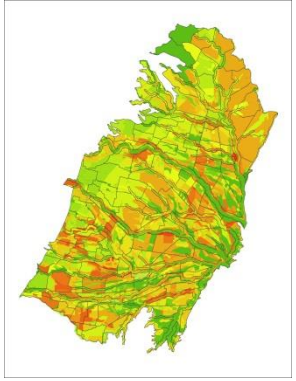

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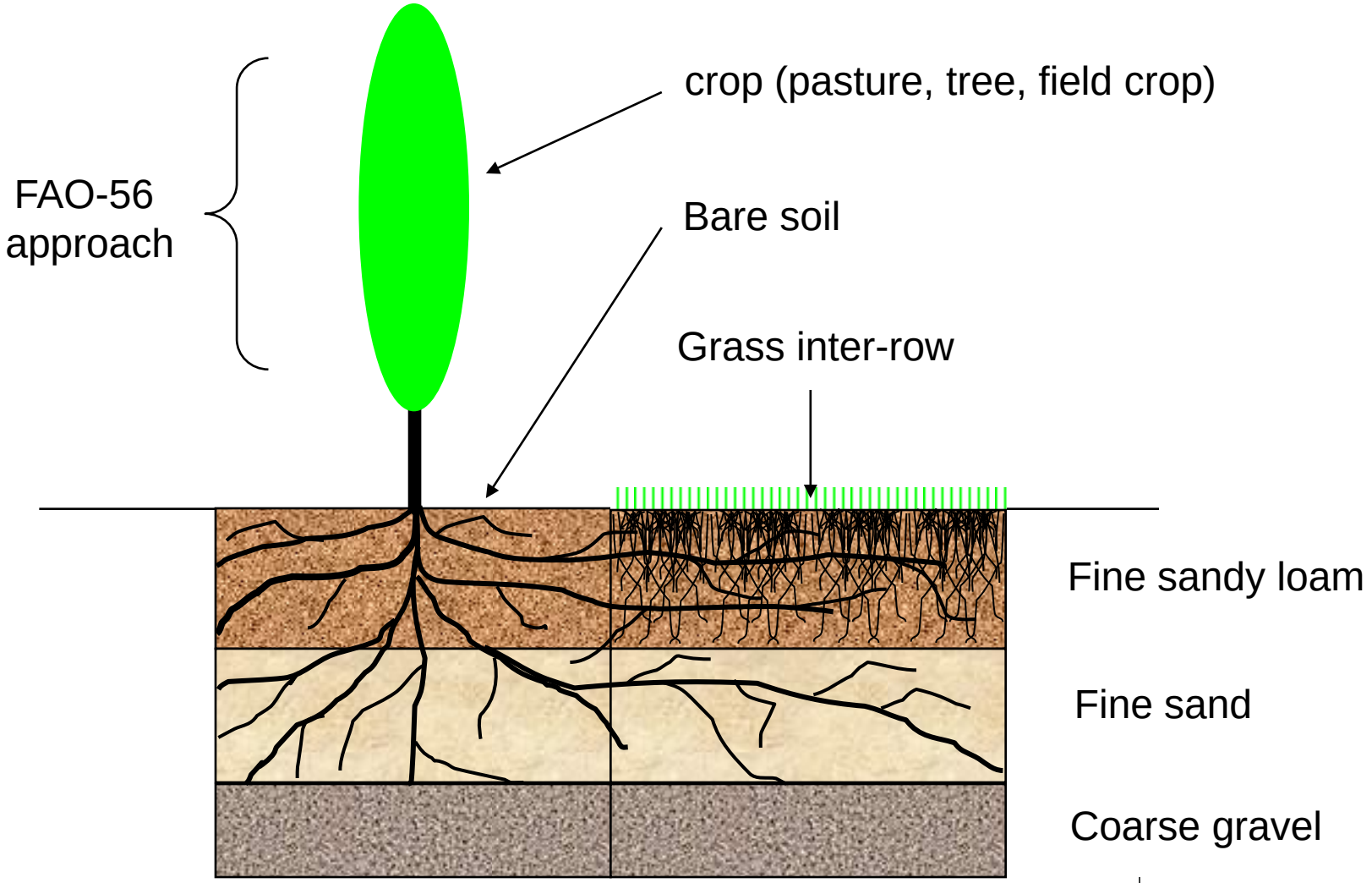
Modelling land use impacts using SPASMO, Waimea Plains

Steve Green, Plant & Food Research, Palmerston North

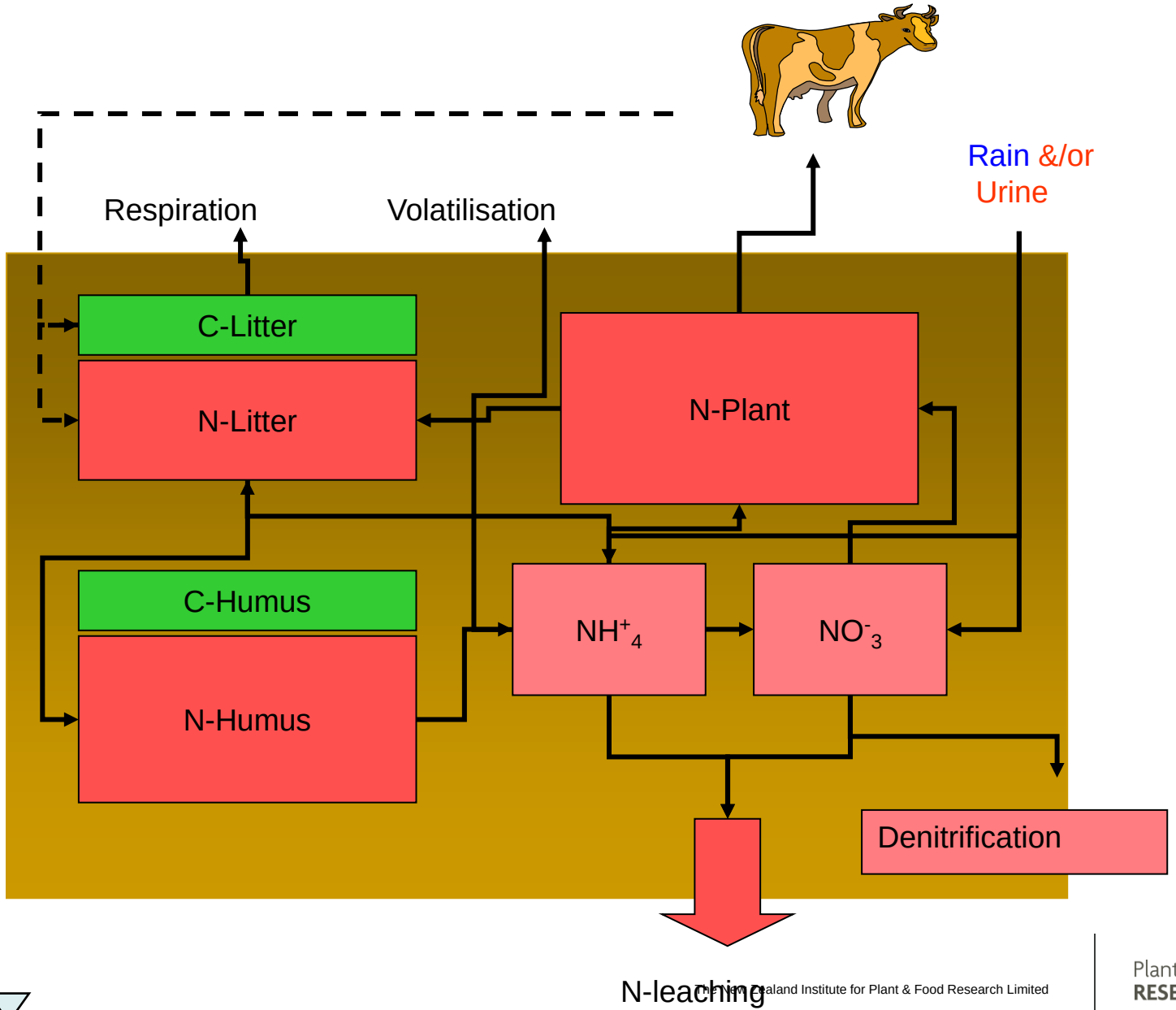
Andrew Fenemor, Landcare Research, Nelson

Landcare Research
Manaaki Whenua

A Soil-Plant-Atmosphere System Model of Water and Nutrient Fate



Soil processes & Nutrient dynamics



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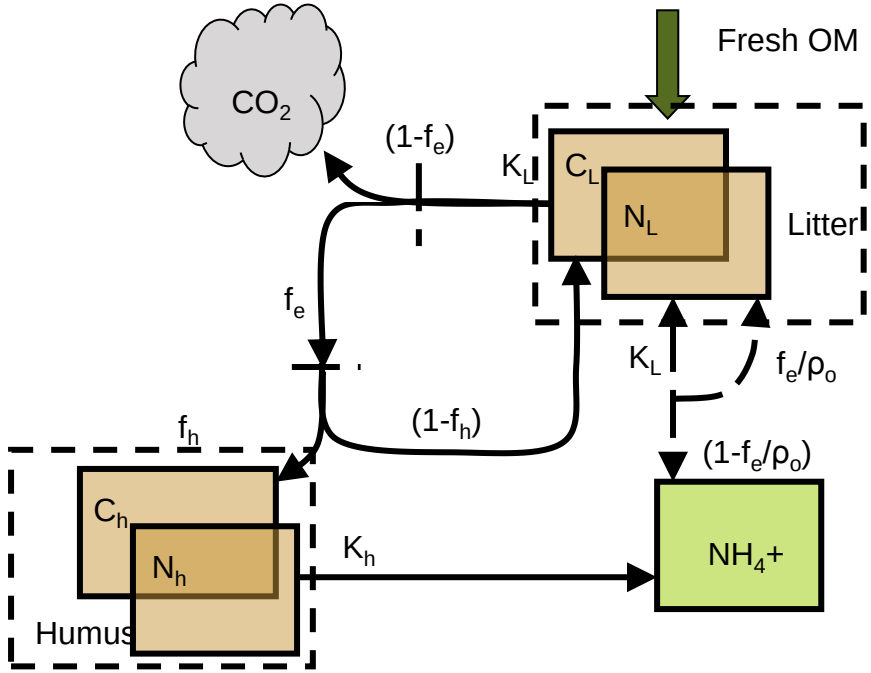
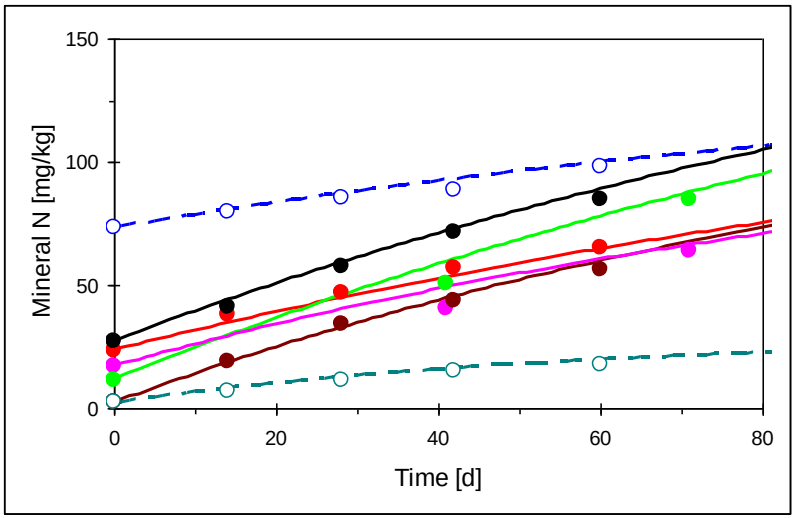
Mineralization of Soil OM



→ 3 pools - litter, humus, manure

→ 1st order rate constants (K's) and efficiency factors (fe, fh) and soil C:N

→ modified by temperature & moisture



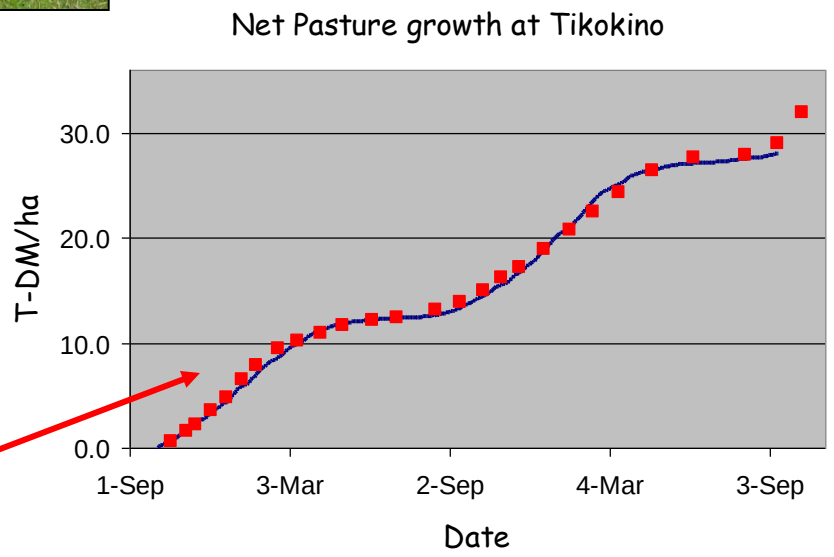
←parameterized using lab incubations

← sensitive to fraction of C_L and the K_L

Measuring & modelling pasture growth

- Pasture cuts every 3-4 weeks to assess growth and N uptake
- Pasture height before and after grazing to assess feed intake

