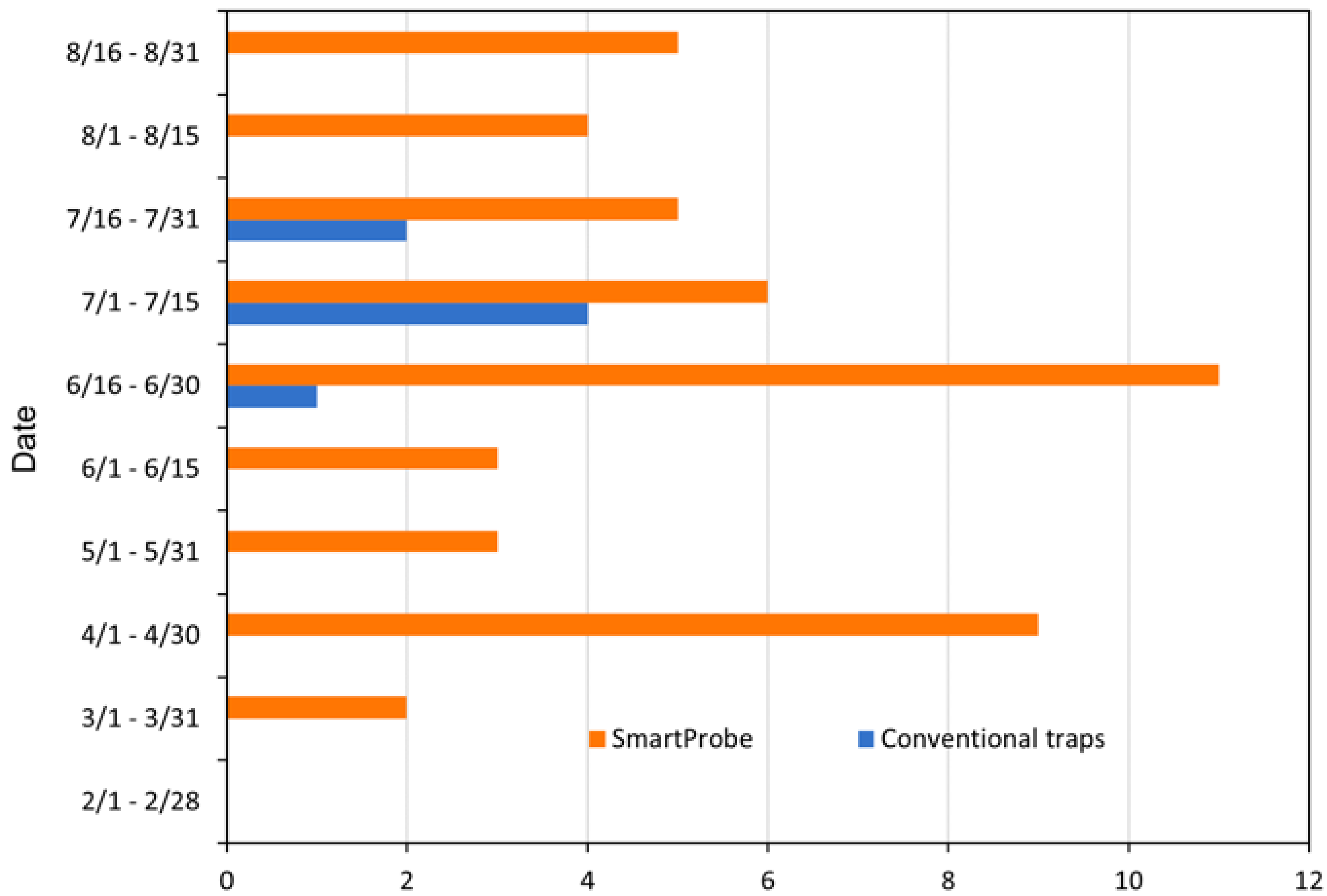
SmartProbe Effectiveness vs. Conventional Traps

