The economic value of potential irrigation in Canterbury

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List of Abbreviations

CDC- Canterbury Development Corporation

CEDM- Canterbury Economic Development Model

CWMS- Canterbury Water Management Strategy

FAO- Food and Agriculture Organization of the United Nations

FTE- Full Time Equivalent

GIS- Geographic Information System

LRIS- Land Resource Information System

LTEM- Lincoln Trade and Environment Model

LUC- Land Use Capability

MAF- Ministry of Agriculture and Forestry

NZLRI- New Zealand Land Resource Inventory

OECD- Organisation for Economic Co-operation and Development

SMP- Skim Milk Powder

SONZAF- Situational and Outlook for New Zealand Agriculture and Forestry

WMP- Whole Milk Powder

Executive Summary

The purpose of this report is to provide CDC with the ability to estimate the total benefits for Canterbury and New Zealand from irrigation scenarios under the implementation of the Canterbury Water Strategy.

- This report describes a series of assumptions which under pin a model for valuing irrigation.
- The model is built allowing different prices, uptake rates, irrigated area and different land uses of irrigated land, to be defined.
- The prices valuing land use are informed from both international and national data sources and use the Lincoln Trade and Environment Model (LTEM) to allow the possibility of different international policy market scenarios to be modelled.
- Using these sources the model assigns values to different land uses under irrigation, and projects price trends until to 2031.
- The model gives final outputs in total revenue and employment effects from 2014 to 2031. This includes the direct, indirect and induced effects by using the Canterbury Economic Development Model.
- The results presented here are based on a five year rate of uptake and predicted land uses of irrigated area as 58 per cent dairy, 18 per cent irrigated sheep and beef, 20 per cent arable and 3 per cent high-value arable.
- Additionally irrigated land in all scenarios is assumed to have been previously utilised for dryland sheep and beef farms.

Three modelled scenarios are covered in this report, based on GIS data describing the total potential irrigable area of Canterbury, and a base current irrigation of 500,000 ha in Canterbury:

1. 607,773 ha additional irrigation, the upper bound of irrigation in Canterbury. All potential irrigable land being irrigated.
2. 364,664 ha of additional irrigation, a more realistic estimate. 60 per cent of total potentially irrigable land.
3. 250,000 ha of additional irrigation. An estimate of potential demand for irrigation taken from the CWMS.

Total Effects by scenario, 2031

	Revenue (million NZD)		Employment (FTEs)		Value Added (million NZD)	
Scenario	**Cant.**	**NZ**	**Cant.**	**NZ**	**Cant.**	**NZ**
Scenario 1	5070.07	7335.12	19106	20406	2710.68	3225.98
Scenario 2	3042.04	4401.07	11464	12244	1626.41	1935.59
Scenario 3	2085.51	3017.21	7859	8393	1115.00	1326.97

The results from the first scenario shows a total potential benefit of irrigation in Canterbury for New Zealand, in 2031 of $7.3 billion and over 20,000 Full time equivalent (FTEs) jobs. The second, more realistic scenario, showing a 60 per cent uptake of potential additional irrigable land irrigated netted $4.4 billion in revenue and over 12,000 FTEs. Lastly the third scenario of projected demand from the CWMS gave an additional $3 billion in revenue and over 8,000 FTEs.

Chapter 1
Introduction

The purpose of this report is to provide CDC with estimates of the benefits for Canterbury from irrigation with the implementation of the Canterbury Water Strategy. The report is based on a series of assumptions underpinning a model for the valuation of irrigation. Flexibilities in the model allow key assumptions to be changed and different scenarios to be valued.

Canterbury has abundant land, water and other natural sources in a benign and dry climate. The region has a wide range of abundant natural resources with good fertile land and supply of high quality water. Over 60 per cent of Canterbury land is capable of being cultivated, and Canterbury has by far the highest share of New Zealand's irrigated land. This abundance of resources enables a wide range of rural activities including agriculture, viticulture and horticulture (see Appendix). Considering the water demand and the water availability on an annual basis the Canterbury region has enough water to meet its foreseeable abstractive needs and provide for in-stream flow requirements, but to cope with the seasonal water demand the region has to have water storage.

The region is strategically located with good transport infrastructure, to support generic growth in the agricultural sector, including the airport and the seaports. This is the strength of the region as it allows importing and exporting both domestically and internationally at an affordable price. Lyttelton and Timaru Ports are the two container ports of the region and therefore important for Canterbury and for the South Island, especially for trade through the global transport network.

In terms of the climate the seasons in Canterbury vary dramatically, and the climate is heavily influenced by the Southern Alps to the west. Long dry spells can occur in summer, causing drought conditions, and temperatures are highest when hot dry northwesterlies blow over the plains. Summer temperatures are often cooled by a northeasterly sea breeze, and the typical maximum daytime summer air temperature ranges from 18°C to 26°C. Snow is common in the mountain ranges during winter and the typical maximum daytime winter air temperature ranges from 7°C to 14°C.

The Canterbury Plains are dry which makes agricultural use difficult. The Plains are the largest alluvial plains in New Zealand. They seem flat but they are a series of huge, gently sloping fans built up by the major rivers (Malloy 1993). The substantial amount of water coming from the mountains influences the area's climate and land use. It also makes irrigation possible to achieve a successful growth of a diversity of crops and pastures.

Productivity in Canterbury's agricultural sector has grown consistently over the past years. In particular the growth in the dairy sector has been significant over the past ten years, as shown in the Appendix.

There have been various studies on the use and potential for the use of water in Canterbury and on issues associated with this. In particular, in 2002, the *Canterbury Strategic Water Study* was prepared by Lincoln Environmental for the Ministry of Agriculture and Forestry, Environment Canterbury and the Ministry for the Environment (Morgan et al, 2002). The report began by recognising that seventy per cent of New Zealand's irrigated land is located in the Canterbury region, as is 58 per cent of all water allocated for consumptive use in New Zealand. Canterbury is therefore a very high user of water

1.1 Irrigated land

There is no definitive figure of current irrigated land in Canterbury, instead many estimates have been put forward by various institutions. The government's national infrastructure plan for 2011 states that the national level of irrigation is approximately 620,000 ha, with 520,000 being in the South Island. The infrastructure plan from the previous year, put the estimated irrigated land in Canterbury as of 2009 at 363,614 ha, up from 347,022 ha in 2000. In contrast, the CWMS put the figure for irrigated area in Canterbury much higher at 500,000 ha as of 2008, making up for 70 per cent of the country's total (an increase from287,000 ha in 2002).

Table 1.3 shows a summary of irrigated land in the districts of the Canterbury Region and New Zealand. This shows in Canterbury the highest population of land is irrigated by spray systems, accounting 81.4 per cent, followed by 16.7 per cent which are irrigated by flood systems.

