Fermengator

A data acquisition system for cacao fermentation

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2025 IRES Cohort

A very complex problem

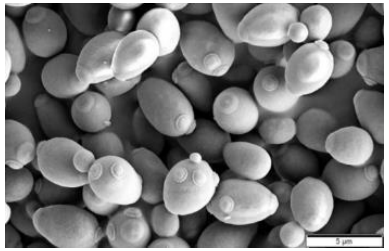
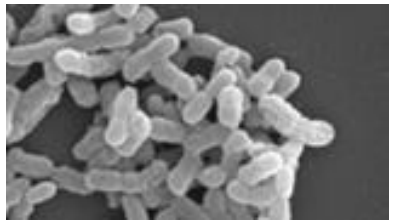






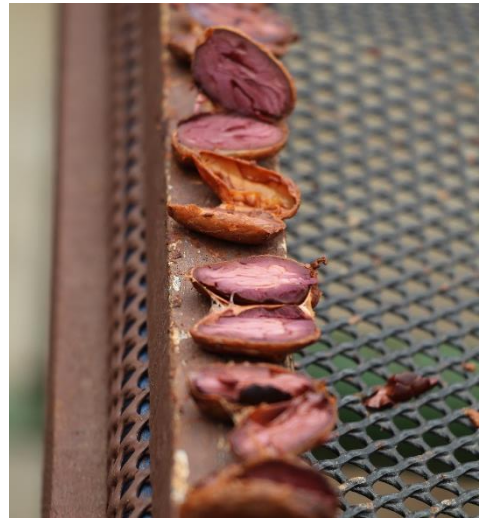

10 major genetic groups


Varying composition
Incl. amount of mucilage and maturity

Varying yeast and bacterial populations

Pathogens




Varying results

Cacao Fermentation

Black

(Dayn

Different fermenter designs
Conflicting reports
Myths
No standard set of reported data
No small-scale fermenters for smallholders

- Minimizes variability,
- Easy to operate,
- Affordable, and
- Farmers willing to use?

Objectives

- To fabricate a low-cost data acquisition system for research on cacao fermentation.
  - Multi-sensor (Temperature, pressure, humidity, VOCs, weight)
  - Data logging
  - IO capability
  - Real-time display

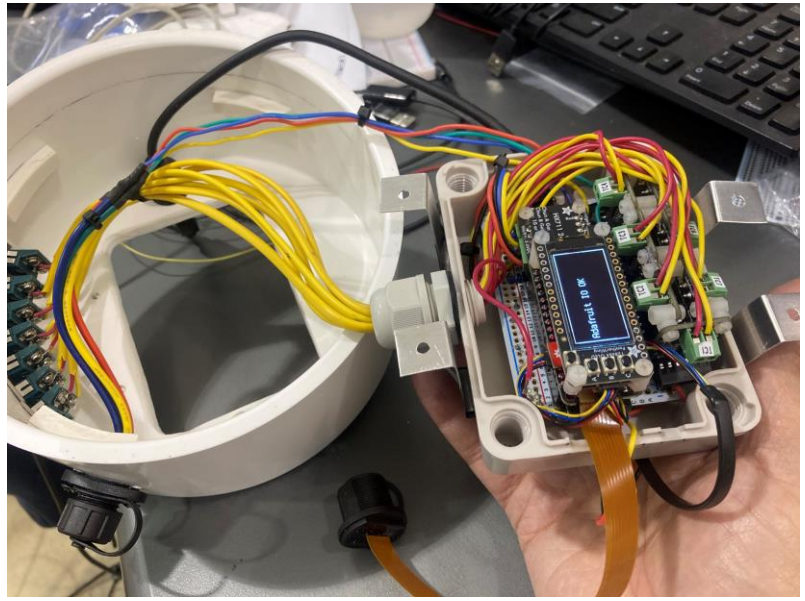
- To test a low-cost, small-scale (25 kg) cacao fermenter

