Title and Content

- **Content page with table**
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  - To change table style:
    - Select the table.
    - From the top menus, under Table Tools, select Design.
    - Select one of the Table Styles.

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Annual Horticulture; evaporation based irrigation management.

Tilwin Westrup

Supporting your success

Consider;

Great science leaves **legacy** when it leads to **innovation and technology** that provide **sustainable competitive advantage** for **commercial ventures.**

Plant - water use

- Plant water use (PWU) is driven by the plants need to remove heat so it can transpire and grow

- PWU is affected by crop and environmental factors:

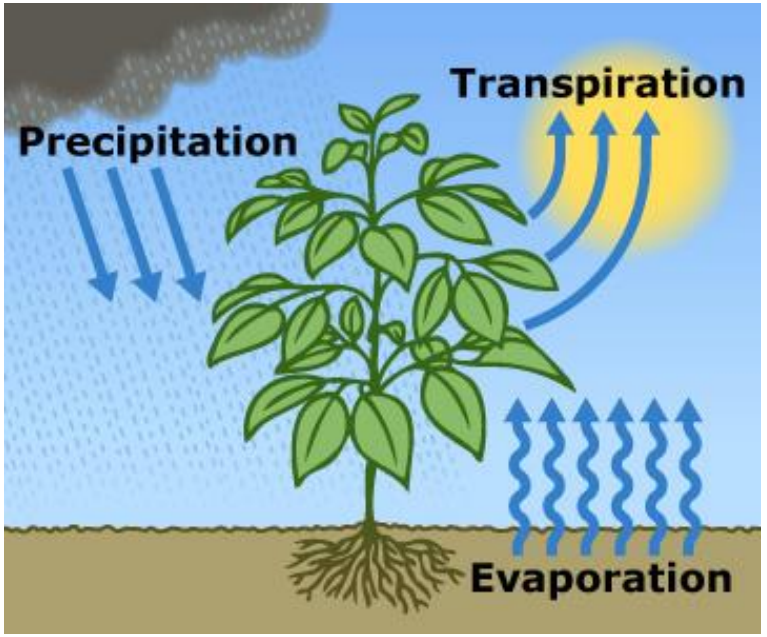
Environmental factors in order of effect on daily evaporation

- Solar radiation (the energy delivered by the sun)
- Wind
- Temperature
- Humidity

Crop factors

- Canopy cover
- Fruit load
- Field conditions

- Evaporation can be calculated
- Crop factors need to be determined



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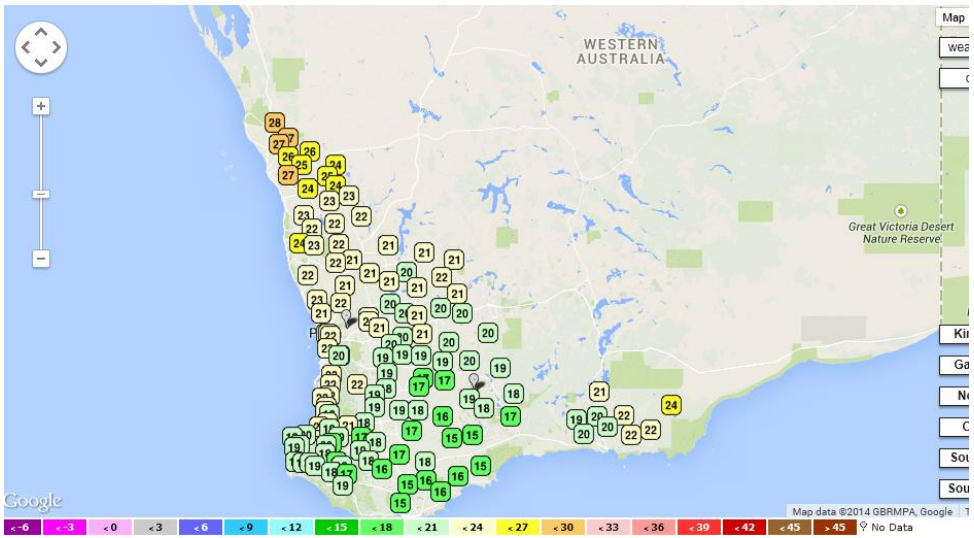
Where to find Evaporation data

