30th Annual INCOSE international symposium

Virtual Event
July 20 - 22, 2020

Paper 96, Session 7 Track 2: Roodt* & Van Zyl

A Transdisciplinary Design and Implementation of Sustainable Agricultural Principles in the Waikato Region of New Zealand

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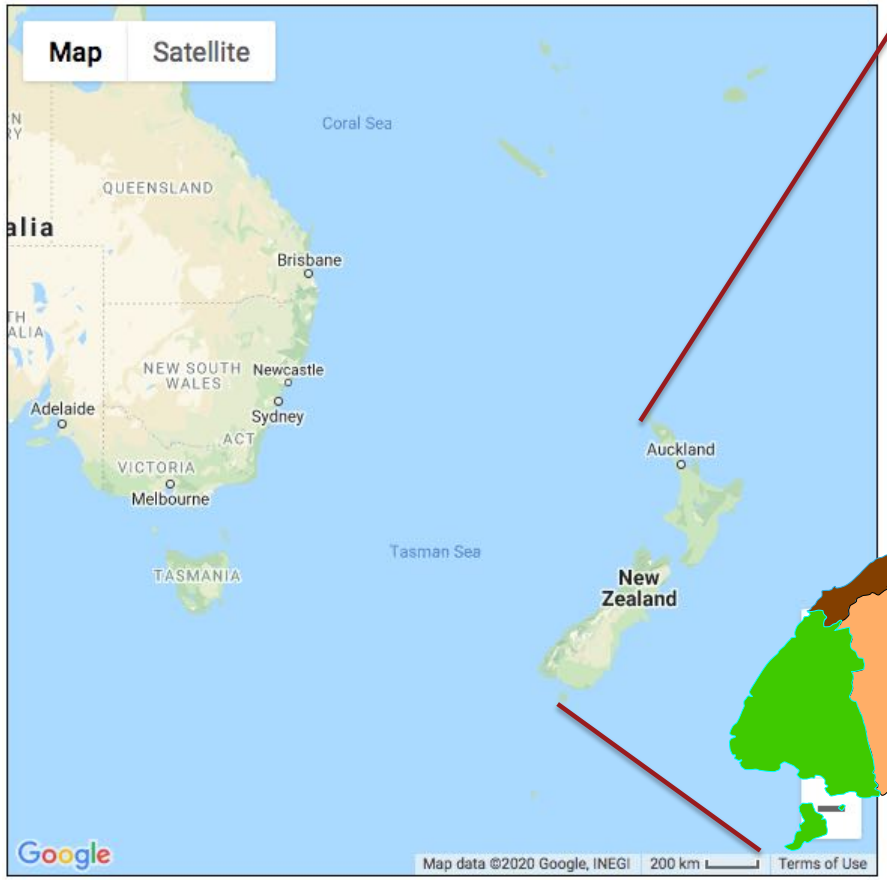
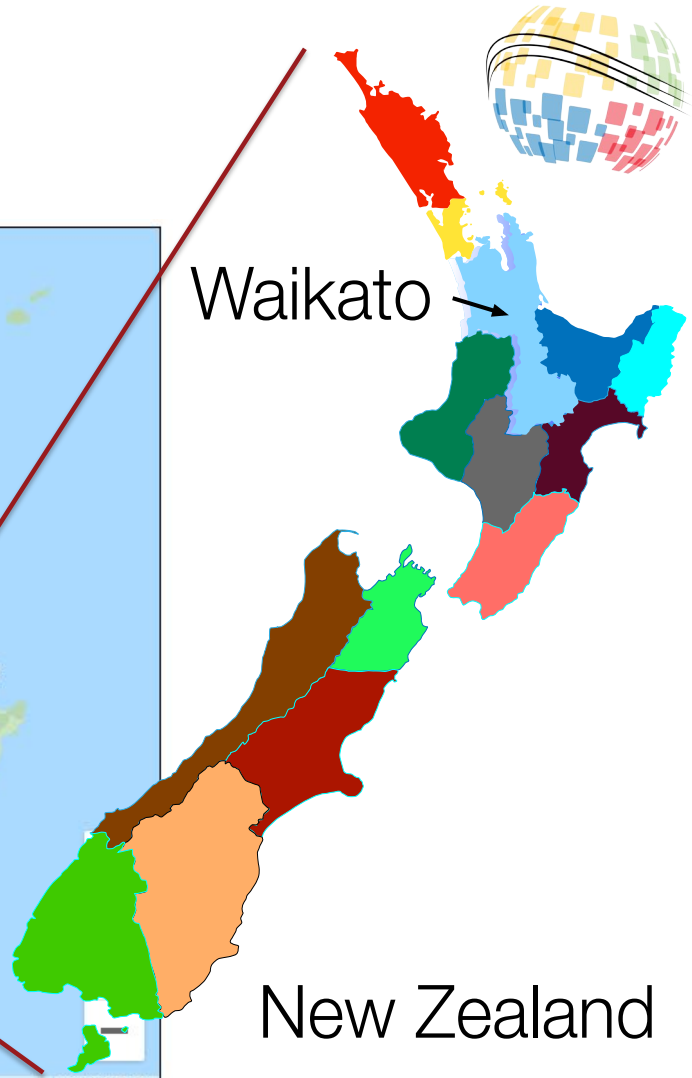
Outline of the Presentation

