The Use of Smart Sensor Technology for Precision Irrigation, Climate Monitoring & Disease Forecasting – Substrate Berry Production

Agenda

- Agri-tech Survey results
- SMART sensor Technology - future proofing the hardware
- RTK Topography mapping – updates
- Agri-tech App – update
- ATS Client login / dashboard – updates
- Auto drain station
- Irrigation Automation
- Strawberry Powdery Mildew (SPM) model
- Tissue Analysis – is there an interest in this?
- What next?

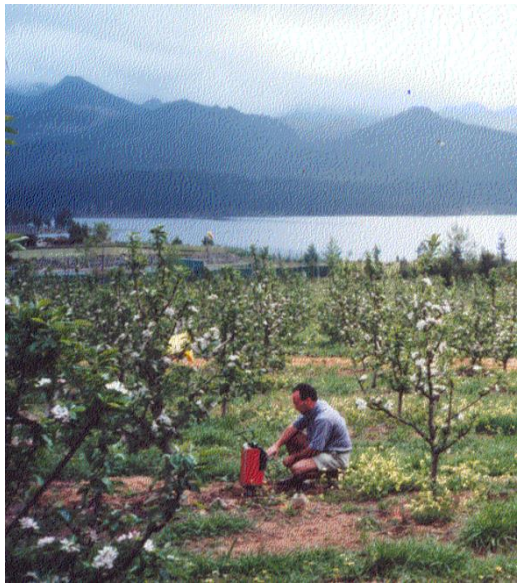
About us

Founded in 1992 – focussed on Precision Irrigation using sensors to schedule irrigation in soil grown crops

First GPRS telemetry systems deployed in the late nineties

Climate Monitoring sensors introduced in the late nineties

Precision Farming services introduced in the early 2,000's



About us

We've been analysing in-field sensor data for 30 years

Cloud based solution introduced 2009 with home designed DTU

Our overseas Business required us to establish a relationship with a reputable hardware supplier with a Global supply and support network & an open API (application programming interface) – METOS provided the solution

We needed an In-house cloud based web portal for data analysis - designed for Growers by Growers – Enabling analysis of big data to be quick and easy to aid key decision making – specific to Substrate Berry Production

Survey Results

Q1 Would you find the app more useful if it auto calculated run-off?

Q2 Would you be interested in full automation of your drain stations?

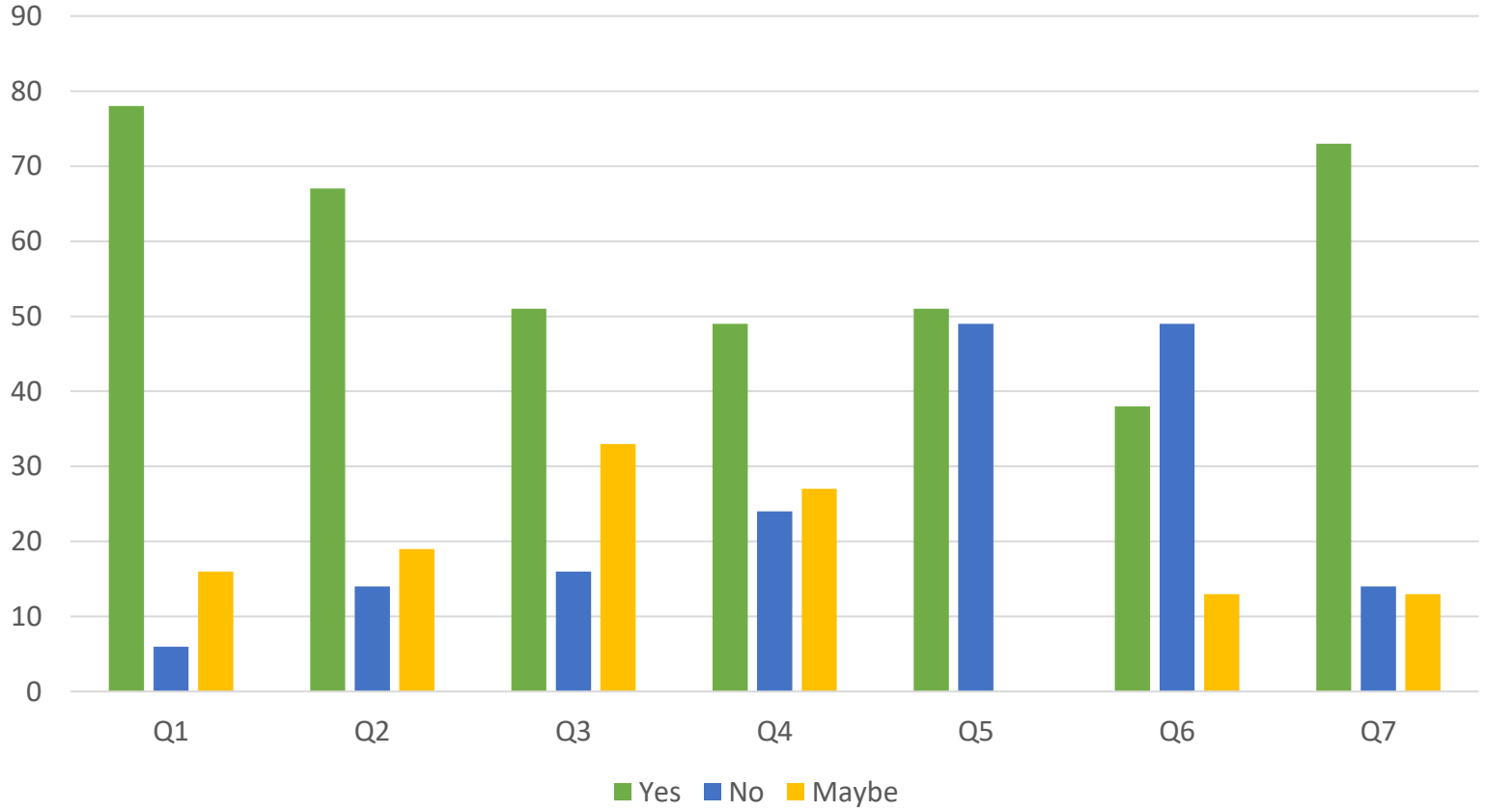
Q3 Would you be interested in full automation of your irrigation system?

Q4 Are you interested in monitoring light levels?

Q5 Are you aware of our Topography mapping service to assist with irrigation design?

Q6 Is saving fungicide and money with our SPM model something you would be interested in?

Q7 Are you currently analysing leaf tissue / sap throughout the season, and if not would you be interested in this?



Global supply network of SMART Sensors by METOS

Existing Hardware

Probes measure

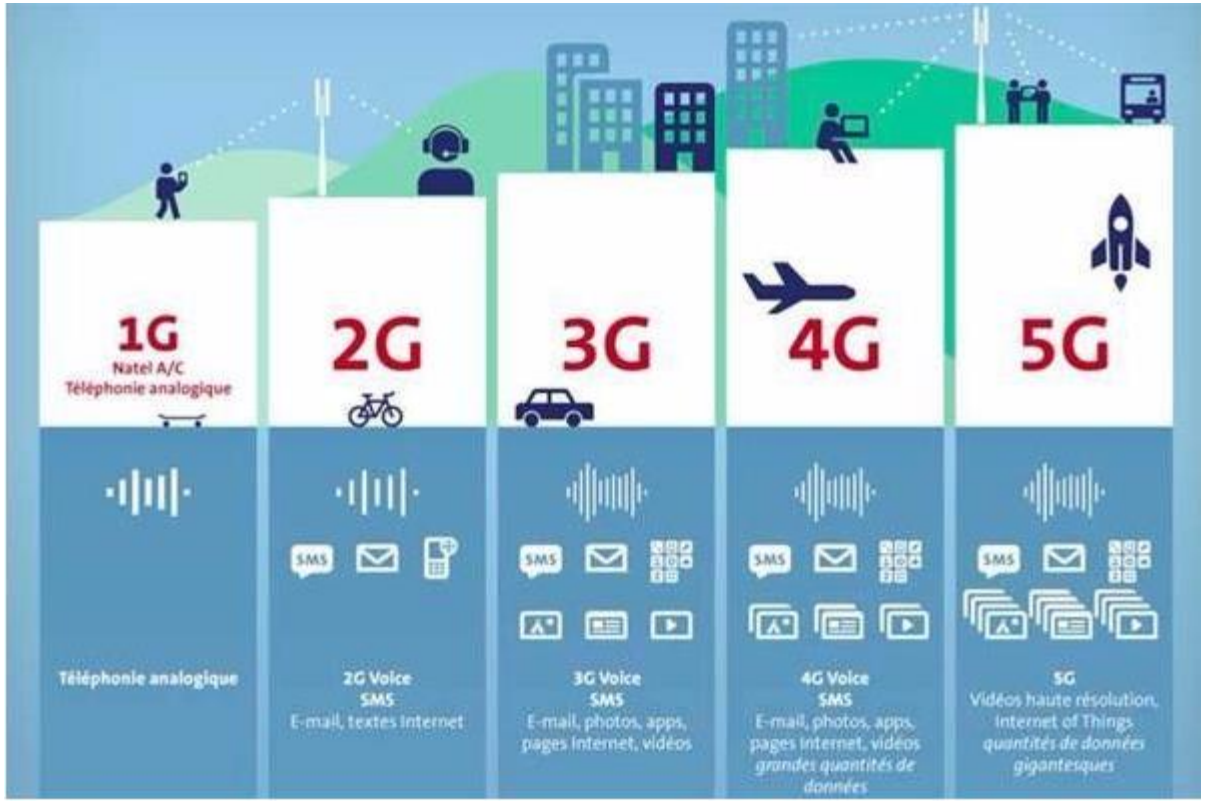
- Moisture
- Temperature
- EC

External sensors

- Run-off
- Temperature / humidity
- PAR sensors (light)

Added data logger required

Kb data sent to the cloud over the 2G network
reliable / robust / slow / power hungry



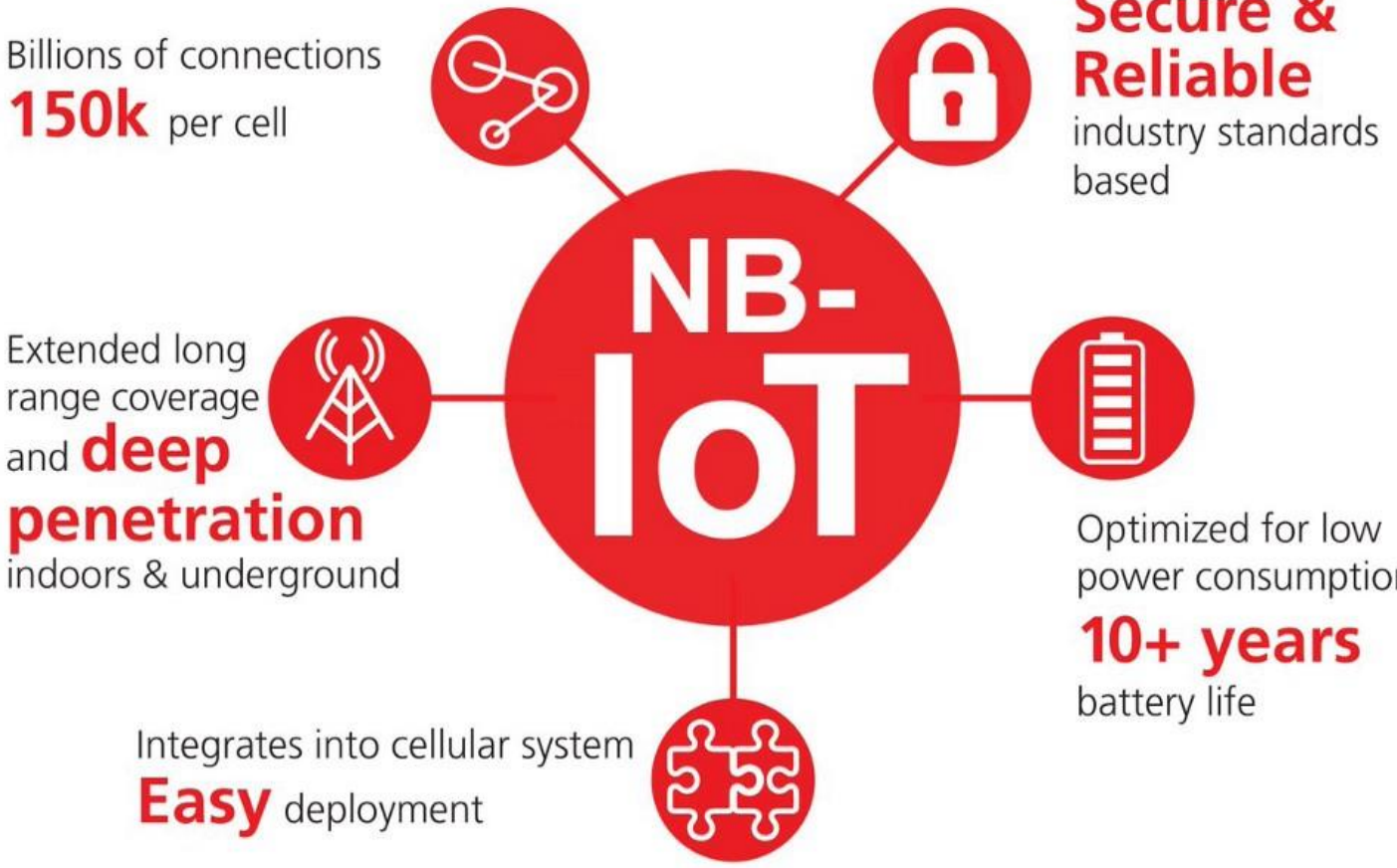
2G planned to be switched off 2030
3G planned to be switched off 2025

New SMART sensor Technology - Why NBIoT?

15 minute upload

NBIoT hardware
With 2G fall back

Kb data – very low power requirement



Topography Mapping / Surveying Service

RTK GPS Precision for height data

Setting up RTK Base Station

In-field mapping

As the Rover unit moves up and down the field thousands of height measurements are being recorded all Geo referenced

The data is then transferred to some mapping software to create a detailed topographic map

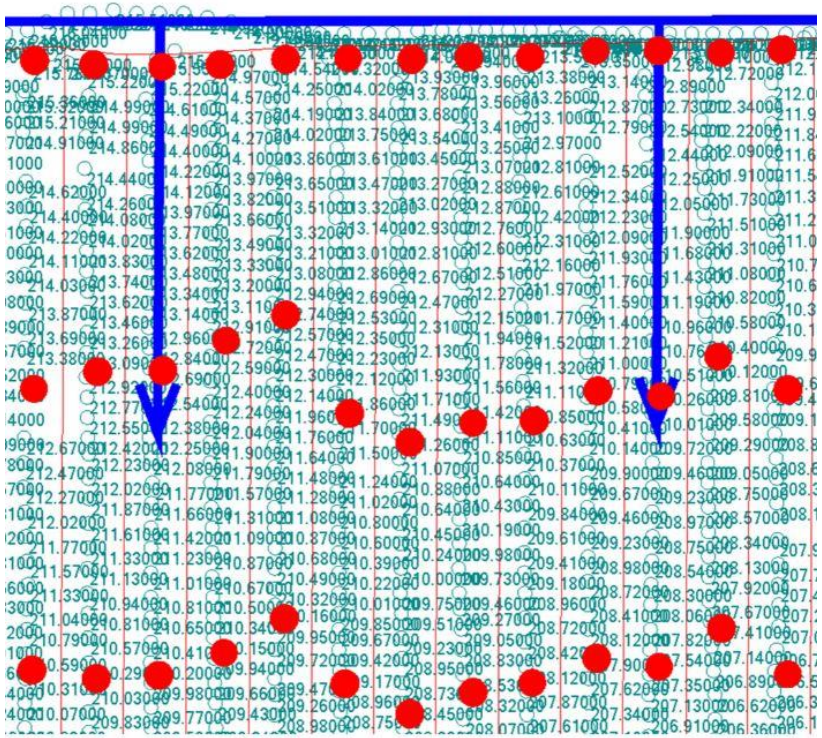
Topographic Survey

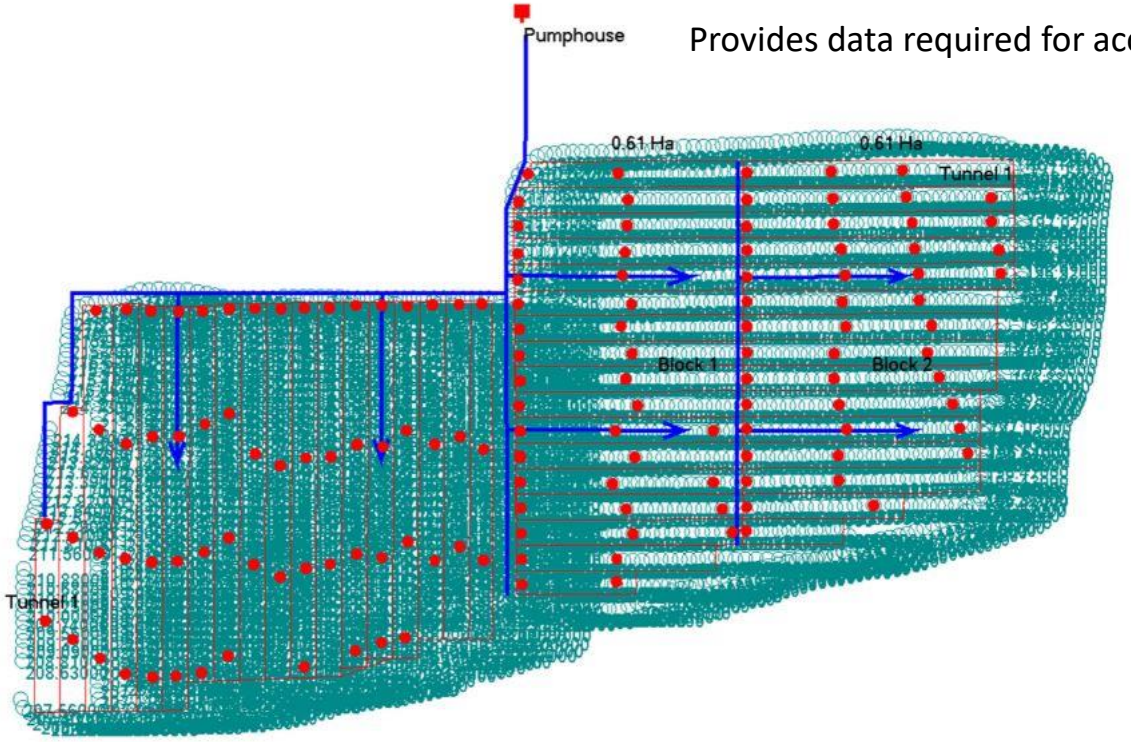
Thousands of height measurements taken

1-2 cm accuracy – near laser precision with RTK

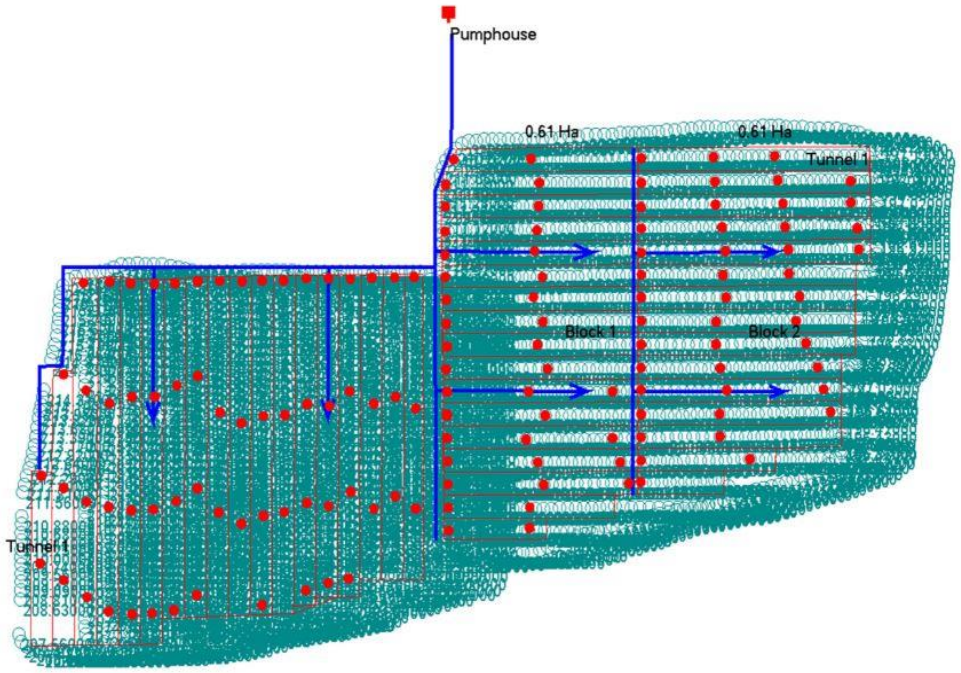
Data plotted to create a map

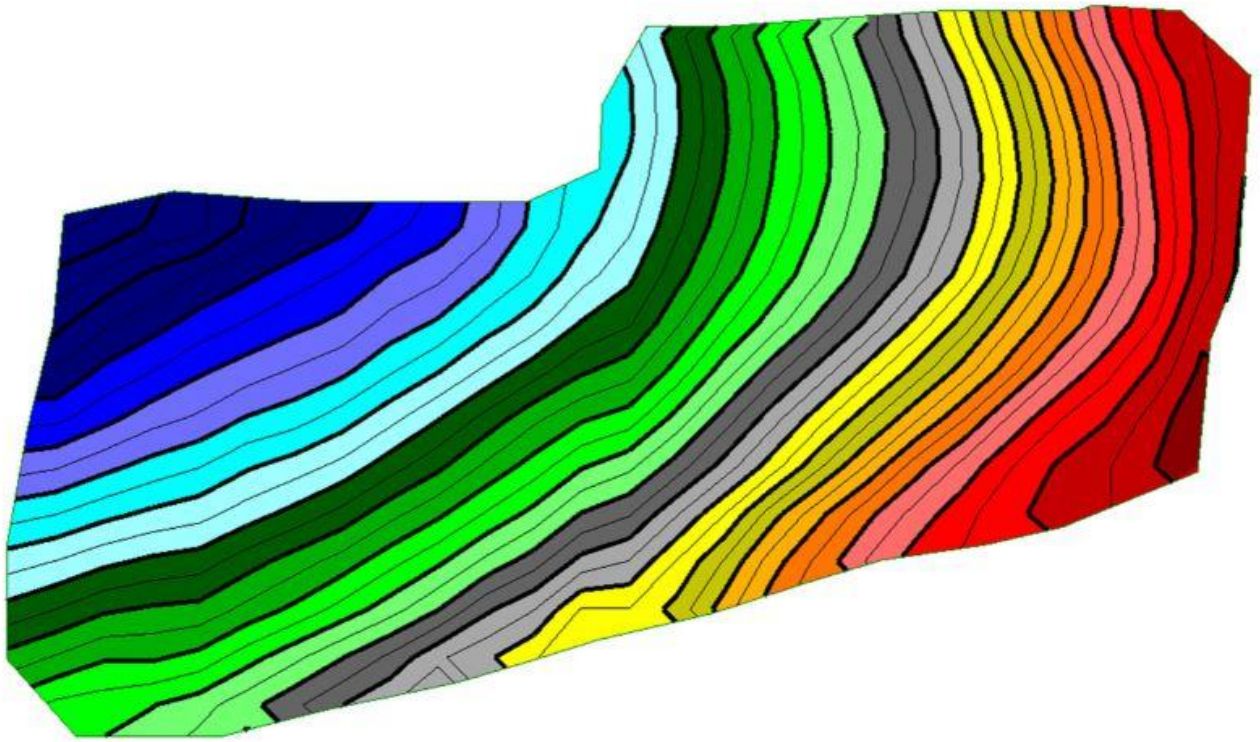
Provides data required for accurate design





