



Optimizing The Commercial Freeze Dry Process

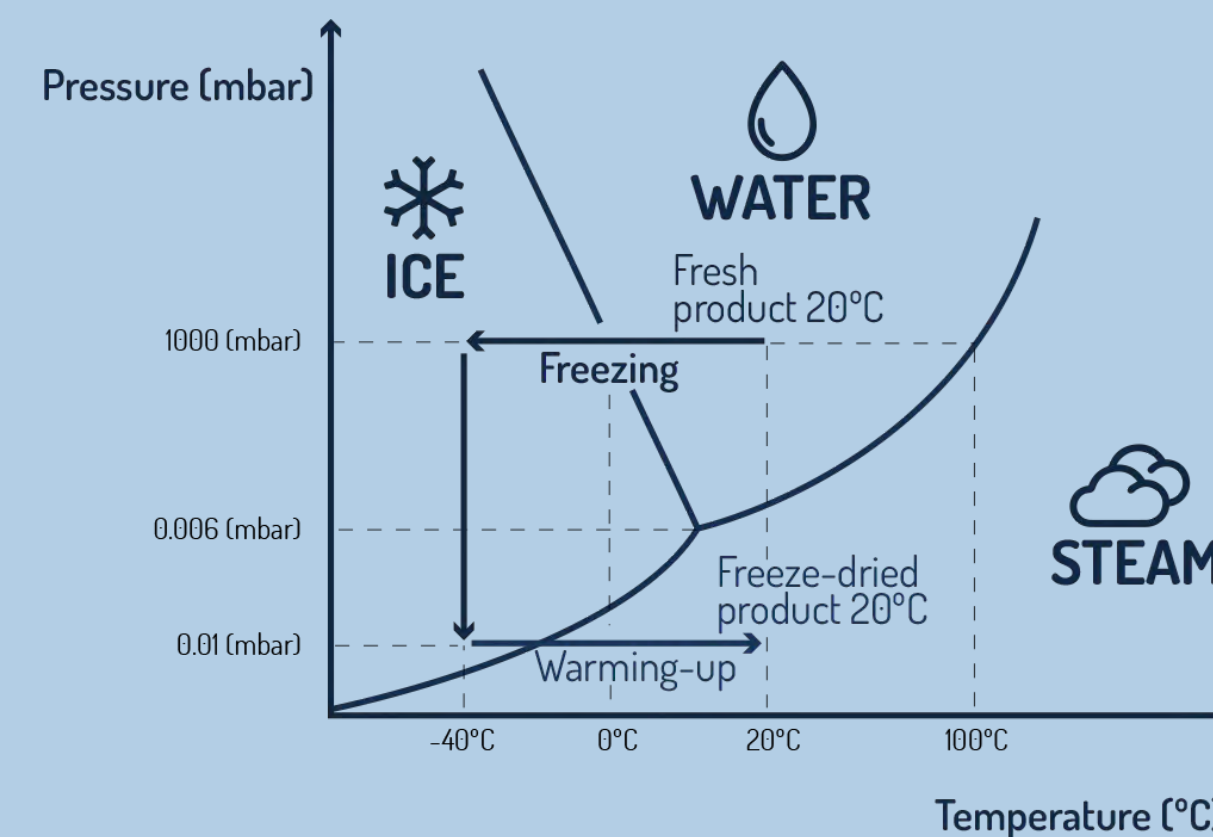
John Livingston, Bennie Okamoto, Emerson Powell, Branden Webb
Advisors: Dr. Kim Park, Dr. Sameer Rao

BACKGROUND

The FDA standard for a shelf stable food is “water activity”, which is a vapor pressure ratio comparing the food to that of distilled water. A water activity of under 0.20 [1] is shelf stable. Getting to the desired water activity level can be a guessing game, as ongoing freeze dry cycles cannot be interrupted once started. To minimize risk of losing product, Brooke and Bradford is consistently overdrying their product, often reaching water activity levels of 0.02. Overdrying their product is unnecessary and a waste of time and money.



