The Australian Hazelnut Program of Research (AUSHAZ)

Project 3.1
Hazelnut Drying: From Understanding to Optimisation

Dr. Yong Wang
Pavittar Singh Sandhu

University of New South Wales, Sydney
School of Chemical Engineering

Background and Project Summary (2024-29)

Primary Goal:

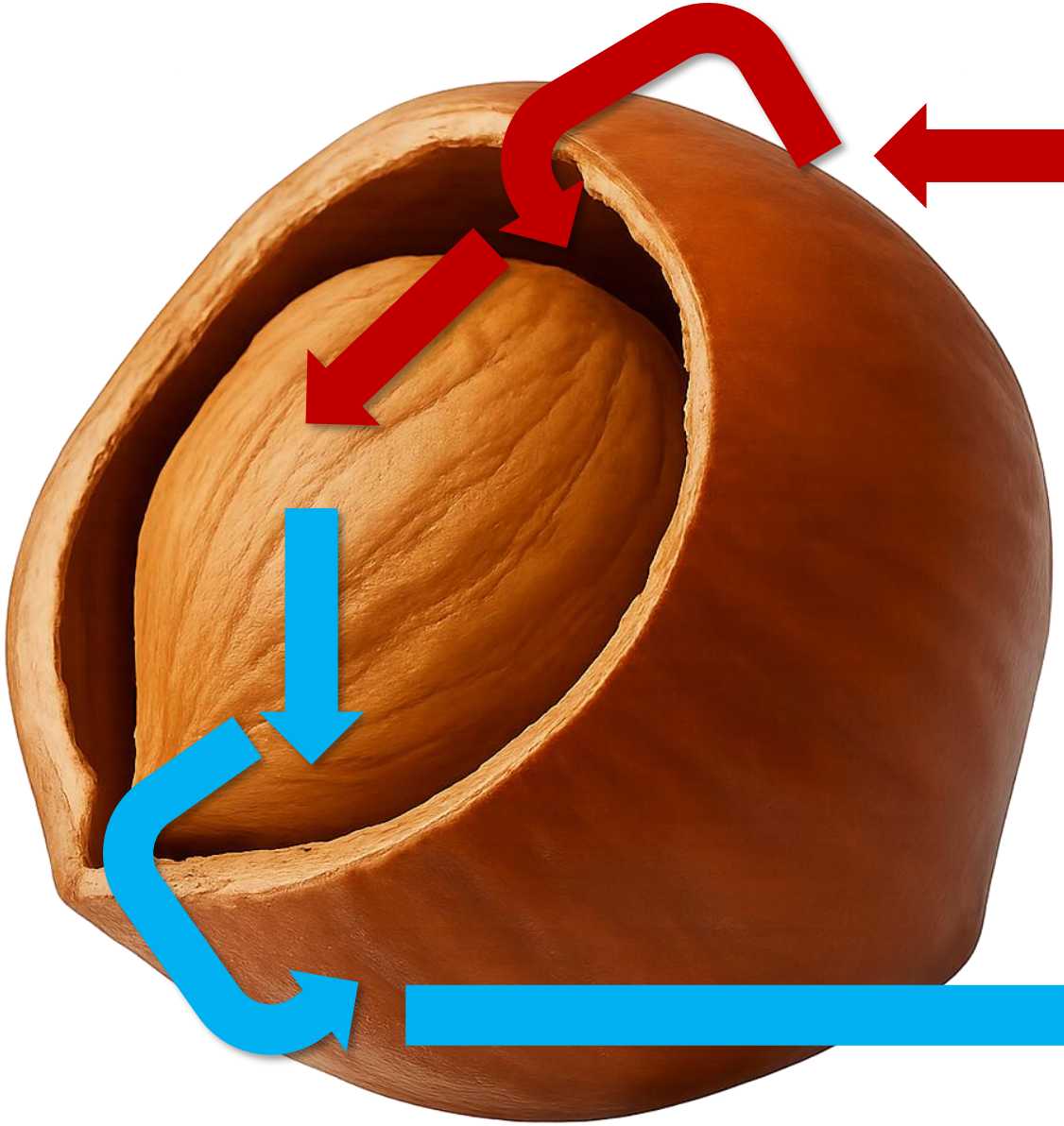
- To design, construct, and validate a post-harvest drying system optimized for hazelnuts.

Feature

- Scalable, low-cost, energy-efficient, real-time monitoring drying system tailored to Australian conditions.

Specific Objectives:

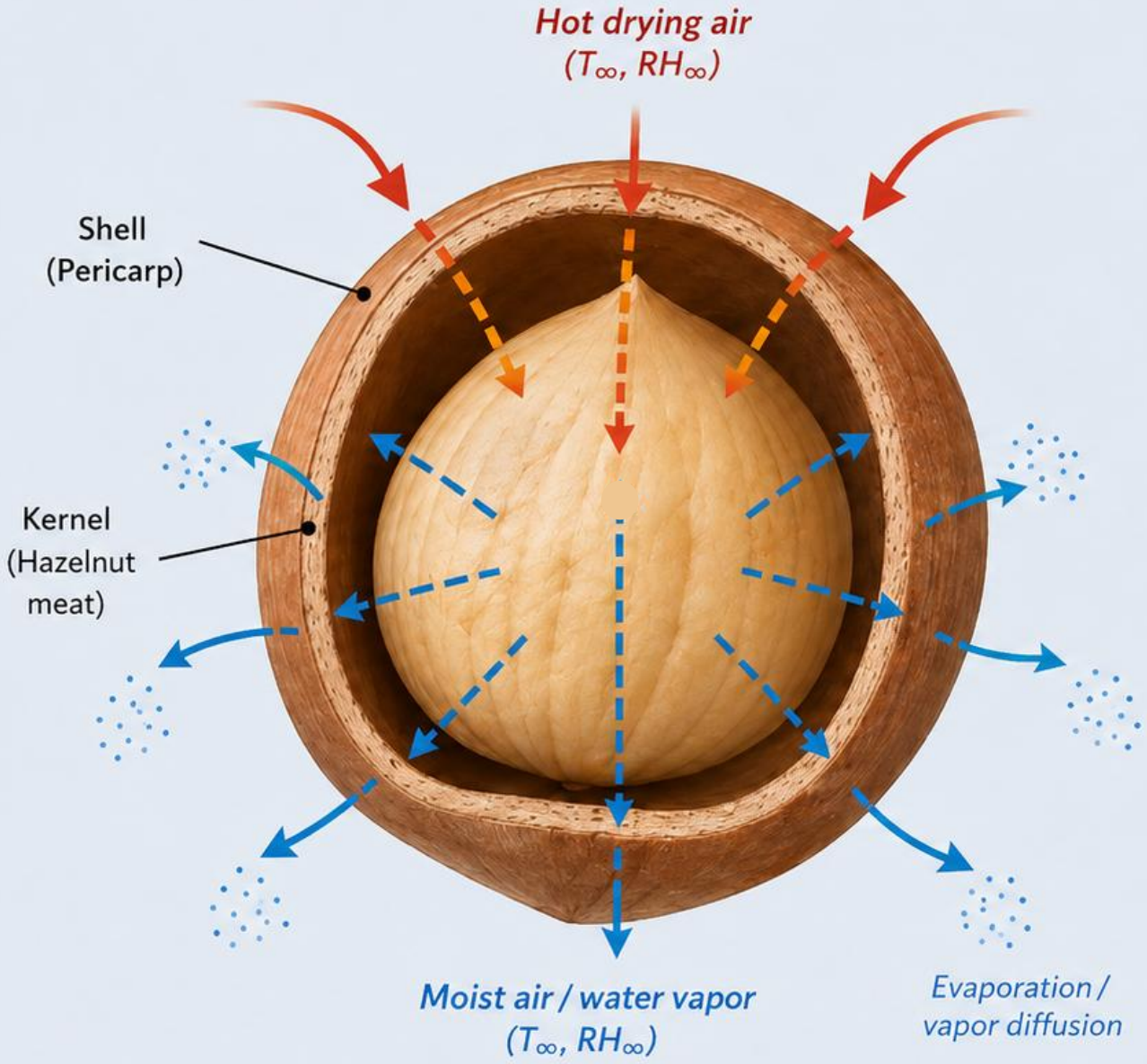
- Achieve uniform moisture reduction without quality degradation.
- Enable real-time monitoring of drying conditions via IoT integration.
- Investigate drying kinetics and nutritional changes.
- Low cost.



Heat transfer

What happens during drying hazelnuts?

Moisture transfer



MASS AND HEAT TRANSFER DURING HAZELNUT DRYING

Heat moves inward while moisture diffuses outward.

HEAT TRANSFER

- Heat is convected from the hot drying air to the shell surface.
- Heat conducts through the shell and into the kernel.

MOISTURE TRANSFER

- Moisture diffuses from the kernel interior to the shell.
- Moisture continues through the shell and evaporates into the drying air as water vapor.

Heat convection (in air) | Heat conduction (in solid) | Moisture diffusion (in solid) | Vapor transport (in air) | Water vapor in drying air

Agenda

ON-FARM TRIAL SETUP

REMOTE DATA LOGGING SYSTEM

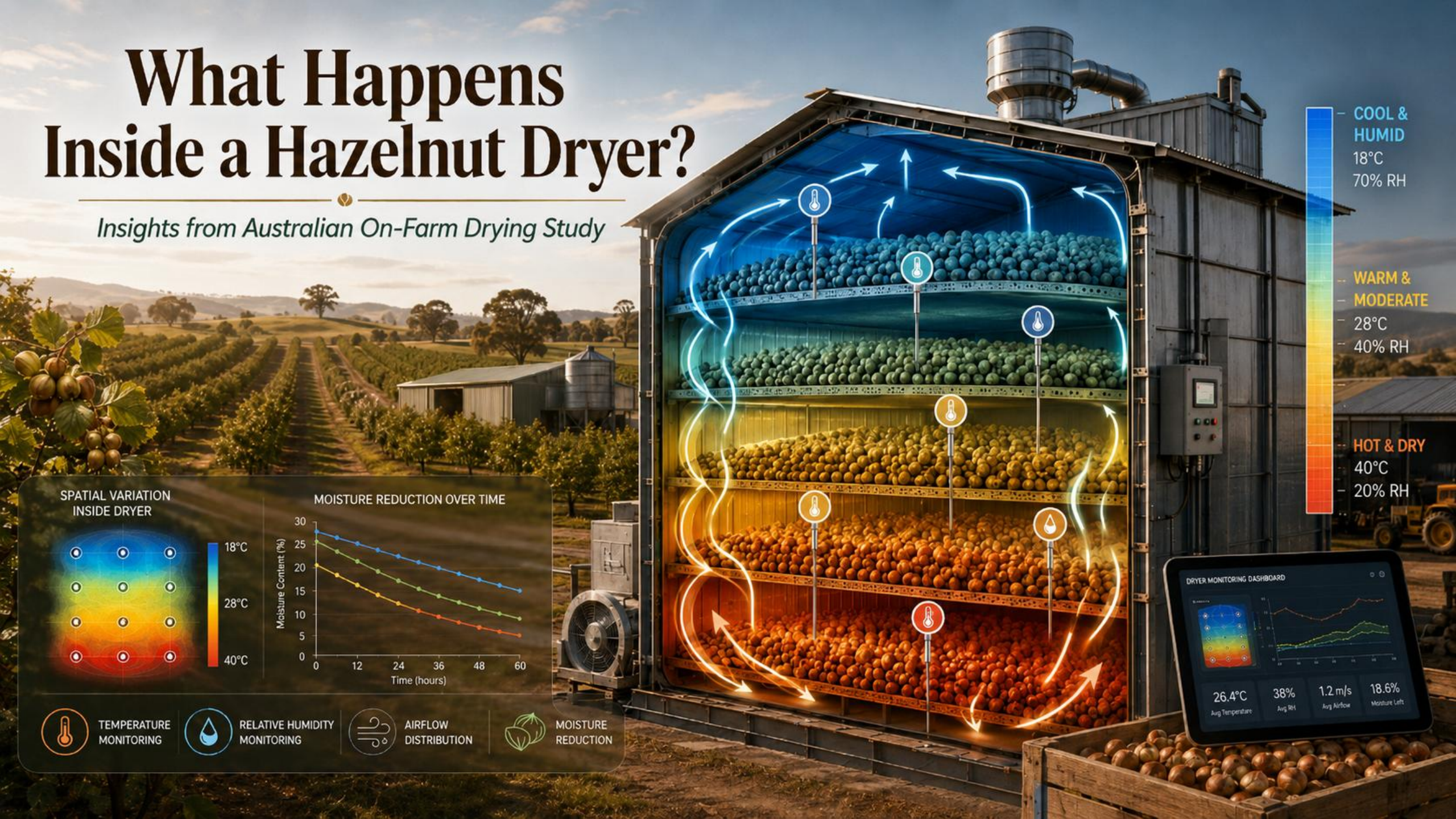
DRYER PERFORMANCE RESULTS

PRELIMINARY OUTCOMES

RESEARCH PIPELINE

What Happens Inside a Hazelnut Dryer?

Insights from Australian On-Farm Drying Study



Current Setup: The Problem

Hot air enters from the bottom, creating non-uniform conditions through the hazelnut bulk.