- Background to the System Design Problem
- Design and methodology of proto-intervention
- Results
- Concluding Remarks

Geopolitical

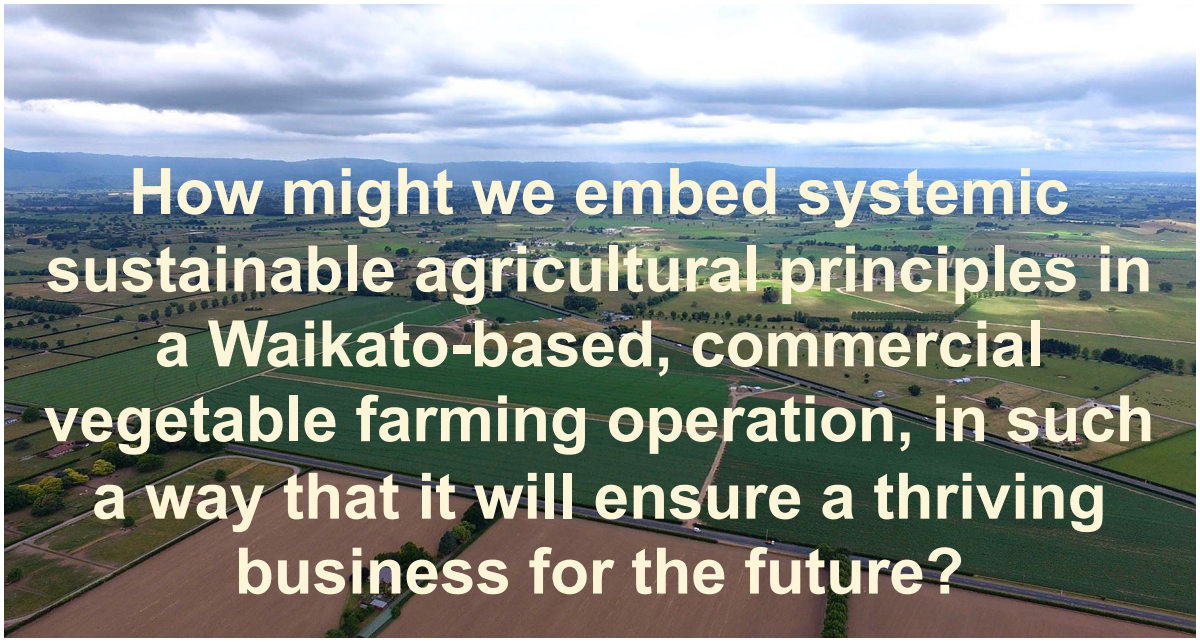
- Pacific nation to the East of Australia
- Strong environmental policies
- Agriculture a core primary industry





