

The background features abstract, overlapping green geometric shapes in various shades, creating a modern and dynamic visual effect. The shapes are primarily triangular and polygonal, with some areas appearing more translucent than others.

# Genius Garden

Chris Garces

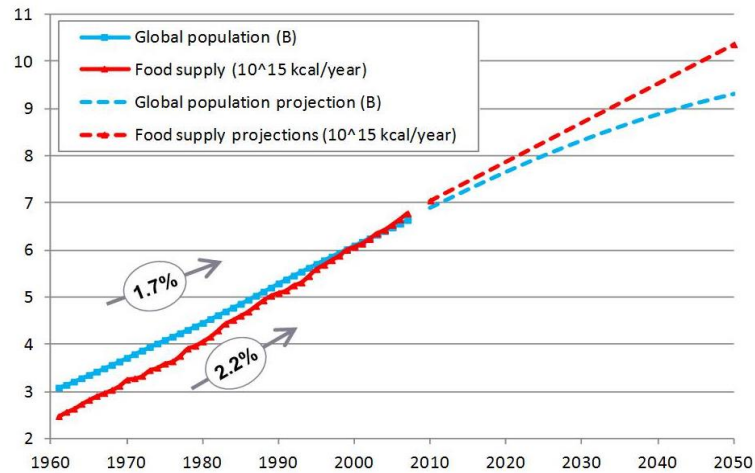
iLAB1 project showcase

Master in Data Science and Innovation

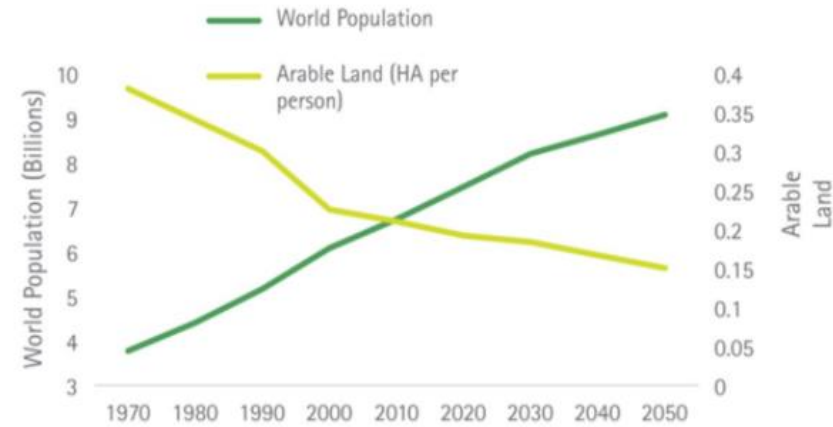
University of Technology Sydney

# Food demand forecast:

Global population and food supply - 1961 to 2051

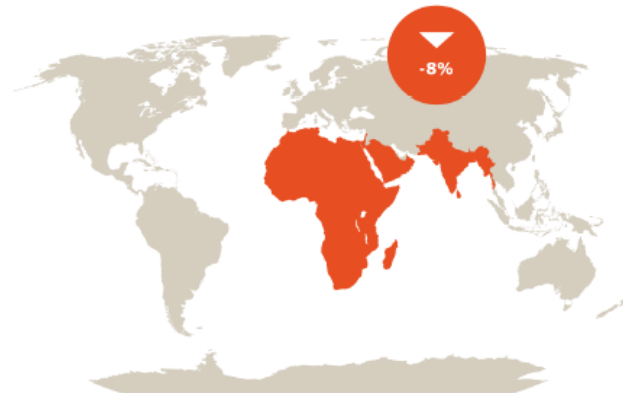


Source: <http://www.tasteofsustainability.com/wp-content/uploads/2012/02/2050-global-population-and-food-supply1.jpg>



Source: FAO, United Nations, WHO

Average decline in yields for eight major crops across Africa and South Asia



Source: <https://cgspace.cgiar.org/handle/10568/35215>  
/Climate change, food security and small-scale producers

# What is Genius Garden ?

- ▶ A community based precession-agriculture backyard farm prototype.
- ▶ Hydroponic method of gardening.
  - ▶ Uses less power and conserved water.
  - ▶ Outdoor garden, very challenging growing climate (sometimes, 4 seasons in one day).
- ▶ Solar powered with small backup battery.
- ▶ IOT implementation.
- ▶ Utilised cloud computing resources for data storage.
- ▶ AI controlled plant growing with insect detection.



