Agri-tech Services (UK) Ltd

Precision Irrigation
“hitting the target”

www.agri-tech.co.uk

Soil less Growing

www.agri-tech.co.uk

Agri-tech
SERVICES

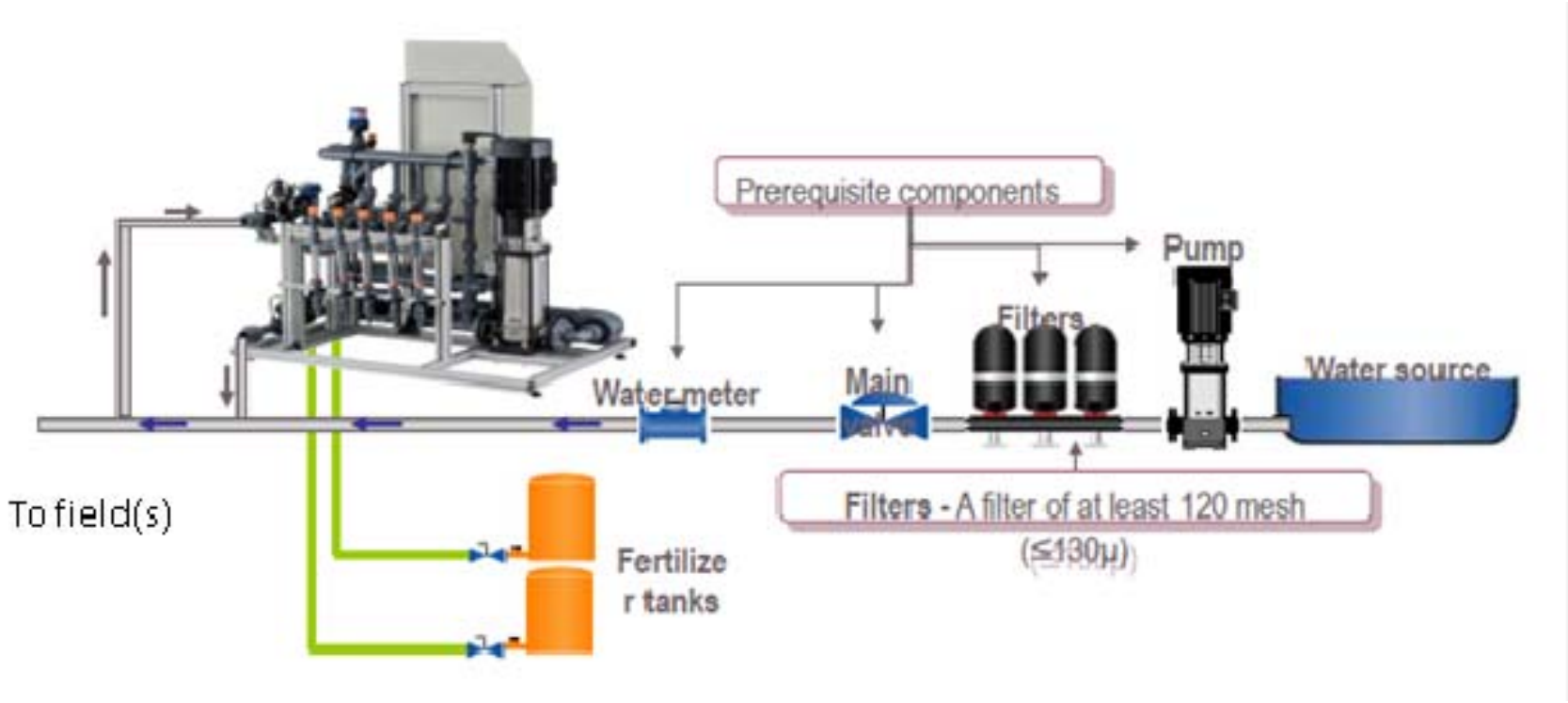
Objective

- Think about your irrigation system
- Identify the areas of weakness
- Where if anywhere does further investment need making
- Come up with two clear plans of action to take back to your farm

www.agri-tech.co.uk

Agri-tech SERVICES

Typical system layout



www.agri-tech.co.uk

Agri-tech SERVICES

Water source

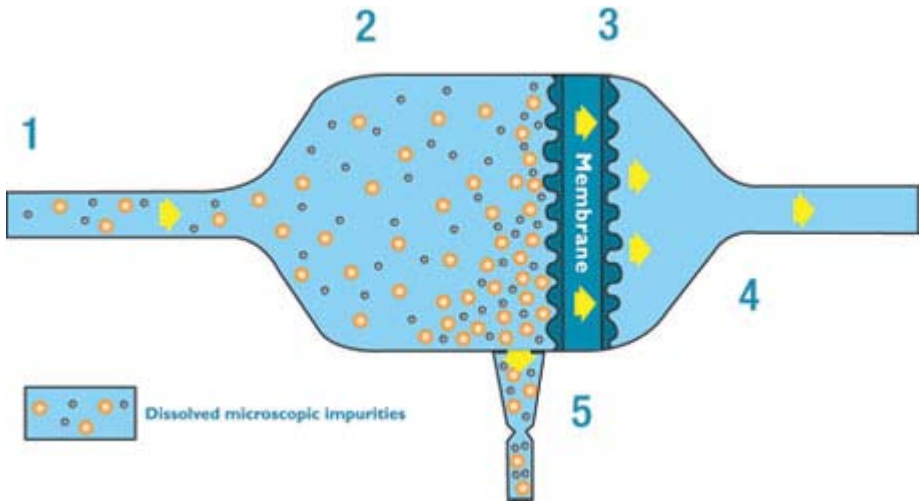
Parameter	Maximum level mg/l	ppm
Electrical Conductivity	850 ms/cm	
Sodium	35 mg/l	35
Chloride	52 mg/l	52
Iron	1.0 g/l	1
Zinc	0.35 mg/l	0.35
Boron	0.33 mg/l	0.33
Sulphate	144 mg/l	144
Source; defra - ADAS		

Ensure water is extracted as close to the surface as possible over the deepest area of the Res / Dam

www.agri-tech.co.uk

Agri-tech SERVICES

RO – Reverse Osmosis



1.Water containing impurities enters the system
2.Impurities are stopped and rejected at the membrane surface
3.Water pressure forces water molecules through the membrane
4.The purified water is then sent directly to the holding tank
5.Impurities are expelled from the system

www.agri-tech.co.uk

Agri-tech SERVICES

Pumps

Backup pump essential in the event of breakdown

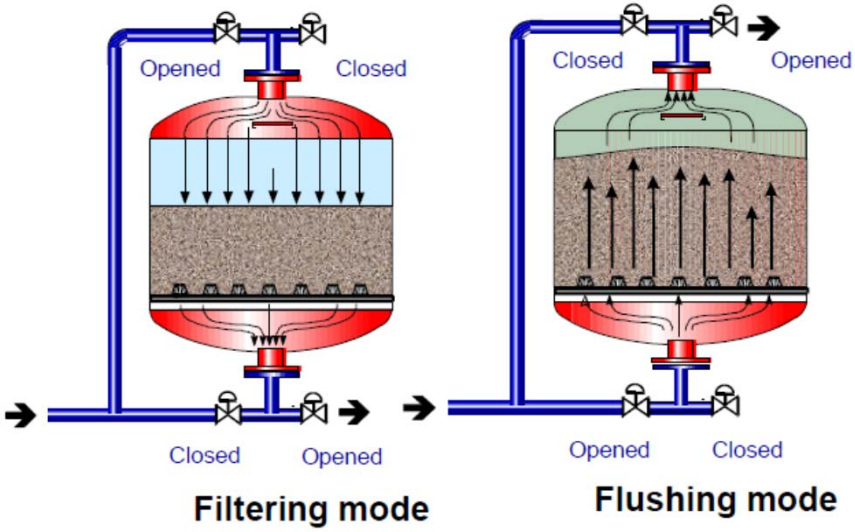
Similarly balanced pumps - pumps “like to be working”

Ability to fluctuate pumps useful

www.agri-tech.co.uk

Primary Filtration

Life span of the drippers completely determined by what is pushed through them



www.agri-tech.co.uk

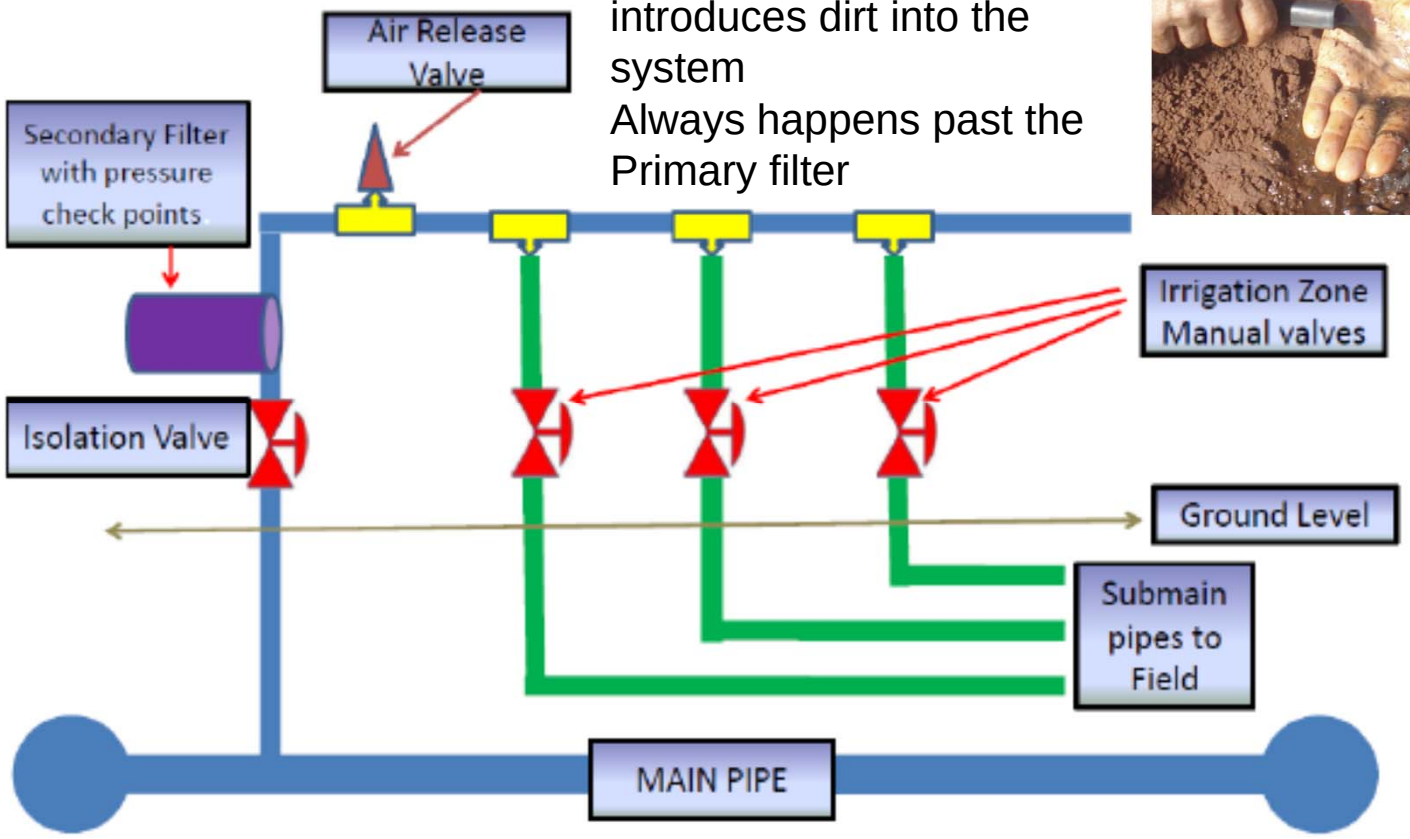
Agri-tech SERVICES

Primary Filtration

www.agri-tech.co.uk

Secondary filtration

Broken pipes always introduces dirt into the system
Always happens past the Primary filter



