in the matter of: the Resource Management Act 1991

and: submissions and further submissions in relation to proposed Variation 1 to the proposed Canterbury Land and Water Regional Plan

and: **Central Plains Water Limited**
Submitter

Statement of evidence of Andrew Webster Macfarlane (farm economics)

Dated: 29 August 2014

REFERENCE: JM Appleyard (jo.appleyard@chapmantripp.com)
BG Williams (ben.williams@chapmantripp.com)

Chapman Tripp
T: +64 3 353 4130
F: +64 3 365 4587

245 Blenheim Road
PO Box 2510, Christchurch 8140
New Zealand

www.chapmantripp.com
Auckland, Wellington, Christchurch

CHAPMAN TRIPP

STATEMENT OF EVIDENCE OF ANDREW WEBSTER MACFARLANE

QUALIFICATIONS AND EXPERIENCE

1 My name is Andrew Webster Macfarlane.

2 I am a registered Life Member of NZIPIM (New Zealand Institute of Primary Industry Management), and a past president of that institute. I graduated from Lincoln College in 1981 with a Bachelor of Agricultural Science degree. I have 33 years' experience as a Farm Management Consultant, 32 of which have been in private practice. I am a registered member of the New Zealand Institute of Primary Industry Management.

3 I have been farming on my own account and in partnership with others, since 1989. Those properties are predominantly irrigated, and a mix of dairy, arable, and sheep/beef/deer. My home property was awarded the "Ballance Farm Environment Award" in 2003, and a number of my clients have won the award since that time.

4 My governance work outside the farm gate is predominately in agriculture, as a director of ANZCO, AgResearch, Ngai Tahu Farming, a council member of Lincoln University, and chairman of Deer Industry New Zealand.

5 My advisory practice has built specific expertise in building and helping farmers execute integrated farm systems that incorporate multiple crop and animal species, grounded on efficient use of soil and water resources in an environmentally sustainable manner.

6 I have acted for many irrigation schemes in the areas of on farm economics, how to integrate profit, environmental and efficiency objectives and how to enhance farmer uptake.

7 In preparing my evidence I have reviewed:

7.1 **Mr. Stuart Ford's** evidence in relation to the OVERSEER work he has undertaken on behalf of CPWL;

7.2 **Mr. Hamish Lowe's** evidence which covers the issues that relate to OVERSEER; and

7.3 **Ms Caroline Saunders** evidence covering the impact on irrigation to regional economics.

8 I also refer to the Land use data provided by Jacobs in relation to the assessed 2011 Lilburne land use, Best Info 2014 CPWL land use and best info 2022 CPWL land use.

SCOPE OF EVIDENCE

9 In my evidence I have been asked to provide an overview of the economic impact to farm profitability of different land use scenarios, and discuss the impact of nutrient management, and mitigations in the Selwyn Waihora catchment.

10 Although this is a council hearing, I have read the code of conduct for expert witnesses in the Environment Court practice note, and confirm that I have complied with the code in the preparation of my evidence. I will comply with that code when giving this evidence.

SUMMARY OF INVOLVMENT WITH CPWL

11 Macfarlane Rural Business (*MRB*) was originally commissioned by Central Plains Water Ltd (*CPWL*) in 2005 to carry out an analysis of the on-farm economics of the Central Plains Water Enhancement Scheme (the *Scheme*).

12 Our analysis consisted of modelling and budgeting typical farm systems.

13 We also assessed typical capital investment, and therefore a marginal return on marginal capital expended.

14 By calculating the district improvement in profit resulting from the investment in irrigation we were able to calculate a rate of return to scheme farmers for their marginal investment in irrigation and the CPW scheme.

15 We updated that analysis in 2007; updated budgets in 2008; provided evidence for the resource consent hearings with Selwyn District Council and Ecan in 2009; updated budgets in 2011; updated our report in 2012; and provided summaries of our work for farmer meetings in May 2013. I have presented at various meetings for shareholders and professionals on behalf of CPWL

16 Since our original work the OVERSEER® nutrient modelling programme has been developed and incorporated in the proposed Canterbury Land and Water Regional Plan. Strict nutrient loss limits have been introduced and have become as important as the economics. The two must now be considered together in any irrigation development.

17 In March 2014, we were instructed CPWL to:

17.1 Revise our farm models to reflect changes in Canterbury farming the past decade.

17.2 Prepare budgets for the new farm models before and after commissioning of the CPW irrigation scheme.

17.3 Calculate the changes in farm profitability resulting from irrigation using the CPW scheme.

17.4 Estimate nutrient losses from each of our model farm systems using Overseer and comment on possible mitigation measures.