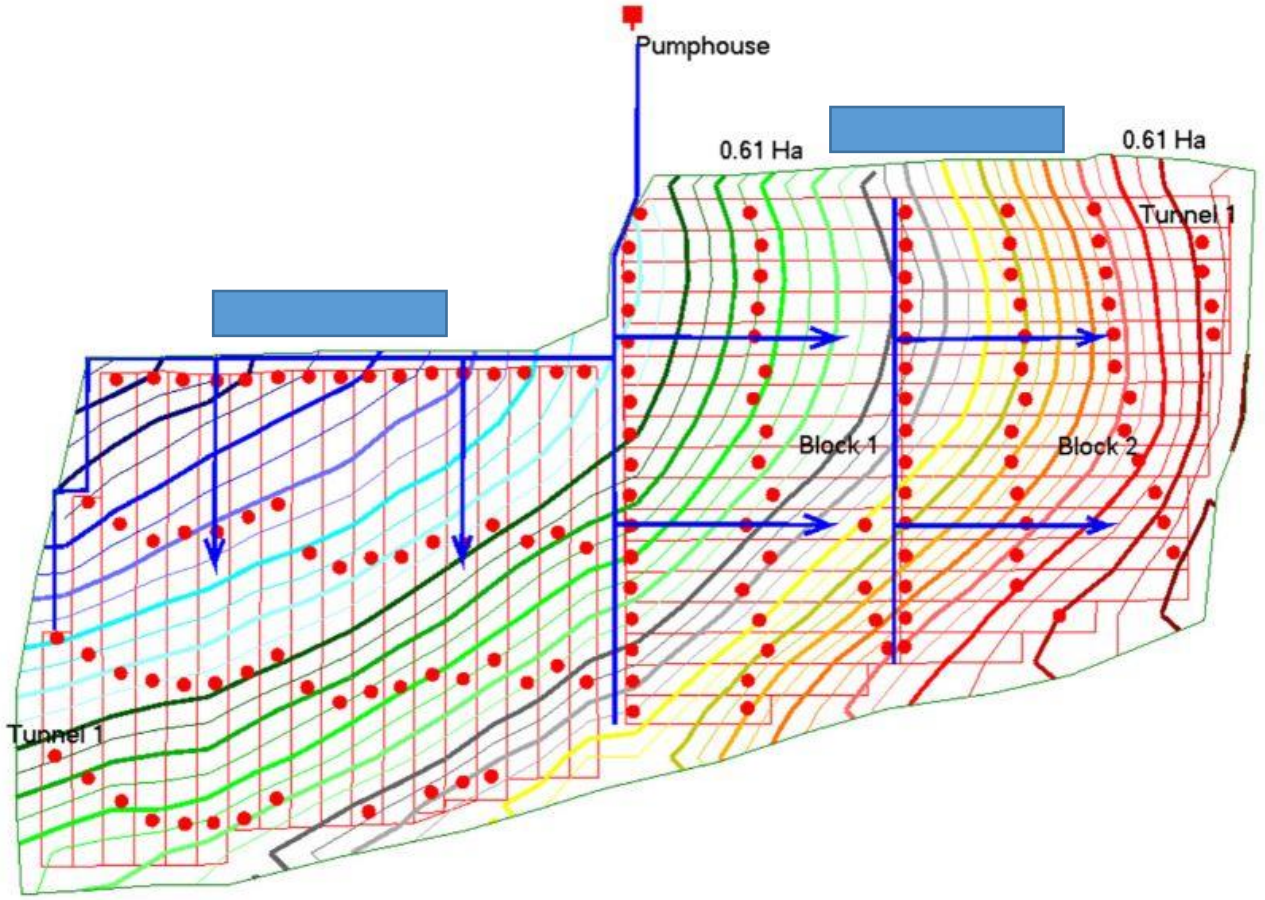
Topographic Survey





Topographic Survey – DNL Plan

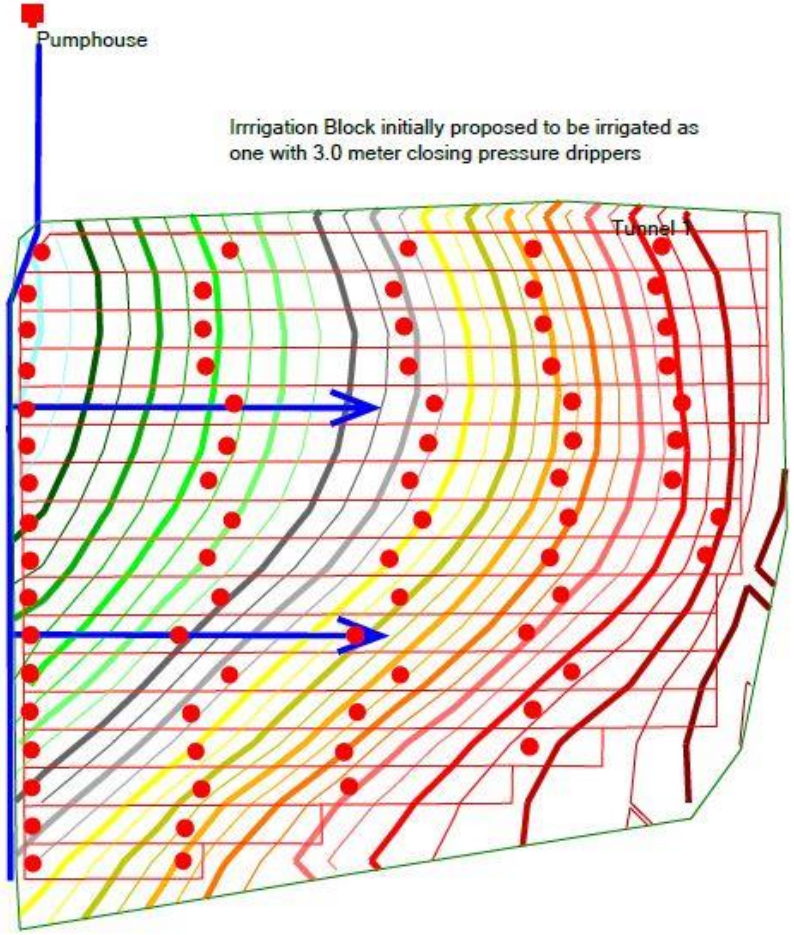
Block 1	TN	Dist	Dist	Dist	Dist
Tunnel number	1	Start	24.7		
	2	Start	31.9	25.9	
	3	Start	30.3	31.3	26.8
	4	Start	34.2	29.3	29.3
	5	Start	31.9	31.9	29.2
	6	Start	31.6	31.7	29.3
	7	Start	28.7	32.5	30.7
	8	Start	26.6	31.6	30.0
	9	Start	36.9	28.2	
	10	Start	39.8	28.3	
	11	Start	38.1	28.0	25.2
	12	Start	37.8	27.3	
	13	Start	35.4	27.8	24.6
	14	Start	35.9	29.1	21.6
	15	Start	31.6	28.3	24.4
	16	Start	35.4	29.6	
	17	Start	33.6	27.9	
	18	Start	36.9	28.2	
	19				
	20				

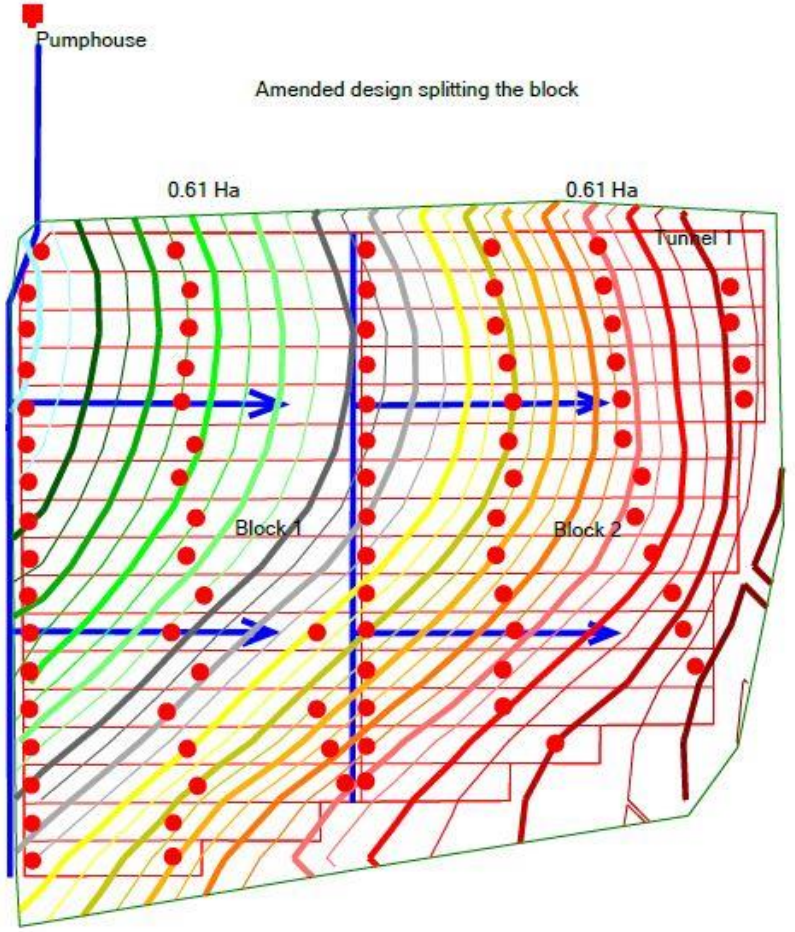


Block 1	TN	Dist	Dist	Dist	Dist	Dist
Tunnel number	1	Start	23.0			
	2	Start	27.9			
	3	Start	27.7			
	4	Start	27.2			
	5	Start	26.6			
	6	Start	28.8			
	7	Start	25.9			
	8	Start	28.7			
	9	Start	26.8			
	10	Start	30.1			
	11	Start	24.2	24.9		
	12	Start	29.1			
	13	Start	23.6	25.7		
	14	Start	26.8	24.4		
	15	Start	28.5	25.3		
	16	Start	24.2			
	17	Start	24.0			
	18					
	19					
	20					

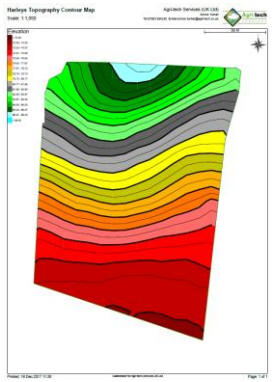
Block 2	TN	Dist	Dist	Dist	Dist	Dist
Tunnel numbe	1	Start	21.4	18.2		
	2	Start	21.8	18.7	21.6	
	3	Start	22.2	20.0	20.2	
	4	Start	24.0	18.6	21.5	
	5	Start	25.0	18.6	20.9	
	6	Start	24.2	19.6		
	7	Start	25.2	21.9		
	8	Start	22.2	23.8		
	9	Start	22.2	26.8		
	10	Start	23.5	28.9		
	11	Start	25.4	28.8		
	12	Start	23.3	32.9		
	13	Start	23.4			
	14	Start	32.3			
	15	Start				
	16					
	17					
	18					
	19					
	20					

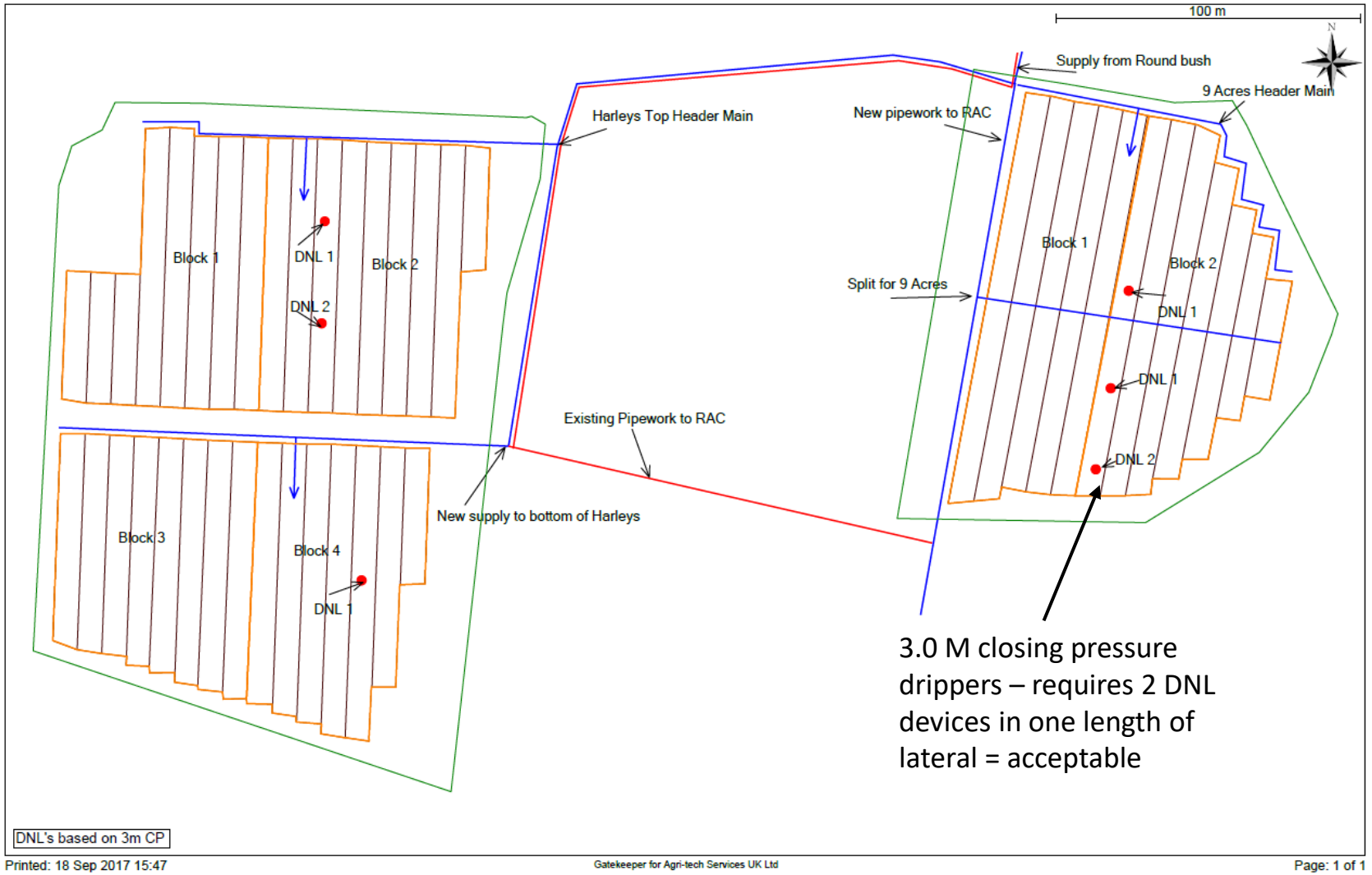
Irrigation Block Design





Irrigation Block Design – Choose the correct dripper





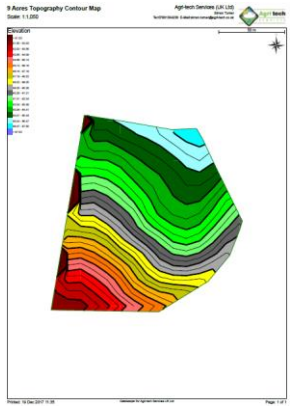
Displayed Layers:

Sub-main

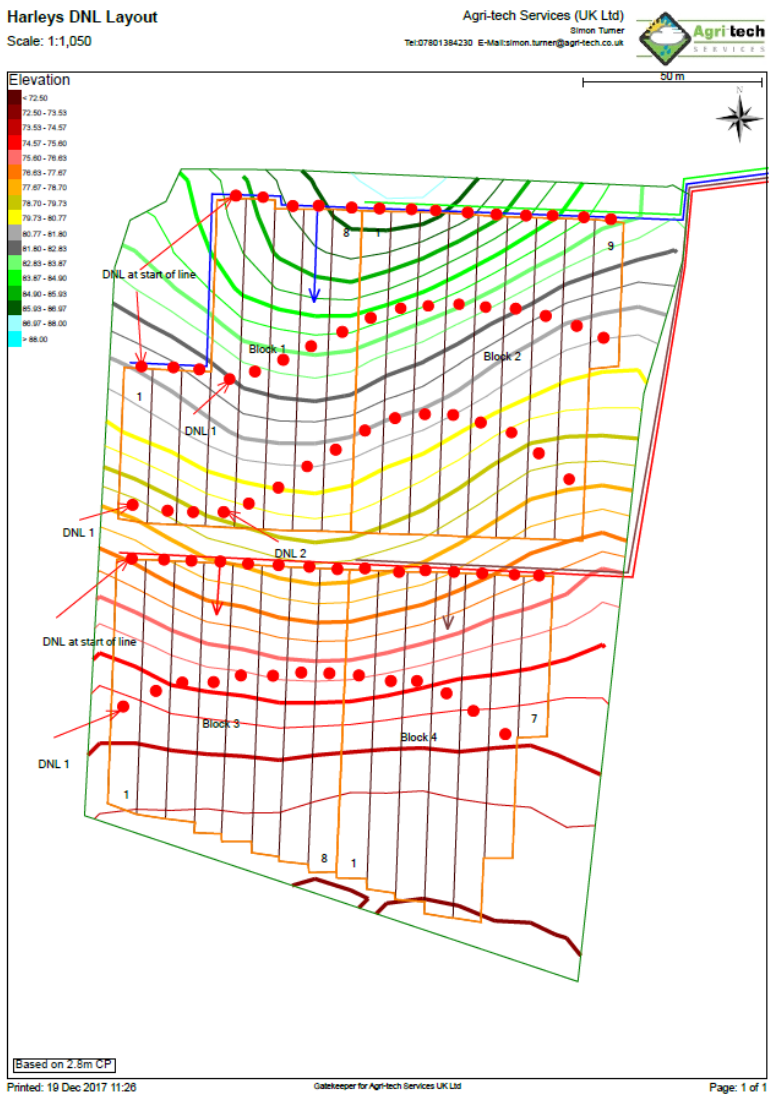
Tunnel layout

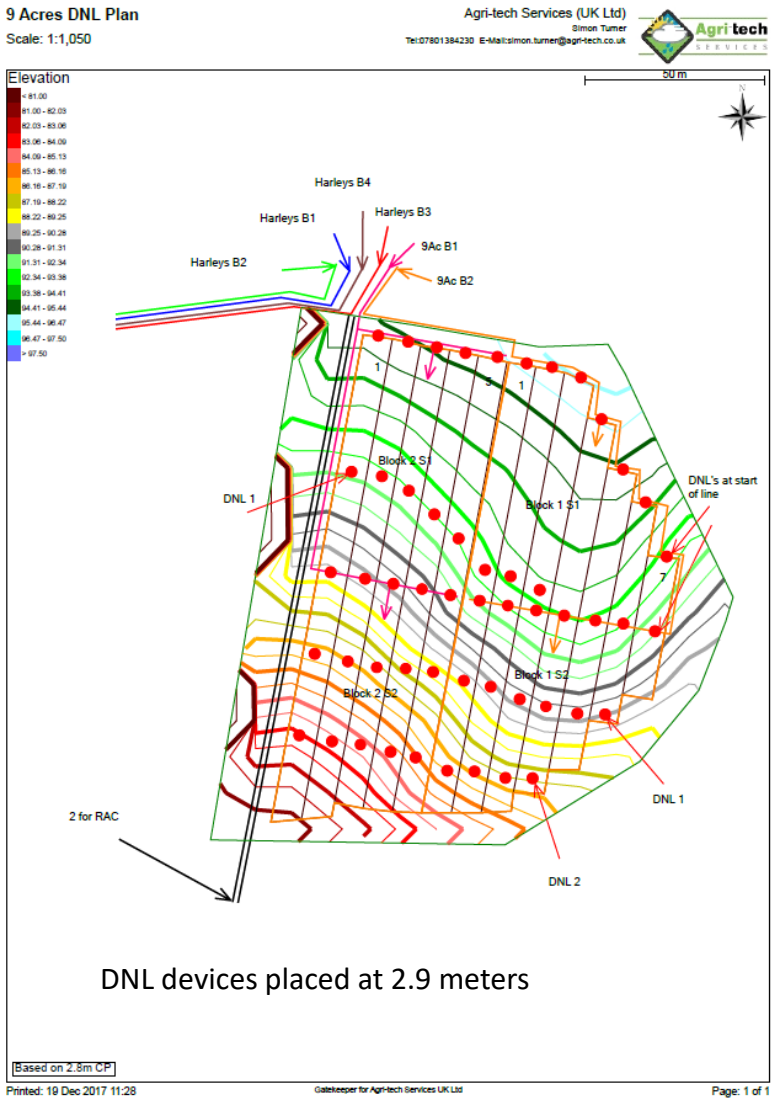
Irrigation blocks

DNL plan



DNL Plan





DNL devices placed at 2.9 meters

DNL Plan

- Detailed plan with exact measurements for Irrigation team
- Ensures DNL's follow contours
- Eliminate the "guesswork"
- Increase irrigation system efficiency
- Reduce in field variation of moisture and nutrients

GPS Mapping Services

DNL Positioning

Grower **A Farmer**
Field **Harleys**

Date 19/12/2017
DNL Plan

Block 1	TN	DNL 1	DNL 2
Tunnel number	1	38.6	
	2	40.0	
	3	39.8	
	4	51.1	37.1
	5	48.6	36.9
	6	42.9	35.6
	7	39.2	33.5
	8	34.7	32.9

Block 2	TN	DNL 1	DNL 2
Tunnel number	1	30.6	31.4
	2	27.8	30.6
	3	26.2	30.2
	4	25.7	30.9
	5	26.0	32.2
	6	26.1	34.5
	7	28.0	38.3
	8	30.3	42.8
	9	33.1	

Block 3	TN	DNL 1	DNL 2
Tunnel number	1	41.2	
	2	36.7	
	3	34.0	
	4	33.7	
	5	31.1	
	6	30.9	
	7	29.6	
	8	29.1	

Block 4	TN	DNL 1	DNL 2
Tunnel number	1	29.9	
	2	30.5	
	3	30.9	
	4	33.9	
	5	38.4	
	6	44.5	
	7		

Distance displayed are in meters from the tunnel ends down. (measured from direction of flow)
DNL 1 is measured from DNL 2

GPS Mapping Services

DNL Positioning

Grower **A Farmer**
Field **9 Acres**

Date 19/12/2017
DNL Plan

Block 1 Section 1	TN	DNL 1	DNL 2
Tunnel number	1	58.3	
	2	59.1	
	3	60.0	
	4		
	5		
	6		
	7		

Block 1 Section 2	TN	DNL 1	DNL 2
Tunnel number	1	22.6	25.3
	2	23.0	23.9
	3	25.0	22.2
	4	25.7	20.3
	5	26.3	
	6	25.7	
	7		