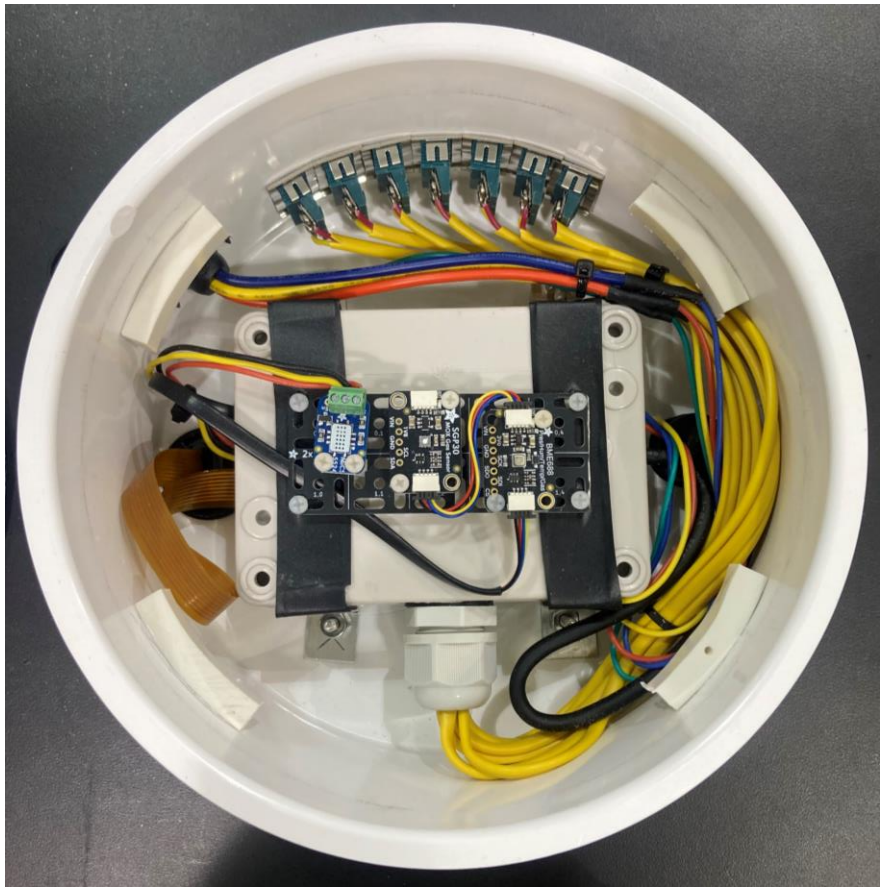
Anatomy

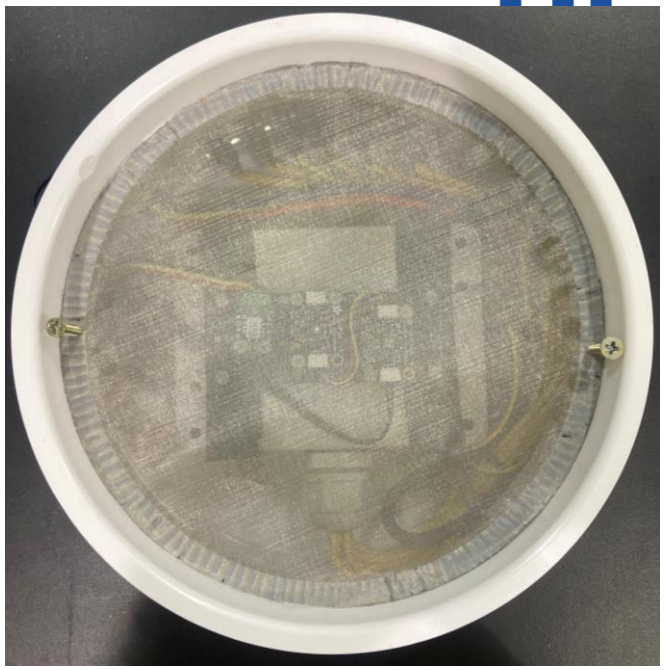
- 7 thermocouples
- Pressure sensor
- Humidity sensor
- Processor temperature
- 4 gas sensors
- Load cell
- datalogger

