



Assessing the impact of agriculture operations on quality of data from sensor arrays in a controlled environment plant production system

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Introduction

- In controlled environment plant production (CEPP) settings, **reliable and accurate data collection from sensors is a crucial aspect of controlling environmental parameters.** Utilizing low quality data can result in gradual or immediate failure of a crop and while regular calibration and validation of sensor could help ensure the reliability of its data, the frequency and interval of such practice is subject to many factors.. **Agricultural Operations include all tasks required of people within a CEPP system that may bring uncertainties that impair the proper responses of sensors to the environment.** Operations such as entering/exiting the controlled system, harvesting plants, recording data, providing nutrient input to the nutrient tanks, CO₂ enrichment, general maintenance, etc. Thus the **goal of this project is to assess the impact of agriculture operations performed in the CEPP system on the quality of data collected by the sensors.**
- Lettuce will be grown with a NFT hydroponic system in a CEPP chamber equipped with sensors placed in multiple locations to monitor the spatio-temporal environmental conditions in high frequency (10 second intervals throughout the experiment).
- Assumptions** : The crop type, crop growth cycle, and the base temperature of the room will not affect the results.
- Hypothesis** : **The frequency and intensity of agricultural operations may negatively affect the quality of the sensing data if the sensors are not well calibrated at proper intervals.** These data will help us to understand the effect of agricultural operations on the quality of data gathered and thus the sensor calibration requirements for CEPP systems.