Block 2 Section 1	TN	DNL 1	DNL 2
Tunnel number	1	38.4	
	2	38.0	
	3	40.5	
	4	45.6	
	5	51.4	

Block 2 Section 2	TN	DNL 1	DNL 2
Tunnel number	1	23.0	23.0
	2	23.4	22.6
	3	23.6	21.8
	4	22.5	23.4
	5	21.8	24.2

Distance displayed are in meters from the tunnel ends down. (Block 1 S1, Block 2 S1)
Distance displayed are in meters from start of line. (Block 1 S2, Block 2 S2)
DNL 1 is measured from DNL 2

Precision Substrate Management using SMART sensor technology

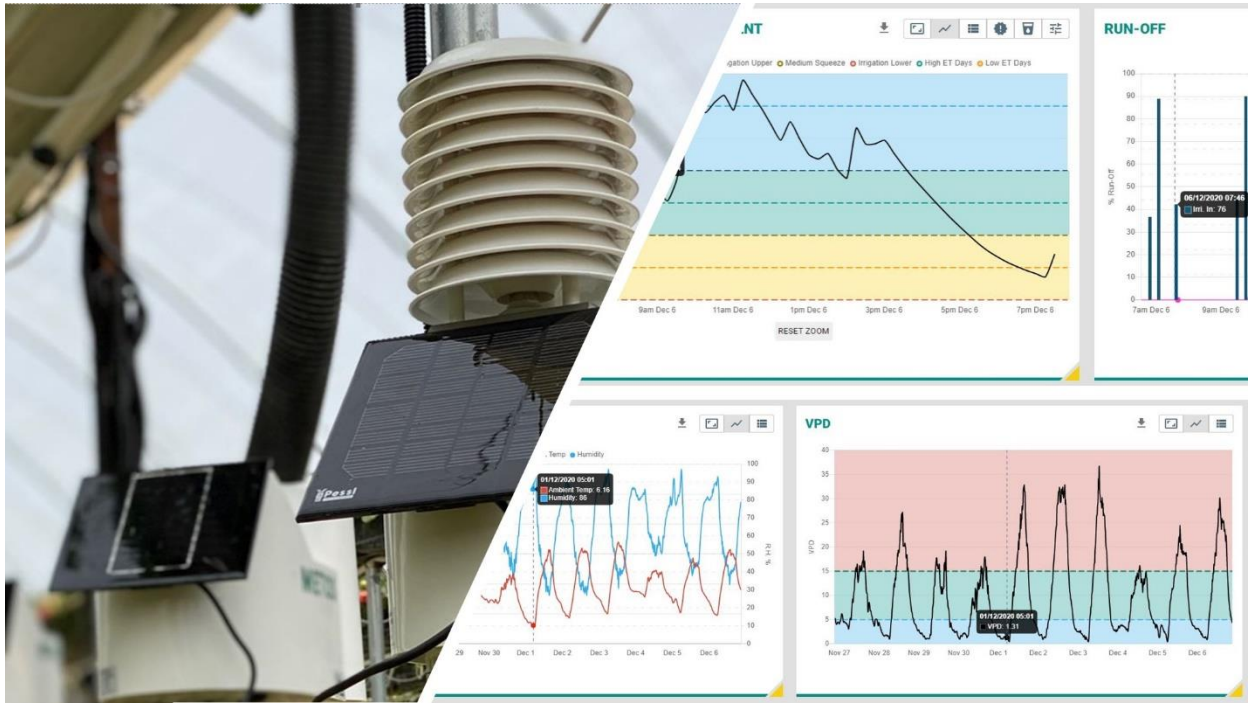
Smart Sensors

The Key to the success & pay back of SMART sensor technology in a farming business is not the sensors themselves, but the way the data is presented to the end user & how it is used.

Precision Substrate Management using SMART sensor technology

Our dashboard has the potential to “talk” to any sensor that sends data to the cloud via an open API (application programming interface)

Our preferred choice is the Metos NBIoT range of sensors due to their flexibility, low cost options and open API

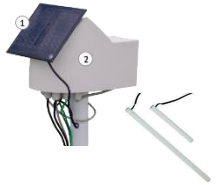


System Dashboard & Data Display

The dashboard is split into the three defined areas being displayed, in one central location, essential for the concept of “viewing all data made easy”

Three zones within each field with multiple Graphing Tools

Irrigation



- Root-zone Moisture Content
- Run-off
- Individual Sensor Moisture Content
- Crop Water Usage & Gains
- Conductivity & Temperature

Agronomics App

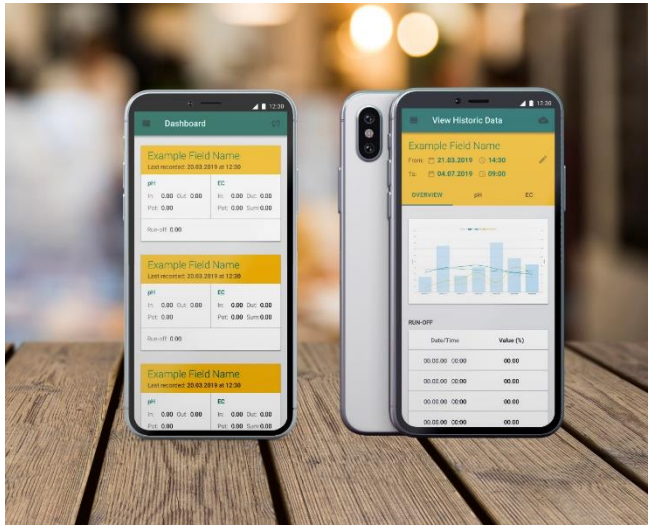
- Agronomics Overview
- Detailed pH Graph
- Detailed EC Graph

Climate

- Temperature & Humidity Graph
- VPD Graph (displayed in Millibars)
- Growing Degree Hour Graph
- Chill Graph
- Strawberry Powdery Mildew

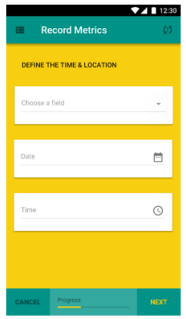
Agronomics App for Drip / Drain Recording

New for 2023



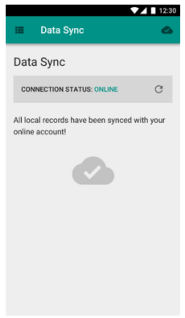
- **Our App is designed for all Substrate Irrigation Management teams.**

It's quick, simple and straight forward to use - enter data once only and view with ease for speedy management decisions



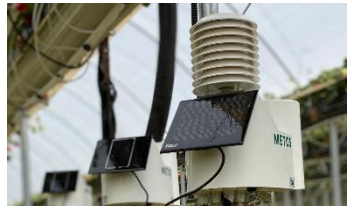
Record it
Choose the field, date & time & enter your data

View it
Check your data input & amend if necessary



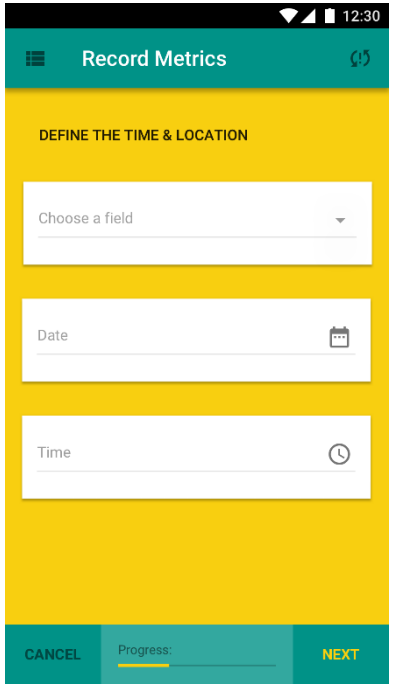
Sync it
Synchronise via wifi to your database

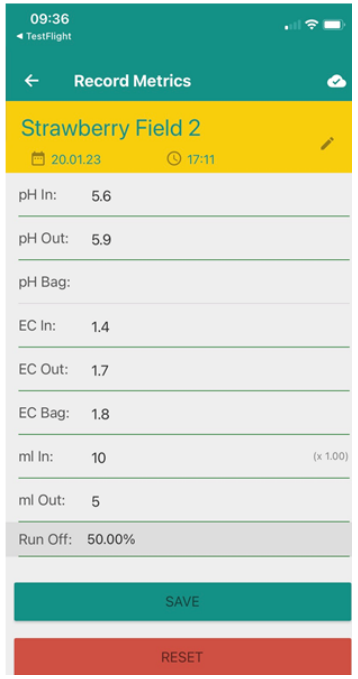
What do you measure in the field?

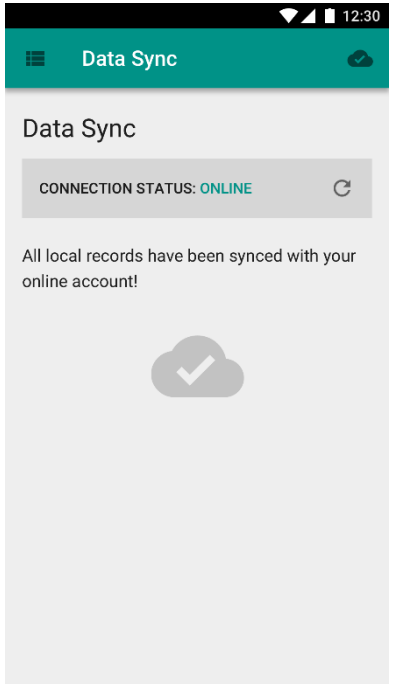


EC at the dripper / EC in the drain / EC in the pot / bag
pH at the dripper / pH in the drain
Run-off percentage now auto calculated – simply fill in mls in / out

The Agri-tech App for Drip & Drain readings







Record it

Choose the field, date & time & enter your data

View it

Check your data input & amend if necessary

Sync it

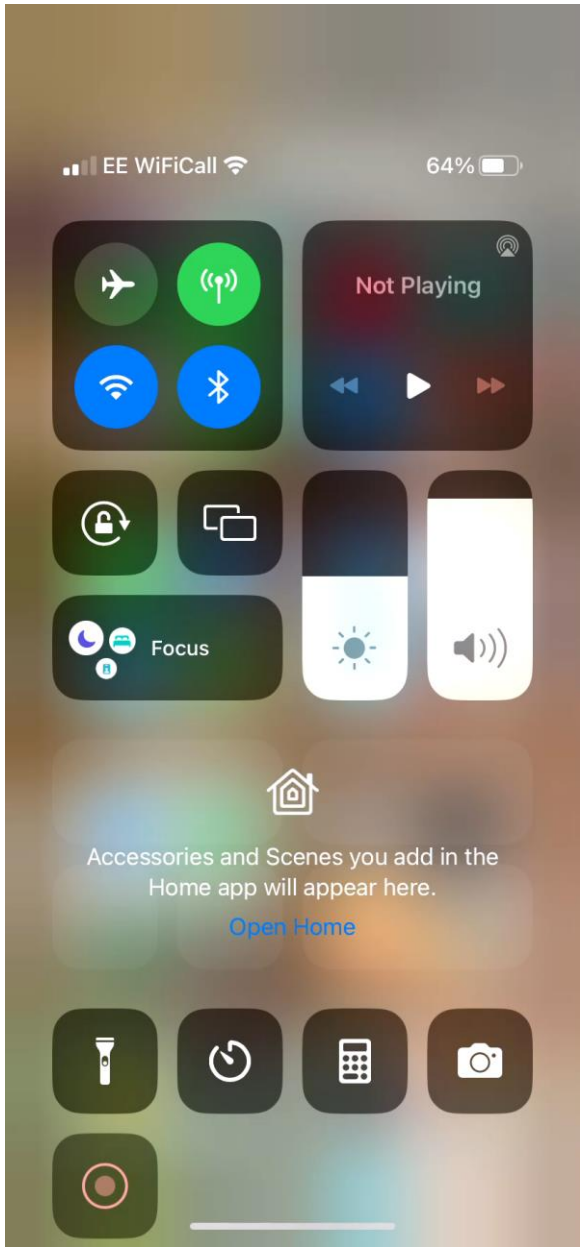
Synchronise via wifi to your database

Run-off percentage now auto calculated – simply fill in mls in / out

Record it

View it

Sync it



ATS Soil Dashboard

"Fuel gauge" indicating moisture status, SMD displayed in mm, and previous 24 hr water use in mm

Irrigation trigger and predicted irrigation date based on the previous 24hr water use

Additional sensor options such as a rain gauge, temperature and humidity sensor

Agri-Tech Demo Farm soil Fields

Search

Name	Moisture	SMD	24hr Water Usage	Irri. Trigger	Predicted Irrigation	Rainfall	Ambient Temp	Humidity
AGRI-TECH SOIL FIELD	221.82	8.18	0.10	200.00	03/03/23	N/A	N/A	N/A
ATS CARROTS	77.06	28.94	5.41	61.00	30/07/22	N/A	N/A	N/A
ATS POTATOES	77.09	23.91	3.23	66.00	31/07/22	N/A	N/A	N/A
ATS ONIONS	98.32	8.68	4.08	82.00	31/07/22	N/A	N/A	N/A

5 rows 1-4 of 4

New ATS Substrate Dashboard & Display – wide screen view

Farming Services & solutions to Agriculture & Horticulture

Farm: Agri-tech Fruit Farm

None
Drain
Probe

Simon Turner
Agri-Tech Demo Farm

Layout:

Agri-Tech Demo Farm substrate Fields

Search

Name	Moisture	Water Usage	Conductivity	Soil Temp	Run Off %	Avg 24hr Run-Off %	Run-Off 24hr	pH In	pH Out	pH Bag	Ec In	Ec Out	Ec Bag	Ec Sum	Ambient Temp	Humidity	VPD	Mildew Risk
BLOCK 4 BLUEBERRIES	46.62	0.03	1.38	27.50	0.00%	21.37%	0.00%	5.68	6.46	N/A	1.49	1.61	1.78	3.10	17.84℃	94%	1.24	N/A
MARAVILLA BK 3	74.03	-0.21	1.49	20.15	0.00%	3.64%	0.00%	N/A	N/A	N/A	N/A	N/A	1.50	N/A	19.88℃	88%	2.81	N/A
BK 1 V5 DRAIN	N/A	N/A	N/A	N/A	N/A	N/A	13.00%	5.20	4.70	N/A	0.77	0.97	1.20	1.74	N/A	N/A	N/A	N/A
BK 2 V10 DRAIN	N/A	N/A	N/A	N/A	N/A	N/A	23.00%	5.90	6.30	N/A	1.20	1.80	1.85	3.00	N/A	N/A	N/A	N/A

20 rows 1-4 of 4

Moisture, EC and temp from the probes

Drip and drain EC, pH and run-off via the app OR new auto drain station

Climate sensor data

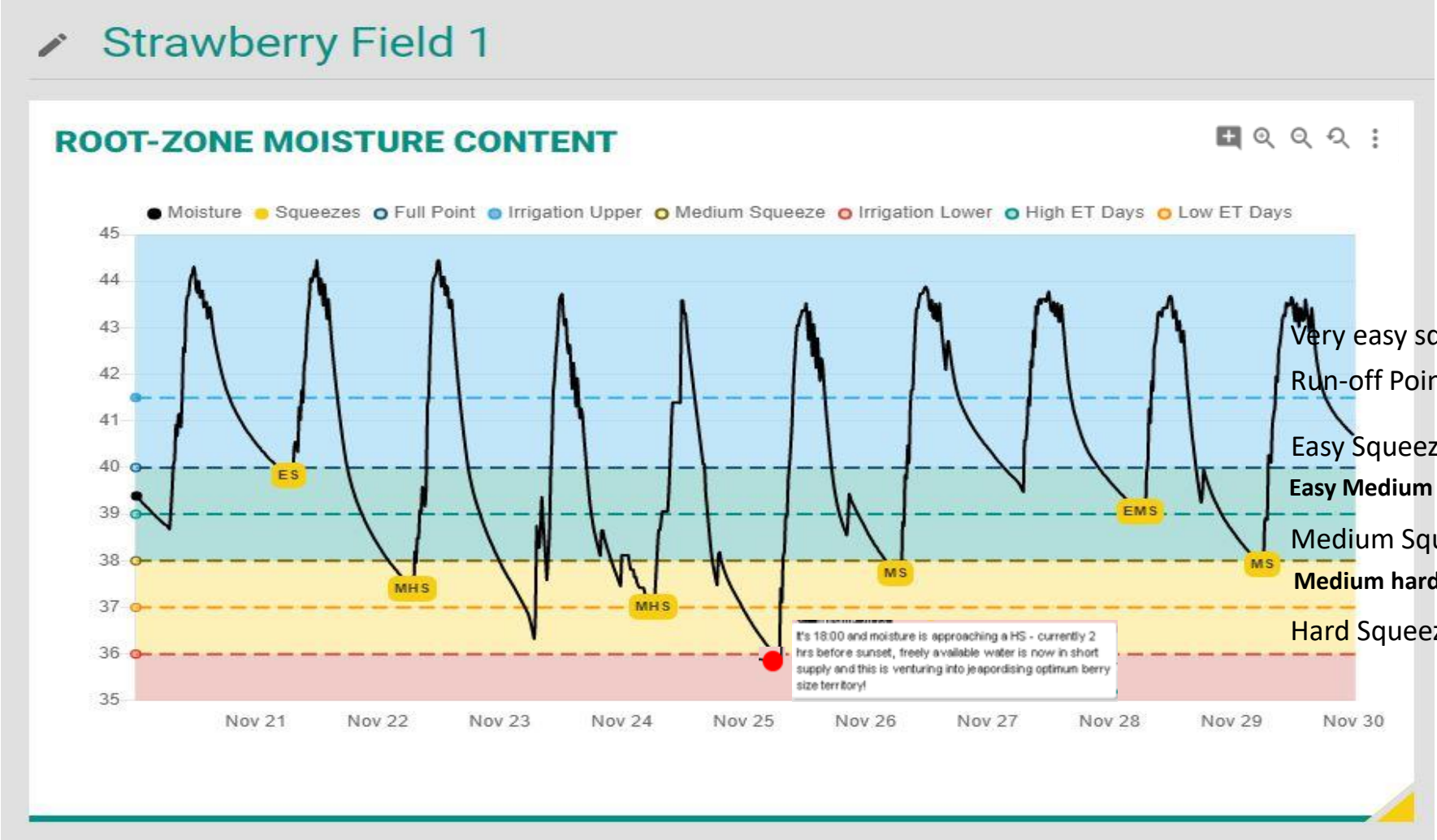
Dashboard – Phone Screen View

Moisture, EC and temp from the probes

Drip and drain EC, pH and run-off via the app OR new auto drain station

Climate sensor data

Rootzone Moisture Content



Very easy squeeze

Run-off Point

Easy Squeeze

Easy Medium squeeze

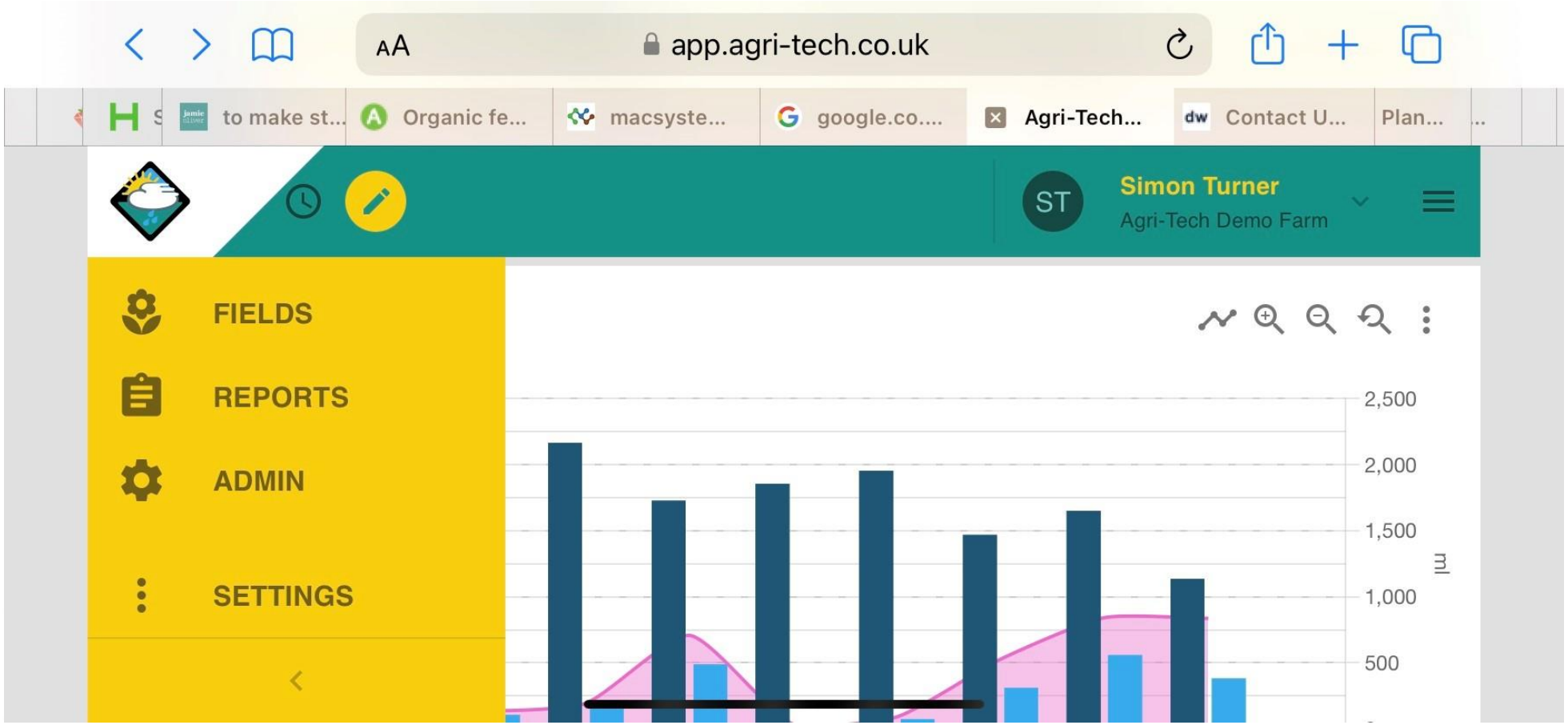
Medium Squeeze

Medium hard squeeze

Hard Squeeze

Charts – Phone Screen View

Charts – Phone Screen View



Dashboard Charts

Irrigation Meeting notes

Agri-tech Fruit Farm Irrigation report 20/01/23

Next meeting scheduled for 27th January 14:00

Bk 4B Monterey	Bk 4B	Agri-tech Fruit Farm	**Optimal**

The next flush of fruit is scheduled to pick w/c 23/01. With warm weather and high VPD days forecast suggest no drier than an EMS first thing in the morning -MS absolute driest. Bag EC's steady at around 1.5, with run-offs in the double figures - aim for 15 to 20% going forwards based on the current weather forecast.