- Pasture growth depends on sunlight & temperature and the availability of soil water and soil nitrogen (consider all other factors to be non-limiting)
- Production ~15 T DM/ha



Feed requirements and production

Animal sub-model

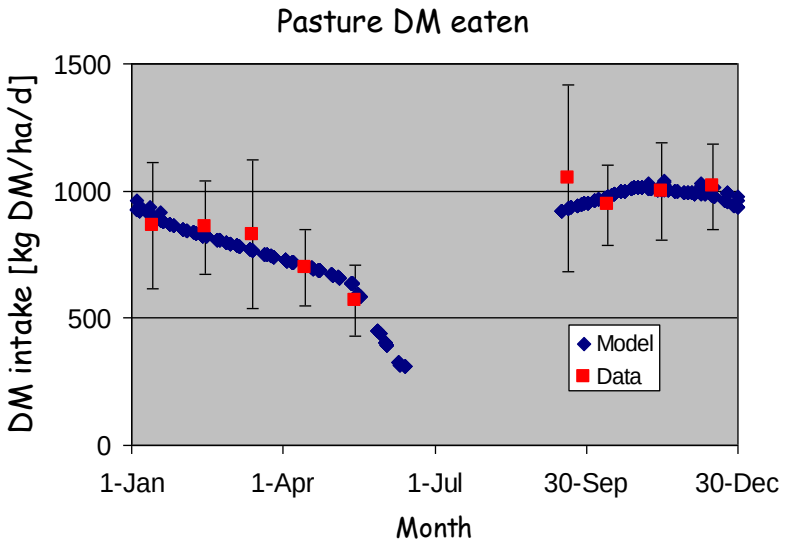
→ rotational grazing

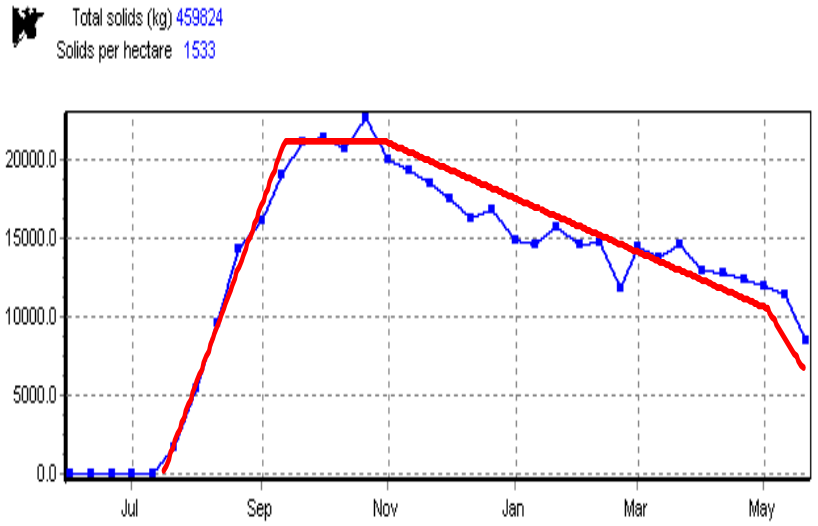
→ match feed intake to production

→ bring in supplements as required

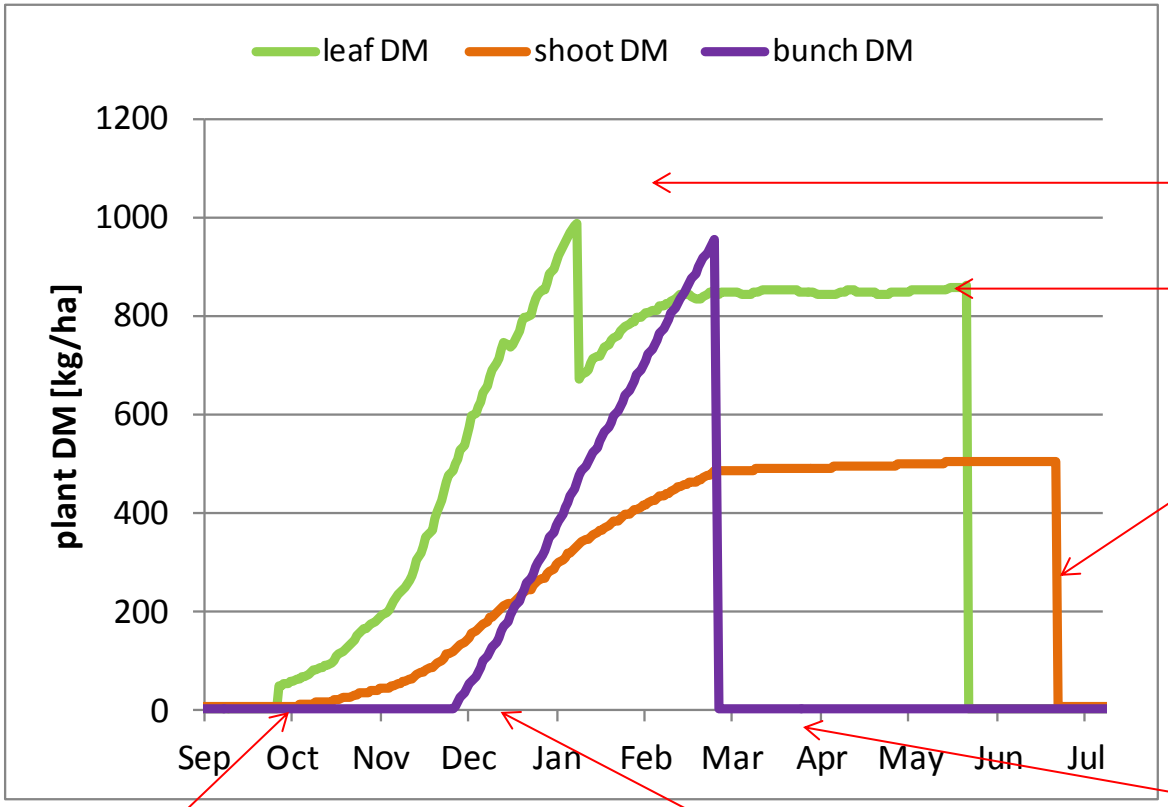
→ dung and urine returns

→ dairy effluent to part of the farm





Crop growth and nutrient uptake → grapevines



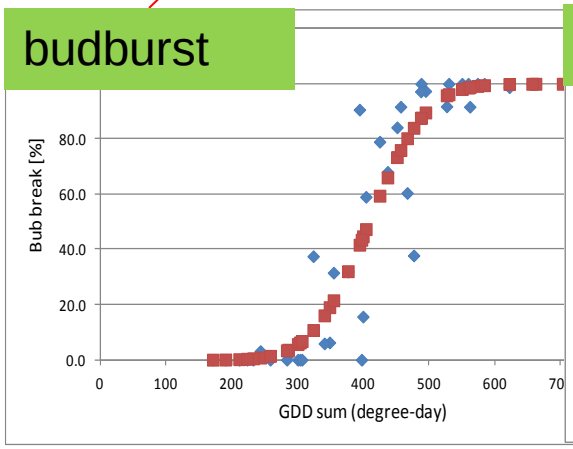
Trimming (LAI ~ 1.0)

Leaf fall

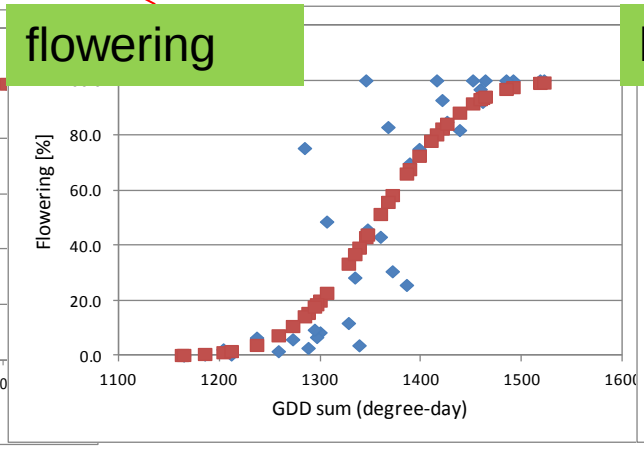
Winter pruning

- phenology → GDD
- growth → f(Rg, Ta, W, N)
- uptake → f(supply & demand)

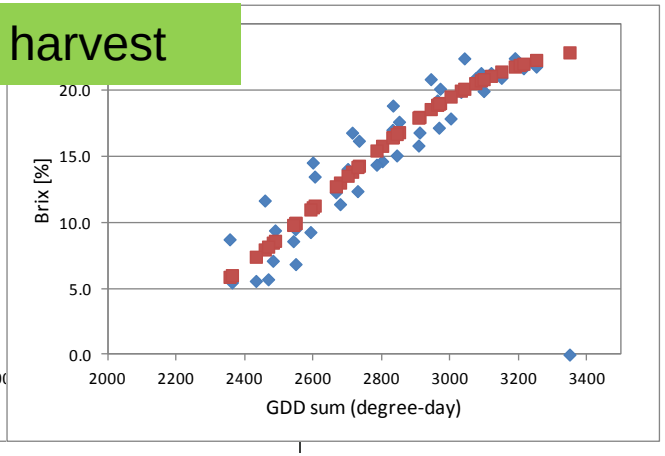
budburst



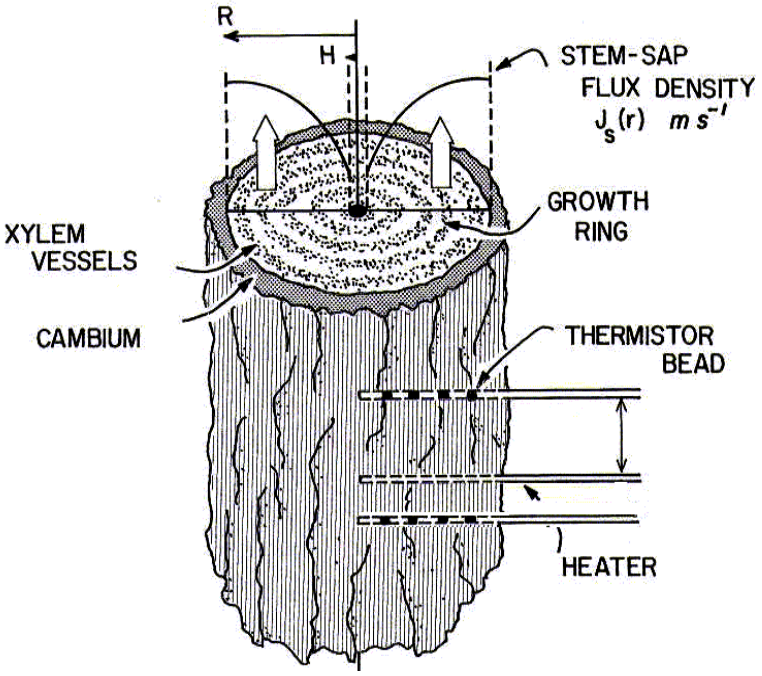
flowering



harvest

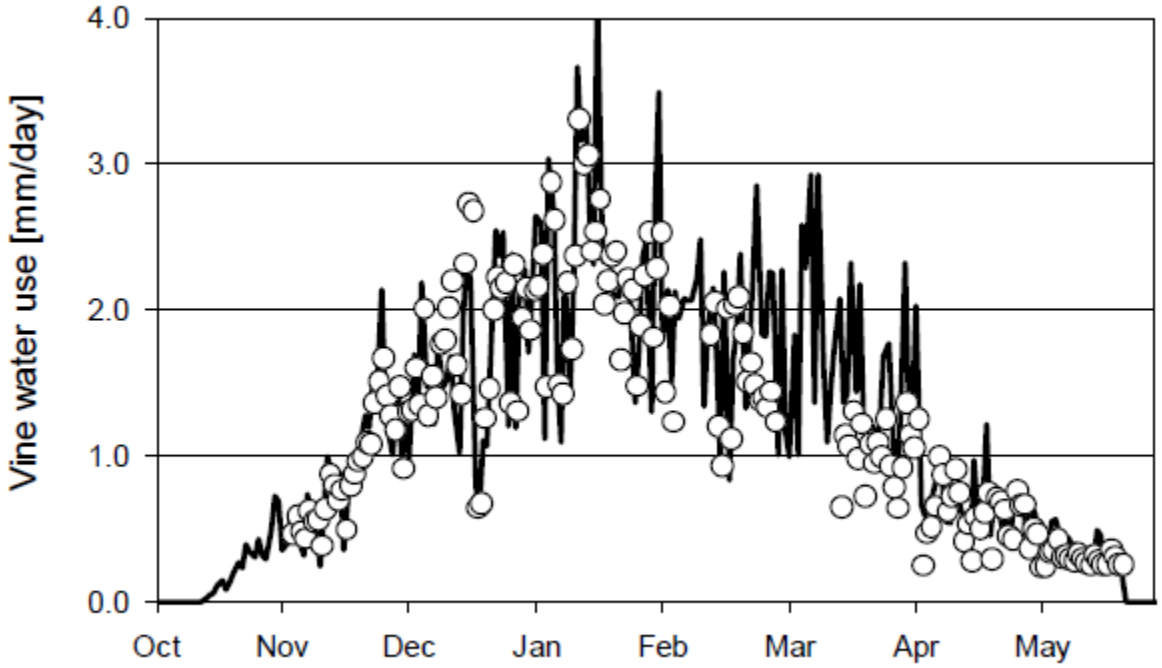


Tress water use by the heat-pulse method



- Sap-velocity profile recorded at 2-6 depths below the cambium
- integrate to get volumetric sap flow [5-10 L/h in mature apple trees]