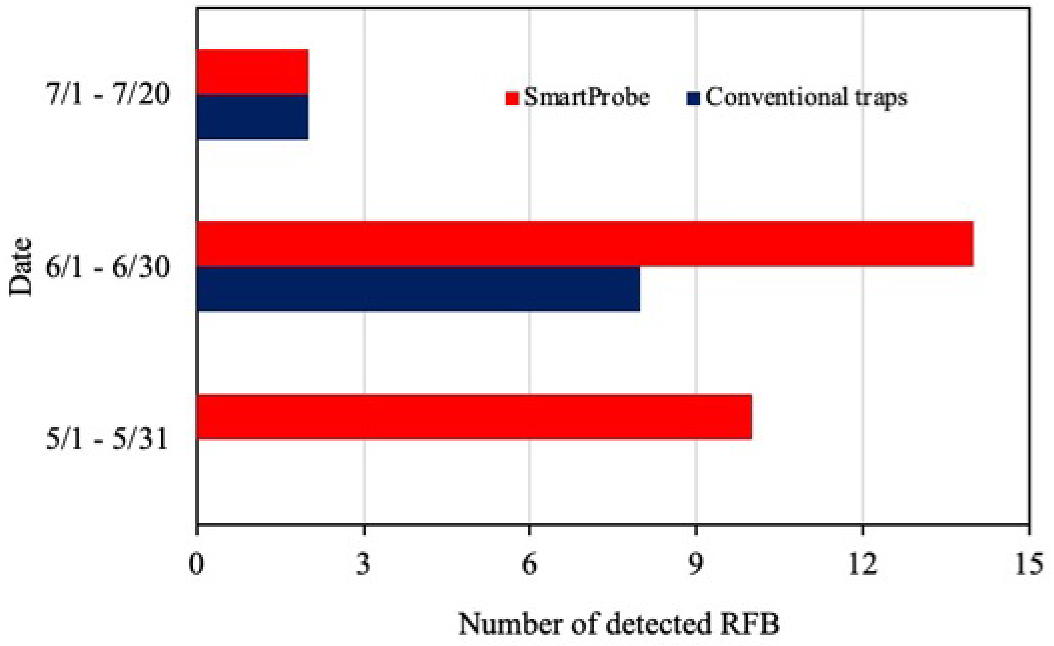


Comparison of the numbers of detected red flour beetles by **three** smart probes vs. **seven** conventional traps in a tree nut packaging room in 2023

