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The New Zealand Institute for Plant & Food Research Limited

Post-Quake: Horticultural Options for Kaikoura & Environs

Brent Clothier & Robert Ward

Plant & Food Research have assessed the suitability of different horticultural crops in response to land and weather characteristics in selected areas of North Canterbury.
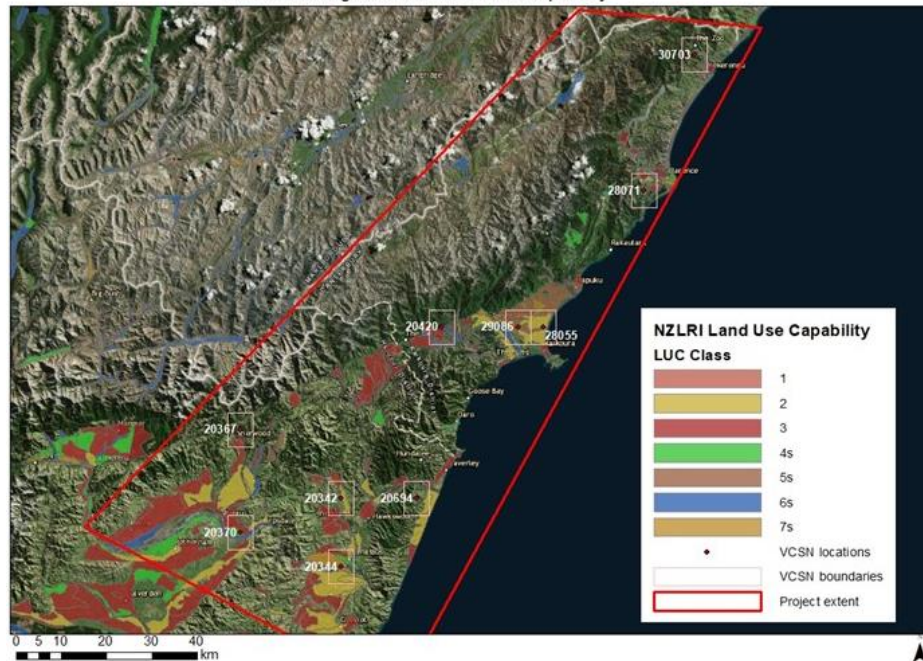
- Firstly, a broad GIS sweep over for an initial screening of the suitability for generic horticultural crops

- Secondly, a more detailed analysis performed for ten Virtual Climate Station Network locations (VCSN), ranging from Kekerengu in the north to Cheviot in the south for the crops of:
  - Apples
  - Kiwifruit
  - Wine grapes
  - Blueberries
  - Hazelnuts and walnuts
  - Avocados.

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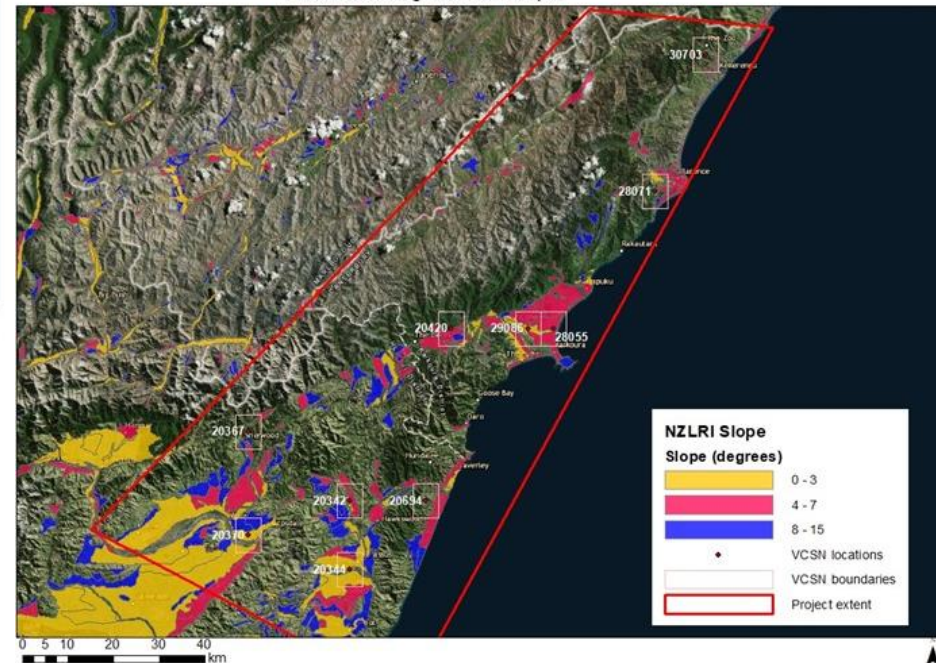
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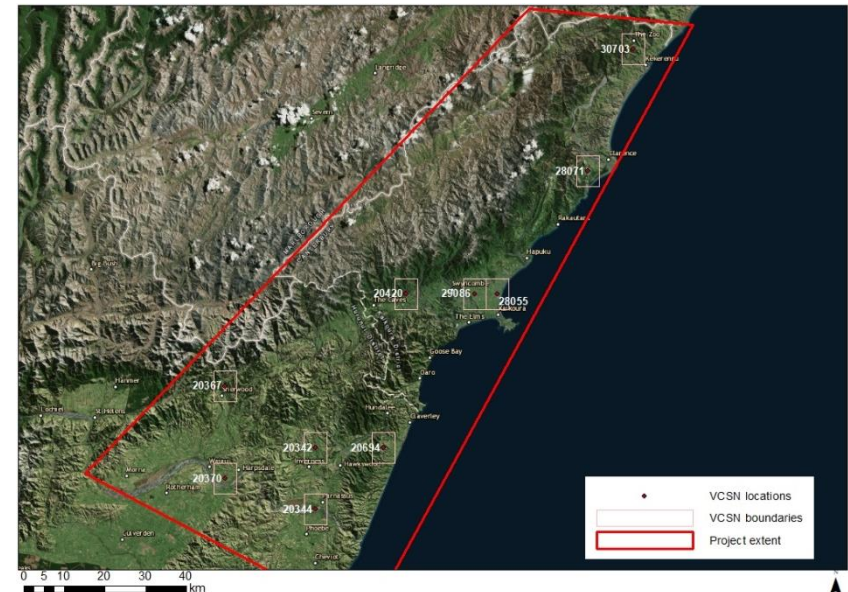
Two Criteria for Land for Generic Horticulture

