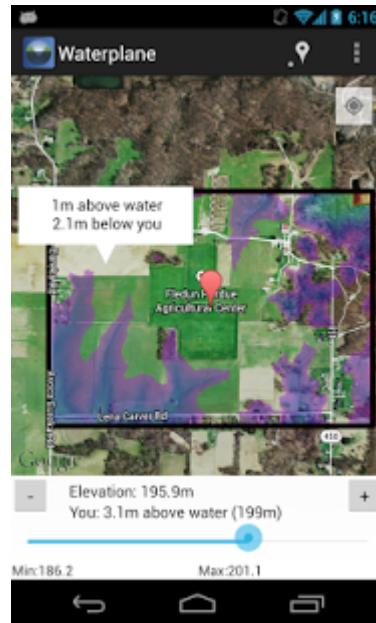
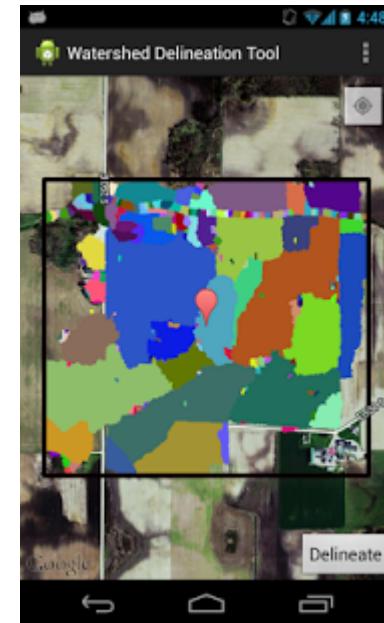