Table 1.1: Irrigable land (ha) by territorial authority and type (1)(2)(3)(4) (Year ended June)

Territorial authority	Total area equipped for irrigation	Irrigable area by flood systems	Irrigable area by spray systems	Irrigable area by micro systems	Irrigable area with systems not specified
Kaikoura	3,653	C	3,296	C	C
Hurunui	30,042	9,107	18,991	1,519	1,042
Waimakariri	29,472	2,076	26,043	711	1,026
Christchurch City	7,083	C	6,050	268	234
Selwyn	84,450	5,793	75,617	1,146	3,246
Ashburton	140,163	30,450	108,033	626	3,166
Timaru	45,068	1,351	41,697	482	2,242
Mackenzie	4,952	1,270	8,798	C	C
Waimate	29,197	9,626	18,738	111	1,004
Waitaki	36,248	8,957	24,739	1,154	2,525
Canterbury	**385,271**	**64,386**	**313,710**	**5,734**	**13,237**
South Island	**522,168**	**108,103**	**384,773**	**25,629**	**23,524**
New Zealand	**619,293**	**110,917**	**456,705**	**41,657**	**34,653**

Note:

(1) Figures may not add to the totals due to rounding.
(2) Land area could have been irrigated using existing resource consents and equipment on the farm.
(3) Irrigable area may be irrigated by more than one system.
(4) Some figures have been revised since the initial release of data in August 2008.

Symbols: C confidential

Source: Statistics New Zealand (2007)

Table 1.2: Summary of current irrigation in Canterbury by source

Source	Total ha irrigated
CWMS [2008]	500,000
NZ Infrastructure Plan [2009]	363,614
Statistics NZ [2007]	385271[e]

Symbols: e area equipped for irrigation

Sources: Canterbury Water (2010), Treasury (2009), Stats NZ (2007)

From MAF estimates, of this irrigated area in Canterbury, 34 per cent is on dairy pasture, 36 per cent other pasture, 27 per cent arable and less than 3 per cent on horticulture and viticulture (LE 2000).

Potentially irrigable land

Given the fact that the estimates of the current irrigated land in Canterbury are uncertain it is not surprising that the potential irrigable land is also a contentious figure. Part of the difficulty of answering this question is the definition of irrigable and how to include existing irrigable land which benefits from more reliable irrigation. In this study as we are assessing the implementation for the Canterbury Water Strategy. Even so this is still contentious especially relating to what is new irrigated land.

The CWMS states that of a gross potentially irrigable area of 1.3 million hectares, 500,000 ha is already irrigated. To further analyse this and the capabilities of the irrigable land this study has drawn on a number of sources as reported below.

A 2002 study (Morgan et al. 2002) utilizing the Land Resource Information System (or LRIS, from Landcare Research), a GIS database, and a set of inclusion criteria for land, found the gross potential irrigable area in Canterbury to be 1,296,371 ha. This number was reduced to 1,002,420 ha after allowances for land-use for housing, shelter belts and other non-irrigated uses. This is a high estimate, which included major forested areas and made no exclusions based on soil suitability, and can be seen therefore as an upper bound figure for irrigation in Canterbury.

Figure 1.2 below is the map of the potentially irrigable areas of Canterbury, from the LRIS. The shows the total land in Canterbury with a slope of 15 degrees or less, the inclination upon which irrigation can take place. Of this total area several further exclusion criteria were enforced. All urban and river areas were taken out. Also areas with unsuitable soil types for irrigation, high rainfall (over 1200 mm/yr), smaller isolated areas and areas above 600m were not included. This area of 1,296,371 was used as the basis for total irrigation in the possible irrigation valuation model in this study.

Figure 1.1: Potential irrigable area of Canterbury

The next task is to determine how much of the total area given by the LRIS potentially irrigable map of Canterbury, is appropriate for different land uses. For this purpose we utilized the land use capability (LUC) classes from the New Zealand Land Resource Inventory (NZLRI) (Landcare 2012) as seen in Figure 1.3. The land use capability classifications define land based on its ability to sustain long-term production. It divides land into eight major classes indicating the land's general ability to sustain production, four sub-classes, which define the main limitation upon production within an area (soil, erosion, wetness and climate), and finally adding a unit to group similar landscapes. The eight LUC classes give the broadest description of suitability of land from various land uses, with LUC 1 being the most suitable class of land for sustained production, and LUC 8 being the least suitable class, unsuitable for any arable and pastoral production. Furthermore, of these classes, LUCs 1-4 are considered suitable for the production of arable crops, and LUCs 1-7 suitable for pastoral usage.

Figure 1.2: NZLRI: Land use capability map

For this project we overlaid the map of LUCs with map of potentially irrigable areas of Canterbury, to find which irrigable areas were suited to various land usages. The overlay is shown in Figure 1.4.

Figure 1.3: Land use capabilities of potentially irrigable land in Canterbury

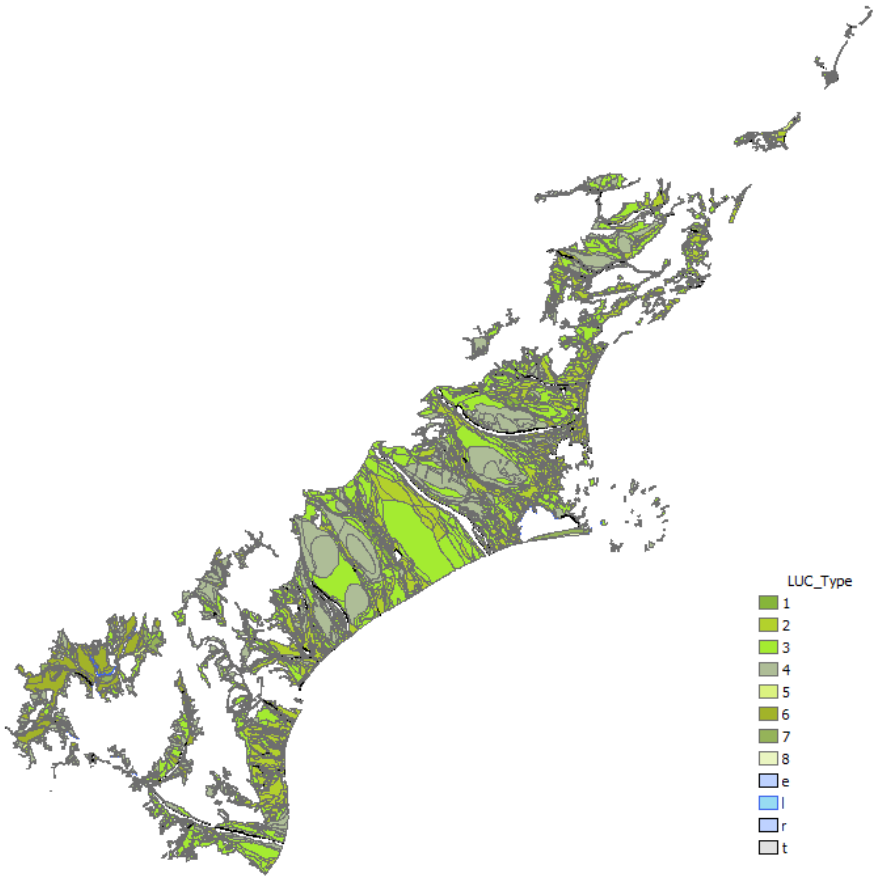


Table 1.5 shows the distribution of land given from the overlay of the two maps. As this table illustrates the majority of irrigable land in Canterbury is either LUC class 3 or 4. As the map of potentially irrigable area already applied certain critera much of the unsuitable land for production has been previously excluded, thus only a small proportion of land falls into LUC 8 or any of the other unsuitable land classes.