Land Use Capability (LUC) Classes: 1, 2, 3, 4s-7s
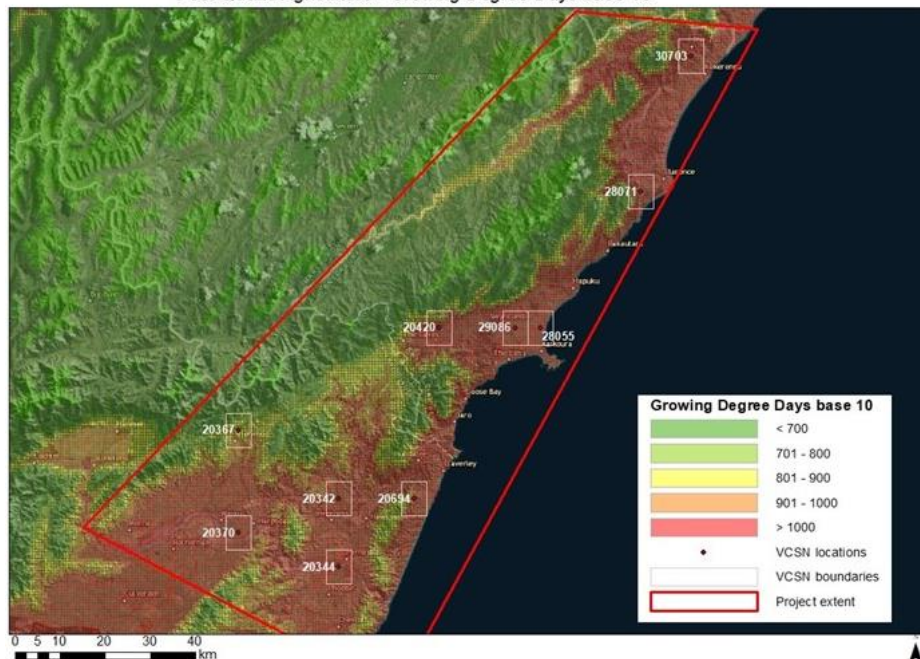

Land with slope < 15 °

Two Criteria for Climate for Generic Horticulture

Growing Degree Days (GDD$_{10}$) > 800 degree days

Post-Quake Agriculture - Growing Degree Days base 10

Growing Degree Days base 10
- < 700
- 701 - 800
- 801 - 900
- 901 - 1000
- > 1000
- · VCSN locations
- VCSN boundaries
- Project extent

0 5 10 20 30 40 km

Frost-Free Period (FFP) > 200 days

Post-Quake Agriculture - Frost Free Period

Frost Free Period (days)
- < 150
- 151 - 175
- 176 - 200
- 201 - 225
- 226 - 250
- > 251
- · VCSN locations
- VCSN boundaries
- Project extent

0 5 10 20 30 40 km

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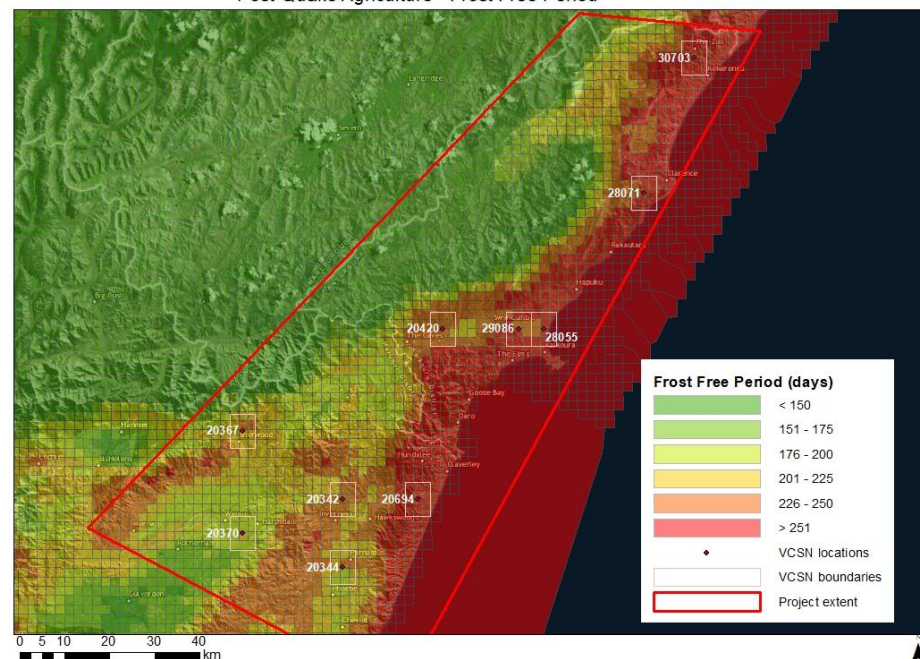
The Potential Area for Horticulture: All Four Criteria Met
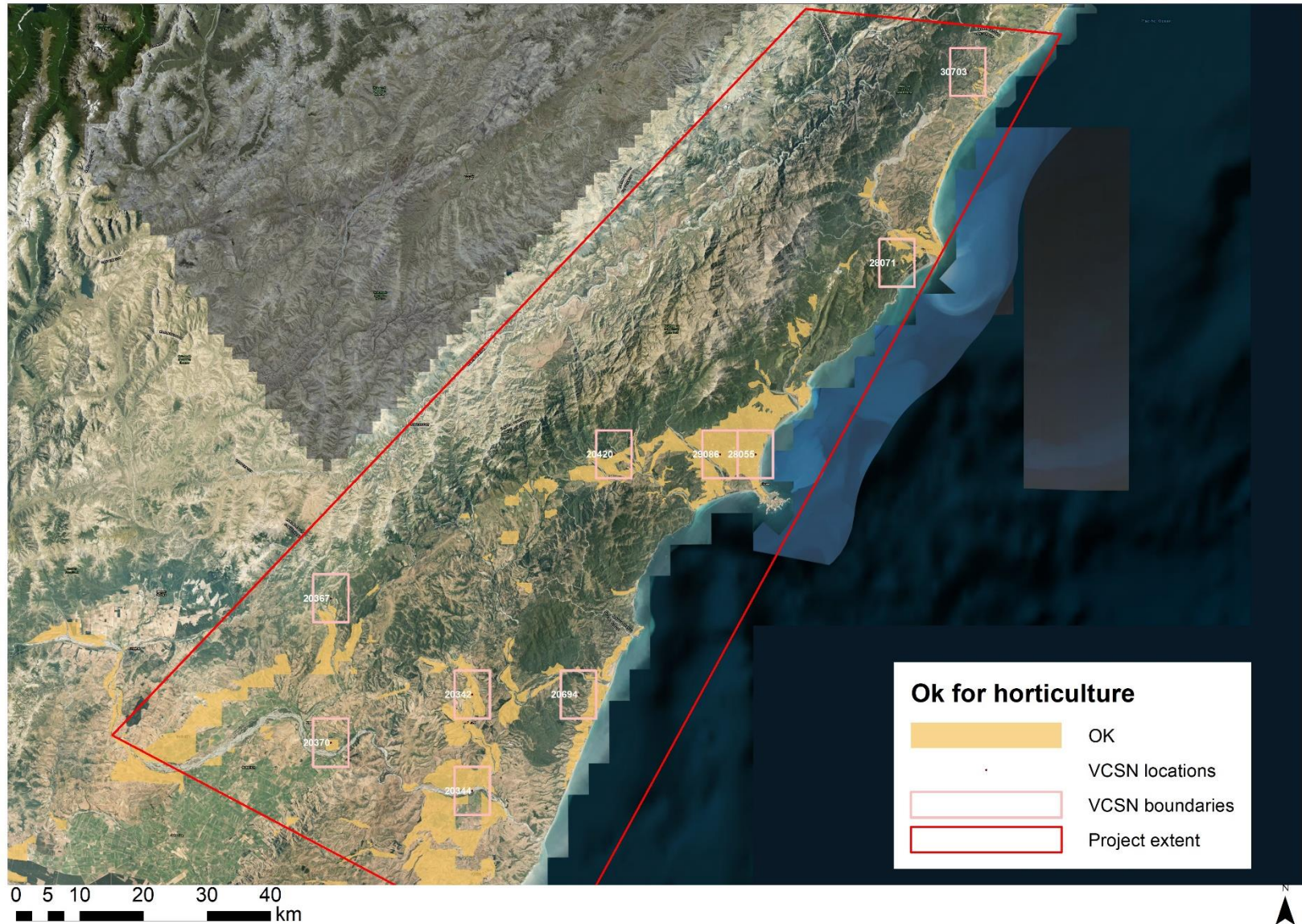
That's 41,515 ha (out of 466,000 ha)