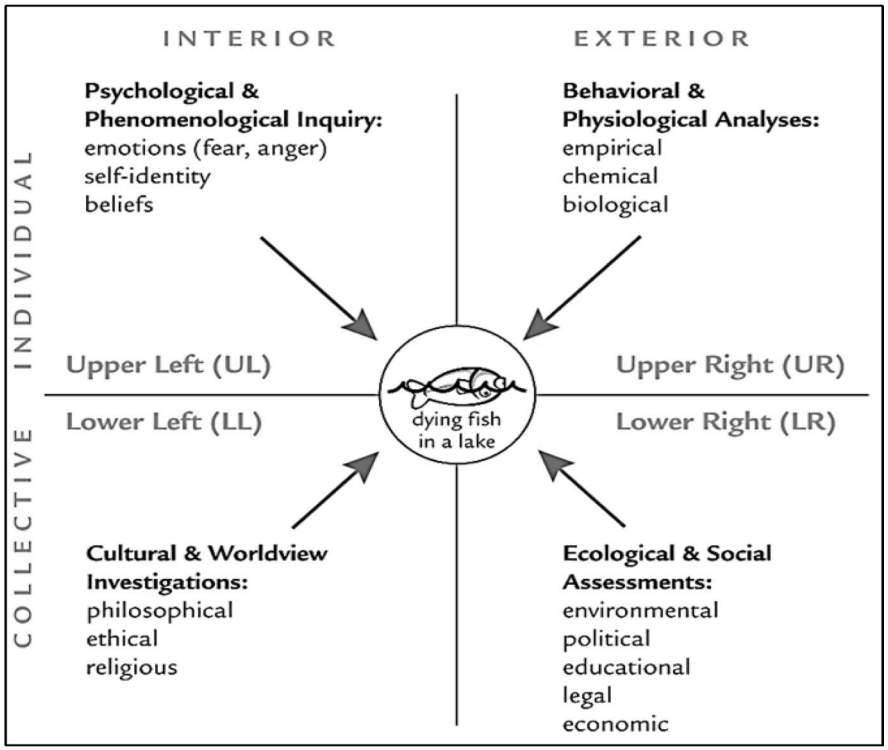
Background to System Design Problem

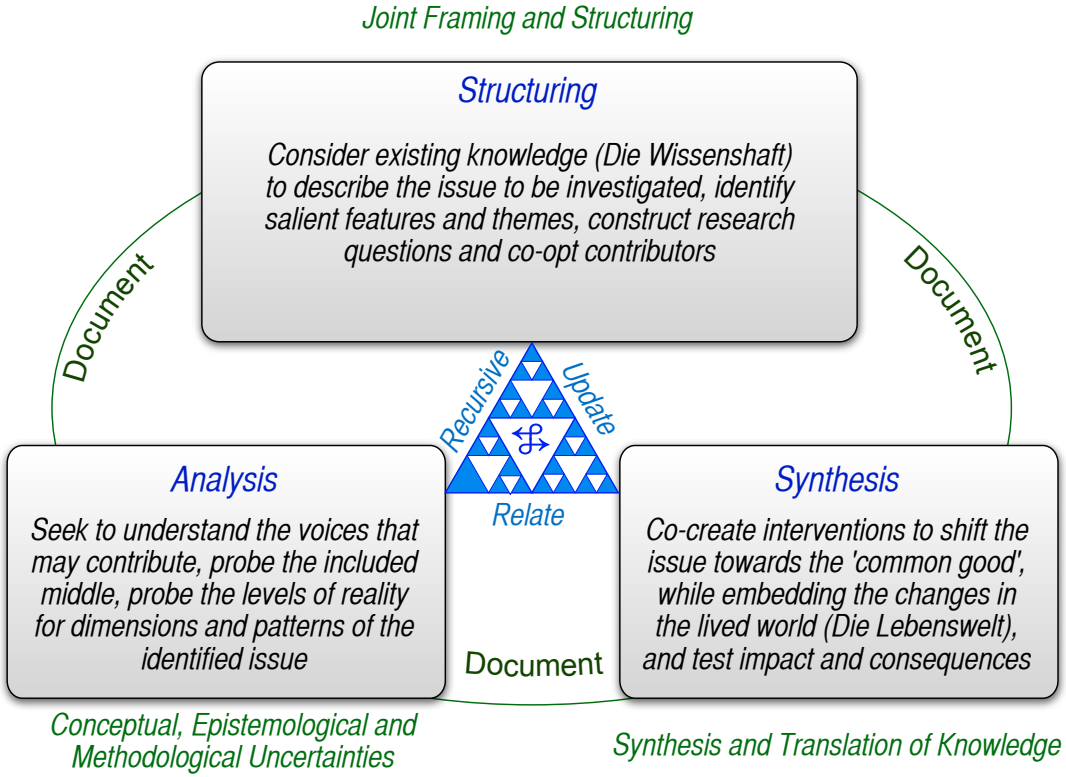
- UN Sustainable Development Goals
- Impact on Commercial Farming
  - Policy & Regulations
  - Societal Perceptions
  - Land Use
  - Financial and Sustainability
- Balancing the intervention development with need for continued operation



