MAXIMISING THE VALUE OF IRRIGATION
Landcare Research & Plant & Food Research led Programme

MASSEY UNIVERSITY
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Landcare Research
Manaaki Whenua

Sensor soil surveys & variable rate irrigation for reducing N leaching losses

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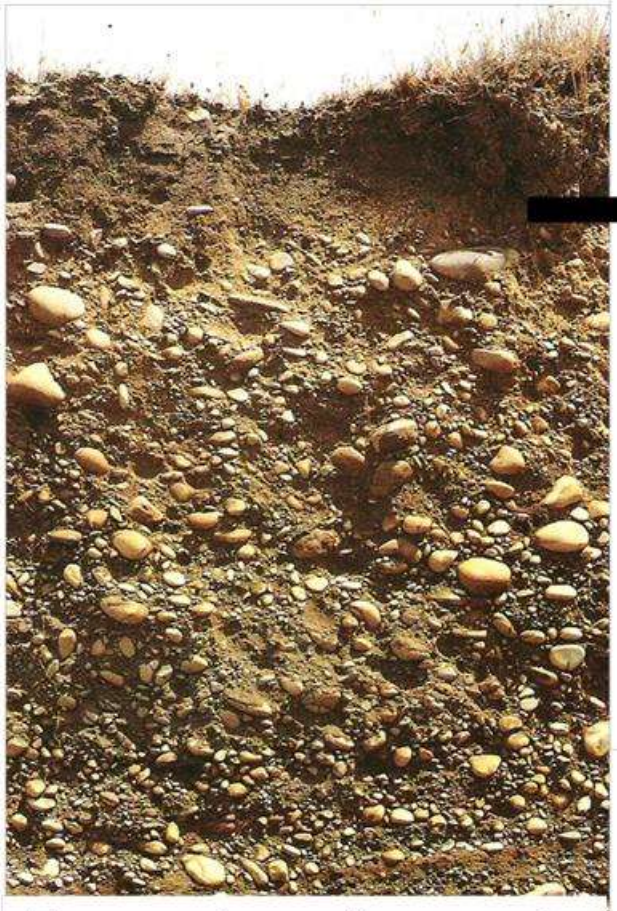
Acknowledgements:
Pierre Roudier, Jagath Ekanayake, Andrew Manderson, Joseph Pollacco, Will Meads, Agri-Optics

Presentation to PAANZ Workshop: Technology to reduce N leaching
18th March 2016, Ashburton

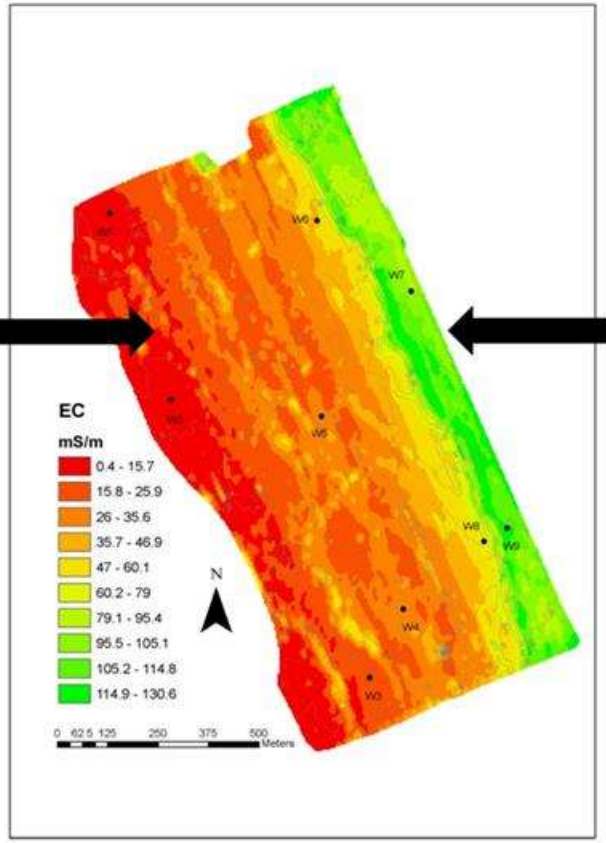
3 EM & VRI case studies

- Mixed cropping under VRI, Hawkes Bay
  - APSIM modelling of drainage
- Methven dairy farm, Canterbury
  - Overseer modelling of drainage and N
- Potatoes, Ohakune
  - Potato calculator modelling of drainage and N