www.agri-tech.co.uk

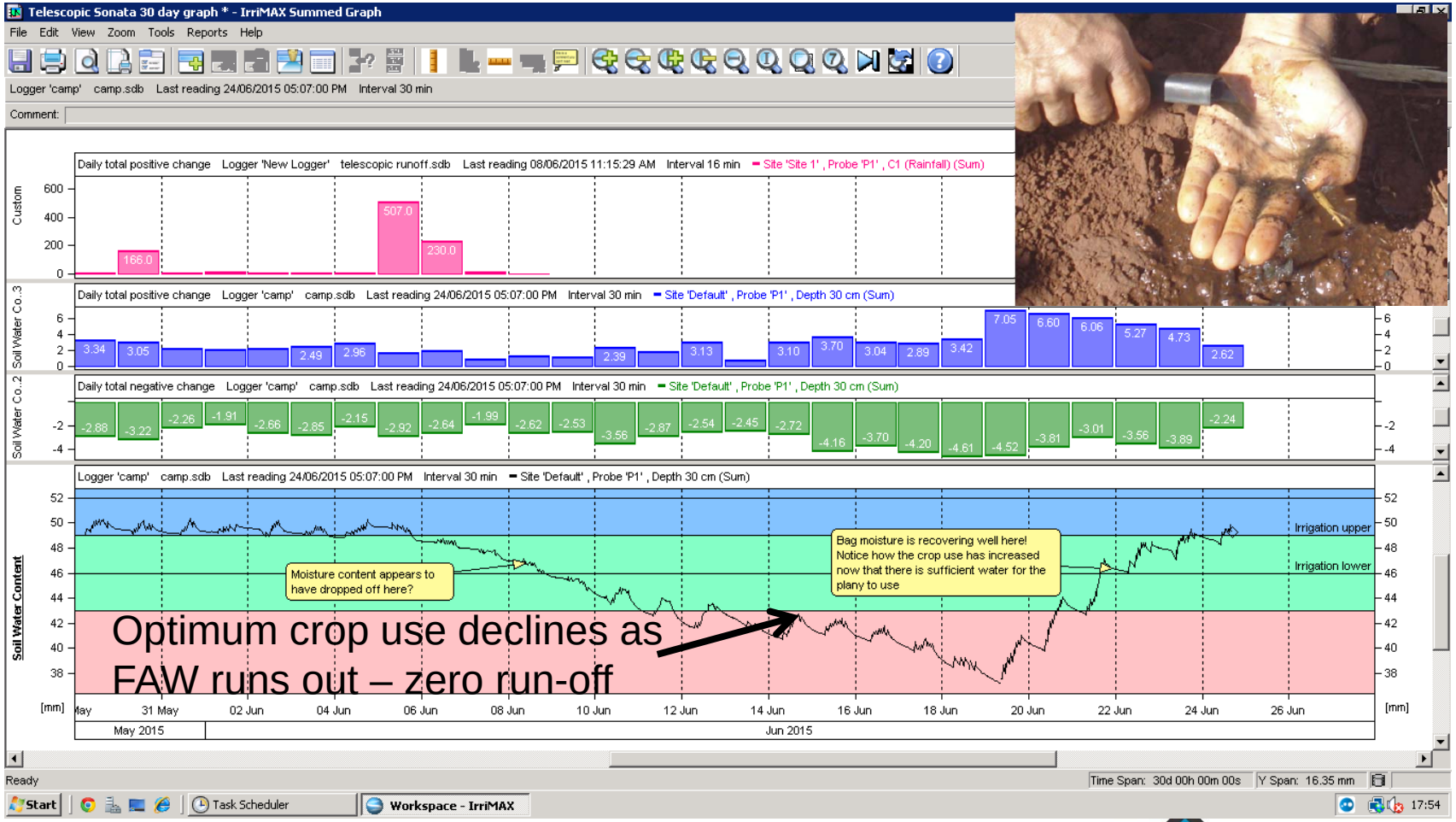
Agri-tech SERVICES

Secondary filtration

Filter

www.agri-tech.co.uk

Partially blocked drippers – the cost??



www.agri-tech.co.uk

Agri-tech SERVICES

Irrigation Uniformity

Need to determine appropriate “Shot Length” for good distribution of water and feed within the pot / bag / trough

Changing weather will determine number of shots per day NOT length of shots

www.agri-tech.co.uk

Agri-tech SERVICES

Pressure test points

www.agri-tech.co.uk

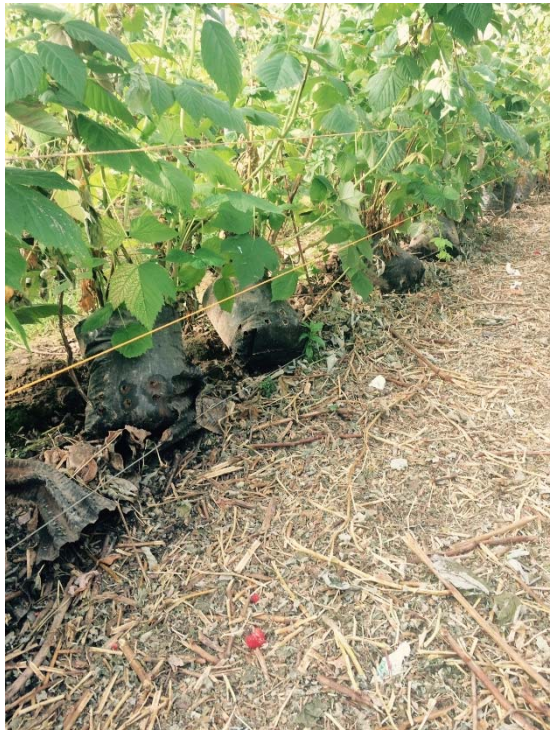
Agri-tech SERVICES

Catch can tests

www.agri-tech.co.uk

Agri-tech SERVICES

Moisture Uniformity



Rigid pots less likely to tilt / tip – better moisture distribution

www.agri-tech.co.uk

Agri-tech SERVICES

Moisture Uniformity

Bags sitting level on gutter

Bags un-level
Bag wetter in middle

www.agri-tech.co.uk

Laser levelled

www.agri-tech.co.uk

Agri-tech SERVICES

Laser levelled???

Note :Every 10 meter drop in height equals a gain in pressure of 1 bar (1 bar = 14.5 psi)

www.agri-tech.co.uk

Agri-tech SERVICES

RTK GPS Precision

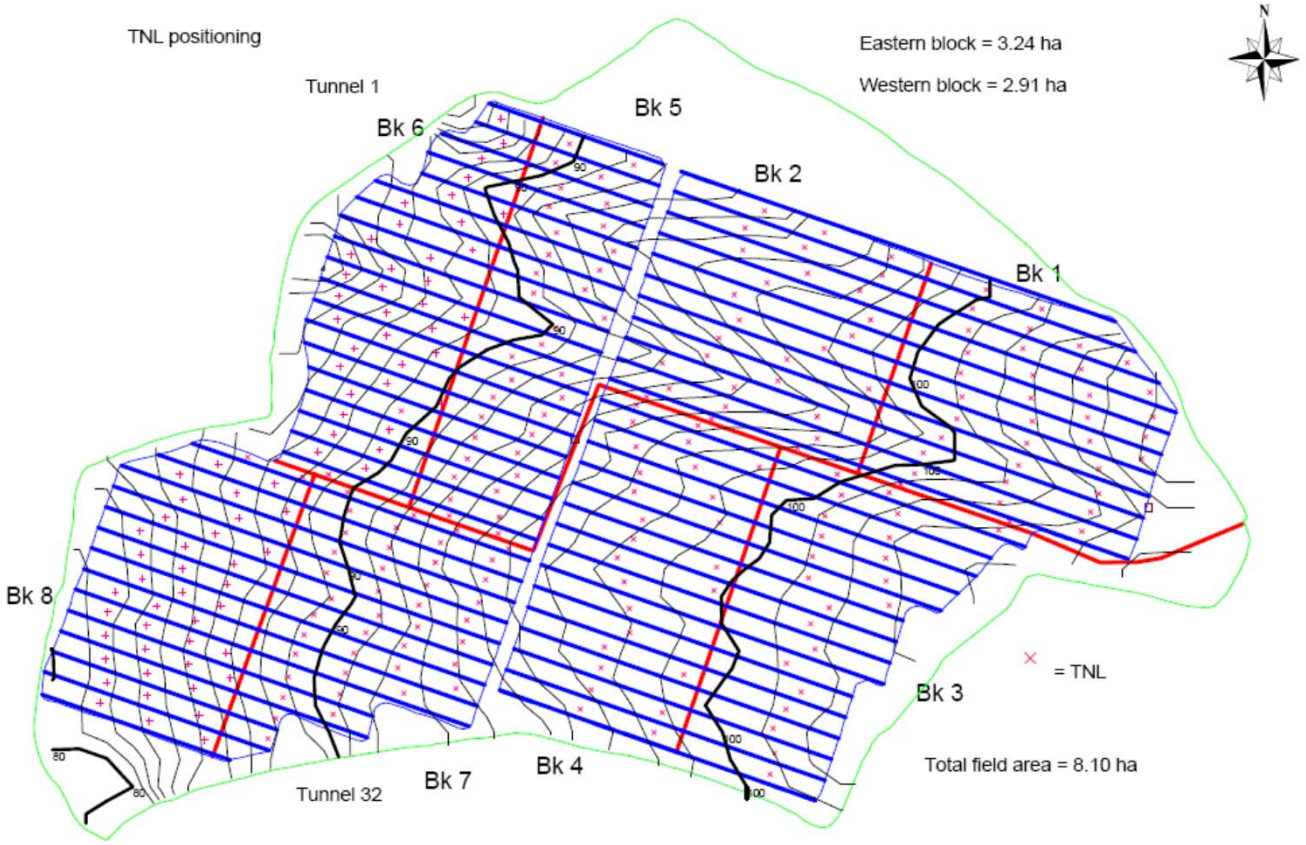
Setting up RTK Base Station

In-field mapping

www.agri-tech.co.uk

Agri-tech SERVICES

Field Mapping – Irrigation block design



Displayed:

Sub-main

Tunnel layout

Irrigation blocks

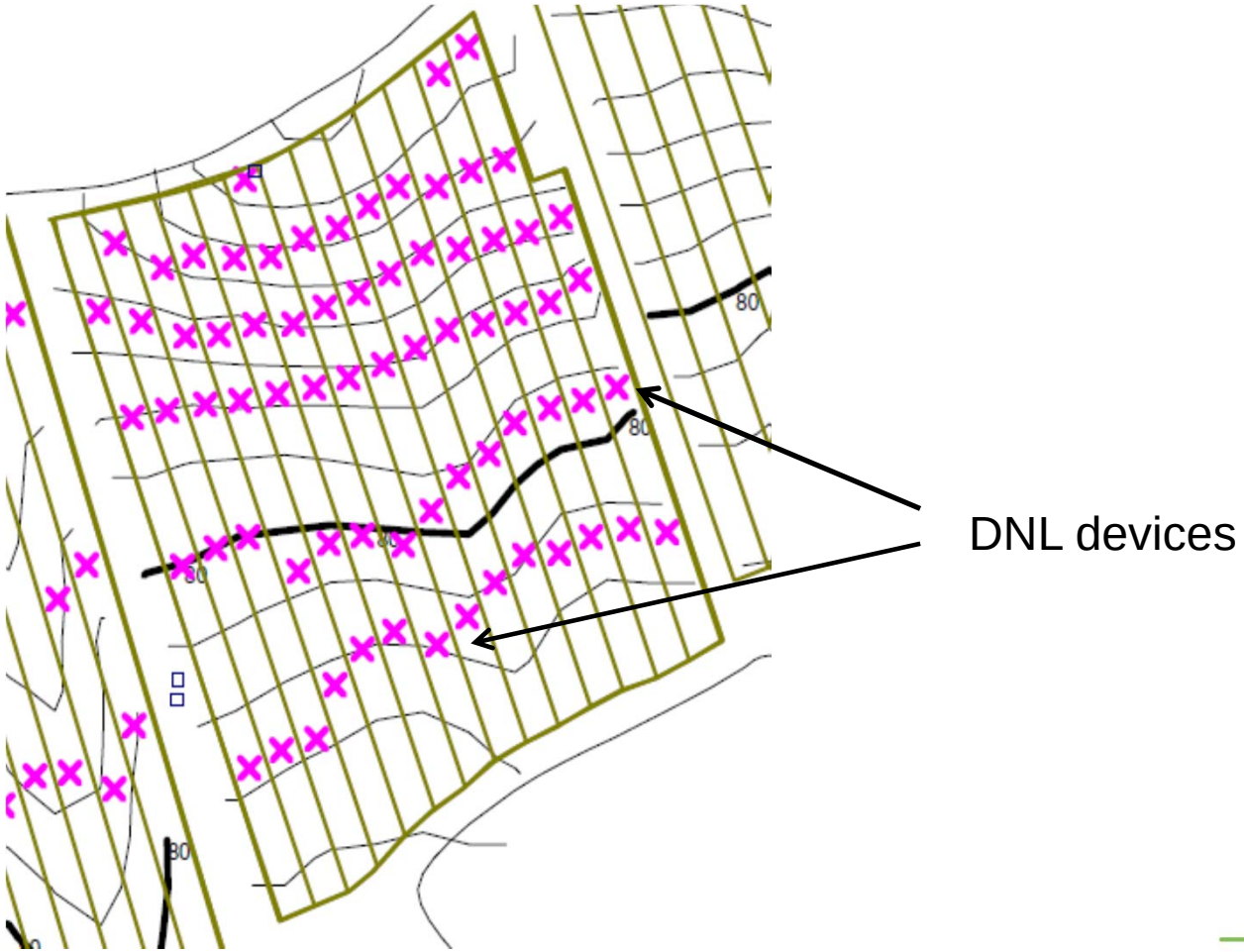
Topography map

TNL plan

www.agri-tech.co.uk

Agri-tech SERVICES

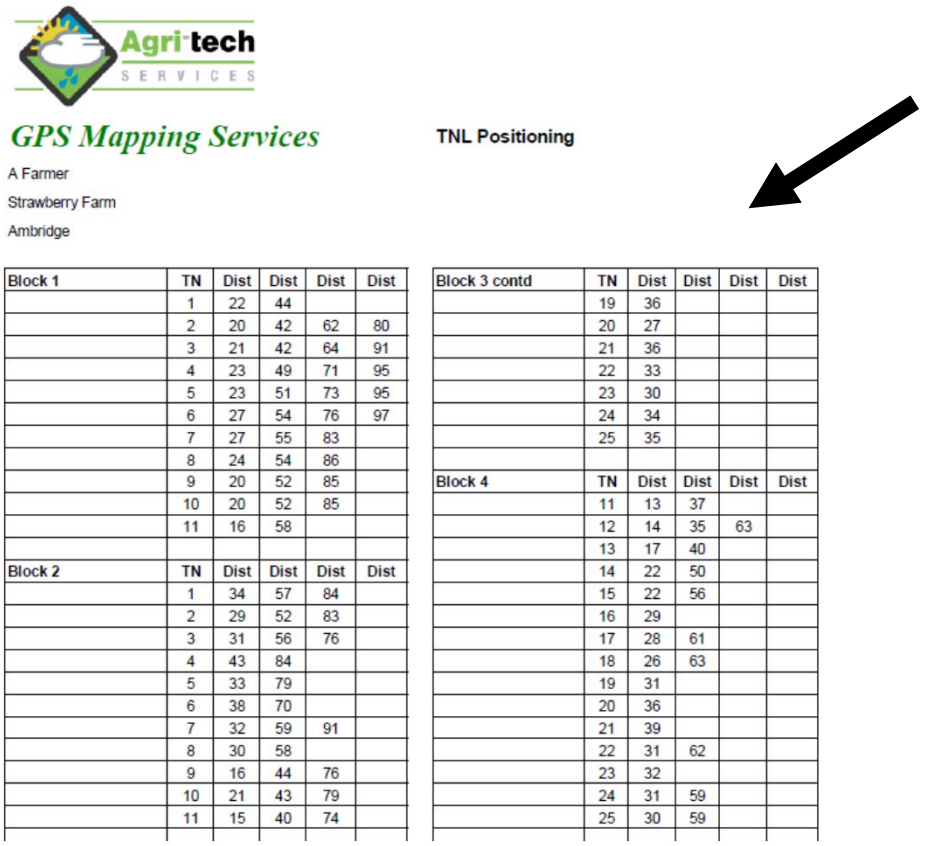
DNL Placement



www.agri-tech.co.uk

Agri-tech SERVICES

DNL Positioning



GPS Mapping Services

TNL Positioning

A Farmer

Strawberry Farm

Ambridge

Block 1	TN	Dist	Dist	Dist	Dist
	1	22	44		
	2	20	42	62	80
	3	21	42	64	91
	4	23	49	71	95
	5	23	51	73	95
	6	27	54	76	97
	7	27	55	83	
	8	24	54	86	
	9	20	52	85	
	10	20	52	85	
	11	16	58		
Block 2	**TN**	**Dist**	**Dist**	**Dist**	**Dist**
	1	34	57	84	
	2	29	52	83	
	3	31	56	76	
	4	43	84		
	5	33	79		
	6	38	70		
	7	32	59	91	
	8	30	58		
	9	16	44	76	
	10	21	43	79	
	11	15	40	74	

Block 3 contd	TN	Dist	Dist	Dist	Dist
	19	36			
	20	27			
	21	36			
	22	33			
	23	30			
	24	34			
	25	35			
Block 4	**TN**	**Dist**	**Dist**	**Dist**	**Dist**
	11	13	37		
	12	14	35	63	
	13	17	40		
	14	22	50		
	15	22	56		
	16	29			
	17	28	61		
	18	26	63		
	19	31			
	20	36			
	21	39			
	22	31	62		
	23	32			
	24	31	59		
	25	30	59		

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

www.agri-tech.co.uk

WET readings and run-off

www.agri-tech.co.uk

Wet readings EC and drain

What is the moisture range within the pots / bags
Is the control (probe) in a representative area
What does the EC value mean – e.g what is making up the EC?? Is it made up of the “Good guys” or the “bad guys”??

How many drain readings per day
24 hr average maybe useful but does not indicate trends through the day
Max run to coincide with max temp / plant water demand
Run down to zero before nightfall

www.agri-tech.co.uk

Agri-tech SERVICES

Weekly record sheet – Moisture EC and drain

WET probe / Run-off records

Field Name 7 DAY READING — SENTEC - PROBE

DATE	WEATHER	INPUT EC FIELD	TIME OF READING	Probe Area %	Probe Area EC	AVERAGE Field %	AVERAGE Field EC	Run-off %	TARGET MOISTURE	TARGET EC FIELD	COMMENTS
16/02/2015	Cool / overcast	1.5	07:30 - 07:35	66.2	2.8	64.3	2.4	15%	60-75	2.0 - 3.0	
17/02/2015		1.5							60-75	2.0 - 3.0	
18/02/2015		1.5							60-75	2.0 - 3.0	
19/02/2015		1.5							60-75	2.0 - 3.0	
20/02/2015		1.5							60-75	2.0 - 3.0	
21/02/2015		1.5							60-75	2.0 - 3.0	
22/02/2015		1.5							60-75	2.0 - 3.0	

www.agri-tech.co.uk

Substrate analysis

- Target guidelines for the macro nutrients
- Target guidelines for the micro nutrients
- Max acceptable levels of Na, Cl etc

- Plot the analysis against the target - similar to moisture.
- We need to identify the trends
- We need to learn what the plant uses and when

www.agri-tech.co.uk

Agri-tech SERVICES

Run-off and Moisture targets

	Coir Substrate		
	Sun Rise	**Day**	**Sun Set**
Moisture Content	50-55%	60-70%	50-60%
New bags / pots	40 – 45%	50 - 60%	45 – 50%
	Run-off low ET	**Run-off high ET**	**Run-off flush event**
	0 - 10%	10 – 20%	> 20%