# Components



26 AH battery



Atlas PH probe



Atlas EC probe



Tentacle T3



DS18B20 Digital Temperature sensor



Raspberry Pi 3



Raspberry Pi Zero W



100 W Solar Panel with Charge controller



Plastic Box as water tank



PVC Pipes



8 MP NoIR Camera



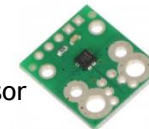
8 MP RGB Camera



12Vdc Peristaltic Pump



5W 12Vdc Immersible Pump

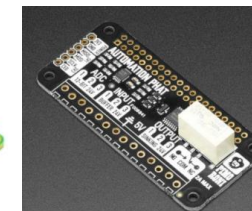


ACS711 Current sensor



DC Relay

Automation pHAT



DHT11 Humidity and Temperature sensor



# Electronics Devices Assembly:

## Motor Control Box

- Used in weather forecast websrape, 4 water circulator mini pumps, and solar panel voltage and current sensors.



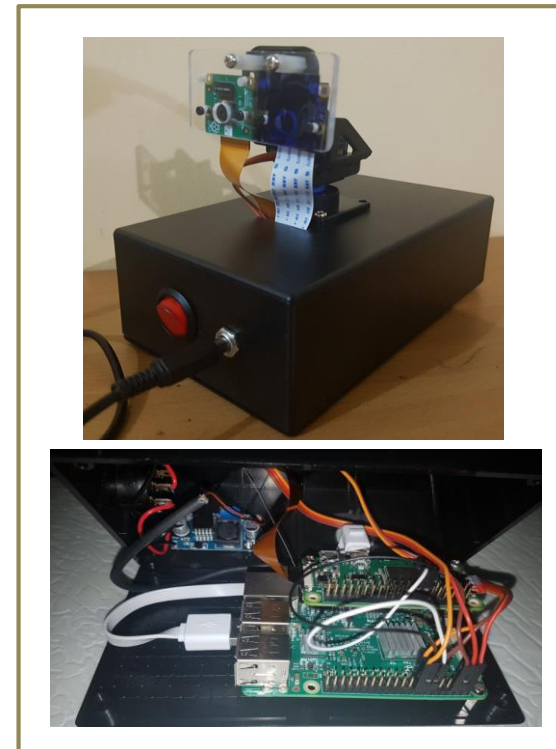
## Nutrient Mixer Box

- Measures pH, EC and water temperature.
- Controls nutrients, tap water and acid buffer mixing.



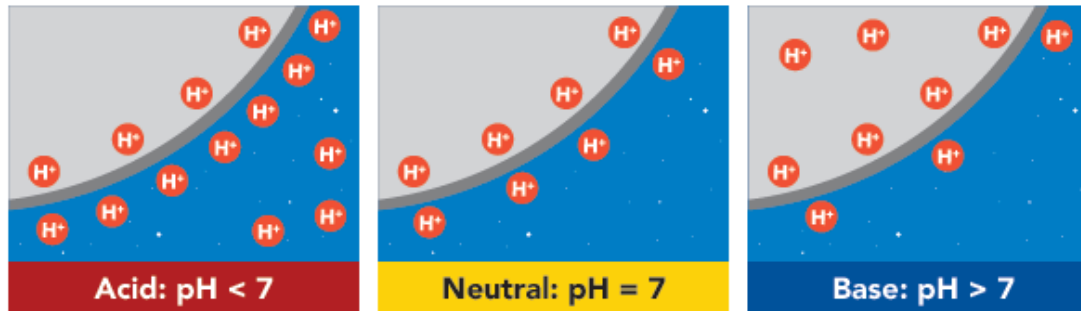
## Plant Health Camera Box

- Captures NoIR, colour and NDVI photos of the plants.