CURRENT DRYER – PHOTOS

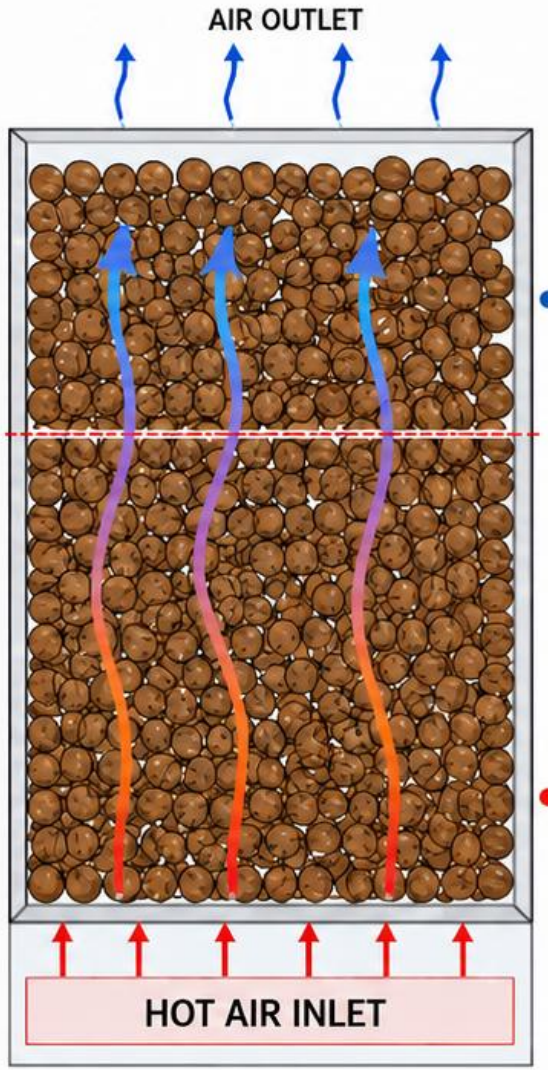
FRONT PLANE

TOP PLANE

BOTTOM PLANE

Hot air is introduced at the bottom of the dryer and flows upward through the hazelnut bulk.

RESULT: NON-UNIFORM DRYING THROUGH THE HAZELNUT BULK

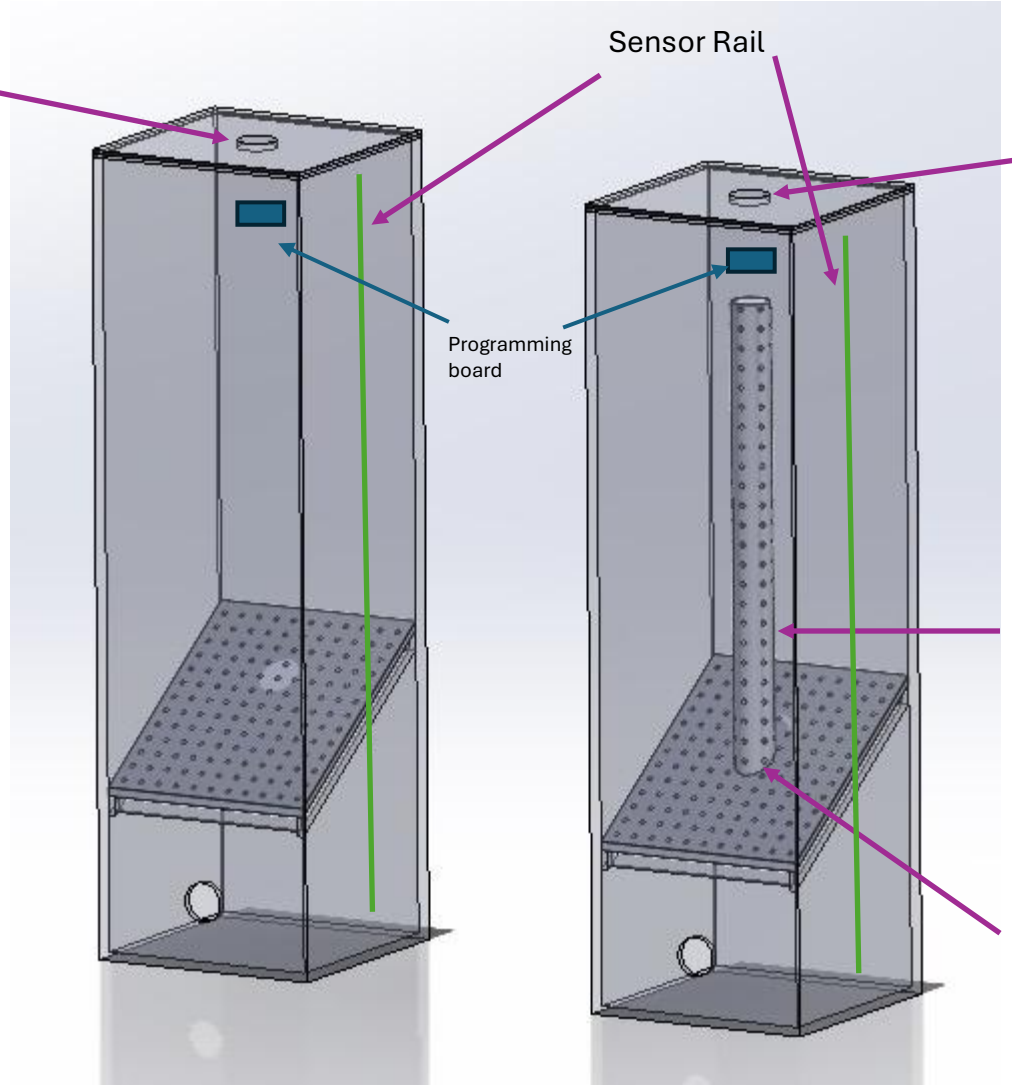


TOP ZONE
- Cooler air
- Highest humidity
- Lowest velocity

BOTTOM ZONE
- Hottest air
- Lowest humidity
- Highest velocity

Hot air enters at the bottom and moves upward, becoming cooler and more humid as it rises.

Farm Trials – The Setup

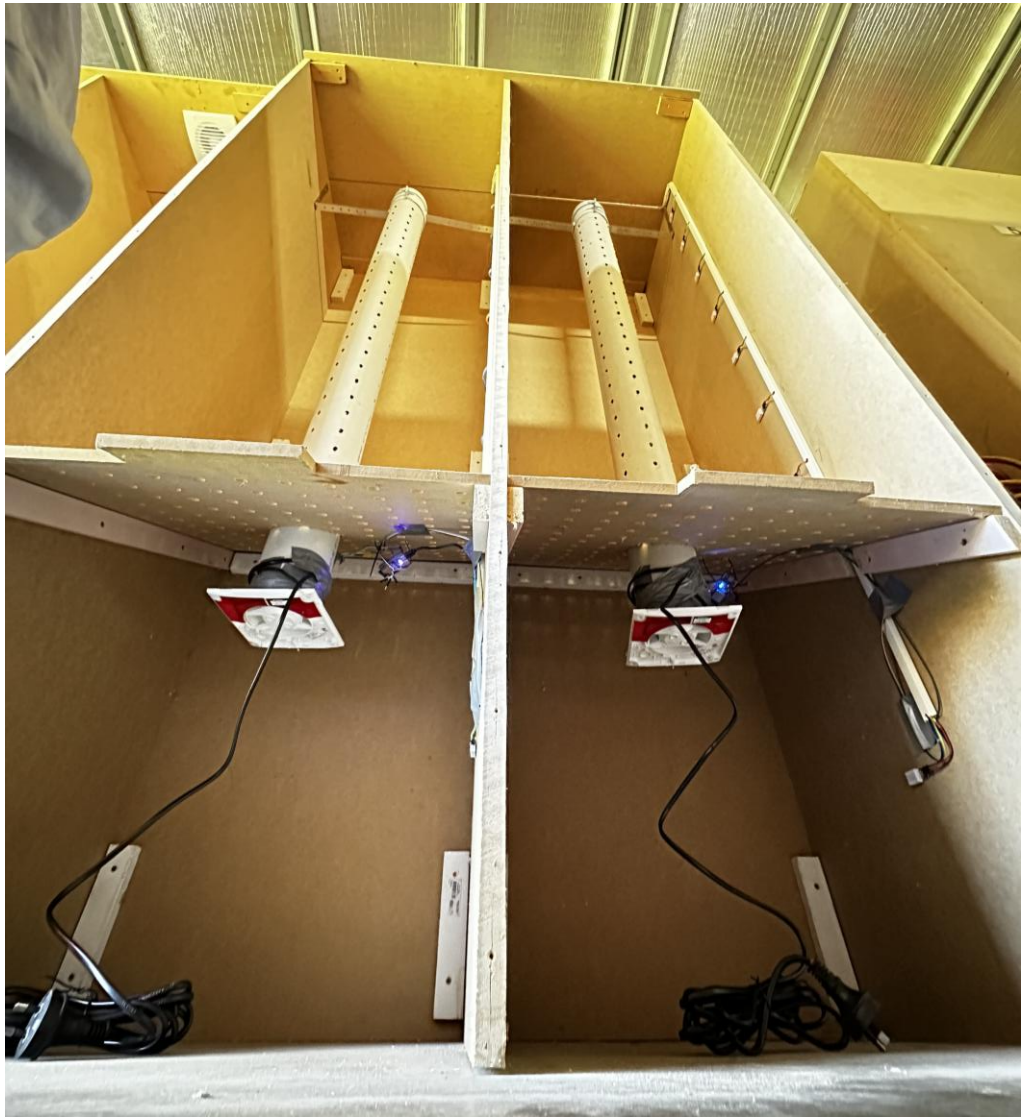


Unmodified
Dryer 1 and 2

Modified
Dryer 3 & 4

Current Dryer Setup

Construction



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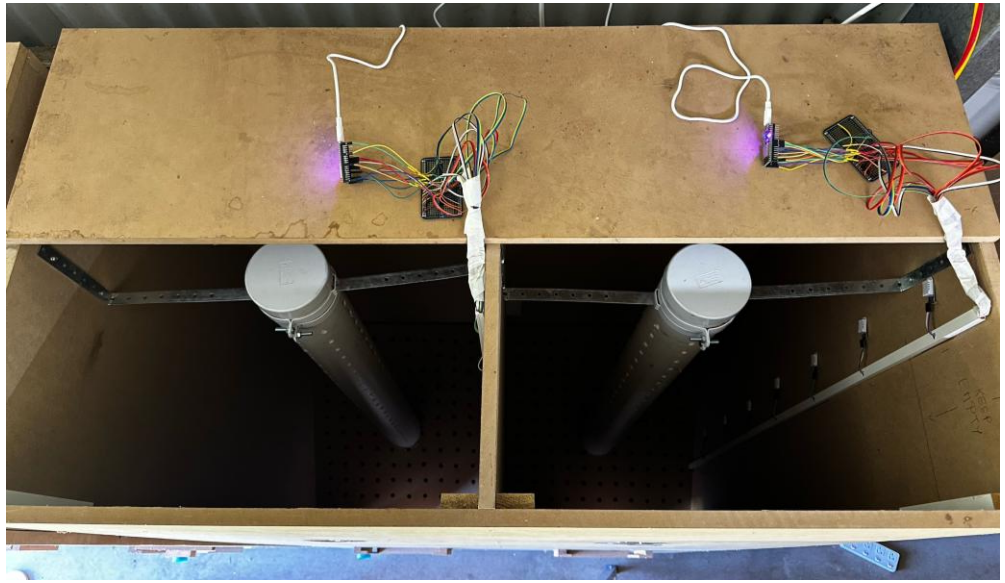
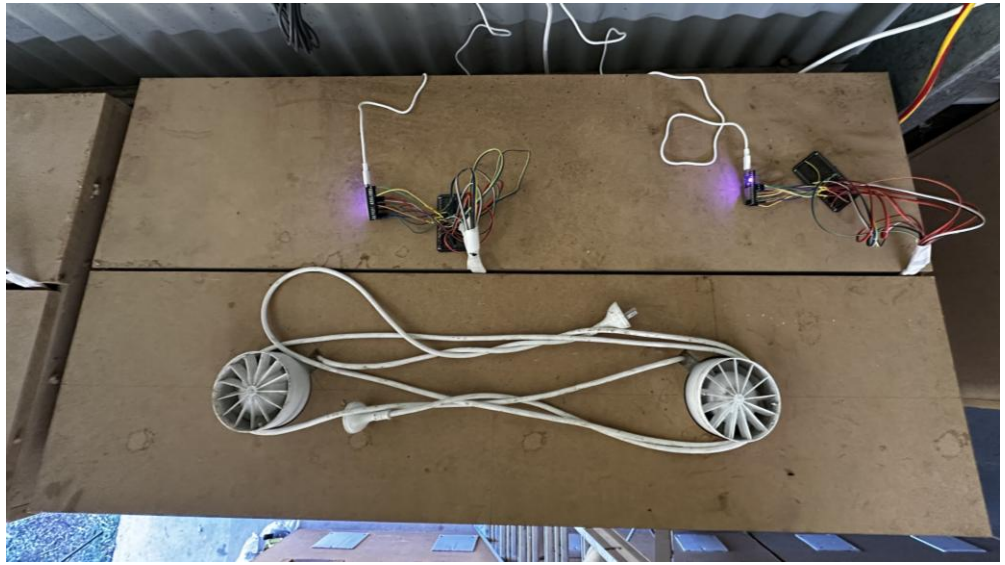
Construction