Weather will have the largest influence on Irrigation requirements
NB This will determine number of hits NOT length of hits

www.agri-tech.co.uk

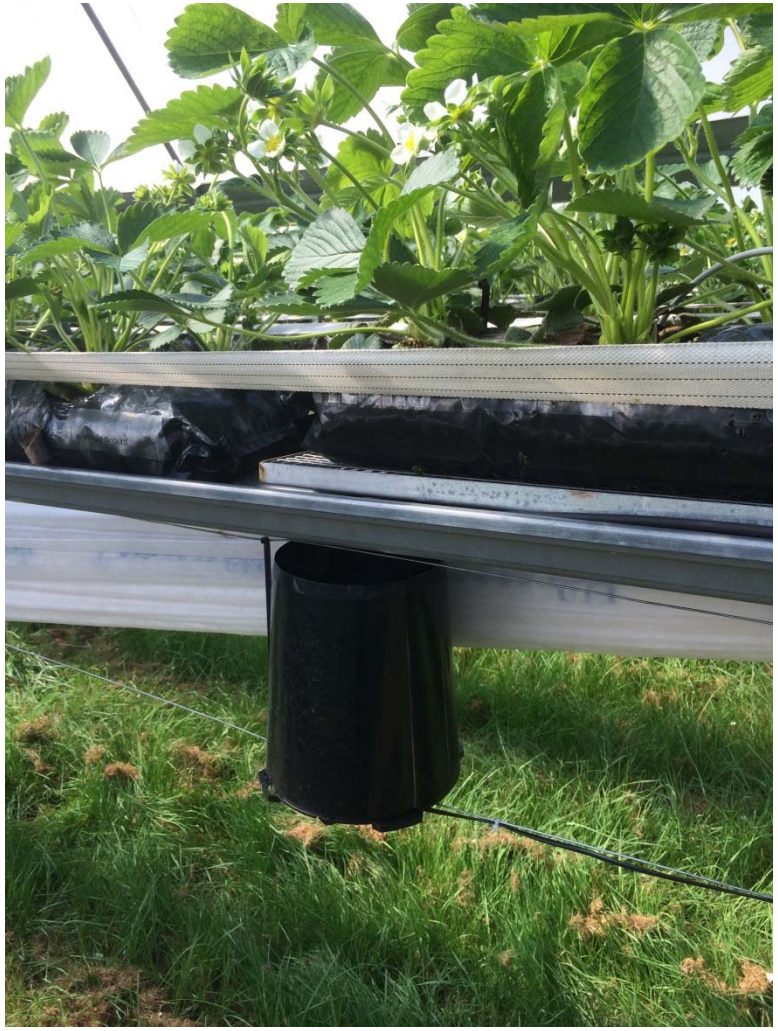
Agri-tech SERVICES

Control – Moisture and Run-off station

www.agri-tech.co.uk

Agri-tech SERVICES

Run-off sensor



24hr Run-off readings useful but little indication as to when the run-off has occurred

Automatic run-off sensor indicates when run-off events take place

Aim for run-off from 10:00 through to 13:00

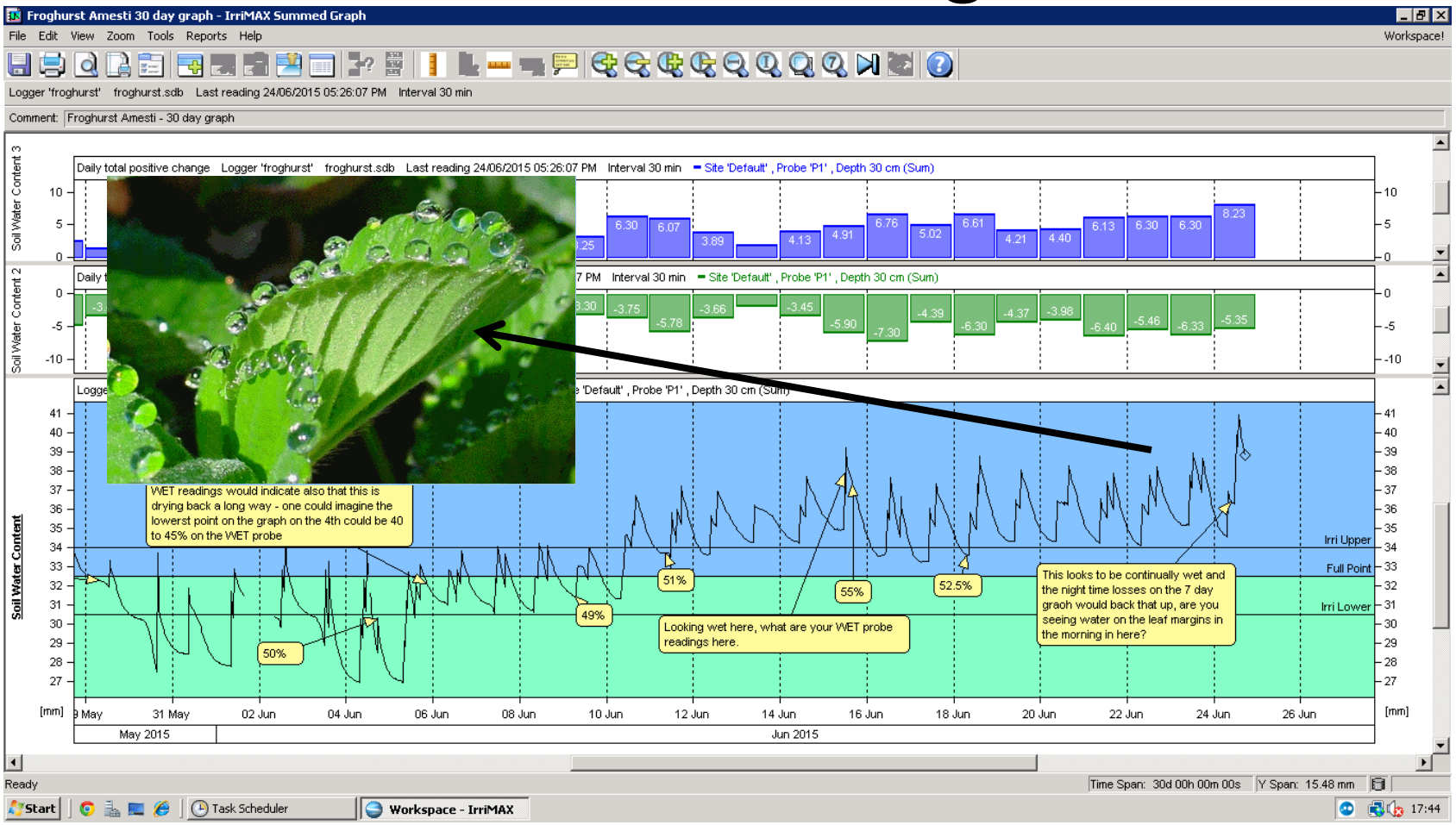
Need coir to dry back in the afternoon to hit the “green zone” on the moisture graphs by night

Avoid wet bags / pots during the overnight period

www.agri-tech.co.uk

Agri-tech SERVICES

Not too wet at night?



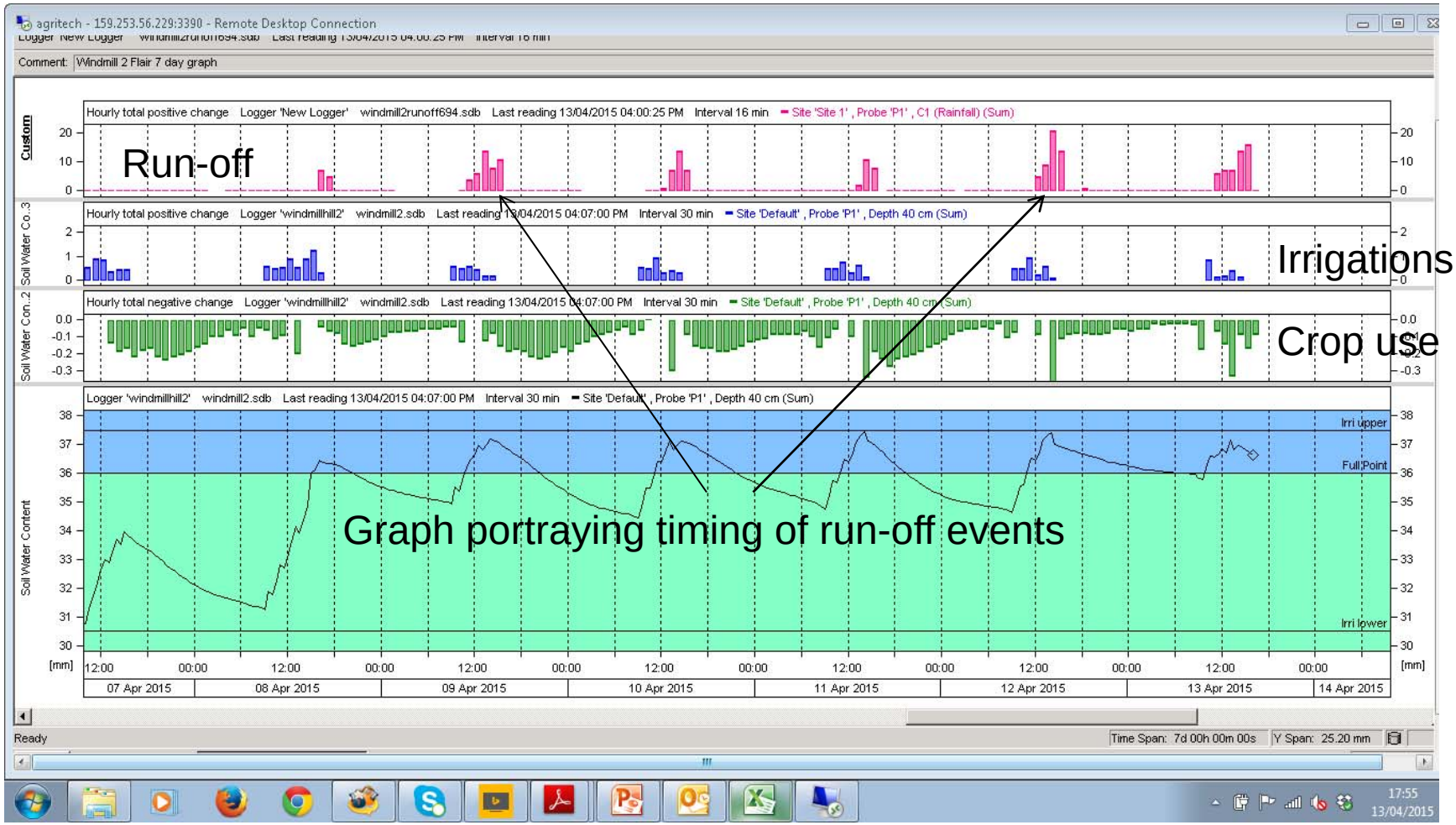
www.agri-tech.co.uk

Agri-tech SERVICES

Quality issues

www.agri-tech.co.uk

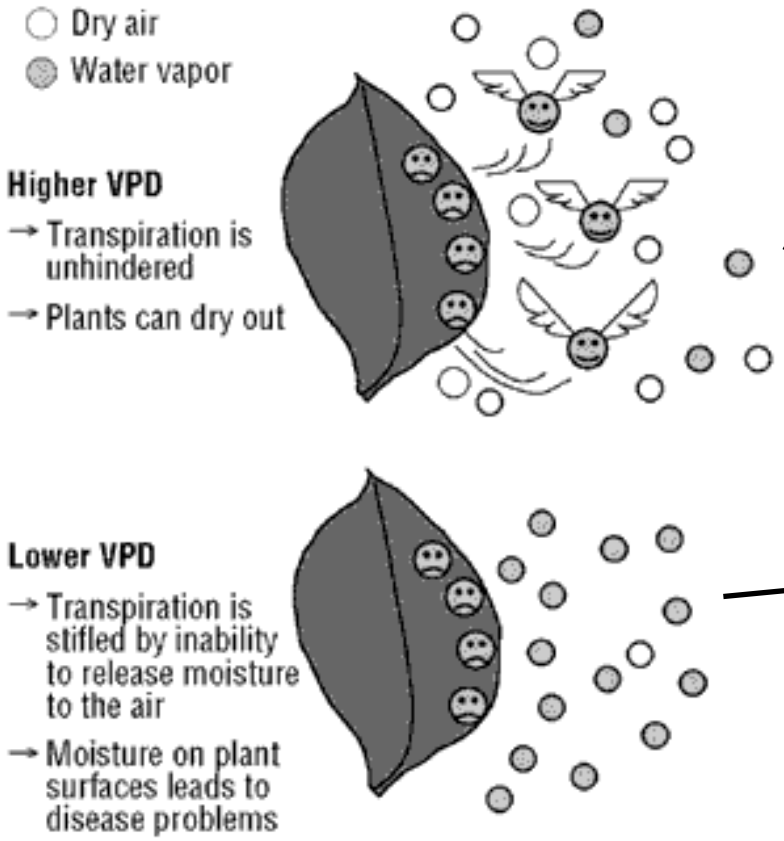
Graph Illustrating time of run-off events



www.agri-tech.co.uk

Agri-tech SERVICES

Tunnel Climate and plant water demand



Tunnel climate has a significant influence on plant water demand but also the “well being” of the plants
- Rad Sum cannot calculate this