Different soils need different irrigation schedules

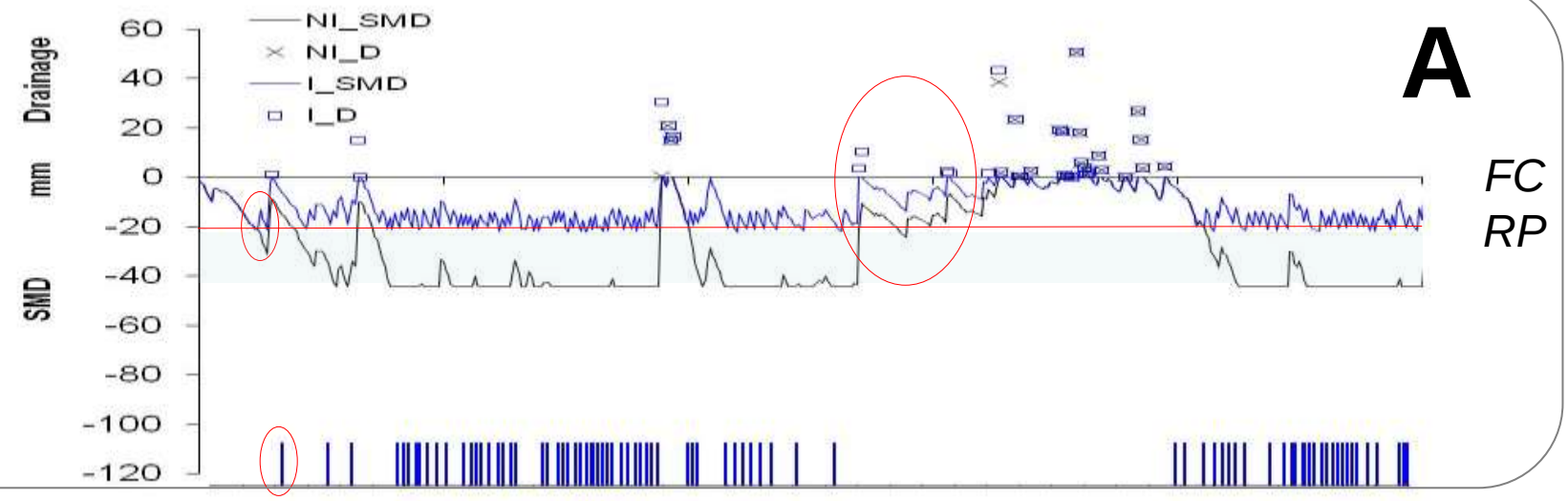


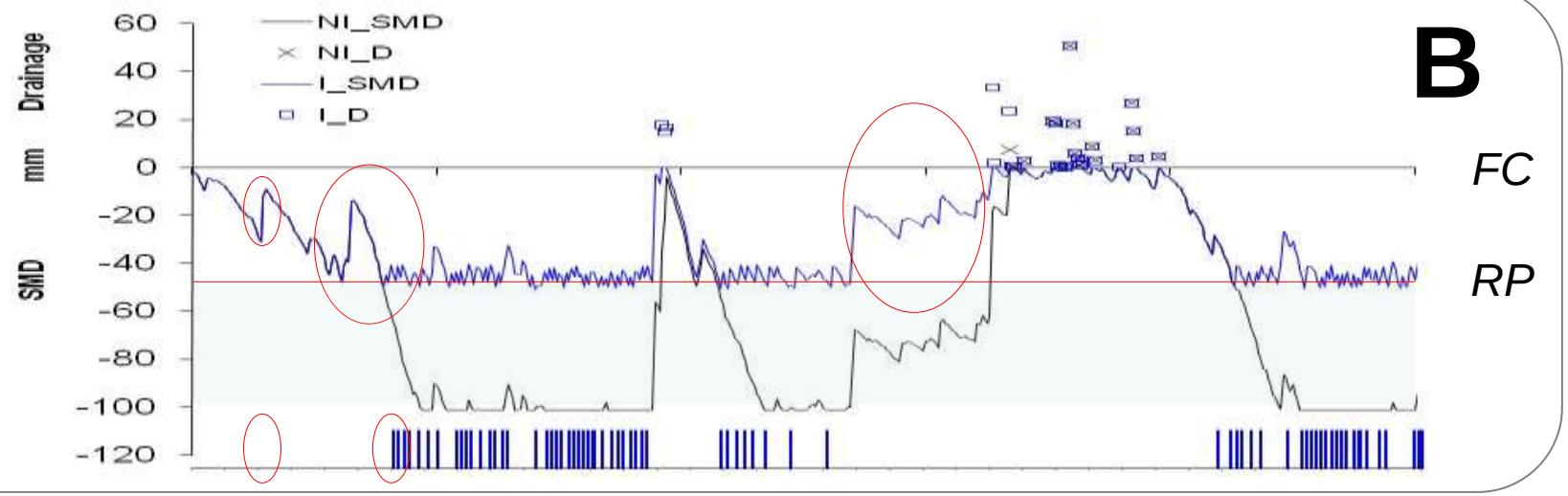
Frequent small amounts



Less frequent larger amounts

Different soils need different irrigation schedules





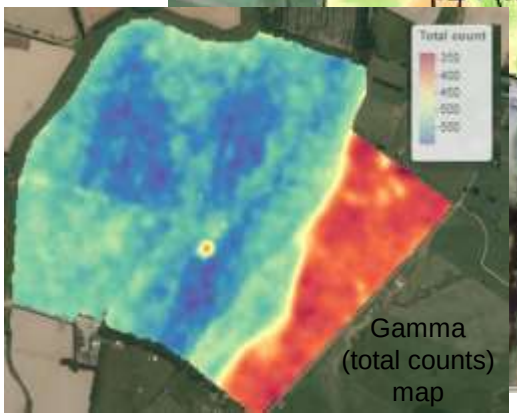
VARIABLE RATE IRRIGATION: Delays irrigation by 29 days to Zone B. 9% water saving/season. 43% reduced run-off and drainage.