18 That work, in conjunction with my earlier work forms the basis of this evidence.

KEY ASSUMPTIONS:

Standard of management

19 Our current projections, and past ones, assume:

19.1 Pre CPW farm models have a district average efficient standard of management.

19.2 Post CPW farm models have a standard of management in the top 20% for NZ but not necessarily top 20% production. I note that typical management in the CPW catchment is already in the top bracket for New Zealand.

20 Farms taking up new irrigation water will be at the top end of productivity because of:

20.1 Younger farmers taking over management through family succession or change of ownership

20.2 Top performers buying more land and expanding

20.3 High debt levels sharpening performance

20.4 Leveraging new technology e.g. new centre pivots compared to older technology such as gun irrigators or flood irrigation

20.5 A management mind-set of accepting new ideas

20.6 Confidence to push the boundaries knowing climatic variation is less likely to limit potential

20.7 Associated leadership in productivity growth

Dairy Farm Management

21 We have assumed the same productivity on dairy units, pre and post scheme. Those farms with insufficient (bore) water pre scheme will experience a definite lift in productivity post

development. We have accounted for that impact in our updated model by increasing the effective area of dairy, as we are aware of a number of dairy farms with insufficient water who currently use the undersupplied component of land for wintering cows only.

Therefore while an individual dairy farm currently receiving insufficient water will generate a high (late teens) ROC from CPW water, we have accounted for that impact in “area of dairy”, not “return per hectare of dairy”.

Area of influence

22 Irrigation schemes influence farm gate income outside the actual irrigated footprint in two ways:

22.1 Firstly, not every farm is 100% irrigated, but the non-irrigated portion of the farm is included in the crop or pasture rotation, and tends to have a higher income than the same land on a non-irrigated farm.

22.2 Secondly, dryland farms associated with, or in close proximity to, irrigated farms have substantial growth in both gross income and EBIT as a result of irrigation. Typical examples of impact include dairy wintering and/or silage supply for nearby dairy farms, or increased dryland grain crops as a result of nearby irrigated crops.

23 Based on this wider influence, our earlier analysis recognised that impact by calculating farm gate returns over 76,000 ha, of which 60,000 ha is actually irrigated.

24 In the CPW area, the most common examples will be in the higher rainfall areas, or large scale cropping farms where maybe 80% may be irrigated by pivot, and the rest dryland.

Self sufficiency

25 MRB has completed a mass balance model for the scheme to check that the 35,000ha of dairy we have budgeted on, post scheme completion is sustainable from a feed availability perspective.

26 The 16,000 ha of mixed livestock 100% irrigated, 9,000 ha arable land use under irrigation, and a further 16,000ha of non-CPW dry land (also in mixed livestock) will supply sufficient winter feed, grain and silage, and 80% of heifer grazing for the 35,000 ha dairy land use.

27 Typically, some heifers are transported further away for grazing.

Integrated management

28 We have maintained the basic principles of integrated crop and pasture rotations that has been the strength of Canterbury agriculture.

29 That principle, utilises alternative restorative (in terms of organic matter and nitrogen building phases) and depletive crops (nitrogen using crops that also utilise nitrogen from animal urine). We include winter feed crops in the nitrogen building phase, followed by deeper rooting spring nitrogen using crops such as maize, sweetcorn and wheat.

30 Such irrigated rotations utilize nitrogen far more efficiently than dryland monoculture winter feed rotations, where there is an inability to harvest free nitrogen.

31 In addition, organic matter content of such irrigated rotations increases organic matter content considerably relative to dryland rotations (typically raising organic matter percentage from 4% to 5.5-6%) on mixed crop farms and up to 9% on pasture dominated farms.

SUMMARY OF LAND USE PRE AND POST CPW DEVELOPMENT

32 We have created representative farm models based on our knowledge of farm systems and land use in the area, and verified by other farm management consultants, CPW research, and industry information. I summarise those models as the following pre and post CPW. Please refer to **Appendix 1** for the detail summary of each model:

Pre CPW Models:

32.1 Model 1 rotation: Dryland Livestock

32.2 Model 2 rotation: Dryland component (50%)

32.3 Model 3 Dairying: 3.5 cows/ha, cows wintered off

Post CPW Models:

32.4 Model 4: Mixed arable and livestock 50% irrigated

32.5 Model 6a: arable with process crops

32.6 Model 6b – intensive arable (includes livestock finished)

KEY CHANGES IN ECONOMICS SINCE PRIOR EVIDENCE

33 Since our analysis first commenced, land use and productivity in the area has been characterised by:

34 Firstly, for dairy, a realisation of our predicted 1,612kgMS/ha output. Our current projections are still based on that same output. In comparison to our 2007 numbers, the top farmers are now producing 2,000kgMS/ha, but with either a higher environmental footprint or more capital (concrete) to mitigate that.