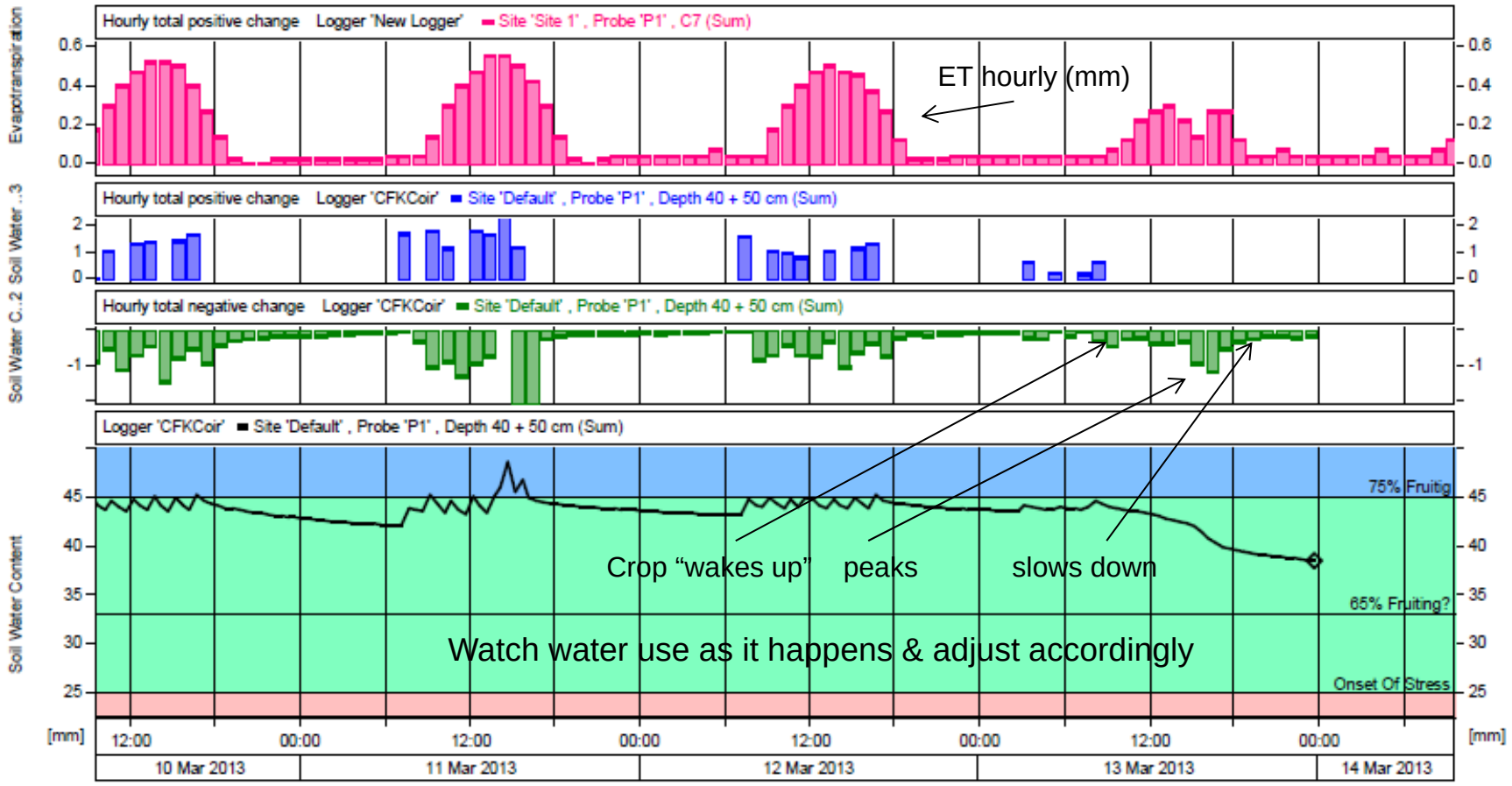
Table 1 shows the VPD in millibars at various air temperatures and relative humidity. Most cultivated plants grow well at VPDs between 8 and 10, so this is the green shaded area. Please note that the ideal VPD range varies for different types of plants and the stage of growth. The blue shaded are on the right indicates humidification is needed where the red shaded area on the left indicates dehumidification is needed.

TEMP		RELATIVE HUMIDITY													
C	F	100%	95%	90%	85%	80%	75%	70%	65%	60%	55%	50%	45%	40%	35%
15	59	0.0	0.8	1.7	2.5	3.4	4.2	5.1	5.9	6.8	7.6	8.5	9.4	10.2	11.1
16	61	0.0	0.9	1.8	2.8	3.7	4.6	5.5	6.4	7.3	8.2	9.1	10.0	10.9	11.8
17	63	0.0	1.0	2.0	2.9	3.9	4.9	5.8	6.8	7.8	8.8	9.7	10.6	11.6	12.6
18	64	0.0	1.0	2.0	3.1	4.1	5.1	6.2	7.2	8.2	9.3	10.3	11.3	12.4	13.4
19	66	0.0	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0	12.1	13.2	14.3
20	68	0.0	1.2	2.4	3.5	4.7	5.9	7.0	8.2	9.4	10.6	11.7	12.8	14.0	15.2
21	70	0.0	1.2	2.4	3.7	4.9	6.2	7.4	8.6	9.9	11.1	12.4	13.7	14.9	16.1
22	72	0.0	1.3	2.6	3.9	5.3	6.6	7.9	9.2	10.5	11.9	13.2	14.5	15.8	17.2
23	73	0.0	1.4	2.8	4.2	5.6	7.0	8.5	9.9	11.3	12.7	14.1	15.4	16.8	18.2
24	75	0.0	1.5	3.0	4.5	5.9	7.4	8.9	10.4	11.9	13.4	14.9	16.4	17.9	19.4
25	77	0.0	1.6	3.2	4.8	6.4	8.0	9.5	11.1	12.7	14.3	15.9	17.4	19.0	20.5
26	79	0.0	1.7	3.4	5.1	6.7	8.4	10.1	11.8	13.4	15.1	16.8	18.4	20.1	21.8
27	81	0.0	1.8	3.5	5.3	7.1	8.9	10.7	12.4	14.2	16.0	17.8	19.6	21.3	23.1
28	82	0.0	1.9	3.8	5.7	7.6	9.5	11.4	13.3	15.1	17.0	18.9	20.7	22.6	24.5
29	84	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.1	24.1	26.1
30	86	0.0	2.1	4.2	6.4	8.5	10.6	12.7	14.8	17.0	19.1	21.2	23.3	25.4	27.5
31	88	0.0	2.2	4.5	6.7	9.0	11.2	13.4	15.7	17.9	20.2	22.4	24.6	26.9	29.1
32	90	0.0	2.4	4.7	7.1	9.5	11.9	14.2	16.6	19.0	21.3	23.7	26.1	28.4	30.8
33	91	0.0	2.5	5.0	7.5	10.0	12.5	15.0	17.6	20.1	22.6	25.1	27.6	30.1	32.6
34	93	0.0	2.7	5.3	8.0	10.6	13.3	15.9	18.6	21.2	23.9	26.5	29.2	31.8	34.5
35	95	0.0	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0	30.8	33.6	36.4

www.agri-tech.co.uk

Agri-tech SERVICES

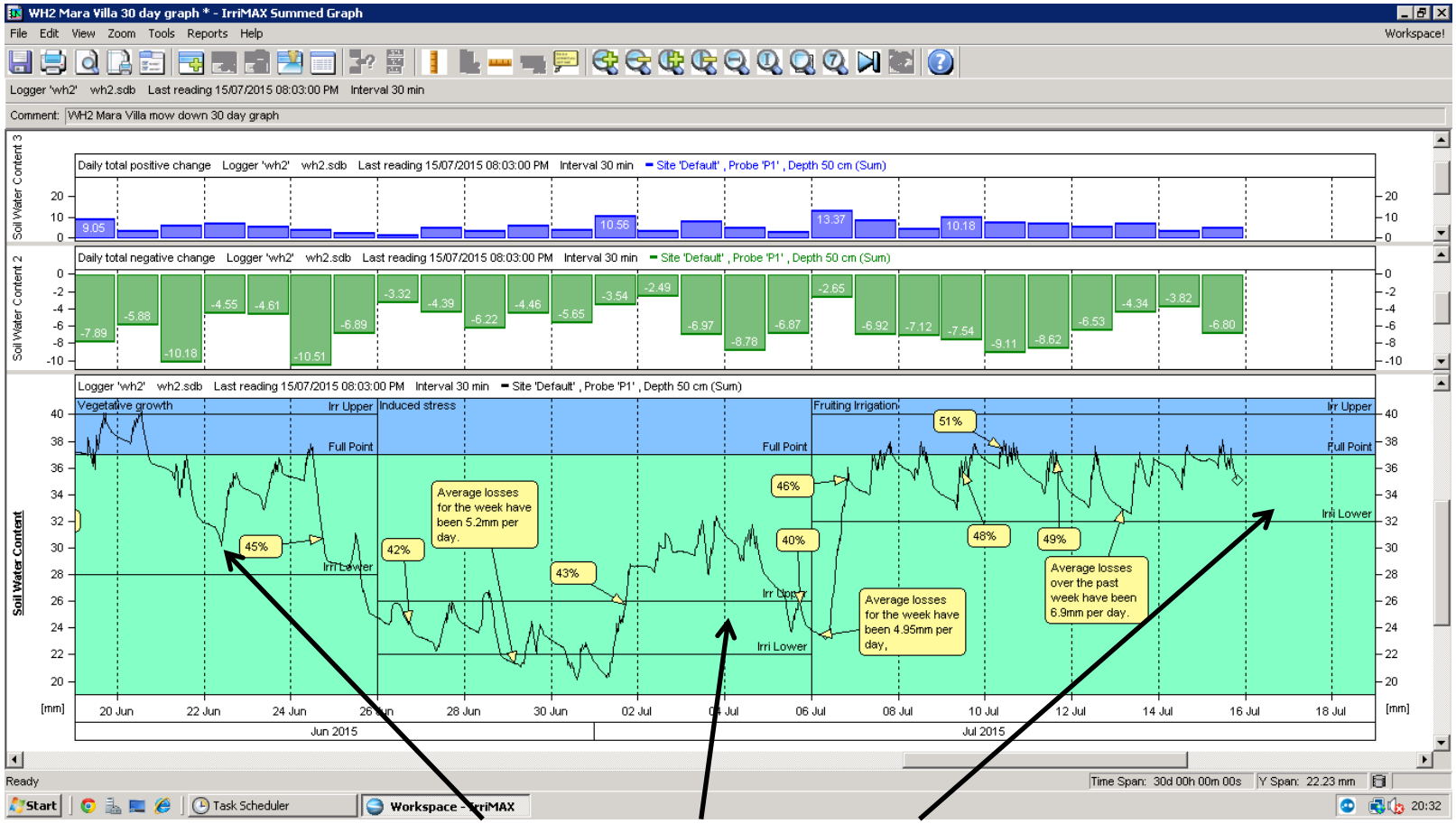
Hourly water use and ET (mm)



www.agri-tech.co.uk

Agri-tech SERVICES

Controlled Deficit Irrigation



Moisture targets differ depending on plant growth stage – manipulate the crop with "precise moisture control"

www.agri-tech.co.uk

Agri-tech SERVICES

Precision Irrigation

- Enables irrigation team to react to changing weather conditions

- “Watch your plants wake up in the morning and go to sleep at night” - essential for precision irrigation decisions