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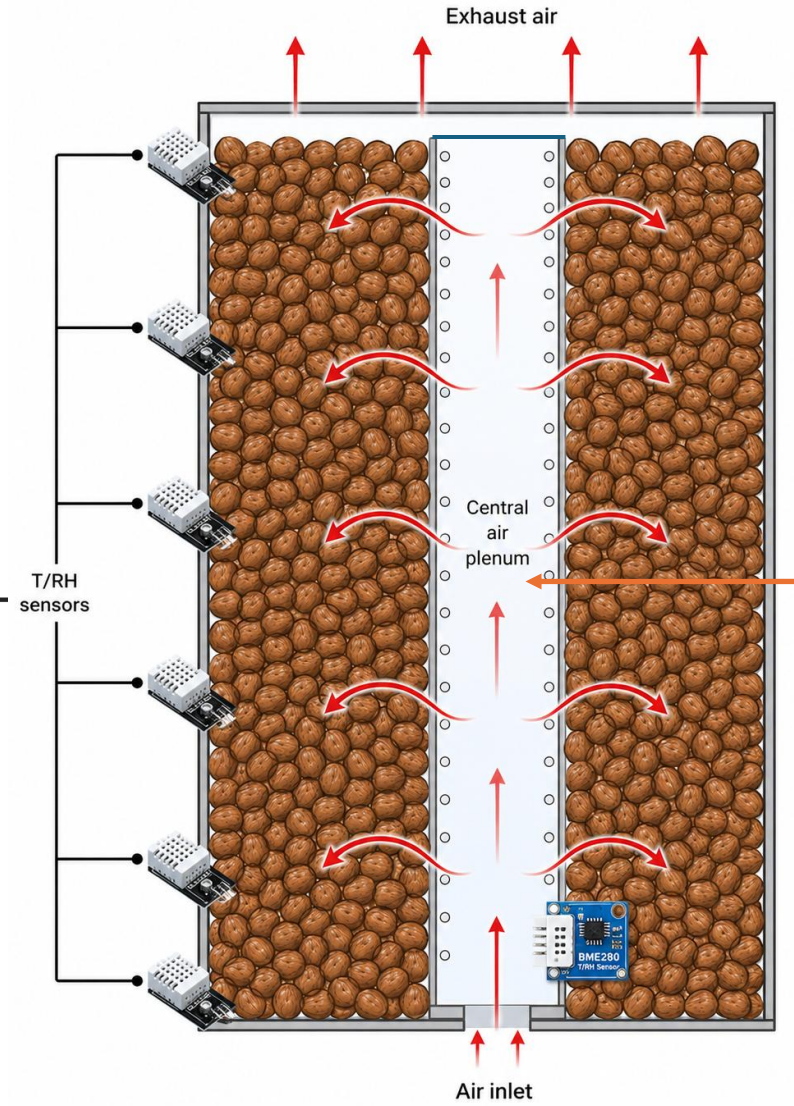
Sensors & IoT System

Temperature + Humidity + Air Velocity Sensors

+

Data Collection via Development Board

Log Data Over Cloud or Store Locally



Hollow Perforated Cavity

How Remote Data Logging System Works

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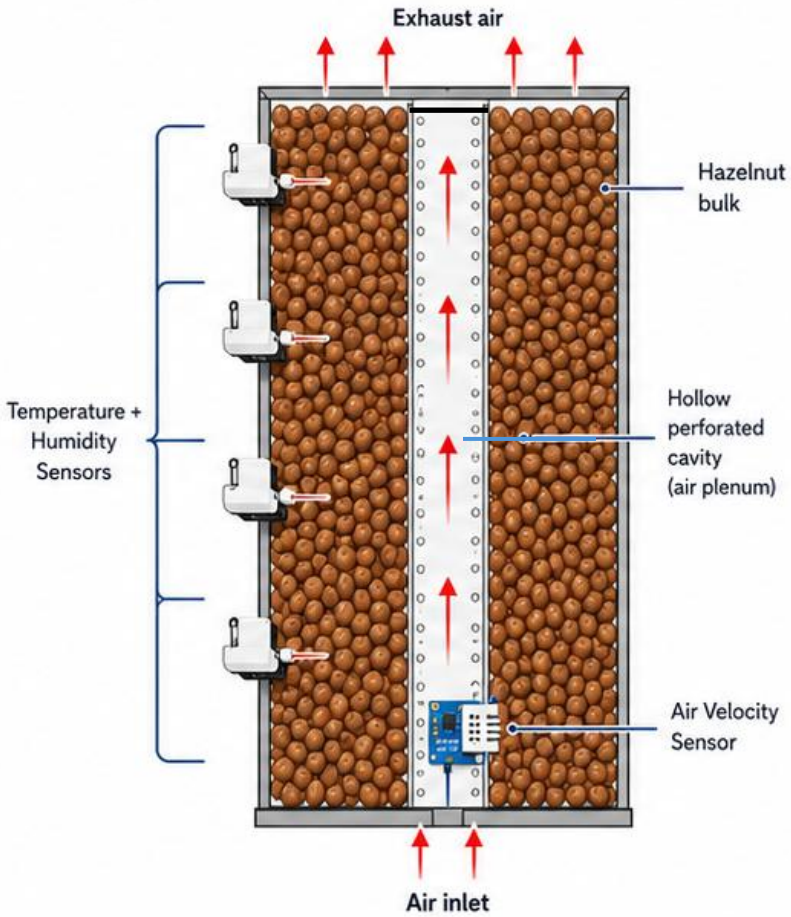
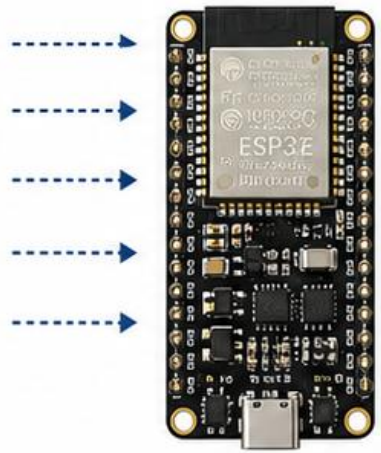
1 Sensors inside the dryer



2 Data collection

Sensors send data to development board.



Development Board

3 Transmission & storage

Data is transmitted wirelessly and stored securely.

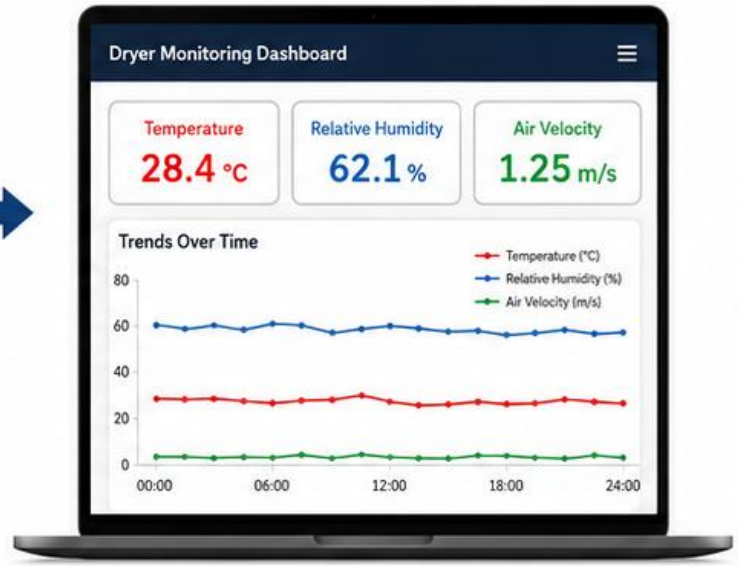
Cloud / Local Storage

OR

Local Storage

4 Use of data

Data is visualized for real-time decision making.



Real-Time Monitoring

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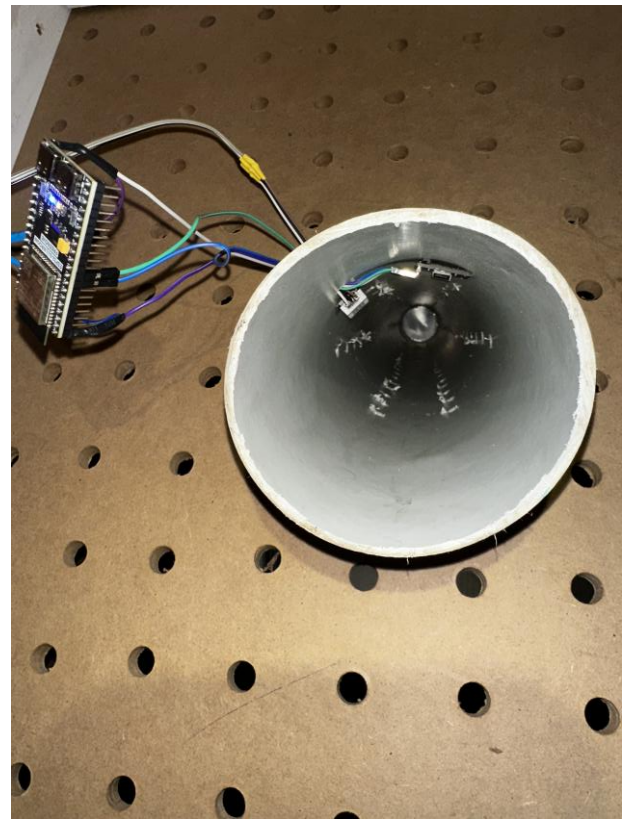
Sensor Placement



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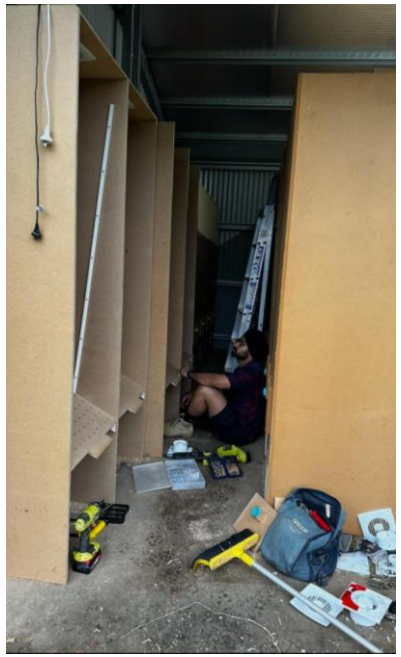
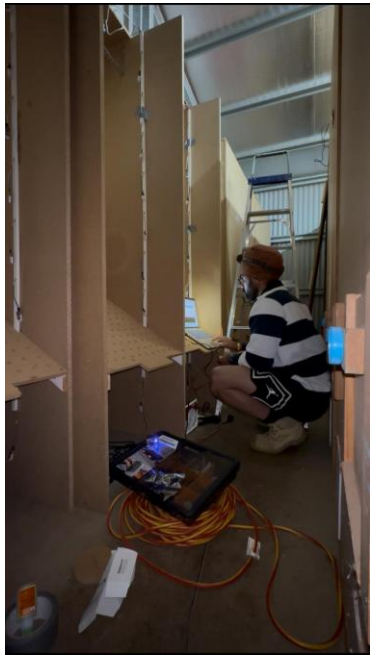
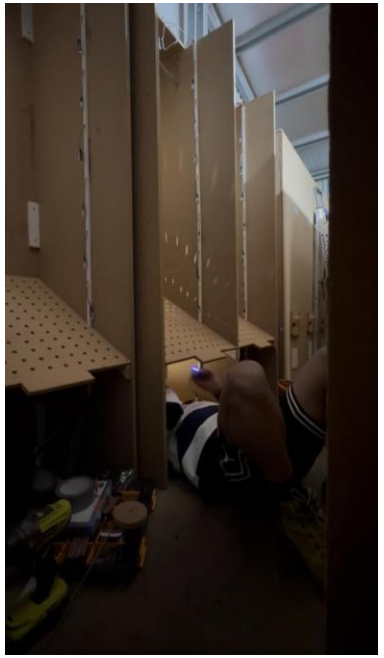
Integration Process – Fourjay Farms, Orange

Modifications


Electronics

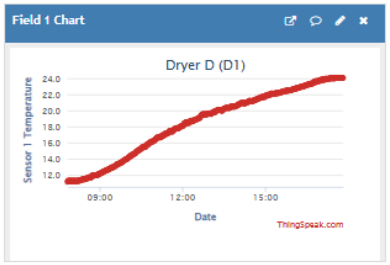



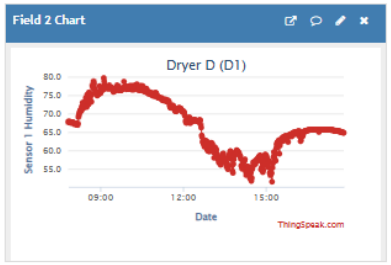
Installation & Troubleshooting

Real Time Data Logging

Temperature (°C)

Relative Humidity





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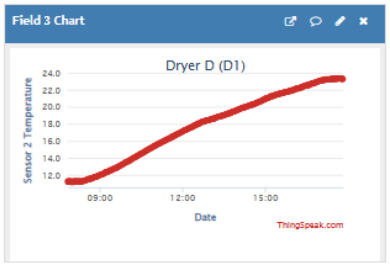

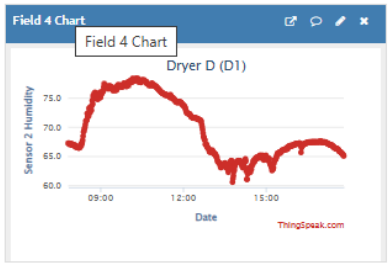

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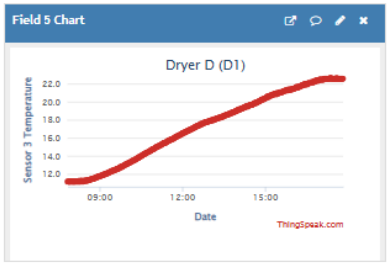

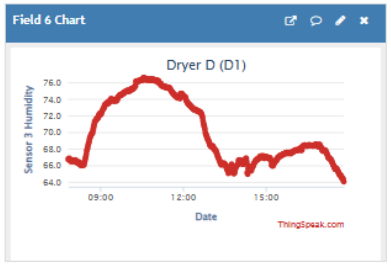

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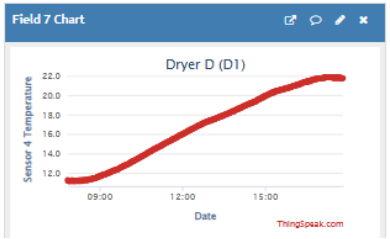