Research and Design Method

Complex Issue





Transdisciplinary Research as a Recursive Process

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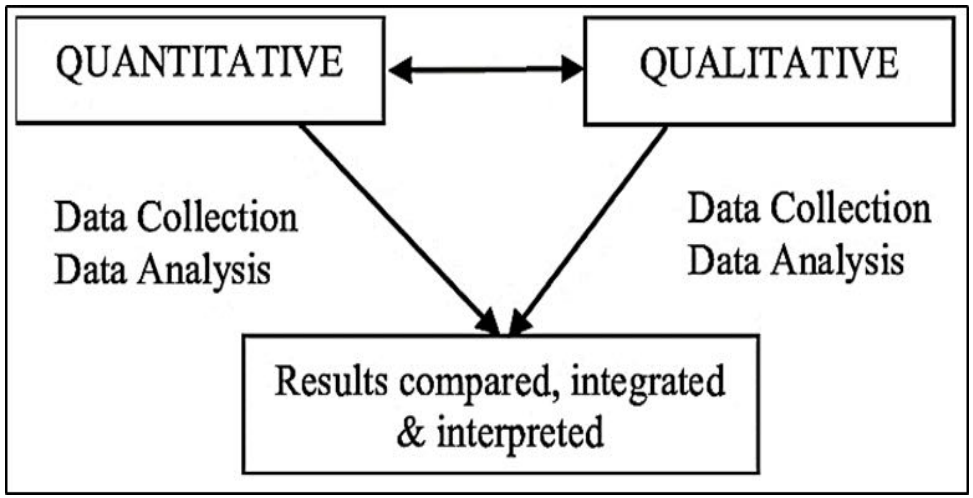
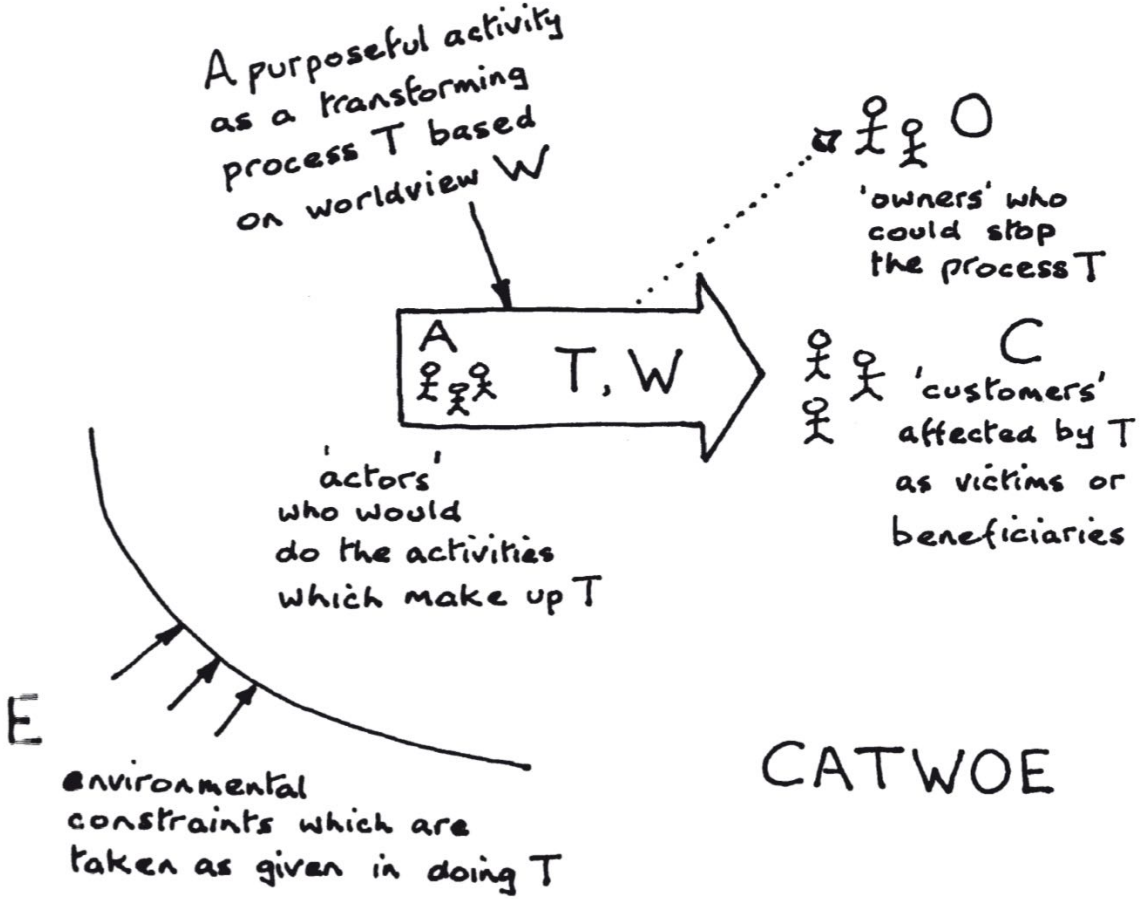
Research and Design Method