WaterApps

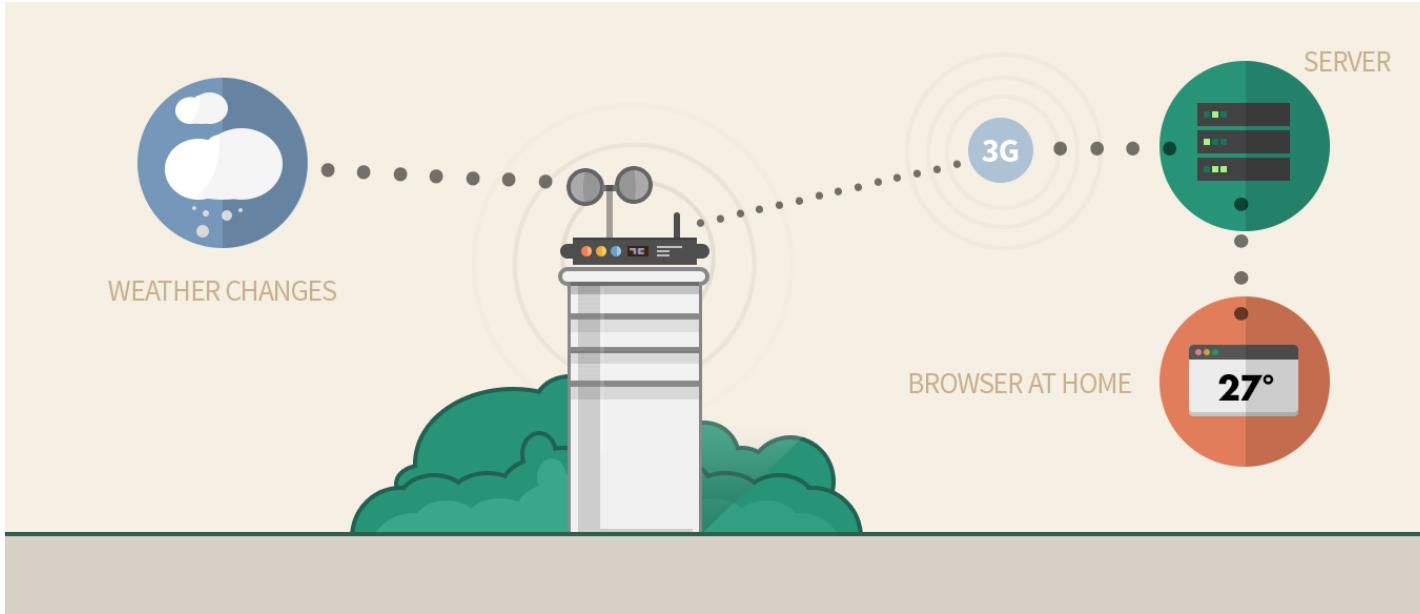


Water Plane App



Watershed Delineation App

Open Source Soil Telemetry & Weather Station



Motivation

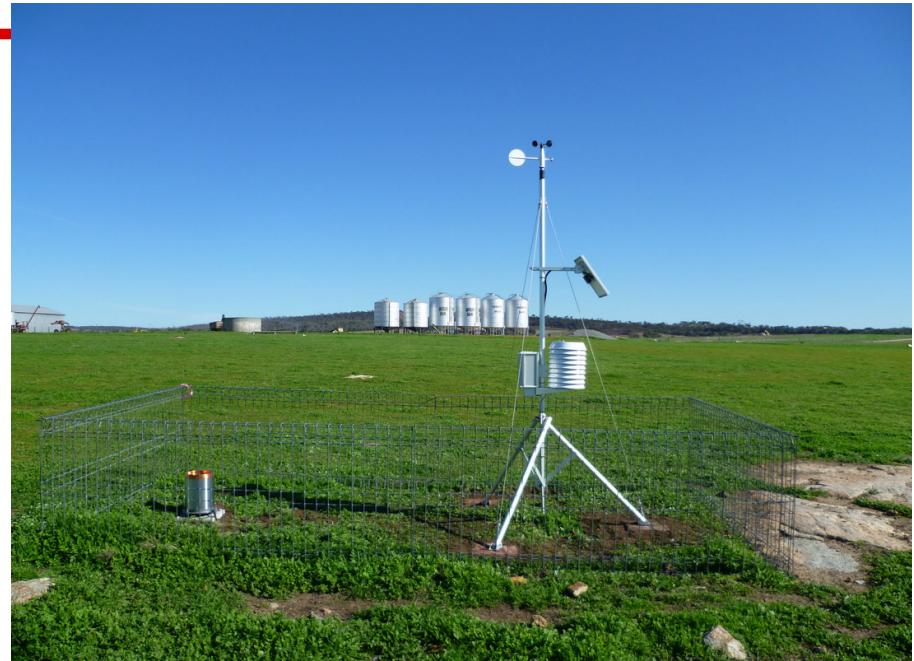
- Model inputs (crop/weather)
- Irrigation decisions
- Data-driven management decisions

Why Open Source?

- Organic standardization
- Framework for Innovation
- Enables innovators/makers
- Stop Reinventing Wheels

Measurements

1. soil moisture



Source: <https://www.agric.wa.gov.au/climate-land-water/climate-weather/agseasons>

Soil Moisture

Objectives: -Fieldwork accessibility
-irrigation timing
-yield forecast



Units: % (volume water / total volume) or pressure

Sensors: dielectric-based, conductance-based,
TDR, tensiometer, potentiometer

Price Range: \$2-\$100, \$100+

Soil Moisture: Sensor Options

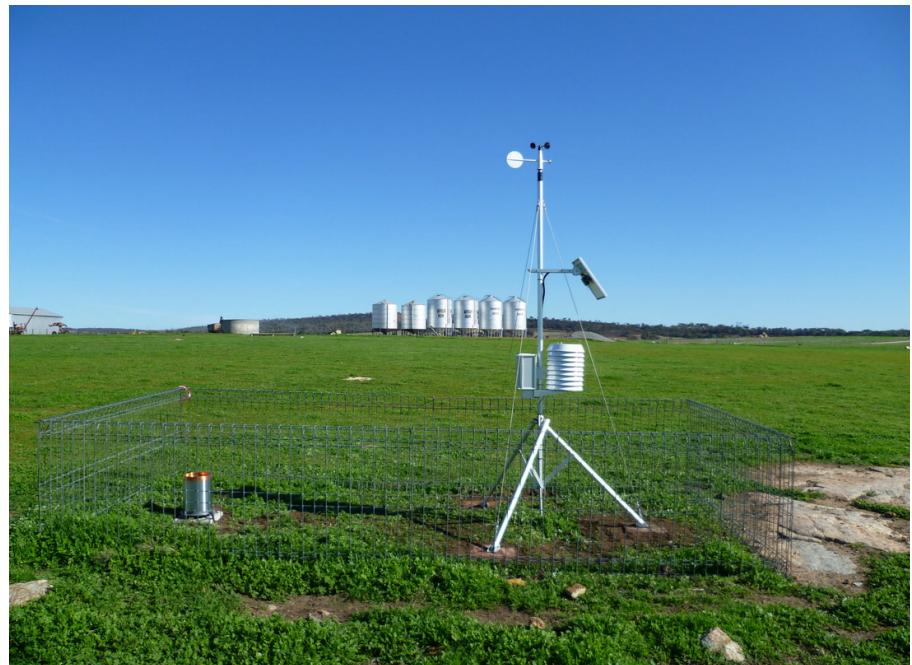
- \$2 [Soil hygrometer module](#)
- \$5 [ImmersionGold](#) sensor for arduino
- \$40 [Spectrum Watermark](#)
- \$50 [Adafruit soil moisture + soil temp](#)
- \$95 [Vernier](#)
- high end, high \$ TDR sensors