While under the definitions of LUCs the class LUC 4 is suitable, this is only a rank of low suitability, with *"severe physical limitations to arable use...[that]…substantially reduce the range of crops which can be grown. (Lynn at el, 2009, p.58)"*. As LUC 4 is not ideal land for all arable growth for the purposes of modelling we have deemed only LUCs 1-3 as potential land for arable use, as to avoid LUC 4 land un-suited to modelled crops or land which could only be worked infrequently due to physical limitations. Similarly we have discounted LUC 7 as being unsuited to pastoral use with irrigation. Whilst this land can potentially be pastoral, it's limitations would make intensive pastoral use difficult.

Therefore, in the model LUCs 1-3 are considered appropriate for arable use, and LUCs 1-6 appropriate for pastoral use. This gives a total potential area of 683,622 ha potential for arable, and 1,107,773 ha potential for pastoral, of which 424,150 ha is appropriate only for pastoral useages.

Table 1.3: Land use class of potentially irrigable land in Canterbury

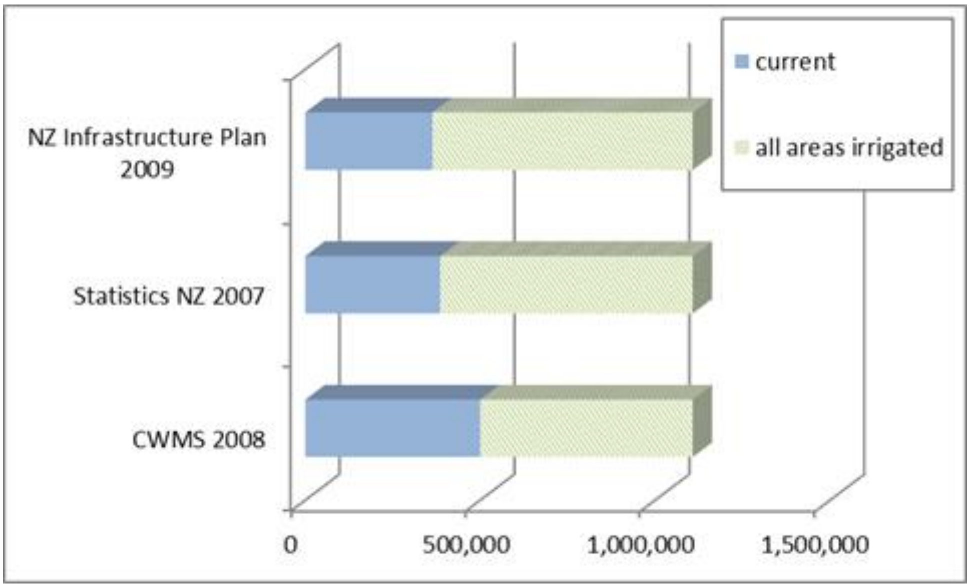
LUC	Area (ha)
1	19864
2	243988
3	419768
4	414820
5	9329
6	144798
7	19349
8	2182
e	274
l	1217
r	16596
t	848

Notes: e,l,r,t: refer to areas of lakes, rivers and urban development

Source: Morgan et al. (2002)

Therefore, for this study we have used the total irrigable area possible in Canterbury at 1.1 million hectares as the definitive figure. This includes existing area irrigated (0.5 million hectares) as we do not know where the existing irrigation is taking place and on what classes of land. Figure 1.5 shows the current area of irrigation as estimated by three sources, as part of the 1.1 million total potentially irrigable land presented in this study. The figure of 1.1 million does not account for the viability, either economically or in terms of physical supply, of irrigation in a particular area. Rather, this figure expresses the potential of the land itself to support irrigation.

Figure 1.4: Total irrigation, current and potential (ha)



Sources: Canterbury Water (2010), Treasury (2009), Stats NZ (2007)

One limitation of the GIS approach to the problem of determining the land available for irrigation in Canterbury is a lack of spatial data for the currently irrigated areas of Canterbury. Thus the distribution of LUCs is assumed to be equal across currently irrigated and non-irrigated land, as the irrigated land cannot be taken out of the mapped area, while accurately portraying the location of areas with different LUCs.

Chapter 2
Benefits of Irrigation

2.1 Value of irrigation

There have been numerous studies on the benefits of irrigation. To assess this requires key sources of information including:-

1. The uptake rates over time for irrigation
2. The increased returns and value added from the change in land use
3. The changes in agricultural land use by type
4. The impact of this on the wider community

1. The uptake rates over time for irrigation

Of course the rate of uptake of any new irrigations scheme will affect the economic benefits from the scheme. This will vary depending upon a variety of factors including land potential; the age of the farmer; size of farm; investment required to develop the infrastructure for the irrigation and alternative uses; market condition and alternative land uses among other factors. There have been relatively few studies of uptake rates ex-post apart from the Opuha dam, (Harris et al 2006). There have been a variety of surveys of farmers re their intentions when irrigation becomes available but these are generally not in the public domain. The other source of information is the secondary data sources of land use in Canterbury as shown in the Appendix. Whilst this cannot be related directly to irrigation it does provide some context for uptake and land use.

In this study we have modelled two scenarios involving a 100 per cent and a 60 per cent uptake targets. These have been assumed to be converted at 20 per cent per year thus taking five years to achieve the assumed uptake rates.

2. The increased returns and value added from the change in land use

To estimate the benefits from irrigation it is important to assess the value of the irrigated activity both in terms of total revenue and also value added. Again there have been a number of studies which have estimated this. In most of these studies the values used have been derived from the MAF Farm Monitoring Reports and the MAF (2004) report on the value of irrigation. These provide information on the key value of outputs and inputs by sectors. This study therefore uses the latest data available from the Farm Monitoring Reports but supplements these data with data from the LTEM (Lincoln Trade and Environment Model), the OECD and other sources as mentioned. This enables the impact of trade policy and changing world demand and supply conditions on prices to be estimated.