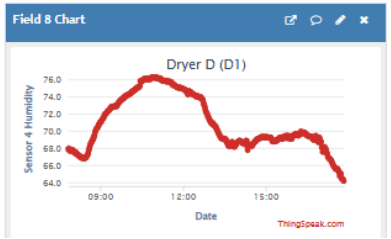

Sensor 4

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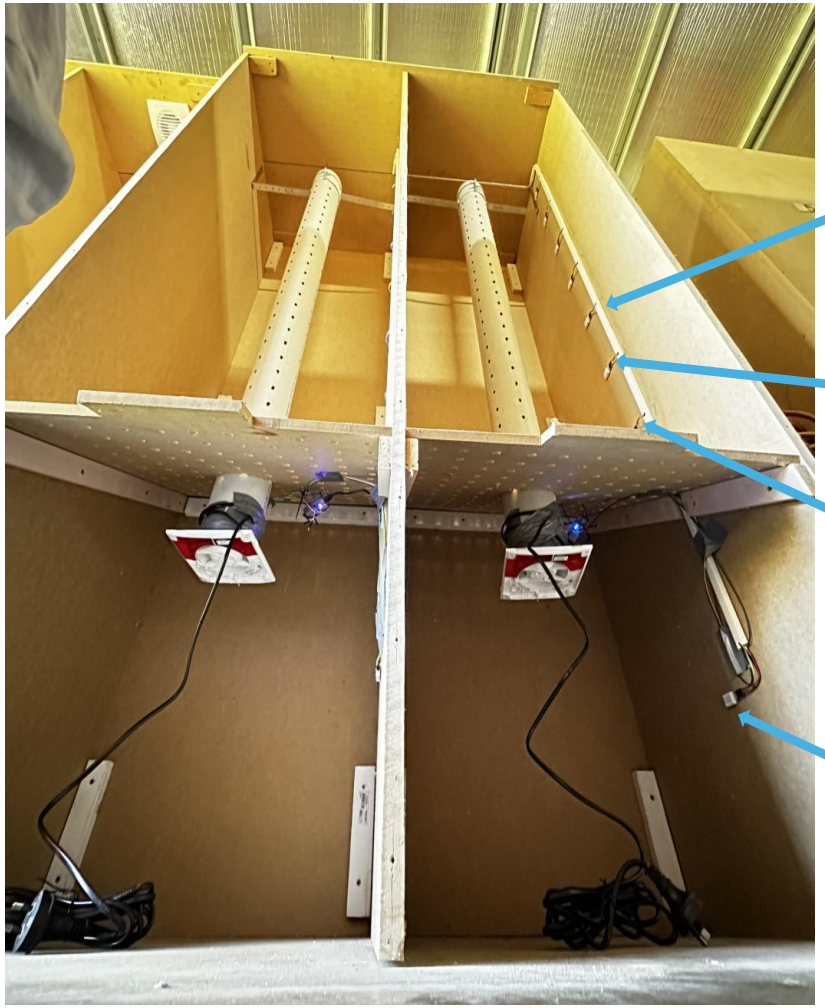
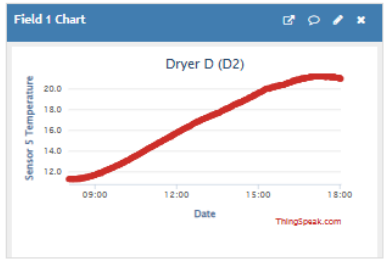
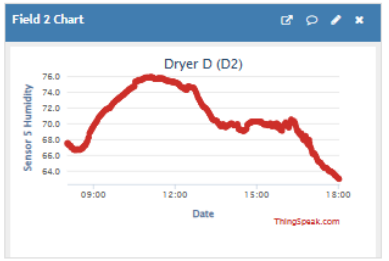
Real Time Data Logging



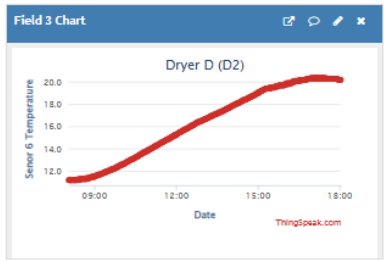
Temperature (°C)

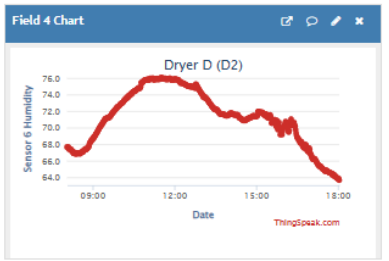
Relative Humidity (%)





Sensor 5





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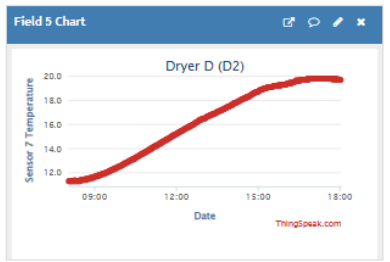

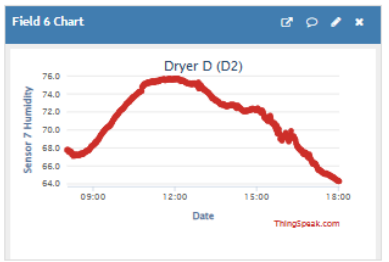

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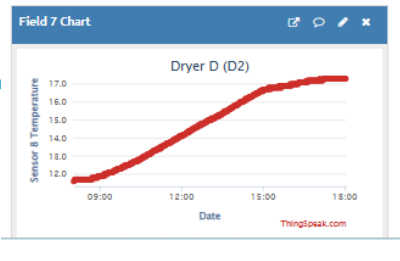

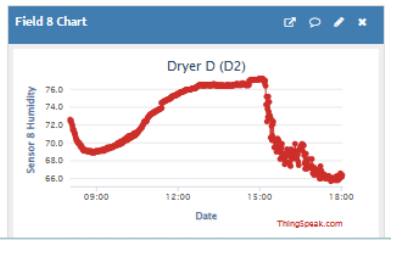

Sensor 8

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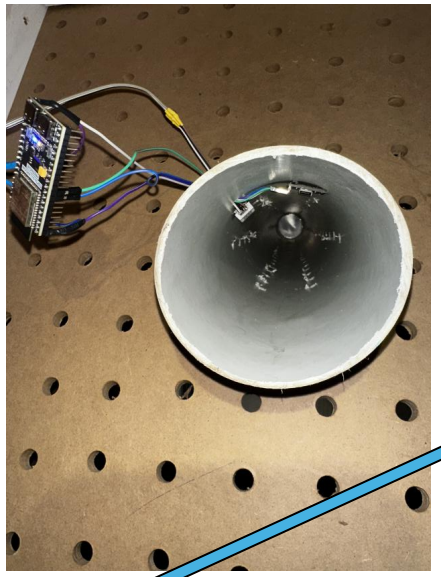
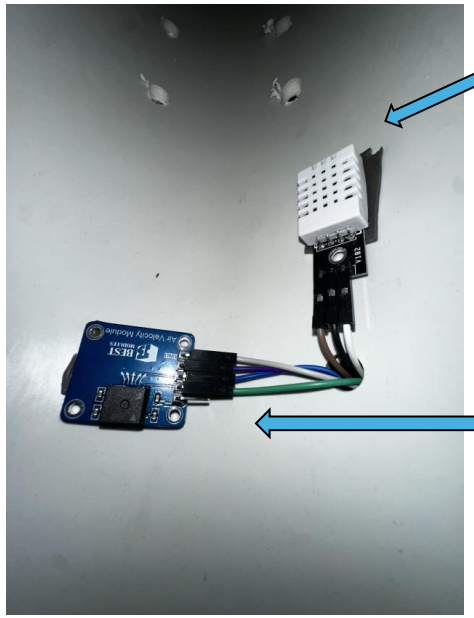
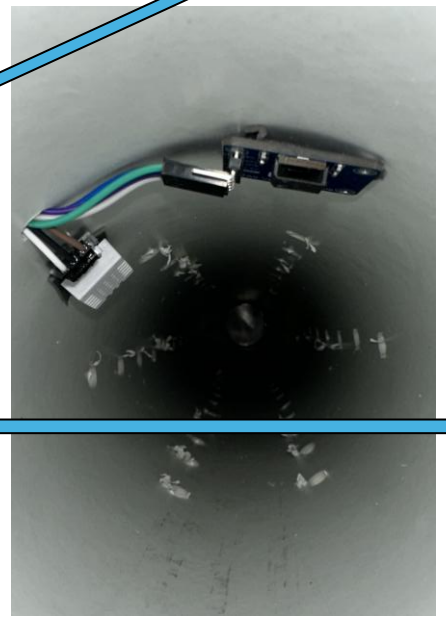
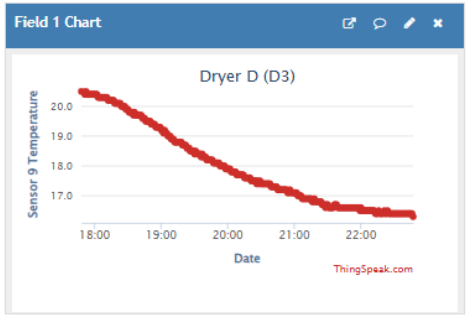
Real Time Data Logging



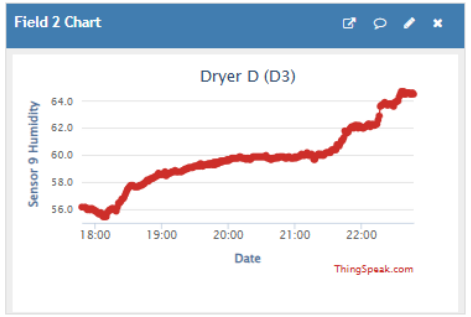




Temperature (°C)



Relative Humidity (%)



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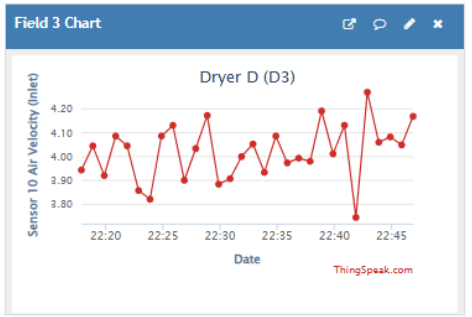
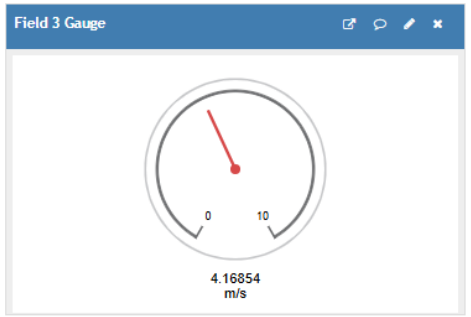
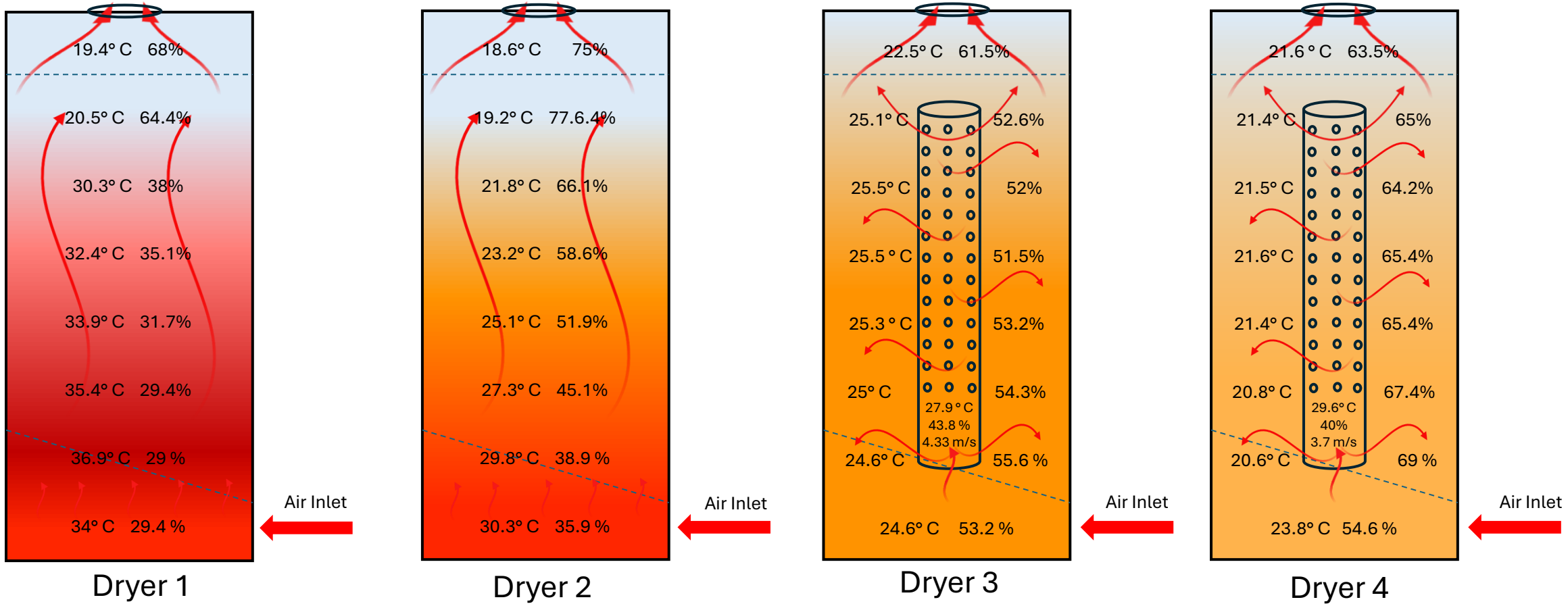




Sensor 10

Air Velocity (m/s)