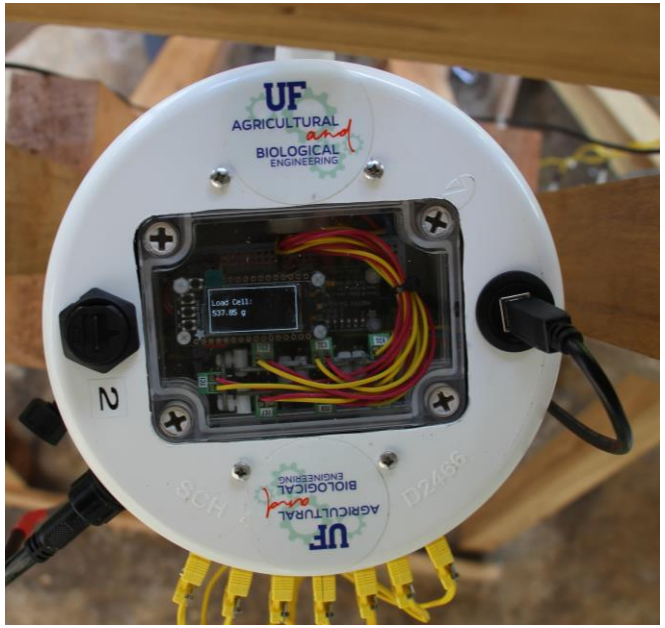
Anatomy


Datalogging Featherwing
ADALOGGER
SD uses SPI
(MOSI MISO SCK)
PCF8523 I2C RTC
RTC Batt: CR1220
feather
HX
711
E- A- A+ B+ B- E+