Vine water use [mm/d] is scaled to potential ET



Vine water use measured with sap flow sensors (markers)
→ scaled to potential ET using a 'crop factor' approach

Soil water content by time domain reflectometry

Automatic TDR – every 6 hours

Soil's volumetric water content [L/L]

Array of probes – from 0-200 cm

Measurements in the control treatment

Water stored in the root zone

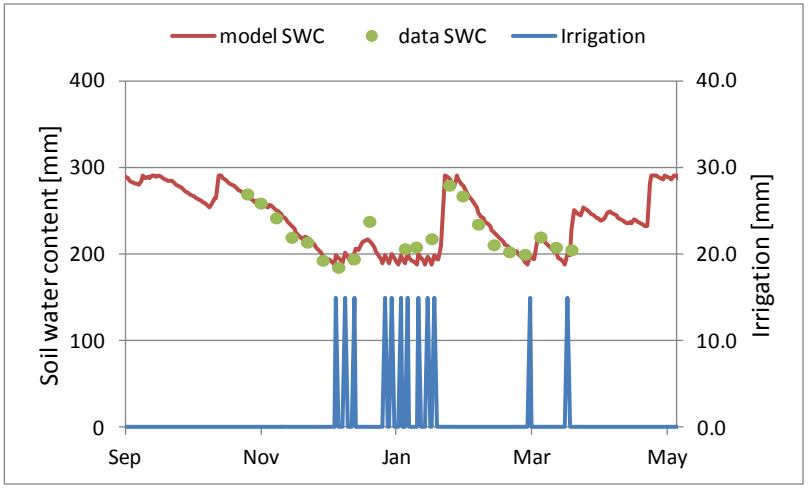
S = stored water [mm]

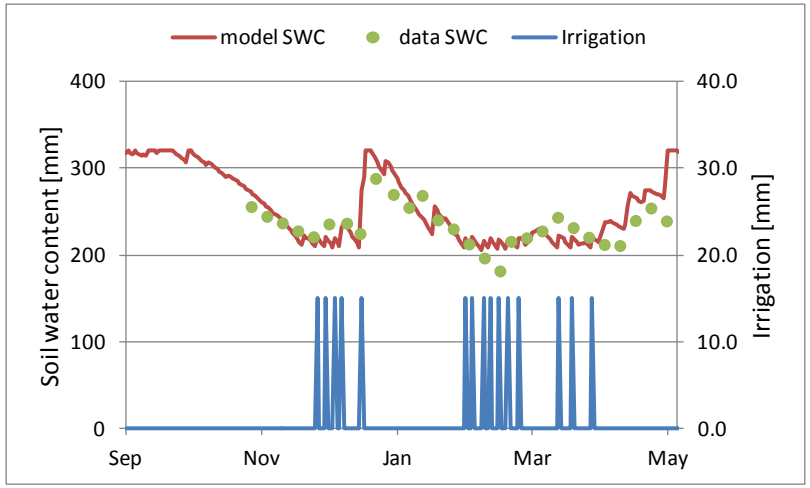
T = average water content [L]

Z = root zone depth [mm]

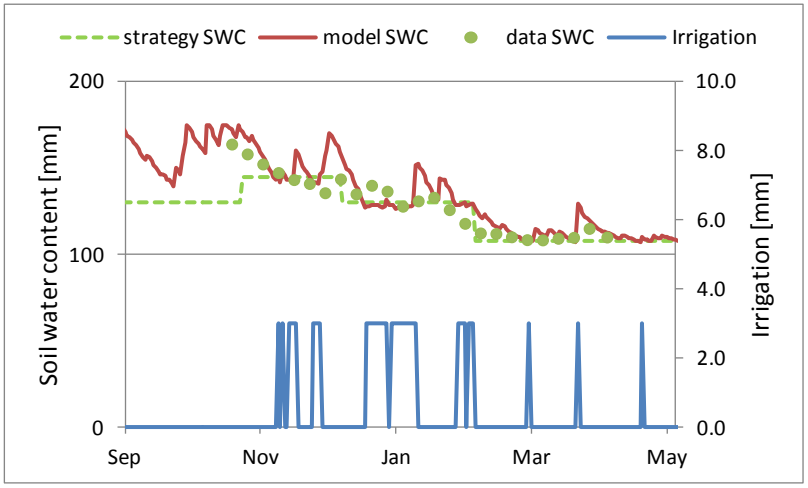
S = T times Z

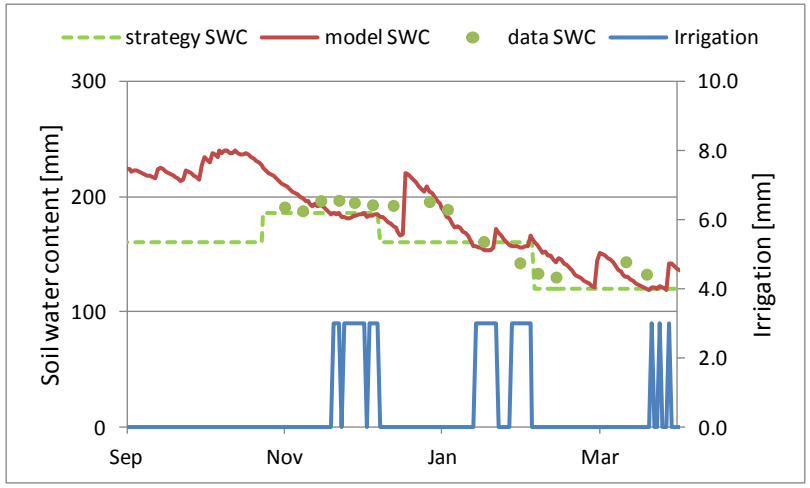
Using growers data to verify the calculation procedures





Apples





Grapes

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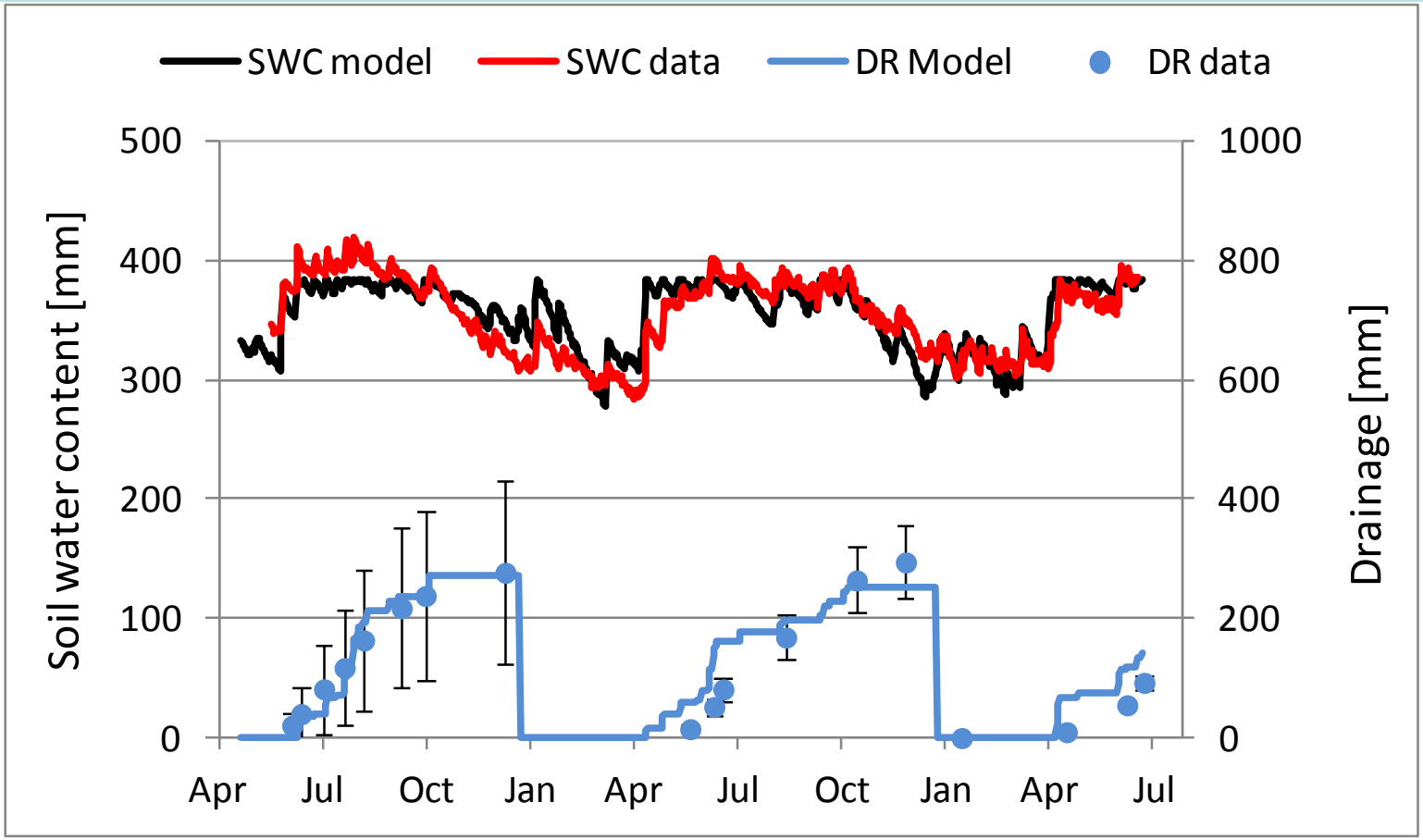
Sensors installed to measure drainage