35 Hence our numbers, while showing a higher EBIT/kgMS ($2.58 compared to $1.71/kg in 2007) are more than offset by a higher capital cost/ha.

36 Secondly, there have been major changes in drystock farming systems in the CPW catchment over the past seven years. The dairy and arable infrastructure in the area has seen an increase in dryland dairy support, including grain production, at the expense of ewe numbers

37 Thirdly, non-dairy irrigated systems have altered. Specialist arable units, including small seeds and vegetable seeds and process crops are a viable land use option for those with the skill set, infrastructure, and on better soils. Specialist irrigated livestock finishing units are not now able to generate sufficient EBIT to generate a viable return on capital. These systems have migrated to a mix of dairy support and arable crops, with some dairy support substituted for lamb or cattle finishing.

38 As the return on capital for such units is increased, ironically, leveraged off nearby irrigation, the marginal gain to irrigated dairy conversion has reduced relative to 5 – 7 years ago.

39 Fourthly, the introduction of some higher yielding forage systems, incorporating crops like fodder beet and maize, that require irrigation, and are not only very high yielding, but also efficient users of both water and nitrogen to convert to dry matter.

SUMMARY OF ASSUMED LAND USE, PRE AND POST CPW

Table 1 Price assumptions for on-farm economics

40 I include key price assumptions below, including assumptions from recent previous analysis.

Item	**Item**	**Aug-09**	**Nov-11**	**Mar-14**
Lamb	Spring/winter	$5.10	$6.50	$6.50
	Summer	$4.30	$6.00	$6.00
	Store lamb	$1.95	$3.00	$2.70
	Cull ewe	$40.00	$90.00	$80.00
	Winter margin	$38.40	$40.00	$50.00
	Summer margin	$13.30	$22.00	$28.00
	LWG finishing margin	$1.60	$1.60	
Wool		$2.60	$4.00	$4.00
Crop	Feed wheat	$380.00	$380.00	$400.00
	Prem milling wheat	$440.00	$440.00	$440.00
	Barley	$350.00	$360.00	$380.00
	Vining peas	$300.00	$300.00	$300.00
	Grass	$2,200.00	$2,200.00	$2,350.00
	Clover	$6,000.00	$6,000.00	$6,000.00
	Lucerne /kgDM	$0.16	$0.22	$0.27
	Straw buy /bale	$35.00	$65.00	$75.00
	Straw sell /kgDM		$0.12	$0.125
Grazing	Calf	$5.50	$6.00	$7.00
	Heifer	$8.50	$10.00	$12.00
	I.C. heifer	$12.00	$19.00	$25.00
	Cow winter /hd/wk	$18.00	$23.00	$27.00
	Standing winter feed			$0.27
Dairy	Cull cow	$400.00	$500.00	$550.00
	Bobby calf	$30.00	$30.00	$35.00
	Milk solids Fonterra	$5.50	$6.30	No
	Milk solids base			$6.50
Beef	Prime beef	$3.50	$4.00	$4.60
	Manufacturing			$4.30
	Cull cow		$500.00	$660.00
Dairy cereal purchase	Barley + wheat	$350.00	$380.00	$390.00
	Silage	$150.00	$200.00	$320.00
	Maize silage		$230.00	$320.00
	PKE			$300.00
	Barley meal			$450.00

41 Table 2 below includes my original land use mix, based on 76,000ha, which has been re-presented in Table 1(a) Pre CPW and 1 (b) Post CPW, below to confirm that 16,000ha of the assessed 76,000ha is non-CPW land but will be used by CPW farmers in the support capacity for the likes of winter grazing/feed production as described above.

Table 2 Original MRB land use assessment Pre and Post CPW

Pre CPW			Post CPW		
Land Use	**Area**	**ROI**	**Land Use**	**Area**	**ROI**
1. Livestock (Dr)	46,000ha	**2.3%**			
2. Mixed (50% Ir)	8,000ha	**2.9%**	4. Mixed L/s (50% Ir)	32,000ha	**4.1%**
3. Dairy (Ir)	22,000ha	**6.4%**	5. Finishing		
			6a. Arable & process	9,000ha	**5.5%**
			6b. Arable	0ha	**2.3%**
			7. Dairy	35,000ha	**6.2%**
Total	**76,000ha**		**Total**	**76,000ha**	**ha**

42 **Table 2(a) Assessed Land use Pre Scheme** (numbers adjusted to reflect 60,000ha scheme area)

Land Use	**Area (Ha)**	**% of scheme**
Livestock (Dr)	36,000	60%
Mixed (50% irr)	6,400	10%
Dairy (Ir)	17,600	30%
Total CPW area	**60,000**	**100.00%**
Additional non-CPW land within the scheme are of influence	16,000	