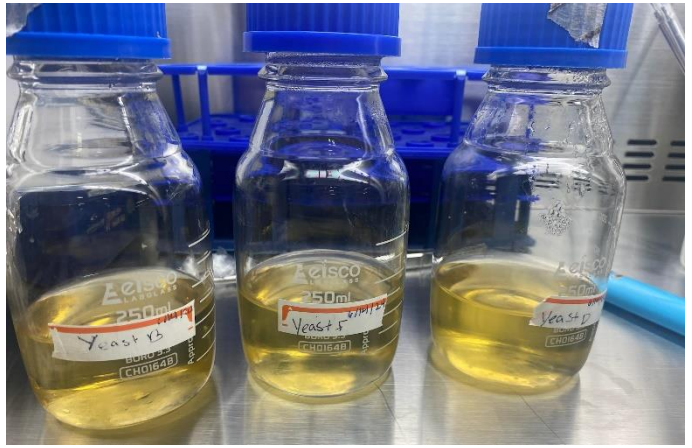



UF
AGRICULTURAL and BIOLOGICAL ENGINEERING

Anatomy

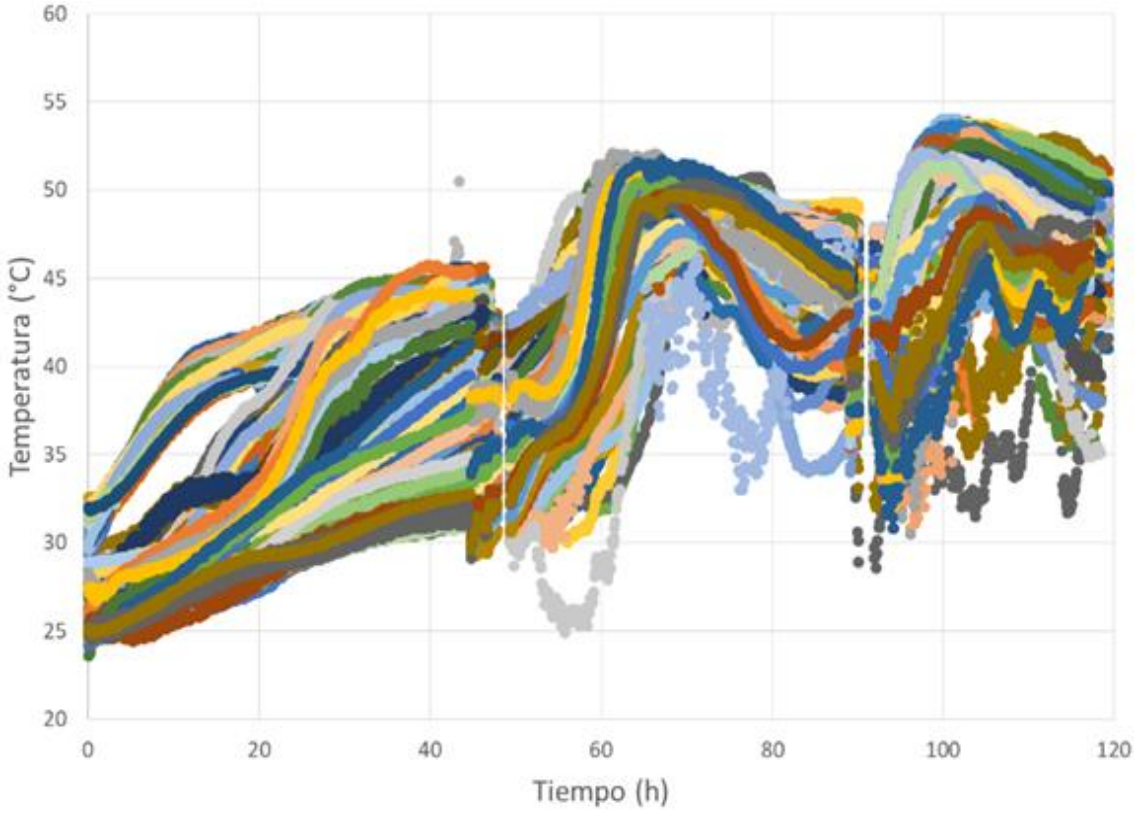
Strategies to reduce variability