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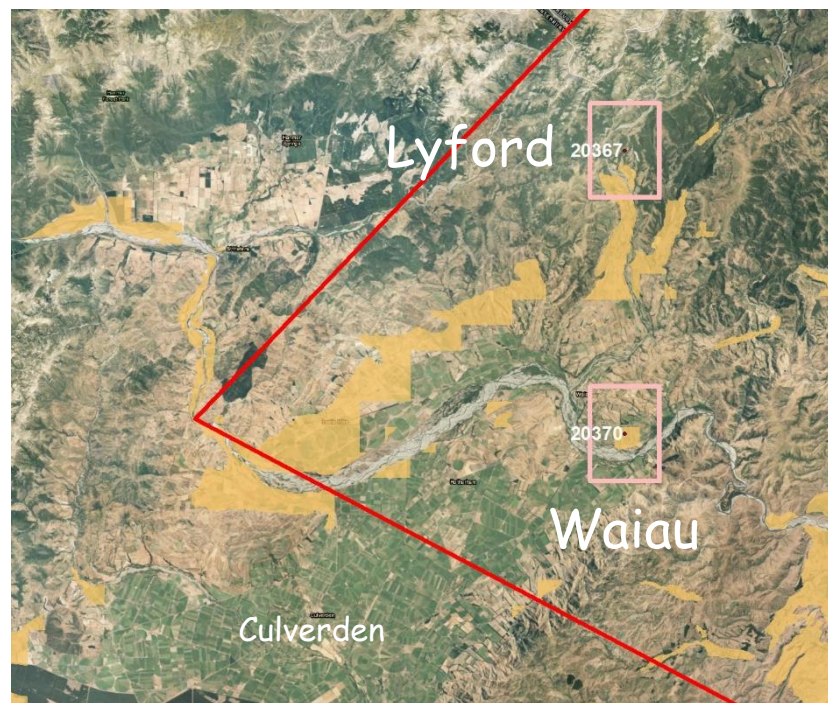
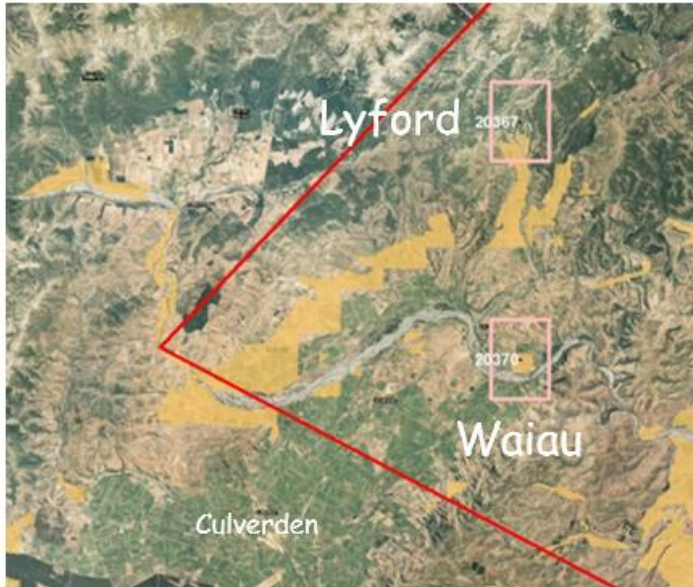# Detailed Analyses: Six Crops across 10 VCSN Stations

Waiau & Surrounds: Waiau & Lyford

- Two VCSN stations

- Apples
- Kiwifruit
- Wine grapes
- Blueberries
- Hazelnuts and walnuts
- Avocados.