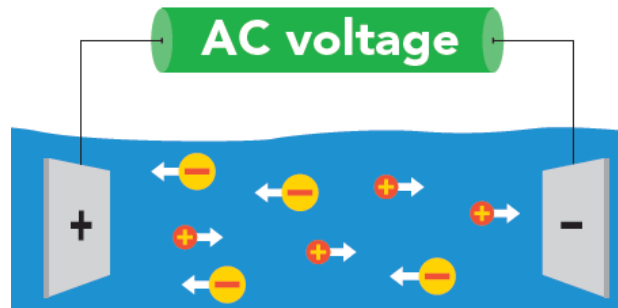
# What is PH?

- ▶ Potential of Hydrogen
- ▶ Is a numeric scale from 1 to 14 used to indicate the Acidity or Alkalinity of water.
- ▶ Water and nutrients solution needs to be in proper pH range for efficient absorption of nutrients by the plant.
- ▶ pH of the nutrient solution is measure by Atlas pH prove.



# What is EC

- ▶ Electrical Conductivity
- ▶ Indicates the amount of nutrients, salt or impurities in water.
- ▶ High conductivity occurs when the water contains more free electrolytes.



- ▶ At high temperature, plants absorb more water to cool down resulting in more nutrient absorption leading to leaf burn-out.
- ▶ EC is measured by Atlas EC probe.



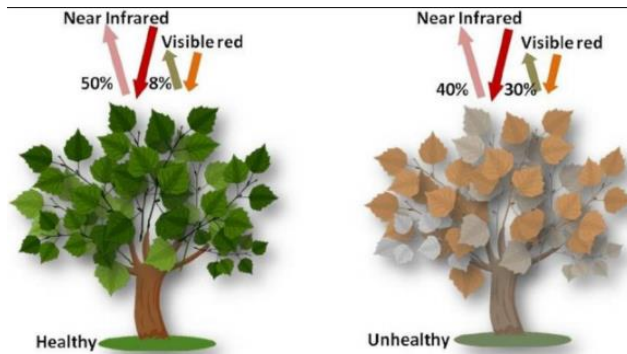
Over-fertilized, the leaf will curl and  
The tips go brown like a burn



Nutrient deficient

# What is NDVI

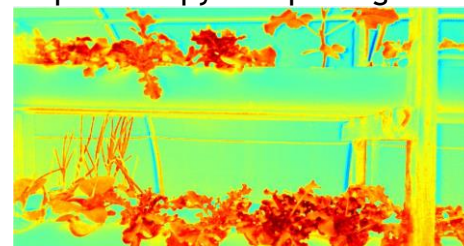
- ▶ Normalised Difference Vegetation Index
- ▶ Uses the visible and near-infrared bands of the light spectrum as a way to indicate plant health.



- ▶  $NDVI = (NIR - RED) / (NIR + RED)$
- ▶ Images below are taken by the dual lens Raspberry Pi Camera and post processed using OpenCV python package.
- ▶ Deep red means healthy plant.