Overview | Daily Summary | 9:00am/3:00pm | Monthly | Yearly

Latest		Today from 9:01am		Yesterday to 9:00am		Year to Date	
Time	11:20:00	Air Temp° min/max	18.3/22.6	Air Temp° min/max	12.3/25.2	Air Temp° min/max	-0.2/44.5
Air Temp°	23.2	Air Temp° avg	20.5	Air Temp° avg	17.8	Air Temp° avg	17.8
Feels Like°	19.7	Humidity% min/max	30.5/41.0	Humidity% min/max	30.8/78.0	Humidity% min/max	7.1/100.0
Rain mm	0.0	Humidity% avg	35.0	Humidity% avg	49.6	Humidity% avg	67.0
Humidity%	30.2	Rain mm	0.0	Rain mm	0.0	Rain mm	565.2
Wind Direction	E	Evaporation mm	1.9	Evaporation mm	8.4	Rainy Days	121
Solar W/m²	1127	ETo Standard mm	1.4	ETo Standard mm	6.4	ETo Standard mm	1399.7
Windspeed km/h	12.13	ETo Tall mm	1.7	Eto Tall mm	7.8	Eto Tall mm	1686.8
Delta T°	9.4	Windspeed km/h max	35.2 SE	Windspeed km/h max	39.4 SE	Windspeed km/h max	53.6 ESE
Battery V	13.8	Windspeed km/h avg	17.2	Windspeed km/h avg	9.7	Windspeed km/h avg	5.0
		Solar Total MJ	7.3	Solar Total MJ	31.2	Solar Total kJ	6753.4
		Battery V min	13.8	Battery V min	12.7	Battery V min	12.6
		Hours of Data	2:00	Hours of Data	24:00	Days Of Data	342.5

www.agric.wa.gov.au/weather-stations



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Scheduling using evaporation

Average effective Daily Evaporation in Manjimup (takes into account rain and soil holding capacity)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Daily Evap	5.6	5.4	4.0	2.2	0.5	0.0	0.0	0.0	1.0	2.5	3.7	4.9
Suggested Crop Factor required Apples	0.7	0.7	0.7	0.7	0.4	0.0	0.0	0.3	0.5	0.7	0.7	0.7

mm required	3.9	3.7	2.8	1.6	0.2	0.0	0.0	0.0	0.5	1.7	2.6	3.5
L/ha	39270	37450	27720	15610	2040	0	0	0	5050	17150	26180	34510

Apples used to demonstrate the variation in crop factor over a year, but what happens in annual horticulture?

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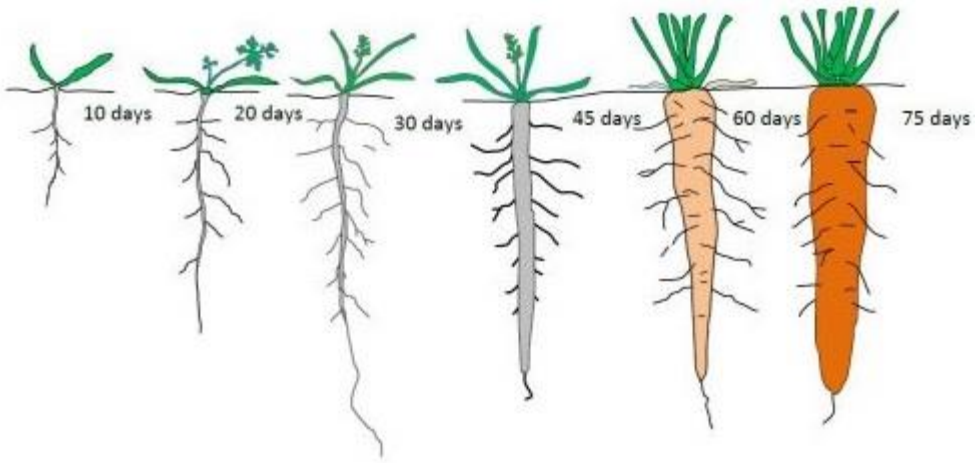
Scheduling using evaporation

Crop factors need to take growth stage into consideration for annual crops

Crop Stage	1	2	3	4	5	6
Baby leaf spinach	0.6	0.7	0.8	0.8		
Brussel Sprout transplants	0.6	0.8	0.9	1		
Capsicum transplants	0.6	0.7	1.1	1		
Carrots	0.6	0.65	0.95	1.05	1.15	1.2



http://www.carrotmuseum.co.