Block 4 Mesena Blues	Bk 4 Blues	Agri-tech Fruit Farm	**Optimal**

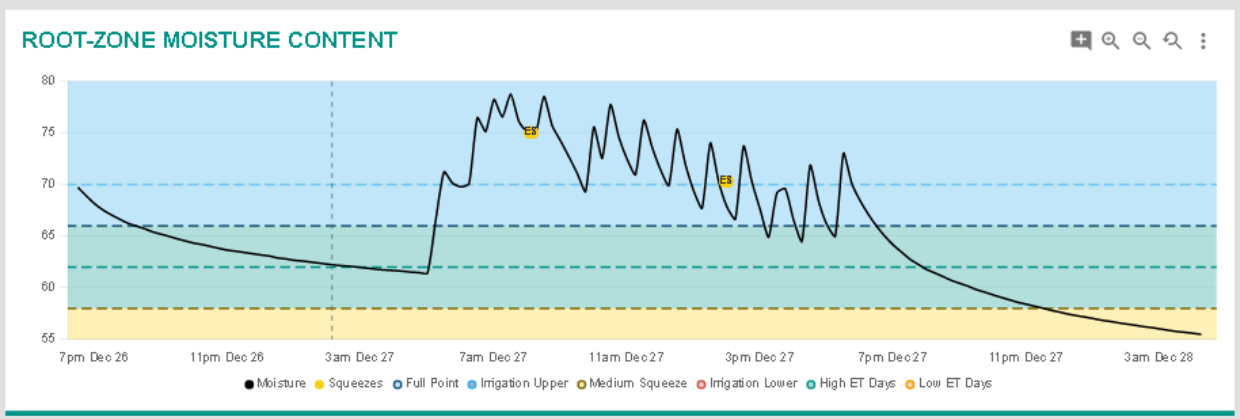
The recent tipping has worked well and encouraged renewed branching - there is good growth continuing here, however there are signs of heat stress on the canopy. Hopefully the new shade net will help combat this. There is plenty of drain here which will help keep humidity up and lower ther VPD slightly. This will also help keep the rootzone temperature in the optimal zone. On the higher VPD days you may need to consider irrigatring later into the afternoon / evening, with shorter rounds to keep the top half of the pots moist enough without the need for drain. Be aware that the pot EC is subtly climbing, so reducing the drip in EC slightly may be necessary given the number of rounds that you are applying through the day.

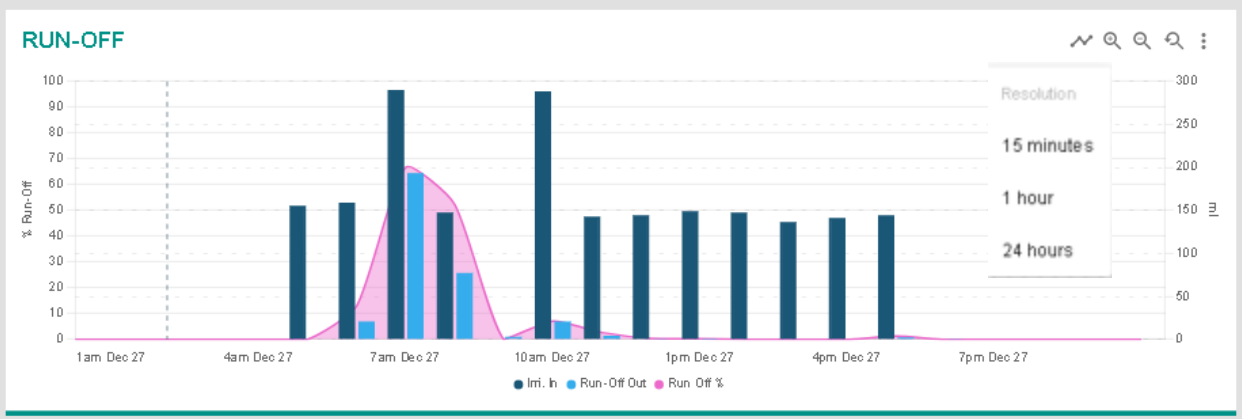
BK3 Maravilla	BK 3	Agri-tech Fruit Farm	Too Dry

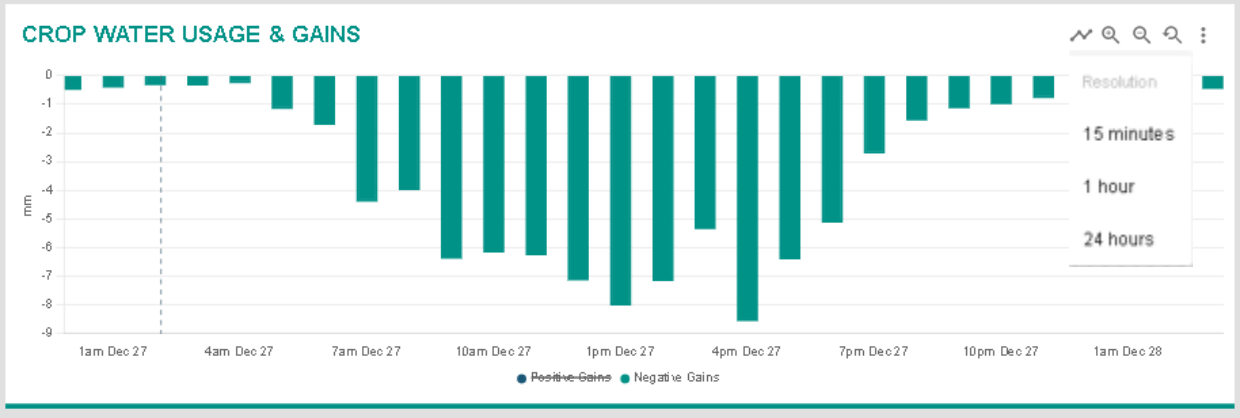
The irrigation system is running flat out, with rounds starting at 05:00 and continuing on an hourly basis through out the day. As discussed the system cannot cope with the crop's demand hence moisture falling away particularly towards the bottom of the pots after around 09:00 with drain finishing commonly after 09:00 - 10:00.

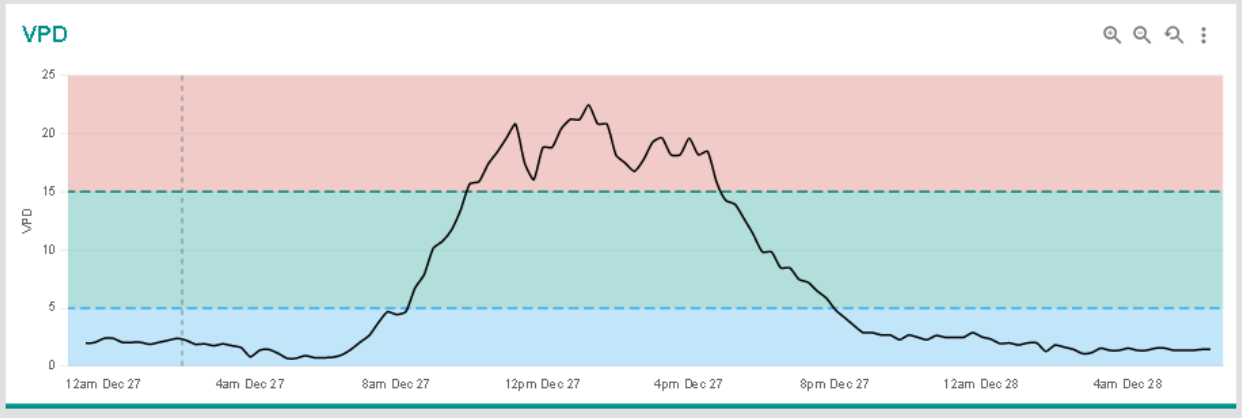
There is a limit to what can be done here right now, howver I would suggest irrigating later into the day (18:00 - 19:00) in an effort to get some late drain, but also ensure there is sufficient moisture through the evening leaving you with a MS first thing in the morning. Currently the stop time is too early for a crop in its peak pick, and having a MHS to HS by 5pm will ultimately jeapordise optimal berry size in here.

User defined zoomed charts – 24hr period





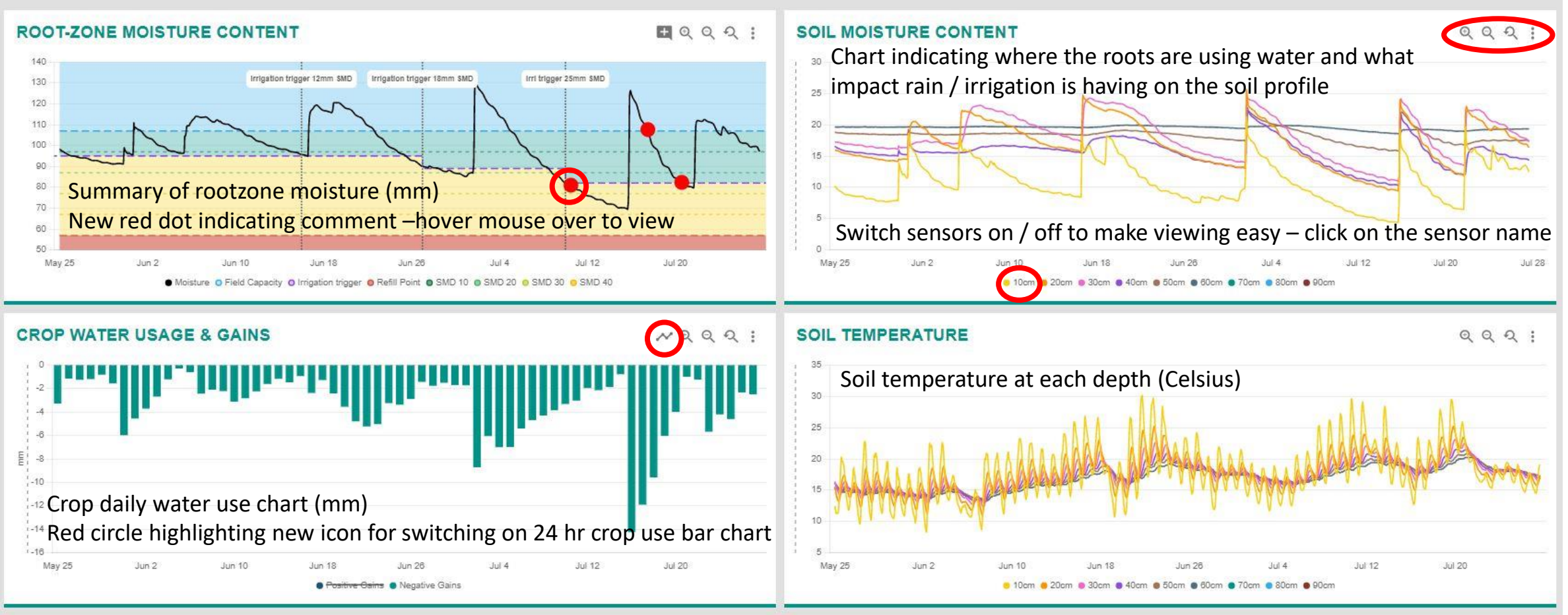




Soil charts for data evaluation

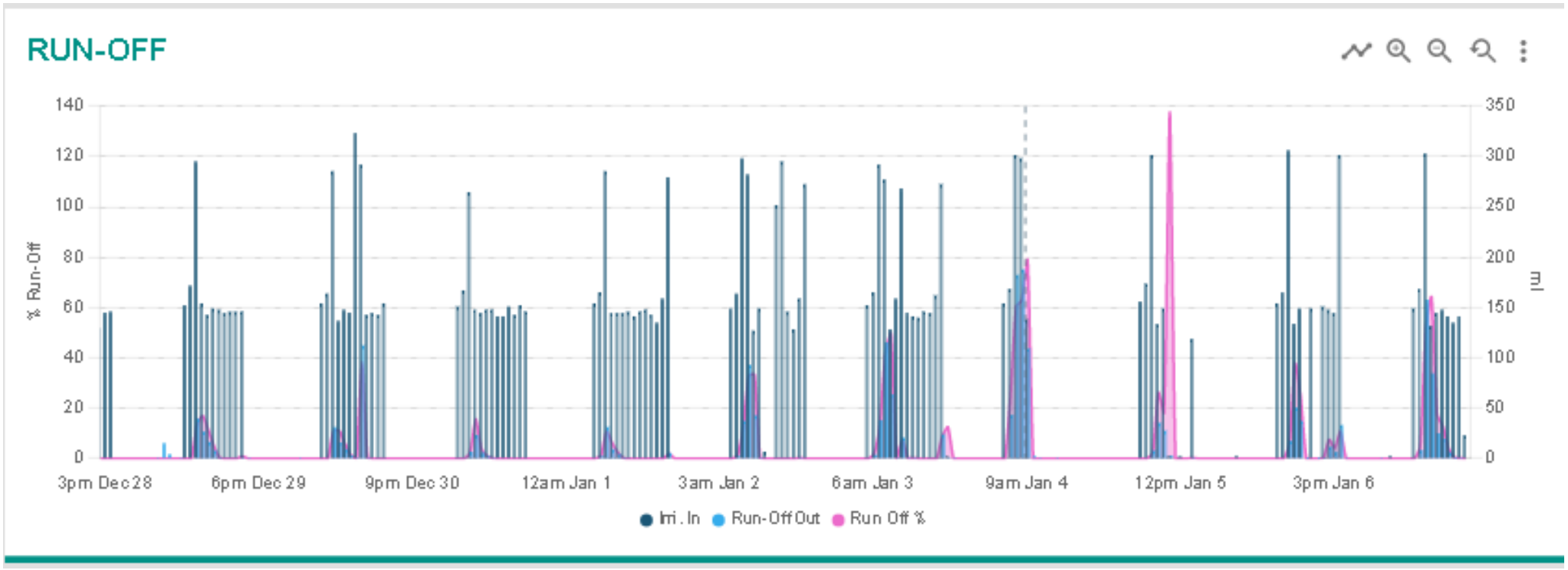
Soil conductivity chart also available – indicative of nutrient status of each soil zone

Zoom in / out / re-set & menu options

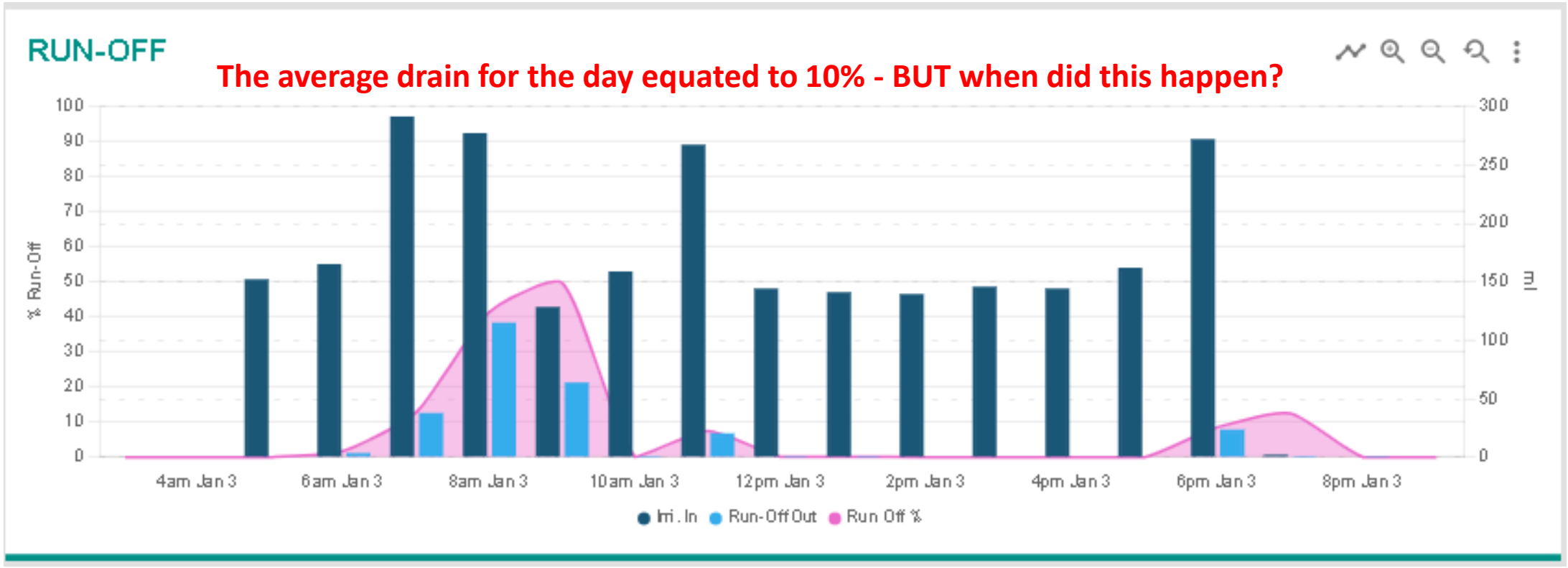


Auto run-off

Hourly run-off summary over 10 days



Auto run-off – Daily Breakdown

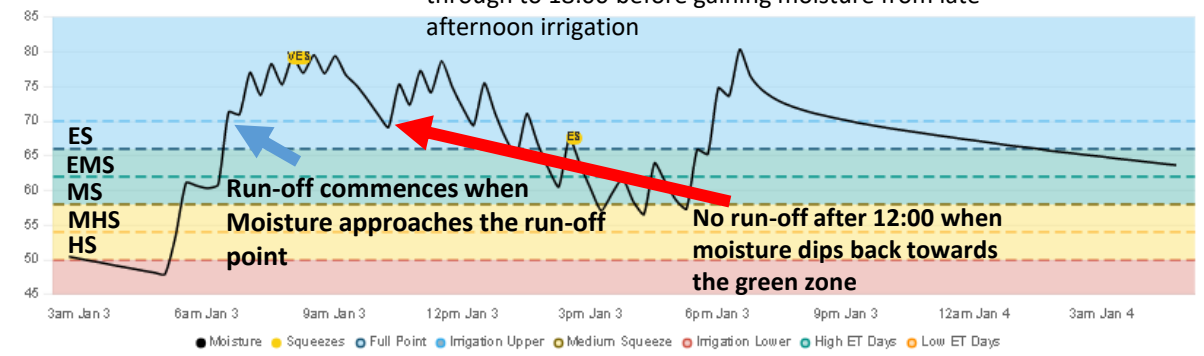


05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	
0%	1%	13%	41%	49%	0%	7%	0%	0%	0%	0%	0%	0%	9%	Daily Average = 10%

System infrastructure prevents more than one round of irrigation per hour – crop use exceeds moisture input during the peak uptake period of the day

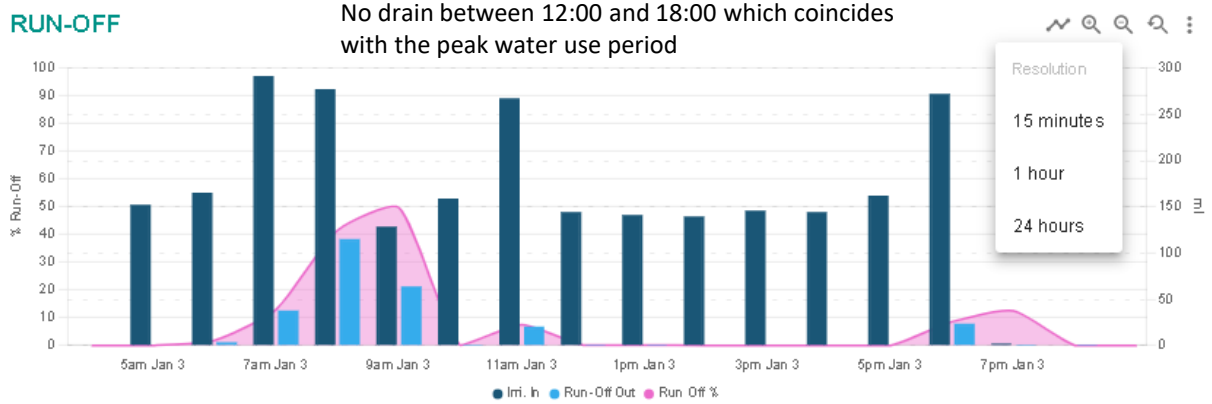
ROOT-ZONE MOISTURE CONTENT

Pot moisture peaks at 09:00, thereafter drops through to 18:00 before gaining moisture from late afternoon irrigation

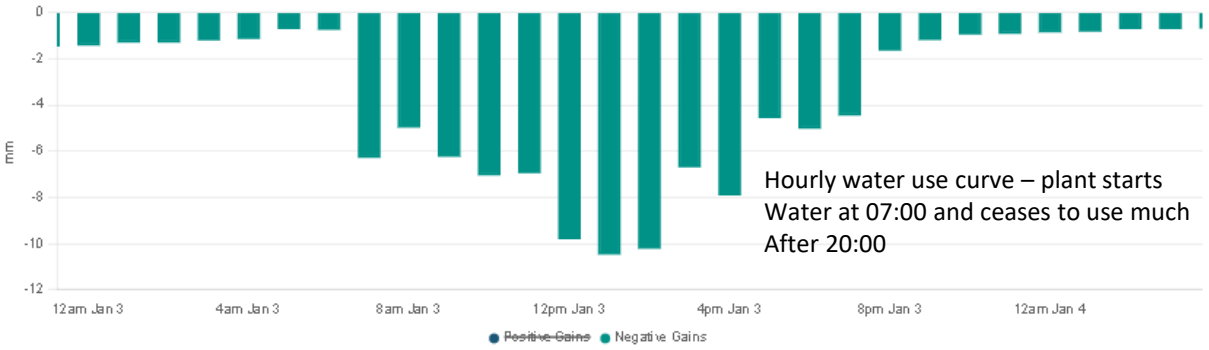


RUN-OFF

No drain between 12:00 and 18:00 which coincides with the peak water use period

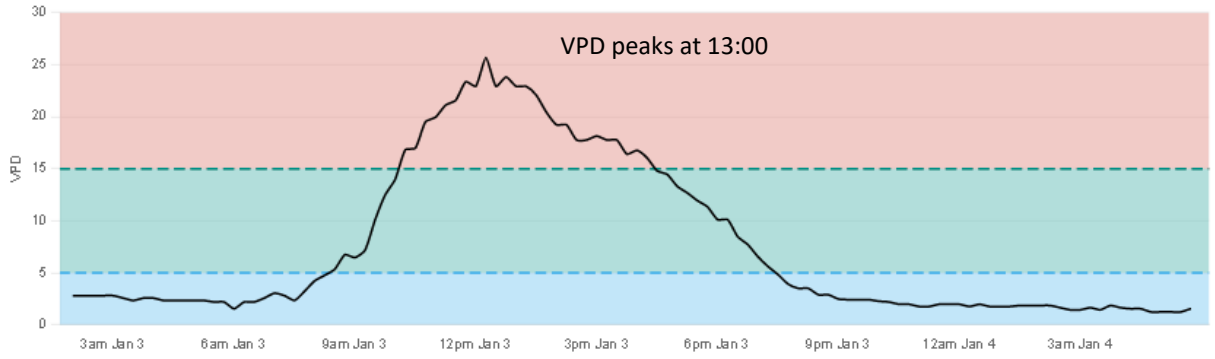


CROP WATER USAGE & GAINS



Hourly water use curve – plant starts Water at 07:00 and ceases to use much After 20:00