Geophysical sensors - surveying soil differences

Responding to differences in, e.g.
- soil texture
- moisture
- stoniness
- parent materials

Case study 1:
Mixed cropping under VRI

EM map of Otane VRI pivot



EC(mS/m)

32.84
40.83
48.81
56.80
64.79

Classify EM data into 3 management zones

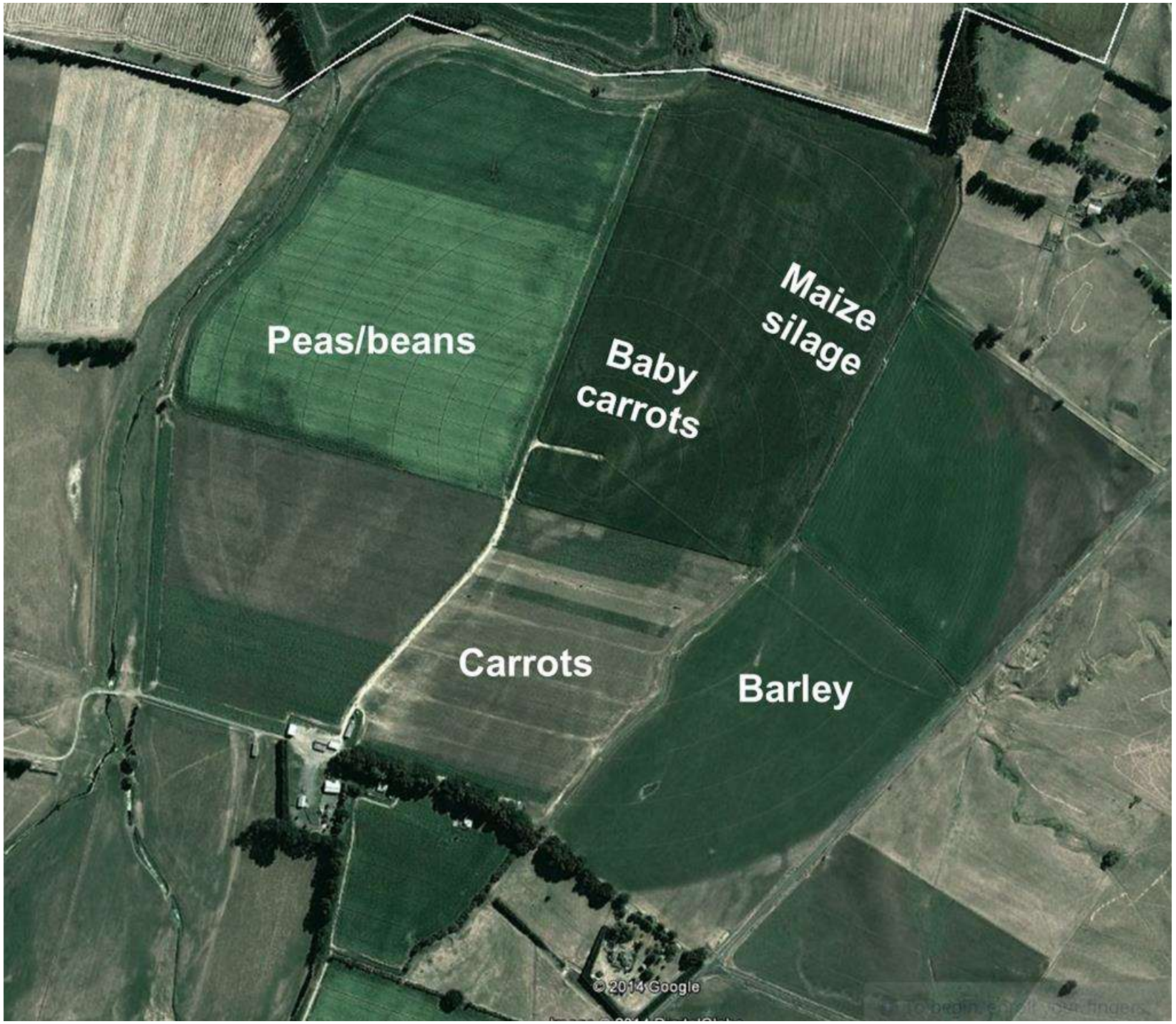
EC	Clay (%)	Sand (%)	FC (%)	WP (%)	RAW (mm/m)	Texture
Low	15	47	36	11	170	Loamy silt
High	29	1	40	21	90	Silt loam

S-map siblings, present at this farm

	Hastings_29a1	Waimakariri_41a2	Flaxton_69a1
Root barrier	No	No	37-54 cm
Texture	Loam over sandy loam	Loam over sandy loam	Silty loam over clay
Top clay	20%	13%	30%
Permeability	Moderate over rapid	Well drained	Moderate over slow
Water logging vulnerability	High	Very low	High
Soil classification	Typic Orthic Gley Soils	Weathered Fluvial Recent Soils	Typic Orthic Gley Soils