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Application

Measure your wetted area and know your soil to work out how much water your vines root zone can store in one irrigation

Drippers spaced at 0.5m the wetted area may be between 0.5 and 1.5 m depending on soil type, hard pans and flow rate.

Assuming effective rooting depth of 0.4 m (where most of the roots are) and each 0.1m depth can hold 4mm of readily available water.

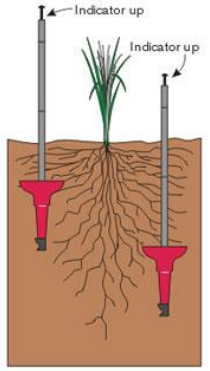
If the wetted area is say 1.0 m wide
Water holding capacity is between per metre of crop is
0.4/0.1 x 4 =16 L/m
So depending on how much is required you can work out how often to apply water in different periods of the year

Sounding complicated yet?

Soil moisture monitoring devices

Porous media – tension/potential

- Tensiometers – high accuracy but higher maintenance
- Resistance blocks – lower accuracy, low maintenance



Water content sensors

- Capacitance probes – smaller area measured
- Time domain reflectometry (TDR) - accurate and repeatable
- Frequency domain reflectometry – cost effective TDR
- Neutron moderation – older manual readings

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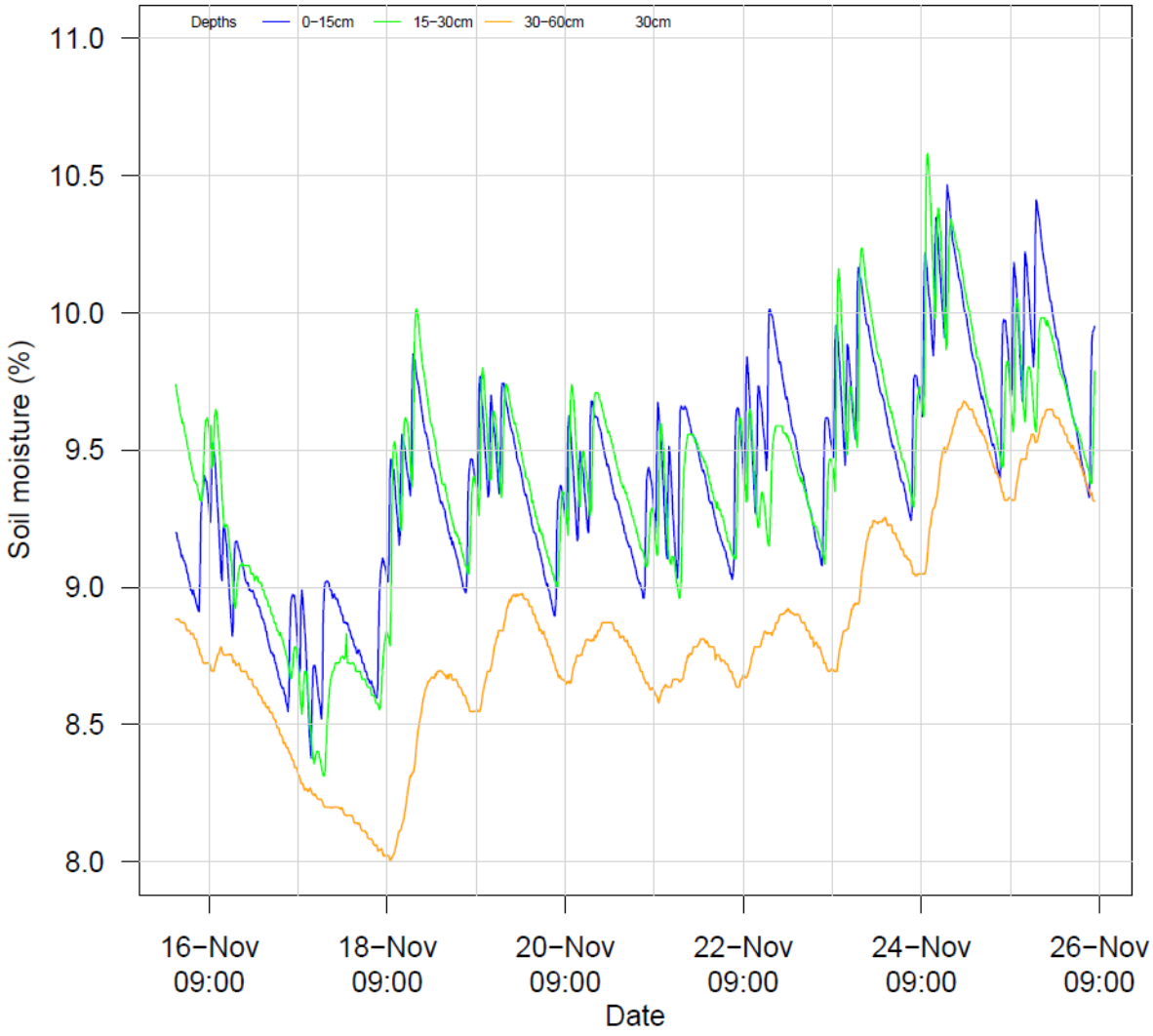
Soil moisture - trends



