OTOP Scenario Economic Assessment

Technical Report

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Summary of Scenario findings

Environment Canterbury (ECan) has in 2009 launched the Canterbury Water Management Strategy (CWMS) which is being implemented by ten Zone committees. These Zone committees have representatives from their local council, from ECan, as well as papatipu rūnanga, and community members including from such organisations as Fish and Game New Zealand.

One such Zone in South Canterbury is the Orari-Temuka-Opihi-Pareora Zone abbreviated to the OTOP Zone.

This technical report describes the research and analysis which has been completed to assess the economic impacts at the Zone level of different possible scenario outcomes resulting from different futures of water availability and water use in the OTOP Zone. The economic outcomes from these scenarios have been modelled under four sets of assumptions as proposed by the Zone committee and provided to BERL researchers by the ECan professionals.

The scenarios modelled

The Scenarios specified fall into two groups. The first group analyses the land use in the whole OTOP Zone with the current water supply. The second group of assessments model 'what if?' scenarios to measure the impacts if areas within the OTOP Zone were to be supplied with new water brought into the Zone. In order to model these changes, specific areas have been identified, but these actual outcomes are hypothetical as individual land owners shall make their own decisions on water use should the scenarios eventuate.

A summary description of the four Scenarios are as follows:

Scenario 1, the Current Pathway assessment. This assessment initially models the current land-based economy with the current land use, and current water use. It then models the shape of the OTOP land-based production and economy, based largely on the present situation, except that it allows for changes in land and water use as a result of the requirements to reduce water takes from over-allocated groundwater in some of the Groundwater Allocation Zones (GWAZs).

Scenario 2, In-Zone gains assessment. This assessment models the potential 'In-Zone' gains from better use of existing water resources. It aims to explore improved water use for the current general pattern of land use, rather than attempting to model the optimal balance of change in land use towards high value uses. Specifically it models the ability to maintain current production while using water with technically more efficient methods, releasing some currently used water for environmental improvements. It also models a scenario where the reliability of water supplied is increased resulting in greater production and value from the current pattern of land use.

Scenario 3A Small scale New water and Scenario 3B Large scale New water supply of 'Replacement water'. Scenario 3A comprises parcels of land which are a sub-set of the parcels included in Scenario 3B. The difference between the Scenarios is whereas 3A utilises currently consented surface water from the Rangitata River, and Waitaki River, Scenario 3B in addition combines that water with additional water from an alpine source yet to be identified.

The other commonality between the two Scenarios is that each scenario withholds from new irrigation uses, an amount of water sufficient to irrigate 2,840 hectares of dryland. This water is then used as 'top-up and replacement water' to be supplied to 5,680 hectares of land currently irrigated substantially with groundwater. This replacement water will allow some reduction in groundwater takes as well as providing increased reliability of water supply to irrigation on these 5,680 hectares.

Scenario 3A Small scale New water dryland irrigation This scenario assesses the impacts when existing consented schemes source new supply of already consented Rangitata River water, and Waitaki River water. As well as the 'replacement water' discussed above, the new water shall be available for irrigation of identified areas of dryland, totalling 12,253 hectares. This land is in the lower Opihi/Temuka catchments

Scenario 3B Large scale New water dryland irrigation This scenario assesses the impacts when the changes modelled in Scenario 3A are combined with additional new water entering the Zone from an alpine source yet to be identified. As well as the replacement water, and as with the Small scale scenario, the Large scale one shall also make new water available for irrigation of identified areas of dryland, totalling in this case over 27,100 hectares. As well as the 12,250 hectares of dryland assumed to be irrigated in scenario 3A, this will thus include a further 14,850 hectares of identified dryland.

The modelling method

The approach to modelling the impacts of these scenarios is to identify the land use of areas of interest in the Zone using the GIS data supplied by ECan. The model developed is necessary to model only the parts of the Zone economy relevant to the activity generated directly and indirectly by the land uses relevant to the use of water in the catchments. It is thus a partial analysis of the Zone economy rather than a complete model of all sectors and industries in the Zone. Nor does it cover non-economic elements of costs and benefits such as those that impact on the waterways in the Zone.

As a partial analysis it is necessary to measure the values to the Zone economy generated by land uses without irrigation in comparison to those under irrigation, or for example, under irrigation with different levels of water reliability. This will enable comparison of economic activity when land uses change.

The actual partial measures used to assess the economic effects of land use are the gross margins earned per hectare from each land use when exercised on a dryland basis and when exercised as irrigated production. The gross margin is the measure which is the gross revenue per hectare less the variable costs per hectare in producing that hectare of output. The variable costs do not include the fixed costs associated with the ownership of the land or the fixed capital tied up in production.

These gross margins are therefore equivalent to the concept in economics of the value added in production. In turn the value added from a hectare of production is the contribution to Gross Domestic Product (GDP) in the Zone from that hectare. The actual employment on-farm to achieve the production is also measured.

This information comes from a range of sources of industry data and the objective is to reflect the expected levels of costs and returns in the present.

Once the direct on-farm and in-orchard impact is measured, the impacts are extended to include the backward and forward linkages along the value chain within the region. The backward linkages are the suppliers of goods and services to the on-farm producers and the forward linkages are the activities which take the produce from the farm and market it, process it, manufacture it, and forward it on to sale.

The method used to estimate the value chain impacts uses an inter-industry flow table, or input-output table of the transactions between industries in the region's economy. This table can show the multipliers of the direct GDP and employment which show the increases resulting from the increased activity in the backward and forward linkages from the on-farm production.

Summary outcomes from Scenarios : the whole Zone scenarios

The current land use in the Healthy Catchment area totals 381,600 hectares of which 330,100 hectares are in dryland production and 51,500 hectares in irrigated production.

Scenario 1, the Current Pathway assessment: The Current Pathway allows for reduction of water takes to 90 percent of their current consented allocations in two over-allocated GWAZs. This reduction takes effect in the first round of consent renewals. In total it reduces the water available in the current irrigated area by approximately 4 percent. The economic impact of this change is not great as shown in the table.

Table 1: Summary outcomes Current Pathway Scenario

Economic outcomes for Scenarios		Current land use Current water	Current Pathway Restricted water
Direct gross margin (GDP)	Dryland	$142 million	$142 million
	Irrigated	$159 million	$153 million
	Total	**$301 million**	**$295 million**
Value chain GDP	**Total**	**$509 million**	**$498 million**
Direct employment		**2,371 FTEs**	**2,326 FTEs**
Value chain employment		**4,993 FTEs**	**4,307 FTEs**
Net change from current land use			
Direct gross margin (GDP)			**Reduced $6 mn**
Value chain GDP			**Reduced $11 mn**
Direct employment			**Reduced 45 FTEs**
Value chain employment			**Reduced 86 FTEs**

The reductions in Direct gross margins and in Value chain GDP are about 2 percent of the current levels and the employment reductions are a similar rate.

Scenario 2, In-Zone gains assessment The first analysis in this assessment, models the ability to maintain current production while using water with technically more efficient methods. This analysis found that a majority of the irrigation in the Zone is by relatively efficient spray irrigation methods. Nevertheless, a realistic level of move to the more efficient spray methods could release for environmental improvements a volume of from 6 to 9 million m^3 annually of the currently used water.

The second analysis postulated an improvement in the reliability of supply of irrigation water resulting in greater production and value from the current pattern of land use.

Table 2: Summary outcomes In-Zone gains from reliable water

Economic outcomes for Scenarios		Current land use Current water	In-Zone gains Reliable water
Direct gross margin (GDP)	Dryland	$142 million	$142 million
	Irrigated	$159 million	$174 million
	Total	**$301 million**	**$316 million**
Value chain GDP	**Total**	**$509 million**	**$532 million**
Direct employment		**2,371 FTEs**	**2,453 FTEs**
Value chain employment		**4,993 FTEs**	**4,557 FTEs**
Net change from current land use			
Direct gross margin (GDP)			**Increased $15 mn**
Value chain GDP			**Increased $23 mn**
Direct employment			**Increased 82 FTEs**
Value chain employment			**Increased 163 FTEs**

The outcomes from this modelling indicate increased gross margin on the irrigated land by about 9 percent, which overall increased the contribution from all of the land by 5 percent. Much of this increase was achieved in production per hectare, and consequently required an increase in employment of only about 3.5 percent. This implies an increase in labour productivity as well as productivity on the land.

Summary outcomes from Scenarios: the new water scenarios

These two scenarios are firstly Scenario 3A for a total area of about 15,000 hectares, and secondly Scenario 3B for a total area of about 30,000 hectares. These areas are smaller than the current total irrigated area of 51,000 hectares in the previous scenarios.

Scenario 3A and 3B New water for Top-up replacement water. This water is held back from irrigating 2,840 hectares of dryland and is supplied as top-up and replacement water to 5,680 hectares of land currently irrigated substantially from groundwater. This water will ensure the water supply is more reliable, and will consequently have a small increase in economic impact from this 5,680 hectares of land. However the main benefit shall be environmental, as an ability to reduce the groundwater takes in key areas.

Scenario 3A Small scale New water dryland irrigation This area in scenario 3A is modelled to receive new alpine water from currently consented takes from the Rangitata and Waitaki Rivers. It will provide irrigation water to an additional 12,250 hectares of dryland for irrigation in the lower Opihi/Temuka catchments.

Scenario 3B Large scale New water dryland irrigation. This scenario is assumed to access additional alpine water from sources yet to be identified. It shall also make new water available for irrigation of identified areas of dryland, totalling in this case over 27,100 hectares, being the 12,250 hectares of dryland assumed to be irrigated in Scenario 3A, plus a further 14,850 hectares of identified dryland.

The impacts of providing larger areas of dryland with irrigation water are significant as shown in the table.

Table 3: Summary outcomes New water Small scale and Large scale scenarios

Economic outcomes for Scenarios	Scenario 3A: Small scale		Scenario 3B: Large scale	
	Dryland	When irrigated	Dryland	When irrigated
Total scenario area (Hectares)	12,250	12,250	27,100	27,100
Direct gross margin (GDP)	**$9 million**	**$44 million**	**$18 million**	**$92 million**
Value chain GDP	**$16 million**	**$71 million**	**$32 million**	**$147 million**
Direct employment	**81 FTEs**	**265 FTEs**	**157 FTEs**	**559 FTEs**
Value chain employment	**146 FTEs**	**522 FTEs**	**286 FTEs**	**1,095 FTEs**
Net change from current land use				
Direct gross margin (GDP)		**$35 million**		**$73 million**
Value chain GDP		**$55 million**		**$115 million**
Direct employment		**184 FTEs**		**403 FTEs**
Value chain employment		**376 FTEs**		**809 FTEs**

The outcomes generated from these scenarios show that if additional water were accessed from outside the Zone and made available to existing dryland producers there could be significant increases in activity in the Zone's economy.

In fact compared with the contribution to the economy by the Current Pathway land uses, the activity from the New water Large scale Scenario 3B would increase the contribution to the Zone's value chain GDP by about 23%, and the New water Small scale Scenario 3A would increase it by about 11 percent. The impacts on the employment in the Zone are similar orders of magnitude.

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1 Introduction

Environment Canterbury (ECan) has in 2009 launched the Canterbury Water Management Strategy (CWMS) which is being implemented by ten Zone committees. These Zone committees have representatives from their local council, from ECan, as well as papatipu rūnanga, and community members including from such organisations as Fish and Game New Zealand.

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This technical report describes the research and analysis which has been completed to assess the economic impacts at the Zone level of different possible scenario outcomes resulting from different futures of water availability and water use in the OTOP Zone. The economic outcomes from these scenarios have been modelled under four sets of assumptions as proposed by the Zone committee and provided to BERL researchers by the ECan professionals.

The initial assessment is of the current land use projected into the future to represent the 'Current Pathway' of the land use, water use and economic activity. It assesses the implications of the current rules and plans under the current land use. This Current Pathway scenario will act as the comparator with the other three posited scenarios. Consequently, the form of expression of the land use pattern, the basis of assessment, and the economic model behind it must be in such a form that it can accommodate the changes to be assessed for the other three scenarios.

The second scenario to be assessed is one in which water availability remains the same as for the Current Pathway scenario but which models the potential In-Zone Gains possible with improved water management within the available water in the Zone, releasing some water for environmental improvement.

The other two scenarios are to be assessed on a 'what if?' basis. The scenarios that the Zone committee has settled on at the time of this assessment are respectively Scenario 3A: New Water, Small Scale entering the Zone; and Scenario 3B: New Water Large Scale entering the Zone.

1.1 Methodology of modelling the economic impact

The model developed is necessary to model only the parts of the Zone economy relevant to the activity generated directly and indirectly by the land uses relevant to the use of water in the catchments. It is thus a partial analysis of the Zone economy rather than a complete model of all sectors and industries in the Zone. Nor does it cover non-economic elements of costs and benefits such as those that impact on the waterways in the Zone.

As a partial analysis it is necessary to measure the values to the Zone economy generated by land uses without irrigation in comparison to those under irrigation. This will enable comparison of economic activity when land uses change.