- Use starter cultures
  - Select adequate yeasts and bacteria

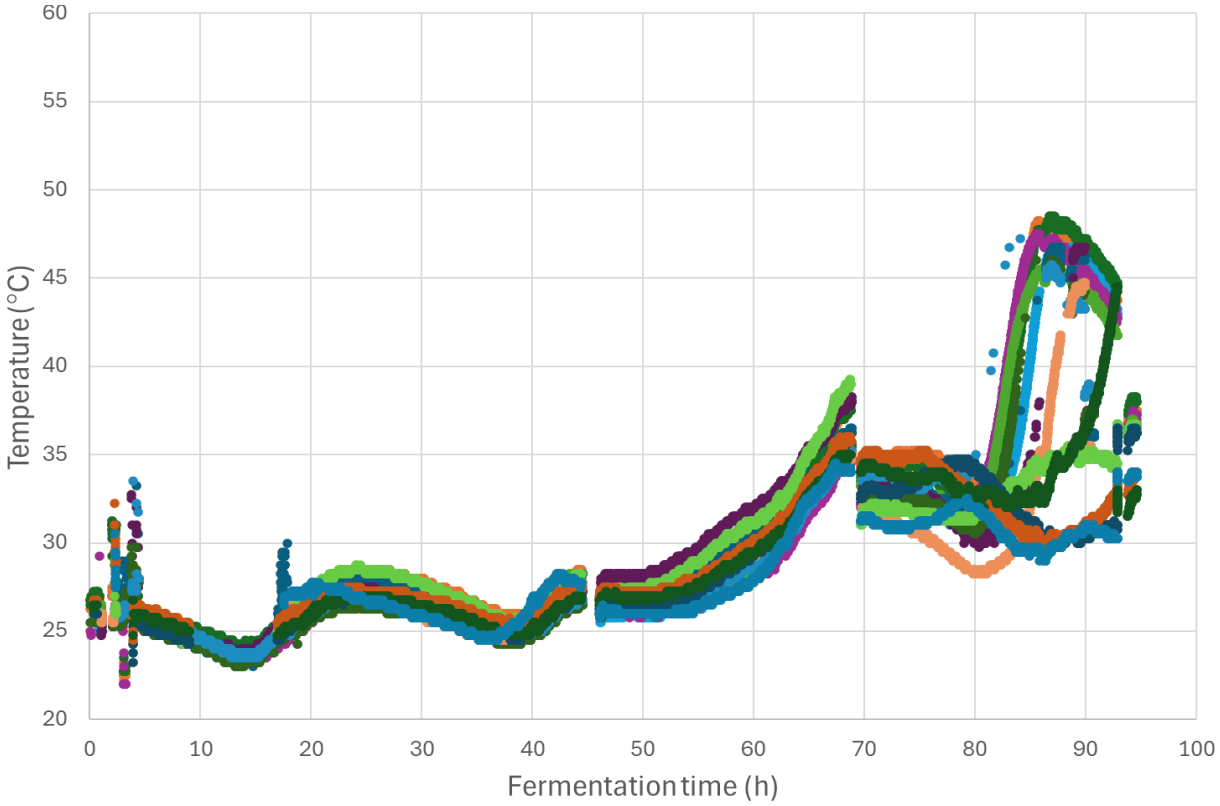


- Design small-scale fermentors
  - For research