43 **Table 2(b) MRB assessed Land use Post Scheme** (numbers adjusted to reflect 60,000ha scheme area)

Land Use	**Area (Ha)**	**% of scheme**
Mixed livestock (100% irr)	16,000	27%
Arable & Process	9,000	15%
Dairy (Ir)	35,000	58%
Total CPW area	**60,000**	**100%**
Additional non-CPW land within the scheme are of influence	16,000	

44 Table 2 also notes the absolute return on total capital invested for each of the modelled land uses.

45 Examples of how movement from one “Pre CPW” land use to another “Post CPW” land use affects marginal return on marginal capital spent are:

45.1 Dryland to CPW mixed 50% irrigation 8.2%

45.2 Dryland to intensive arable 11.5%

45.3 Existing dairying to CPW dairy with no increase in water available on reliability 4.2%

45.4 Existing dairying to CPW dairy where water reliability improves 18%

46 Many existing dairy farmers with reliable and sufficient water are changing to CPW to protect themselves against future increases in energy and pump repairs and maintenance.

47 The return on capital significantly exceeds the cost of capital on most farms and is also significantly better than the return on capital from additional land (as demonstrated by Table 2).

48 I have summarised the trend in marginal return on marginal capital from scheme uptake in table 3.

Table 3 Trends in Return on Capital Over Time in our CPW analysis

Marginal Return on Investment	Jul-07	Sep-09	Dec-11	Jun-14
Area (ha)	85,250	76,000	76,000	76,000
Scheme-wide marginal EBIT	$187,441,913	$85,850,282	$93,789,345	$93,781,193
Scheme-wide capital cost	$1,165,283,581	$545,660,500	$722,943,550	$1,069,828,703
Scheme-wide capital cost/ha	$13,669.02	$7,179.74	$9,512.42	$14,076.69
Scheme-wide RoC	16.1%	15.7%	13.0%	8.8%

Return on Investment by Farm Type	Jul-07	Sep-09	Dec-11	Jun-14
1. Livestock (Dr)	0.5%	0.5%	1.7%	2.3%
2. Mixed (50% Ir)	3.1%	3.4%	2.5%	2.9%
3. Dairy (Ir)	8.9%	4.3%	5.1%	6.4%
4. Mixed L/s (50% Ir)	3.2%	3.7%	5.3%	4.1%
5. Finishing	2.7%	n/a	n/a	n/a
6a. Arable & process	6.4%	5.8%	4.9%	5.5%
6b. Arable		3.8%	2.9%	2.3%
7. Dairy	10.8%	6.3%	7.0%	6.2%

Note:			Dec-11	Jun-14
Capital cost of scheme			$6500/ha	$7500/ha
Capital charge for scheme			Nil	Nil

49 The downward trend in marginal return on marginal capital across the scheme is not surprising, as noted earlier.

50 Firstly, land values have increased to reflect the imminent CPW irrigation.

51 Secondly, the development cost for both the irrigation itself and associated development (such as dairy)) has increased considerably, part due to cost inflation, part due to higher specifications from enhancements such as Variable Rate Irrigation (VRI) technology on pivots that minimise drainage.

52 Thirdly, the 30,000 ha of existing irrigation has stimulated higher land use options from nearby dryland, hence increasing returns from “Pre CPW” options.

53 Fourthly, much of the gain from more efficient irrigation using existing bore sourced irrigation water has already occurred, limiting further production gains with a different water source, given that environmental constraints may limit short term growth in output.

NUTRIENT LOSS OUTCOMES

54 In our latest revision of the land use change economics, we have tested the land use change through OVERSEER in order to model potential nutrient loss outcomes.

55 Table 4 summarises those outcomes

PRE-IRRIGATION						
	Model 1 - Dryland Livestock	Mayfield Soil	16,000 ha	16 kgN/ha	8.25 N ppm	0.1 kgP/ha
		Lismore Soil	30,000 ha	16 kgN/ha	8.25 N ppm	0.1 kgP/ha
	Model 2 - Mixed Crop 50% Irrigated	Chertsey Soil	8,000 ha	18 kgN/ha	5.04 N ppm	0.7 kgP/ha
	Model 3&7 - Dairy	Lismore Soil	22,000 ha	36 kgN/ha	16.40 N ppm	0.8 kgP/ha
	AVERAGE		76,000 ha	22 kgN/ha	10.27 N ppm	0.4 kgP/ha