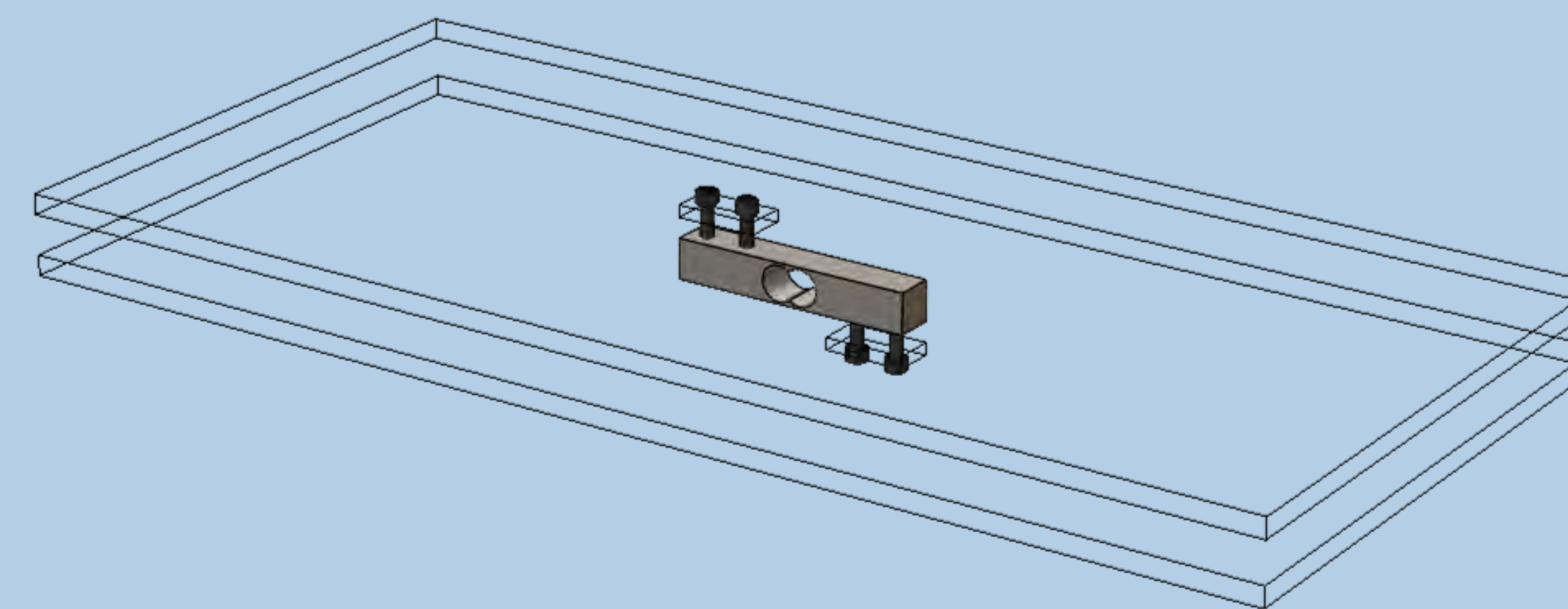
Harvest Right freeze dryer.



Phase diagram of water and its relation to the freeze drying process.



Corn before and after the freeze drying process.