3. The changes in agricultural land use type

The actual land uses to which farmers convert will depend on a variety of factors including investment required, relative returns and their security, among others. Obviously the major land use type over the last decade that farmers have converted to is dairy. To estimate value of irrigation, therefore we need to estimate what farmers will convert their land use too.

Morgan et al (2002) did estimate these, as shown in Table 2.1. This shows the potentially irrigated areas categorized in six land use groups based on their water requirements. The total gross area of potentially irrigable land in the Canterbury Region is estimated to be 1,296,361ha. It records that the highest potential rate of the regions irrigated land is for intensive livestock/dairy support (46 per cent) and for dairying (33 per cent).

Table 2.1: Summary of assumed land-use (ha) for potentially irrigable land in Canterbury

Water Resource Area	**Land use category**								
	Dairying	Intensive livestock & dairy support	Arable	Lifestyle	Horticul-ture & processed crops	Viti-culture	Forestry & other non-irrigated	**Total by resource area**	
Clarence		1,653						**1,653**	**0%**
		100%							
Coastal Kaikoura	8,297	5,981						**14,278**	**1%**
	58%	42%							
Waiau	10,867	43,339						**54,206**	**4%**
	20%	80%							
Hurunui	21,601	26,616				9,085	6,414	**63,716**	**5%**
	34%	42%				14%	10%		
Ashley/ Waipara		52,306		18,447		16,977		**87,730**	**7%**
		60%		21%		19%			
Waimakariri	18,975	34,186	2,196	26,647		6,501	11,352	**99,857**	**8%**
	19%	34%	2%	27%		7%	11%		
Selwyn	84,977	64,520	39,748	26,434				**215,679**	**17%**
	39%	30%	19%	12%					
Banks Peninsula				5,993			6,678	**12,671**	**1%**
				47%			53%		
Rakaia	6,896	5,462	5,089					**17,447**	**1%**
	40%	31%	29%						
Ashburton	145,479	84,530	51,212					**281,221**	**22%**
	52%	30%	18%						
Rangitata	9,619	8,131						**17,750**	**1%**
	54%	46%							
Opihi-Orari	74,260	42,074	8,703		6,968			**132,005**	**10%**
	56%	32%	7%		5%				
Coastal Sth. Canterbury	27,719	49,650	4,392		3,801			**85,562**	**7%**
	32%	58%	5%		5%				
Waitaki	22,904	176,574				13,118		**212,596**	**16%**
	11%					6%			
Total by land use type	**431,594**	**595,022**	**111,340**	**77,521**	**10,769**	**45,681**	**24,444**	**1,296,371**	**100%**
	33%	**46%**	**9%**	**6%**	**1%**	**3%**	**2%**	**100%**	

Source: Morgan et al. (2002)

Another source of data on the potential land use changes was the study of the impacts the Opuha Dam had on the surrounding economy and community showed the differences in land-use, between comparable irrigated and dryland farms within the command area of the Opuha scheme. Seen in Table 2.2, only farms with irrigation had land used for dairying, showing a changing land use away from sheep and to a lesser extent beef towards dairy in the case of livestock farms. Farms with irrigation also showed higher stocking rates. As for cropping, the total percentage of effective area devoted to cropping was 10 per cent higher on farms with irrigation. While a smaller percentage of this effective area was used for cereal grain, small seed and other crops, more was used on feed crops and process vegetables relatively. The table shows smaller proportions of cropping area for both cereal grain and other crops in irrigated farms, however interestingly due to the larger effective area used for cropping, the total average hectares for cereal grain and other crops is higher than in the dryland sample.

In this study the farms surveyed as 'irrigated' had a total of 5,129 Ha irrigated out of a total 10,410 Ha effective area, leaving slightly under half of the total effective land un-irrigated. Thus whilst Table 2.2 shows considerable changes in land-use, there would be expected a larger shift towards dairy, vegetables and crops, and away from sheep and beef as seen, if the total effective area was irrigated. The relatively low proportion of potential land actually irrigated may reflect the fact the study was completed only a short time after the scheme was finished.

Table 2.2: Land use on sampled farms

	Dryland	Irrigated
Proportion of Pastoral Stock units %		
Sheep	75%	44%
Beef	18%	12%
Dairy	0%	35%
Deer	8%	9%
Stocking Rate on Effective Area (su / ha)	9.0	9.9
Stocking Rate on Livestock Area (su / ha)	11.4	13.7
Proportion of Cropping Area		
Feed crops grown for sale	2%	9%
Cereal grain area	53%	38%
Process Vegetable area	3%	23%
Small seed area	28%	23%
Other crop area	15%	7%
Crop as a % Effective Area	15%	25%
Horticulture, Viticulture and Other		15%

Source: Harris et al. (2006)

4. The impact of this on the wider community

The benefits of irrigation are of course not just on farm but encompass the wider community. Again there have been a number of studies which have estimated this. The CWMS estimated that irrigated land in Canterbury is estimated to contribute $800 million net at farm gate to the national GDP and 1.1. billion of exports in 2007/08 (CWMS, 2009).

In a study looking into the impacts of the Opuha Dam on the provincial economy and community, the total revenue was found to be 2.4 times as high (at $2,073/ha) for irrigated farms than dry land farms (at $862/ha) (Aoraki Development Trust, 2006). Additionally, irrigated farms were found to generate 2.0 times as many jobs, 2.3 times as much value added and three times as much household income per hectare compared to dryland farms (Aoraki Development Trust, 2006). At a community level, it was found that for every thousand hectares of irrigation there was $7.7 million in output, 30 FTE in employment, $2.5 million in value added and $1.2 million in household income (Aoraki Development Trust, 2006).

These studies generally use input output tables to estimate these wider benefits. This approach will also be taken by this study using the input output tables in the Canterbury Economic Development Model as outlined in next section.

2.2 Irrigation Valuation Model

For the purposes of this project a model was developed in order to estimate the potential direct, indirect, induced and total monetary and employment effects a change in land-use associated with a further irrigation of Canterbury would yield. The model projects these impacts out to 2031, with the use of projected prices from the Lincoln Trade and Environment Model (LTEM), based on current commodity prices informed from MAF Farm monitoring reports among other sources as identified where used. The model is also calibrated to allow various levels of irrigation and different proportions of types of land-use to be specified, allowing various farmer uptakes and land-use scenarios to be modelled.

The area of irrigable land is a variable in the model which can be adjusted to various scenarios. For this project the figure obtained through cross referencing the LRIS and NZLRI GIS land maps, was 1,107,773 hectares. As this area is further divided to express the suitability of land for arable and pastoral use, a constraint was added to the model to restrict the total areas within the total irrigable land that could be used for arable.