Hot Air Trend



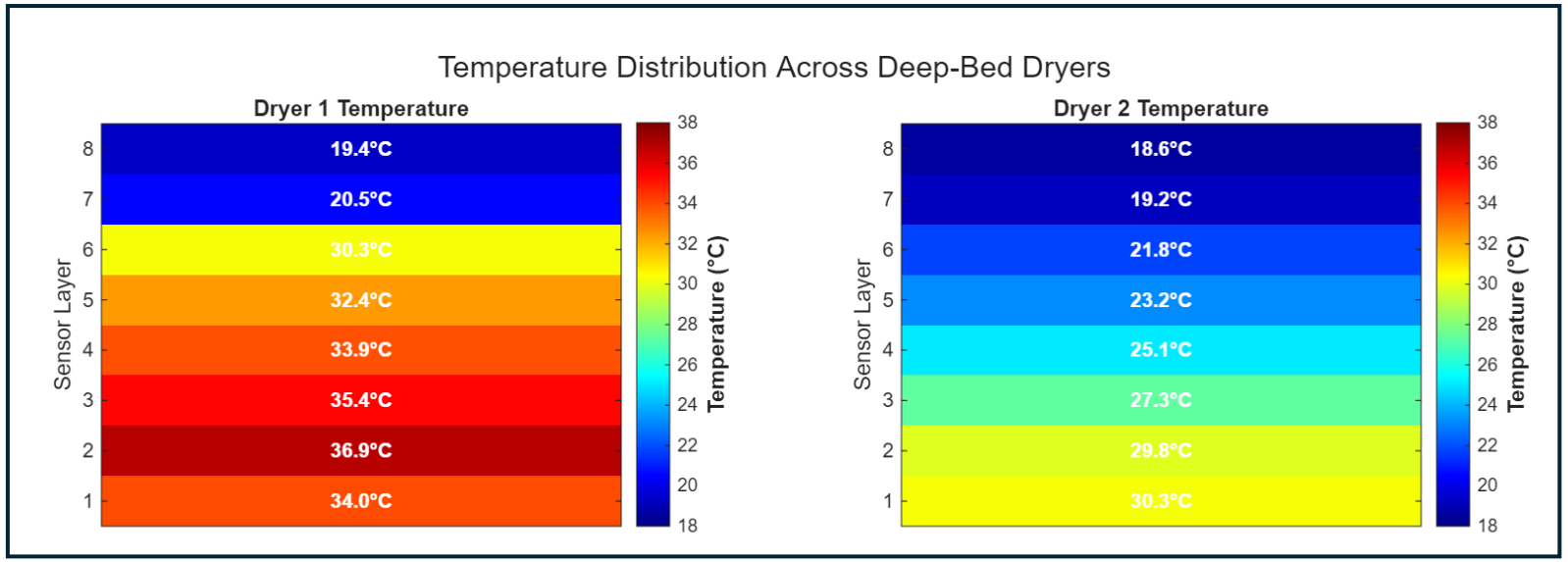
Control

Modified

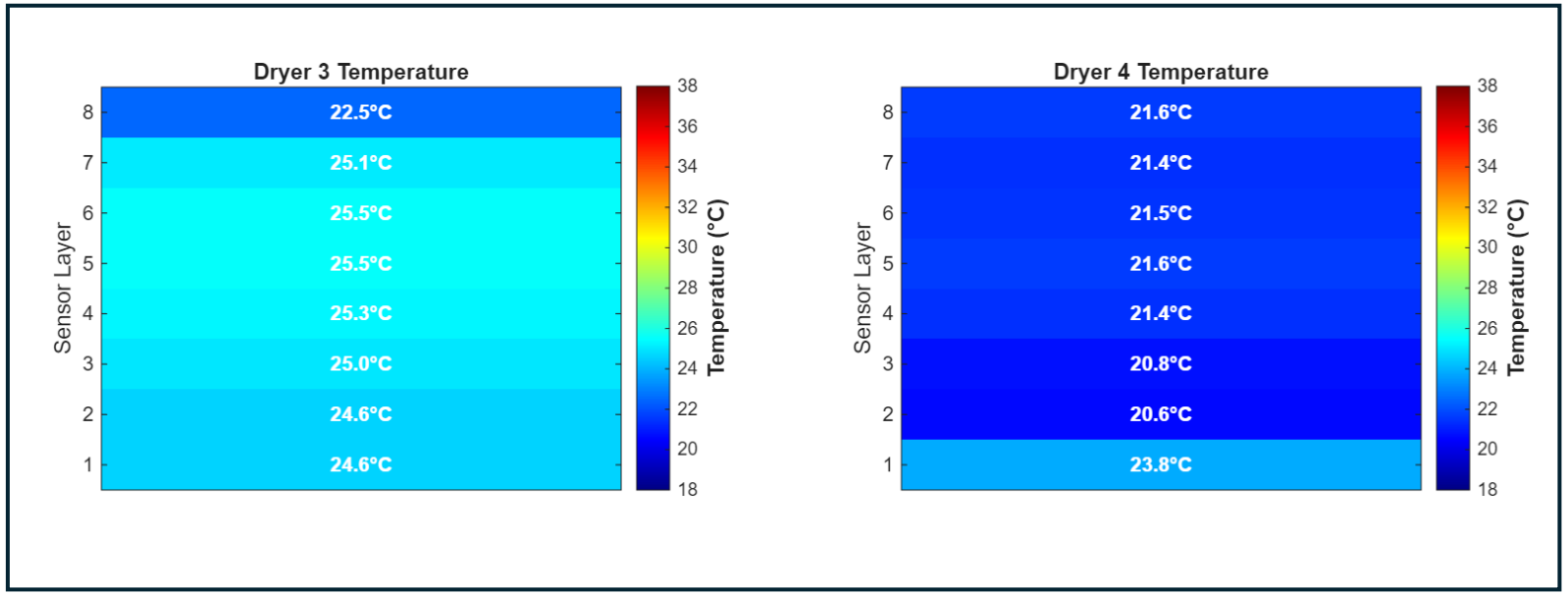
Senor Readings: 14/05/2026 03:30 PM

Hot Air Trend

Current Dryers



Modified Dryers



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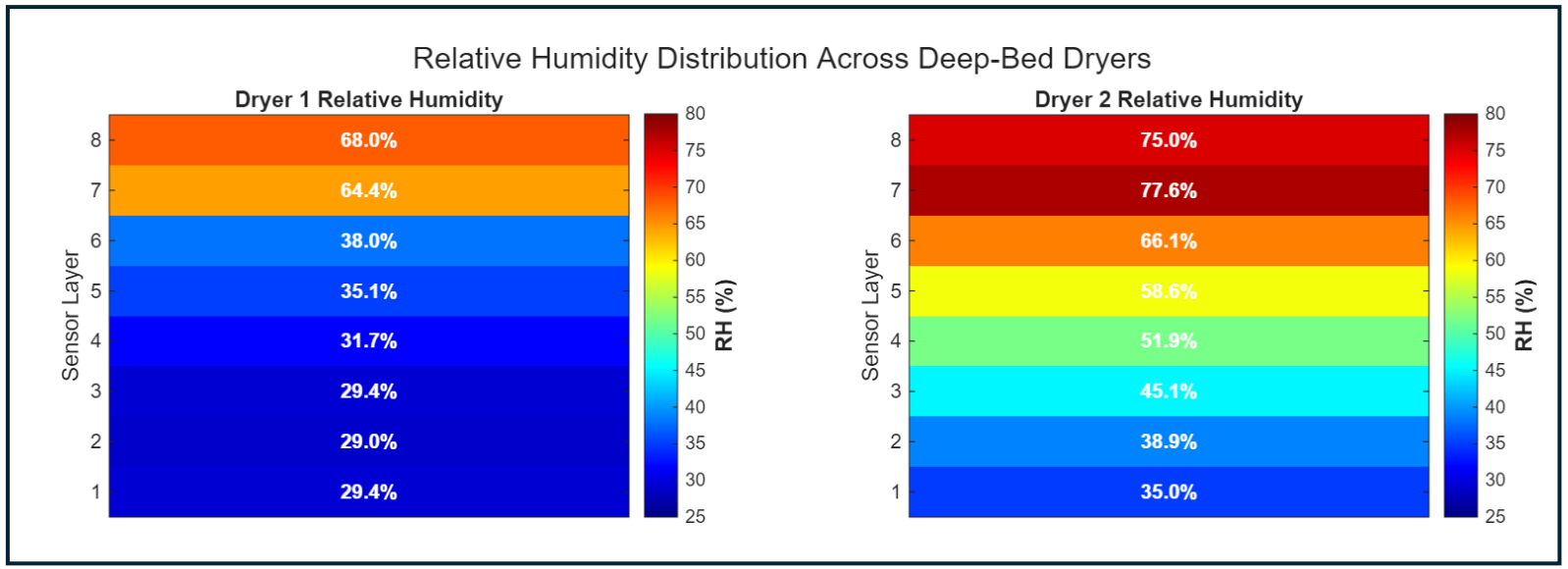
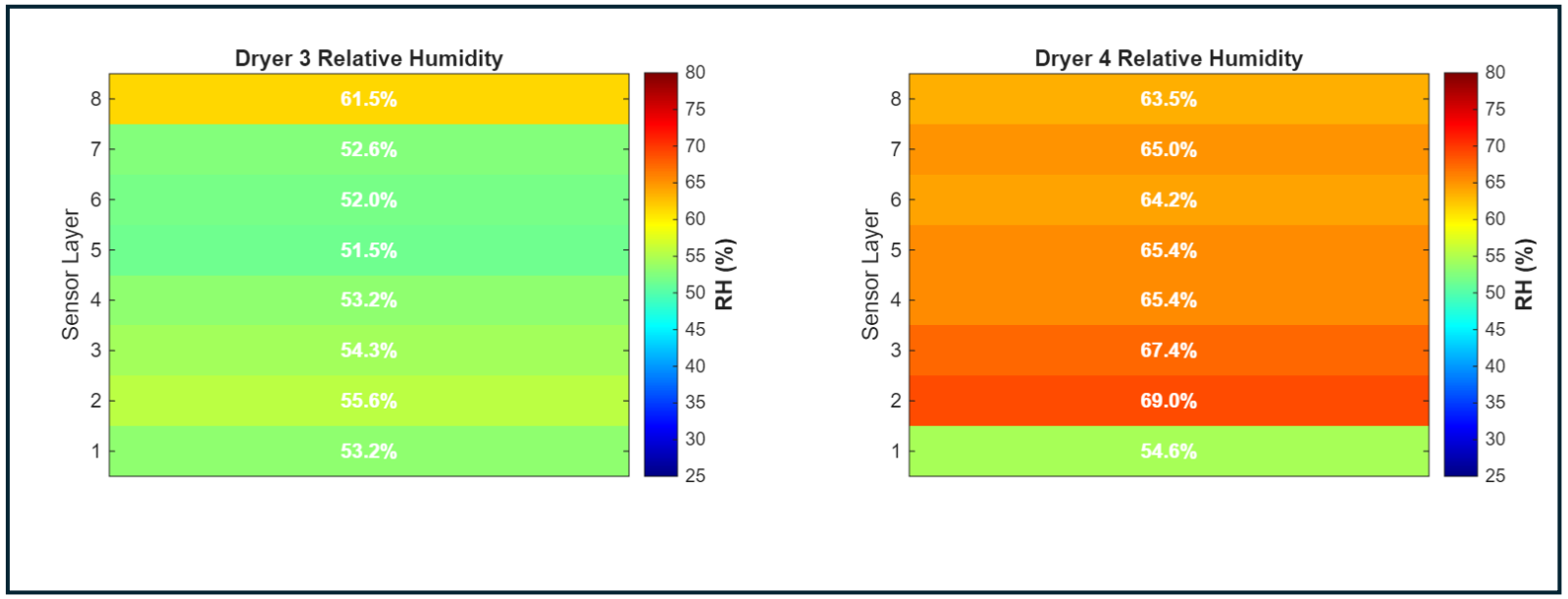
Hot Air Trend