The actual partial measures used to assess the economic effects of land use are the gross margins earned per hectare from each land use when exercised on a dryland basis and when exercised as irrigated production. The gross margin is the measure which is the gross revenue per hectare less the variable costs per hectare in producing that hectare of output. The variable costs do not include the fixed costs associated with the ownership of the land or the fixed capital tied up in production. These gross margins are therefore equivalent to the concept in economics of the value added in production. In turn the value added from a hectare of production is the contribution to Gross Domestic Product (GDP) in the Zone from that hectare.

By modelling the current land use in its future form, we show the gross margin per hectare of each land use as dryland production, and separately as irrigated production. Taking the total area in each main land use in the healthy catchment areas of the Zone multiplied by the gross margin per hectare we show the direct contribution to GDP from the total of those land uses. This is the value added on-farm and in-orchard.

The total of those gross margins is called the Direct Value Added or contribution to the GDP in the Zone's economy.

The on-farm and in-orchard production requires inputs to the production from goods and services suppliers in the Zone, and these suppliers in turn contribute value added to the Zone's economy. The goods produced by the on-farm and in-orchard production also contribute to value added in downstream activity, and that adds value to the Zone's economy.

The upstream and downstream value added resulting from the on-farm and in-orchard activity is added to the Direct value added and this amount is called the Total Value Added, or Total contribution to the Zone GDP.

A similar process is applied to the employment. The direct employment is the on-farm and in-orchard employment. It is measured as Fulltime Equivalent employees (FTEs). In other words all work input including part-time work is converted to the work completed by an equivalent number of employees working fulltime for the year.

1.2 What the modelling shows

The Current Pathway scenario can be thought of as the base case, or the benchmark of what the current land use will contribute to the future Zone economy under the current rules and plans. The direct land use gross margins, and the resulting total contribution to Zone GDP and FTE employment becomes the benchmark against which can be measured the modelled future outcomes of the 'what if?' scenarios.

For Scenario Two, the In-Zone Gains, the main interest will be in the possibility to maintain the current pathway level of production while using less irrigation water. This will indicate the extent to which water can be released back to the environment while maintaining the current level of production and contribution to the Zone economy.

For Scenarios 3A and 3B, the direct increase in gross margins will show the extent to which producers would obtain increased margins available to cover the funding cost of the capital needed to bring the New Water onto their farms and orchards. The Direct margins feed into the business case on farm and orchard, and the Total margins show the extent to which the Zone community will benefit from the production using the New Water.

2 Part One: Scenario 1: Current Pathway assessment

This assessment is called Scenario 1, the Current Pathway assessment. It is required in order to determine the shape of the OTOP land-based production and economy, based upon land use largely as at present. However it does allow for major changes in water use and allocation, to be implemented in the near future and the resulting land use changes.

2.1 Scope of the assessment

The assessment and the land use and economic model behind it must be in such a form that it can accommodate changes to be assessed for Scenarios Two, 3A, and 3B. These are respectively Scenario Two: In-zone gains from improved management of existing water; Scenario 3A: New Water, Small Scale entering the Zone; and Scenario 3B: New Water Large Scale entering the Zone.

In order to provide flexibility in the modelling for later Scenario comparisons, and to provide clarity and transparency, the first assessment is of the actual current land use, water use, and the value added and employment generated in the Zone economy. The next assessment explicitly shows the changes necessary to represent the Current Pathway land use, water use, value added and employment.

Again, in order to allow comparisons in the later Scenarios, the water allocation and use is described in terms of:

- efficiency of water use
- reliability of water supply
- availability of water
- nutrient levels.

Nutrient management assumptions for the Current Pathways are stated in Appendix 3 of the *OTOP Zone Current Pathways Planning Overview – November 2016* to be that:

- all properties are assumed to be operating at Good Management Practice
- all properties are modelled at current land use
- no permitted intensification is modelled under the PC5 rules, as this is limited by water availability.

For these reasons nutrient management is not required in the Current Pathway assessment:

- we assume that the "existing" amount of allocation remains the same for the "under or fully allocated" Groundwater allocation zones (GAZs)
- assume that the "existing" amount of allocation remains the same irrespective of whether the river or stream is under or over-allocated relative to the environmental flow and allocation limits in the Land and Water Regional Plan (LWRP), Opihi River Regional Plan (ORRP) and the Pareora Catchment Environmental Flow and Allocation (Regional) Plan (PCEFAP)
- where existing surface water and stream depleting groundwater takes have different minimum flows to those in the LWRP, ORRP, and PCEFAP, they are assumed to be brought into line with the relevant plan minimum flows over time.

For these reasons regulatory costs are assumed not to change, as there are no changes to allocation levels. It is expected that even if there were a change in regulatory costs, these would be of a relatively small magnitude.

2.2 Assessment with actual current land and water use

This description and assessment of actual current land and water use is provided in order to allow comparison with the outcomes consequent on changes to be made in water use and land use under Current Pathways assumptions as described in later sections of the assessment.

2.2.1 Current land use

Land use under irrigation and dryland

BERL has used the ECan-provided GIS databases to determine the land uses in the Healthy Catchment area of the OTOP Zone. These GIS files are titled *OTOP healthy catchment area land use*; and *Irrigated area.* The requirement in this assessment is that the economic measures are at the Zone level, rather than the individual farm level. In order to be able to model the impacts of the current land use on the OTOP economy, we have related these land uses to the main farm types in the OTOP region. The farm types are:

- sheep and beef breeding
- sheep and beef breeding and finishing
- sheep and beef intensive plus dairy support
- sheep and beef mixed cropping
- arable cropping and seed production
- deer farming
- dairy production
- horticulture.

OTOP Zone Land Use

The main land uses and the current land areas in dryland production and in irrigated production are shown in Table 4.

Table 4: Current OTOP healthy catchments main land uses

Land Use	Current Land Use (Ha)		
	Total	Dryland	Irrigated
Dairy cattle farming	44,998	13,913	31,085
Beef cattle farming	24,568	22,527	2,041
Mixed Crop Sheep and Beef farming	179,345	175,853	3,492
Sheep farming	68,539	64,370	4,170
Arable cropping or seed production	22,461	17,057	5,404
Deer farming	21,641	19,244	2,397
Grazing other peoples stock & dairy dry stock	10,262	7,997	2,265
Vegetable and Fruit Growing	953	343	610
Forestry	8,764	8,753	10
Weighted average these uses	**381,531**	**330,057**	**51,474**

Source: ECan GIS OTOP healthy catchments landuse, BERL

As well as the land uses included in the table there are some minor productive land uses which have little impact on the scale of the Zone economy. These include other livestock, mainly pigs, horses and others on 1,190 hectares of which 215 is irrigated. There is also a considerable area covered by new records with an unconfirmed farm type, and ones where the use was unspecified by the farmer. These categories totaled 9,358 hectares of which 992 was irrigated. However the land uses included in the table generate the main economic activity in the area.

Land uses which do not necessarily lead directly to economic activity include land used for lifestyle living, occupying 4,694 hectares, and the category of 'native bush' which covered 55,859 hectares. It appears that most of the native bush is in specific reserves, as in each of the Districts the individual blocks were mostly under a single Farm ID. For example in Timaru District under the same Farm ID was one block of 39,573 hectares and a further 8 blocks which occupied 1,754 hectares. In Waimate District were two blocks occupying a total of 500 hectares and in Mackenzie Country District were six blocks totaling 13,799 all with the same Farm ID. In Timaru District apart from the nine blocks mentioned, there were a further eleven blocks each with a different Farm ID, and the eleven occupy a total of 69 hectares or an average size of about 6 hectares. It is likely that these are small blocks of native bush on farm properties.

Looking at the distribution of land uses in Table 1, by far the most dominant irrigated land use is in dairy farming as dairy production platforms. This dairy production accounts for nearly 60 percent of the irrigated land. The rest of the agricultural production is across a range of land uses which is more diverse and more comprehensive than in most regions of New Zealand. Compared with other New Zealand regions, there is a stronger presence of arable farming including substantial units involved in high-value seed production. The arable production includes grains which are sold to prepare proprietary animal feeds and also are sold direct from the arable farmer to the livestock farmer for animal feed.

As well there is sheep, beef and mixed animals and cropping.

There are also small areas of high value vegetables and fruit production, mostly for processing.

The total irrigated area accounts for about 12 percent of the total recorded area of land.

2.2.2 Number and size of properties

Analysis of the GIS data on *OTOP healthy catchments Land use*, shows the number of Farm IDs in each of these main uses and the estimated average area in each farm ID. They are referred to as Farm IDs as they could be single farms as stand-alone businesses, or they could be a unit within a group of units making up a larger business. In South Canterbury there are a number of substantial groups of farms operating as a single business entity. The average Farm ID area for dairy cattle farming is 279 hectares. We have data from Dairy NZ as to the average area per herd in these Districts, and that data implies an average area of about 220 hectares for the herds contained in the healthy catchments area.

Table 5: Current OTOP healthy catchments number and size of properties

Land use	Count of Farm IDs	Average Farm ID area
	Number	*Hectares*
Dairy cattle farming	155	279
Beef cattle farming	252	96
Mixed Crop Sheep and Beef farming	294	594
Sheep farming	326	209
Arable cropping or seed production	97	225
Deer farming	120	169
Grazing other peoples stock & dairy dry stock	106	73
Vegetable and fruit growing	14	64
Forestry	32	164

Source: ECan OTOP Healthy catchments Landuse, BERL

The total farm IDs in these land uses in the healthy catchments area is 1,396.

2.3 Gross margins for current land uses

The measures used to assess the economic activity generated by each land use are the gross margins earned per hectare from the land use when exercised on a dryland basis and when exercised as irrigated production. The gross margin measure is the gross revenue per hectare less the variable costs per hectare in producing that hectare of output. The variable costs do not include the fixed costs associated with the ownership of the land or the fixed capital such as buildings and machinery tied up in production. These gross margins are therefore equivalent to the concept in economics of the value added in production. In turn the value added from a hectare of production is the contribution to Gross Domestic Product (GDP) in the healthy catchments Zone from that hectare.

In this section the gross margin per hectare of each land use has been modelled as dryland production, and separately as irrigated production.

2.3.1 Estimation of gross margins for land uses

For the purpose of this assessment the estimation of gross margins for different land uses were made based on a range of sources of industry information listed below. While the various sources give industry-wide averages for cost elements and productivity per hectare or per stock unit, where possible these have been calibrated to known levels of cost and productivity within the OTOP healthy catchments area.

The main sources of information are those as listed.

- DairyNZ, *Dairy NZ Economic Survey 2014-15*. Table 7.3 Cash operating surplus and profit - $ per effective hectare. (Earlier years for comparison.)
- DairyNZ, *New Zealand Dairy Statistics 2014/15*. Table 3.3 Herd analysis by district in 2014/15, and Table 3.4Herd production analysis by district in 2014/15. (Earlier years for comparison.)
- NZIER, *Value of Irrigation in New Zealand*, AgFirst and MPI: C1 Canterbury dairy, C2 Canterbury arable
- ANZ Research, ANZ Agri Focus October 2013, *Just Add Water: Investigating the returns from irrigation*. With information on Canterbury dairy; Sheep, beef and dairy support; Arable and processed crops.

- Beef and Lamb NZ; *Sheep and beef farm survey 2015/16*: Class 6: South Island finishing breeding; Class 7: South Island intensive finishing. (Earlier years for comparison.)
- Ministry for Primary Industries: *Farm Monitoring: South Island deer*.
- Lincoln University. *Financial budget manual 2014*.
- AFIC/BERL, *Economic impact assessment of arable production in 2015*. Aug 2016. Table 3.6 Areas of certified and production seed in 2013 and 2015; Table 3.7 Value of seed production 2013, 2015. This publication also provides relevant multipliers.

It is important in any budgeting exercise to ensure that the market price of the outputs is realistic, and that the production inputs are relevant to the level of output as modelled. It is particularly important for dairy production platforms, because the price of outputs, namely Milk Solids has fluctuated quite widely in recent years. BERL's own monitoring of the changes in expenditure by farmers on feed and fertiliser as measured in the DairyNZ Economic Survey over the years shows that when prices of milk solids are high e.g. $8.54 per kg MS in 2013/14, the level of spending on feed is markedly higher than in years with a lower pay out, such as in 2014/15 when the pay out was just $4.67 and in 2015/16 was $4.30.

Taking the longer term view the inflation-adjusted pay out price for milk solids over the past 43 years has averaged $5.92 per kgMS in 2016 dollars, and in the last 17 years has averaged $6.22 per kgMS in 2016 dollars. This indicates that even though the pay out was just $4.67 in 2014/15 and 4.30 in 2015/16, it is not realistic to budget at those levels, but rather to budget at a figure of about $6.00 per kgMS.

For the same reason judgement is needed in budgeting the amount spent on feed and fertiliser which was low in those two years, but much higher in 2013/14 when the pay out was $8.54 per kgMS.

The gross margins have been estimated as an average expected level for each land use. As necessary, this has applied judgement to the information obtained from the above sources, and reflects realistic value and cost expectations as in 2016/17.