Shallow (blue) 15cm sensor moves with each irrigation event.

15-30 cm (Green) sensors movement is slightly delayed but still moving with each irrigation event.

Deep 30-60cm (orange) sensors not moving with each irrigation but is increasing and draining over the day

Sensors at each depth increasing indicating over irrigation

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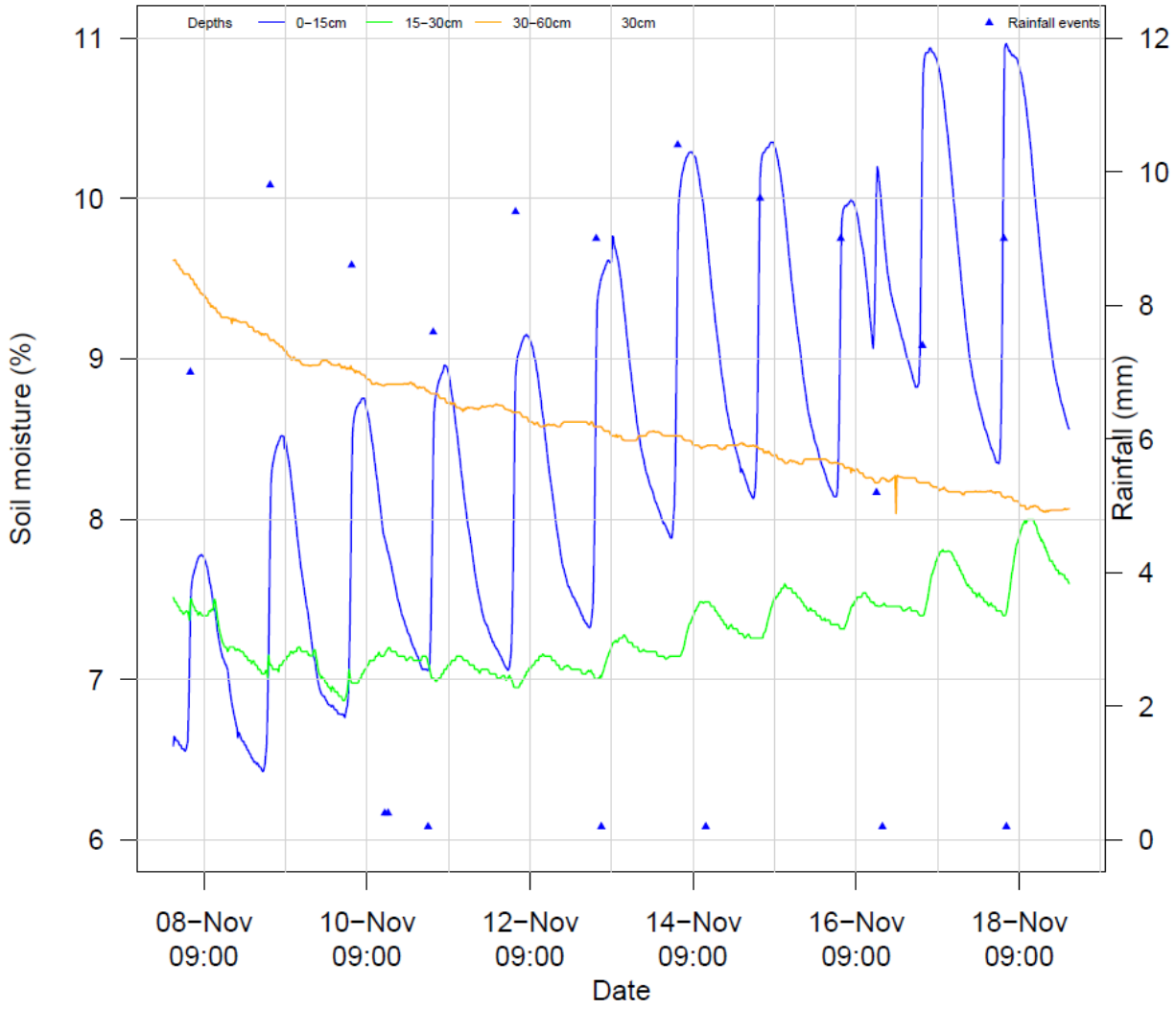
Soil moisture - trends