Current Dryers



Modified Dryers



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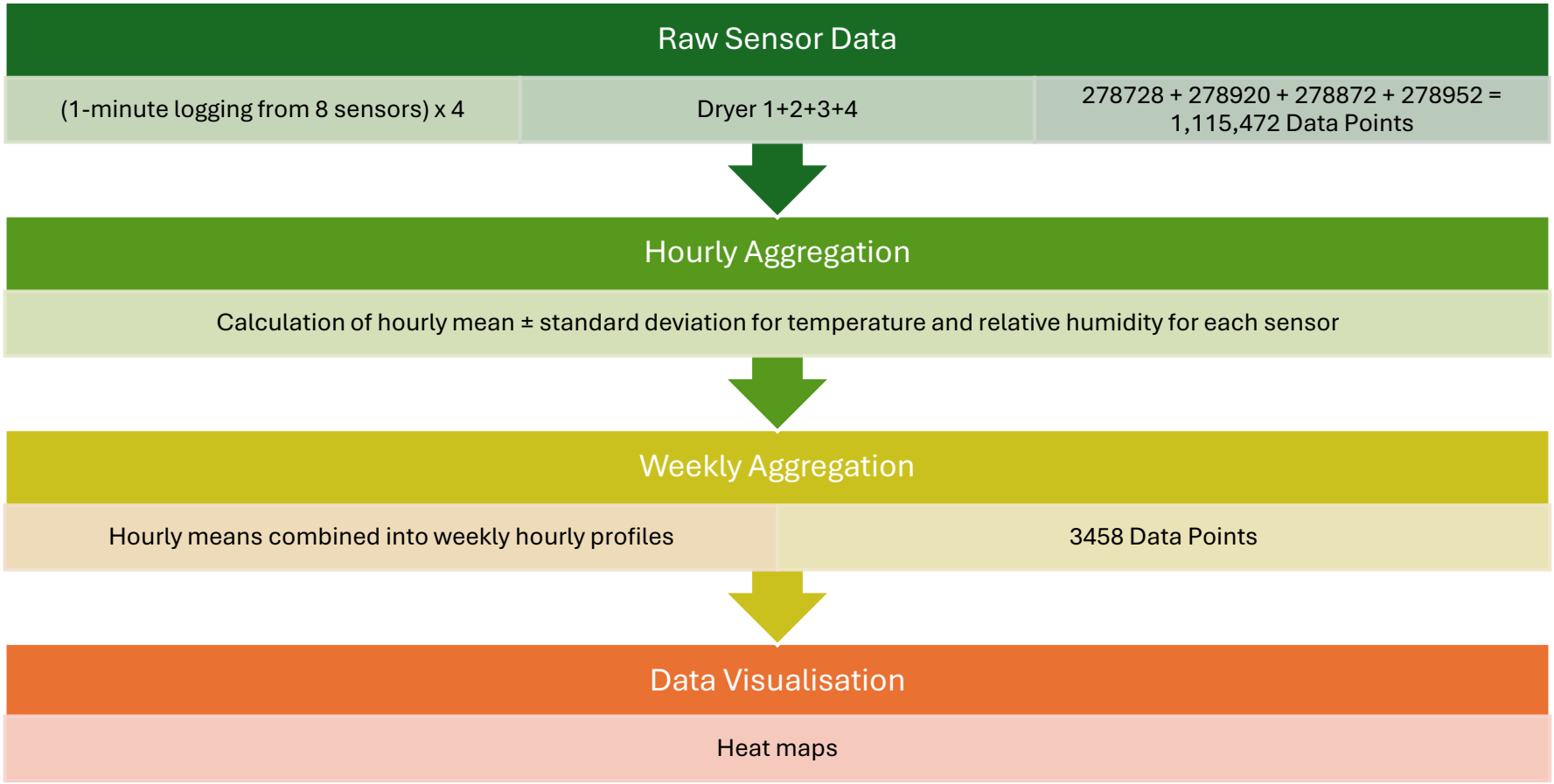
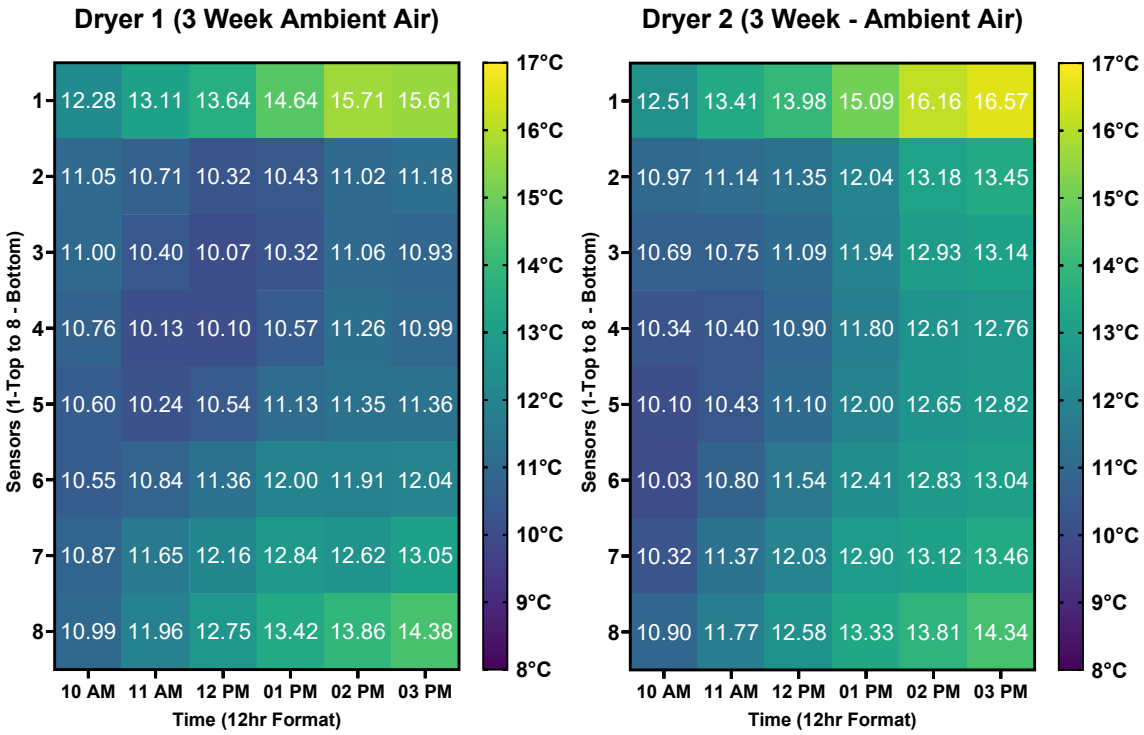
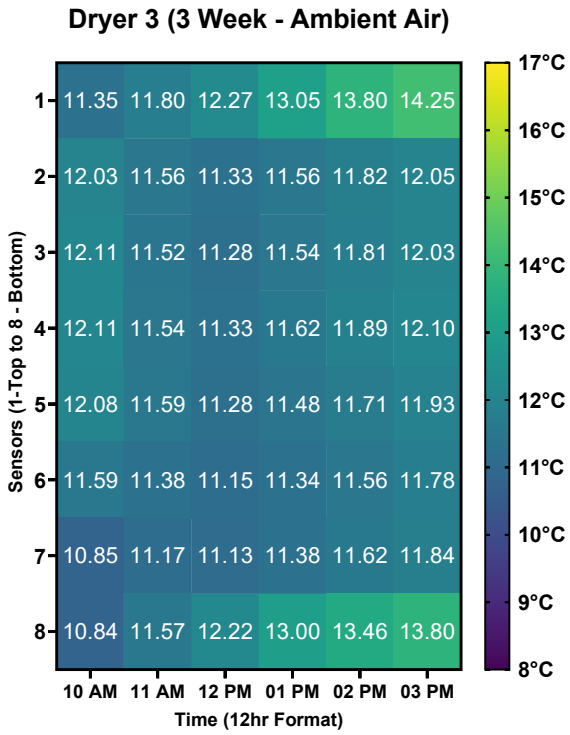
Data Reporting Criteria