Complex Issue



Iterative and Participative



Results - Qualitative

- Literature Review
- Semi-Structured Interviews
- Thematic analysis
- Maori Values

Themes

Sustainability theme	Number of times mentioned	Supportive literature
Planet/ Environment	7	(Mann & Schäfer, 2018)
People/ Social	6	(Buttel, 1990)
Soil health	6	(Reeve et al., 2016)
Ongoing/ Long term	6	(Gliessman, 2014)
Profit/ Financial	5	(Pigford, Hickey, & Klerkx, 2018)

Results - Qualitative

"Threats" themes	Number of times mentioned	Supportive literature
Financial aspects	7	(Greenhalgh, Samarasinghe, Curran-Cournane, Wright, & Brown, 2017)
Soil	7	(Brussaard, De Ruiter, & Brown, 2007)
Regulatory changes	6	(Waikato Regional Council, 2018)
Land	5	(Chappell & LaValle, 2011)
Reduced yields	3	(Malherbe & Marais, 2015)
Agro chemicals	2	(Scherr & McNeely, 2008)
Cover crops	2	(Malcolm et al., 2018)
Dust pollution	2	(McCrea, 1990)
Markets	2	(Hatt et al., 2016)

Results - Qualitative

Māori values and human ends	
Value/Human-end	**Definition**
Manawhenua	Control over resources
Whanaungatanga	Togetherness
Arohatanga	Care, Love, Respect
Manaakitanga	Hospitality, Kindness
Wairuatanga	The spiritual dimension
Kaitiakitanga	Guardianship
Tino Rangatiratanga	Self-determination
Taonga Tuku Iho	Holding and passing down protected treasures – may include knowledge, objects or natural resources
Whakapapa	Genealogy, lineage, descent

Results – Quantitative (On-Farm)

Onion Trials

- Roots
- Soil microbes
- Yield

Treatment number	Fertilizer regime
T 1	Fertigation
T 2	Fertigation + compost
T 3	Standard fertiliser + compost
T 4	Standard fertiliser

Results – Quantitative (On-Farm)