POST-IRRIGATION						
	Model 3&7 - Dairy	Lismore Soil	35,000 ha	36 kgN/ha	16.40 N ppm	0.8 kgP/ha
	Model 4 - Mixed Arable	Mayfield Soil	15,000 ha	22 kgN/ha	6.90 N ppm	0.9 kgP/ha
		Lismore Soil	17,000 ha	23 kgN/ha	6.80 N ppm	0.2 kgP/ha
	Model 6a - Arable and Process	Mayfield Soil	1,000 ha	11 kgN/ha	3.41 N ppm	1.0 kgP/ha
		Chertsey Soil	8,000 ha	10 kgN/ha	2.97 N ppm	0.6 kgP/ha
	AVERAGE		76,000 ha	27 kgN/ha	10.79 N ppm	0.7 kgP/ha

56 Key assumptions behind the model include:

56.1 Firstly, soil moisture holding capacity (SMHC)

Soil Type Name	**Soil type**	**Area (ha)**	**SMHC 0-30 mm**	**SMHC 30-60mm**
Mayfield	Mod deep silt loam	16,000	46	30
Lismore	Shallow silt	52,000	60	28
Chertsey	Silt loam	8,000	71	52
		76,000		

56.2 Secondly, MRB has modelled applied water to each model per instructions from Stuart Ford of Agribusiness group

Pre CPW	**Land use**	**Rainfall**	**Irrigation**	**ET**
Model 1	Dryland/livestock	758	-	949
Model 2	Mixed, 50% irrigation	918	As required	923
Model 3	Dairy	758	436	939
Post CPW				
Model 4	Mixed, 50% irrigation	918	As required	923
Model 6a	Arable & Process	918	As required	923
Model 7	Dairy	758	416	939

57 It is important to note that to produce the results summarised in Table 6. MRB used OVERSEER® version 6.1.2, including selecting ‘method only’ for irrigation management.

58 In the context of the evidence presented by **Mr Ford** and **Mr Lowe**, we recognise that future changes to OVERSEER® will affect the nitrogen discharge results generated across most farm systems. However, this exercise was valuable as it illustrated that for the three significant land uses anticipated for the scheme – Arable, Dairy and Dairy Support, the numbers assessed by ECan (established we understand through OVERSEER® version 6.0), set out in Table 5 below were confirmed as being in a similar range to our own.

Table 5

Land Use	**MRB Results (kgN/ha/yr)**	**ECan Results (ex Table 6) (kgN/ha/yr)**
Dairy	36	32.6
Dairy Support integrated with arable	22	38,7
Intensive Arable	11	22.7

Note, pure dairy support would be higher than the MRB modelled 22kgN/ha/yr, more in line with ECan’s modelled dairy support of 38.7kgN/ha/yr. However there is no ‘typical’ diary support system, i.e. Dairy support is largely integrated into mixed farm systems, in varying proportions. In our typical farm model, the higher leaching winter feed crops are averaged down by nitrogen utilising crops in the rotation.

59 Table 6.0 illustrates the calculating of existing and new irrigation nitrogen leaching allocation – prepared by Environment Canterbury February 2014

<table>
<tr><th colspan="2">Land use</th><th>2011</th><th>2017</th><th>2022</th><th>Area</th></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="2">Existing irrigated</td><td>964 t N (average 32.1kg N/ha</td><td>1042 t N (average 34.8kg N/ha</td><td>840 t N (average 28kg N/ha</td><td>30,000ha</td></tr>
<tr><td colspan="2"></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">New irrigated land</td><td>468 t N (as dryland) average 15.6kg N/ha)</td><td>902 t N (average 30kg N/ha)</td><td>902 t N (average 30kg N/ha)</td><td>30,000ha</td></tr>
<tr><td rowspan="5">Apportionment</td><td>New irrigated dairy support</td><td></td><td>81 t N (average 38.7kg N/ha)</td><td>81 t N (average 38.7kg N/ha)</td><td>2100ha</td></tr>
<tr><td>New irrigated sheep and beef</td><td></td><td>89 t N (average 22.8 kg N/ha)</td><td>89 t N (average 22.8 kg N/ha)</td><td>3900ha</td></tr>
<tr><td>New Dairy</td><td></td><td>391 t N (average 32.6 kg N/ha)</td><td>391 t N (average 32.6 kg N/ha)</td><td>12000ha</td></tr>
<tr><td>New irrigable arable</td><td></td><td>272 t N (average 22.7 kg N/ha)</td><td>272 t N (average 22.7 kg N/ha)</td><td>12000ha</td></tr>
<tr><td>Additional load for the new Dairy Support as a result of new dairy (which might occur outside CPW)</td><td></td><td>68 t N</td><td>68 t N</td><td></td></tr>
</table>

60 I anticipate that once the 'bugs' in OVERSEER are corrected, the weighted average of 27kg/ha/yr will increase. It is difficult to predict the extent of the increase but it could be in the vicinity of 10%, lifting up the weighted average to around 30kgN/ha/yr.