NDVI image processed using  
OpenCV 3 python package



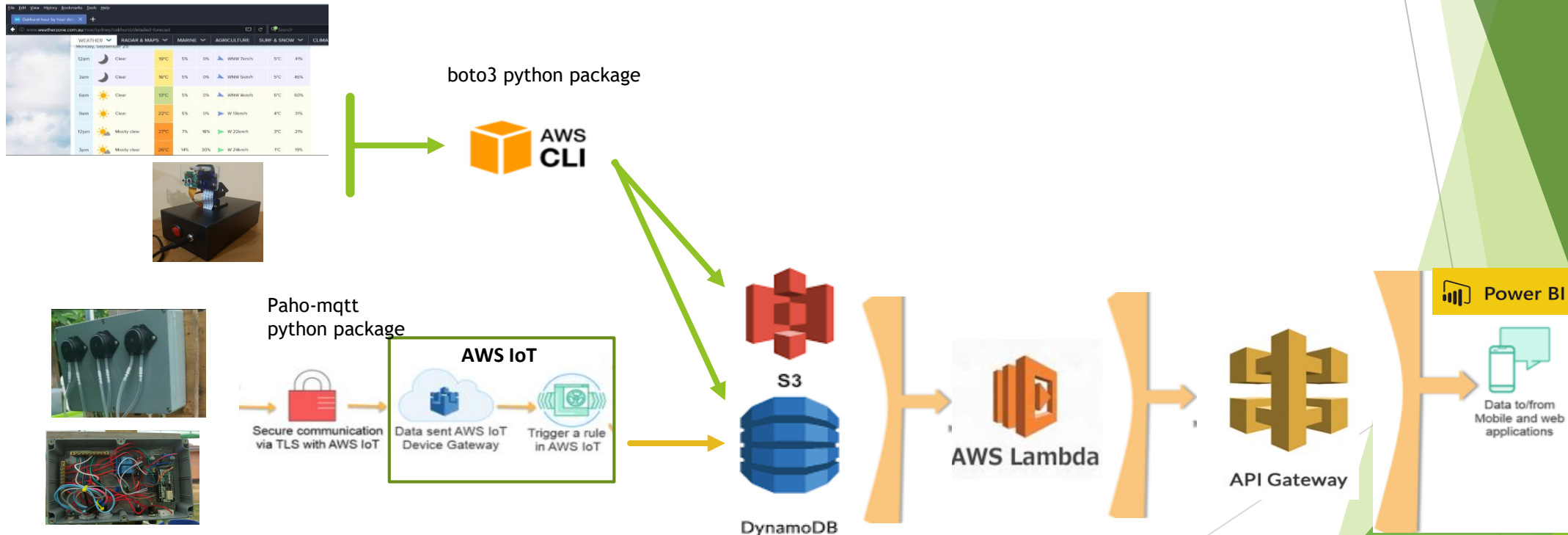
Raspberry Pi Dual  
Camera





# End to End IOT Architecture

- Web scraped weather forecast, images are sent to AWS IOT Cloud using web API.
- Sensors data are sent to AWS IOT Cloud using MQTT protocol



# Dashboards

Data visualization of collected data using Power BI

## Genius Garden Greenhouse and Hydroponic Sensors Dashboard



## Genius Garden Weather Dashboard





# Plant photos

Various Vegetables



September 2017

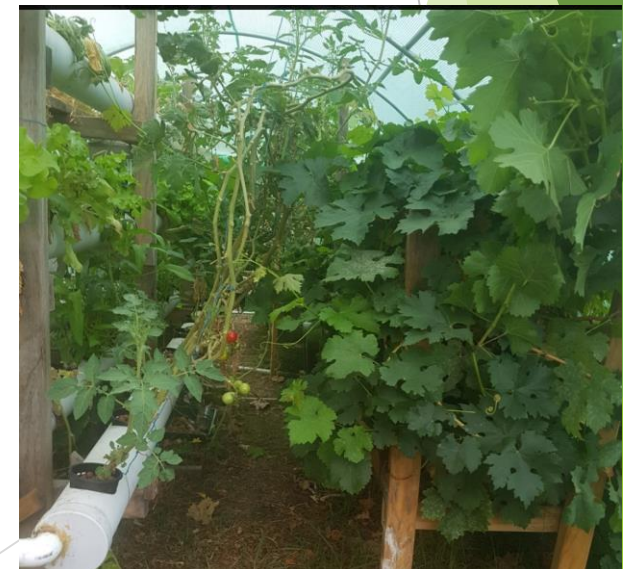
Berries



Grapes



February 2018



## Next Step (iLab2)

- ▶ Development of custom user interface (mobile and desktop app) using Python Kivy package to replace Power BI.
- ▶ Develop Deep Reinforcement Learning model for plant nutrient, acid buffer, water and air mixer to control level of EC, pH and Oxygen with respect to change in temperature and plant growth stage.
- ▶ Insect Detection Feature integration using transfer learning Convolutional Neural Network (CNN).