  - For smallholders

Results

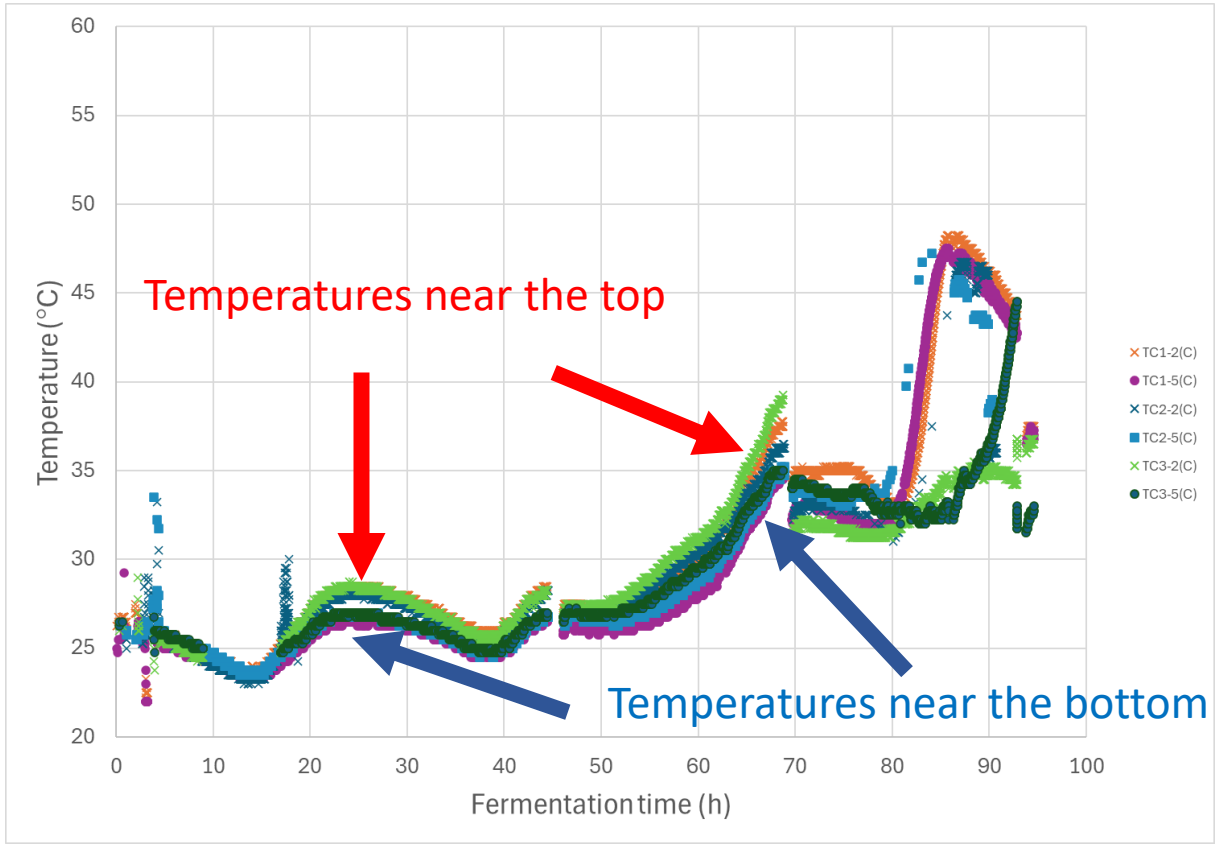


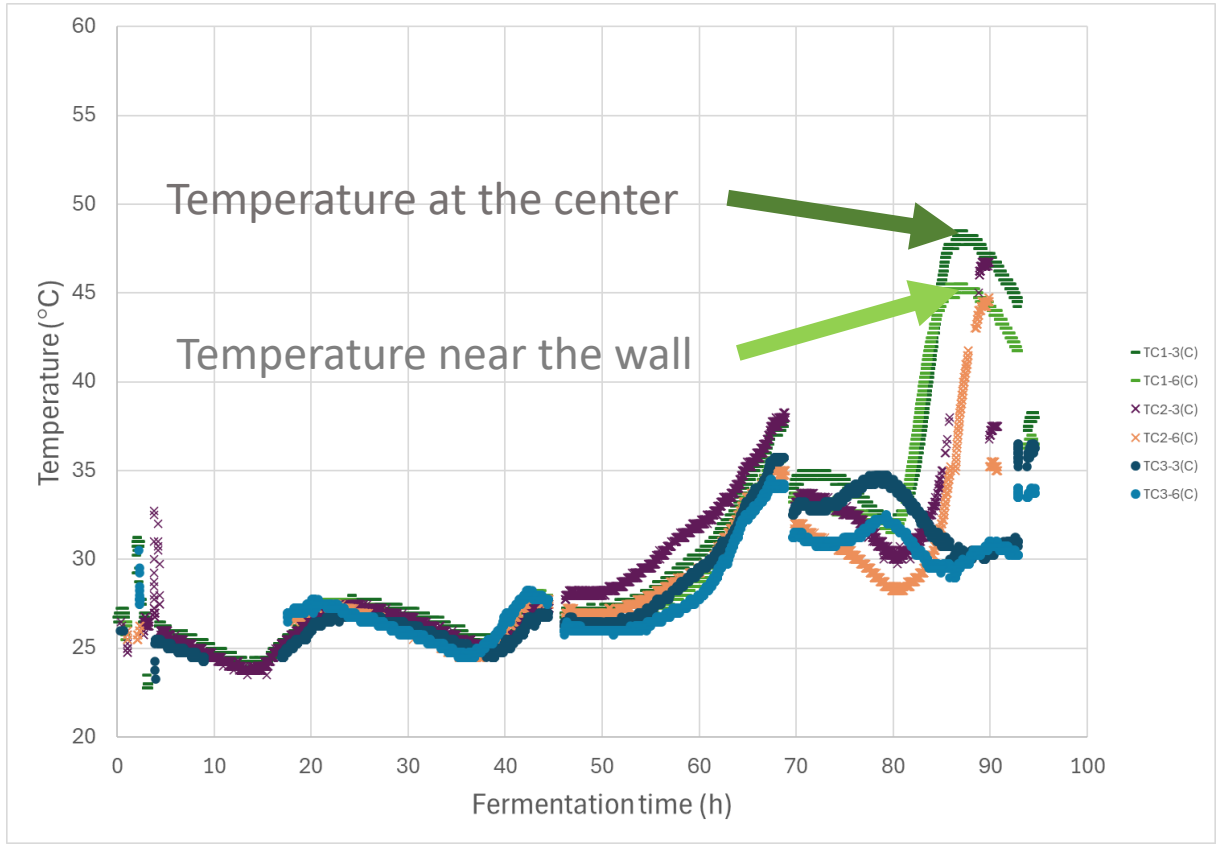
6 batches x 27 thermocouple locations = 162 curves