Increasing upper and falling Lower profile soil moisture

15cm (blue)
Large peak and trough indicating drainage

15-30 cm (Green)
Smaller peak and trough indicating small amount of drainage into this profile, increasing overall moisture content

30-60cm (orange)
decreasing in soil moisture suggesting no drainage from irrigations occurring

What to look for in soil moisture monitoring tools in order of importance

- Suitability – is the probe accurate in the range required for your crop type and soil type, is it sensitive or reactive enough for your crop.
- Repeatability – does the probe read the same reading each time if the value has not changed so that trends can be seen.
- Accessibility – can you access the data remotely or as easily as you would like.
- Accuracy – the ability to reproduce the actual soil moisture water status

- Good reference: Irrigation insights Number One, “Soil Water Monitoring” P. Charlesworth, CSIRO Land and Water
- SEPTEMBER 2000

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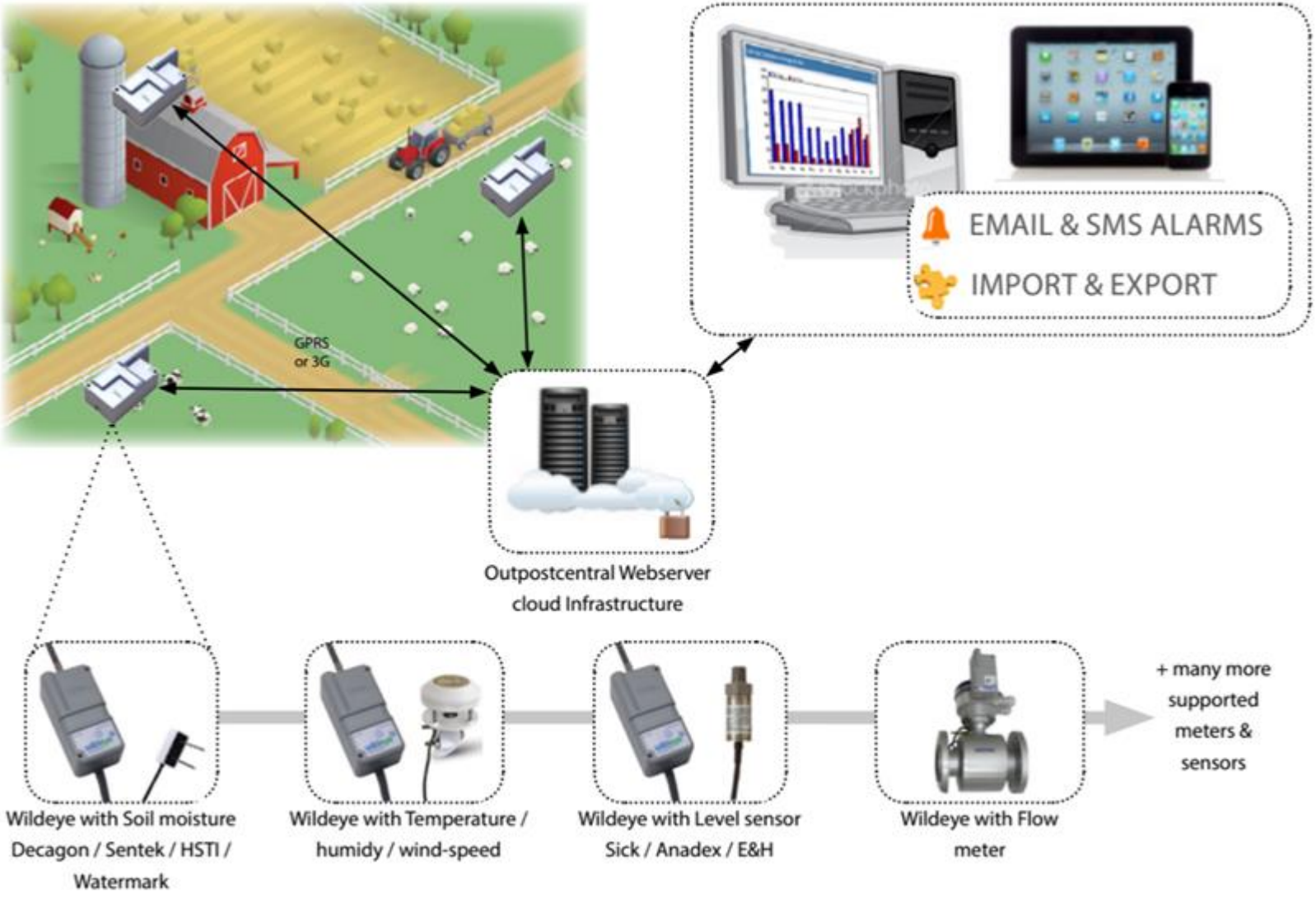
Remote Telemetry and Automation



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Other benefits of monitoring and automation

- Alarms
  - High or low flow
  - High or low pressure
- Activation of pumps, valves and fertigation remotely
- Interruption due to rain
- Travel away from farm and still be able to check on things
- Camera to view crop growth, crop stress or workers activity
- Better water use therefore better returns