Onion Trials - Roots

- T4 Best
- Did not increase yield

Measurement		T 1	T 2	T 3	T 4
Length (mm)	Average	804.42	808.59	737.39	938.89
	Max	1025.90	959.54	1007.01	1519.50
	Min	532.44	601.55	599.10	593.39
Project Area (cm²)	Average	62.12	57.55	62.17	69.51
	Max	75.55	73.48	88.00	114.40
	Min	44.30	43.79	51.77	48.23
Surf Area (cm²)	Average	195.17	180.80	195.32	218.37
	Max	237.36	230.86	276.46	359.39
	Min	139.16	137.57	162.65	151.51
Avg. Diameter (mm)	Average	0.78	0.71	0.84	0.74
	Max	0.85	0.77	0.88	0.81
	Min	0.72	0.64	0.72	0.67
Length per Vol (cm/m³)	Average	804.42	808.59	737.39	938.89
	Max	1025.90	959.54	1007.01	1519.50
	Min	532.44	601.55	599.10	593.39
Root Volume (cm³)	Average	3.79	3.23	4.14	4.05
	Max	4.37	4.42	6.04	6.76
	Min	2.89	2.42	3.04	2.98
Dry Root Weight (g)	Average	2.20	2.06	2.76	2.84
	Max	3.10	3.30	4.00	4.50