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2.3 Value of different land uses

There is a large range of agricultural land-uses that would benefit under irrigation, so rather than to exhaustively explore all possible options for irrigated land, four farm types were chosen, based on the practically of implementation in Canterbury and the availability of data. These farm types are dairy, sheep and beef, arable (grain) and high value arable (representing high value arable and horticulture). In the model, the potential irrigable land in Canterbury is assigned across these farm types depending on the scenario. It is also assumed that potentially irrigable land is converted from dryland sheep and beef farming.

The value for each potential land-use under irrigation was determined by multiplying average production figures with average commodity prices. Production figures were sourced from the Canterbury model farm in MAF's Farm Monitoring Reports in the case of dairy, sheep and beef farming. As the required production data for arable crops is not available from the Farm Monitoring report, arable production is taken instead from average national yields sourced from the OECD agricultural stat database.

Current price data was obtained similarly from MAF's Farm Monitoring Reports for all pastoral commodities, and from the OECD for arable statistics. Prices for dairy, for example, were taken from the Canterbury model farm in MAF's Dairy monitoring reports to most accurately describe Canterbury dairy. The price of 718 (c per milksolid) in 2010 was used, giving an average return per hectare of Dairy of 8550 in the same year.

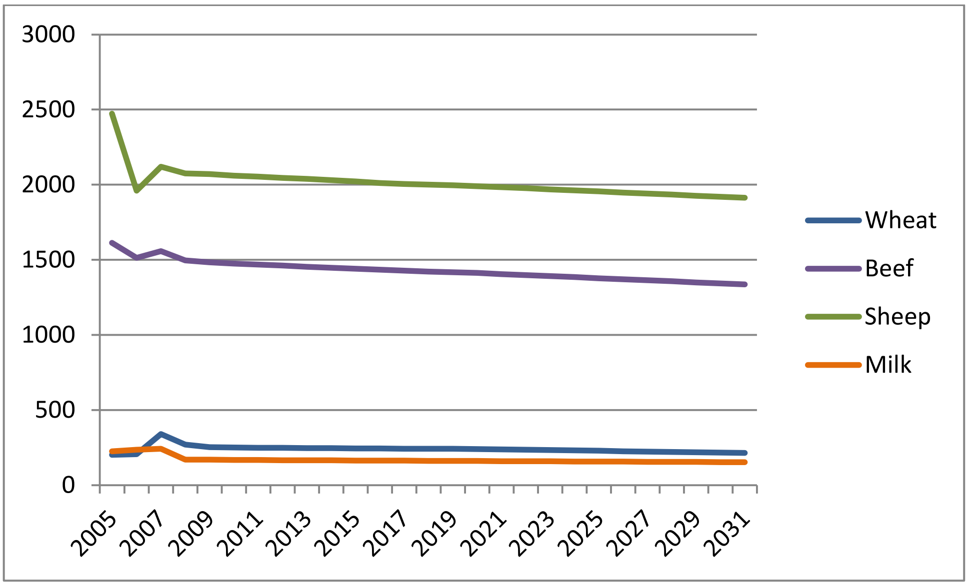
Table 2.4 shows the valuation of each land use as given by the model for the base year 2010.

Table 2.3: Revenue per hectare of land use

Dryland Land Use	**Revenue (NZD/ha)**	**Value Added (NZD/ha)**	**Source(s)**
Sheep & Beef	634	290	Price adjusted MAF estimates
Irrigated Land Use			
Dairy	8550	4157	MAF Dairy Monitoring report
Sheep & Beef	1527	889	Price adjusted MAF estimates
Arable	3029	1499	OECD Ag. Outlook & MAF arable monitoring reports
High Value Arable	8000	3451	…

Price projections for all commodities were modelled in the LTEM up to the year 2020. The LTEM is a partial equilibrium trade model focusing on the agricultural sector. The framework of the LTEM has 20 agricultural commodities and 21 countries, giving a comprehensive map of global agricultural trade. The LTEM simulates global trade, consumption and production of agricultural commodities out to the year 2020. As part of this simulation the LTEM derives national commodity prices for all modelled goods. These projected commodity prices from the LTEM were used in this project to provide an informed future value for farmed commodities in New Zealand. Figure 2.1 illustrates these price projections from the LTEM for a few relevant commodities.

Figure 2.1: LTEM projections of New Zealand producer prices (NZD/t)

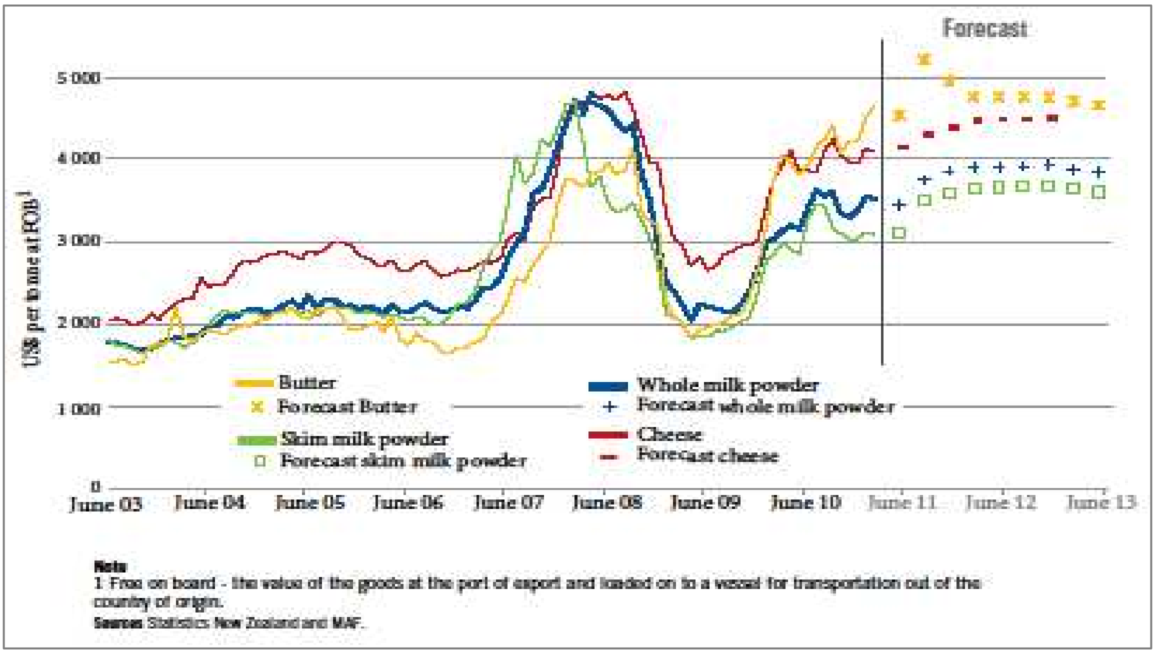


As the LTEM only projects prices to the year 2020, further external projections to the year 2031 were made, based on the trends shown from the LTEM. These secondary projections from 2021 to 2031 were made by mapping the trend in prices from the base year (2008) to the final projected year (2020) from the LTEM, and extrapolating the prices to 2031 based on the observed trend. The final year of 2031 was selected to coincide with models based on census data.