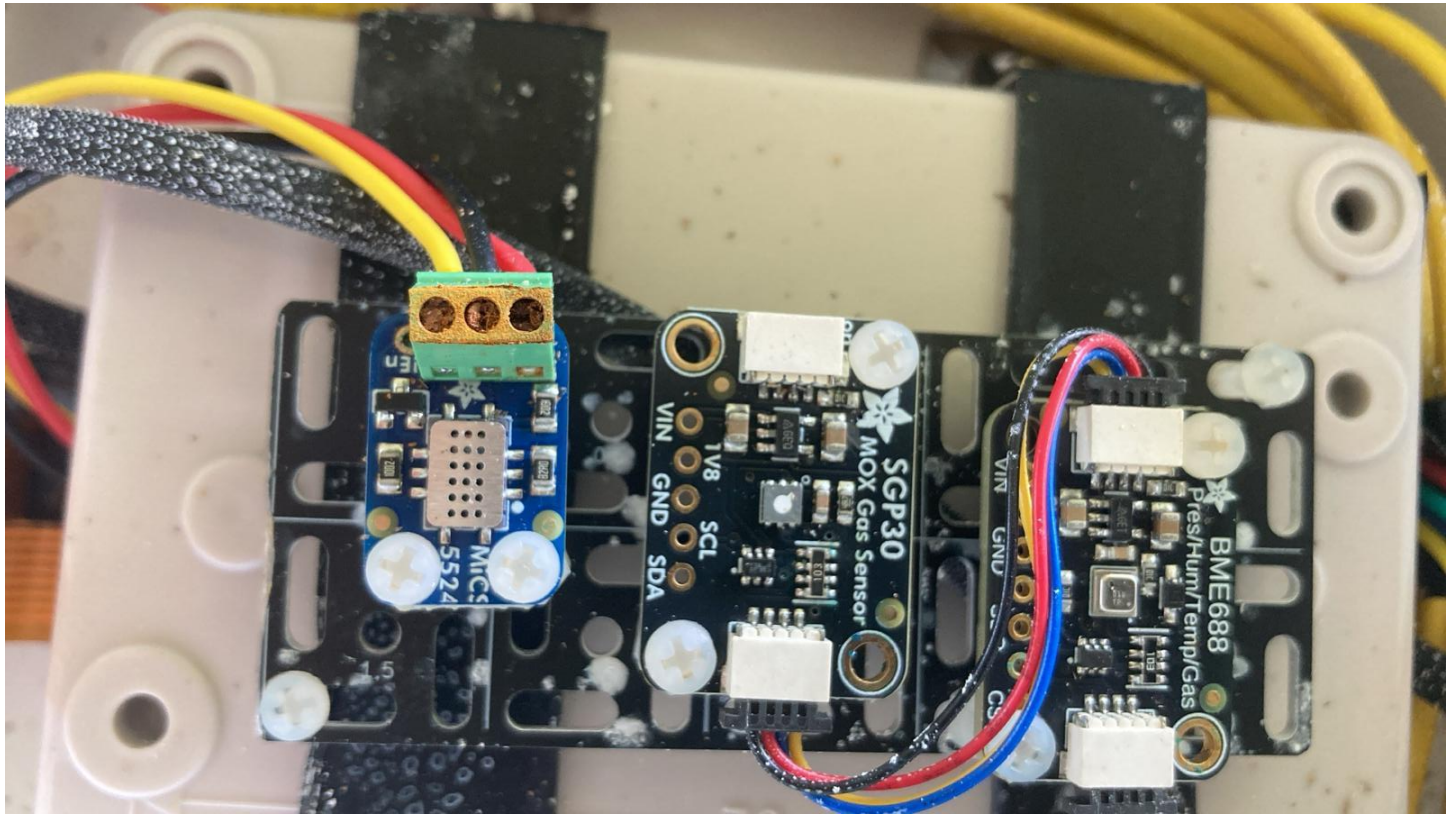
3 batches x 6 thermocouple locations = 18 curves

Results from the first batch





Challenges


SGP30
MOX Gas Sensor
3V3
GND
SCL
SDA
BME688
Pres/Hum/Temp/Gas
VIN
GND

Conclusions

- The fermenter design produced uniform temperature distributions at each locations and to assess temperature differences with cacao depth.
- Insulation must be improved to minimize radial heat losses

- Temperature and lixiviate data collection is reliable.
- Gas setup must be modified to prevent sensor overload and failure.
- Metal connections must be insulated from corrosive VOCs
- Gas sensor calibration must be reassessed

Thank you!