Relationship between measured and S-map values

	LOW EM	MEDIUM EM	HIGH EM
Hastings_29a1	0.19	0.17	0.13
Waimakariri_41a2	**0.05***	**0.06***	0.25
Flaxton_69a1	0.22	0.20	**0.10***
CONCLUSION			


Peas/beans
Baby carrots
Maize silage
Carrots
Barley
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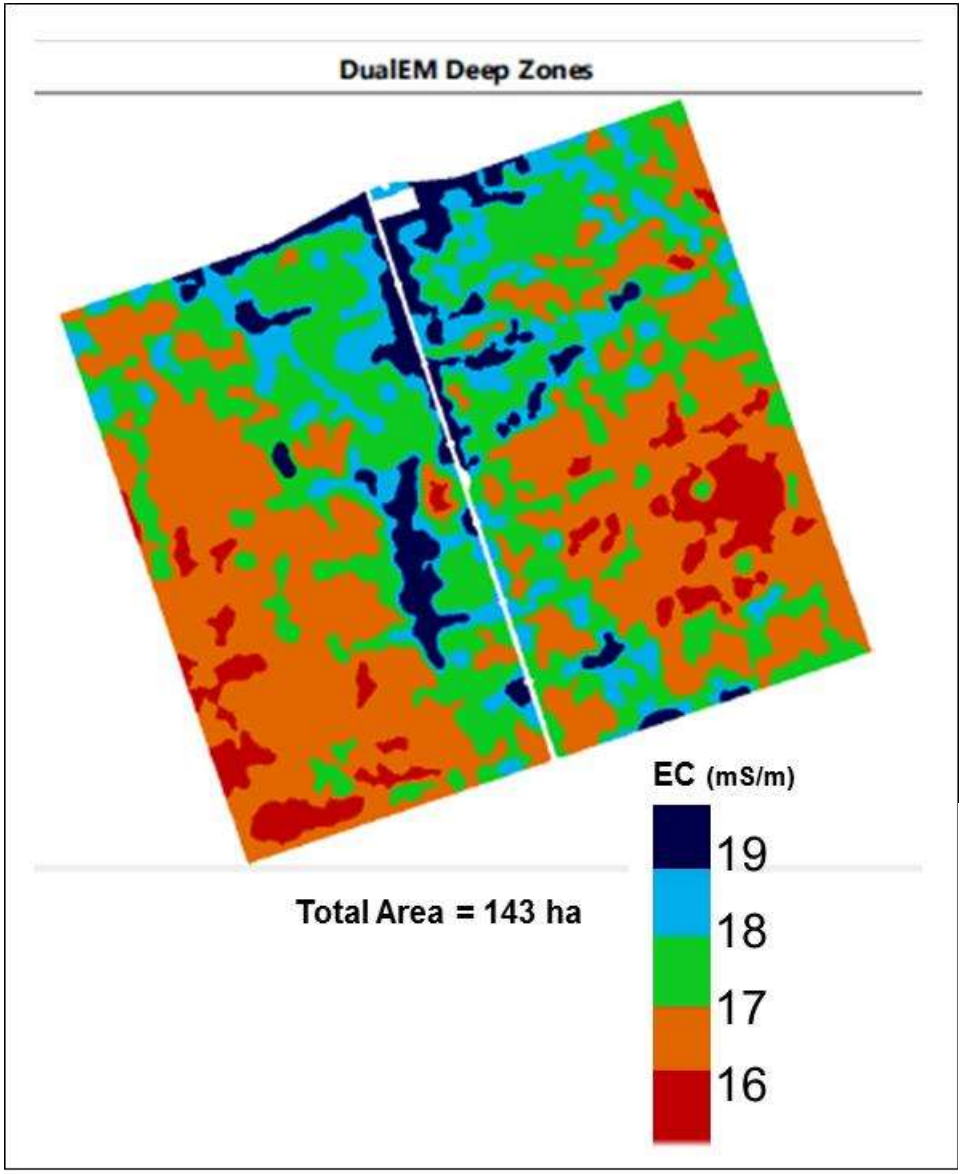
VRI key performance indicators

EC zone	ha	Irrigation (mm/ season)	% saved (mm in brackets)	Drainage & Run-off (mm/season)	% saved (mm in brackets)
Maize					
Low	16	671		478	
Medium	54	660		455	
High	32	520	**8** (53)	305	**14** (66)
Peas					
Low	16	253		249	
Medium	54	246		237	
High	32	175	**11** (28)	158	**14** (35)

- APSIM modelling for a 10-year period
- VRI reduces drainage & runoff by ~ 14%, by minimising (eliminating under best management) irrigation-related drainage
- Benefits of VRI will vary from year to year, depending on patterns of rainfall during the irrigation season