While the price projections informing the model are taken from the LTEM, the yield and production data in the irrigation valuation model are static from the base year (2010). The prices in the model follow modelled trends, however, the potential changes in levels of production from land do not. Thus the model does not account for any changes in stocking rates, yields or increased production from changing technology, farm methods or systems which may occur within the timeframe of the model.

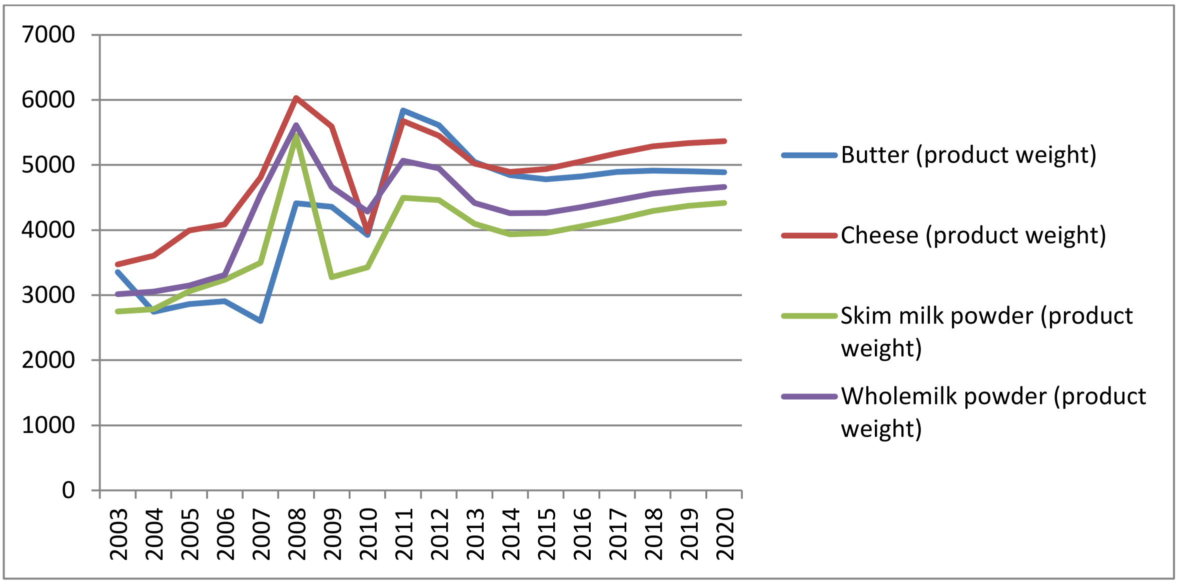
The below three Figures: 2.2-4, show price projections for NZ dairy products from three different sources: MAF's SONZAF report, the OECD-FAO Agricultural outlook (OECD/FAO 2010) and the LTEM respectively. All figures show the spike in dairy prices from 2008. The secondary spike in price beginning in 2010 shown in the MAF and the OECD's data is not seen in the LTEMs projection due to its earlier base year of 2008, where the MAF and OECD projections are simulated from 2010. In the long term however, all models forecast dairy prices dropping from this 2010 high. The MAF forecast is relatively short term only projecting to 2013; while the OECD shows a slight recovery for dairy prices in the long-term after a sharp decline from 2012 to 2014. The LTEMs projections show a downward trend of NZ dairy prices, matching the long term projections from MAF and the OECD, even with the earlier base year as described previously.

Figure 2.2: Dairy export prices and MAF price forecast in US dollar terms



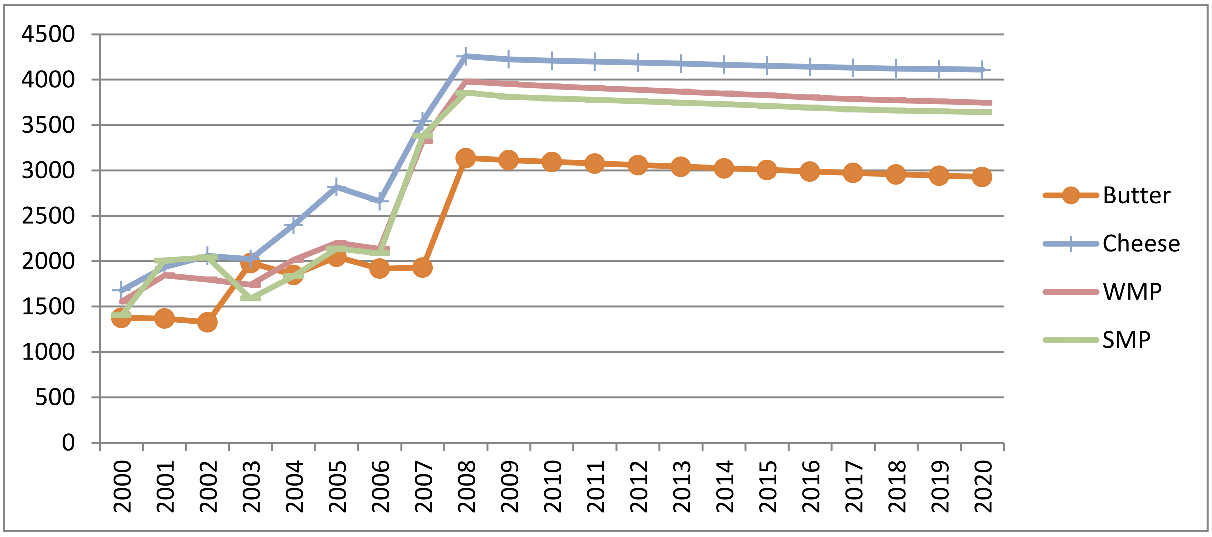
Source: MAF (2011)