Table 6: Current OTOP dryland and irrigated land use Gross Margins per hectare

Land Use	**Gross Margin $ / Ha**	
	Dryland	**Irrigated**
Dairy cattle farming	1,314.7	3,732.2
Beef cattle farming	148.9	550.2
Mixed Crop Sheep and Beef farming	393.0	1,056.0
Sheep farming	148.9	550.2
Arable cropping or seed production	1,900.0	5,500.0
Deer farming	362.1	1,094.7
Grazing other peoples stock & dairy dry stock	148.9	550.2
Vegetable and Fruit Growing	3,442.4	4,392.0
Forestry	0.0	0.0
Weighted average these uses	**442.2**	**3,097.2**

Source: ECan GIS OTOP healthy catchments landuse, BERL

2.3.2 Current water use, water reliability and availability

The GIS data for land use on the one hand, and irrigation type on the other can be used to find the areas of land in each land use which employs each of the irrigation types. This enables estimates of total water demand according to efficiency of each type.

Water use by Irrigation type

The GIS information gives a useful breakdown of irrigation type in each District area in the OTOP Zone. The one weakness of this set of data is that for approximately 20 percent of the area, the irrigation type is unknown. Within that limitation, the share of irrigated land with each irrigation type is as shown in Table 7.

This information will be useful for estimating the potential to increase irrigation efficiency in Scenarios 2, 3A and 3B.

The figures in the table indicate that of the area for which the irrigation type is known, about 62 percent is under Pivot irrigation, approximately 18 percent under K-line and laterals, and approximately 20 percent under Travelling gun and Rotorainers.

Table 7: Profile of irrigation types in OTOP Zone

Irrigation type summary	OTOP Total	Share of Total	Share of 'Known' area
	Hectares	*Percent*	*Percent*
Borderdyke	53	0.1%	0.1%
Travelling gun	5,890	11.4%	14.3%
Rotorainer	2,280	4.4%	5.5%
K-line/Long lateral	4,703	9.1%	11.4%
Lateral	2,562	5.0%	6.2%
Solid set	28	0.1%	0.1%
Pivot	25,678	49.9%	62.3%
Unknown	10,280	20.0%	
Total	**51,474**	**100.0%**	**100.0%**

The attainable application efficiencies for different irrigation system types was measured in research published by Aqualinc in 2006[1]. The Aqualinc / Irrigation NZ information indicates that the mid-points of the ranges of these groups' relative efficiency of application are as follows:

- Pivots — 82.5 percent application efficiency
- K-line and laterals — 75 percent application efficiency
- Travelling gun and Rotorainers — 67.5 percent application efficiency.

Weighting the efficiency of each irrigation type by the share of the area irrigated with that type indicates that the current weighted average of the irrigation application efficiency in the OTOP healthy catchment area is 78.15 percent.

[1] Aqualinc (2006): *Irrigation efficiency gaps- Review and stocktake*. A report prepared for the Sustainable Farming Fund and Irrigation New Zealand by Aqualinc Research Ltd. Christchurch, February 2006.

Overall water reliability

Stakeholders indicated that water availability from the Opuha Dam-provided augmentation of the Opihi River has had a 100 percent reliability factor until the last two to three years. In these years reliability has fallen due to drought conditions. Now this reliability has been faulted, the Scheme management informed BERL that they and the owners are giving consideration to measures to conserve and moderate the supply of water, mainly by increasing within-scheme storage, both on-farm and potentially scheme-owned. With drought conditions, people with consented takes are unable to obtain their water allocation.

Water take information provided by ECan can give an indication of the level of reliability of water takes over recent years. The nature of the data has changed recently as it has become a requirement that users install meters to measure water use. The information provided shows, or can be analysed to show the metered allocation, the (restricted) metered availability of water, and the actual metered usage. As the adoption of metering has been quite recent these metered data have most relevance for recent years.

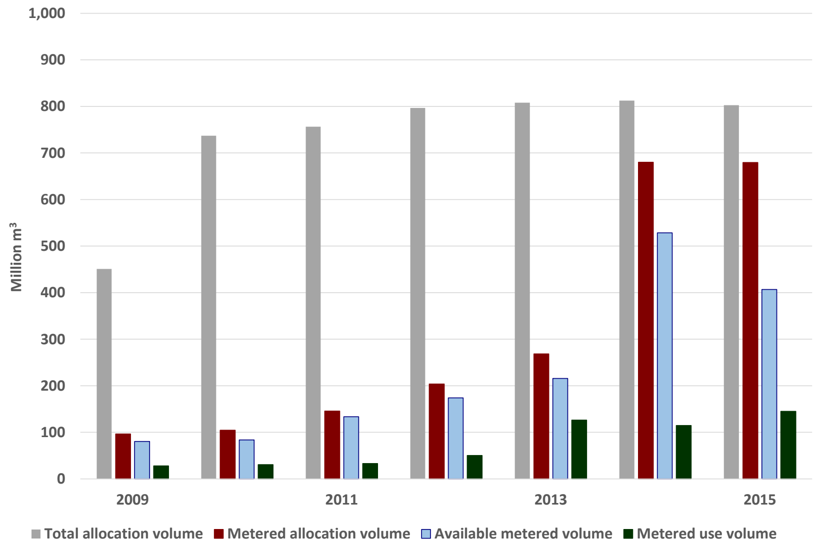
The total allocation volume is the total volume of allocation which has been consented.

The metered allocation volume is the part of the total allocation volume for which metering has been installed.

The available metered volume is the part of the metered volume which was available in the year in question. The reduction would be due to restrictions placed on takes due to reduced water availability.

Finally the metered use volume is the actual amount of water used in the year, as measured by the meters. The profile of the allocation, availability and use for the years 2009 to 2015 are shown on the chart.

Figure 1: Water allocation availability and usage in OTOP Zone 2009 to 2015

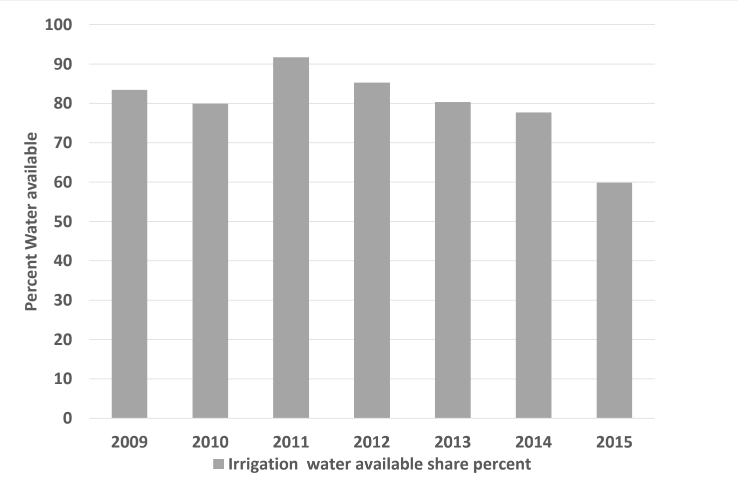


Data for metered allocation and use has been available since 2001, and the level has been reasonably consistent from 2005 to 2009. Since 2009 the metered volume has increased rapidly which is shown in Figure 1. The relatively stable figures for total and metered allocation volume in 2014 and 2015 indicate that although the metered allocation volume in each year was about 680 million m^3, the available metered volume was 530 million and 410 million m^3 respectively, and metered use volume was 115 million and 145 million m^3 respectively.

The available metered volume has been less than the metered allocation volume through the period, but the share has changed. This share reflects the reliability of water supply, at least to those metered users. We accept that it is therefore a partial measure, but it does give some indication of the reliability or otherwise of the overall allocation. It was clearly particularly unreliable in 2015, when Opuha Irrigation Limited had to impose restrictions, with irrigation being turned off for the first time in its history as a result of drought.

The percentage of the metered allocation volume which was available, recorded as the available metered volume, is shown on the graph. This indicates that there has been fluctuation in overall reliability of water supply in the OTOP Zone.

Figure 2: Reliability of water available in OTOP Zone 2009 to 2015



2.3.3 Current land use and economic value

The direct value of the actual current land use with the current available water, is estimated in terms of the total gross margins or value added earned at farm gate or orchard gate. The prices and costs are generally based on the 2015-2016 year, however as stated, the dairy prices and costs have been moderated to represent a more-normal year than the low pay outs per kgMS in 2014-15 and 2015-16. The direct value is estimated based on the above land use shown in Table 4 above and the gross margin per hectare in Table 6.

Table 8: Direct value of current irrigated and dryland production in OTOP Zone

Direct Gross Margin ($m)	**Current Land Use**		
Land Use	**Dryland**	**Irrigated**	**Total**
Dairy cattle farming	$18.3	$116.0	$134.3
Beef cattle farming	$3.4	$1.1	$4.5
Mixed Crop Sheep and Beef farming	$69.1	$3.7	$72.8
Sheep farming	$9.6	$2.3	$11.9
Arable cropping or seed production	$32.4	$29.7	$62.1
Deer farming	$7.0	$2.6	$9.6
Grazing other peoples stock and dairy dry stock	$1.2	$1.2	$2.4
Vegetable and Fruit Growing	$1.2	$2.7	$3.9
Forestry	$0.0	$0.0	$0.0
Total Gross Margin ($m)	**$142.1**	**$159.4**	**$301.5**

This indicates that the land-based direct gross margin, and thus contribution to regional and national GDP totals over $300 million per annum. Of this amount about 44 percent came from dryland and irrigated dairy production platforms, and thus 56 percent came from other land uses. The most important of the other land uses are Mixed sheep and beef farming; and arable cropping and seed production. The arable and seed production generated the second-largest contribution to gross margin from irrigated production, after irrigated dairy production.

The direct value added contribution to the economy is estimated at $301 million per year and taking account of the backward and forward value chain impacts the total contribution to the economy is valued at $509 million per year as shown in Table 9.

Table 9: Regional value chain contribution of current land-based production in OTOP Zone

Regional economic contribution	**Value added GDP $Mn**		**Employment (FTEs)**	
Current Land Use	**Direct**	**Total**	**Direct**	**Total**
Dairy cattle farming	$134	$208	674	1,389
Beef cattle farming	$4	$8	42	76
Mixed Crop Sheep and Beef farming	$73	$130	690	1,235
Sheep farming	$12	$21	113	202
Arable cropping or seed production	$62	$111	589	1,054
Deer farming	$10	$20	156	268
Grazing other peoples stock & dairy dry stock	$2	$4	40	68
Vegetable and Fruit Growing	$4	$7	68	102
Forestry	$0	$0	0	0
Total Economic Impacts	**$301**	**$509**	**2,371**	**4,393**

The contributions to the broader value chain impacts come from across the spectrum of land uses. There has been strong growth in employment in the processing industries as shown in the OTOP Current State economic assessment[2]. The value chain impacts come from the upstream supply of goods and services to the farm level production and the downstream economic activity and employment in processing and manufacturing based on the primary products.

The Statistics NZ databases obtained at a detailed 504-industry level annually by BERL show that in this South Canterbury region, upstream there are over 500 people employed in the shearing and other agricultural support services.

Downstream, the employees in the meat and dairy processing industries have increased from 1,750 people in 2000 to 2,726 people in 2016. Employment in fruit and vegetable processing has been significant at 400 to 500 people. Note that this metric is employment count, namely total people whether part time or fulltime throughout the year. The numbers are not therefore directly comparable with the FTEs shown in our model output above. However the numbers for the employment count do show that the scale of this primary processing and manufacturing employment is very significant as is the number of FTEs estimated above at 2,022. (The total FTEs of 4,393 less directly employed FTEs of 2,371.)

In summary, the modelling shows that the direct employment on the land is estimated at about 2,371 Full Time Equivalent (FTE) employed. Together with the value chain employment of 2,022 FTEs, the total employment generated is estimated at 4,393 FTEs employed.

[2] Sanderson, Kel, Julian Williams and Natalia Fareti. *Orari-Temuka-Opihi-Pareora Zone Current state economic assessment*. Table 6, p11. BERL September 2016.

2.4 Assessment with Current Pathway water use and land use

The main change in water use and land use in shifting from the actual current water and land use to the Current Pathway water and land use is as a result of the requirements to reduce water takes from over-allocated groundwater in some of the Groundwater Allocation Zones (GWAZs).

2.4.1 Current Pathway water use

The Planning Assumptions for the "Current Pathway" economic assessment include the following requirements for consented volumes of groundwater available for consented uses in the GWAZs:

- assume that the currently consented annual volumes remain available for consented uses in GWAZs where these volumes are equal to or less than the allocation limit in Table 16, Section 14 of the Land and Water Regional Plan (LWRP)
- assume that in the Upper Pareora GWAZ the currently consented annual volume remains available even though the water is currently over-allocated, as it is covered in the Pareora Catchment Environmental Flow Allocation (Regional) Plan (PCEFWAP) which does not require any reduction in volume[3]
- for over-allocated GWAZs – Pareora and Rangitata-Orari Zones – groundwater limits remain the same, but the consented volumes will reduce to 90 percent of current consented volumes when consents are renewed
- in the Pareora and Rangitata Orton GWAZs any water that is 'freed up' through consented annual volumes being reduced to 90 percent of previously consented annual volumes does not become available for re-allocation.

These allocation limits and volumes are also shown in Table 4-1 Groundwater allocation limits and volumes in *Current state of the groundwater resource in the Orari-Temuka-Opihi-Pareora area*, ECan, August 2016.