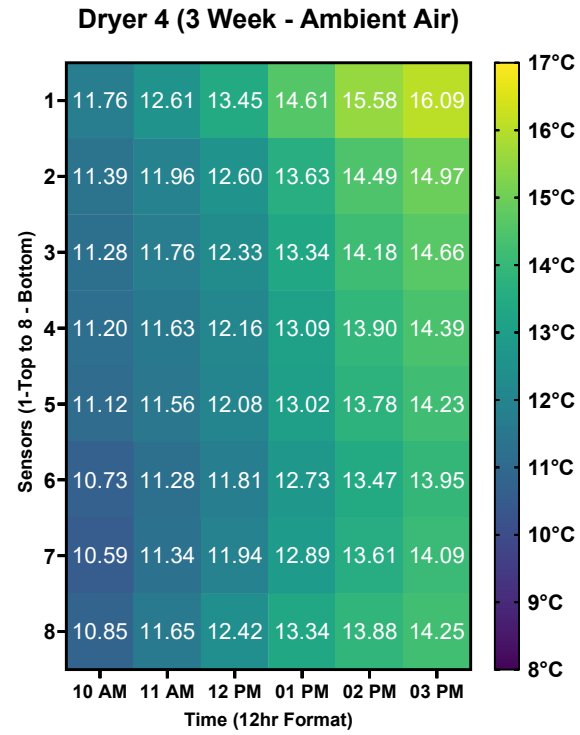


Ambient Air Trend - Temperature



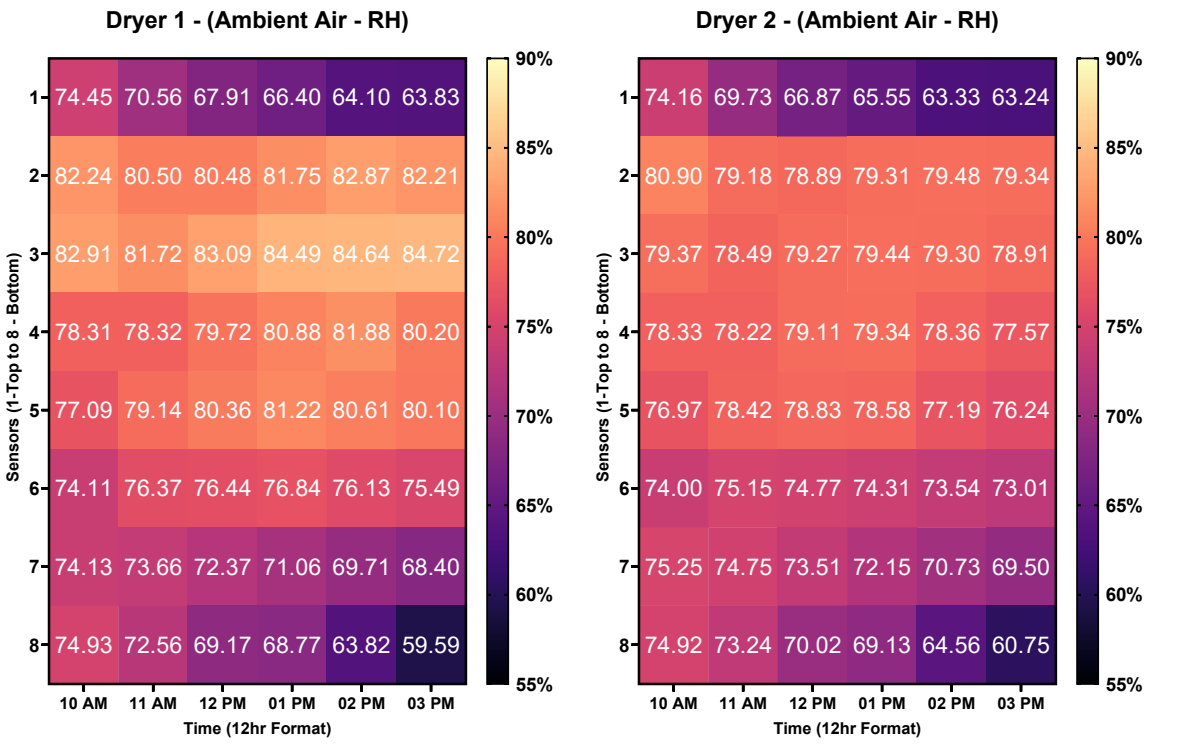
Control Dryer 1 & 2

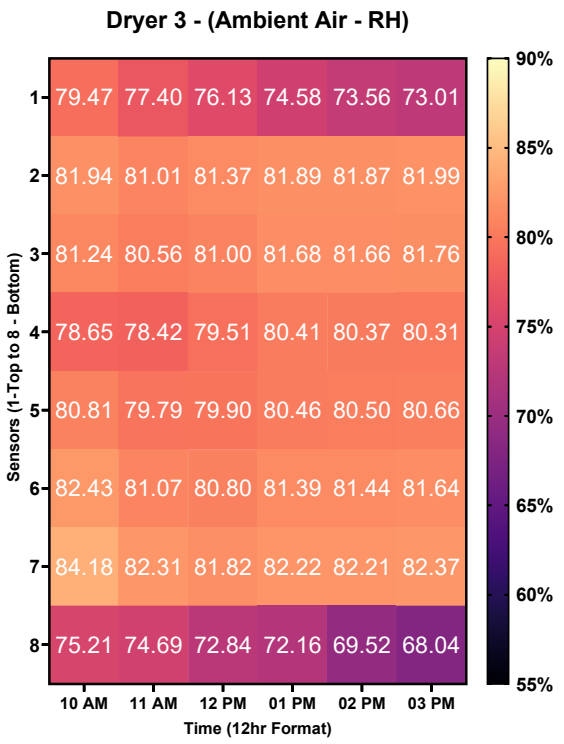


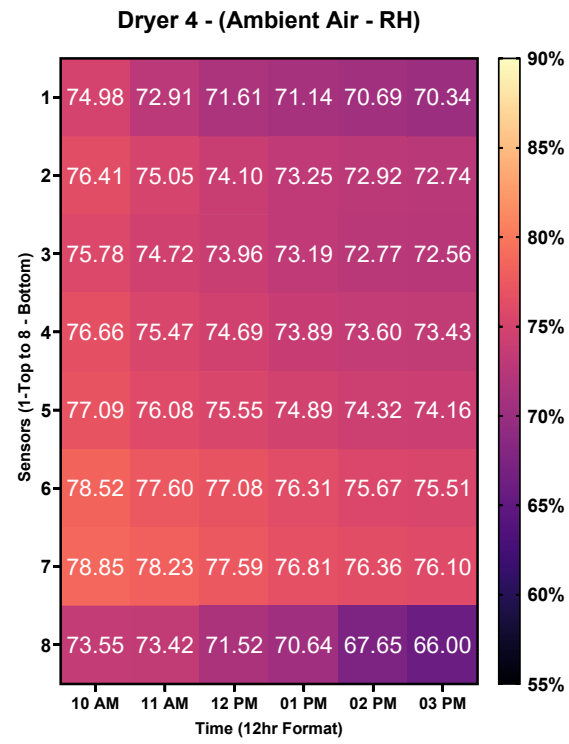


Modified Dryer 3 & 4

Ambient Air Trend - Relative Humidity



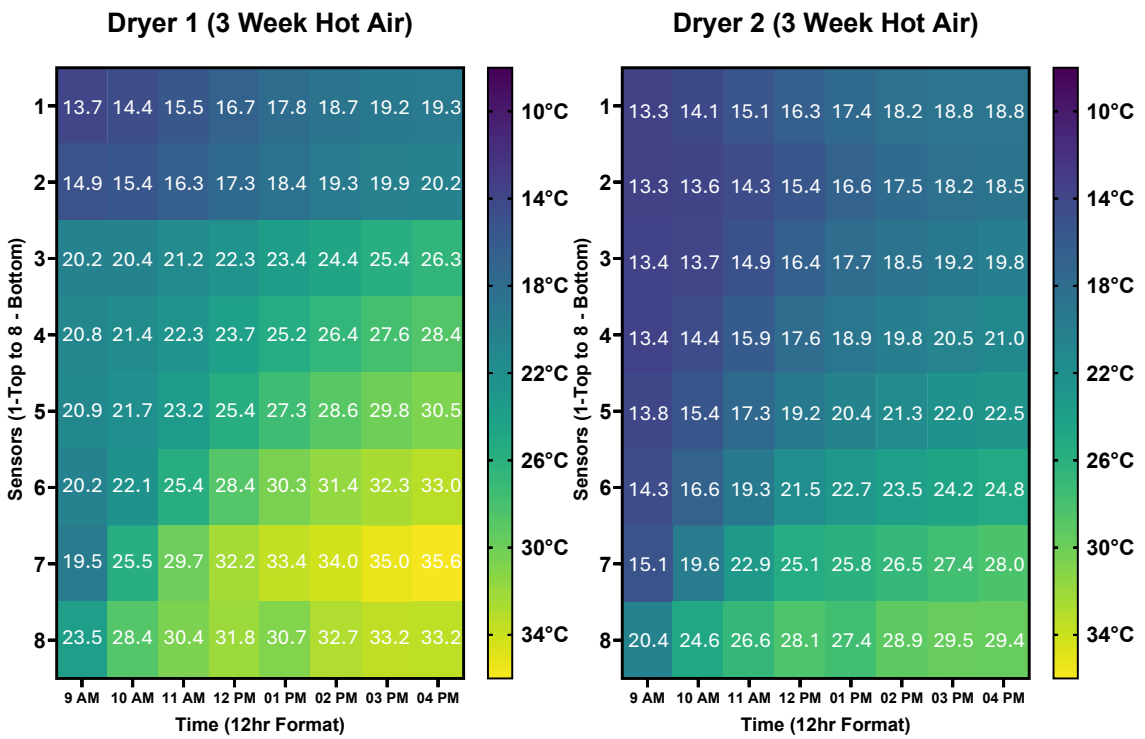


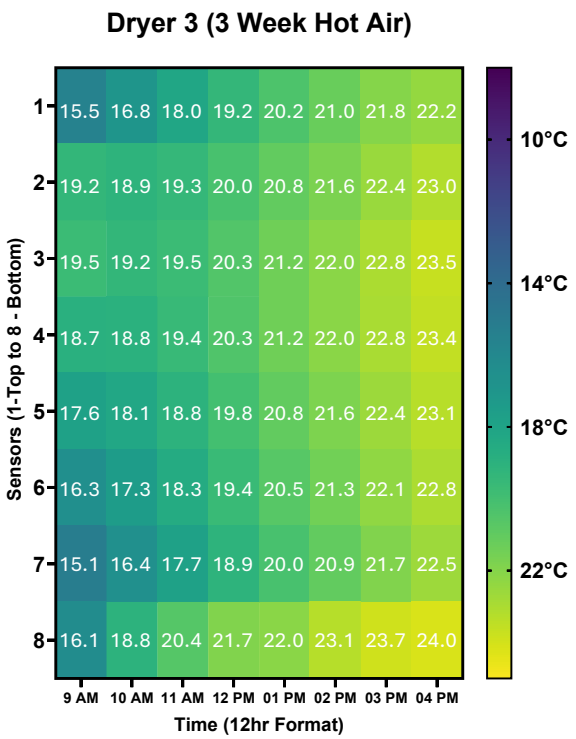


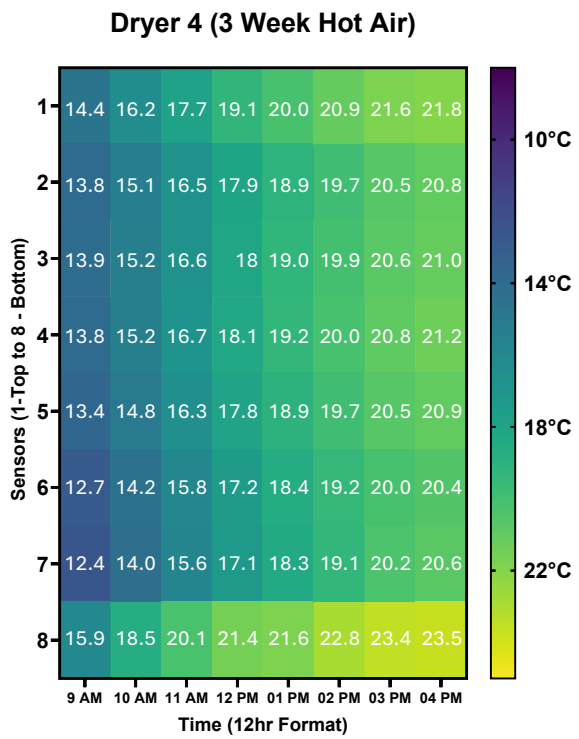
Control Dryer 1 & 2

Modified Dryer 3 & 4

Hot Air Trend - Temperature



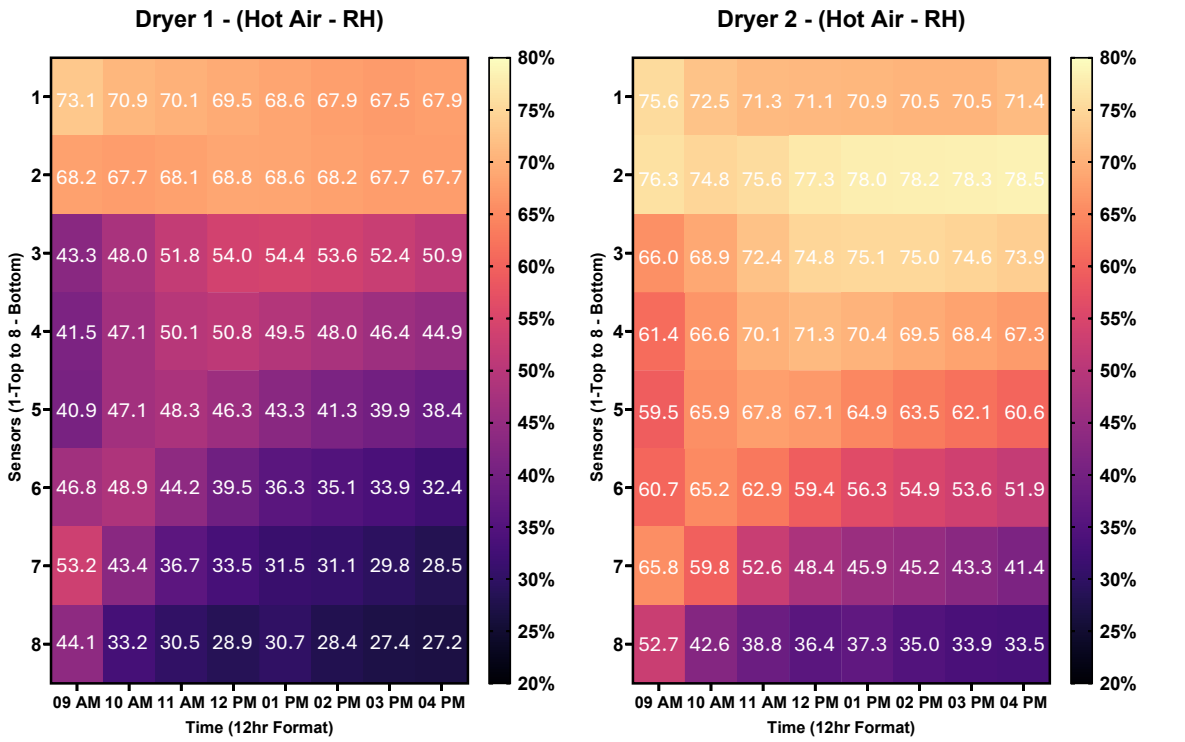


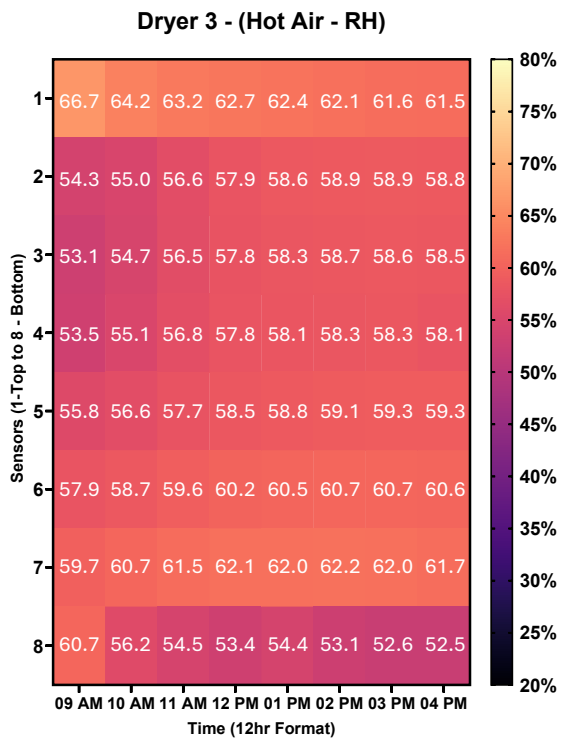


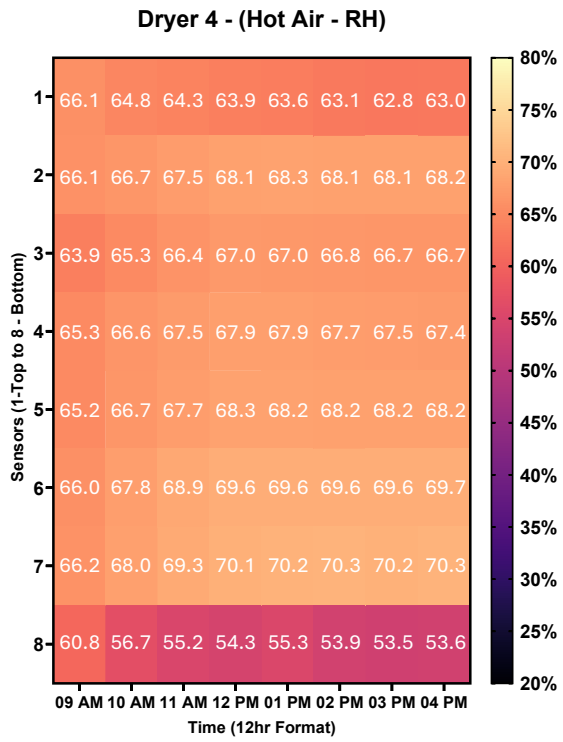
Control Dryer 1 & 2

Modified Dryer 3 & 4

Hot Air Trend - Relative Humidity



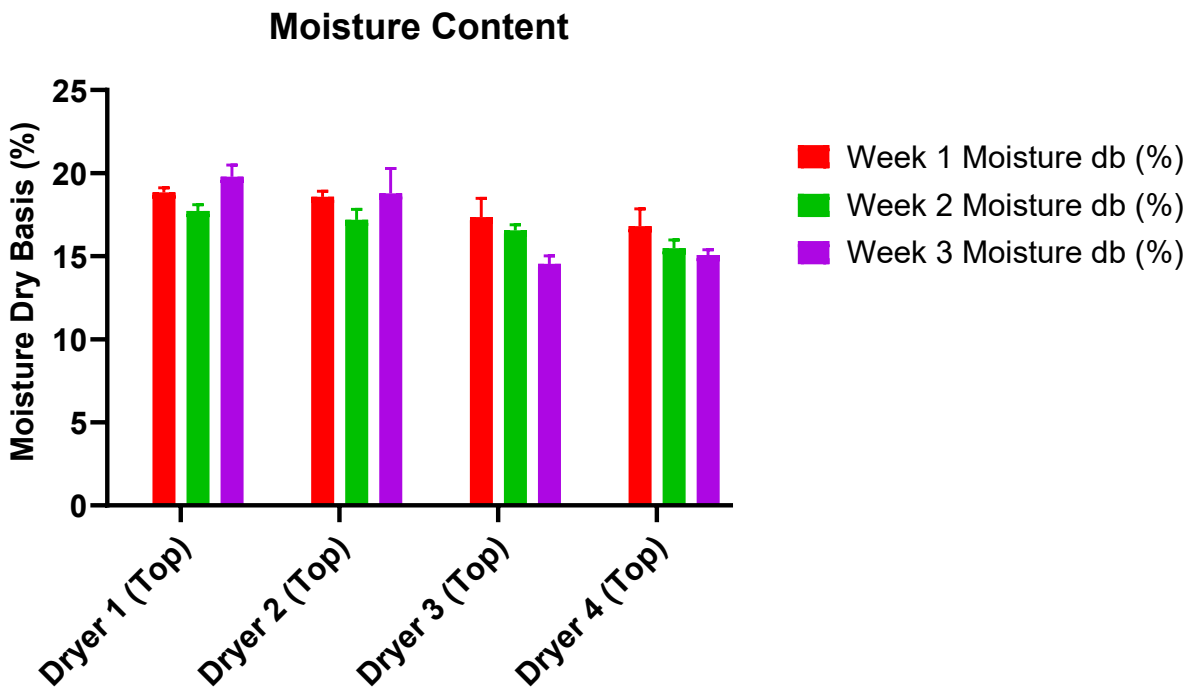


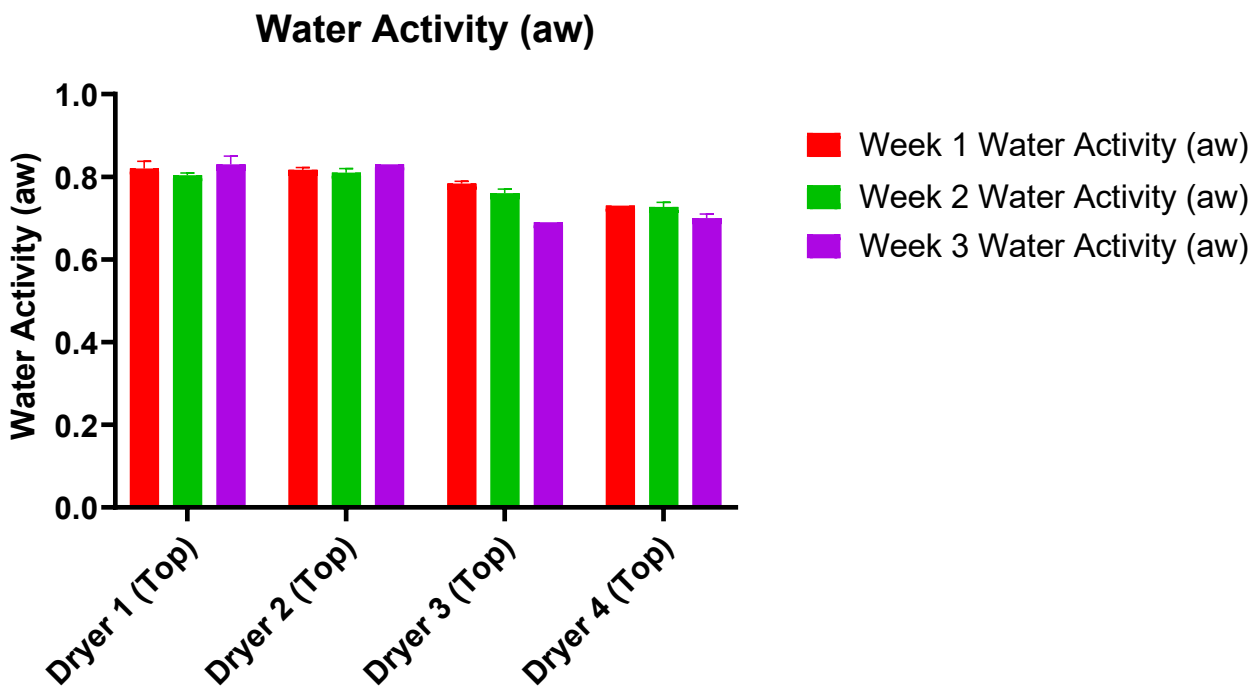


Control Dryer 1 & 2

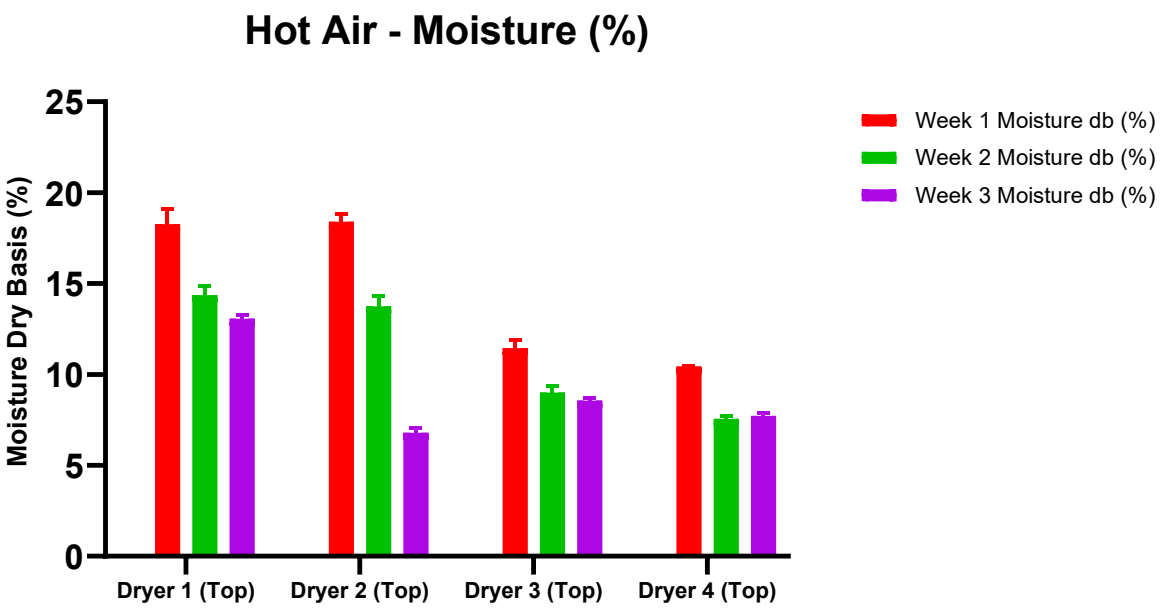
Modified Dryer 3 & 4

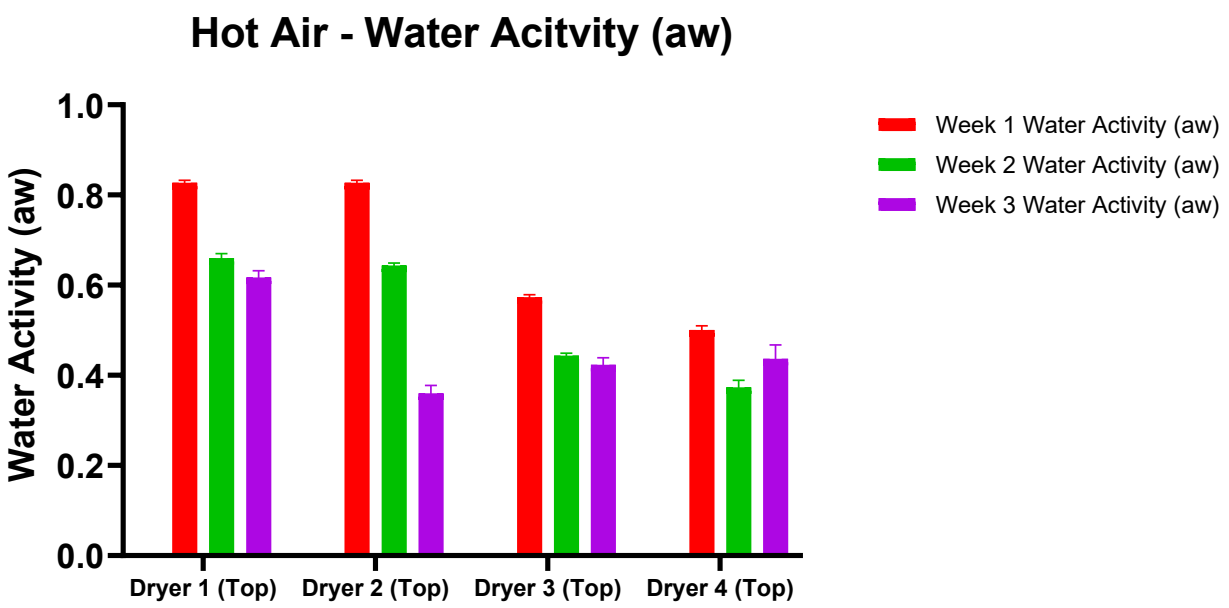
Moisture & Water Activity – **Ambient Air Drying**



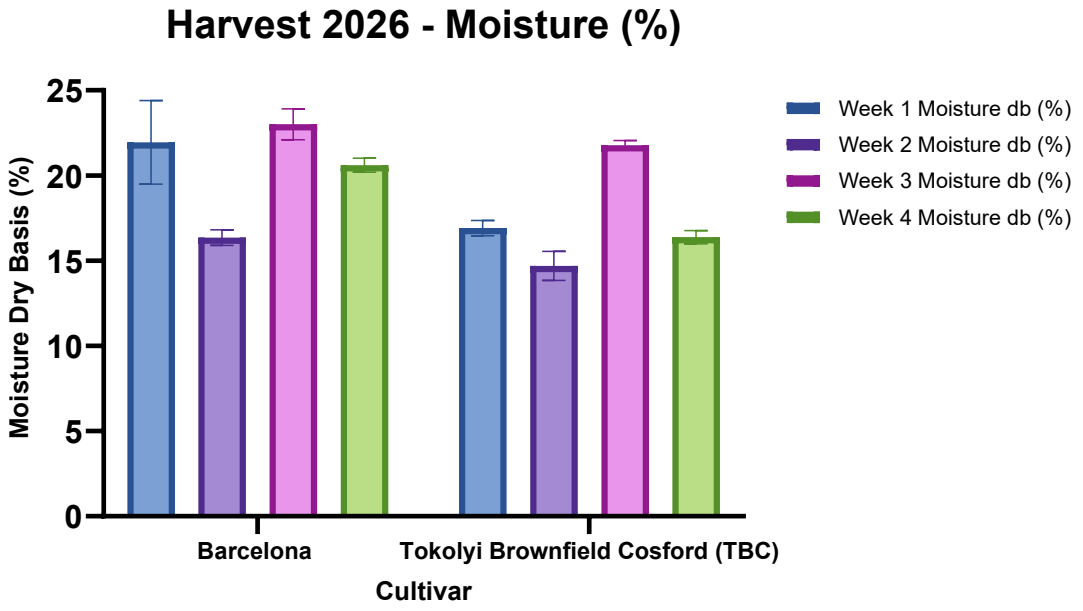


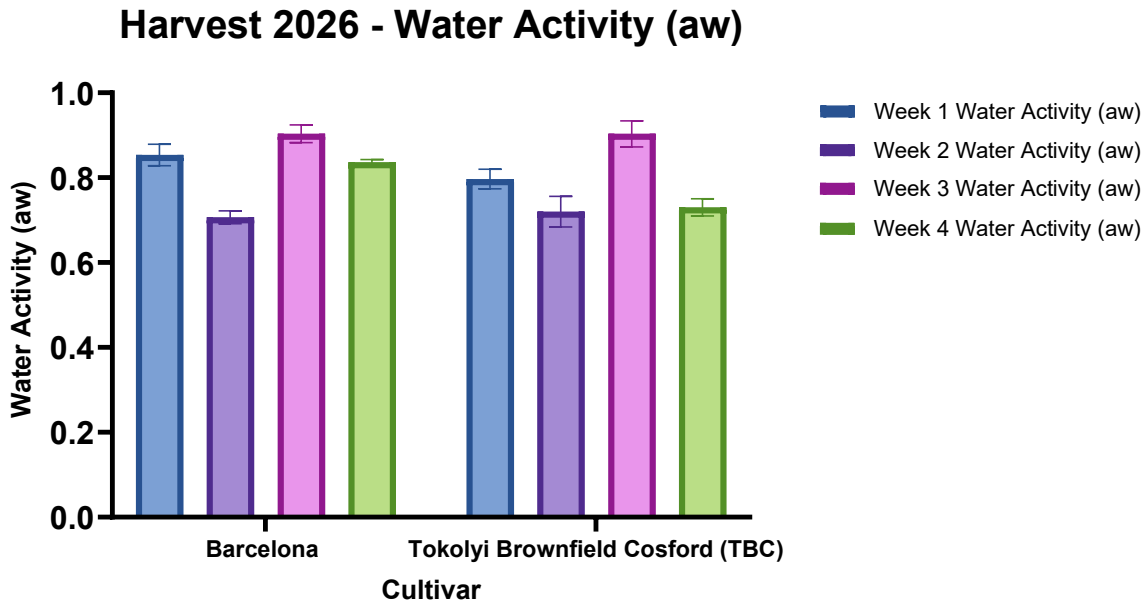
Moisture & Water Activity – **Hot Air Drying**





Results – Harvest 2026 (Block 4)





Preliminary Outcomes

Real-time monitoring established

Non-uniform drying conditions

Current and modified dryers performed differently

Field data supports future optimization

Research Pipeline (2025 - 29)

1		**CFD Validation**	Use computational fluid dynamics to validate and explain the airflow, temperature and humidity patterns observed during on-farm dryer trials.
2		**Chemical Testing**	Assess how drying conditions influence hazelnut quality by measuring key chemical indicators such as antioxidant activity, peroxide value and free fatty acids, etc
3		**Moisture Sensing**	Develop reliable moisture sensing techniques based on the dielectric properties of hazelnuts to support faster and more accurate moisture assessment .
4		**Microstructure Study**	Investigate how drying affects the internal structure of hazelnut using CT - whole nut structure, SEM - pore level changes and, MRI – understand water distribution