A Location-Specific Assessment for Apples


Two VCSN stations

A 46-year weather record

Combined with our knowledge of the impact of weather on apple phenology & yields

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Lyford   Waiau

VCSN	20367	20370
Chill hours, April-September (T < 7°C)		
Mean	2425	1871
20th percentile	2233	1711
46-year minimum	1940	1419
Chill hours, April-September (T < 7.2°C)		
Mean	2494	1942
20th percentile	2291	1778
46-year minimum	2017	1495
Growing Degree Days base 10°C, October-April		
Mean	695	955
20th percentile	602	872
46-year minimum	442	722
Spring and autumn frosts (0°C)		
Mean date of first autumn frost	May 7	May 29
20th percentile first autumn frost	April 21	May 11
46-year earliest frost	March 17	April 19
Mean date of last spring frost	October 11	September 12
80th percentile last spring frost	October 25	September 27
46-year latest frost	December 1	November 12
Mean frost-free period	208 days	259 days
20th percentile frost-free period	185 days	244 days
46-year minimum frost-free period	106 days	179 days
Spring and autumn frosts (-2°C)		
Mean date of first autumn frost	June 6	June 24
20th percentile first autumn frost	May 23	June 4
46-year earliest frost	April 19	May 23
Mean date of last spring frost	September 5	August 2
80th percentile last spring frost	September 22	August 25
46-year latest frost	November 12	October 6
Mean frost-free period	273 days	325 days
20th percentile frost-free period	250 days	295 days
46-year minimum frost-free period	179 days	259 days
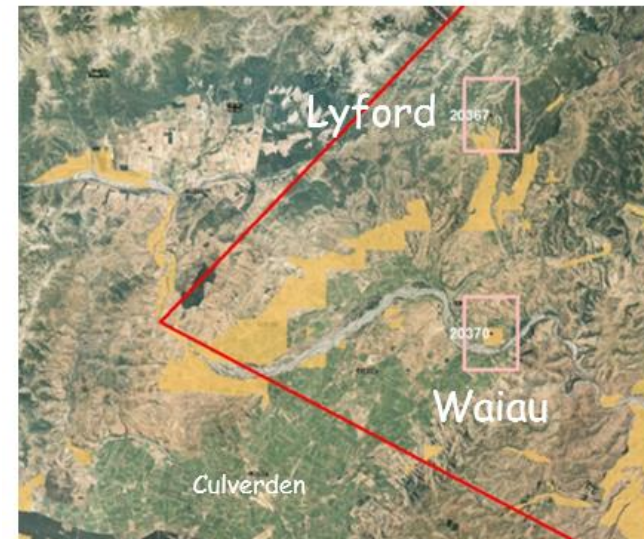
The VCSN Data for Waiau & Lyford

Results for Apple Suitability: Chilling & Warmth

- Winter chilling 1900 hrs < 7.2°C ☑
  [Greater than the 500 required by apples]

- Waiau: Growing Degree Days (base 10° C) GDD = 955 degree-days ☑

  Lyford: GDD = 695 degree days ☒
  [Apples require 800 degree days]

- The 'first-fifty days after flowering' GDD

  Waiau = 171 degree-days; Lyford = 137 ☑
  [Greater than the 120 required by apples]

Apples suitable for Waiau, marginal at Lyford

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Results for Apple Suitability: Frost Risk

	Lyford	Waiau
VCSN	**20367**	**20370**
Mean date of apple flowering	October 30	October 20
Probability of frost after flowering	17%	2%
Mean date of apple harvesting	April 14	March 22
Probability of frost before harvest	15%	0%
Mean GDD_{10} for the first 50 days after flowering	137	171

- Little risk in Waiau
- Some risk around Lyford. Is this bad?

- At Riwaka , Nelson, the frost risk is 16%
- At Tikokino, Central Hawke's Bay the risk is 56%
- A mitigatable risk, therefore, at both places

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Results for Kiwifruit Suitability: Chilling & Warmth

- Winter chilling ☑ May-July temperatures 6.2 & 7.8 °C
  [Kiwifruit require May-July temperatures between 11.7 – 15 °C]

- Growing Degree Days (base 10° C) GDD = 695 & 955 degree-days ☒
  [Less than the 1100 degree days required by kiwifruit]

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Results for Kiwifruit Suitability: Frost Risk

	Lyford	Waiau
VCSN	20367	20370
Mean temperature from May to July	6.2°C	7.8°C
Mean date of green kiwifruit budbreak	September 11	September 12
Probability of frost after budbreak (green-fleshed kiwifruit)	91%	43%
Mean date of gold kiwifruit budbreak	September 10	September 13
Probability of frost after budbreak (gold-fleshed kiwifruit)	91%	41%

- High frost risk at Lyford
- Moderate risk at Waiau. Mitigation would be required

But unsuitable for kiwifruit due to low summer-warmth (GDD_{10}).

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Results for Grape Suitability: Chilling & Warmth

VCSN	20367	20370
Mean temperature in July	7.5°C	6.5°C
Mean monthly rainfall for March and April	108.9mm	65.6mm
Mean number of summer days with maximum temperature above 40°C	0	0
Mean autumn date where temperatures drop below 13°C	March 20	April 8
Mean budbreak date for Pinot noir	October 13	October 7
Mean GDD_{10} for Pinot noir growing season	614	896
Mean budbreak date for Sauvignon blanc	October 17	October 9
Mean GDD_{10} for Sauvignon blanc growing season	610	894
Risk of -1°C frost after budbreak (Pinot noir)	13%	0%
Risk of -3°C frost after budbreak (Pinot noir)	10%	0%
Risk of -1°C frost after budbreak (Sauvignon blanc)	0%	0%
Risk of -3°C frost after budbreak (Sauvignon blanc)	0%	0%

- Winter chilling ☑
  [Mean July temperature ≈7 ° C is < 12 °C needed]

- Growing Degree Days (base 10° C) GDD ≈ 600 & 895 degree-days ☒ & ☑
  [Pinot noir need 800-1000 & Sauvignon blanc 850-1050]

- Low frost risk ☑

- Waiau alright with summer rains [Should be < 70 mm month^{-1}] ☑. Not Lyford

- Suitable for Waiau only

Results for Nut-Crop Suitability: Chilling & Warmth

	Lyford	Waiau
VCSN	**20367**	**20370**
Probability of >400 winter chill hours	100%	100%
Probability of >800 winter chill hours	100%	100%
Probability of >1200 winter chill hours	100%	100%
Probability of >1600 winter chill hours	100%	87%
Probability of autumn frost before March 15	0%	0%
Probability of spring frost after October 15	2%	0%
Probability of spring frost after November 1	2%	0%

- Winter chill < 7 °C ≈ 1600 hours ☑
  [Suitable for hazelnuts & walnuts with low-moderate chill ≈ 1200 hours
    Careful walnut cultivar selection as some have > 1600 hour requirements]

- Growing degree days GDD_{10} = 695 & 955 degree days ☒ ☑
  [Exceeds GDD_{10} for nuts of 800 degree days only at Waiau]

- Low frost risk

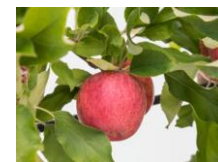- Well suited to nuts at Waiau only. Cultivar selection necessary

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Lyford & Waiau Suitability for:

- Apples
- Kiwifruit
- Wine grapes
- Blueberries
- Hazelnuts and walnuts
- Avocados.