[More info](#)



Measurements

1. soil moisture
2. soil temperature



Source: <https://www.agric.wa.gov.au/climate-land-water/climate-weather/agseasons>

Soil Temperature



Objectives: planting condition suitability

Units: degrees F or C

Sensors: thermistor, thermocouple

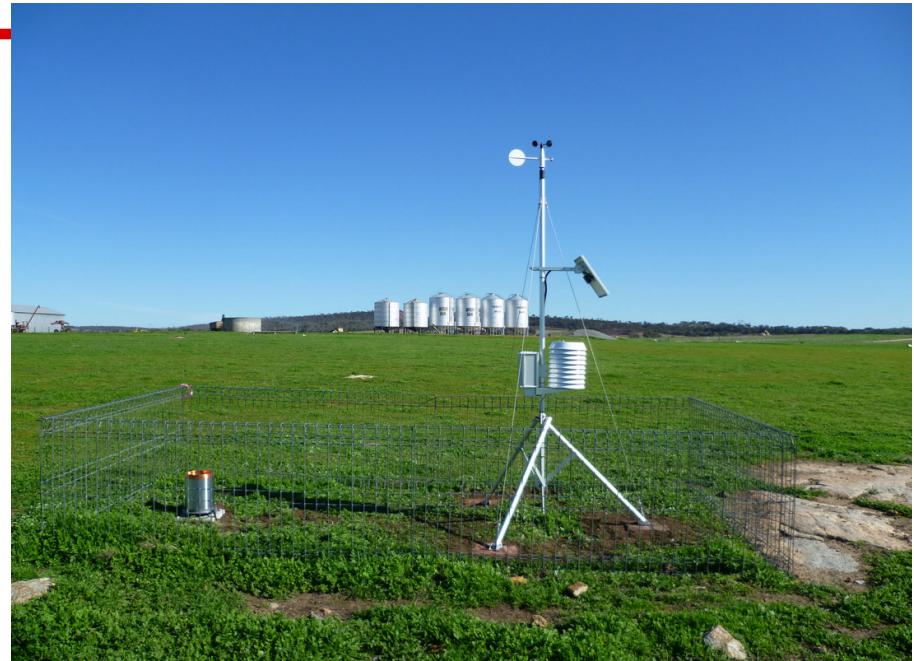
Price Range: \$30 - \$55+

Soil Temperature: Sensor Options

- \$30 - \$40 Vegetronix
- \$45 - \$55 Spectrum
- \$500 FTS moisture + temperature
- \$? Campbell Scientific

Measurements

1. soil moisture
2. soil temperature
3. rainfall



Source: <https://www.agric.wa.gov.au/climate-land-water/climate-weather/agseasons>

Rainfall

Objectives: -irrigation prediction
-yield prediction

Sensors: tipping buckets - 0.01" per tip

Units: in or mm

Price Range: \$75 - \$600+

Rainfall: Sensor Options

\$75 [Davis](#)

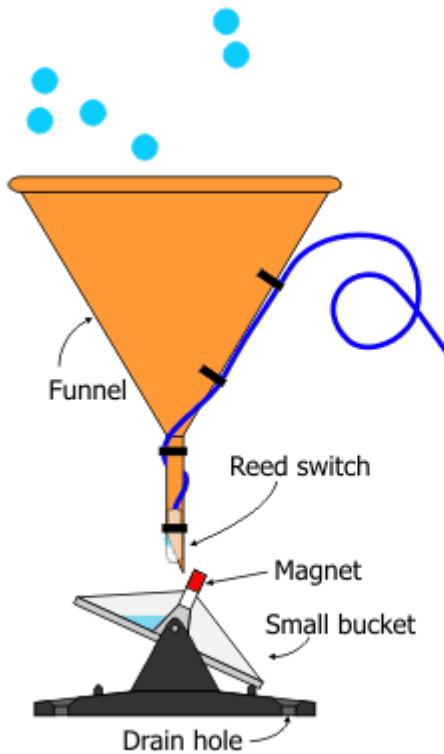
\$230 [Weathershop](#)