VPD



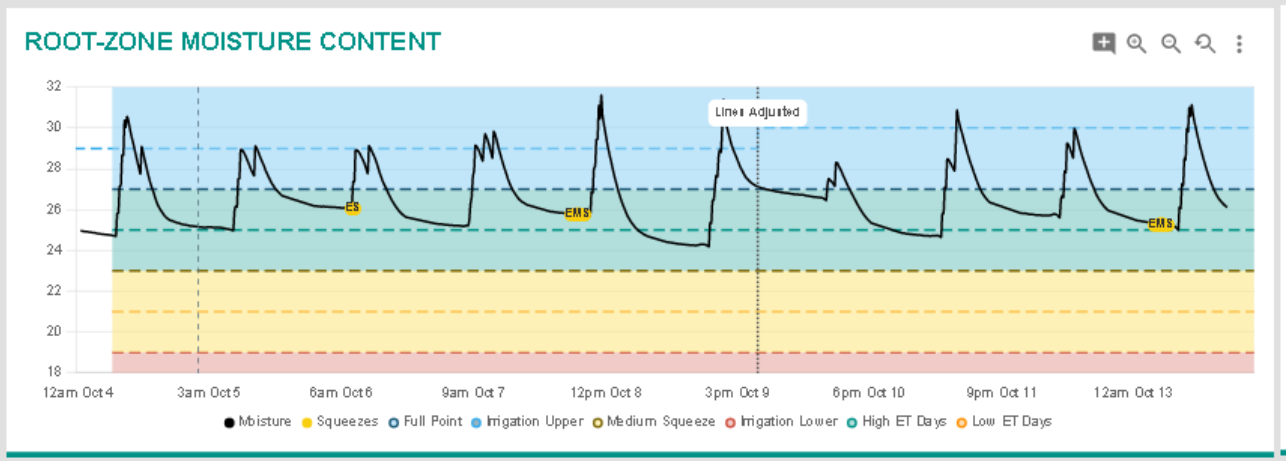
Agri-tech Automatic Drain Station

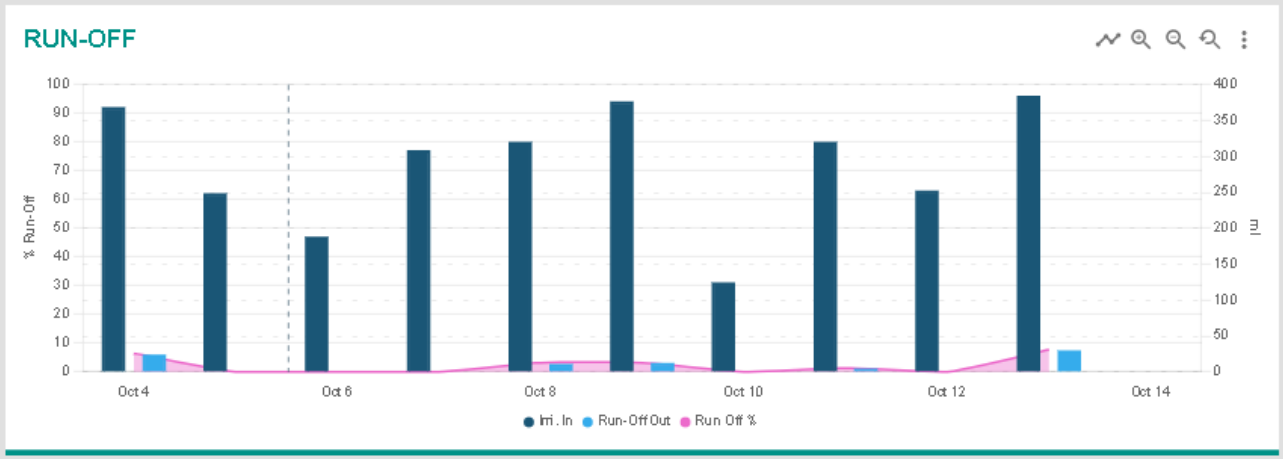
Agri-tech Auto-drain Station

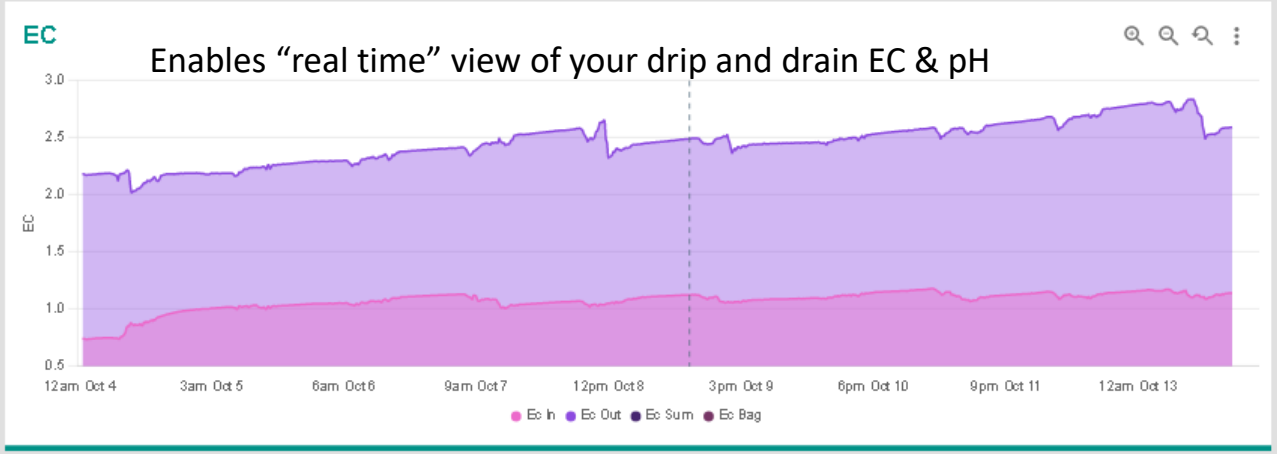
Hardware consists of 1 DTU, 2 rain gauges with sensor well fitted, 2 pH / EC interfaces and 2 each of pH & EC sensors

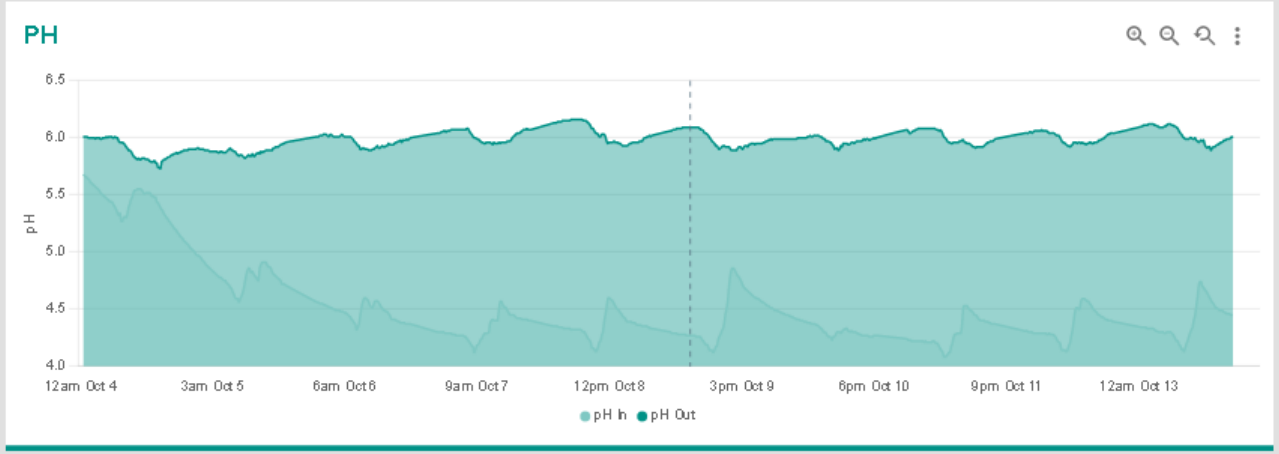
Fully automated measurement 24/7 of your drip and drain pH / EC and run-off

Agri-tech Automatic Drain Station – EC, pH & Run-off



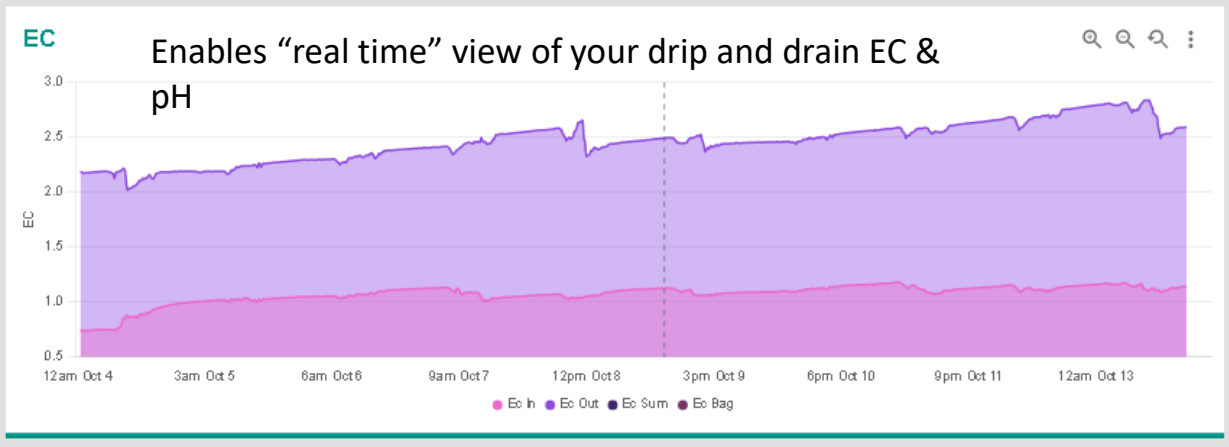


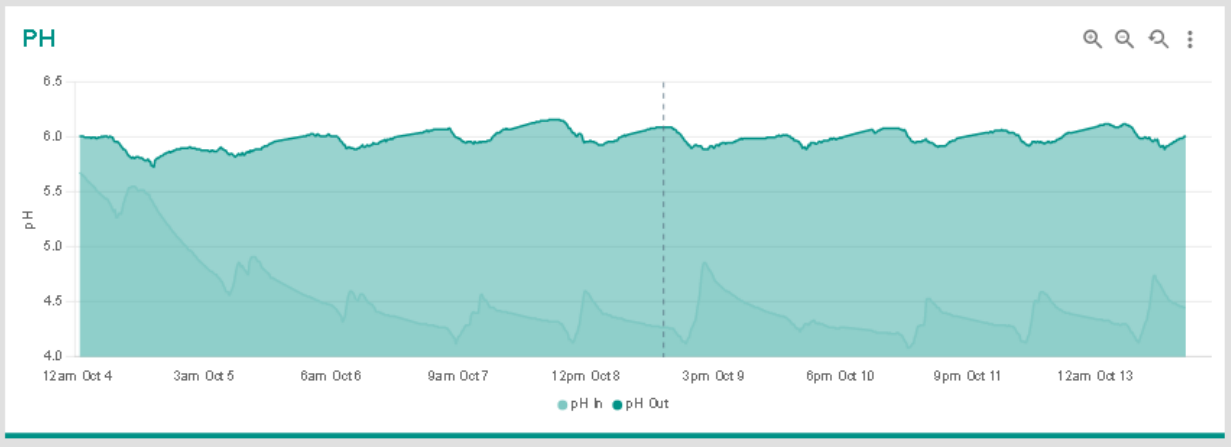




Quote – Dave Parnham – Irrigation Manager Berrysweet Australia

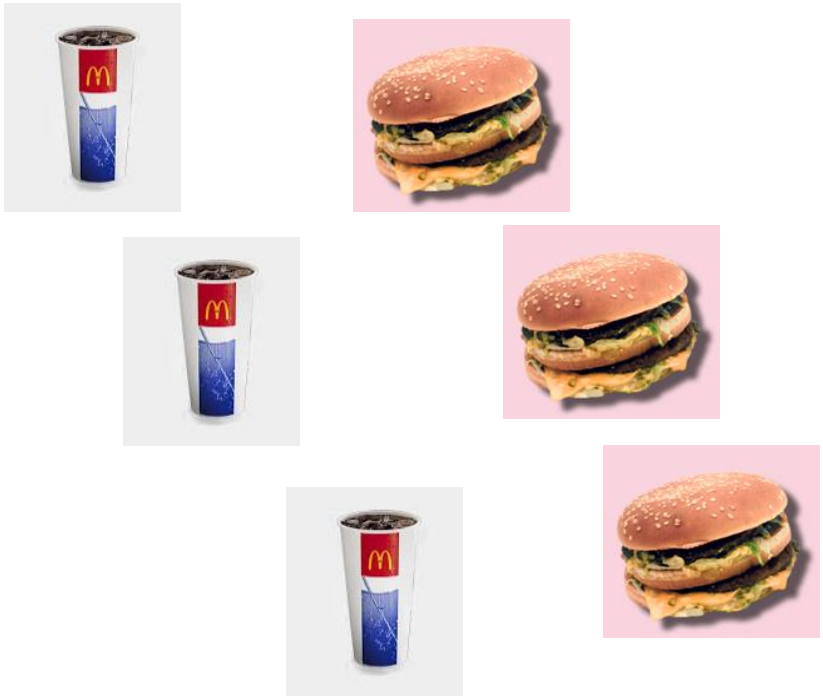
"With the Agri-tech full Auto drain installed, watching in real time is fantastic – you know immediately if there's a problem with the rig and is far superior to once per day reading from the manual drains"





EC Management

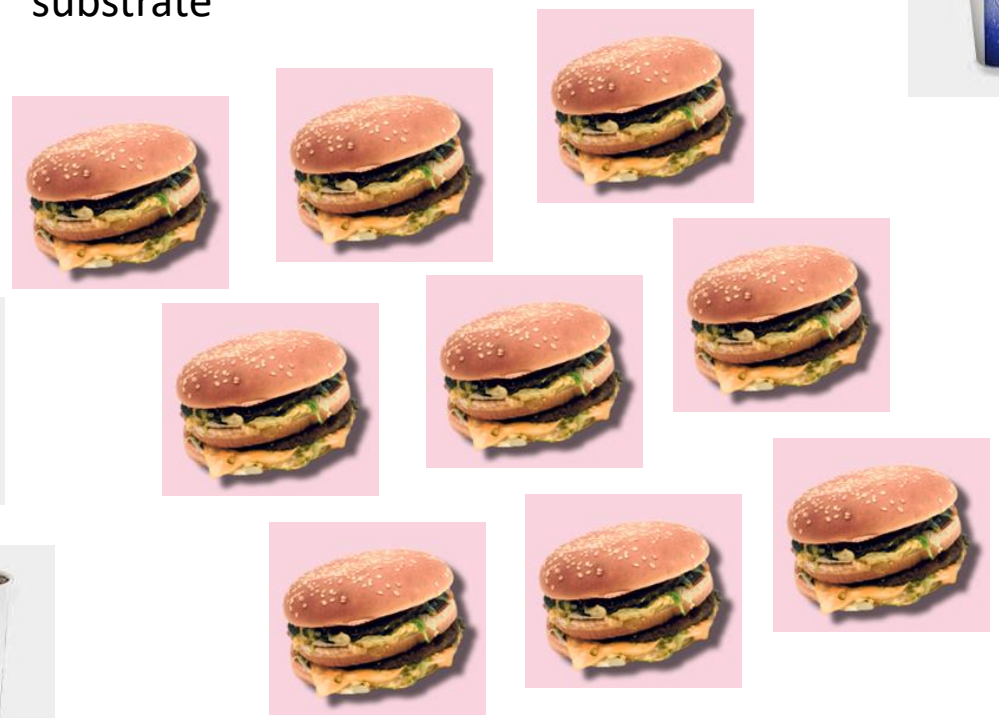
Low ET day



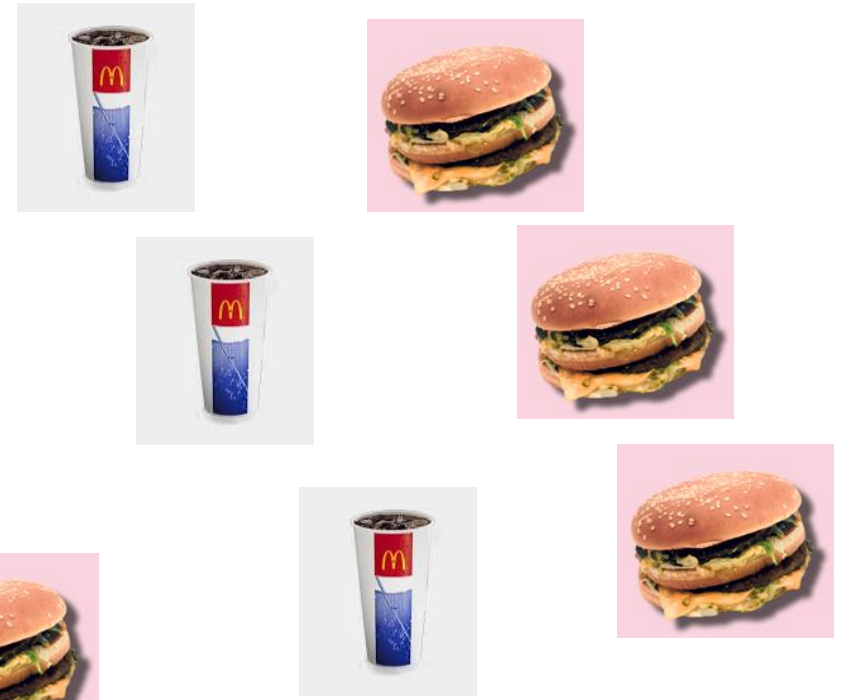
EC Management

High ET day

Too much feed – EC build up in substrate



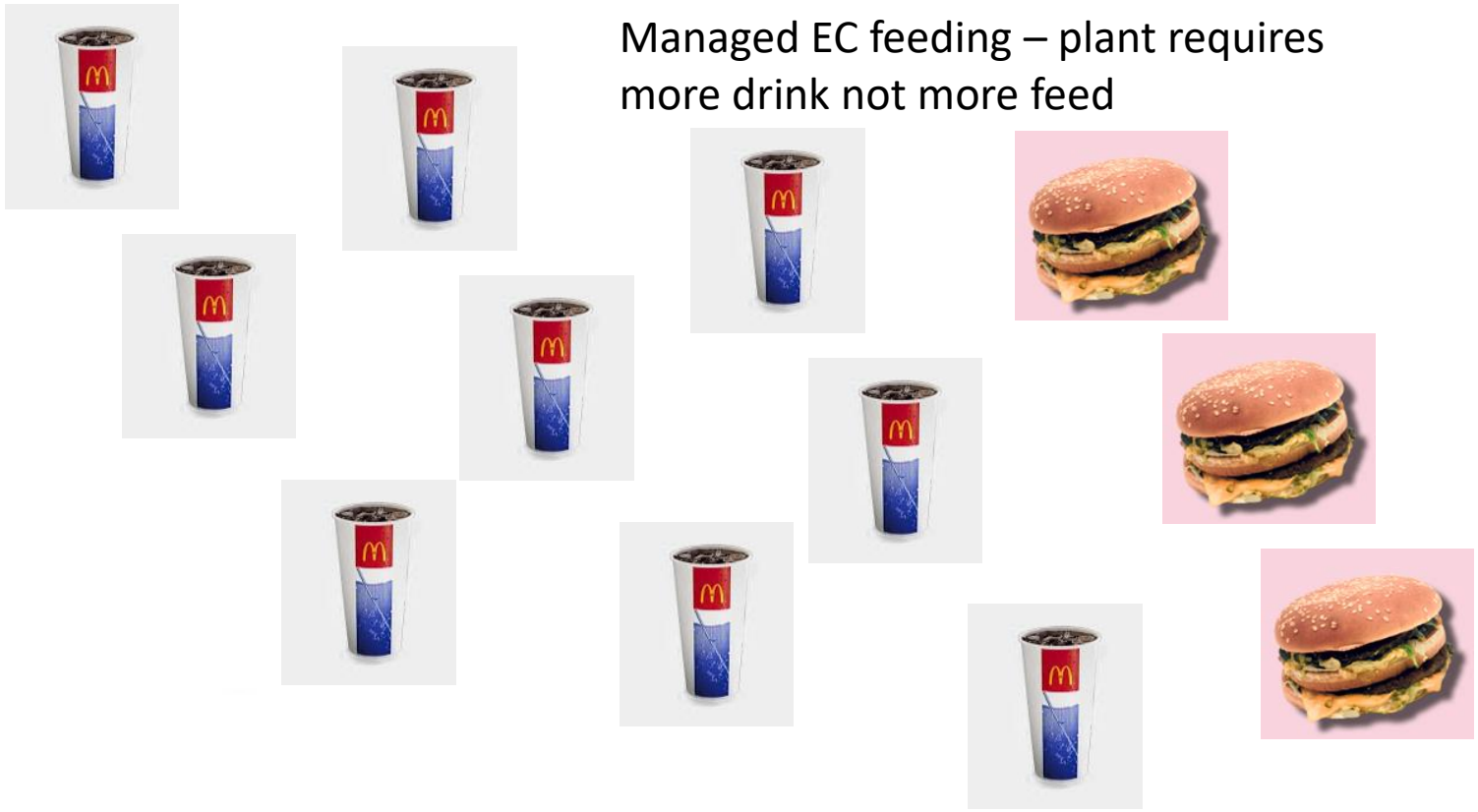
Low ET day



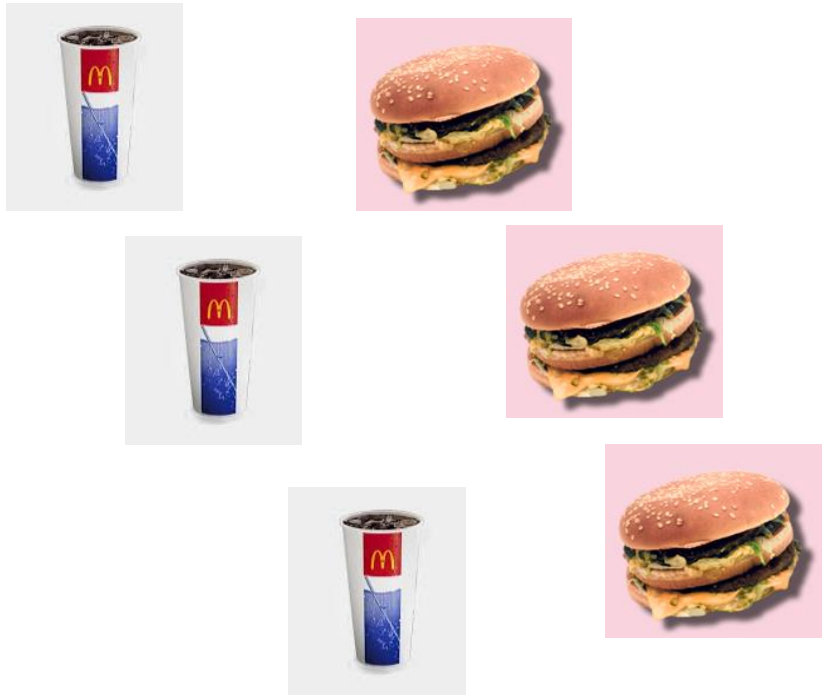
EC Management

High ET day

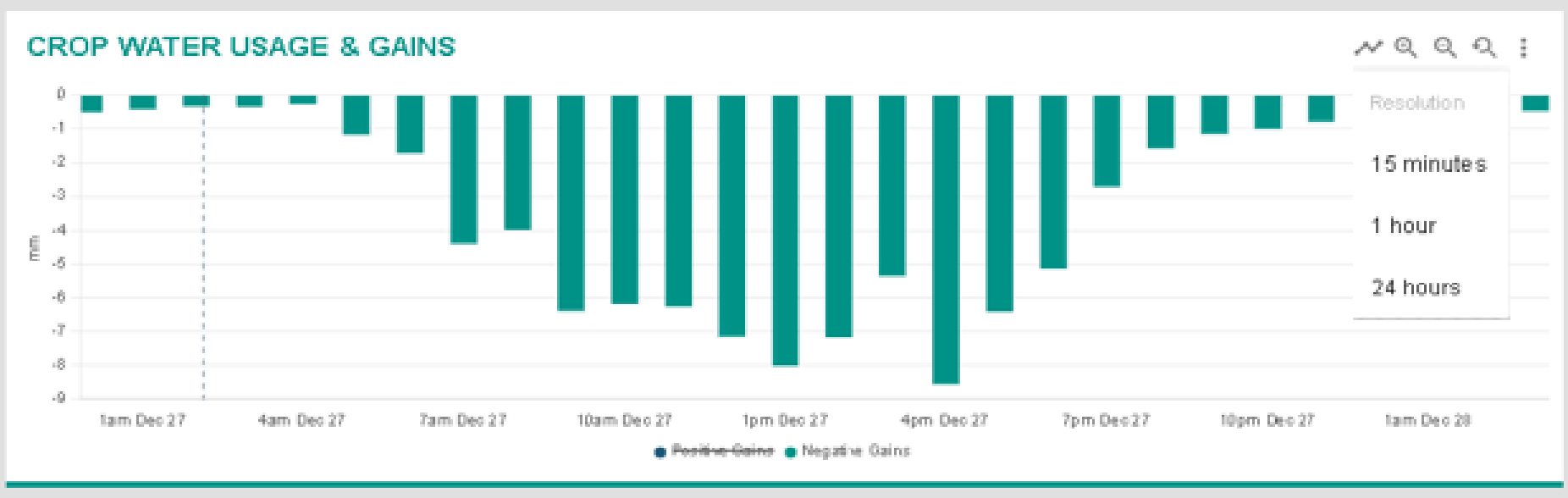
Managed EC feeding – plant requires more drink not more feed