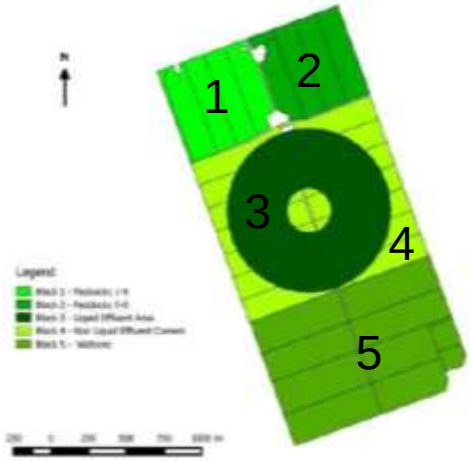
Case study 2:
Methven dairy farm

EM map used to derive blocks for Overseer



(Agri-Optics)

Block Number	Block Description
1	Paddocks 1-4
2	Paddocks 5-8
3	Liquid Effluent Paddocks
4	Non-Liquid Effluent Corners
5	Watson Block



Block Number	Block Description
1(a)	Paddocks 1-4 (Eyre)
1(b)	Paddocks 1-4 (Mayfield)
2(a)	Paddocks 5-8 (Eyre)
2(b)	Paddocks 5-8 (Mayfield)
3(a)	Liquid Effluent Paddocks (Eyre)
3(b)	Liquid Effluent Paddocks (Mayfield)
4(a)	Non-Liquid Effluent Corners (Eyre)
4(b)	Non-Liquid Effluent Corners (Mayfield)
5	Watson Block

(Meads, 2015)

Methven Dairy Farm in Overseer

Blocks per management group		Estimated N Leached / Ha			
(V=variable; F=fixed return/depth)	AREA	*VV*	*FV*	*VF*	*FF*
Block 1 -Paddocks 1-4	39	39	43	58	142
Block 2 -Paddocks 5-8	38	39	43	58	141
Block 3 -Liquid Effluent	85	48	53	68	154
Block 4 -Non-Liquid Effluent	57	39	43	58	141
Total	219	**42**	**47**	**62**	**146**

***VV cf. FF* (kg N/ha)**	**-104**

Blocks per EM-defined soil zone		Estimated N Leached / Ha			
(V=variable; F=fixed return/depth)	AREA	*VV*	*FV*	*VF*	*FF*
Block 1a (Eyre)	29	39	43	58	142
Block 1b (Mayfield)	10	24	24	26	67
Block 2a (Eyre)	24	39	43	58	141
Block 2b (Mayfield)	14	23	22	24	65
Block 3a (Eyre)	49	48	53	68	154
Block 3b (Mayfield)	36	32	31	33	76
Block 4a (Eyre)	37	39	43	58	141
Block 4b (Mayfield)	20	24	24	26	67
Total	219	**37**	**39**	**50**	**118**

EM-Block vs Block (kg N/ha)	**-5**	**-8**	**-12**	**-28**
(%)	**13%**	**16%**	**20%**	**19%**

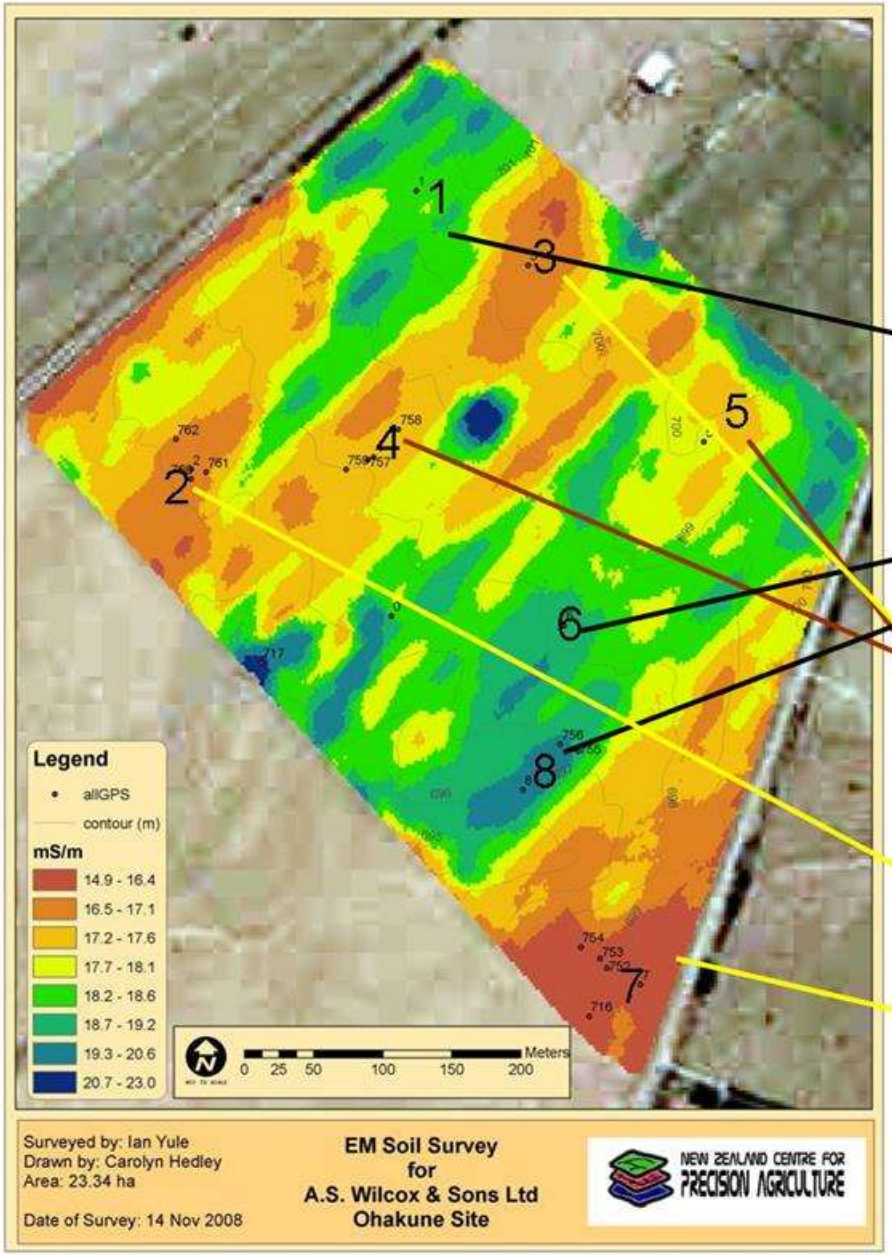
Acknowledge: Will Meads, Craige Mackenzie, Stu Bradbury