	Min	1.80	1.30	1.80	1.90

Results – Quantitative (On-Farm)

Onion Trials - Soil

- Compost T2, T3 returned H_0 for fungal stimulation, but increased total bacteria

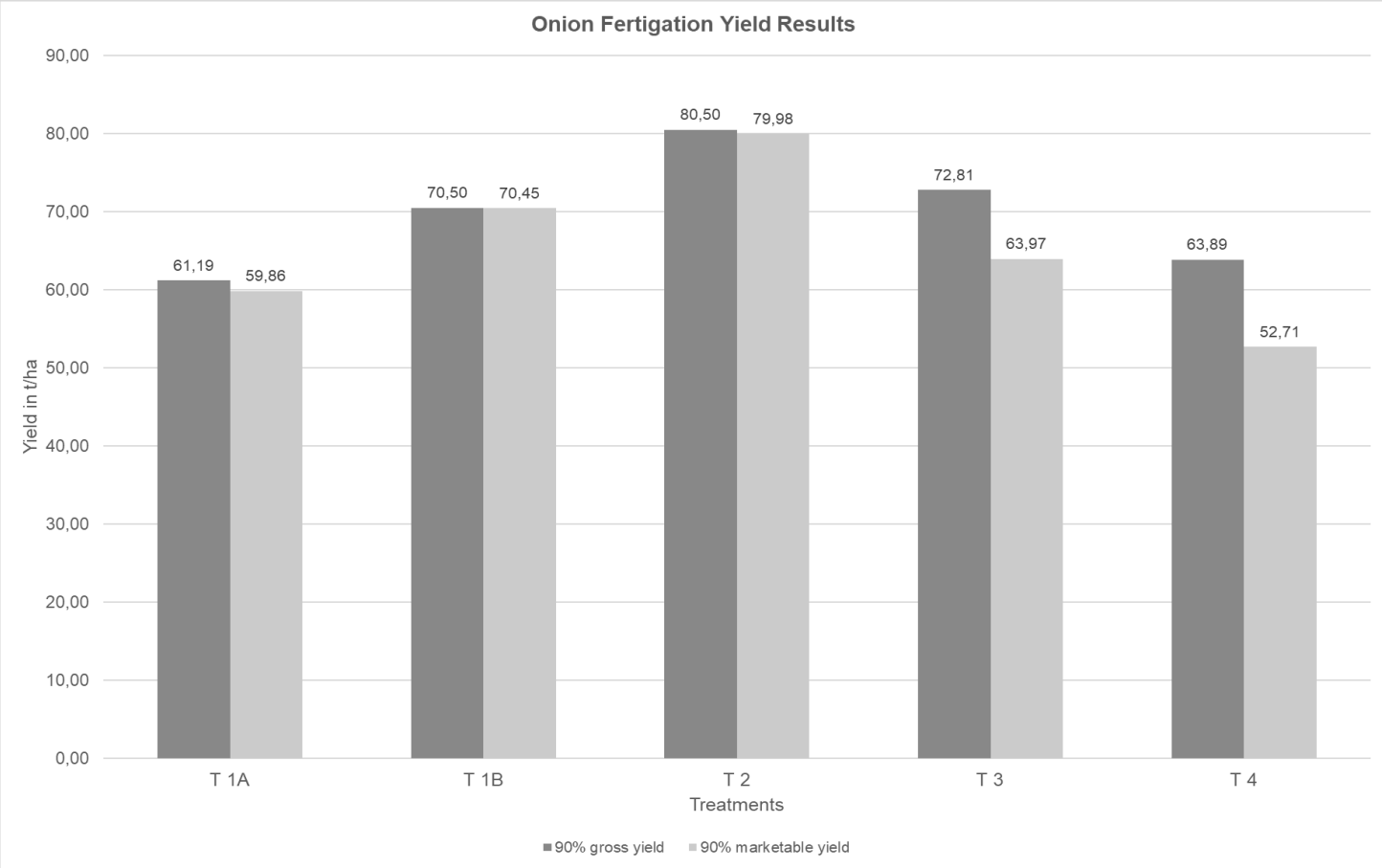
SFI report	2018-07-04											
Invoice number	5857											
Pre plant		>30	>300	>40	>400	0.75-1	>0.10	>0.10	0.75-1	>10000	>10000	<47
		Active Fungi	**Total Fungi**	**Active Bacteria**	**Total Bacteria**	**TF:TB**	**AF:TF**	**AB:TB**	**AF:AB**	**Flagellates**	**Amoebae**	**Ciliates**
T 1	Fertigation	5,64	117,01	24,53	490,88	0,24	0,05	0,05	0,23	21555,53	2155,09	715,25
T 2	Fertigation + Compost	10,02	167,29	16,52	317,9	0,53	0,06	0,05	0,61	22019,74	7316,09	439,98
T3	Standard + Compost	1,18	250,93	36,3	398,93	0,63	0	0,09	0,03	7255,78	4368,28	724,63
T 4	Standard	1,18	158,48	18,42	361,53	0,44	0,01	0,05	0,06	9078,32	9078,32	1312,68