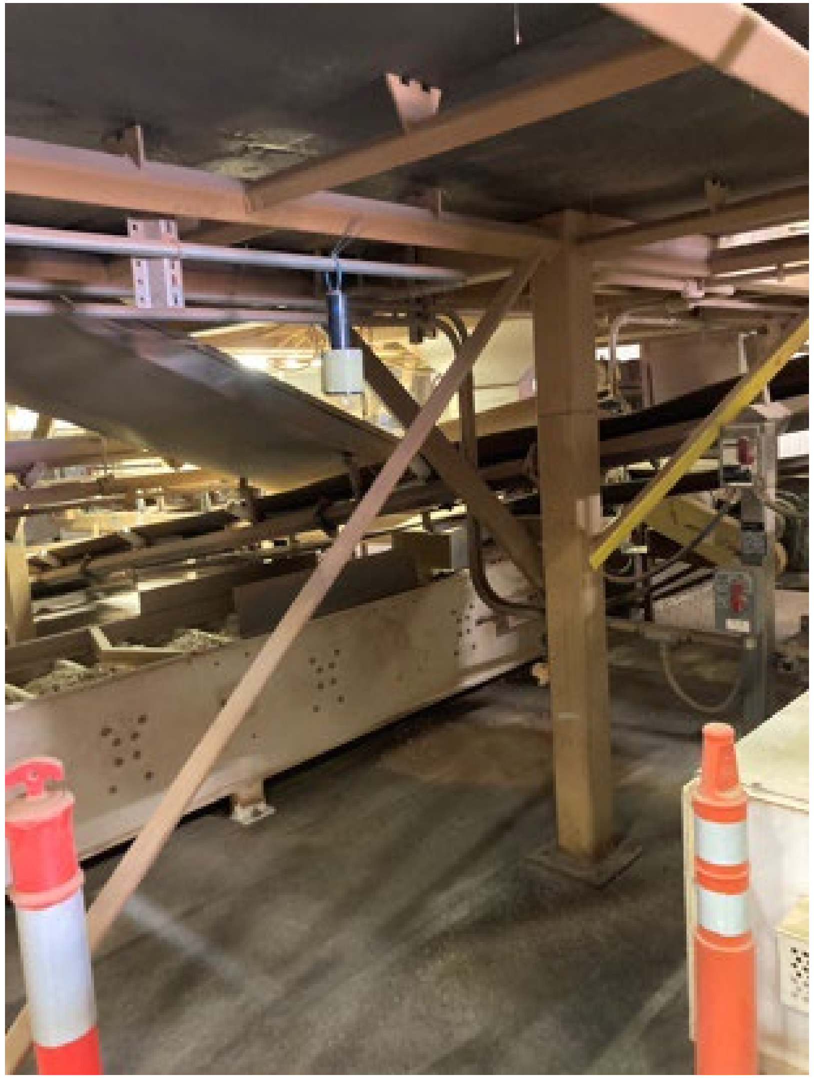
Vector light trap

Protecta trapper

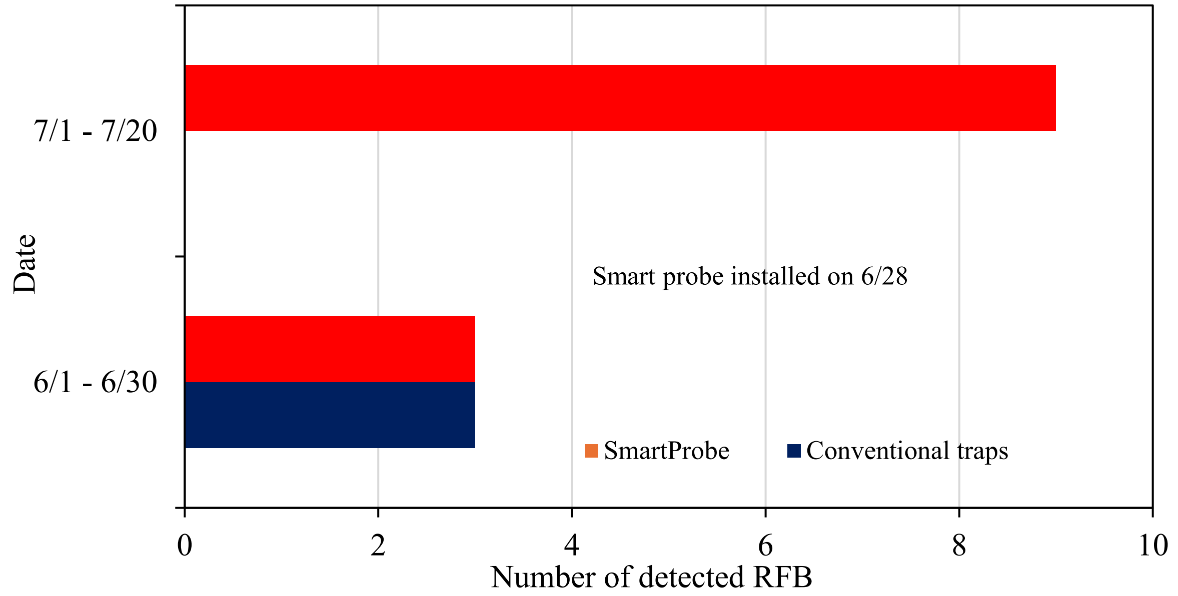
Effectiveness: SmartProbe vs. Conventional Traps in Dusty Environment



One SmartProbe vs. two conventional traps in the Building #25 from 5/1/24 to 7/20/24



Effectiveness: SmartProbe vs. Conventional Traps in Dusty Environment



Numbers of RFB insects detected by one probe and conventional traps (4 pheromone traps, 2 light traps) in the Building #23 from 6/1/24 to 7/20/24

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Case Study Results: Moisture Monitoring – Lab Test

Sensor		ABC	
MC% Almond samples	RH (%)	MC (%)	RH%
9.0	55.6	8.3	56.0
10.7	64.8	10.9	65.0
12.0	69.7	12.2	69.0

ABC: Almond Board of California (Stockpile Management Best Practices)