\$360 [Texas Electronics](#)

\$815 [FTS](#)

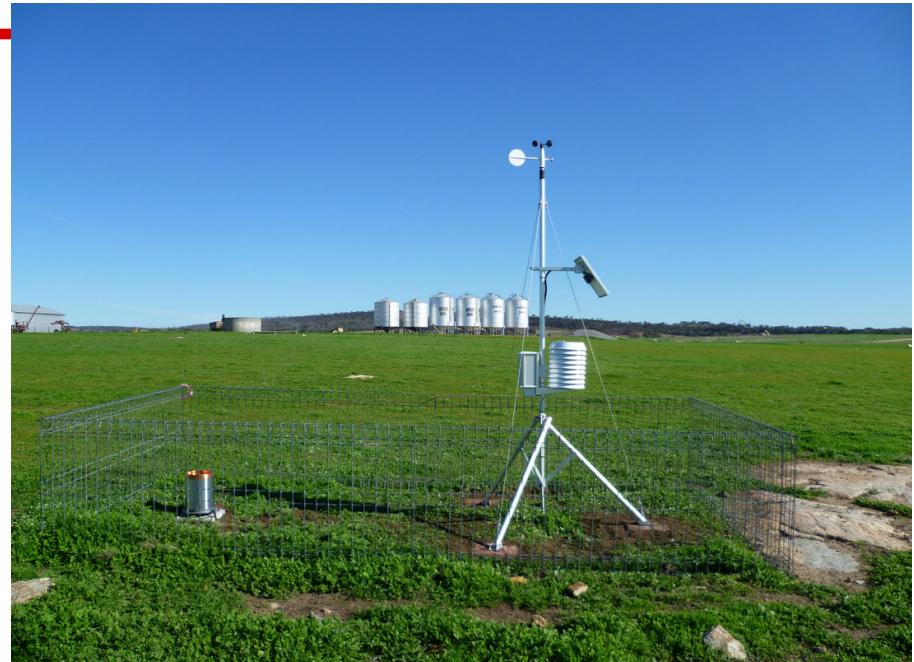
\$? [Novalynx](#)

\$? [Global Water](#)



Measurements

1. soil moisture
2. soil temperature
3. rainfall
4. relative humidity



Source: <https://www.agric.wa.gov.au/climate-land-water/climate-weather/agseasons>

Relative Humidity

Objectives: - evapotranspiration estimation

- disease forecasting
- plant stress

Units: % (partial pressure of water vapor/saturated vapor pressure of water)

Price Range: \$10 - \$50

Relative Humidity: Sensor Options

- \$10 [Sparkfun](#)
- \$42 [Adafruit Humidity + Temperature](#)
- \$? [Campbell Scientific](#)
- \$? [Decagon](#)

Measurements

1. soil moisture
2. soil temperature
3. rainfall
4. relative humidity
5. air pressure



Source: <https://www.agric.wa.gov.au/climate-land-water/climate-weather/agseasons>