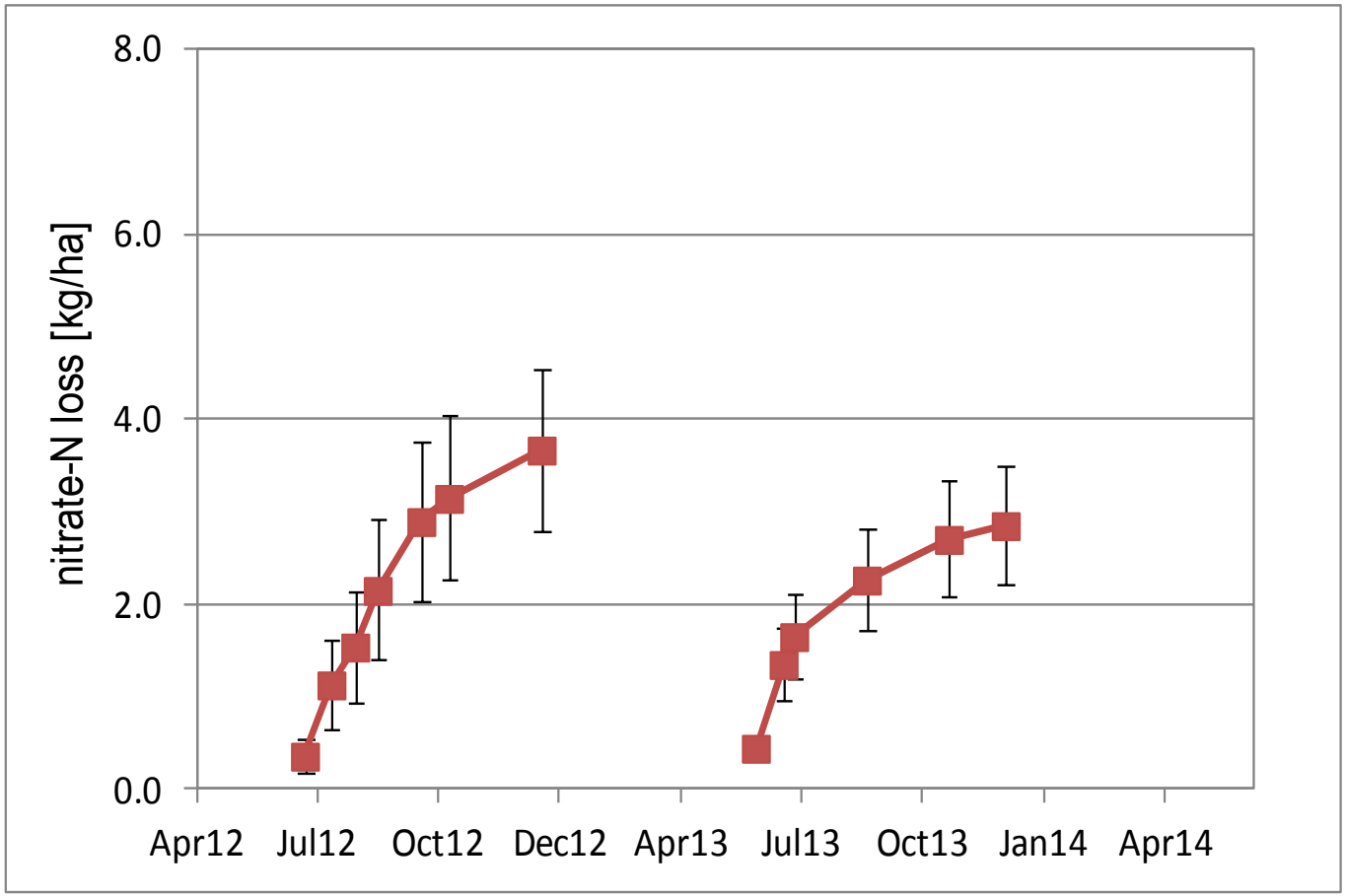
- Sensors were installed in the Motukawa vineyard at Giffords Road
- Our presentation provides an update of trial results where we are measuring nitrate loss under vineyard soils on the Wairau Plains.

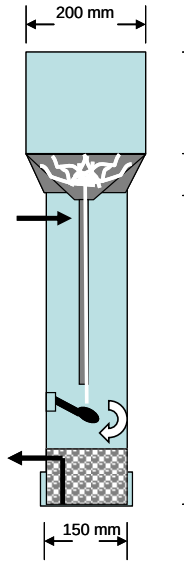
Soil water balance for the vineyard



- A simple water balance model to estimate changes in soil water content & drainage losses from the vineyard
- This data will be useful in estimating recharge rates and testing models of the land surface & groundwater interactions

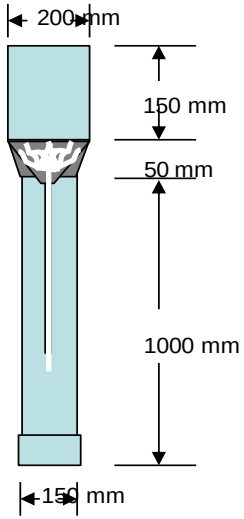
Cumulative losses of Nitrate-N

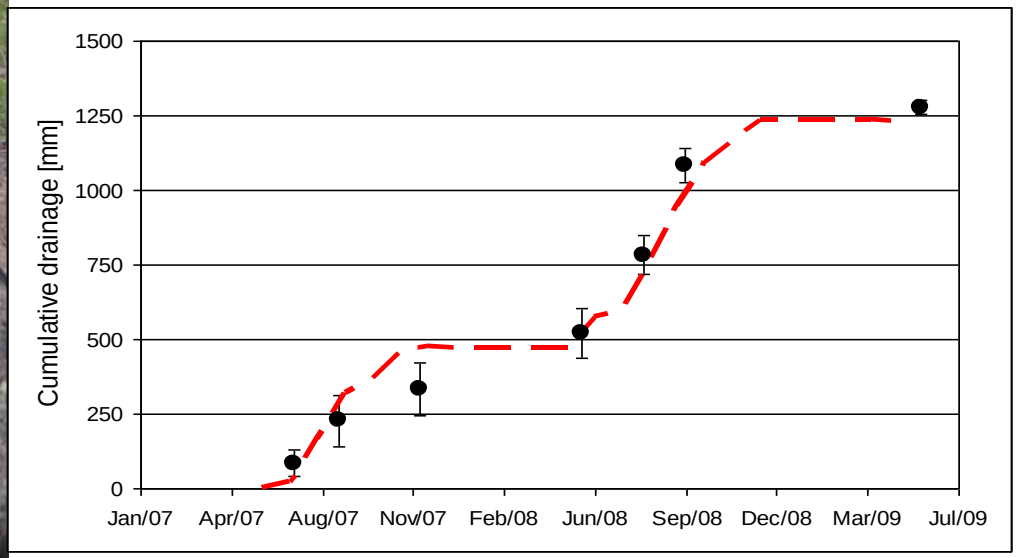




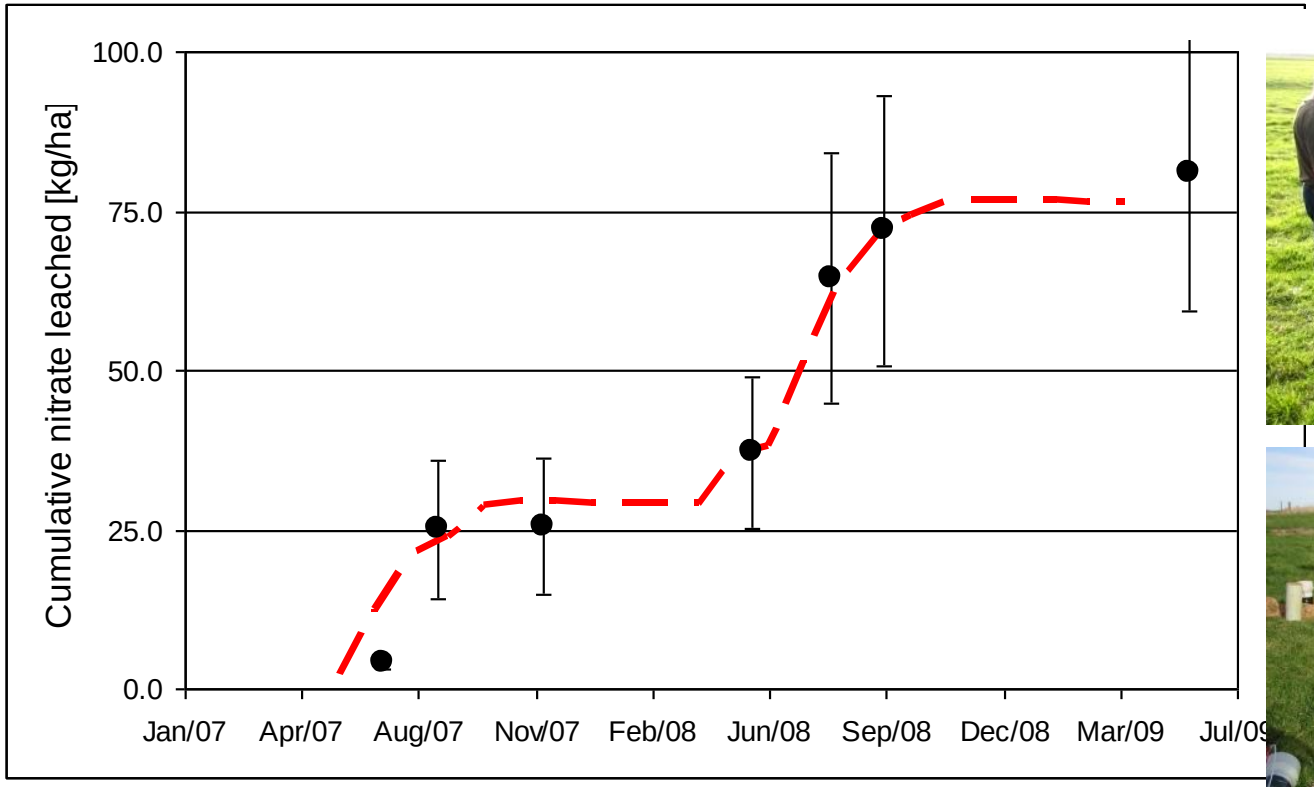
- The NO_3-N leaching is approximately 3-4 kg/ha/yr.
- The NH_4-N leaching rate is quite small (< 0.5 kg/ha/yr)

Drainage meters for water and nutrient fluxes





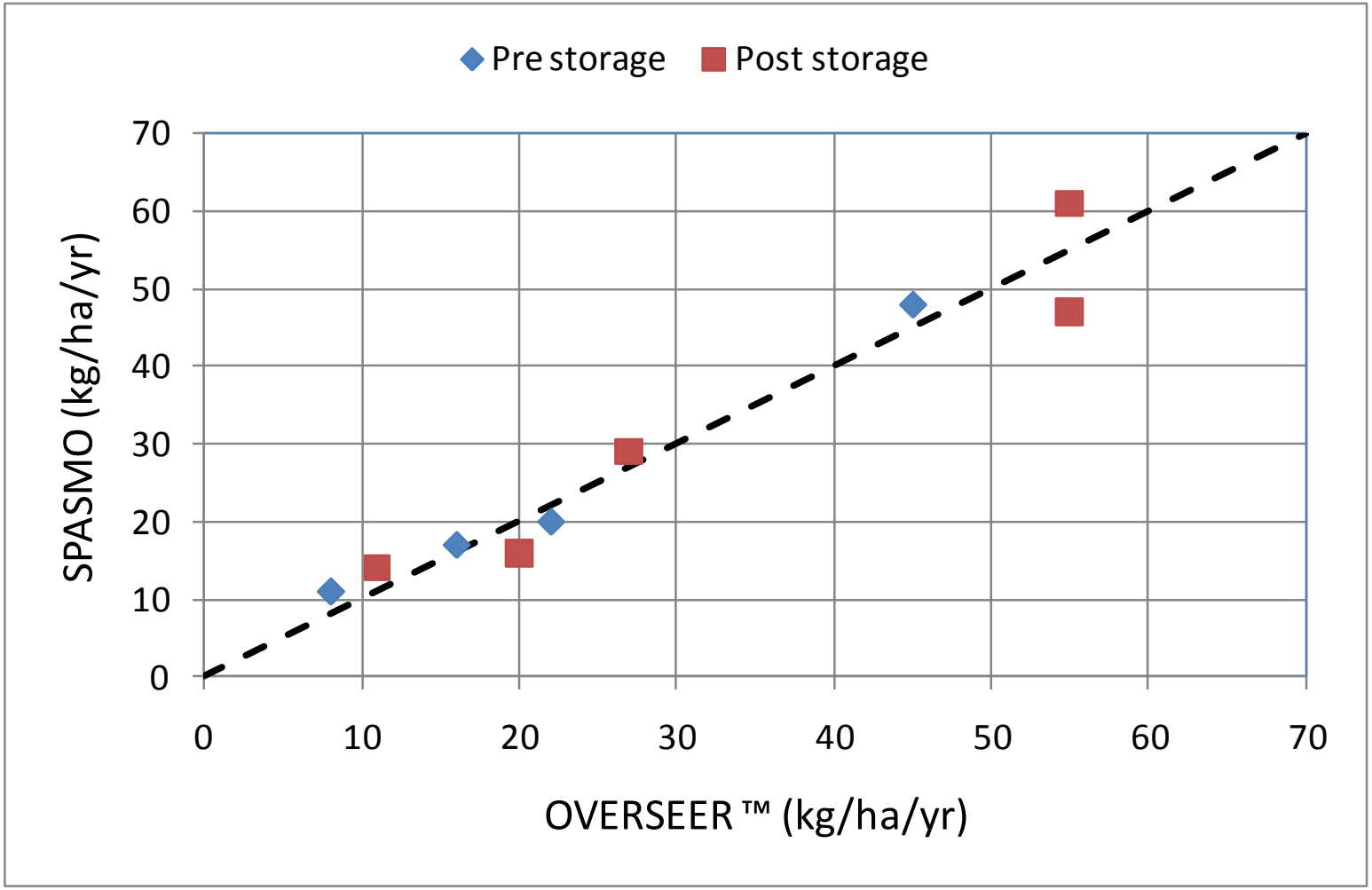
Modelling nitrate leaching under Dairy



- Drainage samples from 45 suction lysimeters
- 50 cm depth on three separate paddocks)
- Large coefficient of variation in the data