61 At this point, I simply highlight that the vulnerabilities inherent in OVERSEER® numbers will make compliance reporting a challenge going forward, this point has been thoroughly discussed in both **Mr Ford's** and **Mr Lowe's** evidence. Table 4 illustrates that the drainage concentration (Nitrogen present in the water below the root zone) fall within a range of between 5ppm and 16ppm.

62 CPW's existing water 'use' consent includes drainage concentrations as a measure of compliance. For CPW a Farm Environmental Plans is required to demonstrate acceptable mitigation practices if the concentration is between 8ppm and 16ppm. Measuring concentrations is a less volatile approach to determining leaching, and one that I would recommend as a counter check to OVERSEER, until such time that the corrections are made and results generated are consistent.

63 Secondly, dryland livestock and dairy support systems typically have shallow root systems, and much less ability to grow deep rooting summer crops that utilize N. Without N interception ability, and less water availability able to lower N concentration, N concentrations from cattle wintering on dryland are higher than many would expect, and higher than a more balanced irrigated rotation including the same winter feed crops.

64 Thirdly, once the same cattle wintering capacity is introduced to mixed arable models under irrigation, the higher N deposits from cows wintered are more easily intercepted under irrigated mixed cropping, and diluted with the water applied.

65 Fourthly, the dairy losses at 36kg/ha and 16.4ppm are very close to the original limits set for CPW.

66 While those N losses are increased without some key tools such as nitrate inhibitors, they have potential to slowly reduce as new science emerges. In addition, they are promising enough to not necessarily require large scale investment in concrete in order to bring N levels marginally lower, at massive capital expense.

67 While shed and wintering pads are an option for a minority of farmers, particularly those with very heavy soils (ironically, also the soils with the lowest N leaching potential), there are a number of tools available to reduce N leaching that generate a higher return on capital, and a greater impact on N losses.

68 The weighted average N lost, post irrigation, at 27kg/ha and 10.8ppm is well within expected limits, based on current versions of Overseer, and key assumptions.

69 I believe the impact on the CPW water on N concentration will be more positive than modelled. The dilution effect of new alpine water

applied is accounted for in OVERSEER®. The impact of leaving 30,000 ha of water from existing bore fed irrigation systems in deep aquifers is not accounted for, and is extremely significant. At 4,500m^3/ha/yr over 30,000 ha, water left in the aquifer is 135M m^3/year, a massive diluting influence.

70 P losses are increased in irrigated systems relative to dryland, but only marginally, from 0.1 to 0.7 ppm. In a scheme where land is flat, like CPW, P losses are unlikely to be an issue due to the flat contour as long as lowland stream margins are planted and stock removed from river flows.

71 Clearly our modelling represents the middle of a “bell curve” of economic and nutrient loss outcomes, driven off variable capital expenditure requirements.

72 In addition, science is still being developed, or to be developed, that better increases the accuracy of Overseer. The absolute numbers we are demonstrating here are subject to variability as the Overseer “backend” assumptions improve in informed accuracy.

73 Innovation in irrigation systems continues at a huge pace.

74 To date the largest gains have occurred from:

74.1 reducing drainage though more accurate application and timing of water;

74.2 telemetry to make it easier to monitor soil moisture status, pump status, flow rates, and climate predictability;

74.3 the ability to measure nitrogen concentrations in groundwater in real time is being developed; and

74.4 the ability to slow the conversion of ammonium to nitrate, giving plants more time to utilize the N resource has slowed with the loss of DCD. Science will take more time to develop alternatives.

75 I am encouraged that the robustness of our analysis, using farm business budgets, underpinned with Farmax feed budget modelling, and tested through Overseer, gives us results consistent with what we see in on ground farm businesses on a weekly basis.

76 I acknowledge that once the expected corrections are made to OVERSEER®, we will see an overall increase in reported leaching N/ha. The averages that I have discussed are likely to increase, possibly in the vicinity of 10%. Consideration should be made for this in any nitrogen allocation establish for the scheme. In preparing dryland to irrigation conversion analysis it is critical that

landowners have the confidence the appropriate nitrogen allocation is available, as well as the affordable good management practice mitigations to enable them to invest in irrigation in full knowledge that they can comply, not sometime in the future, but from day one.

77 My on ground experience, as a farm management consultant and farmer, combined with my knowledge of science advances via my interactions at AgResearch, Lincoln University, and overseas, and market knowledge via my roles in the red meat industry, also gives me confidence that while the economic proposition has tightened, price projections (Table 1) and productivity projections will be out performed in practice. That outcome would be no different than what I have experienced over my 35 years participation in the rural sector.