Barometric Pressure

Objectives: weather prediction

Units: inHg, kPa

Sensors: pressure transducer

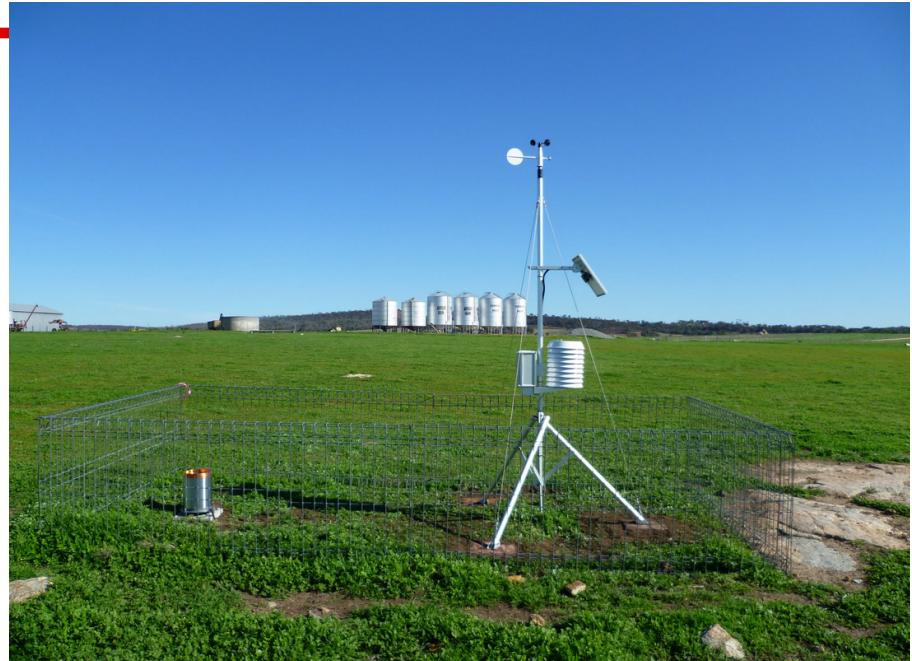
Price Range: \$10 - \$20

Barometric Pressure: Sensor Options

- \$10 [Sparkfun](#)
- \$12 [Adafruit](#) temp + pressure

Measurements

1. soil moisture
2. soil temperature
3. rainfall
4. relative humidity
5. air pressure
6. air temperature



Source: <https://www.agric.wa.gov.au/climate-land-water/climate-weather/agseasons>

Air Temperature

Objectives: - calculate growing degree days
 -affects plant photosynthetic activity
 -affects soil water availability

Units: F or C

Sensors: thermistor, thermocouple

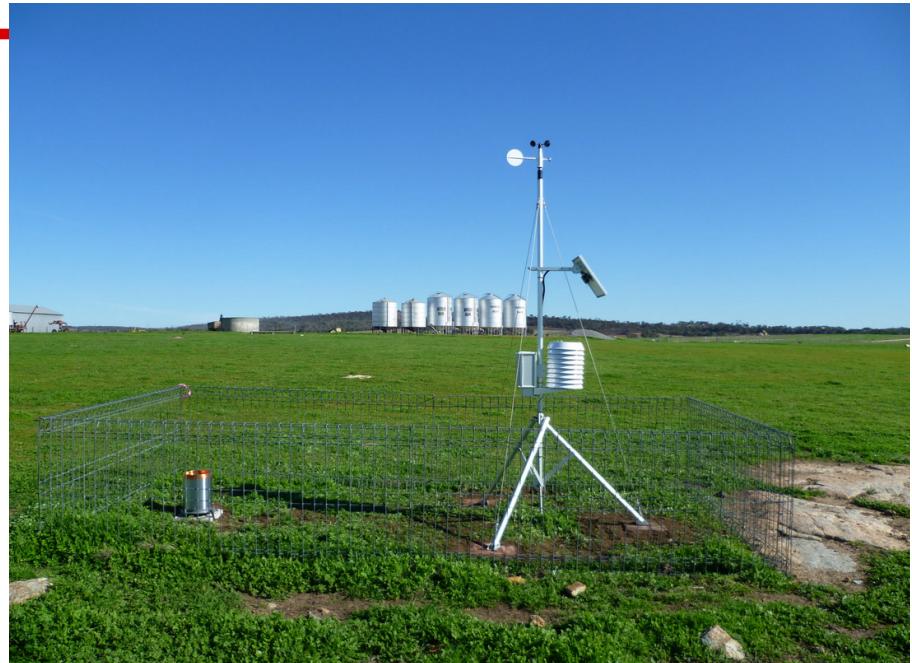
Price Range: \$2 - \$55

Air Temperature: Sensor Options

- \$5 [Sparkfun](#)
- \$5 [Adafruit](#)
- \$45 - \$55 [Spectrum](#)

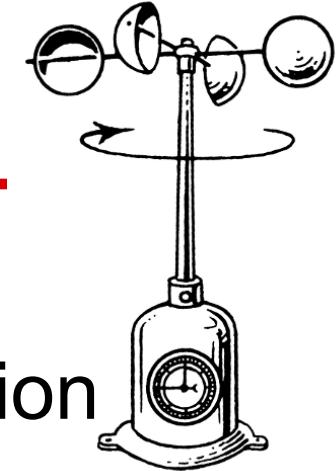
Measurements

1. soil moisture
2. soil temperature
3. rainfall
4. relative humidity
5. air pressure
6. air temperature
7. wind speed