Methodology

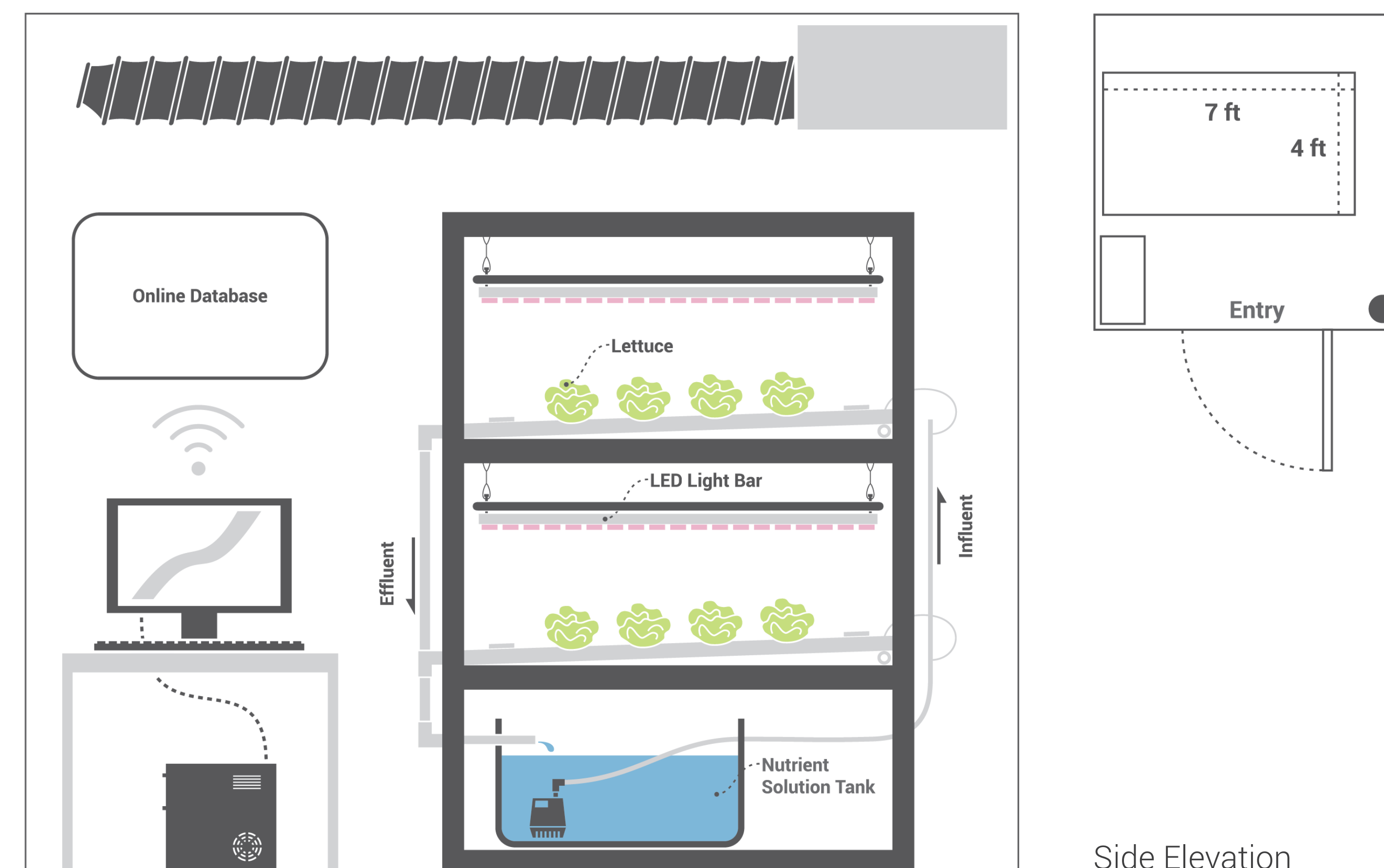
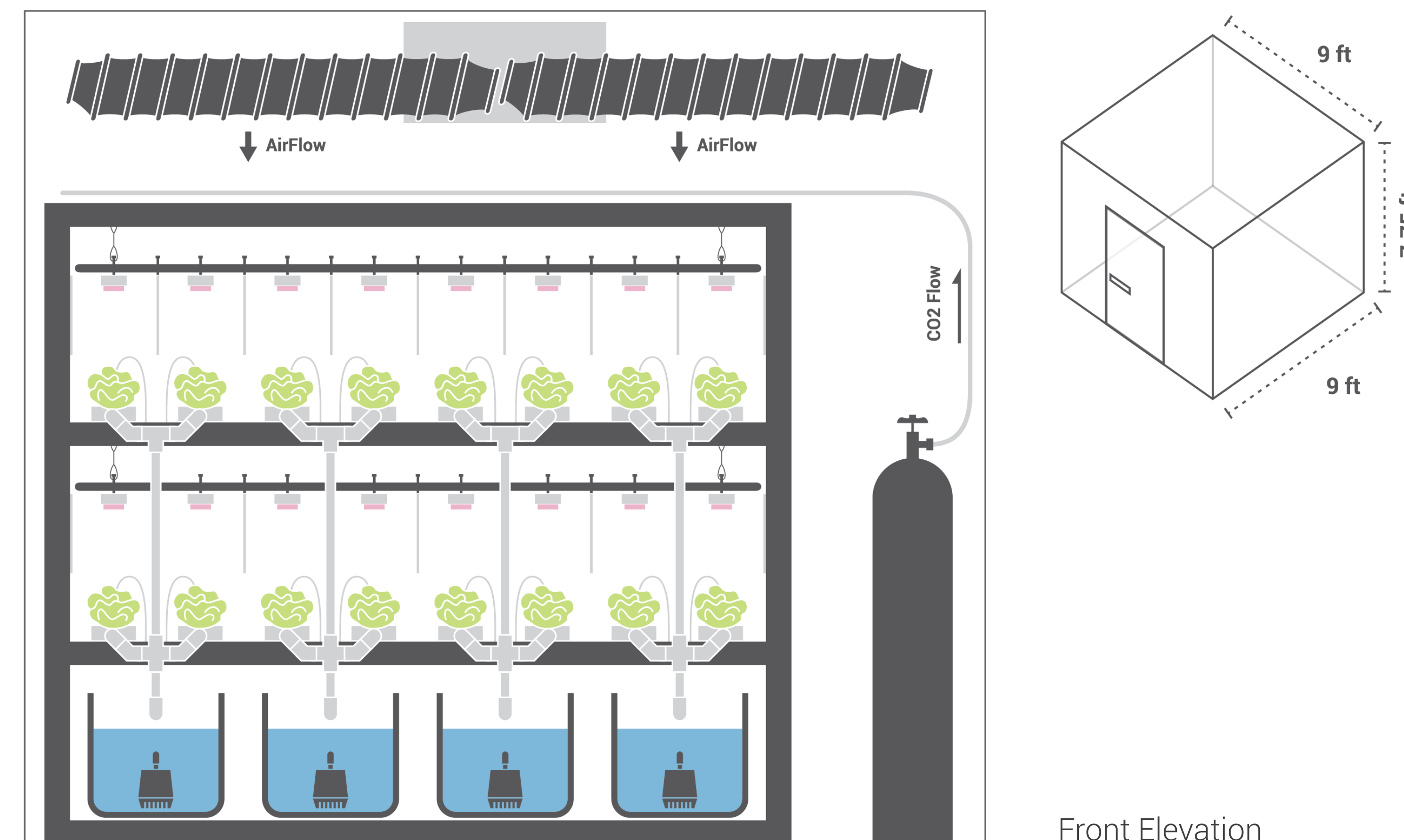
- Two data logging sensor arrays will be implemented in the CEPP system for future data quality comparison, these will include :
 - A wired Arduino sensor system communicating with a database
 - An Autopilot CO₂/Temp/Humidity monitor and data logger
- Data quality will be measured by comparing the accuracy and fluctuations of the readings, and errors such as drift over time, and linearity.** Time series data of agricultural operation occurrence and duration will be used to investigate the effect and relationship of these operations on the data quality from the sensor arrays over time.
- The environmental parameters of interest include : Air temperature, CO₂ concentration, relative humidity (RH), and the temperature, pH, electrical conductivity (EC), dissolved oxygen (DO) of the nutrient solution.
- A control data set will be used to quantify the impact of the experiment and operations.** This data set will be gathered over 5 days where the chamber will be untouched/unopened, without any plants growing within, while all other systems operate as normal.