Ravensdown

Comparing the annual leaching losses



Nitrate Losses from Waimea Plains Farm Systems: Initial Results for Discussion by Waimea FLAG

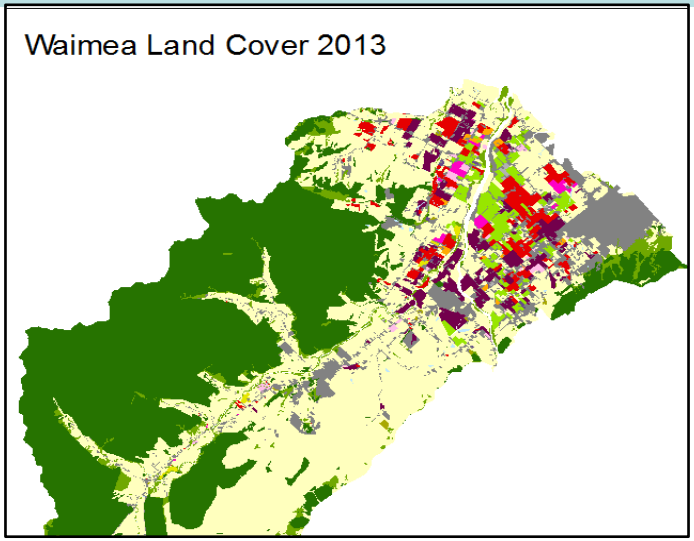
SPASMO model of four farm types

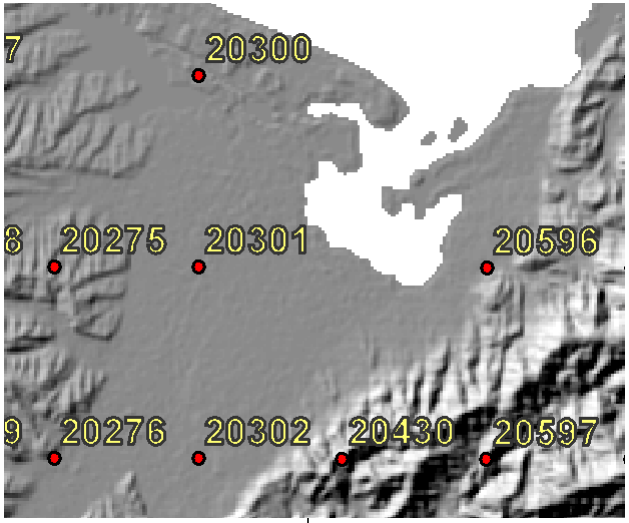
- Grapes – a typical vineyard
- Pipfruit – a typical apple orchard
- Dairy – a typical dairy farm
- Outdoor vegetable production

On Four Soil Types

- Ranzau very stony silt loam
- Waimea & Motupiko silt loams
- Wakatu & Dovedale silt loams
- Richmond silt loam

And One virtual climate (VCSN 20302)





Soil Groups and Hydraulic Parameters (1m of soil)

Soil#	Soil Group	Saturated soil water content (mm)	Field Capacity FC (mm)	Stress Point (mm)	Wilting Point WP (mm)	Total Avail. Water TAW (mm)
1	Dovedale silt loam (& Wakatu)	338	208	136	84	124
2	Ranzau stony silt loam	408	149	78	39	110
3	Richmond silt loam	430	344	239	146	198
5	Waimea silt loam & sandy loam; (& Motupiko)	399	287	188	112	175

Model outputs → a soil water balance

Water balance [mm/year] - Pasture					
Site number	1	2	3	4	5
ET crop	979	977	981	980	980
Rainfall	1056	1056	1056	1056	1056
Irrigation	557	523	507	536	517
Drainage	375	470	316	473	459

Example of a pasture water balance

** model includes intercepted rainfall losses and runoff (not shown)

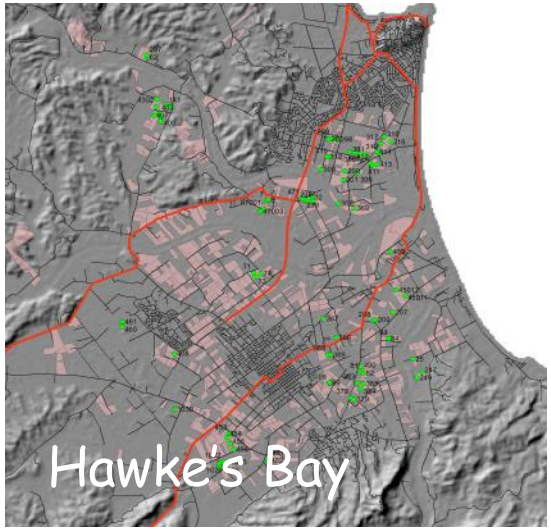
Irrigation demand with scenario modelling of water restriction rules

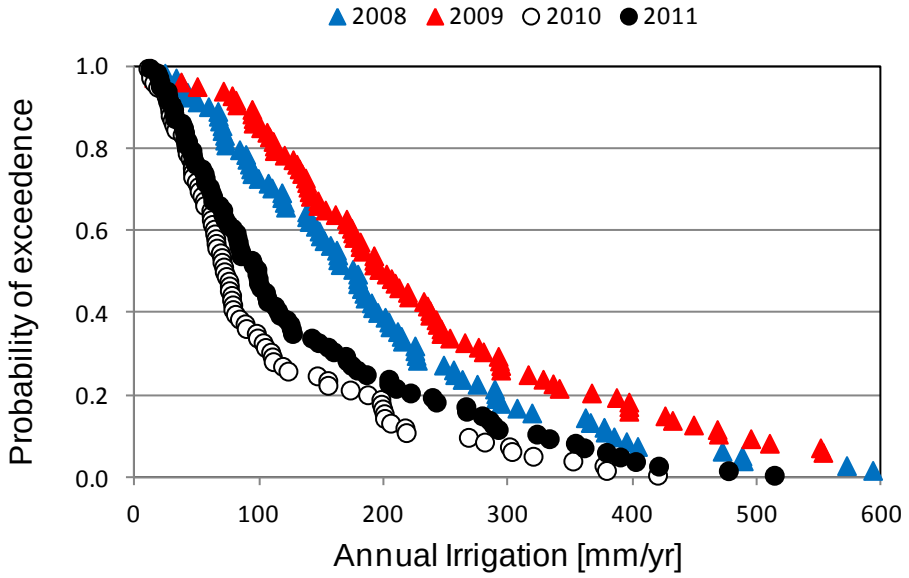
Water balance [mm/year] - apples					
Site number	1	2	3	4	5
ET crop	535	546	575	583	568
ET alley	259	222	260	246	251
Rainfall	1056	1056	1056	1056	1056
Irrigation	116	104	103	91	103
Drainage	234	317	173	247	273

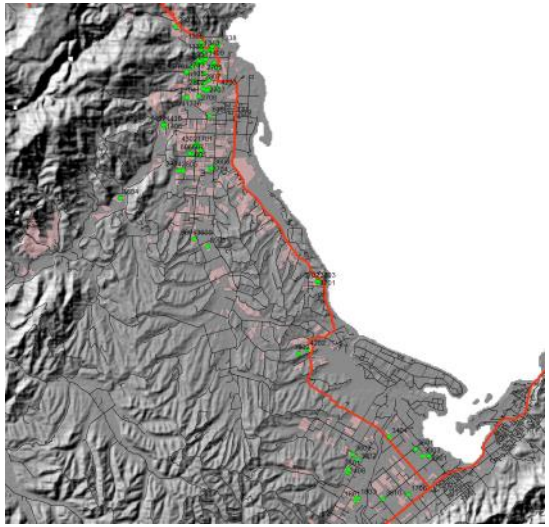
Example of a orchard water balance

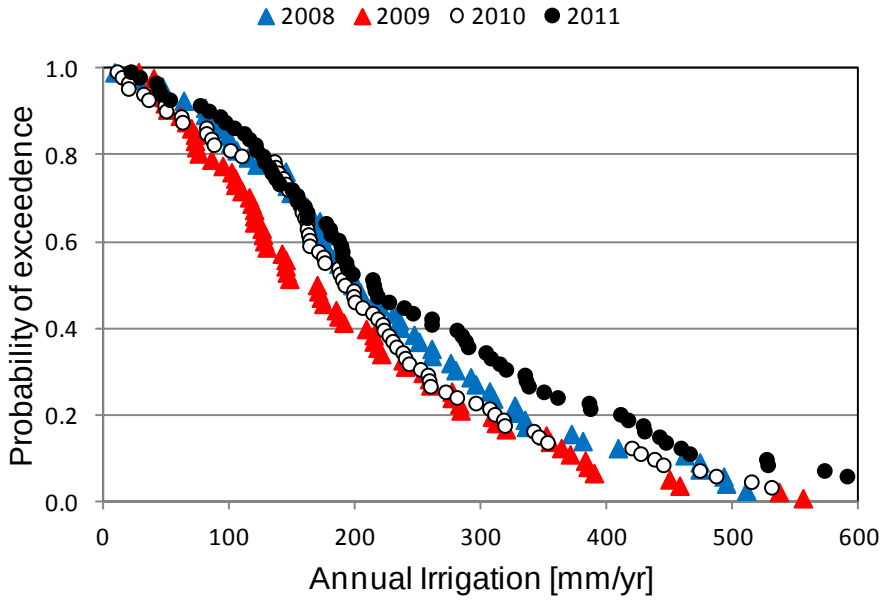
** model includes intercepted rainfall losses and runoff (not shown)