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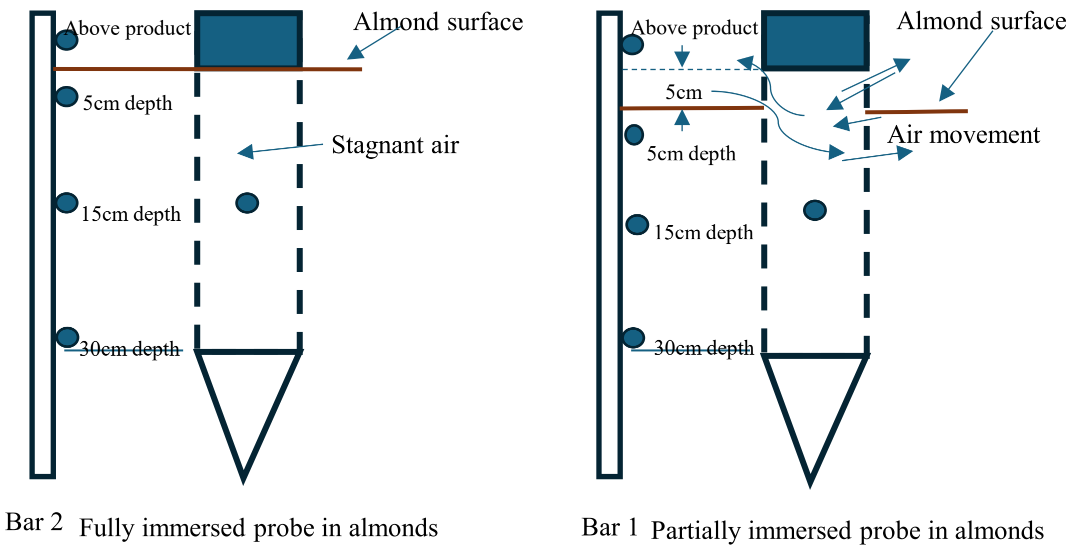
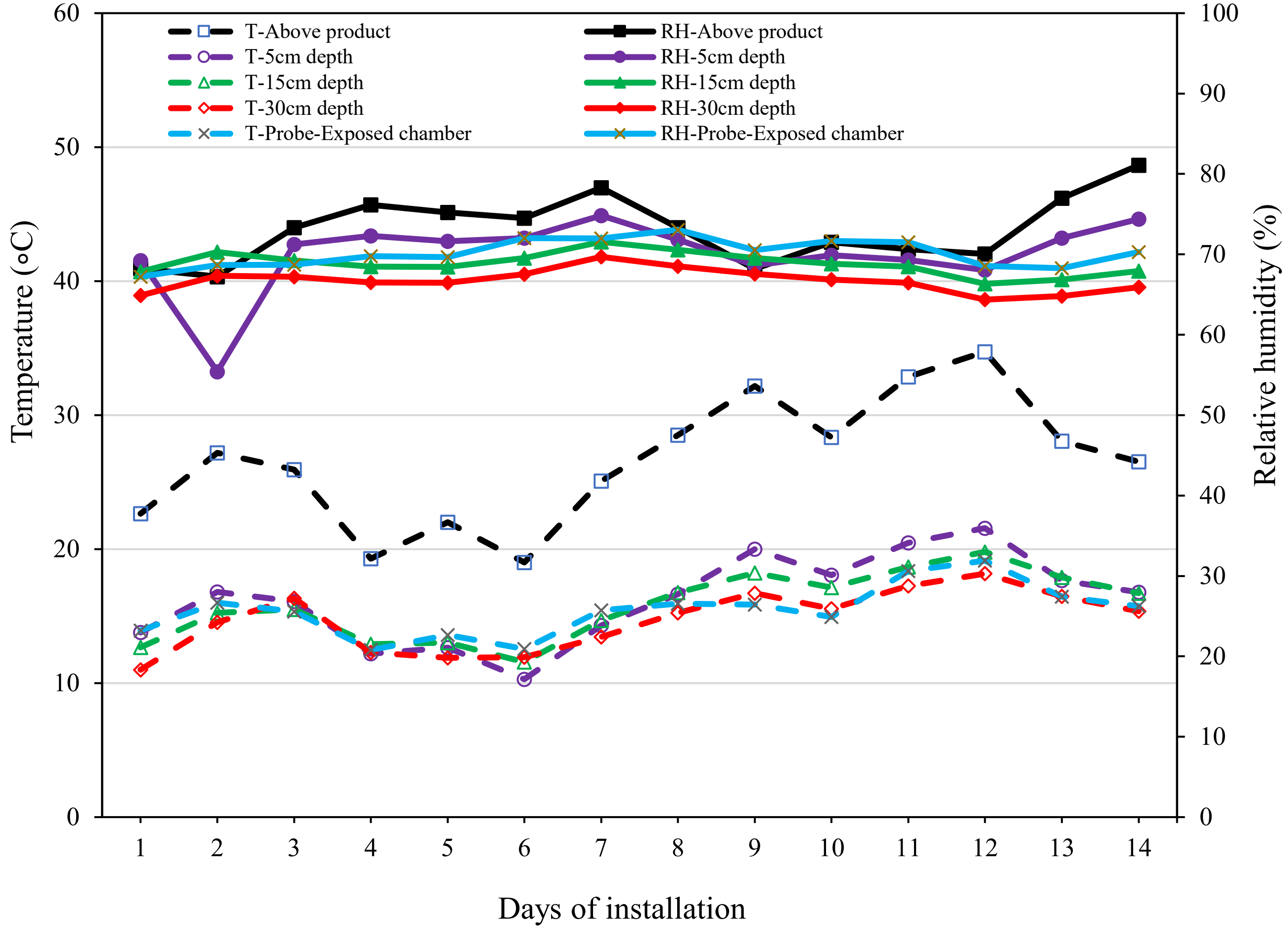
Case Study Results: Moisture Monitoring – RH in stockpiles