The main variation from the current actual water use on currently irrigated land to be accounted for in the Current Pathway assessment is to reduce the current consented annual volume allocated in two of the GWAZs to 90 percent of the currently consented annual volumes. These necessary changes are shown in the table.

Table 10: Current Pathway available groundwater – with 90 percent of consented volumes in over-allocated zones

Groundwater Allocation Zones (GWAZ)	**Allocation limit**	**Currently consented annual volumes**	**Initial consented volumes available Current Pathway**	**Reduction necessary**	**Reduction percent**
	Million cubic metres per year				***Percent***
Fairlie	37.00	1.63	1.63	0	0
Levels Plain	32.90	28.73	28.73	0	0
Orari-Opihi	71.10	70.18	70.18	0	0
Pareora	7.19	11.71	10.54	1.17	10%
Rangitata-Orton	42.50	52.30	47.07	5.23	10%
Timaru	4.24	2.30	2.30	0	0
Upper Pareora	4.31	6.77	6.77	0	0
Total Groundwater	**199.24**	**173.62**	**167.22**	**6.40**	**4%**

[3] Ford, Raymond, ECan. *pers.comm*; 16 August 2017

The table shows that a reduction to 90 percent of the currently consented annual volume in the Pareora and Rangitata-Orton GWAZs reduces the total currently consented annual volume in the OTOP Healthy Catchment area by 6.4 million cubic metres per year, or by about 4 percent.

However, the reduction to 90 percent of the consented volume will be repeated on the next occasion when these consents are to be renewed. This means that in the medium- to long-term, the consented annual volumes will tend towards the allocation limit in these two GWAZs. For this to be achieved, the consented annual volumes would be reduced in Pareora by a further 3.35 million m^3 per year and in Rangitata-Orton by a further 4.57 million m^3 per year, a total further reduction by 7.92 million m^3 per year.

The current reduction by 6.4 million m^3 and the eventual additional reduction by a further 7.92 million m^3 gives a total reduction over time by 14.32 million m^3 per year. This is approximately 8 percent of the currently consented groundwater volume in the OTOP Healthy Catchments Zone. When this is achieved, if the consented volumes stay the same as at present this will be a reduction by 8 percent by volume.

By that time however, it is possible that the consented annual volumes in some of the other GWAZs in the Healthy Catchments area such as Fairlie, Levels Plain, and Timaru may have increased towards their allocation limits.

2.4.2 Economic value assessment under Current Pathway water use

The main estimate thatwe have which will inform the changes in economic value under the Current Pathway compared with the current actual land use and economic value generated, is the reduction in consented volume of groundwater available. This amount of reduction in the Pareora and Rangitata-Orton GWAZs is estimated at 6.4 million m^3 per year, which is 4 percent of the consented groundwater in the Healthy Catchment area of the OTOP Zone.

The estimates of economic value for the current land use as described in section 2.3.3 have been estimated based upon irrigation using both groundwater and surface water. The amount of groundwater use as provided in the ECan database titled '*Water Take from ECAN 29 07 16*" showed as the actual 'sum of irrigation metered usage' in the year to June 2015 which was 97.7 million m^3. As metering has been implemented, the metered usage of groundwater has continued to increase year-by-year and this is the most recent data reading supplied to BERL.

The same data source shows that the surface water 'sum of irrigation metered usage' in the years to June 2013 to 2015 were respectively 52.2 million m^3; 52.5 million m^3; and 47.4 million m^3. This is a simple average of 50.7 million m^3 per year

This data indicates that the metered usage of groundwater and surface water on the irrigated area was about 97.7 plus 50.7 equals 148.4 million m^3 per year.

This amount of water applied to the 51,474 hectares of irrigated land implies an average metered usage of about 2,883 cubic metres per hectare per year.[4]

With 6.4 million m^3 consented volume not available under the Current Pathway assumption, this could reduce the metered usage by a maximum of that amount, which would reduce it from 148.4 million m^3 to 142 million m^3. In turn this would reduce the average metered water usage per hectare to 2,759 m^3 per hectare, a reduction by 4.3 percent

[4] This average estimated from the ECan water use and land use databases is less than would be expected as estimated for pasture, for example by *the Irrigation Reasonable Use Database* of AquaLinc, MPI Sustainable Farming Fund, and Irrigation New Zealand. However some uses in the OTOP Zone, such as arable and seeds are more seasonal and can use less water than pasture.

This can be interpreted that the average reliability of irrigation over the Healthy Catchment area would be reduced by 4.3 percent. The reduction in availability of water for irrigation by 4.3 percent could in turn reduce by 4.3 percent the average margin per hectare generated by irrigation compared with dryland production.

On this basis the gross margins would be reduced to those in Table 11.

Table 11: Current Pathway dryland and irrigated land use Gross Margins per hectare

Land Use	Gross Margin $ / Ha	
	Dryland	Irrigated
Dairy cattle farming	1,314.7	3,571.7
Beef cattle farming	148.9	526.6
Mixed Crop Sheep and Beef farming	393.0	1,010.6
Sheep farming	148.9	526.6
Arable cropping or seed production	1,900.0	5,263.5
Deer farming	362.1	1,047.7
Grazing other peoples stock & dairy dry stock	148.9	526.6
Vegetable and Fruit Growing	3,442.4	4,203.1
Forestry	0.0	0.0
Weighted average these uses	**442.2**	**2,964.0**

Source: ECan GIS OTOP healthy catchments land use, BERL.

Note that the average gross margin per hectare of irrigated land at $2,964 is less than the average under current land and water use of $3,097.2 by the 4.3 percent reduction in water reliability.

2.4.3 Current Pathway reduced water reliability economic value

Applying these gross margins to the land use pattern gives the following estimate of economic value under the Current Pathway assumptions.

Table 12: Current Pathway direct value of dryland and irrigated production OTOP Zone

Direct Gross Margin ($m)	Current Pathway water reliability		
Current Pathway Land Use	Dryland	Irrigated	Total
Dairy cattle farming	$18.3	$111.0	$129.3
Beef cattle farming	$3.4	$1.1	$4.4
Mixed Crop Sheep and Beef farming	$69.1	$3.5	$72.6
Sheep farming	$9.6	$2.2	$11.8
Arable cropping or seed production	$32.4	$28.4	$60.9
Deer farming	$7.0	$2.5	$9.5
Grazing other peoples stock & dairy dry stock	$1.2	$1.2	$2.4
Vegetable and Fruit Growing	$1.2	$2.6	$3.7
Forestry	$0.0	$0.0	$0.0
Total Gross Margin ($m)	**$142.1**	**$152.5**	**$294.6**

The direct value of the gross margins shows that the value of irrigated production reduced from the current level of $159.4 million, to $152.5 million, a net loss of $6.9 million at farm gate. This effect is now projected out to the value chain impact.

The regional value chain impacts have been estimated using the same process and value chain parameters as in the estimates for the current land use in section 2.3.3, and are shown in Table 13 .

Table 13: Regional value chain contribution of Current Pathway land-based production in OTOP Zone

Regional economic contribution	**Value added GDP $Mn**		**Employment (FTEs)**	
Current Pathway water reliability	**Direct**	**Total**	**Direct**	**Total**
Dairy cattle farming	$129	$200	649	1,338
Beef cattle farming	$4	$8	42	75
Mixed Crop Sheep and Beef farming	$73	$129	688	1,232
Sheep farming	$12	$21	112	200
Arable cropping or seed production	$61	$108	577	1,032
Deer farming	$9	$20	154	265
Grazing other peoples stock & dairy dry stock	$2	$4	39	67
Vegetable and Fruit Growing	$4	$7	66	99
Forestry	$0	$0	0	0
Total Current Pathway Economic Impacts	**$295**	**$498**	**2,326**	**4,307**
Total Current Land Use Economic Impacts	**$301**	**$509**	**2,371**	**4,393**
Reduction due to Current Pathway	*$7*	*$11*	*45*	*86*

2.4.4 Assessment of the Current Pathway economic impacts

The impacts on the regional economy consequent on the reduced reliability of water in the two GWAZs with reduced consented volumes are relatively small. This is particularly so when compared with the contribution by irrigated land uses to the expansion of the Zone's economy over recent years.[5]

To illustrate the difference we have shown at the bottom of Table 13 the difference in economic impacts from the current land and water use and the Current Pathway land and water use. This indicates that the reduction of water consented volumes in over-allocated GWAZs would reduce the Value Added GDP impacts by about $11 million or 2 percent, and the employment impacts by 86 FTEs, also by about 2 percent.

As has been noted above, these reductions will occur when all consents in the two affected GWAZs have been renewed in their next round of renewals, resulting in groundwater consented volumes being reduced by 4.3 percent in the Healthy Catchments area. However as future rounds of consent renewals take place, the consented volumes in these two GWAZs will reduce further until they are reduced to the current allocation limits. The total change from the current consented volumes is a reduction by about 8%, or about twice the level of reduction we have modelled as the impacts of the first-round of consent renewals.

2.4.5 Current Pathway nutrient management

The assumptions under the Current Pathway are that all properties are assumed to be operating under Good Management Practices, when modelled at current land use. The minor reduction in groundwater use as modelled in the Current Pathway scenario is expected to have limited impact on land use and thus on nutrient management.

[5] Sanderson, Kel, Julian Williams and Natalia Fareti. *Orari-Temuka-Opihi-Pareora Zone Current state economic assessment.* The OTOP Zone – water's role. Page i. BERL September 2016.

3 Part Two: Scenario 2: In-Zone gains assessment

3.1 Overview and scope of the assessment

This assessment is called Scenario Two: In-Zone Gains – improving management of the available water within the Orari-Temuka-Opihi-Pareora (OTOP) Zone. The assessment describes the economic impacts in terms of impacts on main farm types and horticulture production types, expressing these at the OTOP Zone scale.

It builds on the Current Pathways Scenario assessment.

This Scenario Two assessment models the potential 'In-Zone' gains from better use of existing water resources. It aims to explore improved water use for the current general pattern of land use, rather than attempting to model the optimal balance of change in land use towards high value horticulture or specialist crops using water to generate a very high value per cumec, compared with dairying, and pastoral uses. The latter approach could imply fundamental changes in land use, land values and consequently land ownership and community structures.

The main potential In-Zone gains from better use of existing water are from:

- delivering the water from the water source, within the scheme more efficiently and with less loss
- on farm/orchard application of the water to the plants by more efficient methods
- delivering the water at a higher level of reliability when required
- utilising less water to achieve the same production effect, releasing water for environmental values
- irrigation management / timing of water application
- regular monitoring of irrigation efficiency.

These can be captured under three general pathways of gaining In-Zone efficiencies from better use of existing water resources, which will allow for comparison with the Current Pathways Scenario. The pathways are:

- efficiency
- reliability
- availability.

Changes in availability of water supply is not within the scope of Scenario Two as the Scenario is limited to existing water resources (i.e. no change in surface and ground water allocations or consented volumes). We note that it has been observed that 'Groundwater levels have increased under the Rangitata South Irrigation Scheme (RSIS).'[6] These changes in groundwater levels in the Rangitata-Orton Groundwater Allocation Zone, appear to have begun at the time of the development of the RSIS,[7] and local stakeholders have attributed this to increased recharge resulting from losses from the Rangitata South scheme. However this does not fall within scope of this assessment. It would be the subject of a separate analysis.

This means that In-Zone gains in this Scenario Two are to be achieved through improvements in efficiency and reliability of water supply and use.

[6] Zarour Hisham, Philippa Aitchison-Earl, Marta Scott, Louisa Peaver and Jayath De Silva. *Current state of groundwater resource in the Orari-Temuka-Opihi-Pareora area*. Report No. R16/41. Environ Canterbury Regional Council, August 2016. Summary, Page i.

[7] Ibid, Page 19, Figure 3-4: *Long-term measured and annual moving mean of groundwater level for Well K38/0129, 6.9 m deep, in Orton*

3.2 In-Zone gains of improved technical efficiency of water use

This section explores the potential to increase technical efficiency of water use. It does not analyse the potential to increase economic efficiency of water use by re-allocating from uses generating lower value activities to those generating higher value activities. Within the current economic environment, it is assumed that individual water users will select the use generating what is to them the highest value.

The technical efficiency of water use can be improved by a number of means including:

- conversion from less-efficient to more-efficient irrigation application systems;
- attention to improved timing of water application, including rainfall forecasting; and
- increased efficiency of the production systems being irrigated.

As an example of increased technical efficiency, in the major primary production activity in the OTOP Zone, namely dairy production under irrigation, this efficiency can be summarised as improving the efficiency of converting grass and other nutrients to milk. This would imply changes to farm management and livestock management systems.

The specification of the current analysis does not include measuring the impacts of improved timing of application or of changes to improve the efficiency of the farm management and livestock management systems. However, these are addressed briefly later in the report.

This section therefore concentrates on the increased technical efficiency of water application by conversion from less-efficient to more-efficient irrigation systems.

3.2.1 Land use conversion to spray irrigation systems

There are two main classes of irrigation, flood irrigation and spray irrigation. Flood irrigation is generally less efficient than the various forms of spray irrigation. At present, as shown in Table 7 there is only 53 hectares or 0.1 percent of the irrigated area in borderdyke flood irrigation, and so this can be ignored.