- Manipulate the plant by “Controlled Deficit Irrigation”

www.agri-tech.co.uk

Agri-tech SERVICES

The Essential steps to Precision Irrigation in Substrate cropping;

- Have your substrate site GPS surveyed - Using RTK GPS precision our surveying service can create a “detailed picture of your site” together with essential topographic data
- Surveyed data will assist irrigation team / designer correctly spec the irrigation system
- Once the irrigation is installed ensure DNL devices are placed correctly within blocks to prevent drain down - essential for even distribution of water and fertiliser
- Use hand held moisture meter (WET probe) to determine variation and field averages
- Strategic positioning of Agri-tech Continual Monitoring probes will feed live moisture data 24/7 directly to your PC or SMART device

www.agri-tech.co.uk

Agri-tech SERVICES

Tunnel Climate and plant water demand

TEMP		RELATIVE HUMIDITY													
C	F	100%	95%	90%	85%	80%	75%	70%	65%	60%	55%	50%	45%	40%	35%
15	59	0.0	0.8	1.7	2.5	3.4	4.2	5.1	5.9	6.8	7.6	8.5	9.4	10.2	11.1
16	61	0.0	0.9	1.8	2.8	3.7	4.6	5.5	6.4	7.3	8.2	9.1	10.0	10.9	11.8
17	63	0.0	1.0	2.0	2.9	3.9	4.9	5.8	6.8	7.8	8.8	9.7	10.6	11.6	12.6
18	64	0.0	1.0	2.1	3.1	4.1	5.1	6.2	7.2	8.2	9.3	10.3	11.3	12.4	13.4
19	66	0.0	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0	12.1	13.2	14.3
20	68	0.0	1.2	2.4	3.5	4.7	5.9	7.1	8.3	9.4	10.6	11.7	12.8	14.0	15.2
21	70	0.0	1.2	2.4	3.7	4.9	6.2	7.4	8.6	9.9	11.1	12.4	13.7	14.9	16.1
22	72	0.0	1.3	2.6	3.9	5.3	6.6	7.9	9.2	10.5	11.9	13.2	14.5	15.8	17.2
23	73	0.0	1.4	2.8	4.2	5.6	7.0	8.5	9.9	11.3	12.7	14.1	15.4	16.8	18.2
24	75	0.0	1.5	3.0	4.5	5.9	7.4	8.9	10.4	11.9	13.4	14.9	16.4	17.9	19.4
25	77	0.0	1.6	3.2	4.8	6.4	8.0	9.5	11.1	12.7	14.3	15.9	17.4	19.0	20.5
26	79	0.0	1.7	3.4	5.1	6.7	8.4	10.1	11.8	13.4	15.1	16.8	18.4	20.1	21.8
27	81	0.0	1.8	3.5	5.3	7.1	8.9	10.7	12.4	14.2	16.0	17.8	19.6	21.3	23.1
28	82	0.0	1.9	3.8	5.7	7.6	9.5	11.4	13.3	15.1	17.0	18.9	20.7	22.6	24.5
29	84	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.1	24.1	26.1
30	86	0.0	2.1	4.2	6.4	8.5	10.6	12.7	14.8	17.0	19.1	21.2	23.3	25.4	27.5
31	88	0.0	2.2	4.5	6.7	9.0	11.2	13.4	15.7	17.9	20.2	22.4	24.6	26.9	29.1
32	90	0.0	2.4	4.7	7.1	9.5	11.9	14.2	16.6	19.0	21.3	23.7	26.1	28.4	30.8
33	91	0.0	2.5	5.0	7.5	10.0	12.5	15.0	17.6	20.1	22.6	25.1	27.6	30.1	32.6
34	93	0.0	2.7	5.3	8.0	10.6	13.3	15.9	18.6	21.2	23.9	26.5	29.2	31.8	34.5
35	95	0.0	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0	30.8	33.6	36.4

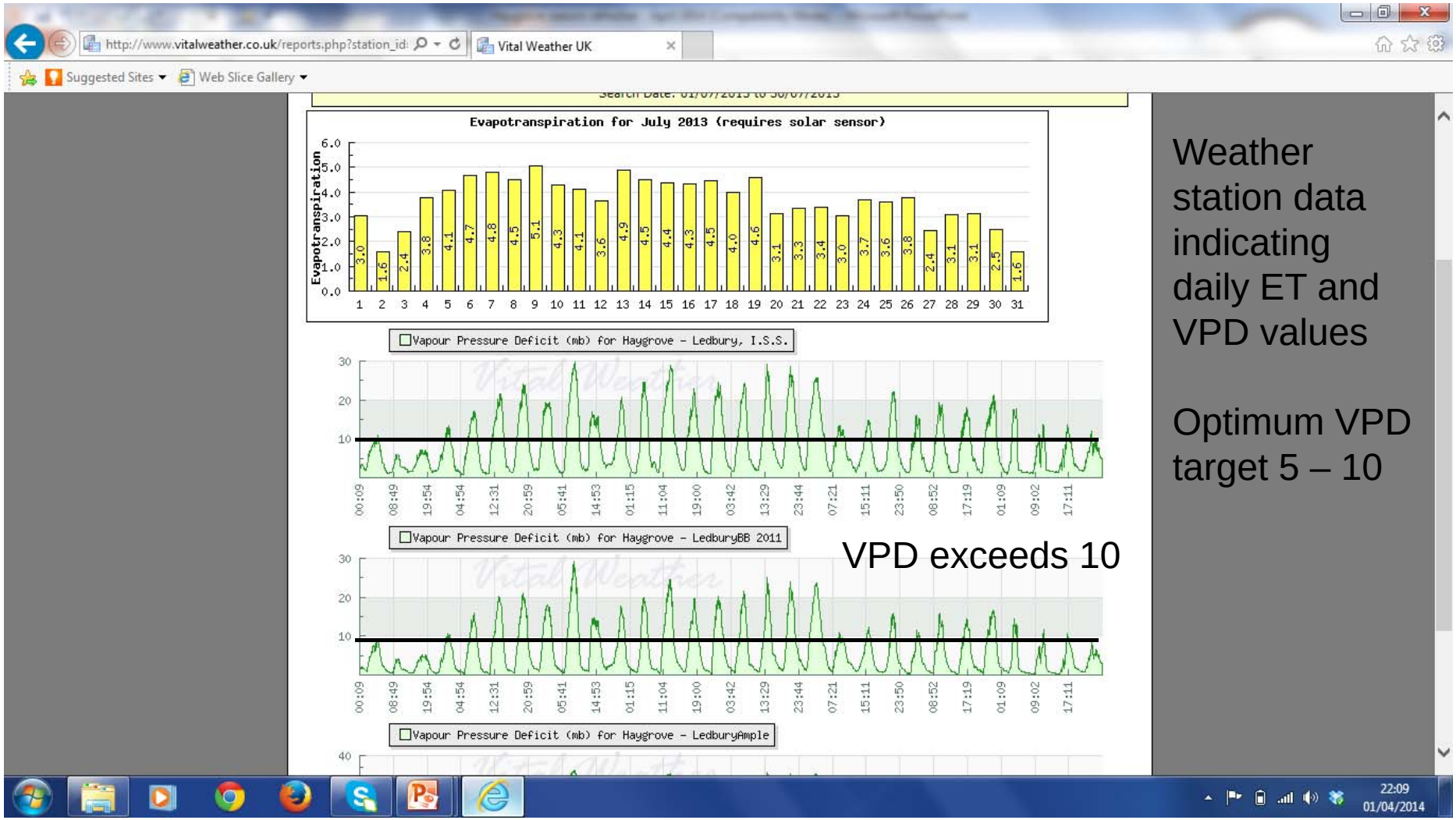
Too humid

Optimum

Too Dry

www.agri-tech.co.uk

Agri-tech SERVICES



Weather station data indicating daily ET and VPD values

Optimum VPD target 5 – 10

www.agri-tech.co.uk

Agri-tech SERVICES

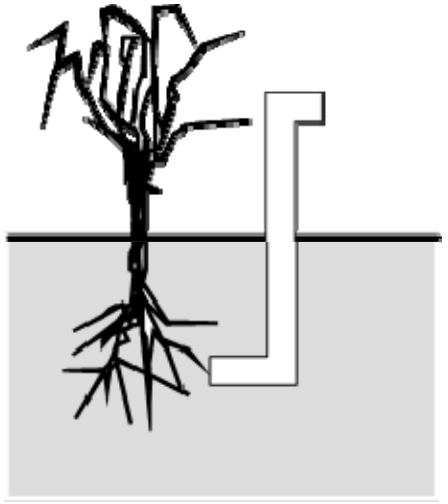
Agri-tech Services (UK) Ltd

Precision Irrigation
“hitting the target”

www.agri-tech.co.uk

Soil

Soil is the “factory” for crop production – therefore beneficial to understand what is happening within the “factory”



www.agri-tech.co.uk

Agri-tech SERVICES

Soil and water

- Where is the plant using water?
- How much water is my plant using?
- How much do I need to apply and when?
- When I irrigate where is the water going?

www.agri-tech.co.uk

Agri-tech SERVICES

Freely available water

Irrigation / rainfall

Saturated – bucket over-flowing – anaerobic conditions

Freely available moisture to the plant

Silty clay loam total FAW could be 80mm
Coarse sand soil total FAW could be 30mm

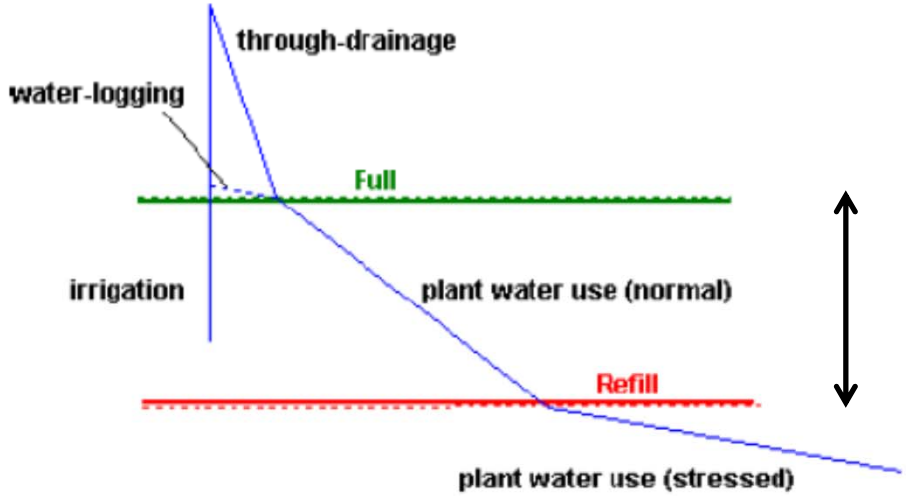
Stress – bucket empty

www.agri-tech.co.uk

Agri-tech SERVICES

Field capacity & Refill

Ffull point and refill points defined on a time graph.