Lyford	Waiau
☒	☑
☒	☒
☒	☑
☒	☒
☒	☑
☒	☒

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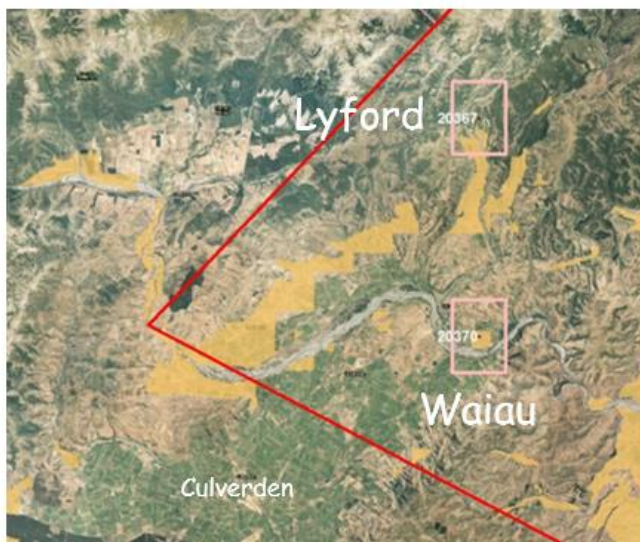
But what about water & the need for irrigation?

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Marlborough: A Thirsty Landscape

Catchments & aquifers are at, or close to, full allocation.

What irrigation allocation is required?

How is water best used?

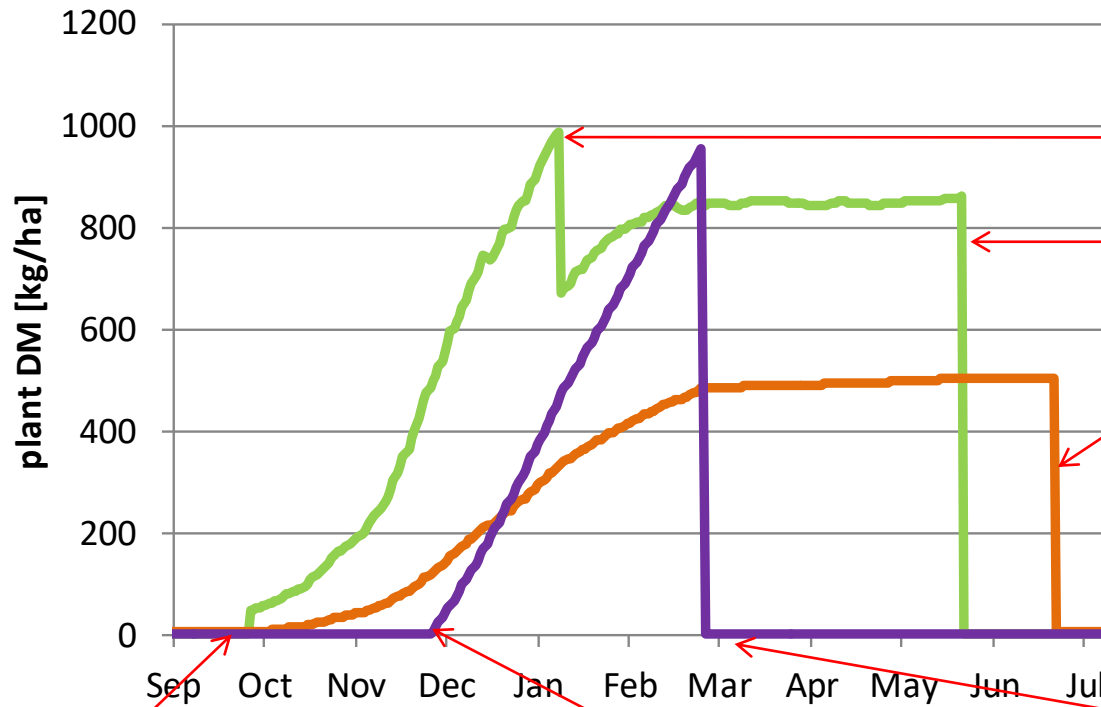# Measurements to Understand Vineyard Water Use