The actual area of main land uses under irrigation is 51,474 hectares. Of this area approximately 20 percent has unknown type of irrigation system. In order to estimate the productivity changes when the bulk of the irrigation is converted to more efficient irrigation types we have to include the land area shown as having an unknown type of irrigation. In the absence of any further information, this land area is allocated pro rata to the known uses. Applying these rates to the total irrigated area gives the land use areas as below.

Table 14: Current estimated land use profile of irrigation types

Irrigation type summary	OTOP Total	Share of Total	Share of 'Known' area	Assumed areas
	Hectares	*Percent*	*Percent*	*Hectares*
Borderdyke	53	0.1%	0.1%	67
Travelling gun	5,890	11.4%	14.3%	7,360
Rotorainer	2,280	4.4%	5.5%	2,849
K-line/Long lateral	4,703	9.1%	11.4%	5,877
Lateral	2,562	5.0%	6.2%	3,201
Solid set	28	0.1%	0.1%	35
Pivot	25,678	49.9%	62.3%	32,086
Unknown	10,280	20.0%		
Total	**51,474**	**100.0%**	**100.0%**	**51,474**

The 51,474 hectares in main land uses is the large majority of the total 53,231 hectares of irrigable land in the OTOP Zone. About 62 percent of this is under pivot irrigation, approximately 18 percent under K-line and laterals, and approximately 20 percent under travelling gun and Rotorainers. Pivot irrigation is the most efficient of these types.

Efficiency gains can be achieved via conversion to more efficient irrigation systems. The assumption is made that the most efficient irrigation system that can be feasibly adopted by irrigators in most land uses in OTOP is spray irrigation. More specifically, the most efficient spray irrigation systems are pivot systems.

There are some farms using a Variable Rate Irrigation (VRI) system which is an advanced modification of the pivot system. Application of VRI generally requires soil survey to indicate the soil available waterholding capacity (AWC). The actual equipment has been quoted as costing $100-$140 per metre of irrigator span, and can achieve water savings in research studies of 8 percent to 36 percent.[8] The economics therefore depend on soils patterns, farm layout, costs of water and electricity. While VRI could be the most efficient irrigation system, it is still being trialled and stakeholders interviewed in the OTOP Zone stated that the associated capital costs could prove challenging relative to the savings for farmers in the Zone. Given the range of efficiencies quoted at this time it would be problematic to arrive at a single, defensible parameter to include in the In-Zone gains scenario.

The following table shows the estimated areas of land under each type of irrigation, ordered from the most efficient to the least efficient. The assumed efficiency of delivery of each type is also shown in Table 15. These efficiency levels were supplied by AquaLinc for a water management study in Northland.[9]

[8] Hedley, C., Craigie, R., & Bradbury, S (2013) *Variable rate irrigation for improved water use efficiency*. Retrieved from maxa.maf.govt.nz/sff/about-projects/search/10-111/report.pdf

[9] Opus International Consultants Ltd., BERL, AquaLinc, *Northland strategic water infrastructure study*, Northland Regional Council 2015. Figure 2.1 Attainable application efficiencies for different system types, Page 11.

Table 15: Profile of irrigation types and efficiency in OTOP Zone under current land use

Irrigation type summary	OTOP Total	Irrigation efficiency	Water use current	Water use Cases 1,2	Water saved
	Hectares	*Percent*	*Million m^3/year*		
Pivot	32,086	82.5%	87.1	87.1	0.0
K-line/Long lateral	5,877	75.0%	17.5	16.0	1.6
Lateral	3,201	75.0%	9.6	8.7	0.9
Solid set	35	75.0%	0.1	0.1	0.0
Travelling gun	7,360	67.5%	24.4	20.0	4.4
Rotorainer	2,849	67.5%	9.5	7.7	1.7
Borderdyke	67	60.0%	0.2	0.2	0.1
Average /Total current land use	**51,474**	**78.17%**	**148.4**	**139.7**	**8.7**
Case 1: Average/ Total All Pivots	**51,474**	**82.50%**		**139.7**	**8.7**
Case 2: Assume Pivot 80% lateral etc 20%	**51,474**	**81.00%**		**142.3**	**6.1**

Sources: ECan land and water use, AquaLinc efficiencies

The current water use was modelled at the level shown in the ECan data for ground water and surface water 'sum of irrigation metered usage.' As recorded in Table 15 above, the total was 148.4 million m^3 per year. The analysis estimates the reduced water use, or water saved for two cases reflecting two assumed levels of efficiency increase. The first case assumes that all irrigation in the Zone can be, and is converted to pivot irrigation. If this were to be the case, the total annual water use would reduce to 139.7 million m^3 per year, a saving of 8.7 million m^3 per year which is 5.9 percent of the water used currently. Due to farm layouts and other realities it is unlikely that all irrigation could be converted to pivots.

The second case therefore estimates the reduced water used, or water saved for the case where 80 percent of the irrigation is by pivot, and 20 percent is by laterals and other spray irrigation types. In this case the weighted average efficiency is increased from 78.17 percent to 81 percent, and the water used reduced by 6.1 million m^3 per year from 148.4 million to 142.3 million m^3 per year. This is a reduction by 4.1 percent on current usage.

These two cases indicate that shifting more irrigation to the more efficient application methods could reduce water use by 6 to 8 million m^3 per year, or 4.1 percent to 5.9 percent on current usage. That would release this water for environmental improvement.

3.3 Improved reliability of water availability

Stakeholders in the Zone have indicated to the BERL research team that the main gains In-Zone from the current water would be from increased reliability of water supply during the irrigation seasons. The main way to increase the reliability of irrigation water supply is to have water storage capacity in the schemes or on the farms.

Introducing storage at either the farm or Zone/scheme level would mean that there would be increased reliability in the water supply for irrigators. Increased reliability of water supply in any Zone can be expected to lead to increases in productivity, whether it be from better crop establishment and yields or more consistent pasture production over a season, and pasture growth for completion of the full lactation in the case of dairy.

3.3.1 A measure of recent water reliability

In the Current Pathway assessment, the importance of water reliability was described.

There are a number of ways of measuring water reliability and in many cases it is quoted as the share of years in which irrigators can reliably meet their annual irrigation demands. The expectation could be that these demands will not be met once in every 10 years, in which case reliability would be said to be 90 percent. Alternatively the irrigation demands may be not met in one year in every 20 years in which case the reliability is said to be 95 percent.

This is a relatively gross measure and it is also possible to express the reliability in terms of the total number of days per year in which the plant available water (PAW) is deficient, or in terms of the number of consecutive days for which the PAW is not met.

For the OTOP Zone the ECan main data of interest which are available for the current modelling are the annual figures for the Metered Allocation volume (for comparison with the Total Allocation volume) and the Available Metered volume. Because metering has become compulsory only relatively recently, the share of the total allocation volume which was metered has been increasing rapidly over recent years and appears to have reached some sort of capacity in 2014. The growth in the metered volumes from 2009 to 2015 are shown *in Figure 1: Water allocation availability and usage in OTOP Zone 2009 to 2015.*

This information was used to estimate the percent of the metered allocation volume which was available in each year from 2009 to 2015, and this information is shown in *Figure 2: Reliability of water available in OTOP Zone 2009 to 2015.*

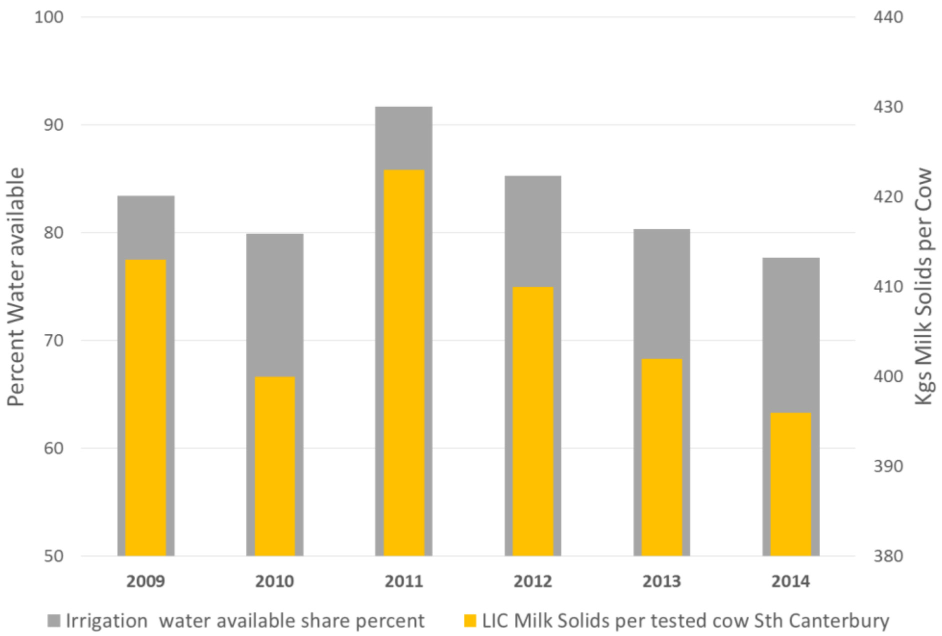
The indication by stakeholders that land use productivity is very dependent upon the reliability of the water supply can be tested by analysing whether or not one or other indicator of land use productivity has followed a track similar to the track of water availability from 2009 to 2014. One strong indicator of land use productivity under irrigated production in the OTOP Zone is dairy productivity. The following section tests whether there has been any apparent relationship between dairy cow productivity and an indicator irrigation water reliability in the OTOP Zone from 2009 to 2014.

3.3.2 Impacts of water reliability on OTOP dairy productivity

For the seasons from 2009 to 2014, BERL has completed analysis of the performance in the dairy farming industry at the regional level for the higher-producing herds tested by the Livestock Improvement Corporation (LIC). The LIC-tested herds made up about 63 percent of the total herds. The track of the average production per cow for the LIC herd-tested cows varied between 396 kgs MS/cow to 423 kgs MS/cow over this period. The changes in MS/cow in each year were similar to the changes in percent reliability of water as measured by the metered availability.

This is shown by graphing the two sets of data at appropriate relative scales on the same chart, in *Figure 3: OTOP irrigation water reliability and South Canterbury production per cow 2009 to 2014.* The two sets of data appear to follow the same track, and there is at least some logic to expect some causality between the availability of water for irrigation and production from cows predominantly farmed with irrigated pasture and feed production.

Figure 3: OTOP irrigation water reliability and South Canterbury production per cow 2009 to 2014



For the purpose of illustrating the scale of production impact possibly due to variations in water reliability, a proposition could be put forward that if a reliability level of 90 percent was achieved in average over the years, the productivity measured as Milk Solids per Cow, could increase from the current recent average of 407kgs MS per cow to about 425 kgs MS per cow. This is an increase by about **4.5 percent from the current average level**. If irrigation water reliability were increased to a healthy 95 percent, this productivity increase could be even greater. If the stocking rate of cows in milk per hectare on the milking platforms remained the same, then production per hectare would increase by the same margins. If the objective were to be to just maintain production, then the stocking rate per hectare could be reduced by these factors.

To provide an indication of the possible impacts of increased irrigation water reliability, different rates of increases in productivity have been assumed across the different land uses.

Dairy: increased productivity is expressed as an increase in milk solid production per cow, with the maintained stocking rate. The dairy productivity is relatively straightforward to track over the years whereas production from other land uses are more complex. To be relatively conservative the assumption made is that irrigated productivity would increase by **4.5 percent for dairy**[10]. Productivity increases for other land uses are assumed to be less.

Note that this 4.5 percent increase in production will come at no additional cost in terms of supplementary feed, fertiliser or general farm, milking and other costs. In other words revenue from Milk Solids sales will increase by 4.5 percent with direct costs constant.

In terms of the gross margin analysis this implies that the gross margin per hectare estimated for the current land use, (see Table 11) of $3,732 per hectare, with improved water reliability, would increase to $4,164 per hectare, an increase in Gross Margin by $432 per hectare, an increase by over 11 percent.

Crops and horticulture: Increased productivity is expressed in terms of an increase in the effective crop yield per hectare. That is, the increased water reliability would ensure that there was sufficient water for seedling

[10] We note here that this analysis provides the opportunity to use an alternative productivity measure of maintaining milk solids production but with fewer cows. This can provide a mechanism for nutrient management.

establishment, and for growing out and filling out the crop to its full potential yield. With improved water reliability the possibility of crop failure would be avoided. For the purpose of illustrating the possible scale of the impacts an increase less than that on irrigated dairy platforms is probably justified. The estimation below assumes an increase of an average of 3 percent yield per hectare over the years.

Other land uses: All land uses other than dairy and crops may also benefit from increased reliability of water supply. However the actual response is likely to be more complicated as for example sheep and beef production systems are quite flexible and can respond with changed timing of feeding supplementary feed crops etc. For the purpose of this illustration there has been no increase modelled into the gross margins for those land uses.

These changes in productivity are reflected in changes to the gross margins per hectare as shown in Table 16.