SFI Report	2019-02-22											
Invoice number	5697											
Post harvest		>30	>300	>40	>400	0.75-1	>0.10	>0.10	0.75-1	>10000	>10000	<47
		Active Fungi	**Total Fungi**	**Active Bacteria**	**Total Bacteria**	**TF:TB**	**AF:TF**	**AB:TB**	**AF:AB**	**Flagellates**	**Amoebae**	**Ciliates**
T 1	Fertigation	3,66	183,65	20,53	429,85	0,43	0,02	0,05	0,18	6200,66	6200,66	37,69
T 2	Fertigation + Compost	3,27	152,74	21,77	512,22	0,3	0,02	0,04	0,15	6148,04	19988,34	663,25
T 3	Standard + Compost	0,54	267,88	7,42	517,91	0,52	0	0,01	0,07	2020,48	4042,42	67,06
T 4	Standard	0,65	224,83	4,42	406,93	0,55	0	0,01	0,15	8294,08	6146,33	399,28

Results – Quantitative (On-Farm)

Onion Trials - Yield

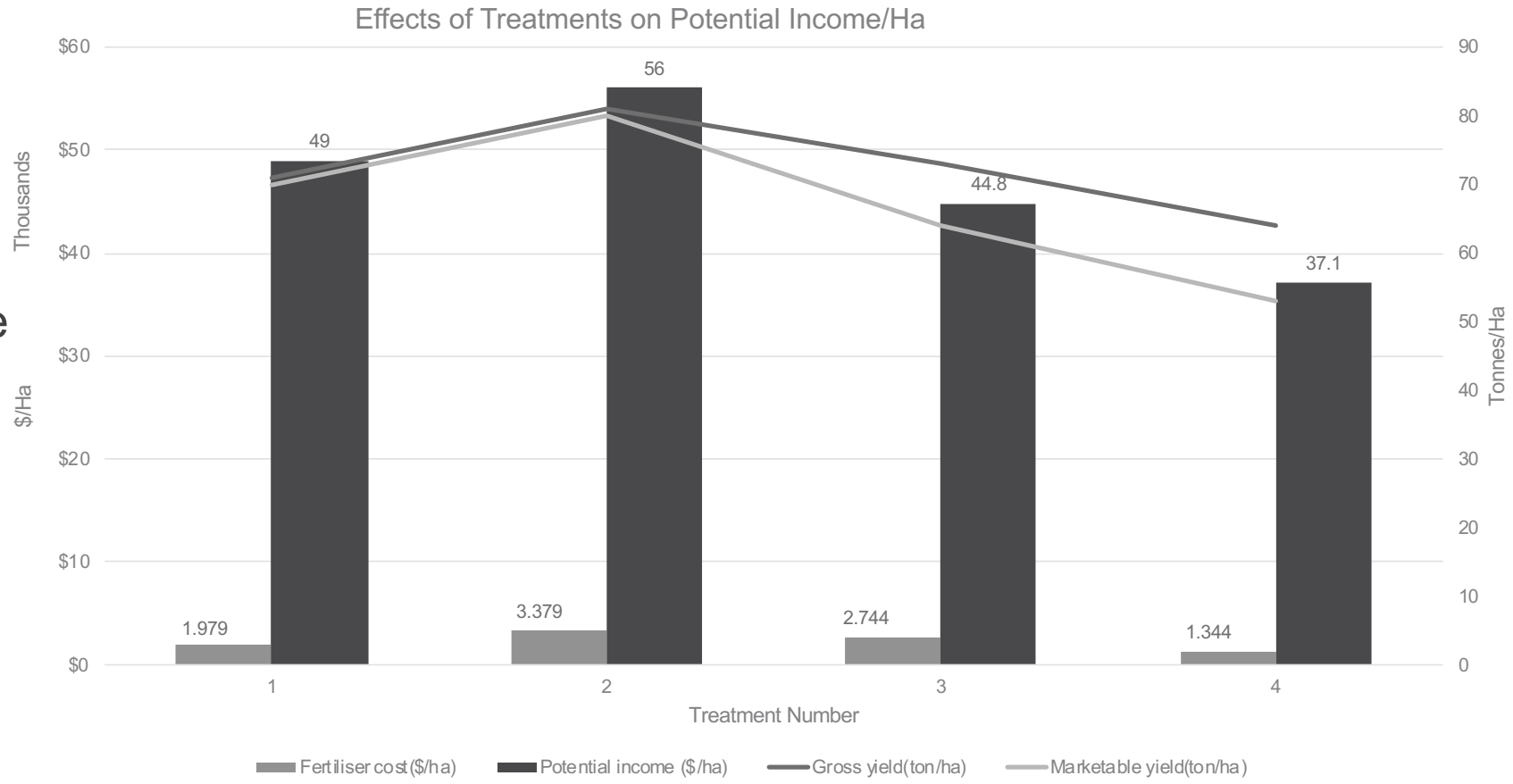
- Compost and Fertigation T2 delivered highest yield



Results – Quantitative (On-Farm)

Onion Trials - Financial

T 2 had a potential income of $56000/ha compared against the standard of T 4 with $37100/ha.



Concluding Remarks

- Clean Green
- Land Ownership
- Soil health is a clear lever for the company and future interventions should focus on that
- Sustainability now a core role in company to drive future change.
- Successful proto-design – larger scale interventions using similar approaches for other crops planned

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Biography

Henk van Zyl is an aspiring PhD candidate at the University of Otago's Centre for Sustainability in Dunedin, New Zealand. He holds a Master degree in Applied Innovation (Agriculture). Henk has a keen interest in agricultural sustainability and spend most of his professional career, both in South Africa and New Zealand, exploring and developing sustainable eco-agricultural practices for thriving commercial vegetable producers. He is a member of the New Zealand Royal Horticultural Society.

Jan Hendrik Roodt is actively involved in the entrepreneurial space in New Zealand. His company launched a wine appreciation app for iOS recently. Commercial projects focus on Industry 4.0, the Circular Economy and environmental regenerative practice. Jan holds a PhD in Engineering Science and MSc in Physics. He leads transdisciplinary professional practice Master and Doctoral studies at several academic institutions in New Zealand and is an active member of the Institute of Information Technology Professionals of New Zealand, the IEEE (Systems Council), the International Council on Systems Engineering (INCOSE), and holds DARPA coin 1313.