Figure 2.3: OECD projection of NZ dairy prices (NZD/t) to 2020



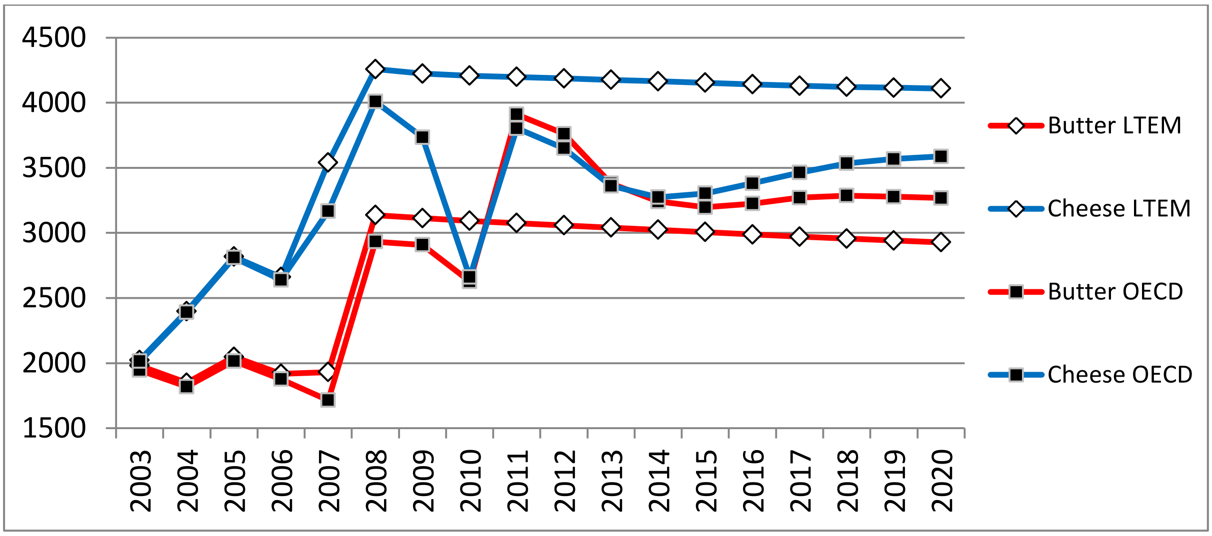
Source: OECD-FAO (2010)

Figure 2.4: LTEM projection of NZ Dairy prices (USD/t) to 2020



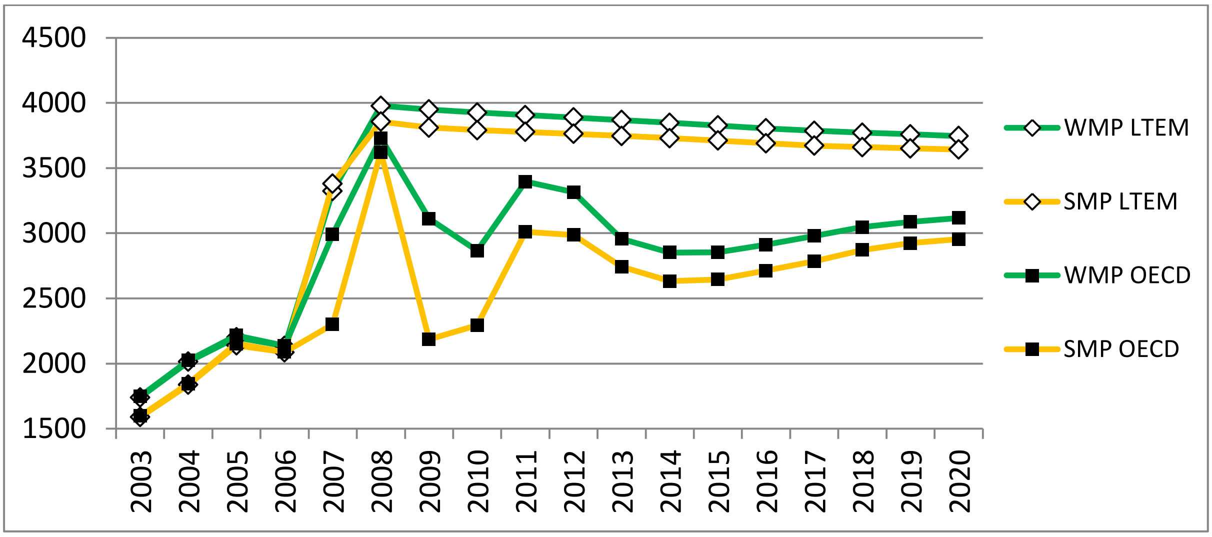
To further compare the different models, Figures 2.5 and 2.6 show projections from the LTEM and the OECD alongside each other. While the LTEM shows a simplified trend in comparison to the OECDs Agricultural Outlook the long term trends are comparable, the LTEM's projections for dairy in 2020 being no more than 20 per cent different from the OECDs. For Dairy, with the exception of butter, the LTEM's prices are higher than the OECDs, due to the high dairy price in the LTEMs base year: 2008. The LTEM's valuations for dairy can then be seen as optimistic in comparison to the OECD's projections. The advantage of linking to the LTEM is the ability to model future changes.

Figure 2.5: Butter and cheese price comparison (USD/t)



Source: MAF (2011)

Figure 2.6: Whole and skimmed milk powder price comparison (USD/t)



Source: MAF (2011)

2.4 Canterbury Economic Development Model

The model uses the methods previously discussed to project the value of land under various land-use changes in Canterbury. It gives these figures for both revenue and employment. These are further divided into three categories, direct, indirect and induced, detailing the upstream effects a change in land-use would produce.

The upstream effects illustrate the effects of one sector on another by measuring the interdependences between a sector and the remaining economy. To measure these effects, the model uses value–added and employment multipliers supplied by the CEDM. The Input/Output table shows the input and output flows for a given sector and the remaining sectors in the economy. Thus, a given sector may require inputs from several other sectors. Therefore, in measuring a change in one sector, the interrelatedness between the sectors' dictates that a proportional change must occur in the related sectors. Through this concept, multipliers provide the relative effect of one sector on another. The multipliers incorporate the direct, indirect and induced inputs on the Canterbury economy. These inputs relate to total returns, value-added and employment.

The upstream effects are divided into three categories: direct, indirect and induced. Each of these categories is described below.

The direct effects describe the total change in output and employment, experienced by the farms due to the addition of irrigation and the change of land-use. In the case of revenue this is calculated as the total annual value of produce on the land under the new irrigated land-use, with the annual value of the baseline sheep and beef pastoral farming subtracted to show the increased value gained with irrigation rather than the total value of farms under irrigation. The change in employment shows the increased farm related employment associated with the increased revenue.

Indirect effects show the revenue and employment benefits experienced by secondary firms and sectors which supply the primary farms implementing irrigation. The increased revenue produced by the direct effects, creates a larger demand for secondary sources which facilitate and supply the farms, sources such as transport, farm management consultancy and the like. It is the changes in revenue and employment in the suppliers of these input goods and services that are quantified in the indirect effects.

Lastly, induced effects are the wider impacts on revenue and employment in the local area, created with the increase in household income and expenditure from the direct and indirect effects. These encapsulate changes in spending resulting from the direct and indirect effects, for example with increased revenue on farm, a farmer will then spend more at his local store perhaps. The changes in direct and indirect effects flow on to affect the wider community due to changed spending.