Low ET day



EC Management – high VPD days

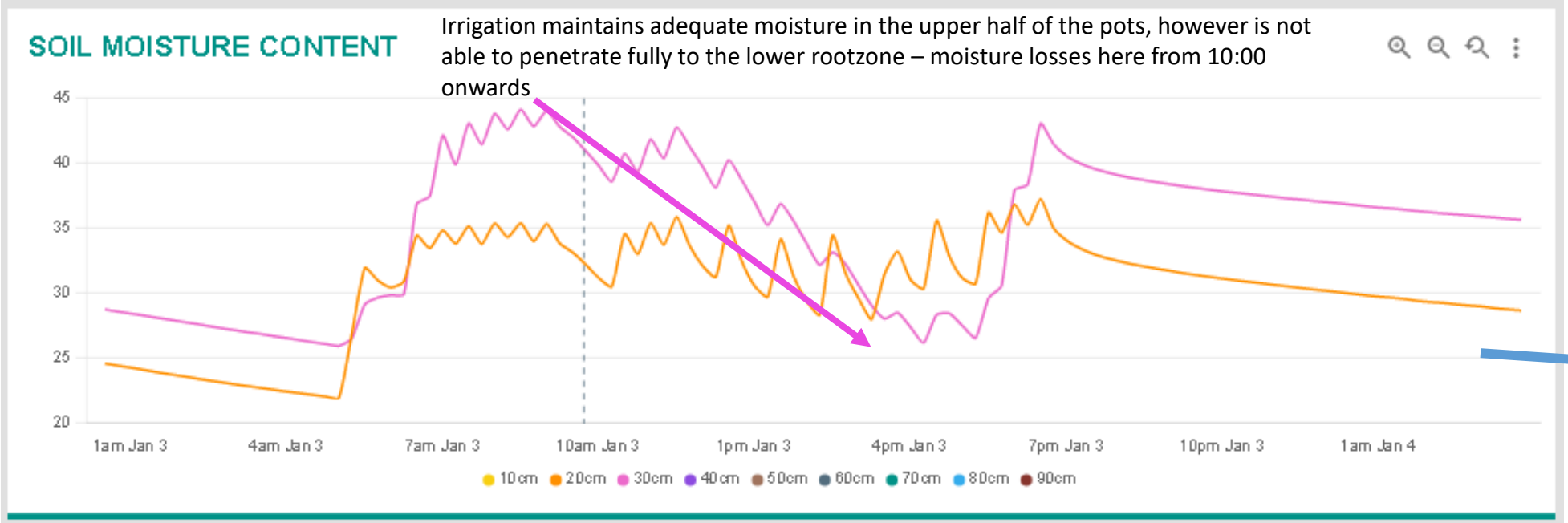


Breakfast

Dinner

Irrigation System Evaluation – can the system cope?

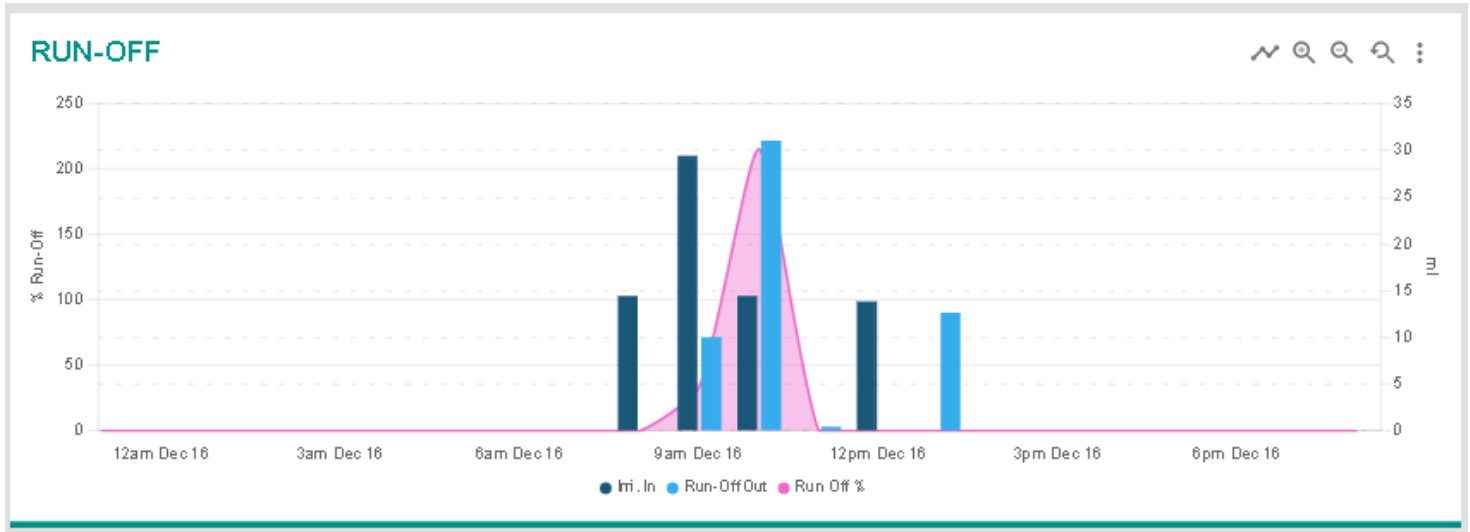
Ideally System infrastructure would have the capacity to apply two shots per hour

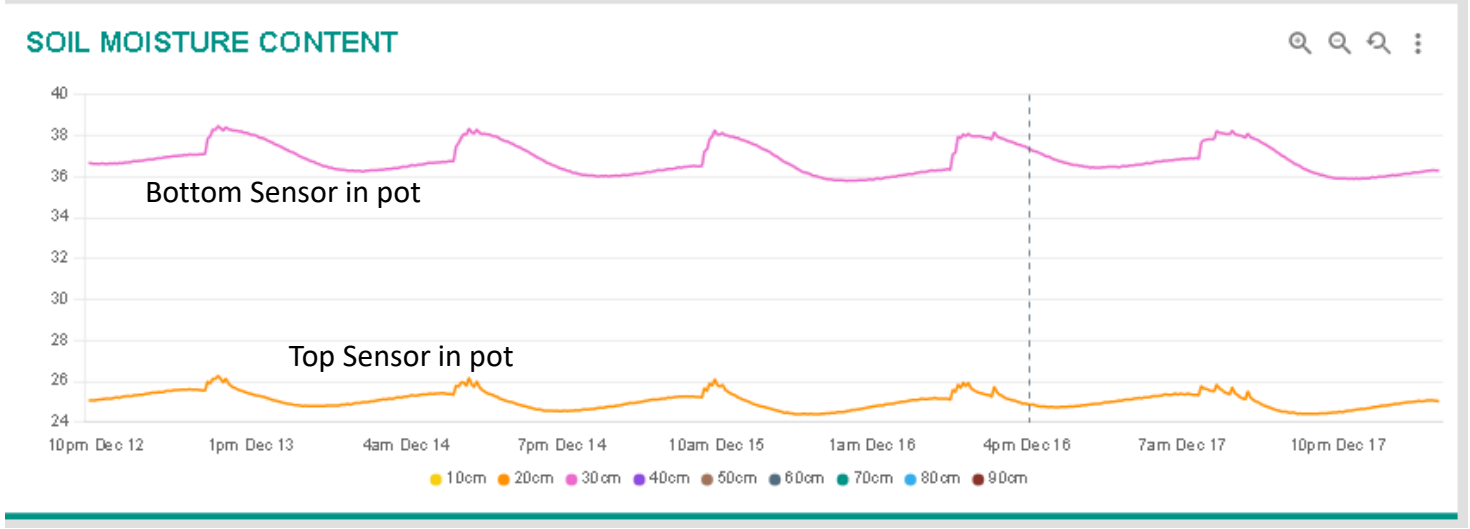


Irrigation Uniformity – Can the hit be too long?

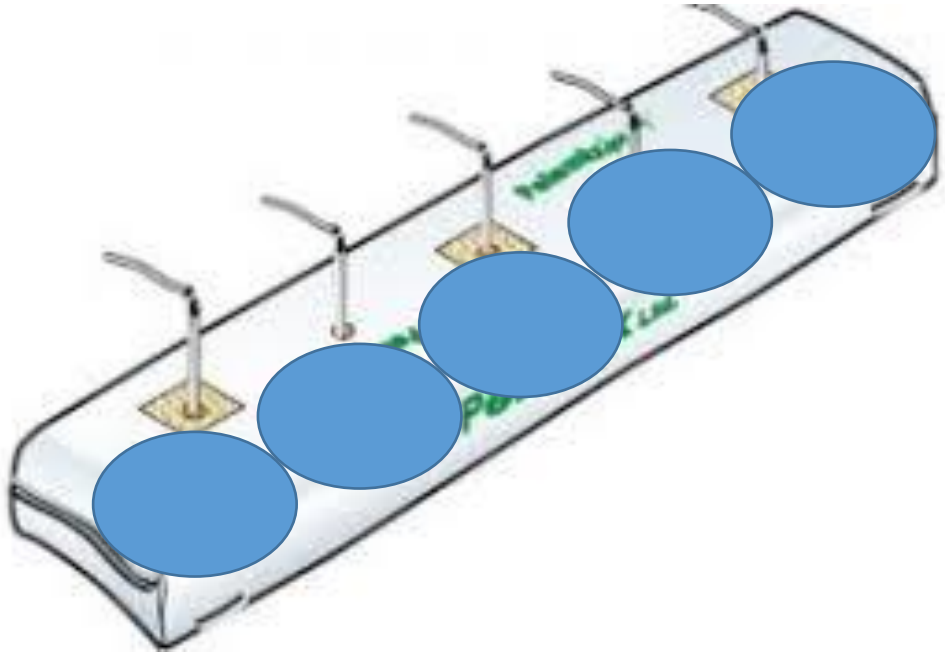
Wet channel created through the pot by the hit length being too long – run-off likely to be on the high side here.

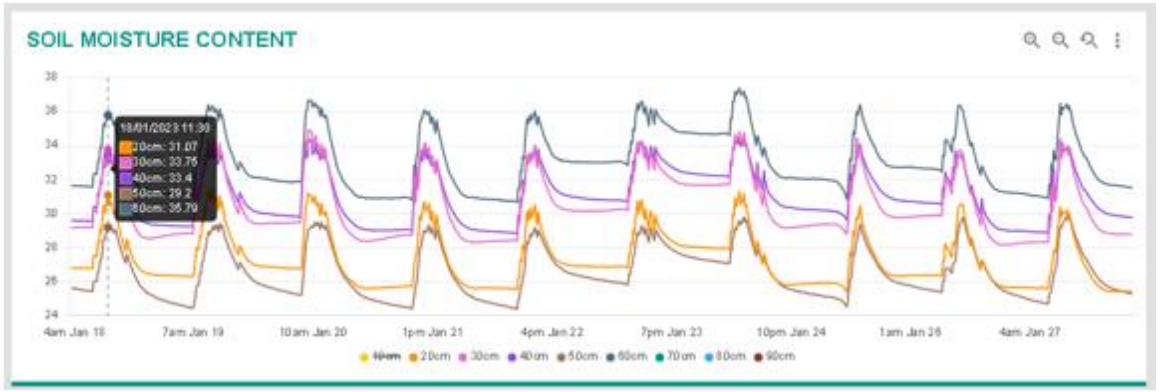
Very dry zones either side of the wet channel.

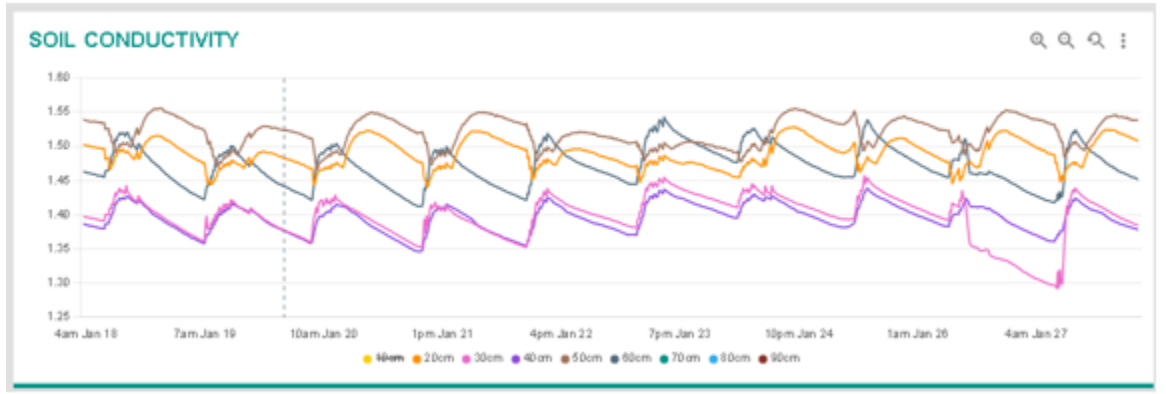




Moisture uniformity

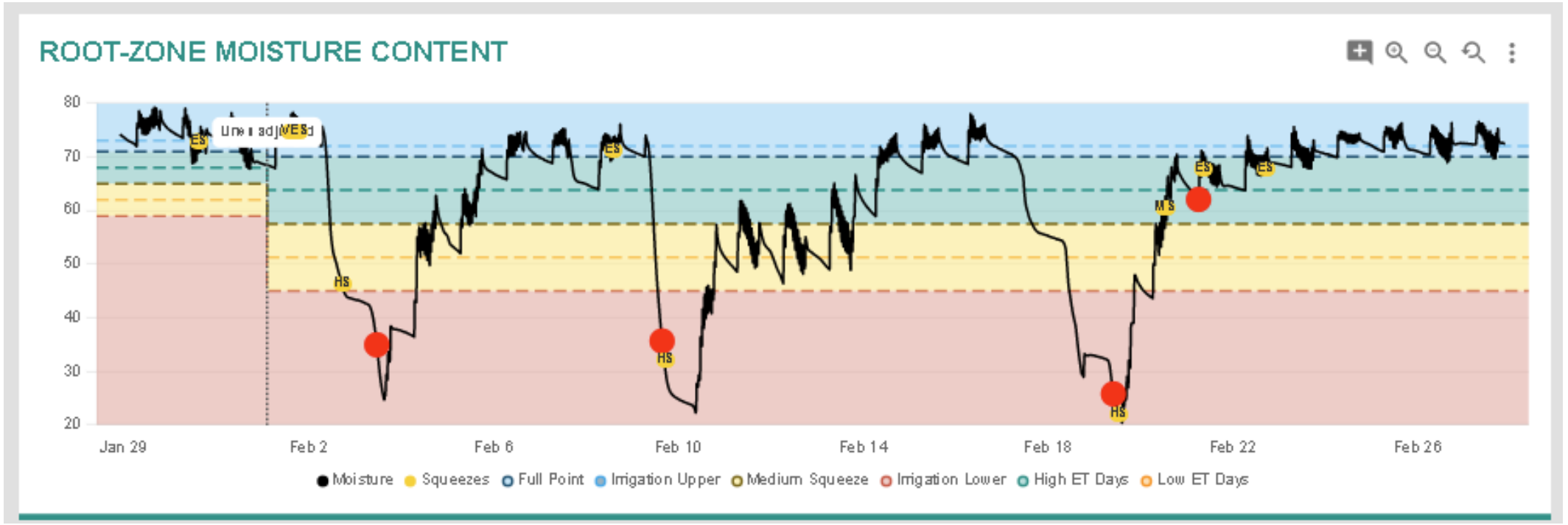






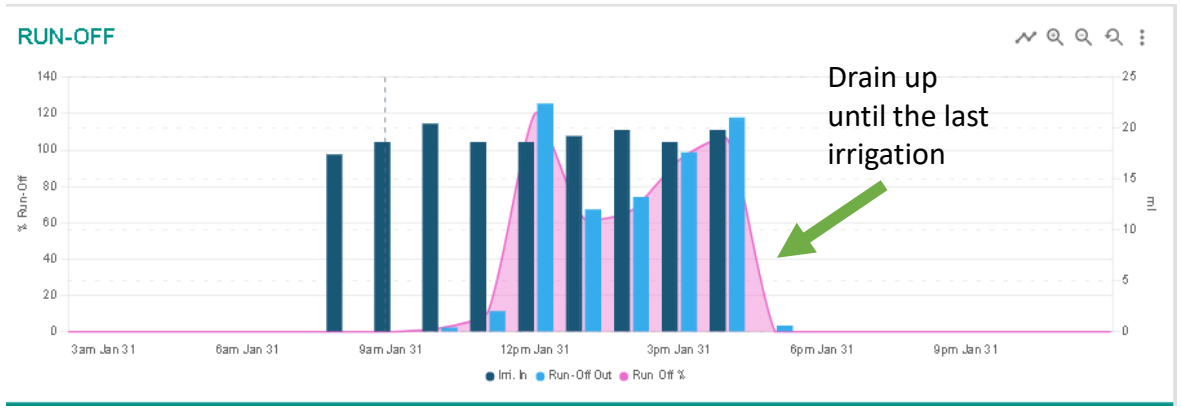
Crop Management – Induced Managed Stress

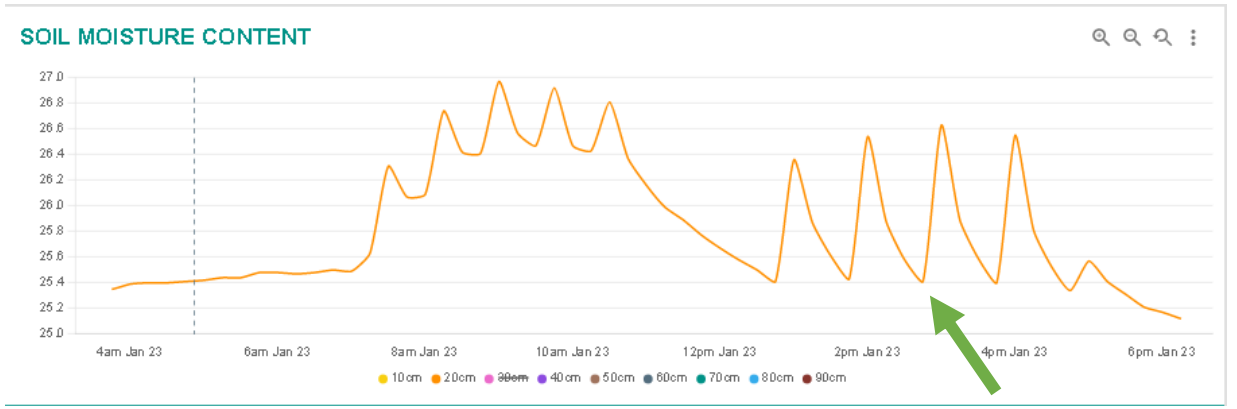
Three induced managed stress events to trigger generative growth



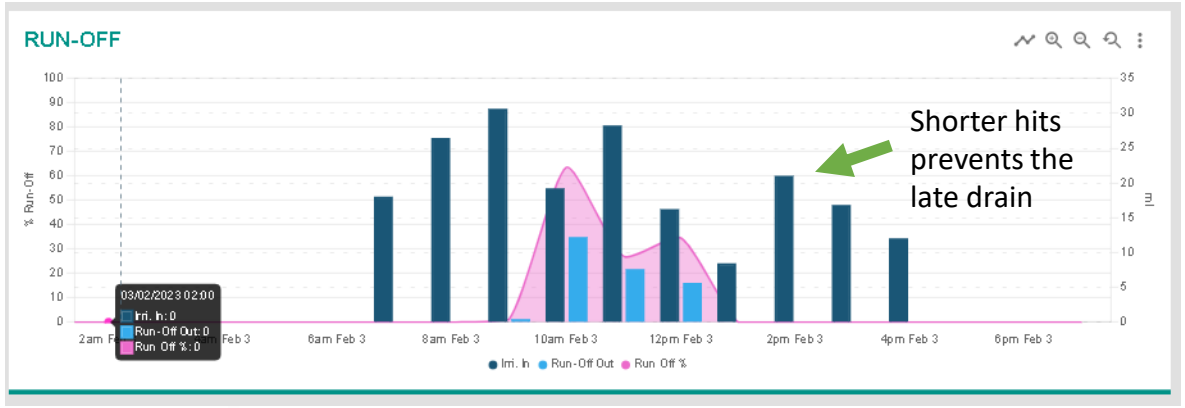
Blueberry Irrigation

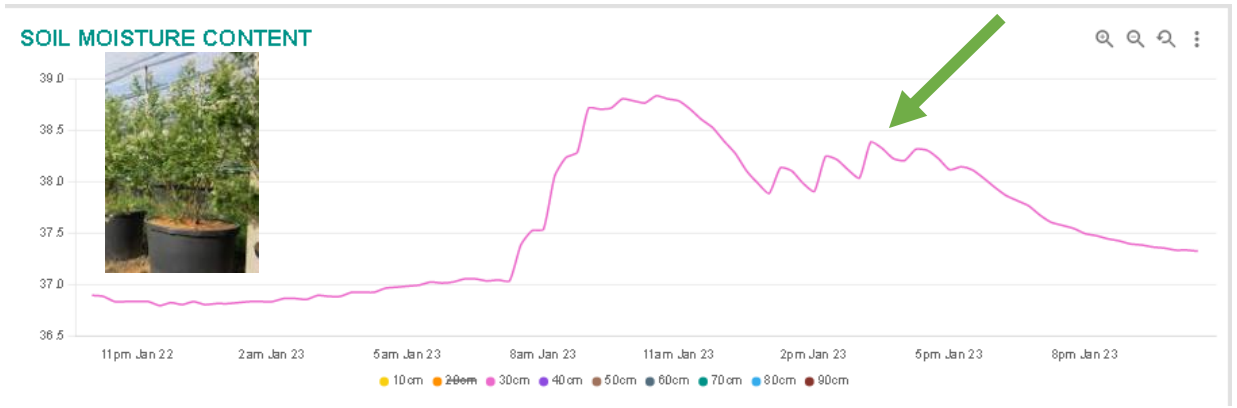
Can the hit length be altered through the day?