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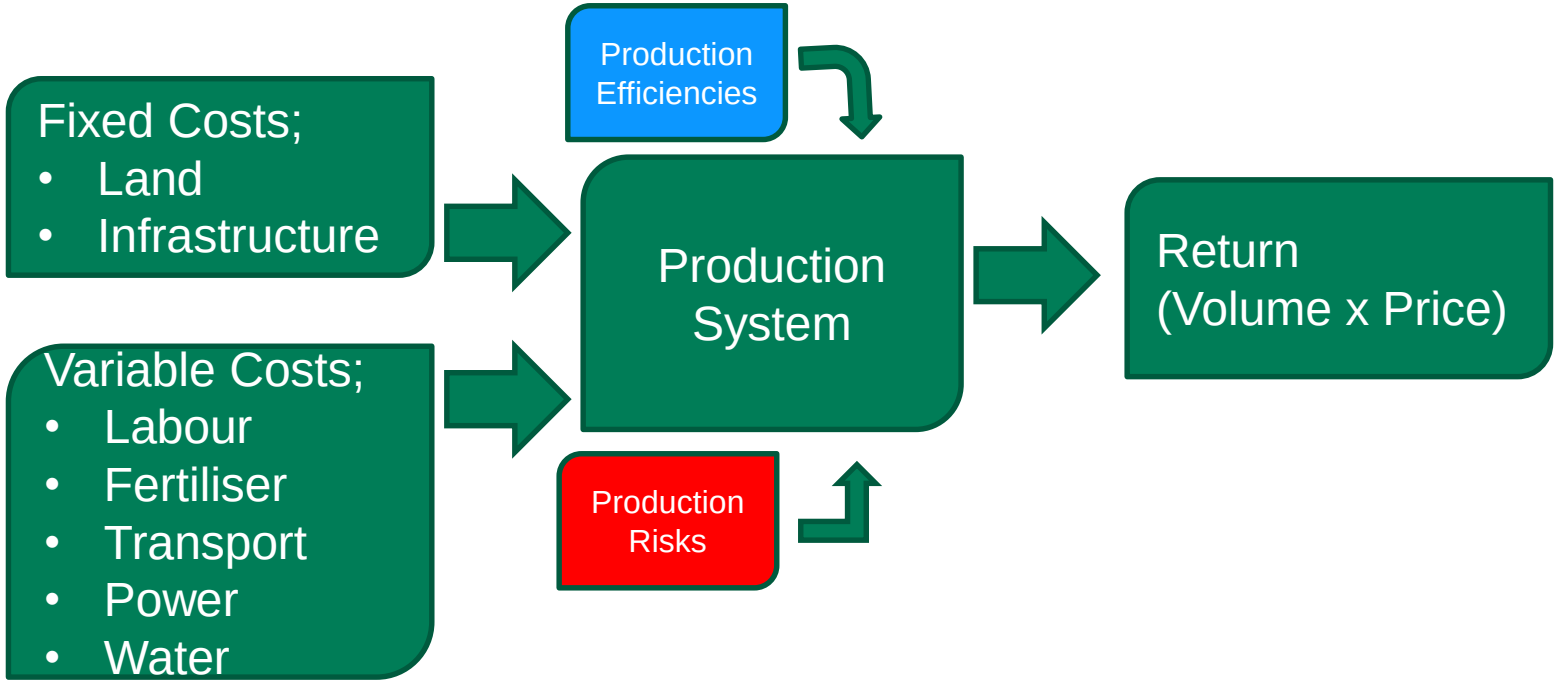
Real life example

Tomatoes	Control	2012	2013	2014
Cost per plant	$5	$5	$5.15	$4.25
Yield per plant	6.5 kg	7.3 kg	9.1 kg	9.1 kg
Profit per plant	$1.50	$2.30	$3.95	$4.85
Profit per hectare	$15,000	$27,600	$47,400	$58,200
Cost of production per kg	76 c	68 c	57 c	47 c

A 40% lower cost of production provides significant competitive advantage

Annual Horticulture Business

Simplified Horticulture Business Model



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Covered Cropping Geraldton

High fixed cost in land and infrastructure

Price advantage due to seasonal supply gap

Adverse weather condition risk protection

Climate control for high yields

Technology in management systems

Duy Ly and Kingsley Songer from 4 Ways Fresh Produce (ABC News)

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Covered Cropping Arthur River

High fixed cost in infrastructure

Relatively low fixed cost in land

Adverse weather condition risk protection

Climate control for high yields

Technology in management systems

Reduced transport costs to wheat belt markets

Damien Rigali from Wide Open Agriculture (ABC News)

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Sea Container Horticulture

- High semi-fixed cost infrastructure
- Relatively low fixed cost in land
- Adverse weather condition risk protection
- Climate control for high yields
- Technology in management systems
- Reduced transport costs
- Scalability
- Portable

Freight Farms, Urban Farm Units, Growtainers and Sproutstack

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Collie Power Station?

The Netherlands; home to a sea of greenhouses.

Awash with energy consumption benchmarking.

An opportunity in Collie to use waste heat in horticulture?

Collie Coal-Fired Power Station

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Thank you

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