Table 16: Land use Gross Margins with more reliable irrigation water

Land Use	Scenario Two Land Use (Ha)			Gross Margin $ / Ha with Reliable water	
	Total	Dryland	Irrigated	Dryland	Irrigated
Dairy cattle farming	44,998	13,913	31,085	1,314.7	4,164.2
Beef cattle farming	24,568	22,527	2,041	148.9	526.6
Mixed Crop Sheep and Beef farming	179,345	175,853	3,492	393.0	1,010.6
Sheep farming	68,539	64,370	4,170	148.9	526.6
Arable cropping or seed production	22,461	17,057	5,404	1,900.0	5,740.0
Deer farming	21,641	19,244	2,397	362.1	1,047.7
Grazing other peoples stock & dairy dry stock	10,262	7,997	2,265	148.9	526.6
Vegetable and Fruit Growing	953	343	610	3,442.4	5,143.5
Forestry	8,764	8,753	10	0.0	0.0
Total / Average	**454,084**	**330,057**	**51,474**	**442.2**	**3,383.0**

3.3.3 Direct economic outcomes of increased irrigation water reliability

The modelling developed for the current land use assessment has been applied to the same land use areas but providing those land areas with more reliable water. The gross margins per hectare have been modified as above to take account of the increased production and revenue as a result of the relatively small increase in the water reliability. This current land use pattern, and increased gross margins per hectare from increased productivity with more reliable water result in the following levels of GDP as shown in Table 17.

Table 17: Total Gross Margins (GDP) generated with more reliable irrigation water

Total Gross Margin ($m)	Scenario Two Land Use, Gross margins with Reliable water		
Scenario Two Land Use	Dryland	Irrigated	Total
Dairy cattle farming	$18.3	$129.4	$147.7
Beef cattle farming	$3.4	$1.1	$4.4
Mixed Crop Sheep and Beef farming	$69.1	$3.5	$72.6
Sheep farming	$9.6	$2.2	$11.8
Arable cropping or seed production	$32.4	$31.0	$63.4
Deer farming	$7.0	$2.5	$9.5
Grazing other peoples stock and dairy dry stock	$1.2	$1.2	$2.4
Vegetable and Fruit Growing	$1.2	$3.1	$4.3
Forestry	$0.0	$0.0	$0.0
Total Gross Margin ($m)	**$142.1**	**$174.1**	**$316.2**

Compared with the current land use total Gross Margin of $301.5 million, and the Current Pathway total Gross Margin of $295 million, the total Gross Margin if water reliability was increased to 90 percent of reliability would be $316.2 million, an increase by about $15 to $21 million per year or 5 percent to 7 percent.

The impacts of these changes in total gross margin or GDP at the farmgate level has been extended to estimate the impacts on the regional value chain as shown in Table 18 .

Table 18: Regional value chain contribution generated with more reliable irrigation water

Regional economic contribution	**Value added GDP $Mn**		**Employment (FTEs)**	
Scenario Two Land Use	**Direct**	**Total**	**Direct**	**Total**
Dairy cattle farming	$148	$229	742	1,528
Beef cattle farming	$4	$8	42	75
Mixed Crop Sheep and Beef farming	$73	$129	688	1,232
Sheep farming	$12	$21	112	200
Arable cropping or seed production	$63	$113	601	1,076
Deer farming	$9	$20	154	265
Grazing other peoples stock & dairy dry stock	$2	$4	39	67
Vegetable and Fruit Growing	$4	$8	76	114
Forestry	$0	$0	0	0
Total Reliable water Economic Impacts	**$316**	**$532**	**2,453**	**4,557**
Total Current Land Use Economic Impacts	**$301**	**$509**	**2,371**	**4,393**
Increase due to reliable water	*$15*	*$23*	*82*	*163*

This indicates that from the current land use, there could be an increase of about $23 million in regional GDP from increased water reliability. This is an increase by about 4.5 percent on the GDP currently contributed to the regional value chain. The employment would increase by 163 FTEs which is about 3.7 percent of the current contribution.

3.3.4 Cost of increasing storage to increase reliability

The increased reliability of water supply for irrigation would increase the productivity, and thus revenue and potentially the gross margin on farms and orchards. Achieving increased reliability is not without cost. It will rely mainly on increased water storage within the schemes and/or on farm.

The volume of additional water required to be stored will depend upon a range of climate factors, the PAW required and the irrigation types. The detailed analyses to estimate this requirement in OTOP to achieve a given level of reliability is not in scope for this analysis. However the $15 million per annum increased gross margin could clearly support funding for some increased level of storage.

A high level indication of the possible scale of the economics and profitability of developing or increasing on-farm storage can be given by looking at the implications of the Rangitata South scheme requirement that irrigators develop on-farm storage with the capacity of 250m^3 of water for every hectare irrigated.

A rule-of-thumb applied in other analyses is that the capital cost of developing storage is about $5 per m^3. This implies that development of on-farm storage in the Rangitata South scheme would be about $1,250 for each hectare irrigated.

It is useful to estimate the approximate buffer this will give the irrigator against a restricted availability of water from the scheme. An average application level could be about 3.5mm of water applied daily. An application of

3.5mm requires 35 m^3 of water per hectare per day. On-farm storage of 250 m^3 therefore provides a buffer of 250/35 days, or a little over seven days buffer against any restricted water supply event on the scheme.

If it were found that this level of buffer was sufficient to bring water reliability to 90 percent from the current average in OTOP, this would imply a capital cost of storage of $1,250 per hectare irrigated. For ease of estimate, if the cost of that capital was 10 percent per annum, this implies a cost to increase reliability of $125 per hectare per year.

The estimate in section 3.3.2 above showed that the increased gross margin per hectare from that increased reliability for dairy platforms could be about $432 per hectare. At this very approximate scale, it appears that it could be profitable and economic to invest in on-farm, and/or in-scheme storage in the OTOP Zone. Where new schemes are concerned the capital costs could be higher.

3.4 Summary outcomes with Scenario Two efficiency and reliability

A summary of the changes in land use and productivity where the Current Pathway water is used with increased efficiency and with storage achieving a greater level of reliability.

Increased efficiency

The main outcome from irrigators adopting more efficient technical application methods could be a reduction in water use, with little reduction in the production and economic value of irrigated production. The change would be relatively small in this Zone because a high proportion of the land is irrigated with relatively efficient spray irrigation methods already.

The analyses found that shifting more irrigation to the more efficient application methods could reduce water use by 6 to 8 million m^3 per year, or about 4 percent on current usage. This would release the saved water for environmental improvement.

Improved reliability

The stakeholders interviewed in the OTOP Zone strongly expressed the view that the reliability of water supply was a key determinant of the profitability and economic value generated by irrigated primary production. In order to test whether the scale of impact from reliability of water supply was greater than other factors, an apparent relationship between a key productivity parameter namely average milk solids per cow in the region, and a measure of reliability of irrigation water availability was observed.

As an attempt to illustrate whether or not water reliability is a key factor in irrigated primary production, analyses were done postulating a level of water reliability of 90 percent, accompanied by increased per cow productivity of milk solids by 4.5 percent. Some increases were also allowed for arable and seed crops, and horticulture production. The scale of change over the outcomes from current land use and current reliability of irrigation water is shown in Table 19.

The increases in productivity/profitability in dairy, arable and horticulture has driven an increase in the total gross margin in irrigated production by over 9 percent.

Table 19: Illustration of gross margins and economic changes with more reliable water

Economic outcomes from Current land use, Scenario Two: more reliable irrigation water		**Current land use**	**Scenario Two more reliable water**	**Scenario Two reliable water change on current land use**	
				Number	*Percent*
Total irrigated area	*Ha*	51,474	51,474	0	**0.0%**
Gross Margin Dryland production	*$ mn*	$142.1	$142.1	$0.0	**0.0%**
Gross Margin Irrigated production	*$ mn*	$159.4	$174.1	$14.7	**9.2%**
Total Direct Gross margin (GDP)	*$ mn*	$301.5	$316.2	$14.7	**4.9%**
Total Value Chain GDP	*$ mn*	$509.3	$533.2	$23.9	**4.7%**
Direct employment (FTEs)	*No.*	2,371	2,453	82	**3.5%**
Total Value Chain employment (FTEs)	*No.*	4,393	4,557	163	**3.7%**

The total range of positive impacts from In-Zone gains are quite significant. Firstly the increased efficiency of irrigation water application can make a volume of water available for environmental improvements.

Secondly the analysis indicates that for a relatively attainable increase in reliability of irrigation water supply, there can be a quite significant increase in the value added from primary production, and the total value chain employment in the Zone.

3.5 Other potential irrigated production improvements

There are supplementary actions or changes in irrigated production management practices which would contribute towards further In-Zone gains. These include actions or behaviours around the timing or irrigation application(s), and production management practices. Data on the extent and impact of these activities is very limited and outside the scope of this assessment. However they are useful to note as complementary or steps for irrigators to take to produce further In-Zone gains.

Irrigation timing

Timing of irrigation application(s) can impact on the efficiency and productivity of farms. Proper timing helps farm managers to:

- maximise irrigation water use efficiency resulting in beneficial use (i.e. production), and conserving local water resources
- meet the water needs of crops to minimise or avoid crop yield loss due to water stress
- minimise the leaching potential of nitrates which may impact the quality of the groundwater.

Applying too little water or delaying irrigation until crop stress is evident can result in yield loss. Conversely, applying too much water can result in wasted water, extra pumping costs, an increased risk of leaching of nitrate, and/or leaching of valuable agrichemicals below the rooting zone.

Proper management of irrigation timing would contribute to In-Zone gains through maximising the beneficial use of irrigation water while conserving the water resource, and minimising the risk of nitrate and phosphorous leaching.

Production management

Another avenue for In-Zone gains to be made is through improved farm management practices. In this case we refer to dairy farm management in particular, as it accounts for the largest proportion of irrigated land use in the OTOP Zone (58 percent).

Farm management could be improved through maintaining the same level of milk solids production, but with fewer cows. This could be achieved through management practices such as calf rearing/nutrition programmes which seek to improve dairy herd productivity and survival. Under such programmes there is real potential to increase the survivability of heifers from birth through to herd entry and subsequent lactations, as well as the level of milk solid production per cow. DairyNZ is now concentrating on these improvements.[11] As productivity per cow increases, herd sizes can be reduced. Smaller herds will mean fewer cows contributing to carbon and nitrate loads.

3.5.1 Scenario Two nutrient management

Under Scenario Two, we assume that nitrogen levels are maintained.

In-Zone gains through improved efficiency are made through the conversion so that 80 percent of irrigated land area is irrigated with pivots, and the remaining 20 percent of land area is irrigated with non-pivot, relatively efficient spray irrigation systems. As pivots are the most efficient irrigation system this increases the weighted average efficiency of irrigation across all land uses/farm types by approximately 3.5 percent.

In turn this means with the same amount of water allocation, there is more water that can be applied to environmental improvements. The requirement for nutrient management may include some catchments going beyond Good Management Practice nitrogen loss rates. Investigation of the economic implications and feasibility of achieving these nitrogen loss rates is being completed by the Farmer Reference Group.

This will enable assessment of this important aspect of catchment management.

[11] Roche,J.R., N.A. Dennis, K.A. Macdonald, C.V.C. Phyn, P.R. Amer, R.R. White and J.K. Drackley. *Heifer rearing to optimise farm profitability*. Proceedings of the 5th Australasian Dairy Scieece Symposium 2014. Pp281-297.

4 Part Three: Scenario 3B: Large scale with New water

4.1 Overview and scope of the Scenario 3B and 3A assessments

Environment Canterbury wishes to assess the economic impacts of introducing new amounts of water into the OTOP Zone to be utilised for irrigation. The water will come from surface water sources.

There are two Scenarios to be assessed, *Scenario 3A: Small scale with New water*, and *Scenario 3B: Large scale with New water*. The set of parcels of land involved in the *Scenario 3A: Small scale* are a sub-set of the parcels of land involved in the *Scenario 3B: Large scale*. It is therefore more logical in presentation to describe and analyse the *Scenario 3B: Large scale* first in this section 4 . The report then describes and analyses the Scenario 3A: Small scale sub-set in the following section 5.

4.1.1 Supply of replacement water for current irrigation

The first function intended for this 'New water' has been described by ECan as the .. 'supply of already consented Rangitata River Water resulting in 5,680 hectares of top-up irrigation.' [12] This is intended to provide water to land which is currently irrigated primarily from groundwater sources. The replacement water will allow some reduction of groundwater takes as well as a top-up to the groundwater to ensure a higher level of reliability of water available for irrigation. To model this impact it is assumed that if one hectare of new dryland irrigation is foregone, that would allow two hectares of currently irrigated land to receive top-up, or replacement irrigation water. The actual process is therefore to model foregoing irrigation on 2,840 hectares of dryland in order to provide top-up irrigation water to 5,680 hectares of currently irrigated land.

The second function is the option of obtaining additional new water from (unspecified) alpine rivers so that in total the already consented Rangitata River water plus the additional alpine water would provide water sufficient to irrigate a total area of 29,946 hectares of dryland. However irrigation of 2,840 of these hectares is foregone in order to provide top-up and replacement water to the 5,680 hectares of currently irrigated land. The water available to irrigate additional dryland is thus the 29,946 hectares, less the 2,840 hectares foregone, which is 27,106 hectares of dryland.