Source: <https://www.agric.wa.gov.au/climate-land-water/climate-weather/agseasons>

Wind Speed



Objectives: -spray drift prediction
-evapotranspiration estimation

Units: mph

Sensors: anemometer (spinning cups)

Price Range: \$30 - \$70

Wind Speed: Sensor Options

- \$45 [Adafruit](#)
- \$55 [Vortex](#)
- \$70 [sparkfun](#) plastic anemometer, rain guage, and vane combo

Measurements

1. soil moisture
2. soil temperature
3. rainfall
4. relative humidity
5. air pressure
6. air temperature
7. wind speed
8. **wind direction**



Source: <https://www.agric.wa.gov.au/climate-land-water/climate-weather/agseasons>

Wind Direction

Objectives: spray drift

Units: N,S,E,W or degrees

Sensors: potentiometer, Hall effect sensor

Price Range: \$50 - \$150



Wind Direction: Sensor Options

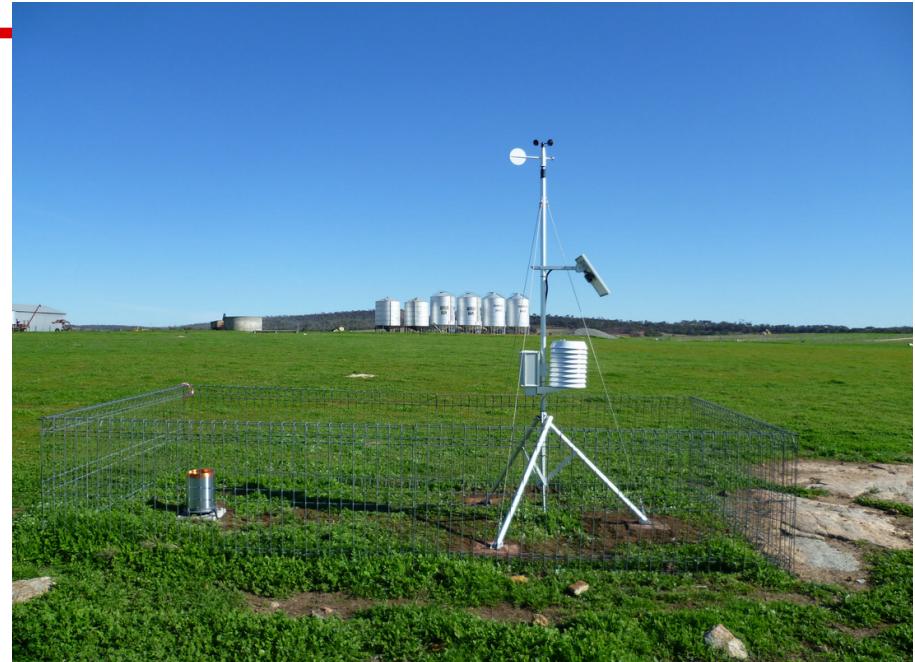
\$130 [inspeed](#) speed + direction

\$130 [Davis Instruments](#) speed + direction

\$? [Vaisala](#) speed + direction

Measurements

1. soil moisture
2. soil temperature
3. rainfall
4. relative humidity
5. air pressure
6. air temperature
7. wind speed
8. wind direction
9. solar radiation



Source: <https://www.agric.wa.gov.au/climate-land-water/climate-weather/agseasons>

Solar Radiation

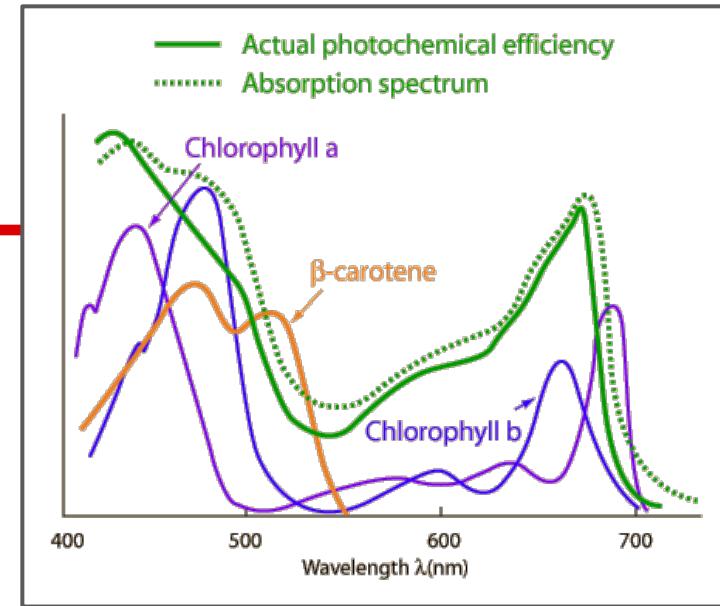
Objectives: yield prediction

Units: hours above a given threshold?