Modelling Vine Growth and Vineyard Water Use

Vine

Bare soil

Grass inter-row

'Big-Leaf' Model
+
5 'zones' of uptake

Fine sandy loam

Fine sand

Coarse gravel
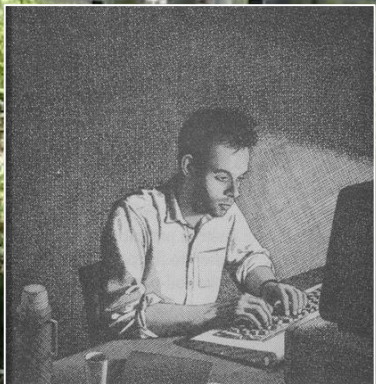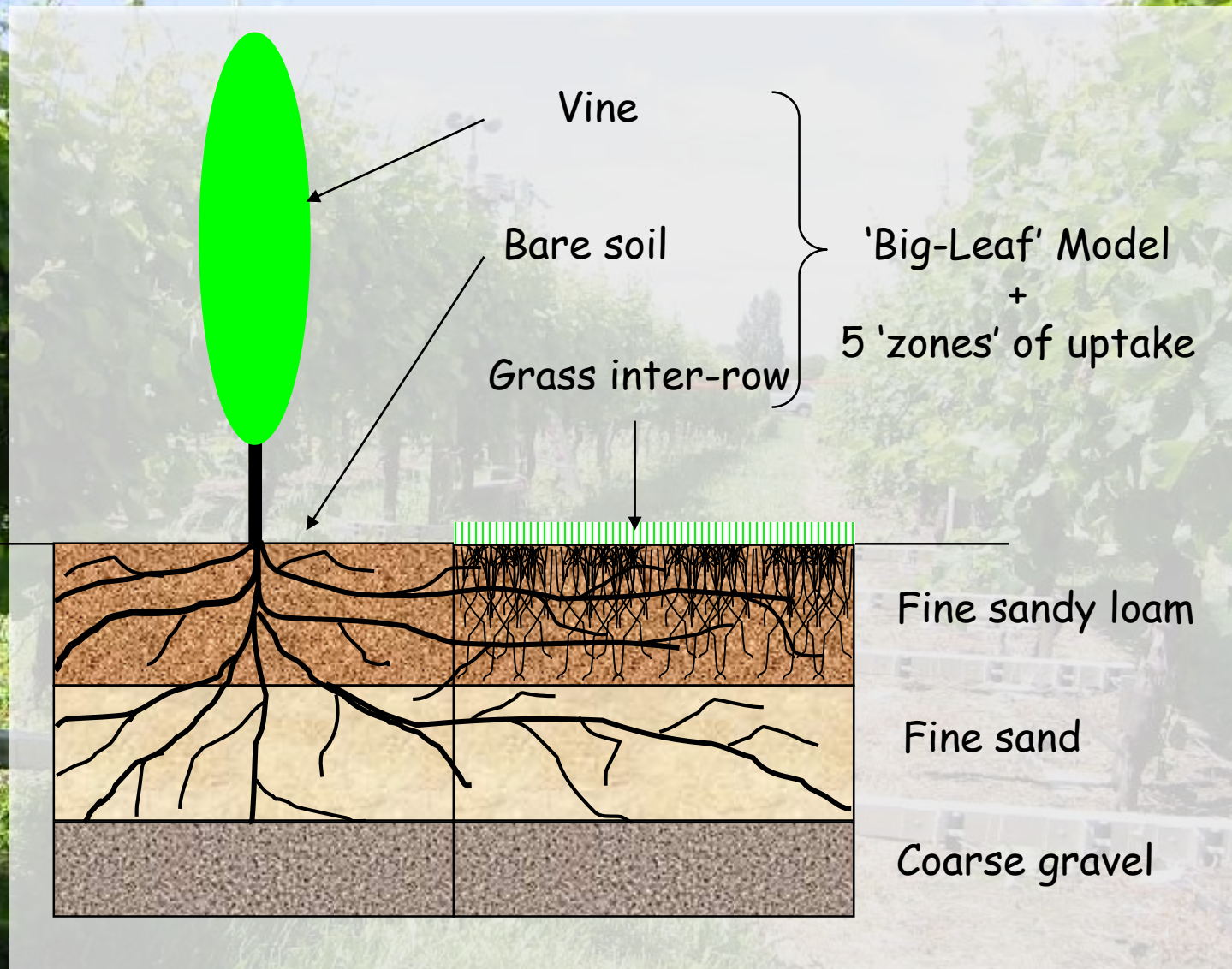
Modelling the Phenology of Grape Vines

— leaf DM — shoot DM — bunch DM

Trimming

Leaf fall

Winter pruning

- Growth → f(Rg, Ta, W, N)
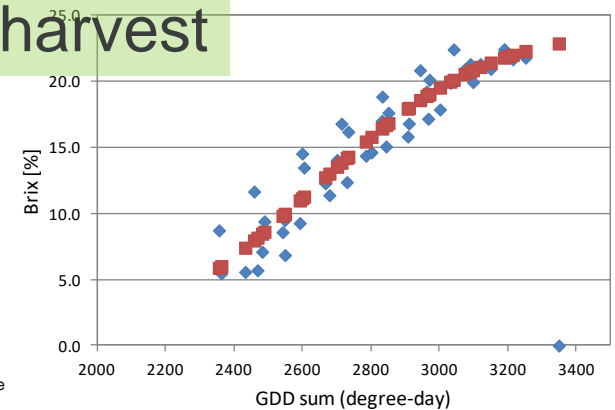- Uptake → f(supply & demand)

- Phenology → GDD

budburst
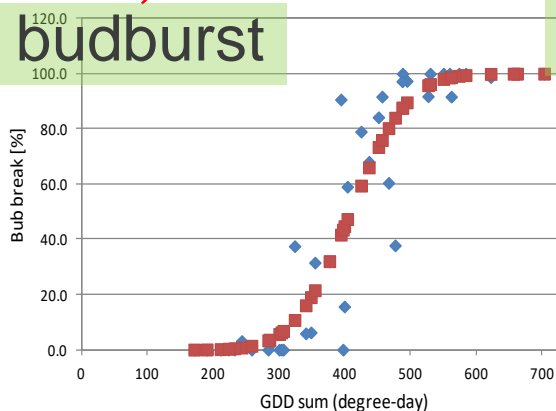
flowering
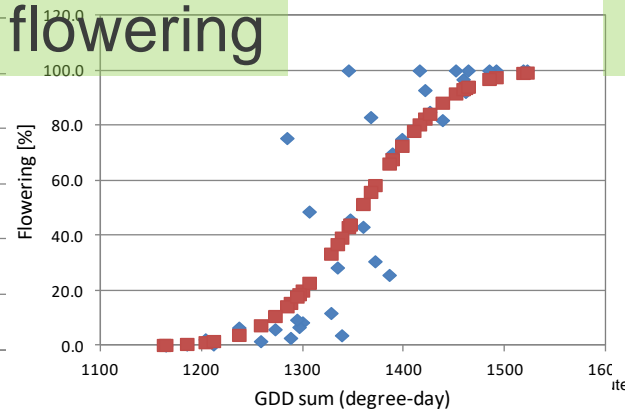
harvest

Sap Flow, Water Use & Leaf Area

Sauvignon blanc - sap flow

Data — Model

Sap flow [L/h] vs Day of year

Leaf/vine = 10 m²

$ET_c = 0.48\ ET_o$
$R^2 = 0.89$

Vine TR [mm/d] vs Potential ET [mm/d]

Crop factor = 0.48

$ET_c = 0.24\ ET_o$
$R^2 = 0.88\%$

Vine TR [mm/d] vs Potential ET [mm/d]