Growers' Irrigation Practices Surveyed

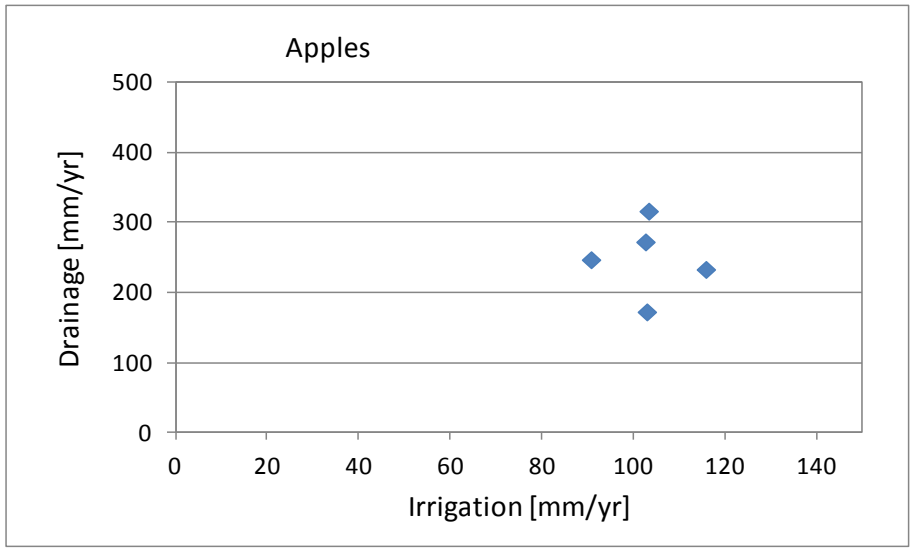


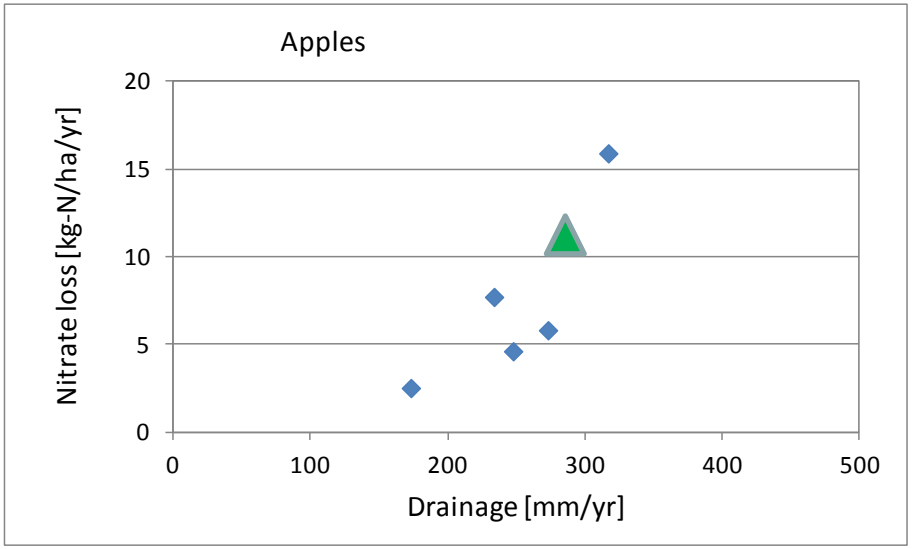


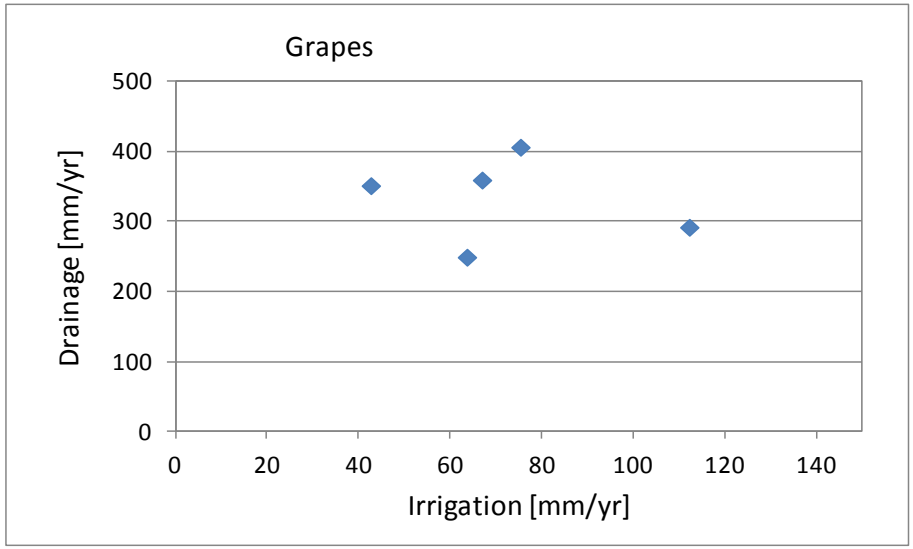


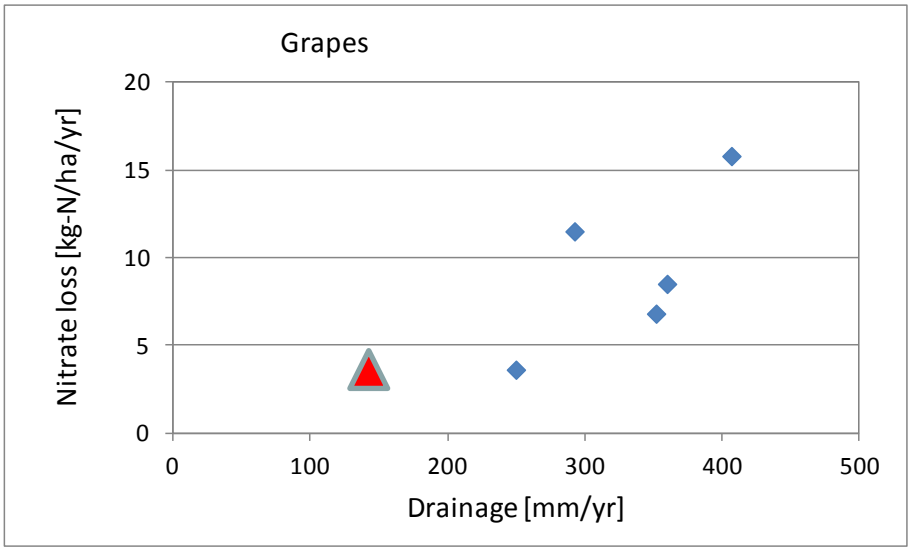


Long term average – tree crops









▲ Apple data - Hawkes Bay ▲ Grape data - Blenheim

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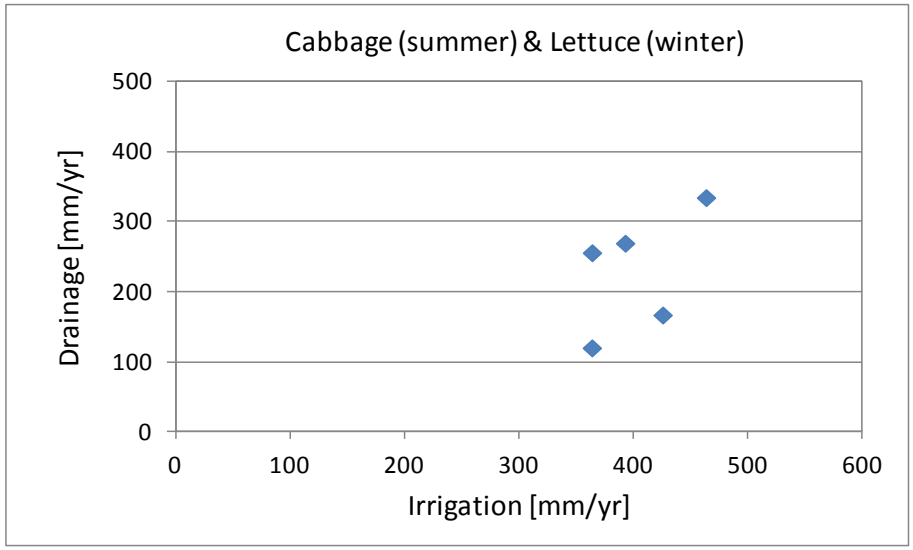
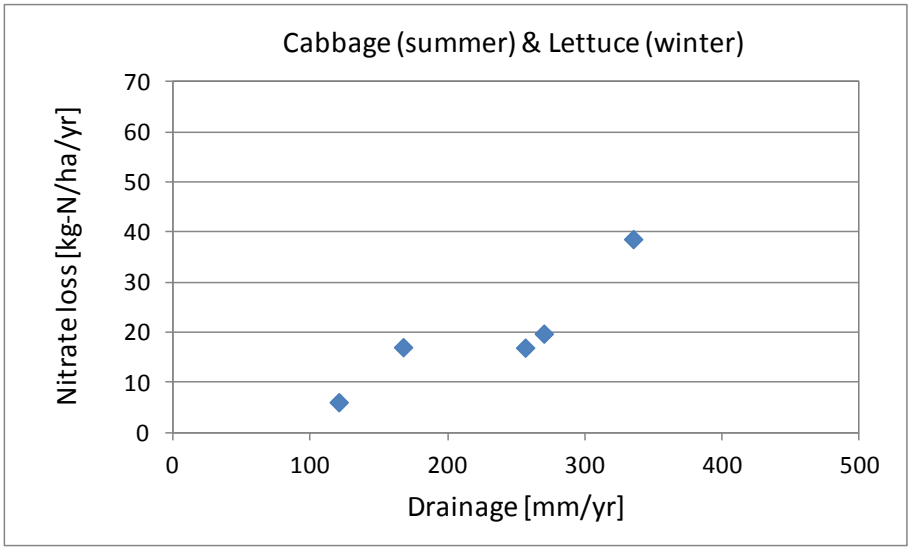
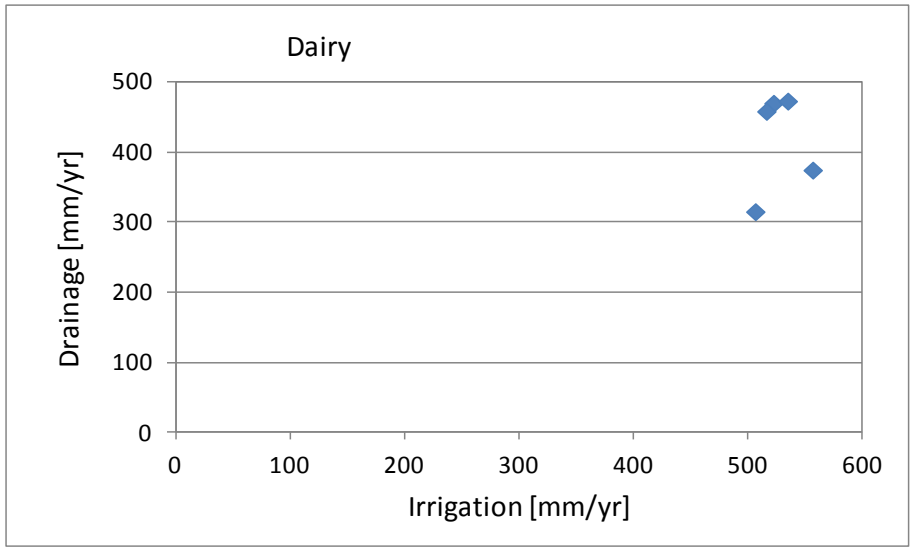
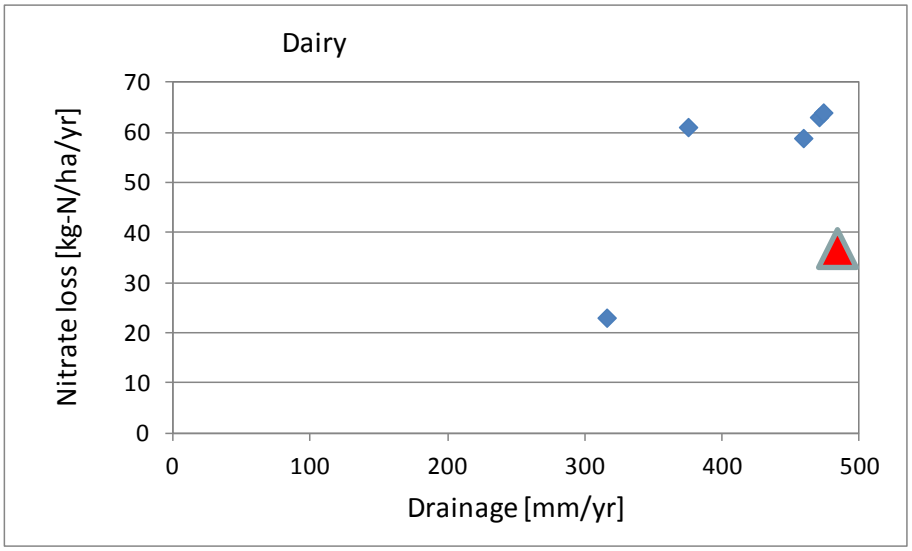
Long term average – field crops









Data – Taupo (dry-land dairy (2.4 cows/ha)

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Modelled average annual nitrate losses by crop and soil type, kgN/ha/yr

LAND USE/ FARM SYSTEM	Ranzau soil	Waimea & Motupiko soils	Wakatu & Dovedale soils	Richmond & Heslington soils	Proxy soil for S&Beef * includes all other soils	Proxy soil for forest & scrub
Dairy pasture	64.7	58.8	62.3	22.8		
Apples (also applies to Berries, hops, kiwifruit, avocados)	18.3	6.6	9.3	3.1		
Grapes (also applies to olives, small nuts)	18.3	9.8	13.6	4.3		
Outdoor vegetables (also applies to nurseries, glasshouse)	56.4	35.3	34.7	18.5		
Other pasture/lifestyle block/non-agricultural (assumes extensive sheep & beef land use)					~10.7	
Forest, scrub						2.5