Sensors: pyranometer

Price Range: \$200+

Can make use of solar panel

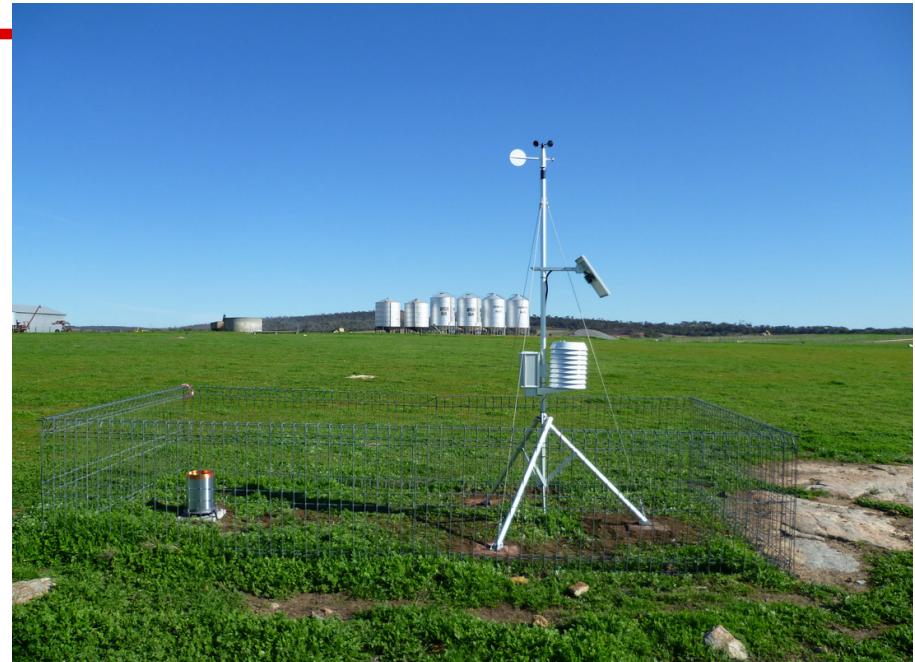


Solar Radiation: Sensor Options

- \$180 [Davis Instruments](#)
- \$200 [Apogee pyranometer](#)
- \$? [Campbell Scientific](#)

Measurements

1. soil moisture
2. soil temperature
3. rainfall
4. relative humidity
5. air pressure
6. air temperature
7. wind speed
8. wind direction
9. solar radiation
10. NPK and beyond



Source: <https://www.agric.wa.gov.au/climate-land-water/climate-weather/agseasons>

Platform

1. Beaglebone Black
2. cell modem
3. GPS cape
4. solar panel
5. battery
6. enclosure
7. mounting bracketry

Other Considerations

- Calibration
- Spatial Variability
- Data Logging
- Station Placement
- Maintenance, Product Life
- Testing

Putting This All Together

Sensor Suite	Platform
1. soil moisture: \$2 - \$100	1. Beaglebone Black: \$50
2. soil temperature: \$30 - \$55	2. cell modem: \$75
3. solar radiation: \$200	3. GPS cape: \$70(NVS)
4. rainfall: \$75 - \$400	4. solar panel: \$75 - \$500
5. relative humidity: \$10 - 20	5. battery: \$ 20 - \$50
6. air pressure: \$10 - 20	6. enclosure: \$25 - \$50
7. air temperature: \$10 - 20	7. mounting: \$30 - \$100
8. wind speed: \$45 - 70	
9. wind direction: \$70 - \$150	
	TOTAL: \$500 - \$2000

Complete Stations and Other Links

\$70 [BBB Weather Cape](#)

\$600 [Davis Instruments Soil Monitoring Station](#)

\$395 [Davis Vantage Weather Station](#)

\$1400 - [HOBO Weather Station](#)

\$1900 - [Watchdog Weather Station](#)

\$? - [Dnymax](#)

\$? [Vaisala Weather Station](#)