5		**Storage/Shelf Life**	Evaluate how different storage conditions, including modified atmosphere packaging/storage, affect hazelnut quality, oxidative stability and shelf life.
6		**Quality Over Time (On Farm)**	Monitor how hazelnut quality changes across seasons and over longer storage periods to understand month to month variation and long term stability in real time on farm.
7		**Real Time Dryer Dashboard Trial – Beta Version**	Develop a simple farmer-friendly dashboard to visualize dryer performance in real time and support better drying decisions on farm.

Acknowledgement

A heartfelt thank you to **Dr Basil Baldwin** and **Jean Baldwin** for welcoming us onto their farm, supporting the drying trials and trusting us with their hazelnut dryers. This work would not have been possible without their cooperation and generosity.

Supervisory team and Project supporters:

Dr Yong Wang – Primary Supervisor, Senior Lecturer, School of Chemical Engineering, UNSW
Prof. Cordelia Selomulya – Head of School, School of Chemical Engineering, UNSW
Prof. Greg Leslie – Professor, School of Chemical Engineering, UNSW

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Organisations:

AgriFutures Australia

HAZELNUT GROWERS OF AUSTRALIA INC

Charles Sturt University

UNSW SYDNEY


HOMEMADE with love
Jean's Hazelnut Cookies
HOMEMADE HAZELNUT TREATS
FOURJAY FARMS
Made with real hazelnuts and lots of love
HOMEMADE PREMIUM QUALITY
No Artificial Flavors or Preservatives
NET WT. 8 OZ (227g)
Special shoutout
to Jean's hazelnut cookies
Market gap
Not available in major supermarkets such as Coles, Woolworths, Aldi, etc.
Needs commercialisation

Questions

Thank you for your time.

For further questions or discussion, please feel free to contact:

Dr Yong Wang
Primary Supervisor, UNSW
yong.wang2@unsw.edu.au

Pavittar Singh Sandhu
PhD Candidate,
Food Science and Technology, UNSW
Pavittar.singh@unsw.edu.au


GROW
DRY
MONITOR
OPTIMISE
QUALITY
LIVE MONITORING
Temperature (°C)
Relative Humidity (%)
Airflow (m/s)

Thank You