Modelled Nitrate-Nitrogen Losses, Waimea lowland catchment

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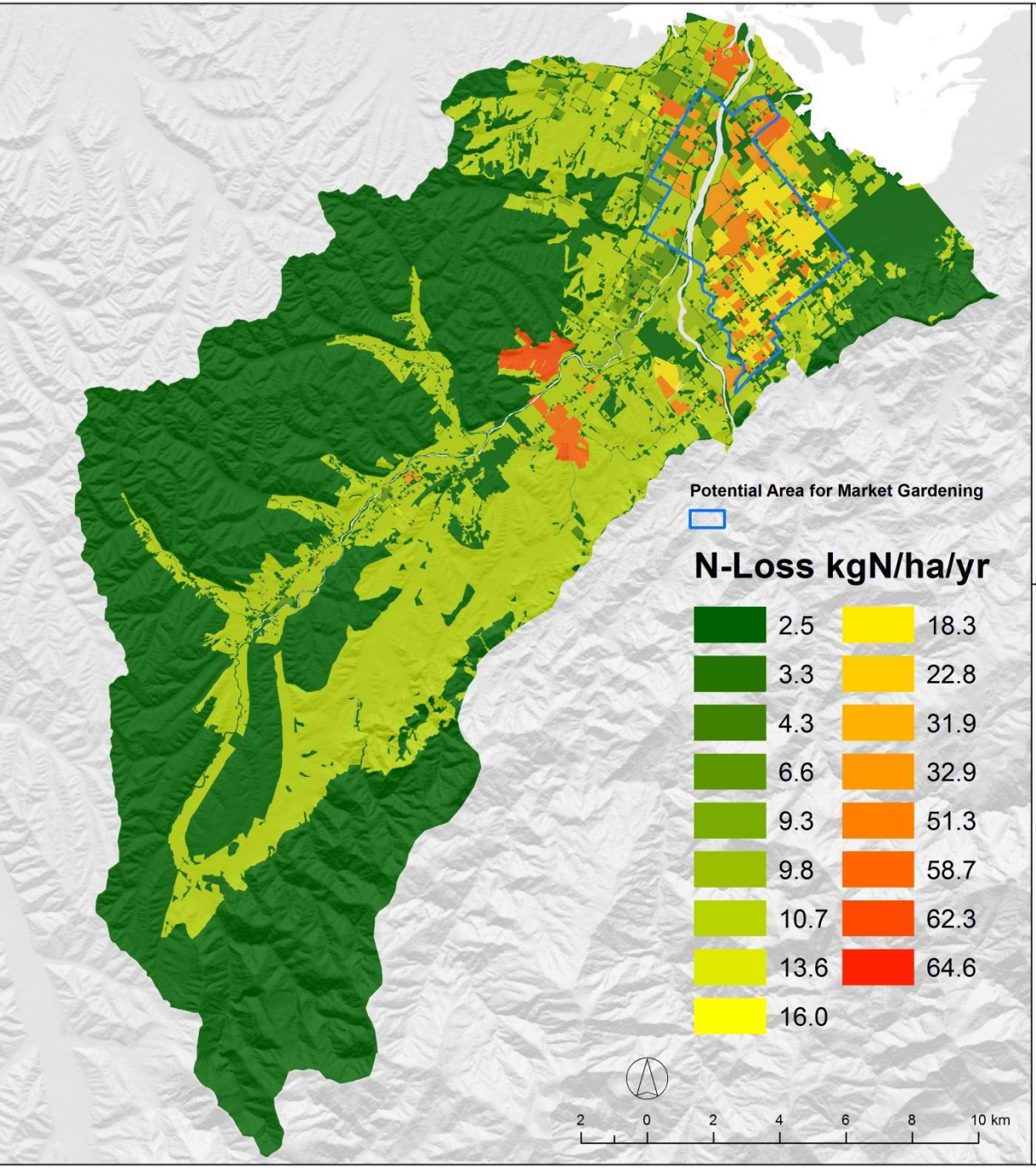
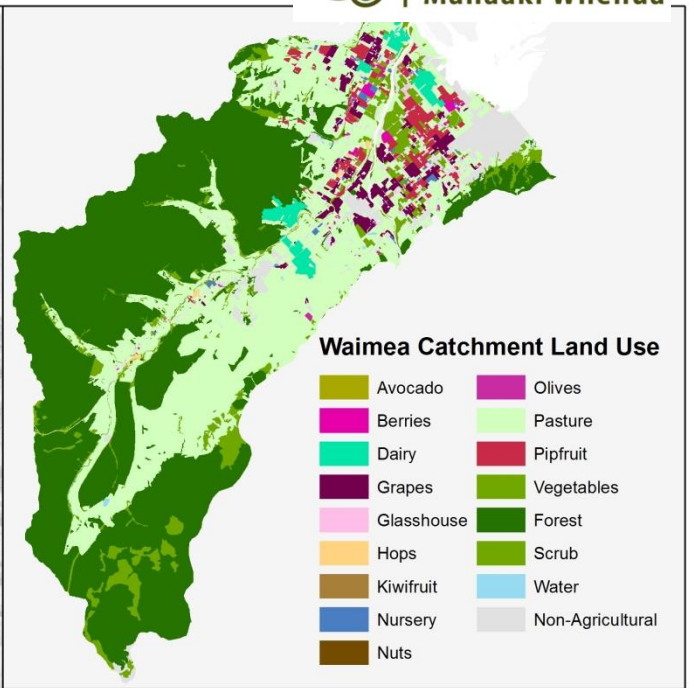
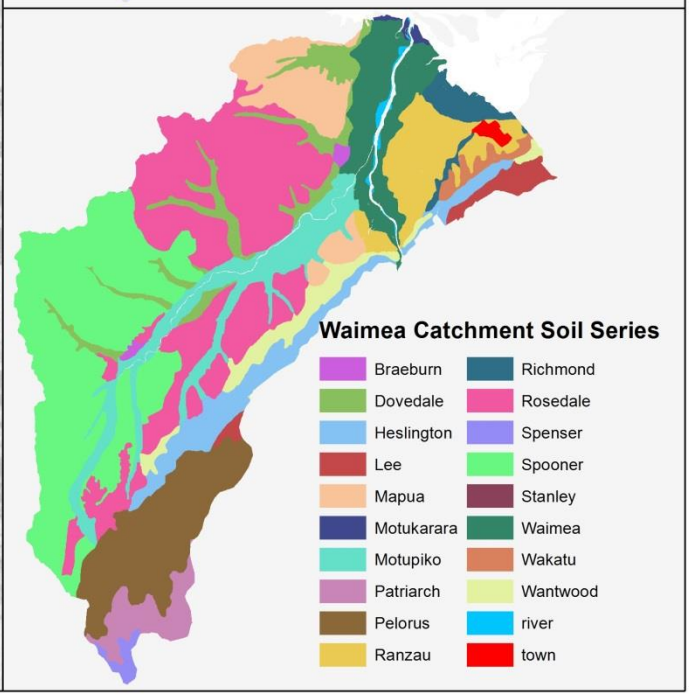
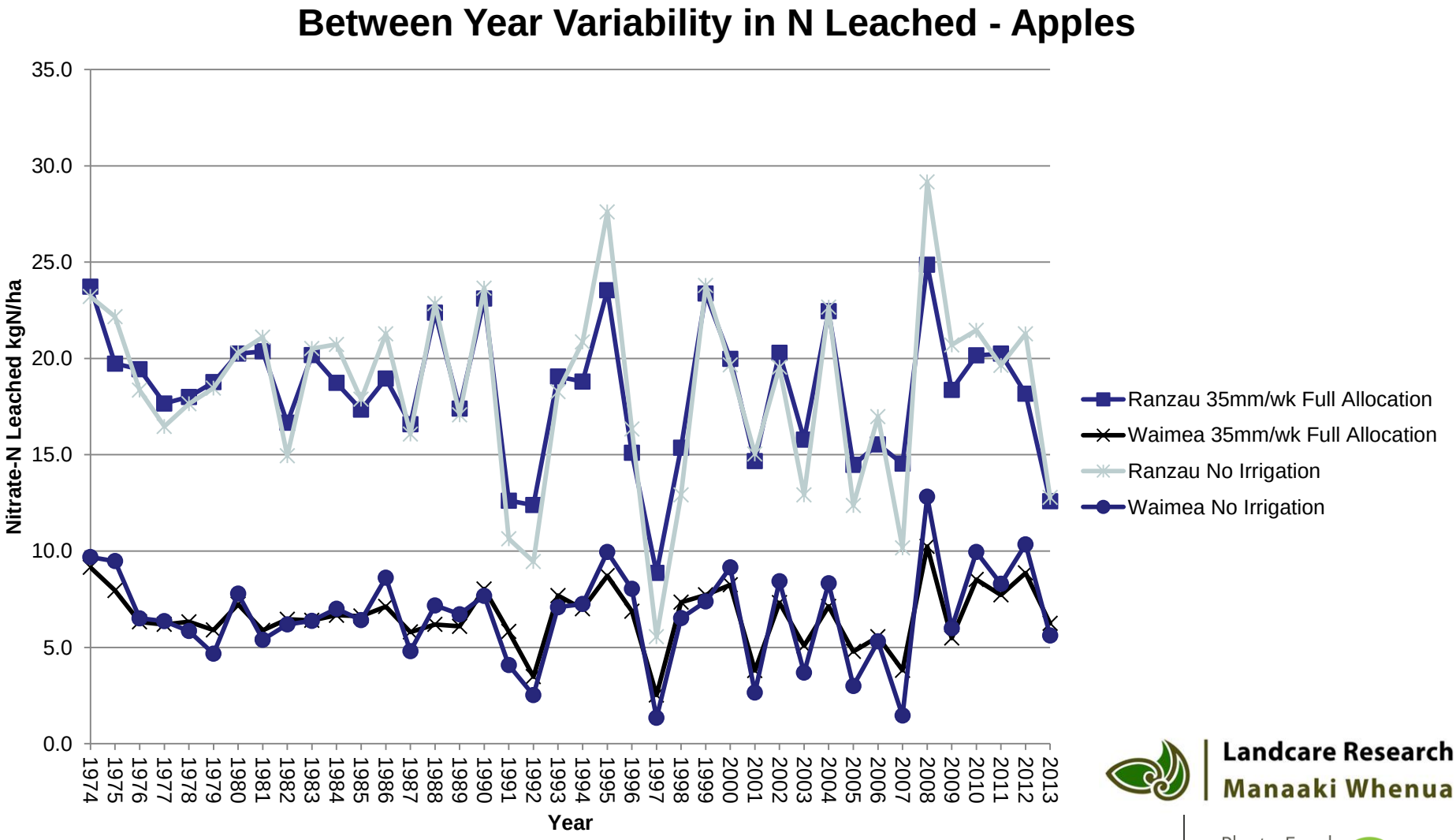