Apple growth rate @ FC could be up to 0.8mm per day but @ the refill point this could be 0.2mm per day

Cell expansion and cell division accelerated the nearer to field capacity the soil is. A lettuce grower sells vegetation – to speed growth the SMD is kept close to FC – irrigation regime could be holding the SMD between 5 and 15

To slow down vegetative growth dry soil out – slows growth.

www.agri-tech.co.uk

Agri-tech SERVICES

Field Capacity and Refill point

Field Capacity

- The maximum moisture content a soil can hold once through drainage of excess water has ceased
- Like pulling a saturated sponge from a bath of water – when the sponge stops dripping it is at the Full Point or Field Capacity – it's holding all it can against gravity

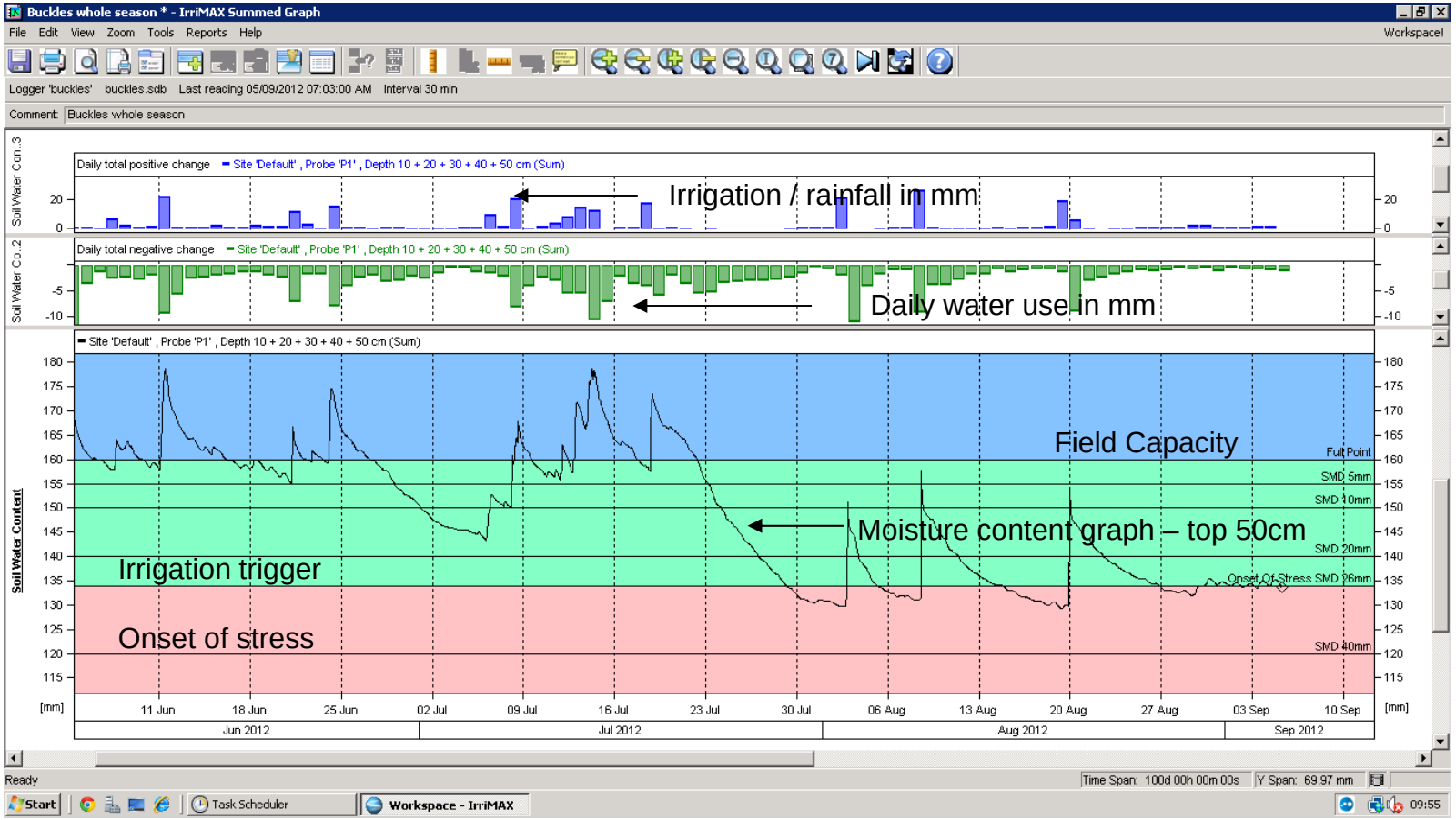
Refill Point

- The point beyond which optimum uptake of water and growth starts to slow down
- Moisture being used at a lower depth in the soil profile
- Will **NOT** always be the irrigation trigger point

www.agri-tech.co.uk

Agri-tech SERVICES

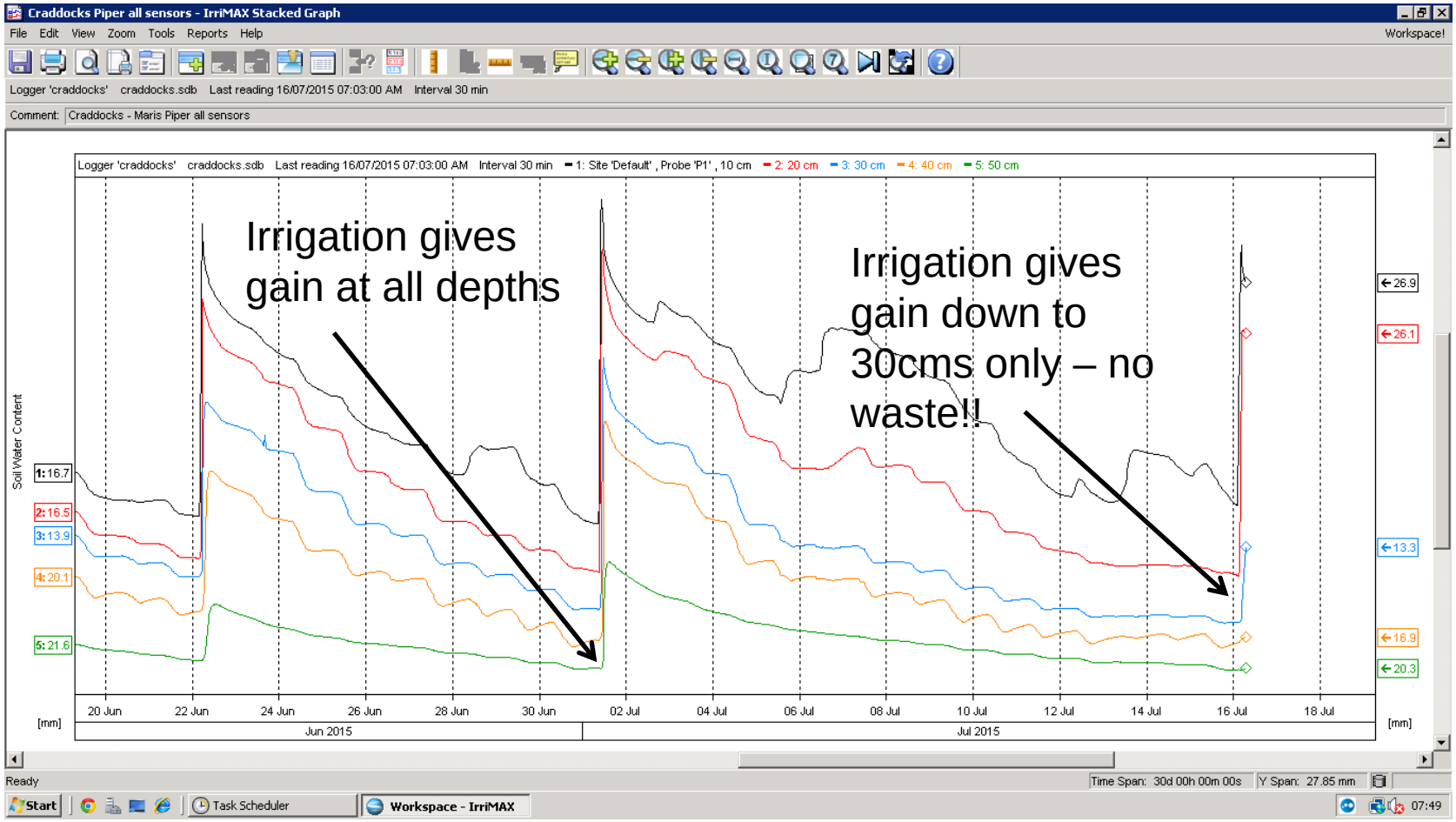
Moisture Parameters



www.agri-tech.co.uk

Agri-tech SERVICES

Hitting the Target – rootzone ?



www.agri-tech.co.uk

Agri-tech SERVICES

Soil augering

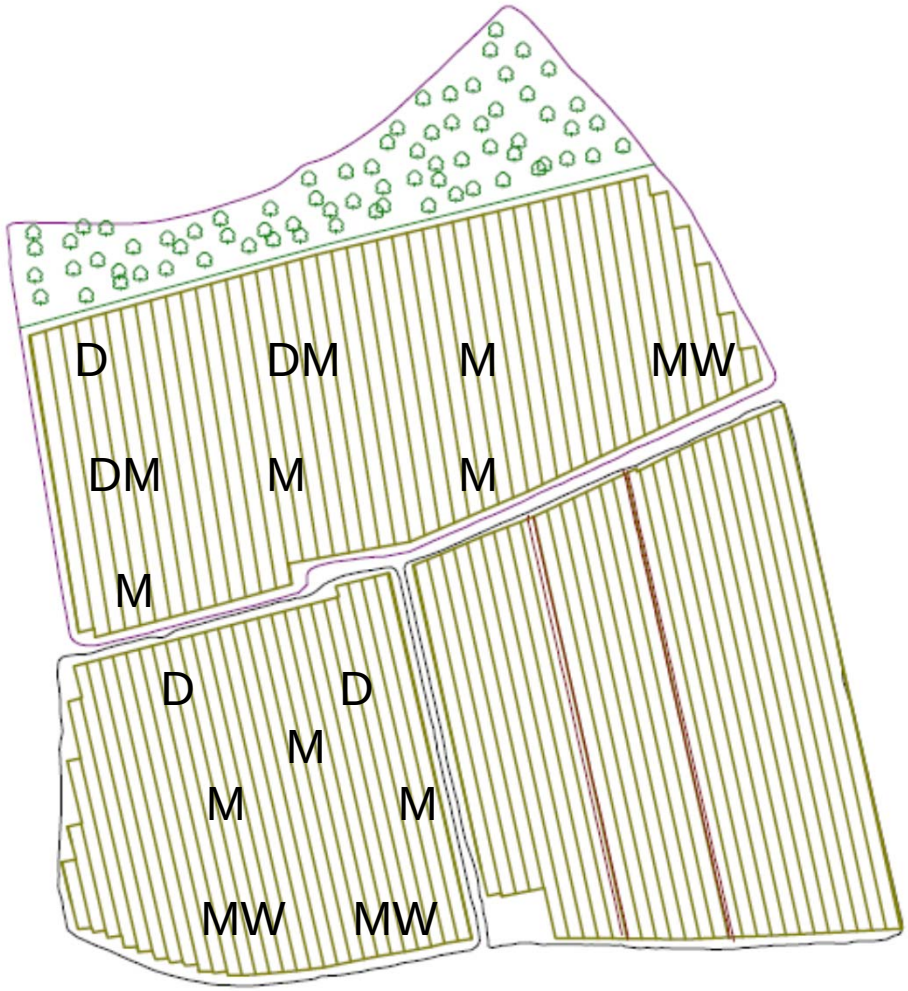
Grade your soil to establish problems / variation