Dated: 29 August 2014

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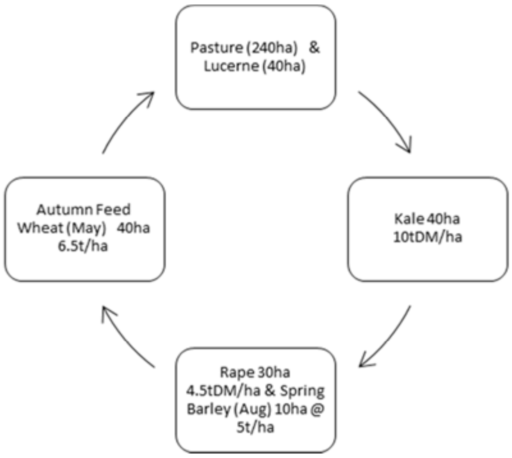
Andrew Webster Macfarlane

APPENDIX 1

SUMMARY OF LAND USE PRE CPW DEVELOPMENT

Model 1 rotation: Dryland livestock

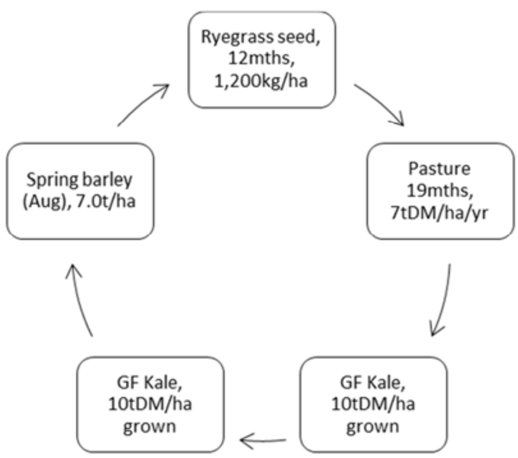


This model is based on 60% pasture/Lucerne, with winter feed crops, followed by some cereal crop.

Changes to typical rotation since 2012

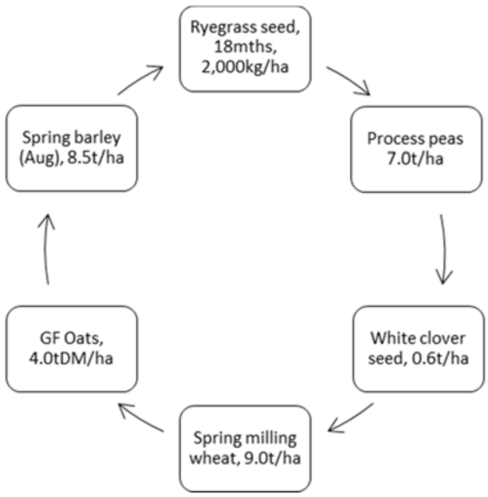
- Sheep numbers reduced from 2,100 ewes to 1,000 ewes (130%) & 250 hoggets (65%)
- Sheep replaced with 300 dairy heifers taken from weaning for 18 months to 30 April i.e. 300 calves from weaning in November to 30 April and 300 yearlings from 1 May to 30 April.
- Surplus winter feeds sold to dairy farmers to winter dry cows.
- Cereal yields lifted by 1t/ha to 6t/ha barley and 6.5t/ha winter feed wheat.

Model 2 rotation – dryland component (50%)



This model has intensified in recent years, with significantly more winter brassica for dairy cow wintering.

Model 2 rotation – irrigated component (50%)



This rotation has maintained a reasonably traditional mixed crop rotation

Grazing capacity within rotations

A typical Canterbury farm system, half irrigated, incorporating sheep and dairy grazers but with 280 ha of arable and forage crops in rotation.

- 400 ha
- 50% irrigated from wells
- Better soils and hence higher yields than Farm Model 1
- 550 ewes lambing 140%, 120 hoggets lambing 60%, finishing 950 winter lambs,
- 120 R1 dairy heifer calves, 120 R2 dairy heifers,
- 300 dairy cows wintered,
- 280ha arable crops of ryegrass seed, white clover seed, milling wheat, barley, process peas, greenfeed kale.

Model 3, Dairying

An irrigated Canterbury plains dairy farm system with a moderate stocking rate and moderate production level. Some existing farms, e.g. in the Te Pirita district may have marginal areas that cannot be reliably irrigated and are used for forage crops instead of lactating cows. This model considers the milking area only.