Leaf/vine = 2.5 m²

Crop factor = 0.24

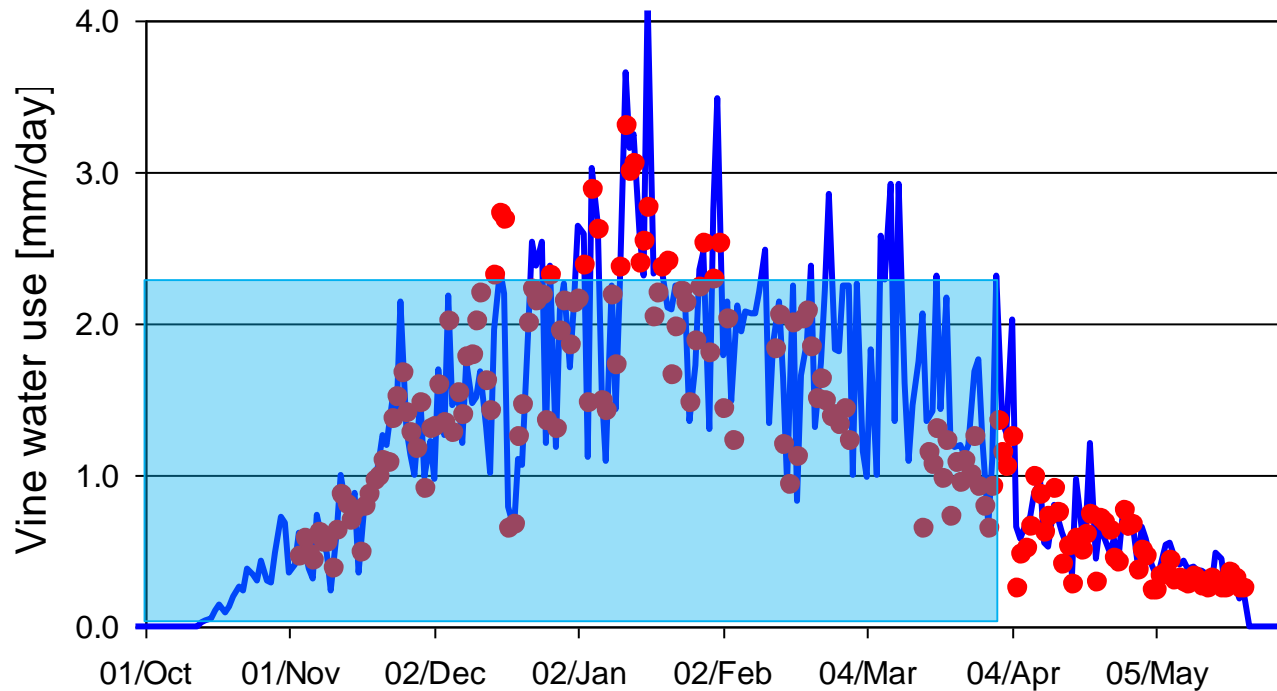The New Zealand Institute for Plant & Food Research Limited

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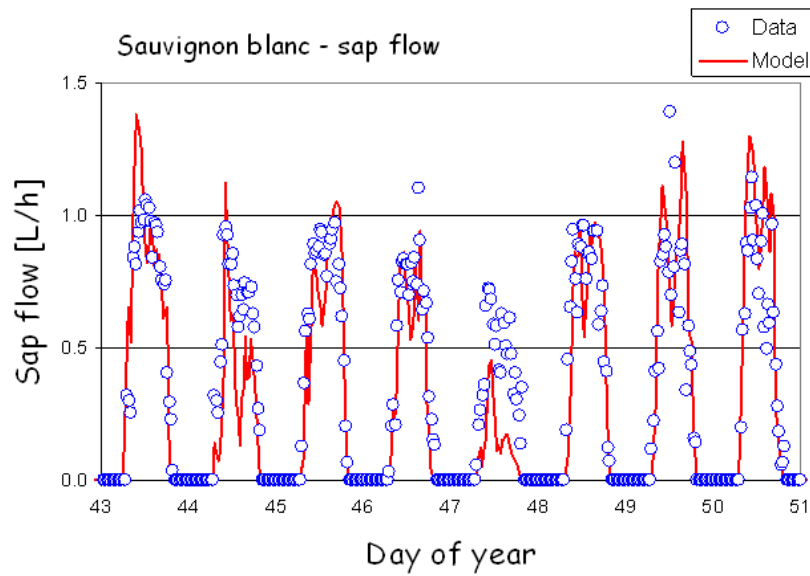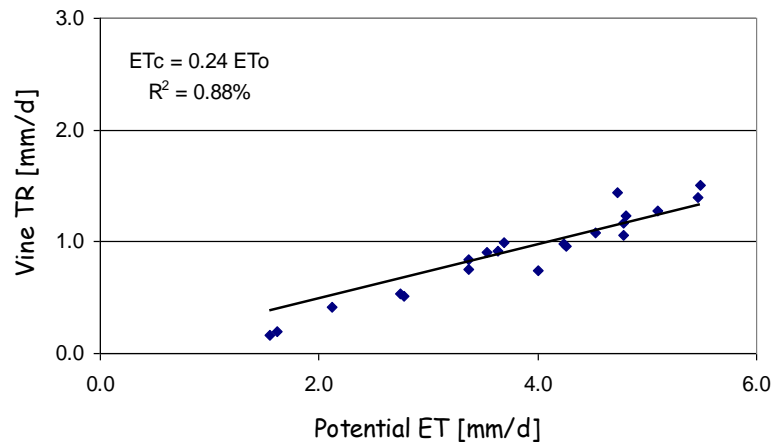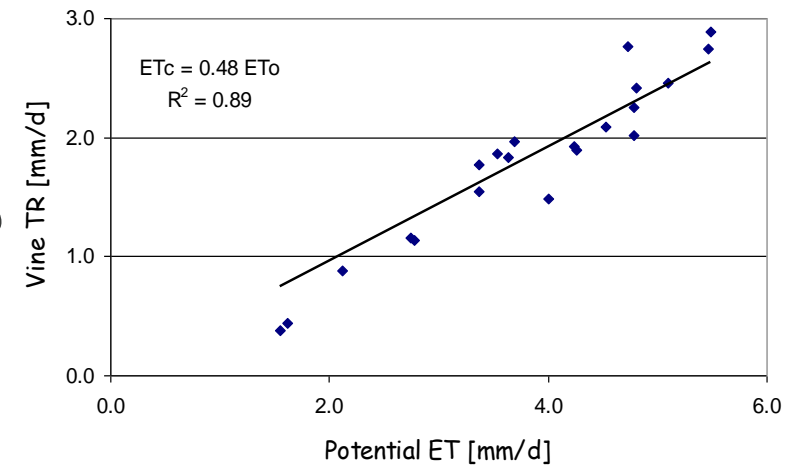
Vineyard Water Use [mm/d] scaled to Potential ET