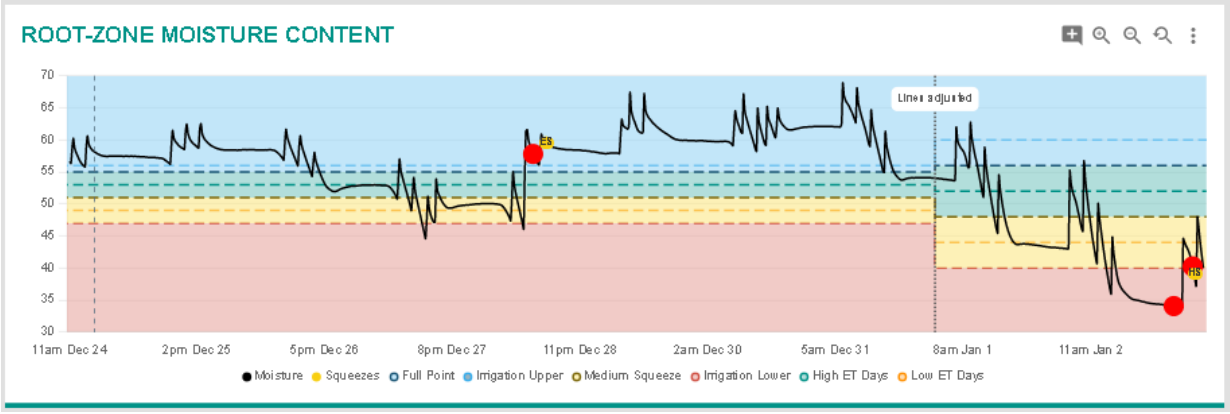


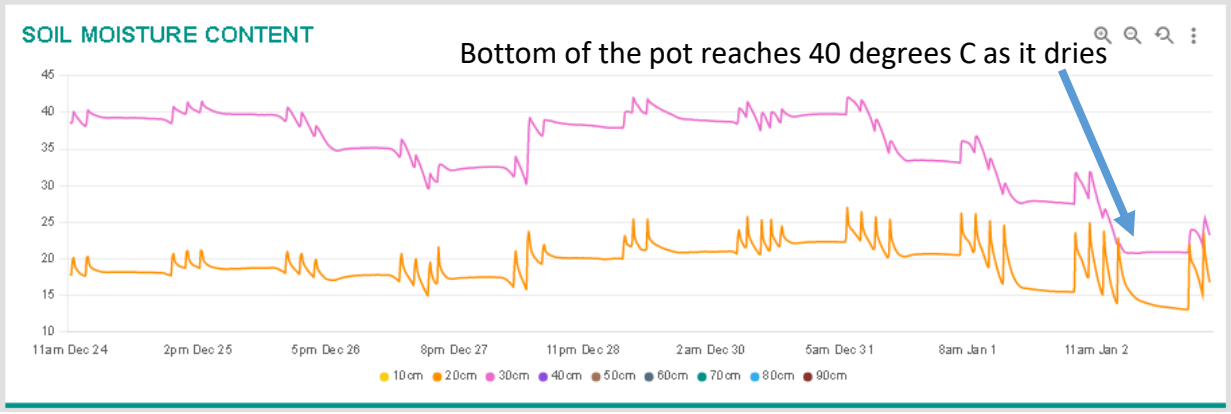
Shorter hits in the afternoon keeps top of the pot optimised whilst preventing drain through

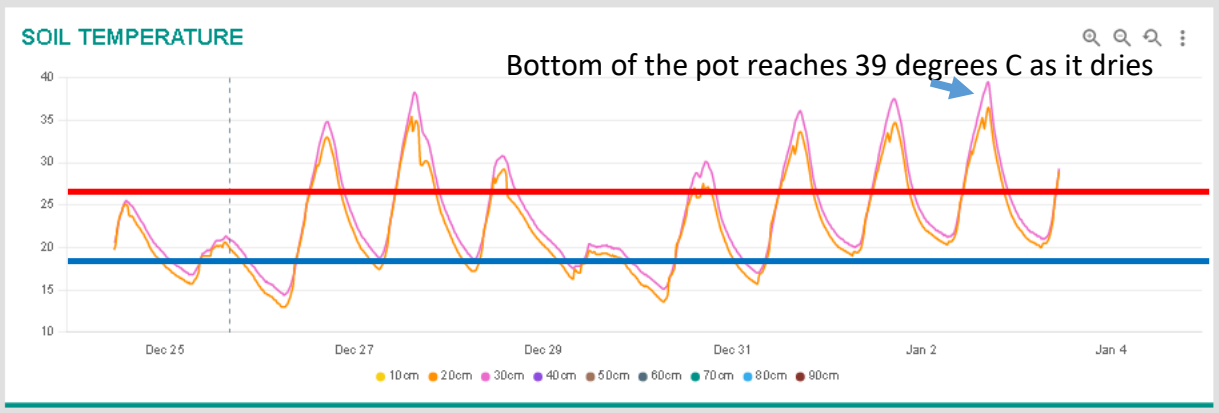


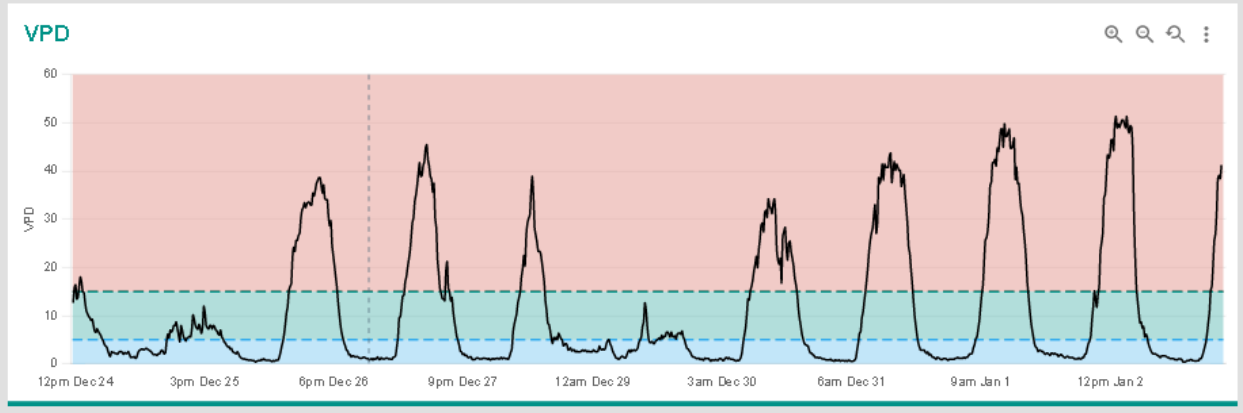


Optimum root zone temperature raspberries 19 – 26 degrees

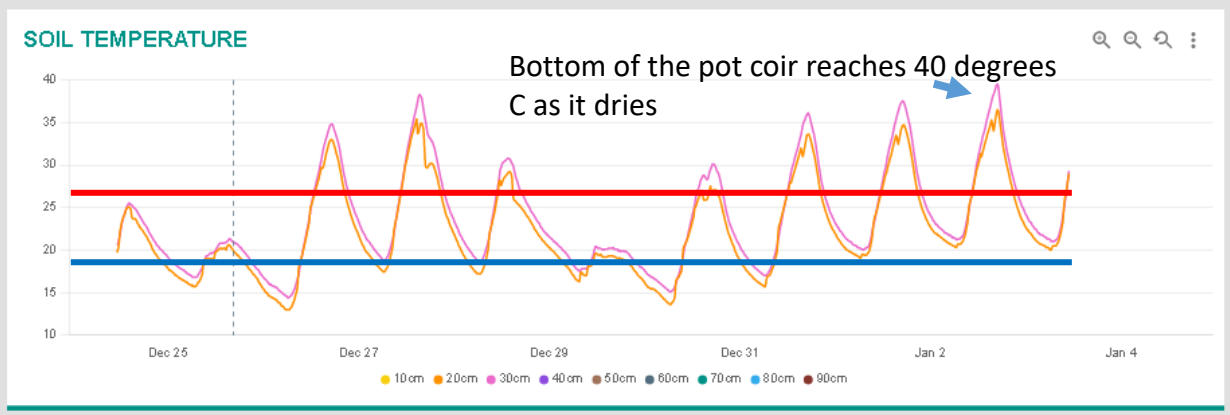


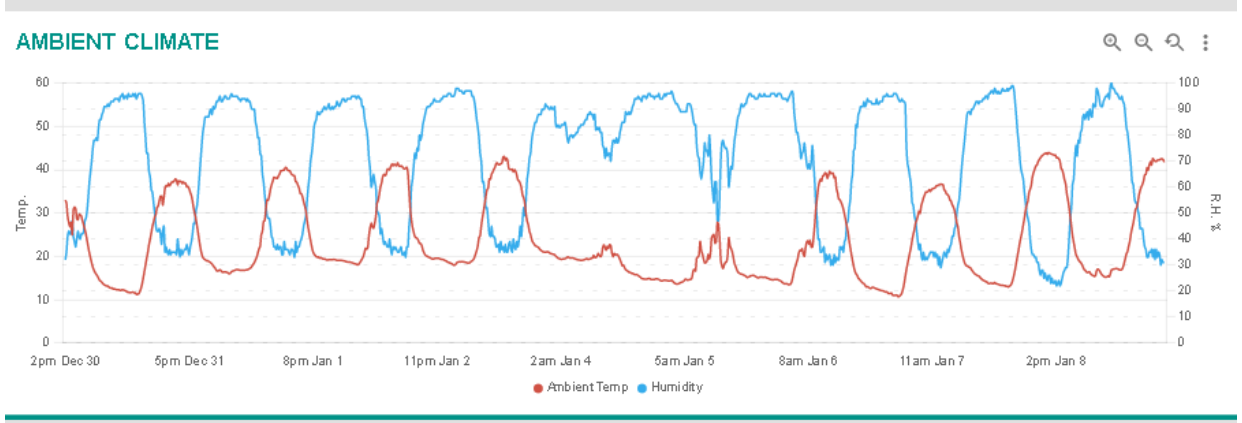






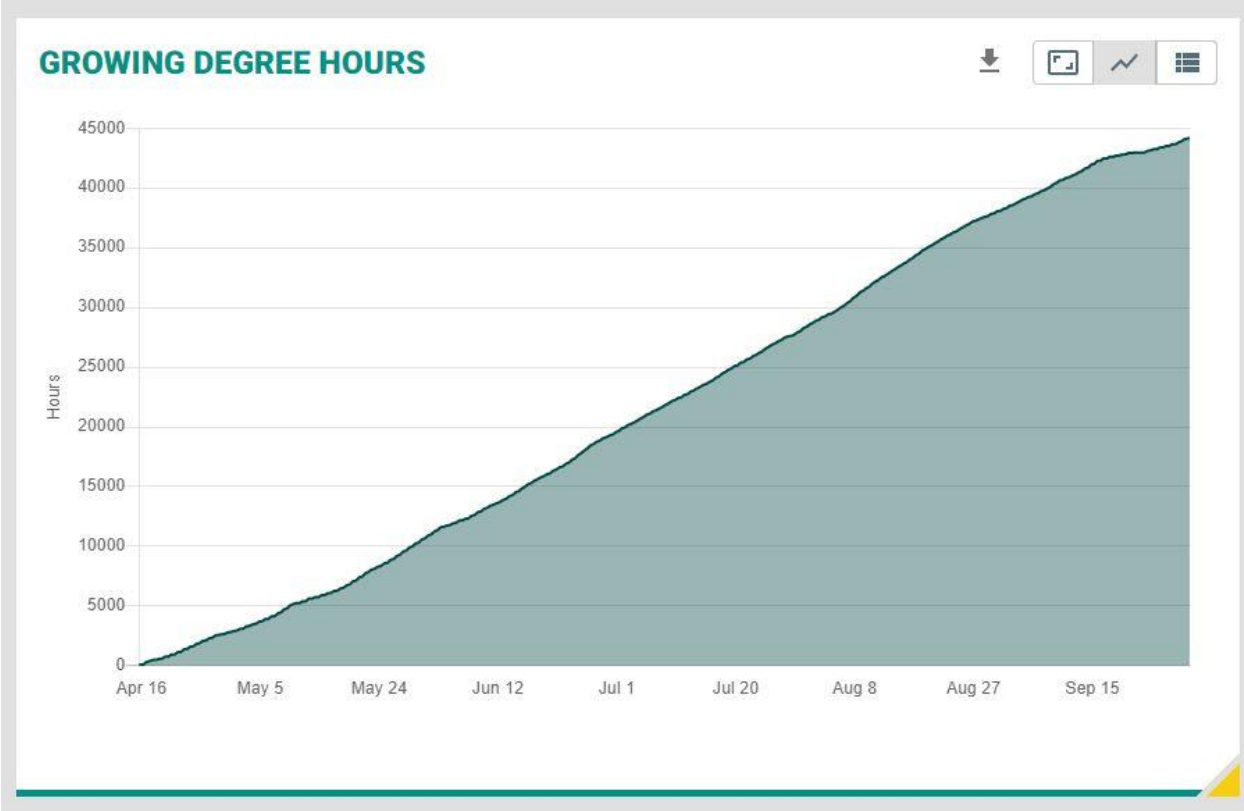
Rootzone Coir too hot – roots damaged by excessive heat

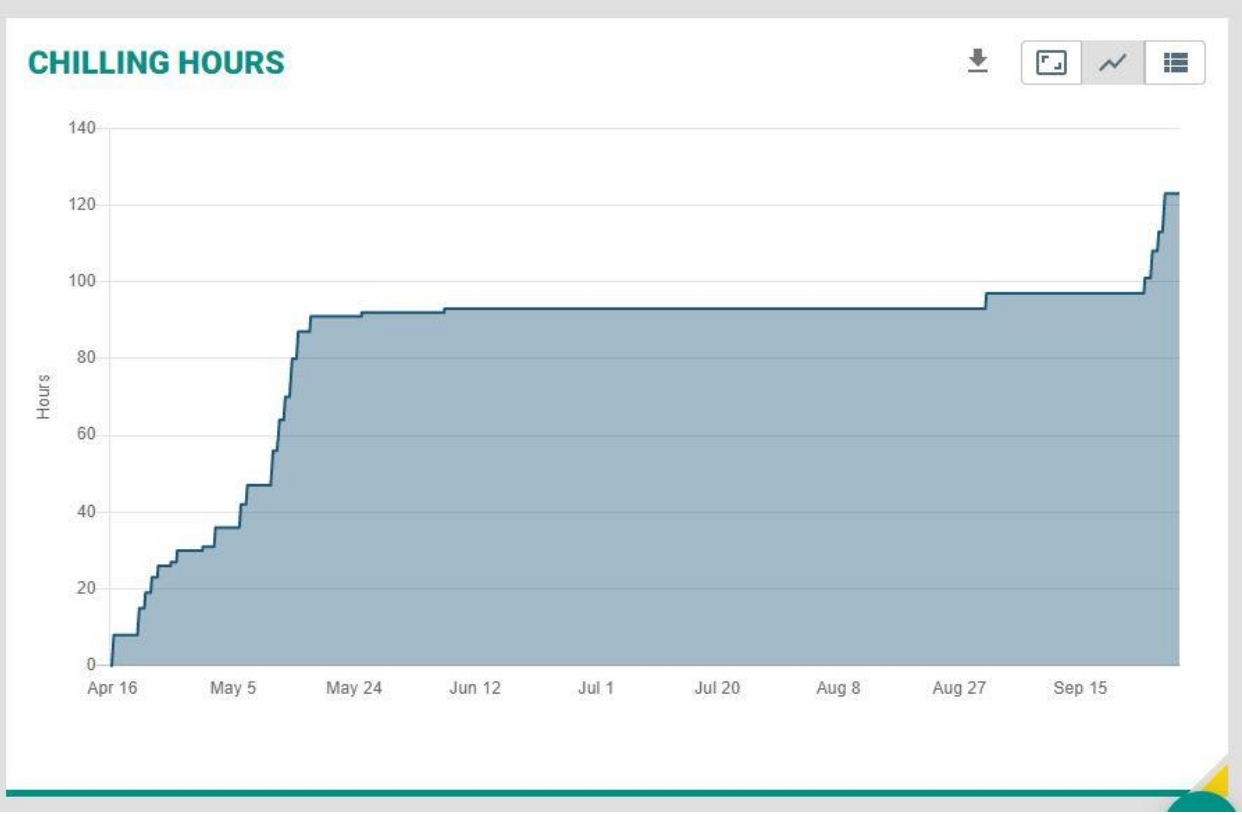




Root health & heat – Black V White pots

Climate Sensor Data





Agri-tech Training

Configuring the Hardware

In Field Installation

Install complete

Irrigation Automation

Why Automate?

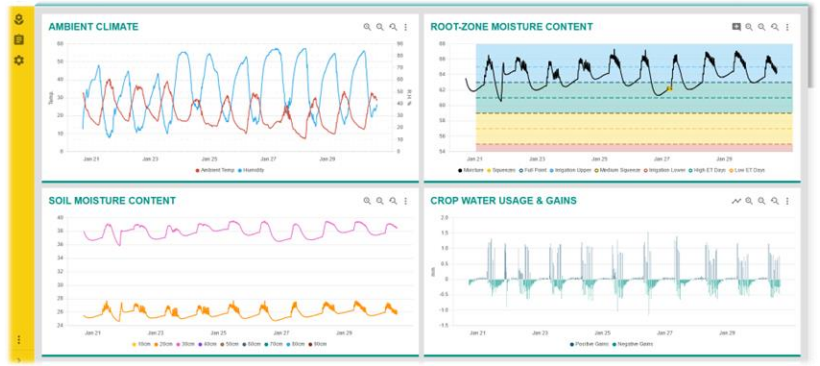
- To perfect our Irrigation practices
- Very changeable climate – Esp Spring & Autumn
- To meet very changeable Crop demands
- An almost unknown Crop Requirement unless modelling VPD 24/7
- New variety knowledge – New learning in yr 1, 2, 3…
- Control Inputs and resources – Why Irrigate 7x when 3 will do?
- Assist Labour requirement – an ongoing challenge
- Reduce costs & maximize growing environment

Irrigation Automation

In Field Sensors

Irrigation Application

Cloud Server



ATS Dashboard - User Interface

Irrigation Automation

Summary

- Realtime, infield data collection
- Multiple sensor input options – Moisture, VPD, Run-off, Light, Climate
- ATS data display and interpretation
- User Interface – User controls
- Universal controller communication*

End

On farm control of strawberry powdery mildew using a decision support system

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Life and Medical Sciences, University of Hertfordshire
a.m.hall@herts.ac.uk

Agri-tech SERVICES

University of Hertfordshire UH

Know your enemy, the disease, the problem

- Strawberry powdery mildew, caused by *Podosphaera aphanis*, can cause between 20% and 70% crop loss a year;
- One UK grower reported a loss of £3/4 million in one year due to the disease;
- Problem has developed with ‘everbearers’ (day neutral) strawberry, now used to give longer harvest season particularly in tunnels;
- Temperature and humidity in tunnels ideal for fruit production and disease development;
- Disease is always present, it arrives on plants from propagators; 5% to 100% plants infected, though colonies so small that you can’t see them
- Epidemics caused by asexual conidiospores.

Challenges for strawberry growers

- Strawberry powdery mildew, most feared epidemic disease that can cause significant financial loss; The disease is always present.
- Many growers use fungicide sprays every 7 or 8 days from April to September/October (20+ sprays) as an insurance;
- Decreasing number of fungicides (active ingredients) available;
- High cost of fungicides;
- Fungicide residues in fruit (number not MRL);
- Lack of labour, cost of labour, very narrow financial margins;
- Supermarket requirements.

Overall aim of the decision support system

- The aim of the decision support system is to support growers to know when to spray fungicides to control strawberry powdery mildew with fewer fungicides
- The aim is to break the life cycle and stop **asexual** spores germinating, hyphae developing and asexual spores forming.

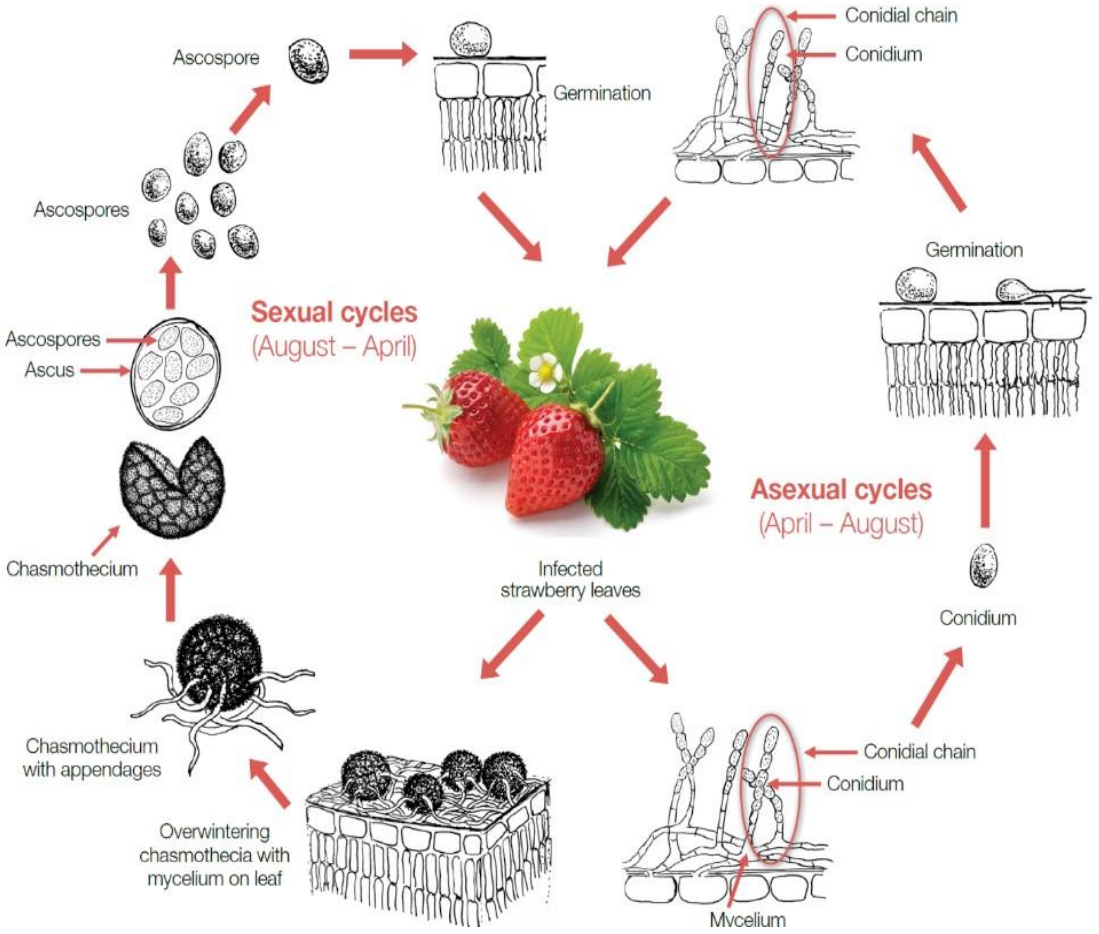


Figure 1. Lifecyle of *Podosphaera aphanis*. Jin (2016)

Parameters for prediction system: Disease Conducive Hours

- 6 hours to germinate at temperatures between 15–30°C , RH>60%.
- 138 hours at temperatures between 18–30°C, RH>60% to grow from germinated spore through elongating secondary hyphae to sporulation and spore release.
- The fungus grows whenever these two parameters occur simultaneously

However, if…:

i. only **one** parameter is satisfied, the fungus grows slowly or not at all.

ii. **both parameters satisfied 24/7**, sprays would be needed every 6 days. This rarely occurs.

iii. **both parameters are only satisfied for 6 hours a day**, then a fungicide spray would only be needed every 24 days.