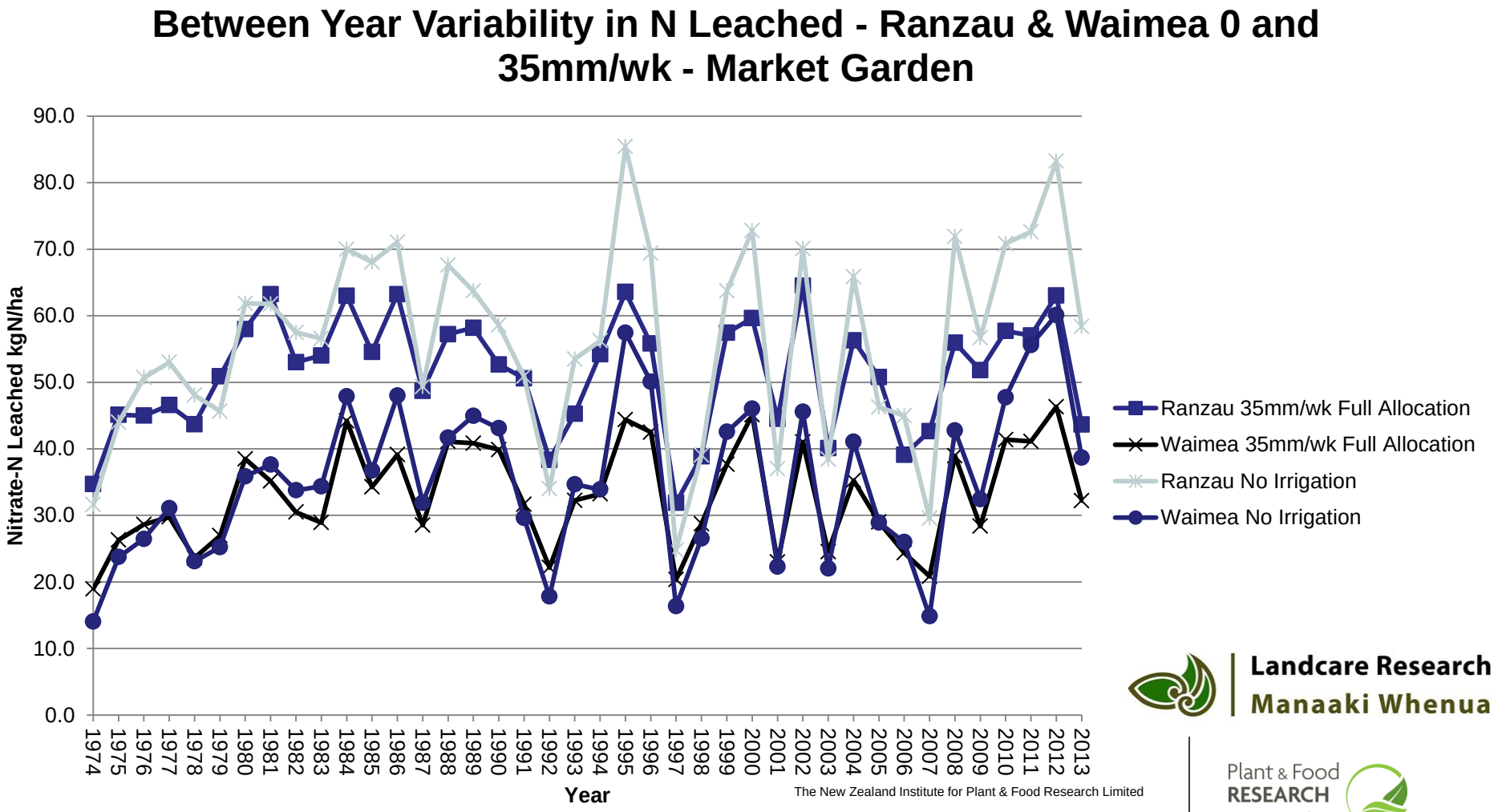




40 years modelled nitrate leaching from apple orchard, Ranzau & Waimea soils



40 years modelled nitrate leaching from outdoor veges, Ranzau & Waimea soils



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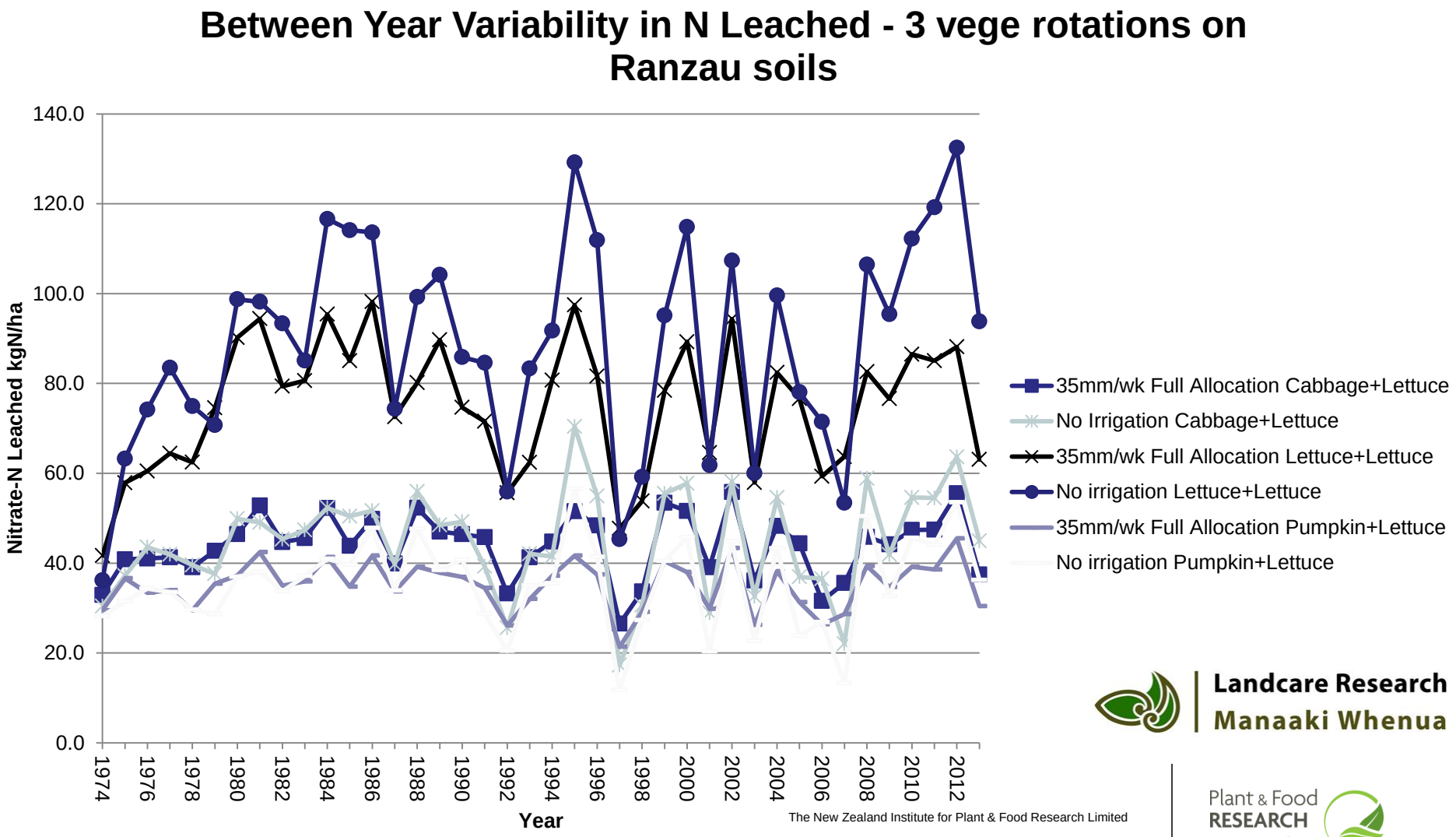
40 years modelled nitrate leaching from 3 outdoor vege rotations, Ranzau soils



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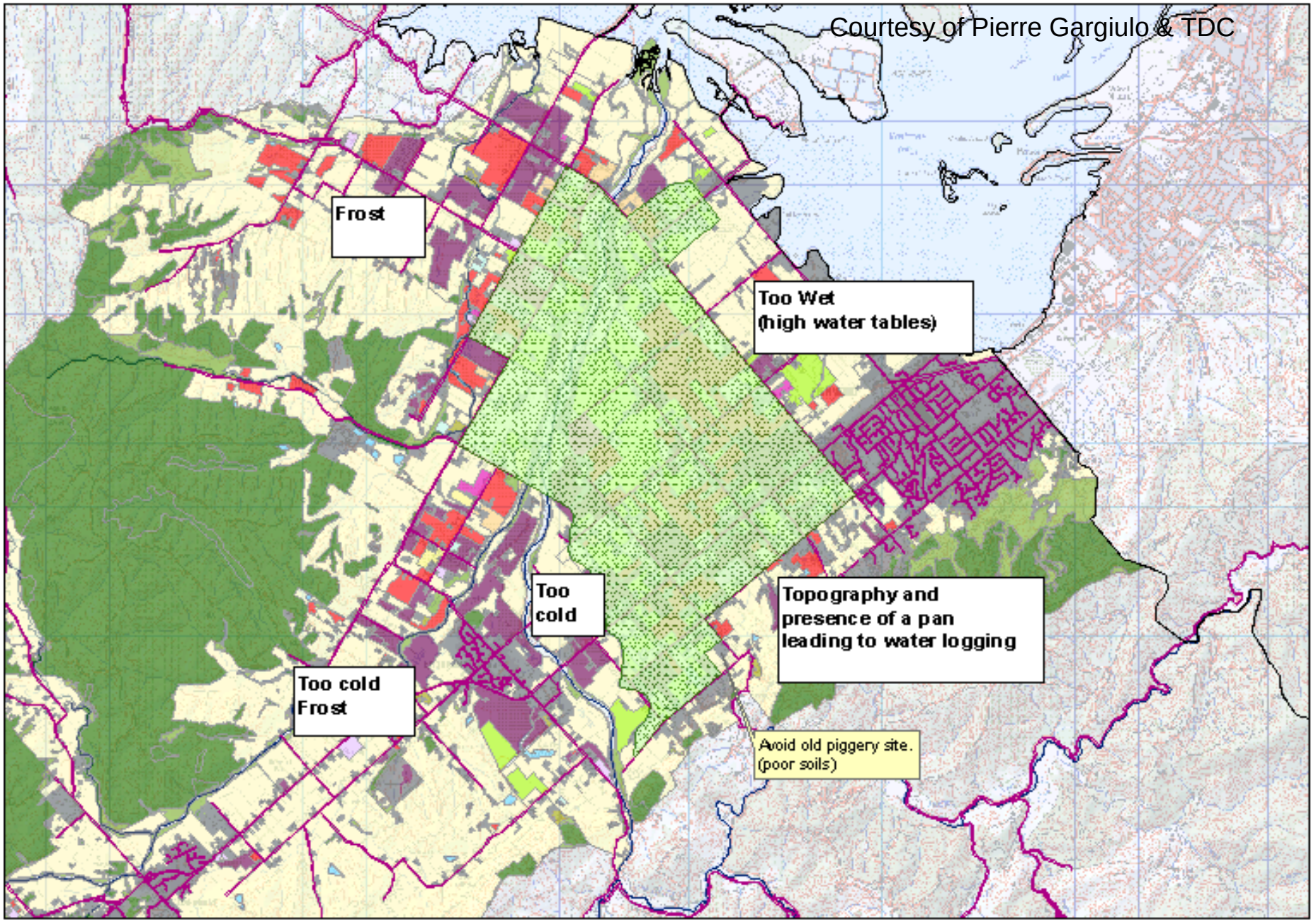
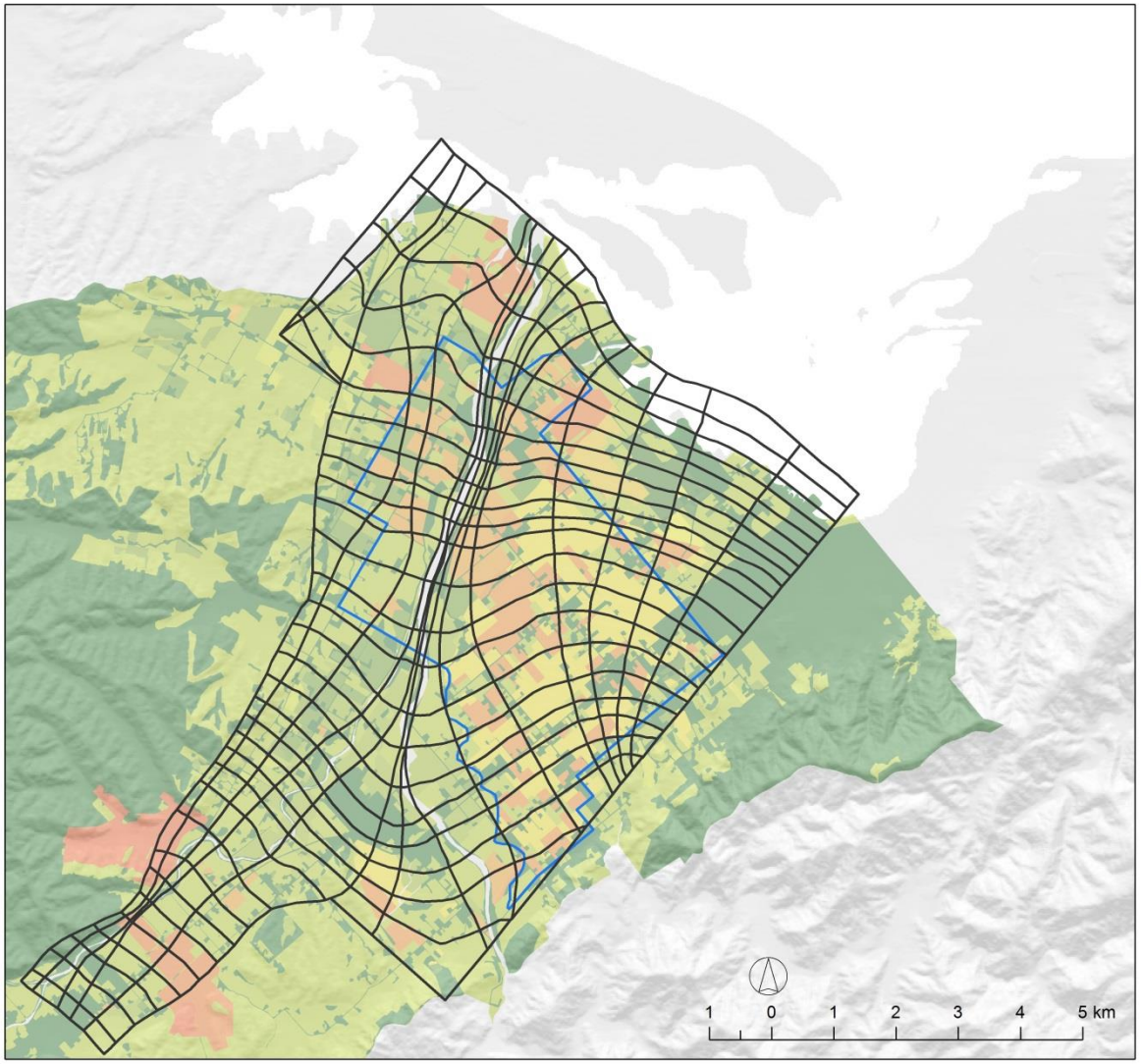
Potentially suitable for market garden expansion



Groundwater Flow Net showing flow directions for leachate in unconfined aquifer

Modelled Nitrate-Nitrogen Losses, Waimea lowland catchment



Flow Net

Unconfined

Potential Area for Market Gardening

N-Loss kgN/ha/yr

2.5	18.3
3.3	22.8
4.3	31.9
6.6	32.9
9.3	51.3
9.8	58.7
10.7	62.3
13.6	64.6
16.0	

Landcare Research
Manaaki Whenua