Average RH from probe (%)	Average RH from Sensor (%)	MC (%)	
		ABC	Measured
70.1±1.7	70.1±4.7	12.55	12.32 ±0.2

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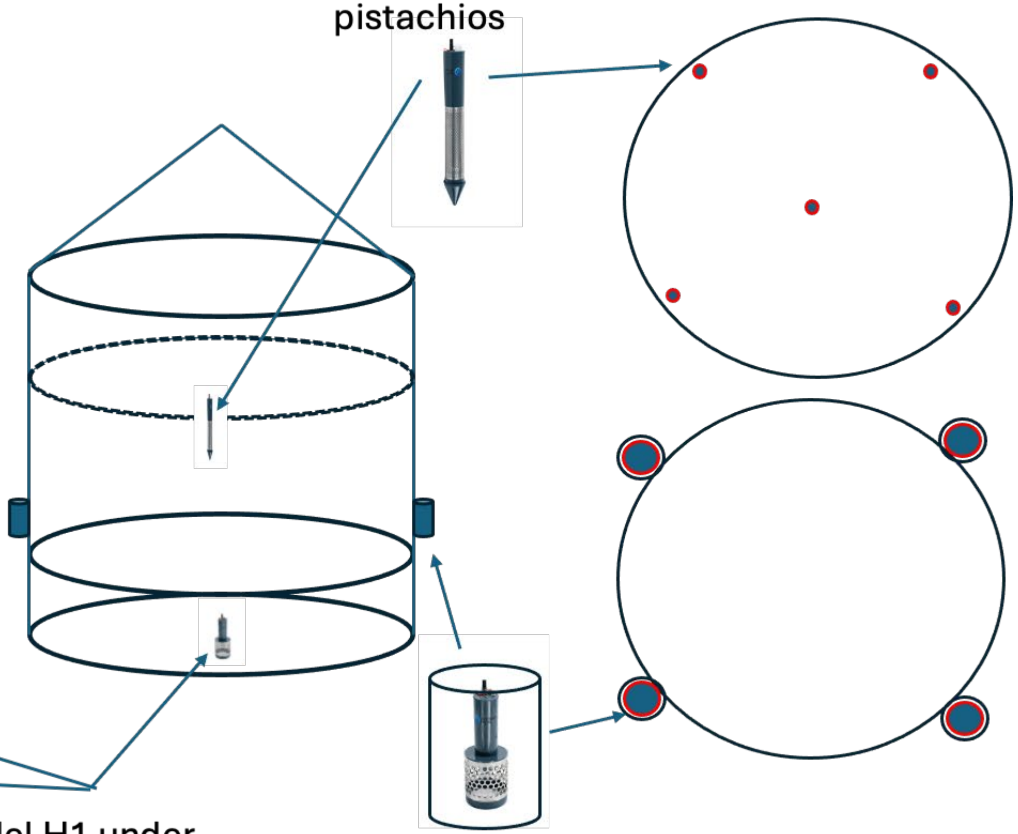
Insect and Moisture Monitoring in Pistachio Silos