System Overview

Lettuce Cultivar : **Varied**
 Substrate : **1" Rockwool**
 Plants per Replicate : **16**
 Number of Replicates : **4**
 Treatment : **22 °C Root Zone Cooling (RZC)**

Day Light Interval : **13 DLI**
 Photoperiod : **16:30 (Light), 7:30 (Dark)**
 Air Temp (Day) : **24 / 26 / 28 / 30 °C**
 Air Temp (Night) : **19 °C**
 CO₂ Concentration : **800 mg/L (ppm)**

CEPP Chamber / NFT System



Data Quality Analysis

- Non-Linear Time Series Analysis will be used to investigate the relationship between the multiple factors that will be recorded in the chamber throughout the experiment, from the agricultural operations to the multiple sensor arrays.
- Correlations between the Agricultural operations data and the sensor drift and accuracy over time of the sensor array will be a primary area of interest.
- The treatment group (22 °C RZC) and control each made up of two biological duplicate treatments will also be investigated for tipburn at the environmental conditions.



Future Work

- This experiment will be conducted multiple times to test the growth of the lettuce cultivars under different air temperature and RZC combinations and to further test the data quality over time in varying conditions.
- Different lettuce cultivars will be tested to compare their growth under the varying air temperature and RZC combinations, and the success of their growth will be evaluated based on fresh weight, dry weight, tipburn, overall size, energy efficacy, brix percentage, and the perceived bitterness of each cultivar / treatment combination.
- Other data such as photographic records of the plant growth during destructive harvests, a timelapse of growth in the chamber, nutrient solution dynamics and nutrient recovery will also be analyzed throughout this and following experiments.

References

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