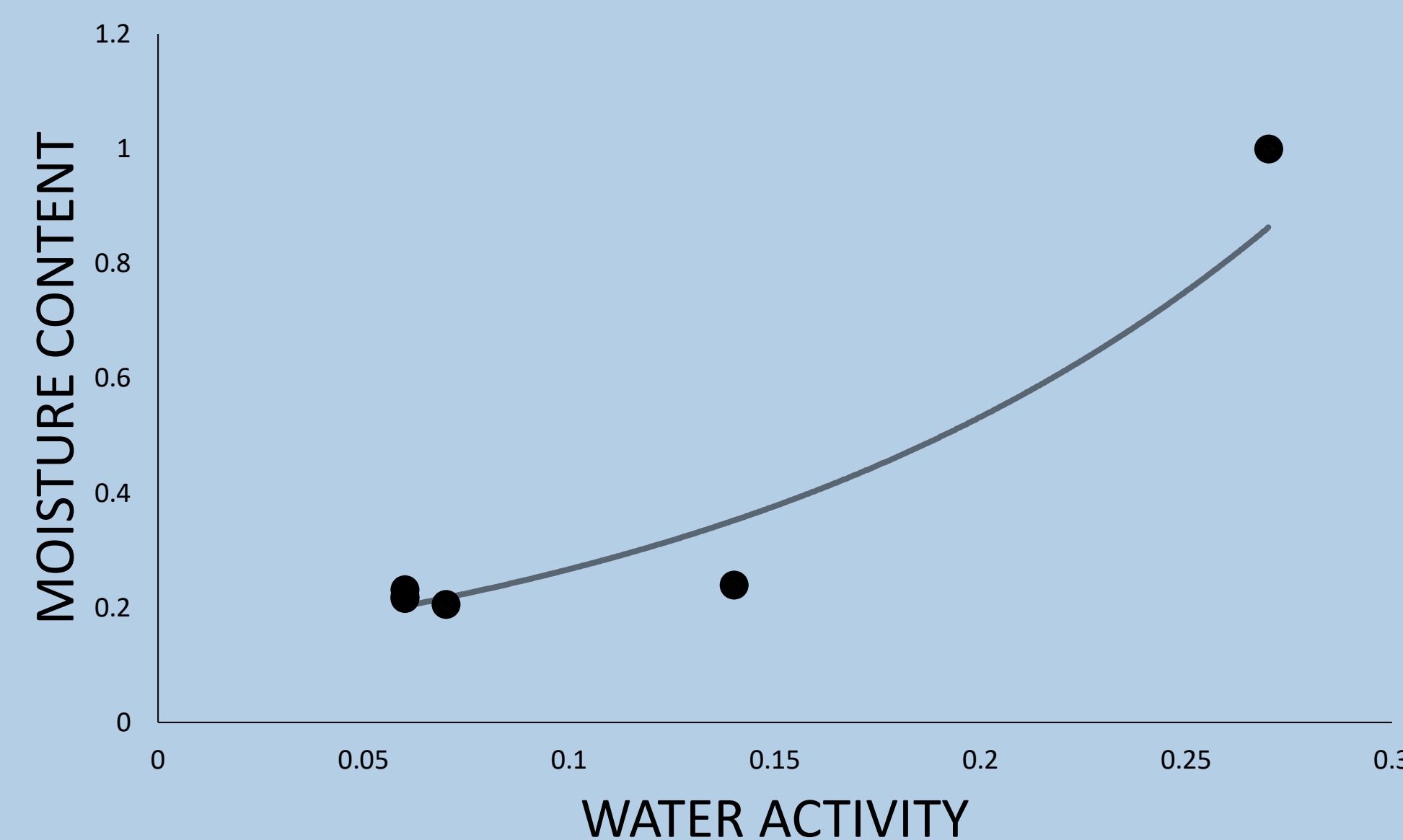
Load cell between two acrylic plates used to monitor weight changes during the freeze drying process.

OBJECTIVES

We seek to reduce overdrying by:

- Actively measuring the weight of food being freeze dried
- Relating the change in weight to moisture content then water activity
- Calculating the time until the product is shelf stable

MOISTURE CONTENT VS. WATER ACTIVITY



Relative moisture content as a function of water activity for corn. R² = 0.96

GOALS

To achieve our goal, we require a prototype capable of:

- Precisely measuring the weight of the product
- Maintaining a similar environment to a commercial freeze dryer