Case study 3:
Irrigated potato field, Ohakune

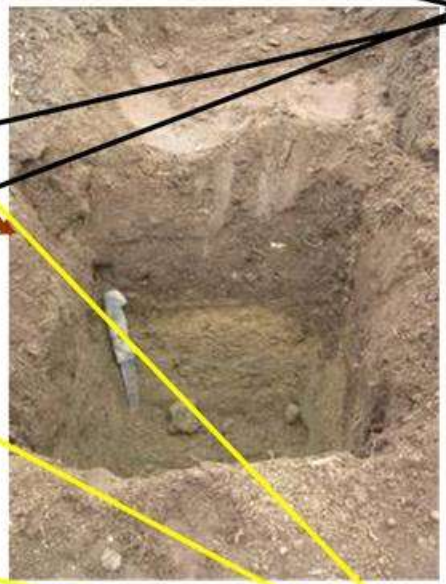
Case study: 23 ha Ohakune potato field

(Acknowledge: Wilcox Growers for research collaboration; Photo: C Hedley)

Different soils require different management



Lahar soil

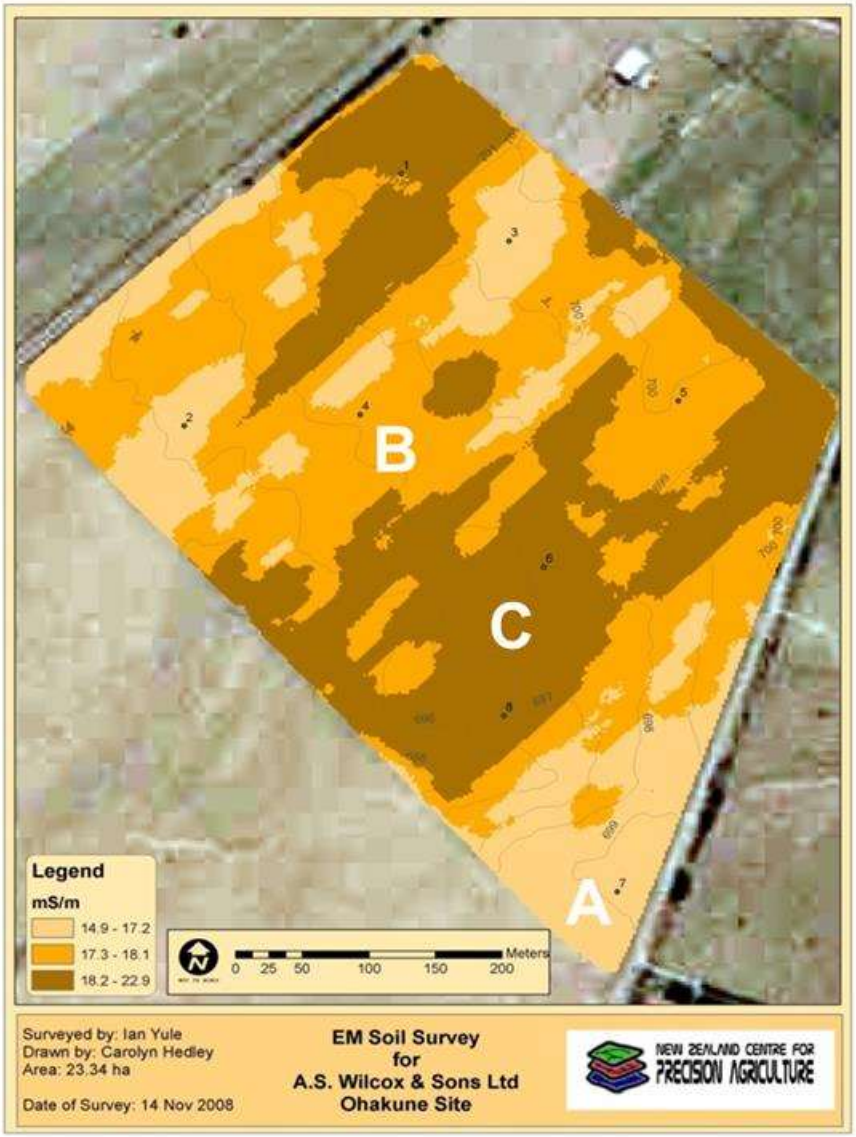


Andesitic Ash Soil

Rhyolitic Pumice Soil

Correct irrigation amount & timing improves potato yield & helps reduce disease

Vary irrigation to each zone to improve water use efficiency and yield

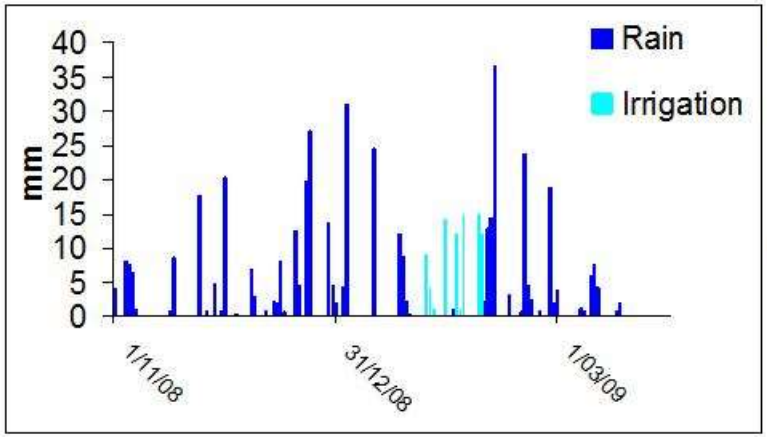


Zone	AWC (mm)	Irrig. Trigger (0.35 AWC)