Applications of SmartProbe

- Silos and storage
- Mills
- Warehouse
- Transportation
- Quality inspection

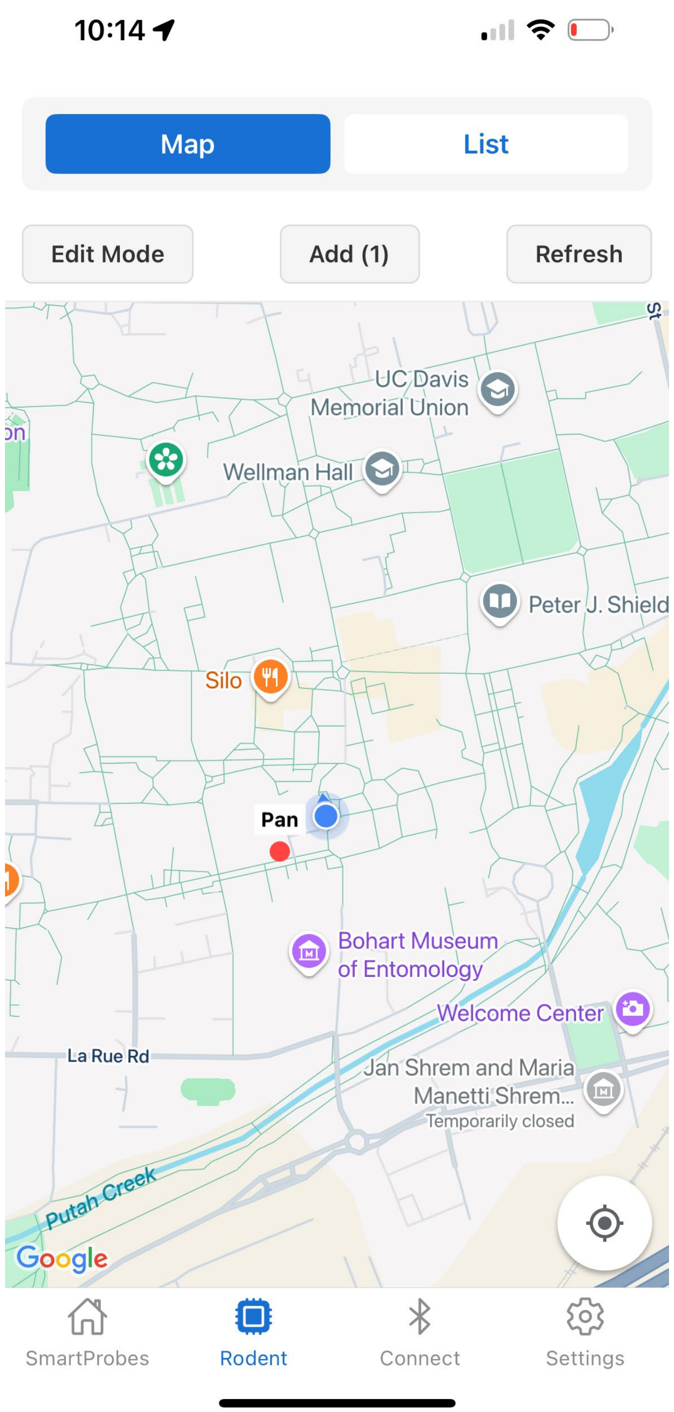
Monitor insect and moisture change in silos and storage