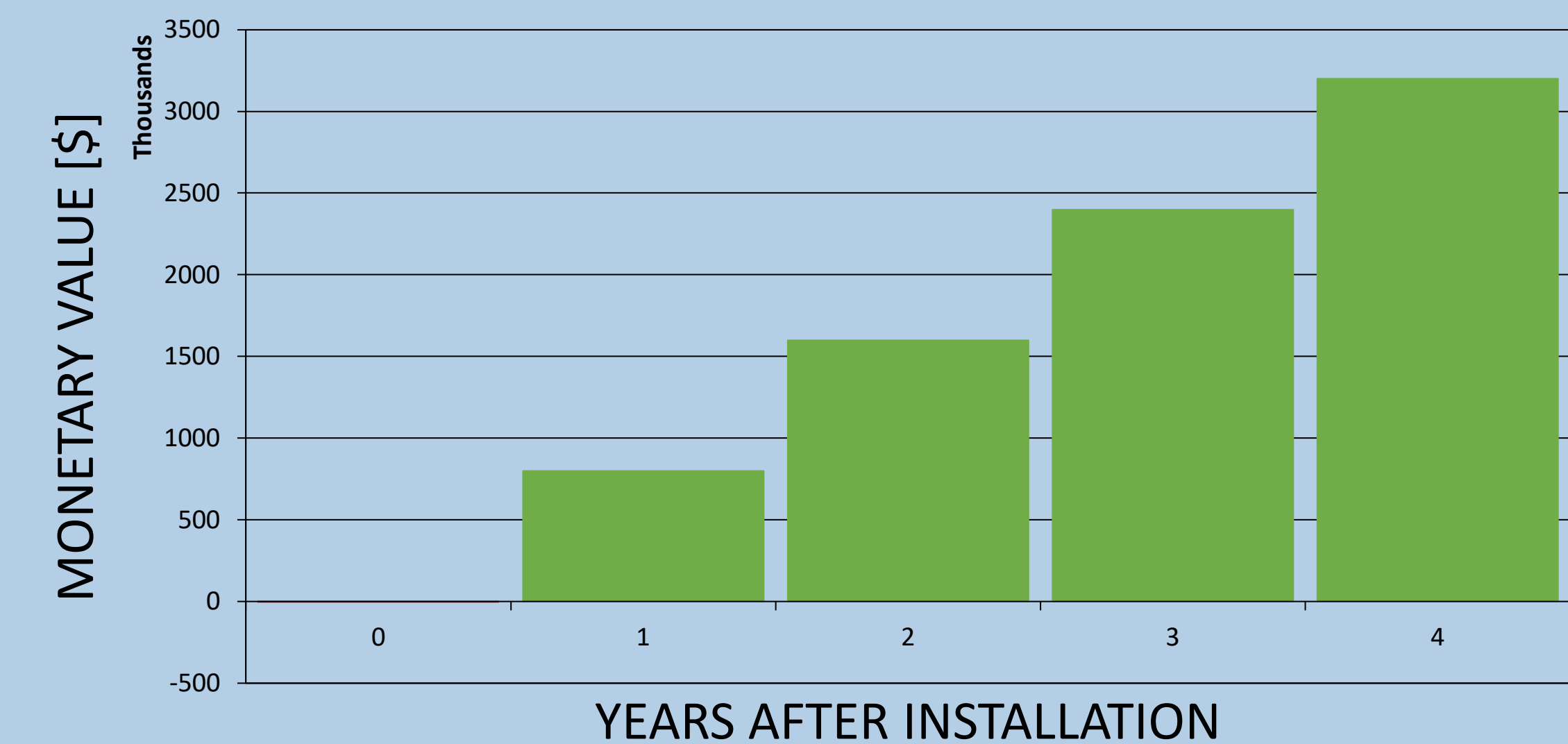
METHODS

- To monitor the weight during the freeze drying process we developed a tray with a load cell
- We measured the water activity using a specialized meter at the end of each experiment
- The change in weight was used to calculate to relative moisture content which was then correlated with water activity
- To verify the precision of the load cell, we measured a single weight and took 50 samples
- We used the weight measurements to confirm the error of the sensor

CONCLUSIONS

- Our device was able to precisely measure the weight of the product within the prototype
- An empirical relation between water activity and relative moisture content was established for corn
- Estimated savings of \$800,000 a year

EXPECTED SAVINGS



Savings based on reducing 8 hours per cycle in 6 machines with a runtime cost of \$100/hr

REQUIREMENTS	GOAL	ACHIEVED
System Steady State Pressure	40mTor-400mTor	Y
Load Cell Functions in Actual Environment	Y	Y
Percent Error of Sensor	0%-5%	Y
Financial Benefit of Device - Cycle Time Reduction	25%	Y

REFERENCES

- [1] <https://www.metergroup.com/en/meter-food/expertise-library/government-regulations>
[2] <https://www.barnalab.com/en/what-about-freeze-drying/>