For each of these modelled analyses, a set of hypothetical parcels of land were identified by the irrigation companies in consultation with ECan, and hypothetical, yet realistic future land uses attached to them. The current land uses of the land parcels are known and are those on the land parcels in the Current Pathway analyses.

For the replacement water, the location and current land use of this area of about 5,680[13] hectares and of the 2,840 hectares of irrigation foregone were provided to BERL in GIS shape files.

The interpretation we take from these shape files is that if there is large scale supply of already consented water from the Rangitata River this can be applied to top-up or replace the water applied to a total of 5,680 hectares in their current irrigated land use. This will require irrigation to be foregone from 2,840 hectares of dryland which could otherwise be irrigated.

This hypothetical situation, and the areas of land which it applies to is the same for Scenario 3A: Small scale New water and Scenario 3B: Large scale New water.

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[12] Ford, Raymond. *Proposed solution to complete OTOP scenario economic assessments*. Additional information requested by BERL,Scenarios 3a &3b. Pers comm, July 2017.

[13] The actual total area of the shapefiles provided totalled 5,811 hectares, however an area of that land was shown as 'Other uses', such as 'New record', or 'Unspecified' and so the number cam be rounded without significantly affecting the findings. A similar situation occurs with the other shapefiles also.

As a matter of interest the 5,680 hectares of land which can be served by this top-up or replacement water is contained on 160 shape file parcels, and the 2,840 hectares of dryland which has to forego irrigation is contained on 100 shape file parcels.

4.1.2 Supply of new water to irrigate new dryland areas

Corresponding to the shapefiles for the supply of new water to replace water currently used for irrigation are two shape files with similar titles, namely: *Irrigation_area_large_scale.shp*, and *Irrigation_area_small_scale.shp*. The irrigated area in the Small scale file totalled 15,085 hectares, and in the Large scale file 29,946 hectares. Again the 380 shape areas of dryland which could be served with New water in the Small scale file contain a subset of 672 shape areas of dryland which could be served with New water if the Large scale water is brought into the Zone.

As noted above an area of 2,840 hectares of potentially irrigated land is forgone from each total, to provide water for the top-up replacement on the currently irrigated land.

The new dryland areas which can be irrigated are, for the Scenario 3A: Small scale New water, a total of 15,083 hectares less 2,840 which is 12,243 hectares. For the Scenario 3B: Large scale New water, a total of 29,946 hectares less 2,840 which is 27,106 hectares.

4.1.3 Simplified land uses for Scenarios 3A and 3B

In the absence of a full farm survey related to the land involved, the estimates are made here on the areas of land which feasibly could be converted to a different irrigated land use. This feasibility is based on information provided on a hypothetical basis by the irrigation companies.

In order to reduce the complexity of the information, and to avoid an appearance of spurious accuracy the main land uses are expressed in five main groups, compared with their descriptions on the ECan GIS files as follows.

Dairy production platforms: replaces Dairy cattle farming;

Arable cropping and seed production, no change;

Vegetable and fruit growing, no change;

Mixed crop, sheep, beef, deer and goat farming: the more intensive pastoral farming, generally 'finishing';

Beef, sheep, dry stock farming: includes, the less-intensive categories Beef cattle farming, Sheep farming, Grazing other peoples' stock, and dairy dry stock.

4.2 Scenario 3B: Large scale New water irrigated land use

The assessment of the economic impacts of the introduction on a Large scale of New water to the Zone requires assessment of:

- the impacts on the current irrigated land use of obtaining surface water with increased reliability; and
- the impacts of the expected change in land use from current dryland use to a future irrigated use.

The relative scale of these two changes is that an area of 5,680 hectares of currently irrigated land, with known irrigated land use, will receive replacement water.

An area of 27,106 hectares of land with current known dryland use, will be able to receive New water for irrigation. The actual land uses of this newly irrigated land has been postulated in the information from the irrigation companies, via ECan. The actual land uses will in fact depend upon the full range of land use factors including in particular the land use capability of the land, the investment needed to change the land use from a dryland use to a different irrigated land use, and the profitability/investment returns to the land owner from making the investment in the land use change.

4.2.1 Current use of land receiving Large scale replacement water

The currently irrigated land uses of the 5,680 hectares which will receive replacement water are already known. As with the areas in the Zone overall, the land uses on the irrigated area is concentrated in the higher valued, more-intensive land uses. The shape files indicate that over 60 percent of the irrigated land which would receive replacement water is used in either dairy production platforms, or arable cropping and seed production. The remaining area is split evenly between relatively intensive mixed crop sheep, beef, deer and goat farming; and more extensive grazing beef, sheep and dairy support.

The profile of the current irrigated land use of this 5,680 hectares currently being irrigated mainly from groundwater, and which would receive replacement water under the Large scale New water scenario is shown in Table 20. There are small areas in other land uses such as lifestyle, native bush, forestry, new records and land where use is unknown or unspecified. This is only 3 percent of the total area. Attempts to allocate parts of this are not justified, and the land is omitted from the table.

Table 20: Current irrigated top-up replacement water and uses for Large scale water replacement

Land Use	Currently irrigated
	Hectares
Dairy production platforms	2,953
Arable cropping and seed production	606
Vegetable and fruit growing	0
Beef, Sheep, dry stock farming	853
Mixed crop, sheep, beef, deer and goat farming	1,268
Total	**5,680**

The new water, Large scale will involve the supply of already consented Rangitata River Water resulting in 5,680 hectares receiving top-up irrigation. This will allow the area to no longer rely solely on groundwater, but the more-reliable surface water supply from the Rangitata River. This 5,680 hectares is the same for the Large scale New water scenario and the Small scale New water scenario.

This change of water source will ensure that the reliability of water supply is maintained at a high level. The economic impact of this change is therefore not great, however it does allow some of the groundwater to be released, to improve environmental outcomes.

4.2.2 Economic and environmental impacts of replacement water use

The economic contribution indicated by the gross margins generated per hectare due to the increased reliability of water supply when top-up replacement water is available is not a major impact on the Zone's economy. The weighted average gross margin per hectare with current water supply is $2,850 per hectare, and with increased water reliability due to Large scale replacement water being available, the weighted average gross margin increases to only $3,127 per hectare.

Table 21: Current irrigated land uses improved margins with reliable Large scale replacement water

Land Use	Currently irrigated	Gross Margin $ / Ha	
	Hectares	Irrigated (ground)	Irrigated (surface)
Dairy production platforms	2,953	3,732	4,164
Arable cropping and seed production	606	5,500	5,740
Vegetable and fruit growing	0	4,392	5,143
Beef, sheep, dry stock farming	853	550	590
Mixed crop, sheep, beef, deer and goat farming	1,268	1,075	1,169
Total / Average	**5,680**	**2,850**	**3,127**

The increase is only $277 per hectare, which applied to the 5,680 hectares gives a total direct increase of GDP by about $1.6 million per year. With the value chain impacts, the total net increase would be about $2.5 million per year, and about 18 additional people employed across the region's value chain.

Likely to be of more importance in the region is the reduction or elimination of groundwater takes from the producers able to obtain replacement water from the Large scale New water source.

4.3 Land changing from dryland to irrigated land uses

BERL has used the ECan-provided GIS databases to determine the land uses in main agriculture, and horticulture uses. The shape files provided and attached spreadsheets indicate that there will be a total of 27,106 hectares of land expected to be able to receive high reliability surface water for irrigation of land which is presently in dryland production. In order to assess the economic impact of these land use changes, the initial requirement is to record the land use profile of the land parcels under the Current Pathways pattern, and compare this with the irrigated land use profile as reflected in the hypothetical assumptions by the irrigation companies.

4.3.1 Land use change in dryland receiving Large scale new water

There is a total of 27,106 hectares of land which is expected to be able to receive new water if the Large scale New water scenario is implemented.

Table 22: Estimated change from dryland to irrigated land uses with Large scale water[14]

Land Use	Dryland	Irrigated
	Hectares	Hectares
Dairy production platforms	3,213	16,726
Arable cropping and seed production	4,846	2,634
Vegetable and fruit growing	105	0
Beef, sheep, dry stock farming	9,056	3,177
Mixed crop, sheep, beef, deer and goat farming	8,564	4,569
Other land uses	*1,323*	*0*
Total area	**27,106**	**27,106**

As can be expected the great majority of the newly-irrigated dryland is expected to be converted into dairy production platforms. The 16,726 hectares is over 61 percent of the newly-irrigated land.

[14] Note that totals may vary due to rounding.

The other three farming land uses have significantly reduced areas.

4.3.2 Large scale New water land use gross margins

In this assessment it is assumed that the land currently in dryland production becomes irrigated and moves to a different, more intensive form of production, with consequently increased gross margins. Further, it is assumed that the new irrigation water is utilised at a high level of efficiency and it is delivered at a high level of reliability, because it will come from surface water sources, and presumably have the storage in-scheme or on-farm associated with that.

Therefore in this analysis it is assumed that the current margins are those of dryland production and that with irrigation, the margins will be those estimated in Part Two of this report with 'In-Zone gains' due to increased efficiency and reliability. These gross margins estimated for dryland production according to the dryland production profile in the Zone and those for the expected irrigated land use profile with reliable supplies of surface water for irrigation are shown below. These are used to estimate the weighted average contribution to the Zone's economy per hectare of this as dryland and irrigated land as shown in Table 23.

Table 23: Estimated Large scale dryland and irrigated land uses with average Gross Margin per hectare

Land Use	Dryland	Irrigated	Gross Margin $ / Ha	
	Hectares	Hectares	Dryland	Irrigated
Dairy production platforms	3,213	16,726	1,315	4,164
Arable cropping and seed production	4,846	2,634	1,900	5,740
Vegetable and fruit growing	105	0	3,442	4,787
Beef, sheep, dry stock farming	9,056	3,177	149	550
Mixed crop, sheep, beef, deer and goat farming	8,564	4,569	393	1,145
Other land uses	*1,323*	*0*	*0*	*0*
Total / Average	**27,106**	**27,106**	**718**	**3,385**

These numbers indicate that in most of these uses the gross margin per hectare in irrigation is three times the gross margin in dryland production. However with the profile of overall land use moving substantially from lower intensity to higher intensity uses, the overall weighted average gross margin per hectare has more than quadrupled from $700 per hectare in dryland use to over $3,300 per hectare in irrigated uses.

4.3.3 Direct contribution of the irrigation Large scale water to GDP

Some simple arithmetic shows that 27,000 hectares yielding $700 per hectare generates about $19 million total gross margin or direct GDP. The same land irrigated is 27,000 hectares yielding $3,300 per hectare which generates about $90 million total gross margin or direct GDP.

Table 24: Estimated change in direct GDP from dryland to irrigated land uses with Large scale water

Total Gross Margin ($m) Land Use	Current Dryland	Future Irrigated	Net Increase
Dairy production platforms	$4.2	$69.6	$65.4
Arable cropping and seed production	$9.2	$15.1	$5.9
Vegetable and fruit growing	$0.4	$0.0	-$0.4
Beef, sheep, dry stock farming	$1.3	$1.7	$0.4
Mixed crop, sheep, beef, deer and goat farming	$3.4	$5.2	$1.9
Other land uses	$0.0	$0.0	$0.0
Total Gross Margin ($m)	**$18.5**	**$91.7**	**$73.2**

The details of the total gross margin generated by the land under each dryland use compared with the changed area irrigated is shown in Table 24. Again this indicates that the 'farmgate' increase in gross margin or GDP is expected to be over $70 million per year.

4.3.4 Regional contribution to the economy

The net contribution to the regional economy of the land use changes can be shown as the direct and the total, or value chain impacts from the current dryland uses on the 27,100 hectares. This estimate can then be repeated for the irrigated land uses, and by subtracting one from the other shows the net impact. The following three tables show these estimates.

Table 25: Estimated current Large scale dryland contribution to the regional economy

Regional economic contribution	**Value added GDP $Mn**		**Employment (FTEs)**	
Current Dryland Use	**Direct**	**Total**	**Direct**	**Total**
Dairy production platforms	$4.2	$6.5	21	44
Arable cropping and seed production	$9.2	$16.4	87	156
Vegetable and fruit growing	$0.4	$0.6	3	6
Beef, sheep, dry stock farming	$1.3	$2.4	13	23
Mixed crop, sheep, beef, deer and goat farming	$3.4	$6.0	32	57
Other land uses	$0.0	$0.0	0	0
Total Economic Impacts	**$18.5**	**$32.0**	**157**	**286**

Current dryland production on the 27,100 hectares generates a total gross margin or value added of $18 million per year, employing 157 FTEs on the land. The total value chain value added is $32 million per year, employing over 286 FTEs across the chain.