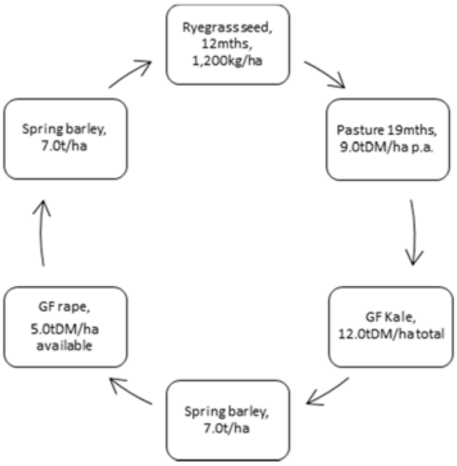
- 400 ha
- 100% irrigated from wells with pivots where practicable
- 1,400 cows at 3.5 cows/ha
- 644,000kgMS total production = 460kgMS/cow & 1,610kgMS/ha

- 864kgDM/cow supplements
- 12,431kgDM/ha pasture consumed
- 207kgN/ha nitrogen application
- Cows wintered off. All replacements grazed off till first calving.

SUMMARY OF LAND USE POST CPW

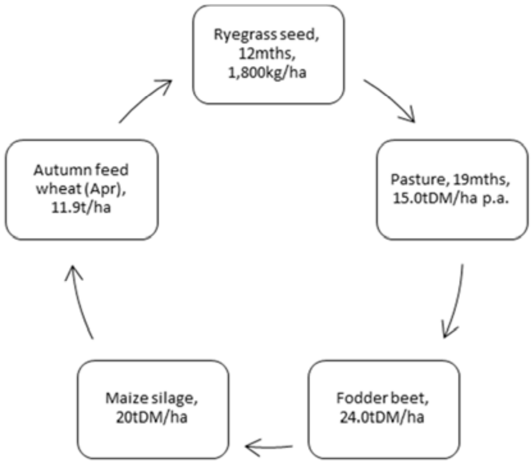
Model 4, mixed arable and livestock 50% irrigated

Dryland component



Partially irrigated farms are intensifying, but within a mixed crop rotation. Dairy heifers and wintering cows have replaced breeding ewes, and in many cases, finishing lambs.

Irrigated component



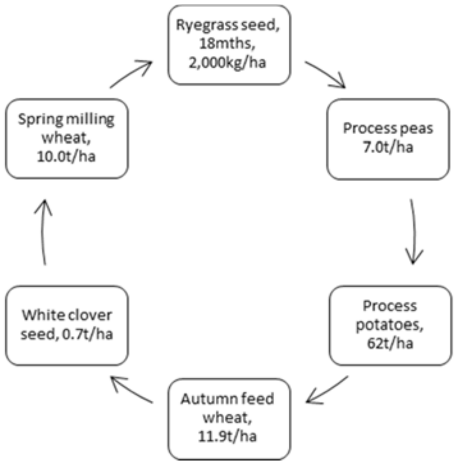
Fodder beet is rapidly replacing kale as a winter feed of choice, given its higher yield, higher profit per hectare, and possibility of a lower than expected N footprint.

Carrying capacity within rotation

A half-irrigated, intensive mixed farm with sheep, dairy heifers and cow wintering plus more intensive crops.

- 400 ha
- 50% irrigated from CPW
- 750 ewes to a terminal sire at 150%,
- Grazing 300 R1 dairy calves, 300 R2 dairy heifers,
- Surplus winter feed sold for dairy cow wintering 1250 dairy cows.
- Grass seed, wheat, barley, dryland greenfeed brassica, fodder beet. Maize silage.
- 50 ha of Lucerne
- Short term high quality pasture 15tDM/ha total production under irrigation and 9tDM/ha dryland.

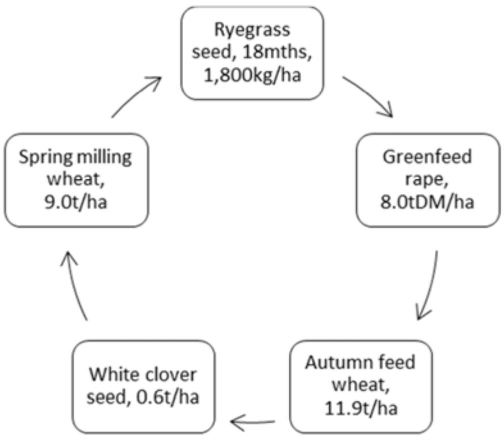
Model 6a – arable with process crops



Livestock: 2,500 lambs finished

Intensive arable farms are still finishing large numbers of lambs to avoid any soil damage where sensitive small seed and vegetable seed crops are grown.

Model 6b – 5 year rotation



Livestock finished: 4,800 lambs

This less intensive rotation is slipping in popularity as profit declines relative to mixed arable and dairy support.