Examine insects and moisture before shipping and at receiving

Monitor insects in mills and examine insects in tailings

Monitor insects in flour and warehouses

Smart Rodent Sensor



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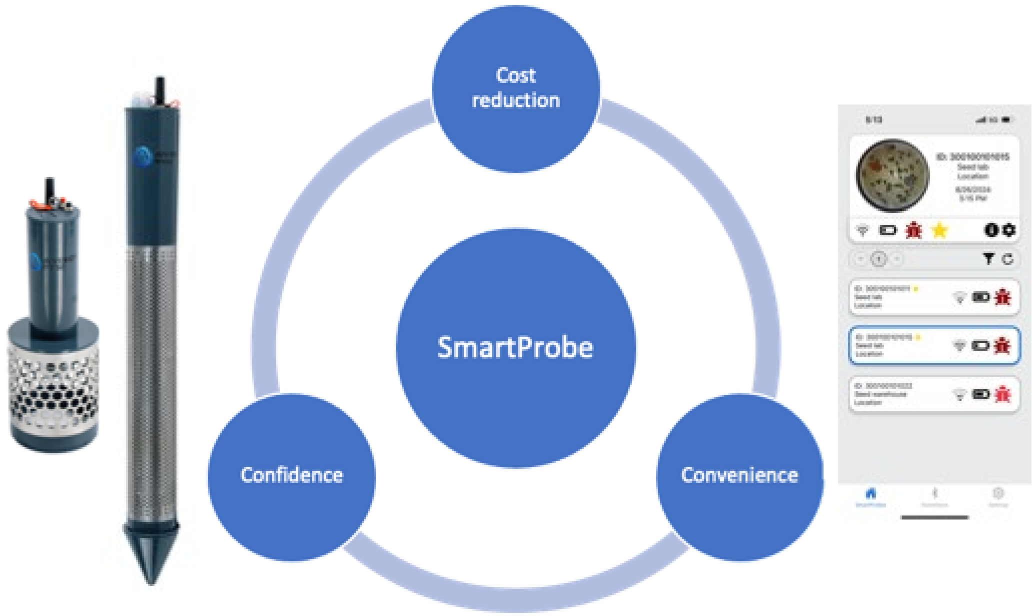
Significant Saving in Labor Cost for IPM

- Labor cost for current IPM practices
  - $30 per hour?
- SmartProbe
  - Work 24/7
  - Last several years
  - ROI – one year?
  - Other savings



VS

Current insect traps with human inspection

Commercial Users of SmartProbe

TOUCHSTONE PISTACHIO Co
USDA ARS
BLUE DIAMOND GROWERS
the Wonderful company
Setton Farms
Primex
Yihai Kerry Company Profi
益海嘉里
ShoEi
Ardent Mills
Miller Milling
UC RIVERSIDE UNIVERSITY OF CALIFORNIA
VANN FAMILY ORCHARDS
UC CE University of California Cooperative Extension
CIC 中国检验认证集团 CHINA CERTIFICATION & INSPECTION GROUP
CARRIERE FAMILY FARMS
CAPEX
TRITON
天津天隆农业科技有限公司 TIANJIN TIANLONG AGRICULTURAL SCIENCE AND TECHNOLOGY CO.,LTD
CORNELL UNIVERSITY
UNIVERSITY ARKANSAS
KANSAS STATE UNIVERSITY FEBRUARY 16, 1863
JIANGSU UNIVERSITY 1902
1956
国家粮食储备库
FRC MERS RICE COOPERATIVE Stegeman Station
California Cooperative Rice Research Foundation, Inc. Rice Experiment Station
HORN TECHNOLOGIES & SERVICES
KEENAN FARMS CALIFORNIA
ACC AMERICAN COMMODITY COMPANY, LLC
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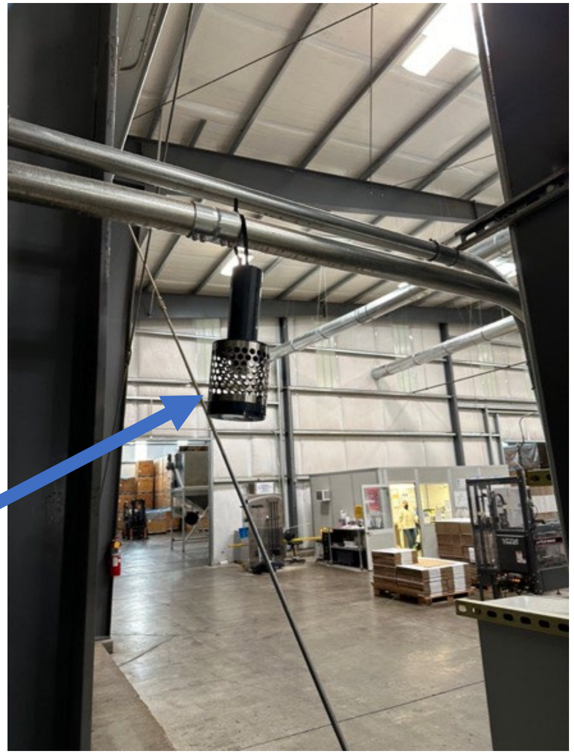
SmartpProbe Ready for You

SmartProbe APP

Smart probe



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Thank You

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