Table 26: Estimated contribution to the regional economy with Large scale water

Regional economic contribution	**Value added GDP $Mn**		**Employment (FTEs)**	
New Irrigated Land Use	**Direct**	**Total**	**Direct**	**Total**
Dairy production platforms	$69.6	$108.0	350	720
Arable cropping and seed production	$15.1	$26.9	143	256
Vegetable and fruit growing	$0.0	$0.0	0	0
Beef, sheep, dry stock farming	$1.7	$3.1	17	30
Mixed crop, sheep, beef, deer and goat farming	$5.2	$9.3	50	89
Other land uses	$0.0	$0.0	0	0
Total Economic Impacts	**$91.7**	**$147.3**	**559**	**1,095**

The estimated future irrigated production on the 27,100 hectares generates a total gross margin or value added of over $90 million per year, employing 550 FTEs on the land. The total value chain value added is $147 million per year, employing over 1,000 FTEs across the chain.

Table 27: Estimated net change in contribution to the regional economy with Large scale water

Regional Net economic contribution	**Value added GDP $Mn**		**Employment (FTEs)**	
The change to Irrigated Land Use	**Direct**	**Total**	**Direct**	**Total**
Dairy production platforms	$65.4	$101.4	328	677
Arable cropping and seed production	$5.9	$10.5	56	100
Vegetable and fruit growing	-$0.4	-$0.6	-3	-6
Beef, Sheep breeding and finishing	$0.4	$0.7	4	7
Mixed crop, sheep, beef, deer and goat farming	$1.9	$3.3	18	32
Other land uses	$0.0	$0.0	0	0
Total Economic Impacts	**$73.2**	**$115.3**	**403**	**809**

These estimates indicate that the net impacts from the 27,100 hectares moving into irrigated production is that approximately $70 million per year is added to the value added at the farmgate, and this is increased to about $115 million per year when the full value chain effects have been allowed for. These numbers are paralleled by an increase in employment on the land by over 400 FTEs, and along the whole value chain, by over 800 FTEs.

4.4 Economic impacts Large scale New water and Current Pathway

The impacts of the Current Pathway of irrigated production in the OTOP Zone was estimated in section 2.4.3 above was approximately $300 million per year direct, at farm gate and $500 million across the value chain. The net addition to the economic impact from the Large scale New water of $70 million at farm gate, and $155 million across the value chain is an increase in contribution by around one-quarter.

The increased employment on-farm of 400 FTEs is an increase by about 15 percent to 20 percent on the employment of 2,300 under the Current Pathway assumption. The value chain employment increase is of a similar scale.

5 Part Four: Scenario 3A : Small scale New water

5.1 Assessment of Scenario 3A, Small scale New water

The Small scale New water scenario will assess the impacts when existing consented schemes source new supply of already consented Rangitata River water, and Waitaki River water.

5.1.1 Current use of land receiving replacement water

Under Scenario 3A which is Small scale, New Water, there would be replacement water made available to top-up ground water sources currently irrigating 5,680 hectares of land. This replacement water would be made available by foregoing irrigation of an additional 2,840 hectares of potentially irrigated area of dryland. The replacement process is fully described and analysed in section 4.1.1 above. The impact under Scenario 3A Small scale New water would be the same as under Scenario 3B Large scale New Water, as described in section 4.2 above.

The economic contribution indicated by the gross margins generated per hectare due to the increased reliability of water supply when top-up replacement water is available is not a major impact on the Zone's economy. The weighted average gross margin per hectare with current water supply is $2,850 per hectare, and with increased water reliability due to Small scale replacement water being available, the weighted average gross margin increases to only $3,127 per hectare.

The increase is only $277 per hectare, which applied to the 5,680 hectares gives a total direct increase of GDP by about $1.6 million per year. With the value chain impacts, the total net increase would be about $2.5 million per year, and about 18 additional people employed across the region's value chain.

Likely to be of more importance in the region is the reduction or elimination of groundwater takes from the producers able to obtain replacement water from the Small scale New water source.

5.2 Land changing from dryland to irrigated land use with Small scale water

The total area able to be irrigated with the additional water made available under Scenario 3A: Small scale New water is 15,093 hectares. However as with the Large scale scenario, an area of 2,840 hectares of dryland irrigation is foregone in order to provide top-up replacement water to 5,680 hectares of land currently irrigated with predominantly groundwater supply. This section therefore analyses the impact of an additional area of 12,253 hectares of dryland assumed to be able to receive water for irrigation under the Small scale New water scenario.

5.2.1 Land use change of land receiving Small scale new water

As with the Large scale scenario, the land use changes in the 12,253 hectares of dryland able to receive the Small scale New water into the Zone are those which have been identified for these parcels by the irrigation companies. To repeat, these parcels are a sub-set of the Large scale scenario parcels.

The profile of land use as dryland production (in the Curent Pathway dataset) and the hypothetical irrigated production is shown in the table.

As with the large area in the Large scale New water scenario, by far the major change has been the conversion to dairy production platforms. In the case of this smaller set of parcels, about 70 percent of the irrigated land is used as dairy production platforms.

Table 28: Change from dryland to irrigated land uses with Small scale water

Land Use	Current Dryland	Future Irrigated
	Hectares	Hectares
Dairy production platforms	831	8,477
Arable cropping and seed production	2,992	1,236
Vegetable and fruit growing	105	0
Beef, Sheep, dry stock farming	4,232	1,303
Mixed crop, sheep, beef, deer and goat farming	3,214	1,236
Other land uses	*879*	*0*
Total	**12,253**	**12,253**

5.2.2 Increased land use gross margins from Small scale irrigating dry land

In this assessment it is assumed that the land currently in dryland production becomes irrigated and moves to a different, more intensive form of production, with consequently increased gross margins. Further, it is assumed that the new irrigation water is utilised at a high level of efficiency and it is delivered at a high level of reliability, because it will come from surface water sources, and presumably have the storage in-scheme or on-farm associated with that.

Therefore in this analysis it is assumed that the current margins are those of dryland production and that with irrigation, the margins will be those estimated in Part Two of this report with 'In-Zone gains' due to increased efficiency and reliability.

Table 29: Estimated Small scale dryland and irrigated land uses with average Gross Margin per hectare

Land Use	Current Dryland	Future Irrigated	Gross Margin $ / Ha	
	Hectares	Hectares	Dryland	Irrigated
Dairy production platforms	831	8,477	1,315	4,164
Arable cropping and seed production	2,992	1,236	1,900	5,740
Vegetable and fruit growing	105	0	3,442	4,787
Beef, Sheep, dry stock farming	4,232	1,303	149	550
Mixed crop, sheep, beef, deer and goat farming	3,214	1,236	393	1,145
Other land uses	*879*	*0*	*0*	*0*
Total	**12,253**	**12,253**	**794**	**3,634**

These numbers indicate that in most of these uses the gross margin per hectare in irrigation is about three times the gross margin in dryland production. However with the shift of overall land use from lower intensity to higher intensity uses in the areas irrigable by the Small scale New water, the overall weighted average gross margin per hectare has more than quadrupled from $794 per hectare in dryland use to $3,634 per hectare in irrigated uses.

These weighted averages are a little higher than those for the whole Large scale dryland converted to irrigation, which indicates that on average the Small scale dryland for irrigating is capable of higher intensity of land use than the overall area of Large scale dryland for irrigating.

5.2.3 Direct contribution of the irrigation Small scale water to GDP

With the 12,253 hectares of land able to be irrigated, the direct value contribution is estimated to be $44 million per year whereas under current dryland production it is estimated at $9 million per year. The increase in direct gross margin or GDP is thus $35 million per year as shown in Table 30.

Table 30: Estimated change in direct GDP from dryland to irrigated land uses with Small scale water

Total Gross Margin ($m) **Land Use**	**Current Dryland**	**Future Irrigated**	**Net Increase**
Dairy production platforms	$1.1	$35.3	$34.2
Arable cropping and seed production	$5.7	$7.1	$1.4
Vegetable and fruit growing	$0.4	$0.0	-$0.4
Beef, Sheep breeding and finishing	$0.6	$0.7	$0.1
Mixed crop, sheep, beef, deer and goat farming	$1.3	$1.4	$0.2
Other land uses	*$0.0*	*$0.0*	*$0.0*
Total Gross Margin ($m)	**$9.0**	**$44.5**	**$35.5**

5.2.4 Regional contribution to the economy from New water Small scale

The net contribution to the regional economy of the land use changes can be shown by showing the direct and the total, or value chain impacts from the current dryland uses on the 12,253 hectares then repeat that for the irrigated land uses, and finally subtract one from the other to show the net impact. The following three tables show these estimates.

Table 31: Estimated current Small scale area dryland contribution to the regional economy

Regional economic contribution	**Value added GDP $Mn**		**Employment (FTEs)**	
Current Land Use	**Direct**	**Total**	**Direct**	**Total**
Dairy production platforms	$1.1	$1.7	5	11
Arable cropping and seed production	$5.7	$10.1	54	96
Vegetable and fruit growing	$0.4	$0.6	3	6
Beef, Sheep breeding and finishing	$0.6	$1.1	6	11
Mixed crop, sheep, beef, deer and goat farming	$1.3	$2.2	12	21
Other land uses	*$0.0*	*$0.0*	*0*	*0*
Total Economic Impacts	**$9.0**	**$15.8**	**81**	**146**

Current dryland production the 12,253 hectares generates a total gross margin or value added of $9 million per year, employing 81 FTEs on the land. The total value chain value added is $16 million per year, employing about 150 FTEs across the chain.

Table 32: Estimated contribution to the regional economy with Small scale water

Regional economic contribution	**Value added GDP $Mn**		**Employment (FTEs)**	
Irrigated Land Use	**Direct**	**Total**	**Direct**	**Total**
Dairy production platforms	$35.3	$54.7	177	365
Arable cropping and seed production	$7.1	$12.6	67	120
Vegetable and fruit growing	$0.0	$0.0	0	0
Beef, Sheep breeding and finishing	$0.7	$1.3	7	12
Mixed crop, sheep, beef, deer and goat farming	$1.4	$2.5	13	24
Other land uses	*$0.0*	*$0.0*	*0*	*0*
Total Economic Impacts	**$44.5**	**$71.1**	**265**	**522**

Future irrigated production the 12,253 hectares generates a total gross margin or value added of $44 million per year, employing 265 FTEs on the land. The total value chain value added is $71 million per year, employing over 520 FTEs across the chain.

Table 33: Estimated net change in contribution to the regional economy with Small scale water

Regional Net economic contribution	**Value added GDP $Mn**		**Employment (FTEs)**	
The Change to Irrigated Land Use	**Direct**	**Total**	**Direct**	**Total**
Dairy production platforms	$34.2	$53.0	172	354
Arable cropping and seed production	$1.4	$2.5	13	24
Vegetable and fruit growing	-$0.4	-$0.6	-3	-6
Beef, Sheep breeding and finishing	$0.1	$0.2	1	1
Mixed crop, sheep, beef, deer and goat farming	$0.2	$0.3	1	3
Other land uses	*$0.0*	*$0.0*	*0*	*0*
Total Economic Impacts	**$35.5**	**$55.3**	**184**	**376**

These estimates indicate that the net impacts from the 12,253 hectares moving into irrigated production is that approximately $35 million per year is added to the value added at the farmgate, and this is increased to about $55 million per year when allowance is made for the full value chain effects. These numbers are paralleled by an increase in employment on the land by about 184 FTEs, and along the whole value chain, by about 376 FTEs.

5.3 Summary of impacts Scenarios 3A and 3B, New water supplied

The new water, small scale will involve the supply of larger volumes each of already consented Rangitata River Water, as well as additional new water obtained from a surface water source, not yet identified.

Replacement of current groundwater with high reliability alpine surface water will allow some increase in productivity due to the improved reliability. The scale of this increase is small. Under Scenarios 3A and 3B, the total gross margin increase from the 5,680 hectares is only about $2 million per year.

The impacts of providing larger areas of dryland with irrigation water are significant as shown in the table.

Table 34: Summary outcomes New water Small scale and Large scale scenarios

Economic outcomes for Scenarios	**Scenario 3A: Small scale**		**Scenario 3B: Large scale**	
	Dryland	**When irrigated**	**Dryland**	**When irrigated**
Total scenario area (Hectares)	12,250	12,250	27,100	27,100
Direct gross margin (GDP)	**$9 million**	**$44 million**	**$18 million**	**$92 million**
Value chain GDP	**$16 million**	**$71 million**	**$32 million**	**$147 million**
Direct employment	**81 FTEs**	**265 FTEs**	**157 FTEs**	**559 FTEs**
Value chain employment	**146 FTEs**	**522 FTEs**	**286 FTEs**	**1,095 FTEs**
Net change from current land use				
Direct gross margin (GDP)		**$35 million**		**$73 million**
Value chain GDP		**$55 million**		**$115 million**
Direct employment		**184 FTEs**		**403 FTEs**
Value chain employment		**376 FTEs**		**809 FTEs**

The outcomes generated from these scenarios show that if additional water were accessed from outside the Zone and made available to existing dryland producers there could be significant increases in activity in the Zone's economy.

In fact compared with the contribution to the economy by the Current Pathway land uses, the activity from the New water Large scale Scenario 3B would increase the contribution to the Zone's value chain GDP by about 23 percent, and the New water Small scale Scenario 3A would increase it by about 11 percent. The impacts on the employment in the Zone are similar orders of magnitude.

6 Appendix

Figure 4: Dairy payout price per kg. for Milk Solids, inflation adjusted 1975 to 2016 (In 2016 $s)