D =	**Dry**
DM =	**Dry to moist**
M =	**Moist**
MW =	**Moist to wet**
W =	**Wet**

www.agri-tech.co.uk

Agri-tech SERVICES

Example Moisture map



D = Dry
DM = Dry to moist
M = Moist
MW = Moist to wet
W = Wet

www.agri-tech.co.uk

Agri-tech SERVICES

Leaks create hygiene issues

Unwanted water must be removed

www.agri-tech.co.uk

Agri-tech SERVICES

Soil texture

Name of soil separate	*Diameter limits (mm) (USDA classification)*
Clay	less than 0.002
Silt	0.002–0.05
Very fine sand	0.05–0.10
Fine sand	0.10–0.25
Medium sand	0.25–0.50
Coarse sand	0.50–1.00
Very coarse sand	1.00–2.00

Clay – feels sticky when wet (plasticine)

Silt – feels “smooth and silky” to the feel

Sand feels gritty – stains your hands when wet

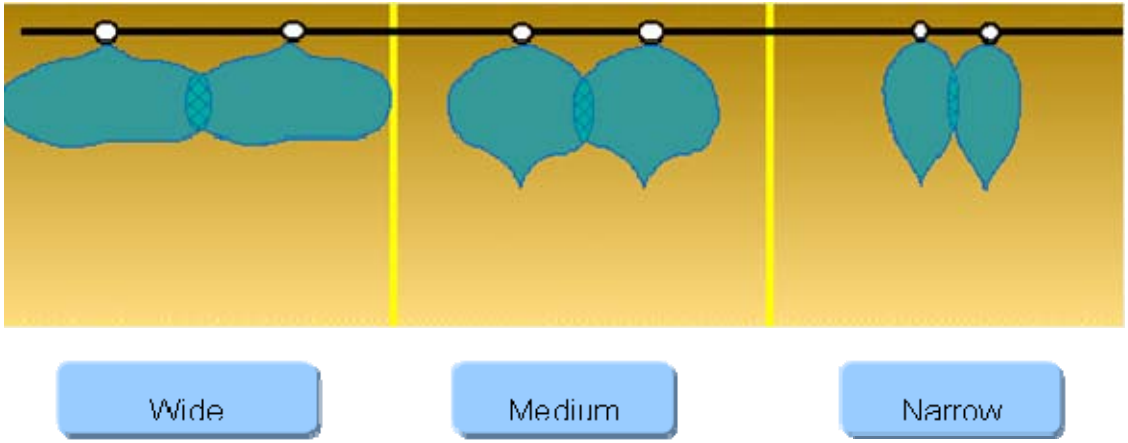
www.agri-tech.co.uk

Agri-tech SERVICES

Soil structure

Built up by the aggregation of textural particles – irfluenced by:

- Organic matter
- Fauna (Earthworms etc)
- Wetting and drying from rainfall / irrigation
- Freezing and thawing
- Root pressure (crop roots can act as a soil aerator)
- Tillage practices
- Traffic



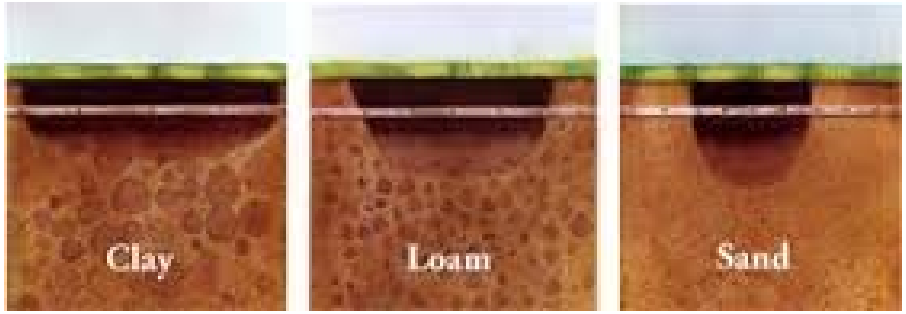
www.agri-tech.co.uk

Tillage operations / Farm traffic and their influence on structure

www.agri-tech.co.uk

Agri-tech SERVICES

How do we calculate depth applied?



Soil texture and structure will have an impact on the wetting pattern of the dripper

Volume (m3) = Depth (mm) * Area (Ha) * 10

We want to apply 12mm to a 1.5 ha block of fruit the calculation is 12* 1.5 * 10 = 180 m3

We want to apply 12mm to a strawberry bed 100m in length with a wetted zone 60cm wide
0.1 * 0.06 = 0.006 of a ha – 12 * 0.006 * 10 = 0.72 m3 or 720 litres

www.agri-tech.co.uk

Agri-tech SERVICES

Irrigation requirement calculator

Irrigation requirement calculator

EDWU = estimated daily water use

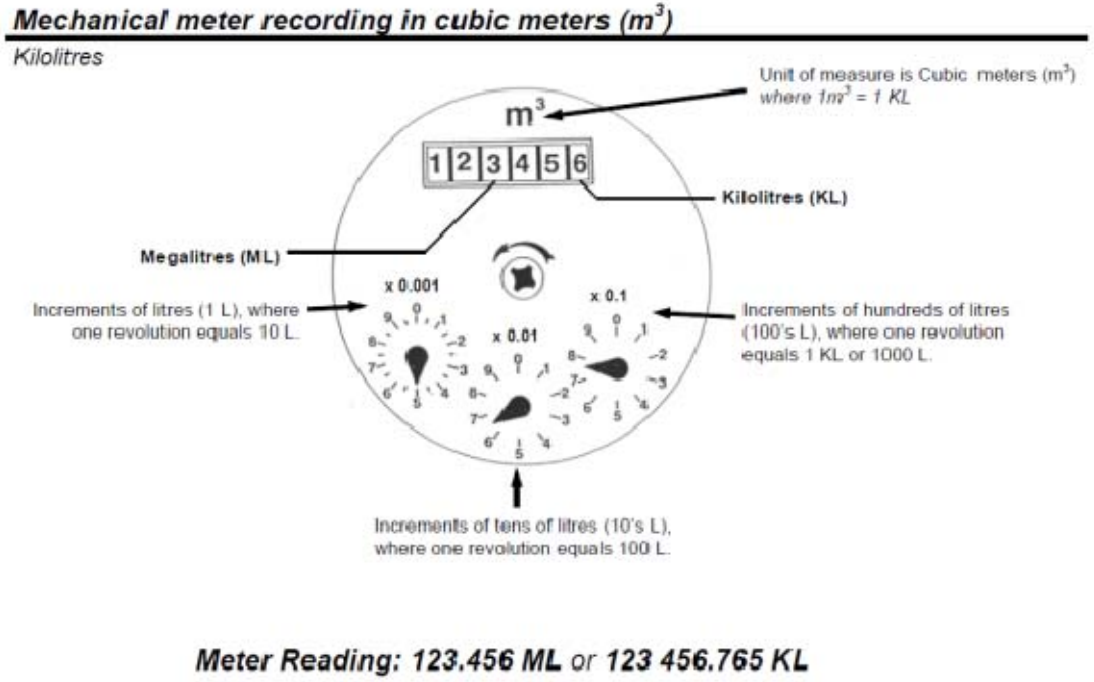
NB Block size = tunnelled area

Irrigated area = actual area irrigated within the block

Block Name	Date	Bk size (ha)	Bed area Factor	Irrigated area	Plant population (/ha)	Start Meter reading	Target SMD	Actual SMD	EDWU	MM required (week)	Planned KL (m3) / week	Planned ltrs / plant / week	Target end meter reading	Actual end meter reading	Actual ltrs / plant / week	Actual irrigation applied (mm)
Block 1	21-Jul	1	0.65	0.65	54000	1000	13	18	4.5	36.5	237.25	4.39	1237.25	1194.67	3.61	29.95
Block 2	21-Jul	0.85	0.7	0.595	55000	1000	10	8	2.6	16.2	96.39	1.75	1096.39	1103.45	1.88	17.39
Block 3	21-Jul	1.3	0.7	0.91	55000	1000	10	7	2.8	16.6	151.06	2.75	1151.06	1162.34	2.95	17.84
Block 4	21-Jul	1	0.7	0.7	55000	1000	25	16	5	26	182	3.31	1182	1176	3.20	25.14
Block 5	21-Jul	0.9	0.7	0.63	55000	1000	25	29	6.5	49.5	311.85	5.67	1311.85	1320.45	5.83	50.87
Block 6	21-Jul	1	0.7	0.7	55000	1000	25	22	3	18	126	2.29	1126	1355	6.45	50.71
Block 7	21-Jul	0.6	0.7	0.42	55000	1000	15	25	2.5	27.5	115.5	2.10	1115.5	1163	2.96	38.81

www.agri-tech.co.uk

Water Meter - reading



www.agri-tech.co.uk

Agri-tech SERVICES

What changes have we made?

- Introduced RTK to our mapping service enabling laser precision to our surveys
- Added ability to record run-off as and when it happens to the probe system
- Introduced ½ hr updates to the probe data giving near “real-time” data to the end user

Future

- Measuring UV – evaluate poly degradation
- Ability to record imagery – remote camera

www.agri-tech.co.uk

Agri-tech SERVICES

What we can offer?

- Strategic overview of your irrigation system
- Offer advice on where investment should be made on system upgrades
- Site Surveys for design
- Irrigation advice based on strategic positioning of soil moisture monitoring probes
- Weekly consultation through the key growing season

www.agri-tech.co.uk

Agri-tech SERVICES

What we need from you

- Irrigation system details
- Weekly WET probe readings and run-off data – substrate production
- Weekly soil maps (soil grown crops)
- Weekly images from all sites – Dropbox
- Scheduled weekly meetings on farm / via Skype
- The motivation and desire to be the best at what you do

www.agri-tech.co.uk

Agri-tech SERVICES