Grape water use from sap-flow sensors (red) scaled to potential ET using a dual crop-factor approach (blue)

Current allocation: 2.2 mm/day from October to April

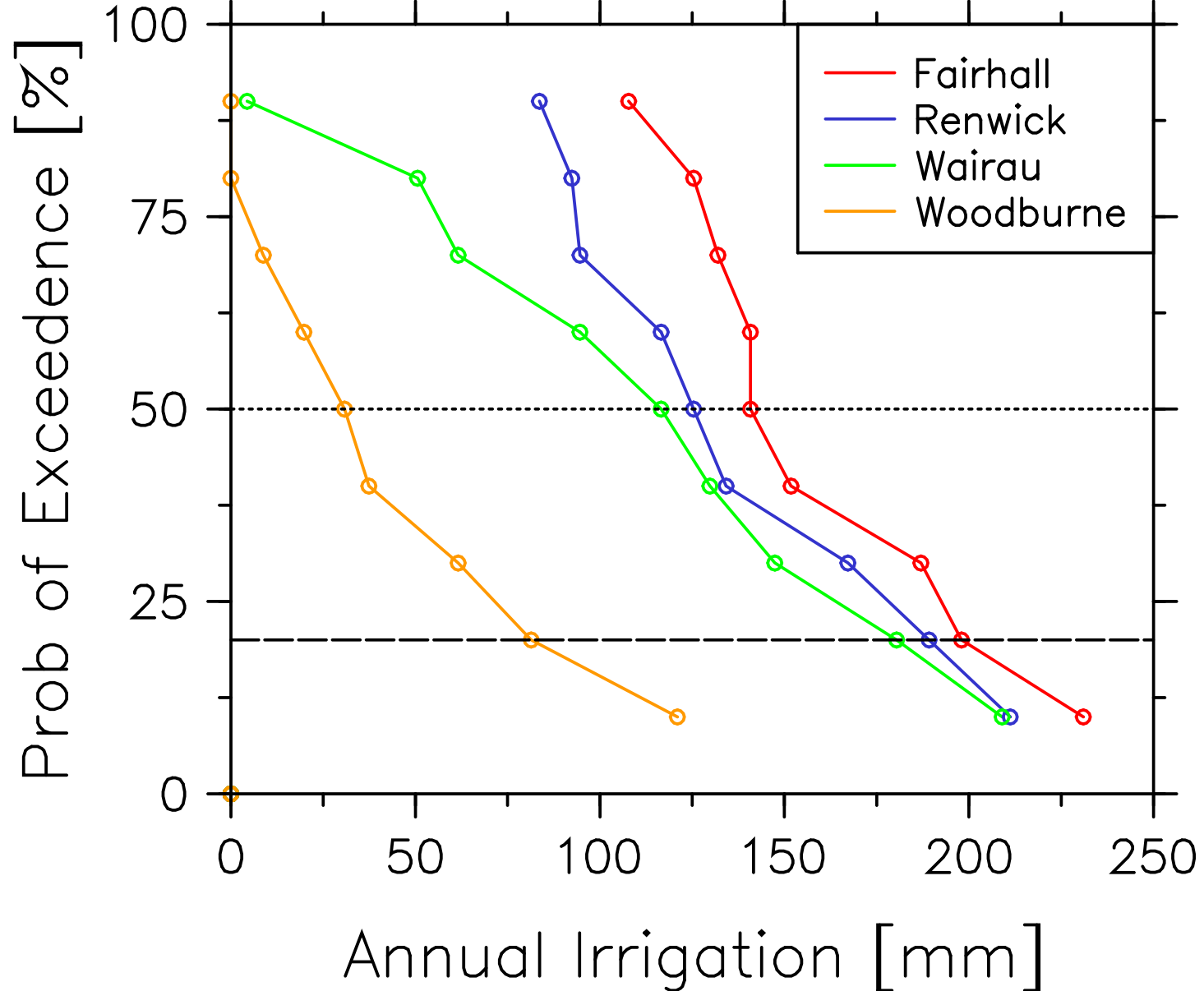The New Zealand Institute for Plant & Food Research Limited

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6

Modelling Allocation of Irrigation Water for Vineyards

Irrigation *Allocation*: A Tool for Policy & Implementation

Climate, crop & soil

SPASMO IRRIGATION ALLOCTION TOOL - Version 2.0 - for demo purposes only

MODEL INPUTS

Application details

Consent number: Joe Bloggs
Irrigated area: 10 [ha]

Water source:
☑ Ground
☐ Surface

Take rate: [l/s]: 1

Weekly Volume: 600 [m3]
Monthly Volume: 5000 [m3]

Select the input files

Climate station: Bridge_Pa
Crop type: Apple
Soil series: Hastings_silty_clay_loam

ETo [mm/yr]: 951.9
Crop T [mm/yr]: 722.2
TAW (mm/m): 212.4

Rainfall [mm/yr]: 759.3
Soil E [mm/yr]: 91.0
PAW (mm/m): 124.1

Calculate Outputs

Re-calculate
Export (csv)

Monthly Volume: 119.3 [mm/mon]
Annual Volume: 354.6 [mm/yr]

Water balance [mm/y]

	1:10 yr low	1:5 yr low	1:2 yr	1:5 yr high	1:10 yr high
Rainfall [mm/y]	603.9	643.4	736.1	860.9	943.5
Crop Transpiration [mm/y]	671.8	684.7	715.1	756.0	783.1
Annual drainage [mm/y]	40.5	59.8	105.3	166.4	206.9

Calculation Done

PE value

860.9
756.0
166.4

MODEL OUTPUTS

☐ 1:10 high
☑ 1:5 high
☐ Average

Seasonal Irrigation Requirements [mm/month]

Oct	Nov	Dec	Jan	Feb	Mar	Apr
0.0	18.7	94.1	119.3	90.4	62.5	24.1

HAWKE'S BAY REGIONAL COUNCIL

Annual Irrigation Requirements [mm/y]

1:10 yr low	1:5 yr low	1:2 yr	1:5 yr high	1:10 yr high
180.8	207.5	270.2	354.6	410.5

Set the Probability: 80
Application efficiency: 100

Exit

This tool is for HBRC Internal use only and is NOT to be distributed or copied. No liability is accepted for the use or mis-use of results generated by this tool.

Probability & system efficiency

Annual & monthly allocations (mm)

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