A	186	SMD=65
B	81	SMD=28
C	156	SMD=55

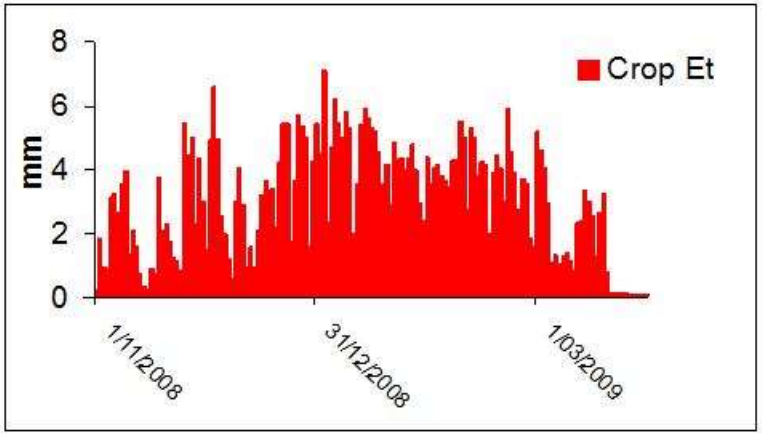
AWC = available water holding capacity
SMD = soil moisture deficit
Automated soil moisture monitoring stations installed to guide irrigation scheduling

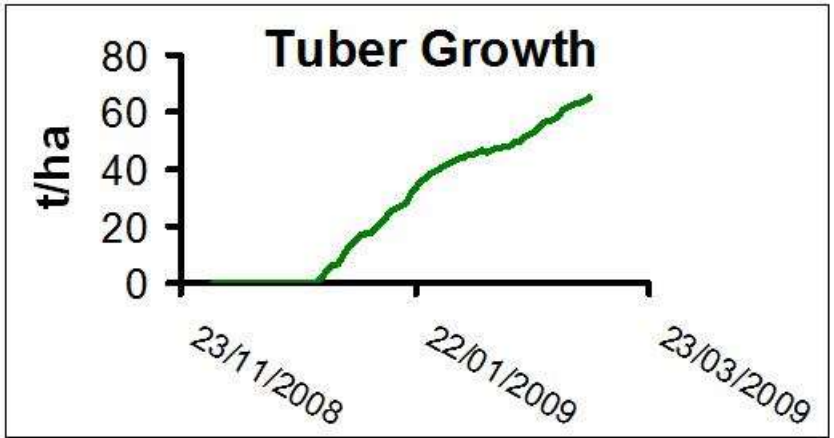
The Potato Calculator Modelling

Planting dates: 27 Nov – 3 Dec
First emergence – 18 Dec
Tuber initiation – 29 Dec
Full canopy closure – 20 Jan
Tops sprayed off – 3 – 27 March



Total rainfall: 422 mm
Irrigation: 83 mm (24 Jan – 8 Feb)
Depletion factor for irrigation: 0.35AWC
Crop Et: 466 mm
Expected yields 65 – 85 t/ha