- In the UK the use of this DSS allows fungicide sprays to be saved in the earlier part of the growing season.

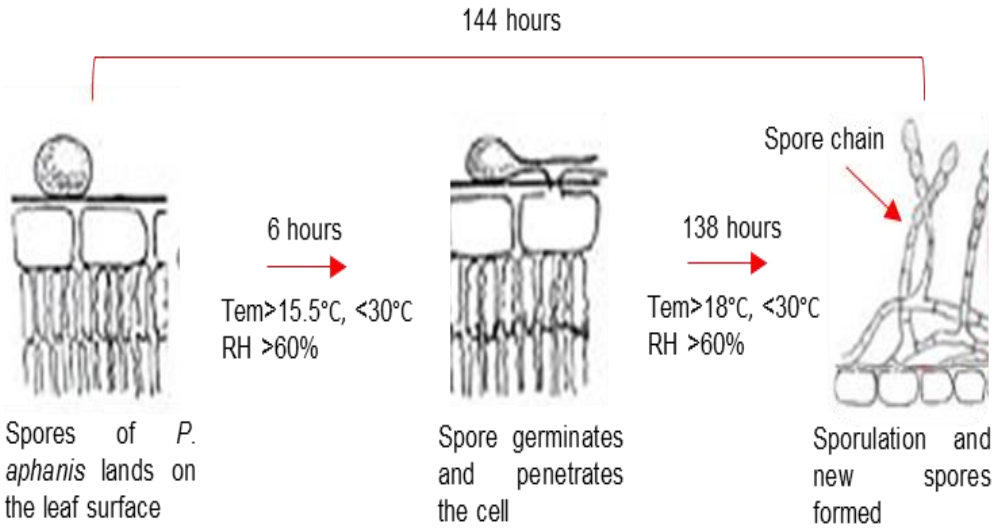
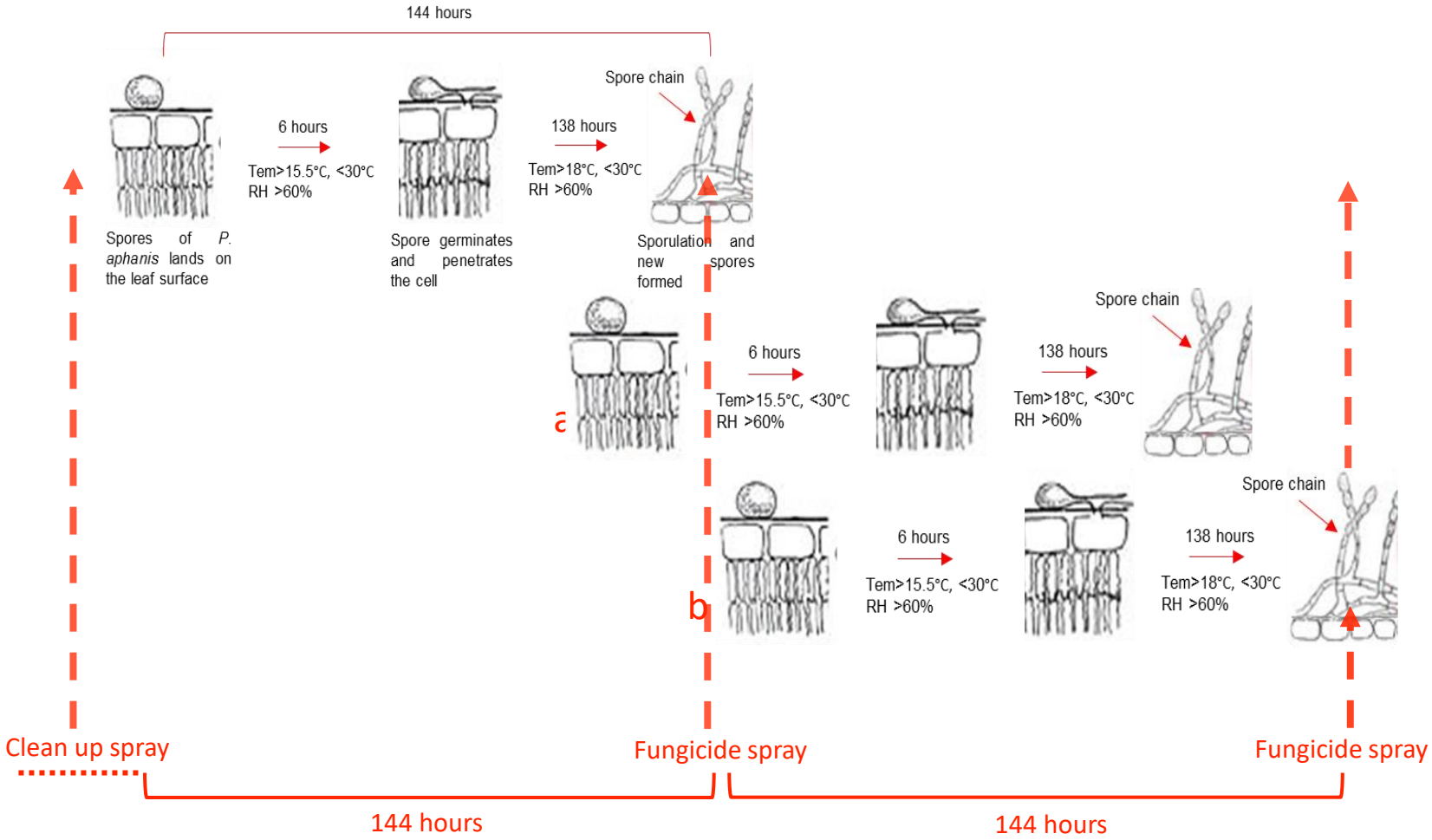


Figure 2. Asexual life cycle of *P. aphanis,* showing the number of disease conducive hours needed for each stage of spore production (Jin, 2016)

Principles behind spray timing (144 hours)



The system aims to keep the **initial inoculum level** as low as possible.

a. **Clean up spray** at beginning of season, to ensure disease levels are as low as possible;

b. The **first spray after 144 hours** of disease conducive hours will kill any germinating or growing hyphae and therefore prevent sporulation;

c. Spores may fall on the leaf after the fungicide spray, but any spores which germinate and grow will be killed at the next spray after 144 hours of disease conducive hours.

Agri-tech SERVICES

University of Hertfordshire UH

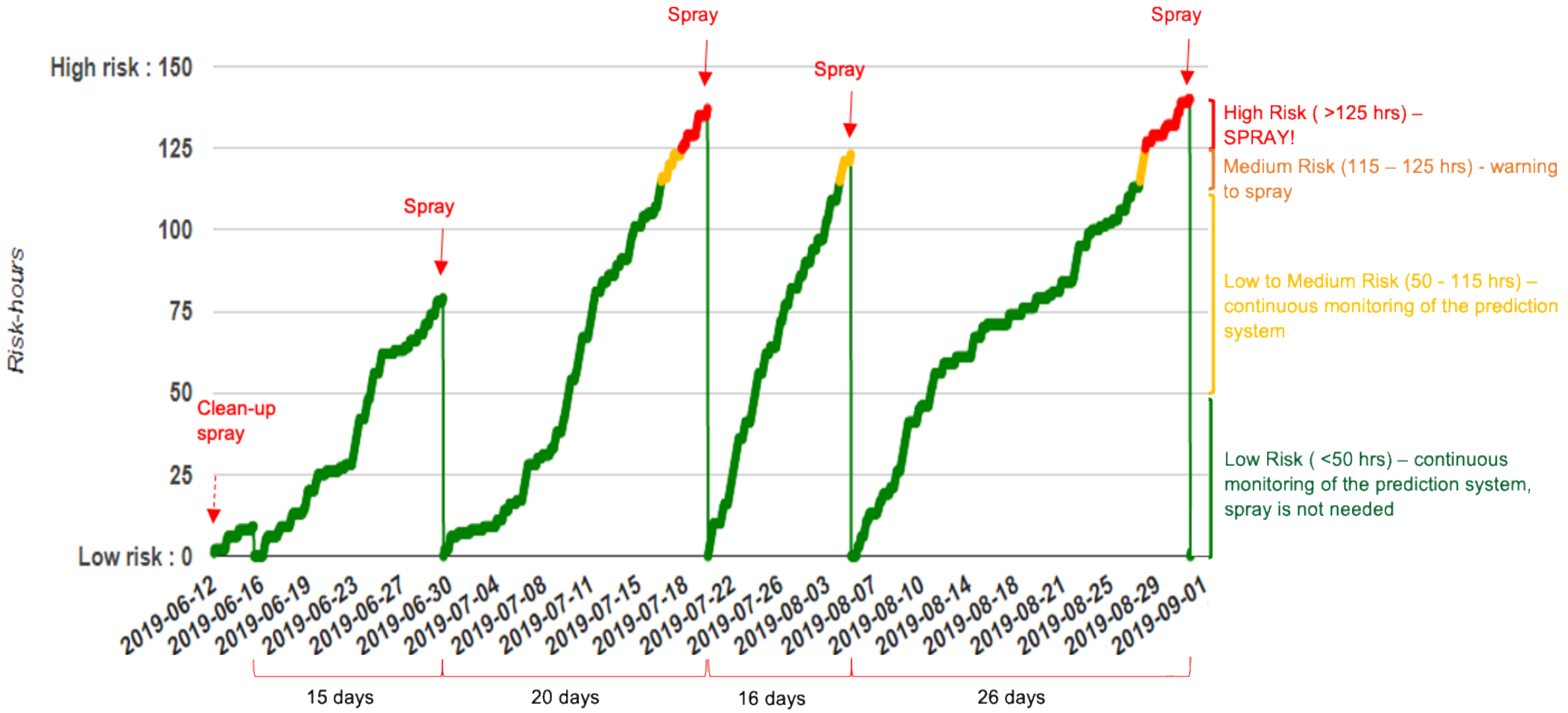
The prediction system

Sensor (all makes can be utilised)

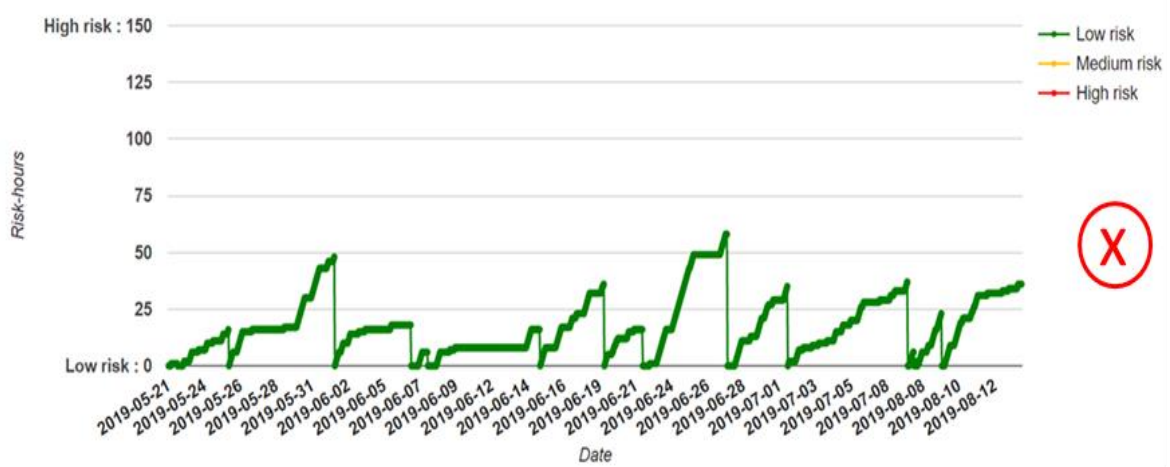
How does it work?

- Sensor in tunnel records temperature and humidity;
- The algorithm on the Agri-tech Services website accumulates **the hours when both parameters are satisfied i.e. disease conducive hours.** This is fed back in real time to the smart device of the grower;
- Grower sprays and enters fungicide into the system;
- Disease conducive hours start to accumulate again;
- Sensors sited where disease is known to develop early.

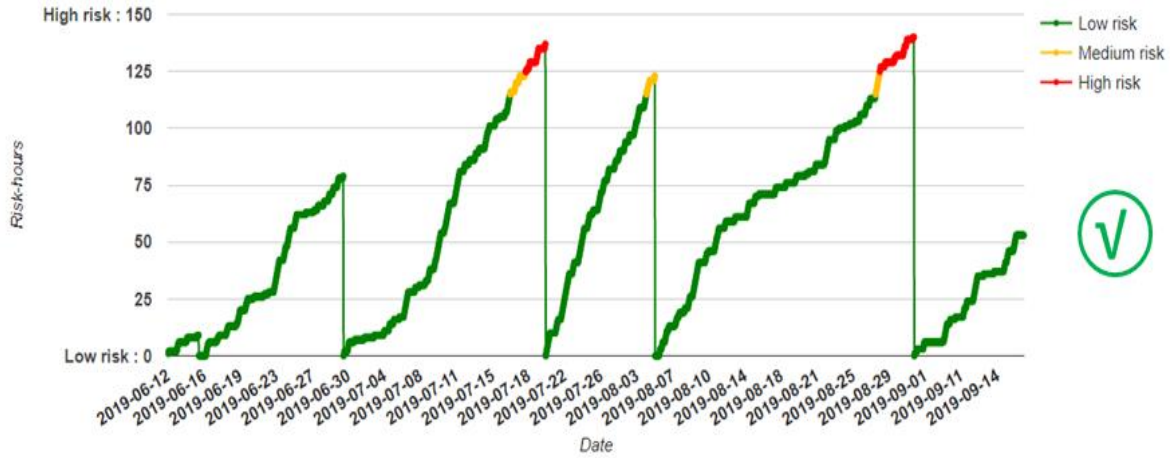
Screen shot at the end of the season



Season's print out from two participating farms in the 2019/2020 validation



(a) Weekly spraying, not following the prediction system



(b) Spraying according to the prediction system

Graph (a):

- a farm where they continued to spray every 8 days;
- spraying when there were only 50 disease conducive hours.

Graph (b):

- a grower who trusted the system, sprayed at 100 hours or more;
- used fewer sprays and recorded no disease.

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Number of participating farms in 2020, 2021 and 2022

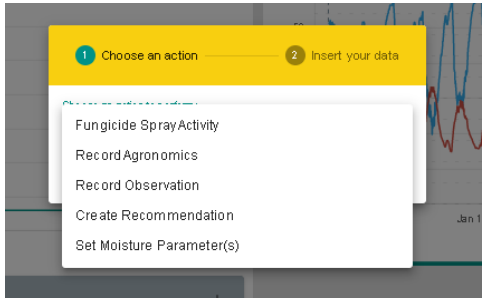
Year	Farm code	County	Number of sites
2020	LRF	Staffordshire	7
	ECD	Herefordshire	6
	JAP	Herefordshire	2
	GBBH	Herefordshire	4
	WFF	Herefordshire	4
2021	AJCIS	Herefordshire	3
	BP	Derbyshire	5
	ECD	Herefordshire	6
	ES	Angus	2
	GBBH	Herefordshire	5
	GBL	Perthshire	2
	JAP	Herefordshire	2
	LRF	Staffordshire	7
	RH	Angus	2
	SF	Nottinghamshire	2
	W	Angus	2
	WS	Suffolk	2
	WFF	Herefordshire	5
2022	WPB	Perthshire	2
	ES	Angus	2
	WFF	Herefordshire	5
	AJCIS	Herefordshire	2
	ECD	Herefordshire	6
	PW	Suffolk	2
	SF	Nottinghamshire	4
	BP	Derbyshire	5

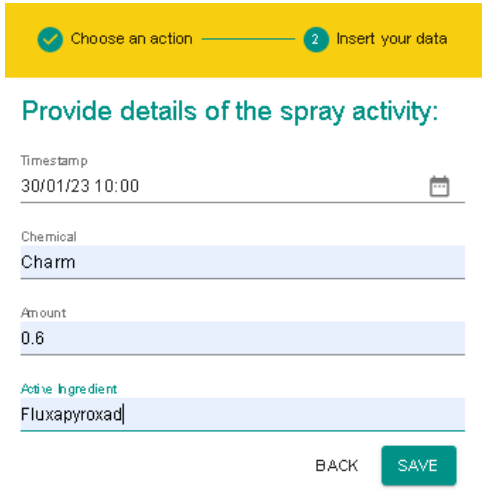
- 4 farms have used the system 3 years running
- A further 4 have used it two years running, sprayer etc.
- Each grower has customised it to their own known conditions (variety, sprayer etc.)
- No disease epidemics reported in monitored tunnels.

Reduction in Fungicide use with use of the decision support system, 2018-2020

Year	Use of DSS on the farm	Number of fungicide sprays applied to control SPM
2018	No use	22
2019	Used on one block of tunnels in the validation	17
2020	Used on all everbearer crops throughout the farm	11
Summary	Reduction in number of fungicide sprays from **22** to **11** in a season.	

Enter your sprays and re-set the model





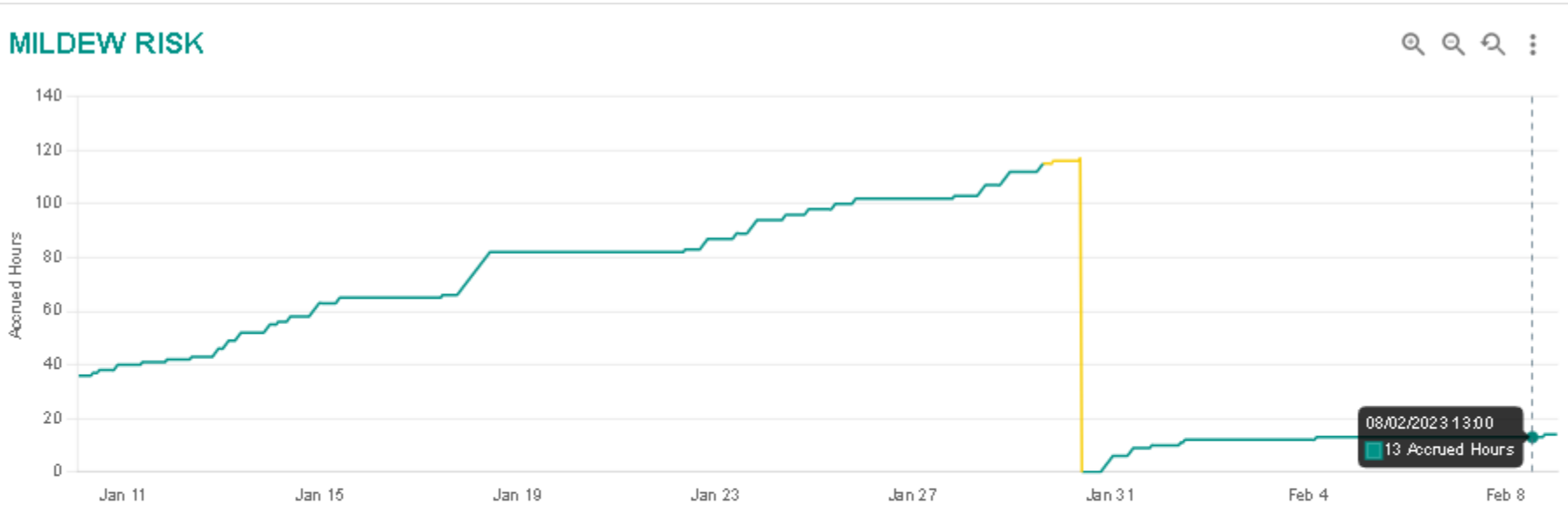


Table Title

Timestamp	Chemical Used	Fungicide	Active Ingredient	Actions
30/01/23 10:00	Charm	0.6	Fluxapyroxad	

Unique features of the DSS

- **Clean up spray** advised before disease is observed
- Real time feedback to growers
- Aim to use fungicides to **PREVENT** epidemics developing, rather than to control epidemic
- Risk measured in **Disease Conducive Hours**
- Grower in control but supported in decision making
- Disease control using **fewer** fungicide sprays (therefore save time, money and reduce environmental impacts)

Acknowledgements

- Funding from HDC, now AHDB Horticulture for SF62 and 62a and SF157;
- Former and present research students and colleagues: Dr Jolyon Dodgson, Dr Bo Liu, Dr Xiaolei Jin, Hannah Wileman;
- Agri-Tech Services for seeing the great potential of a real-time web-based prediction system and partnership in Ceres grant;
- Ceres Grant for validation of the prediction system 2019/2020;
- Growers who took part in the 2019 validation of the prediction system;
- This work could not have taken place without the generosity of our grower partners, H and H Duncalfe of Wisbech who have initiated us into the intricacies of commercial strawberry growing and given field trial space since 2004, supporting 5 PhDs over 15 years.

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Leaf Tissue Analysis



All crops can benefit

Why?

Plant nutritional requirements change throughout the growing season as we know

Nutritional deficiencies and surpluses can occur for many reasons and at any time;

- Crop Stage
- Changes in crop load
- Changes in weather
- Pest and disease pressure
- Varietal variation
- Feed Mix / delivery

How do we currently identify the crops' needs?

- By eye/guess?
- By Recommendation?
- By routine Analysis?
- ATS will collect - in field samples
- Deliver to Lab – for fast Analysis
- ATS Report – Broad Spectrum Results

Nutritional Lab Report

Analysis Results (LEAF)

Customer	EXAMPLE BROAD SPEC LEAF TOP FARM THE VILLAGE UK	**Distributor**	AGRI-TECH SERVICES
Sample Ref	STRAWB	**Date Received**	01/09/2022 (Date Issued: 01/09/2022)
Sample No	EXAMPLE ATS	**Area**	2
Crop	STRAWBERRY		

Nutrient	Result	Low	Normal	High
Nitrogen (%)	4.62			
Phosphorus (%)	0.38			
Potassium (%)	2.54			
Calcium (%)	1.25			
Magnesium (%)	0.18			
Sulphur (%)	0.25			
Boron (ppm)	45.0			
Copper (ppm)	2.4			
Iron (ppm)	112			
Manganese (ppm)	83.0			
Molybdenum (ppm)	2.60			
Zinc (ppm)	17.0			

Leaf Tissue Analysis

A Service from ATS to complement your Irrigation monitoring

Feedback and suggestions welcome