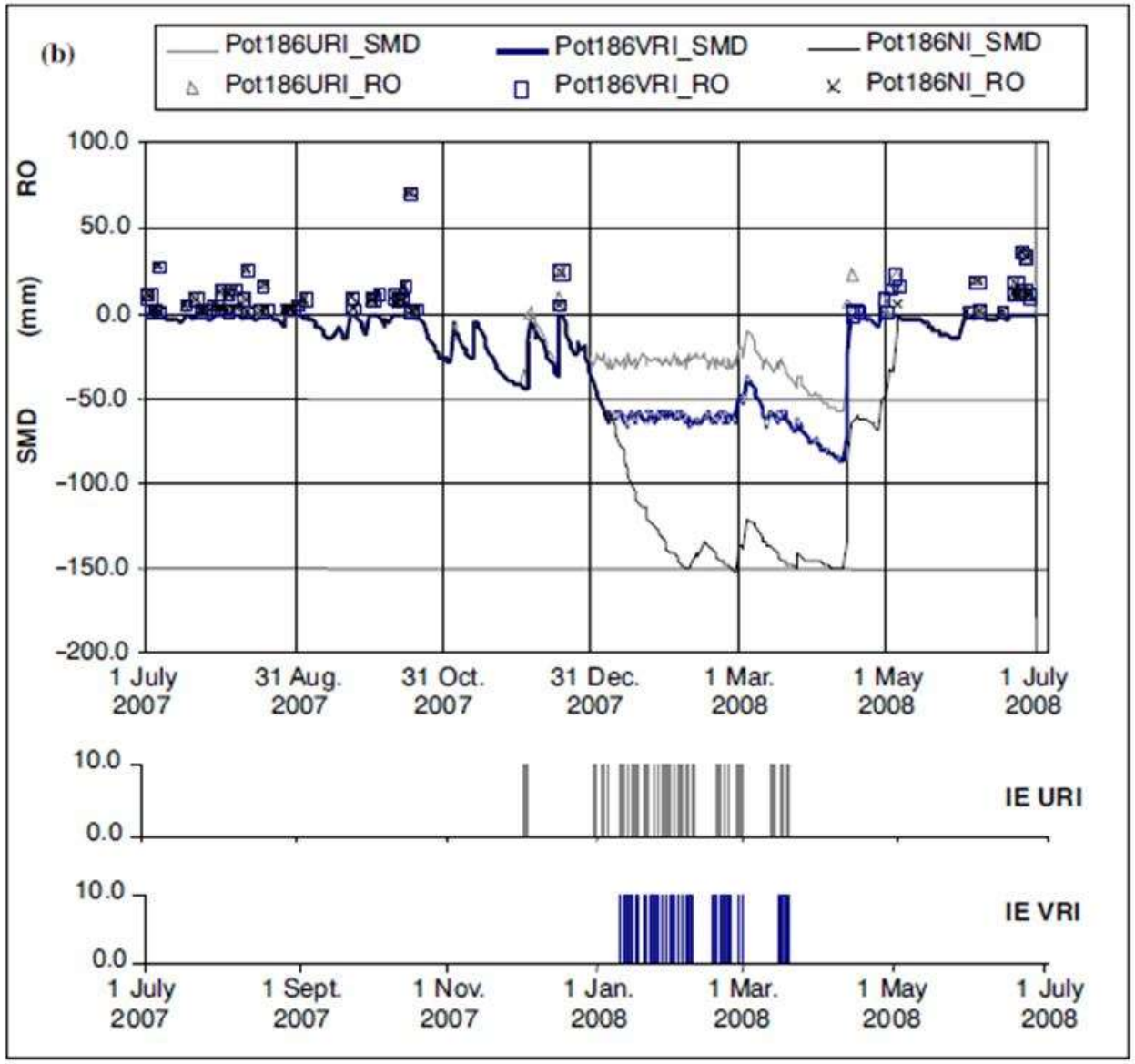


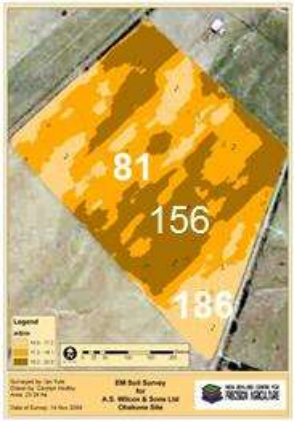


Potato Calculator modelling VRI

KPI	URI	VRI	% saved
Irrigation (mm/season)	215	188	13
Drainage (mm/season)	50	35	29
N leached (kg/ha)	11.9	9.4	21
IWUE (mm/tonne)	13	11	

Variable Rate Irrigation





Hedley, Yule, Tuohy, Vogeler (2009) KPIs for simulated VRI on variable soils in humid regions. Transactions of the ASABE 52(5), 1575-1584

Conclusions

- EM mapping is used to define management zones under one irrigation system
- Precision irrigation varies irrigation to each zone, to maintain or enhance yield, save water and reduce drainage
- Precision irrigation has production and environmental benefits