Thus the model produces the total direct, indirect and induced changes in revenue and employment as a result of irrigation and land-use changes. The analysis does exclude downstream benefits such as an increase in processing. These could be estimated on an ad hoc basis but there is no consistent methodology to assess their total amount.

2.5 Scenarios

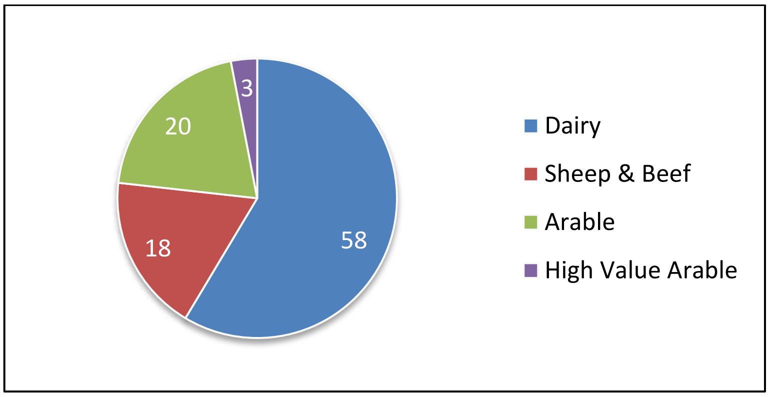
Three scenarios were specifically modelled for this report. The first assumed the total potentially irrigable area of 1,107,773 ha irrigated, demonstrating the maximum potential impacts of irrigation in Canterbury, based on the estimate of 500,000 ha of currently irrigated land in Canterbury, this first scenario then models an additional 607,773 ha of irrigation. The second scenario gives a more conservative estimate, of a 60 per cent uptake (364,664 ha additional) giving a total of 864,664 ha irrigated. The third and last scenario is based on a Canterbury Water Management Strategy projection of an additional 250,000 ha of potential irrigation in Canterbury (Canterbury Water 2012), this scenario then gives 750,000 total hectares irrigated in Canterbury. Each scenario is presented below in Table 2.5.

Table 2.4: Land irrigated by scenario

Scenario	Additional irrigation (ha)	Total irrigation (ha)	Description
Base level	N/A	500,000	Current Irrigation
Scenario 1	607,773	1,107,773	100% of potential additional irrigation
Scenario 2	364,664	864,664	60% of potential additional irrigation
Scenario 3	250,000	750,000	CWMS projected potential irrigation

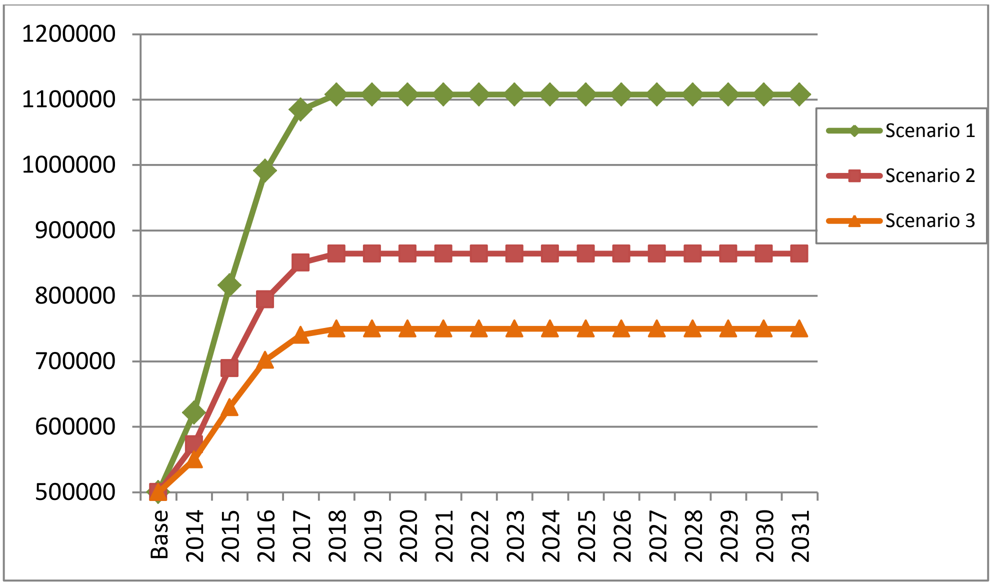
For all scenarios it was assumed that land use changes would primarily turn to dairy and dairy support as evidenced in the Ophua dam study and the CWMS's assumed land-use for Canterbury, with some pastoral non-dairy remaining. We have thus split the irrigated area into 58 per cent dairy, 18 per cent irrigated sheep and beef, 20 per cent arable and 3 per cent high-value arable.

Figure 2.7: Assumed percentage distribution of land use of additional irrigated land in Canterbury



The implementation and uptake of new irrigation schemes can vary greatly depending on the circumstances of new irrigation schemes. As this study deals with the total irrigable land in Canterbury, rather than relating to any particular proposed irrigation scheme a five year uptake rate was assumed. Irrigation is implemented then gradually over this five year period as shown in Figure 2.8.

Figure 2.8: Total modelled irrigation (ha) by year and Scenario



2.6 Results by revenue and employment

The results showing the effects on revenue are presented in Tables 2.6 and 2.7. As expected, with the majority of additional irrigated lands assigned to dairy support and production, dairying provides the highest economic value through direct and indirect induced effects across all scenarios. The total effects from dairy for the 100 per cent scenario are $4,178 million, for the 60 per cent scenario $2,507 million and $1,718 million for the CWMS 250,000 hectare scenario. The next most valuable land use is arable (assumed to account for 20 per cent of newly irrigated land) with total effects reaching $456 million in the 100 per cent irrigated scenario, $274 million for the 60 per cent scenario, and $188 million in the CWMS scenario.

Table 2.5: Revenue effects for Canterbury by land use and scenario in 2031(NZD million)

	Direct effects			Indirect & induced Effects		
	Scen. 1	Scen. 2	Scen. 3	Scen. 1	Scen. 2	Scen. 3
Dairy	2519.52	1511.71	1036.37	1658.17	994.90	682.07
Sheep & Beef	88.20	52.92	36.28	66.44	39.86	27.33
High Value Arable	151.49	90.90	62.31	130.02	78.01	53.48
Arable	241.32	144.79	99.26	214.91	128.94	88.40
Total	3000.54	1800.32	1234.23	2069.53	1241.72	851.28

Table 2.6: Total Revenue effects for Canterbury by land use and scenario in 2031 (NZD million)

	Total Effects		
	Scenario 1	Scenario 2	Scenario 3
Dairy	4177.69	2506.61	1718.44
Sheep & Beef	154.64	92.78	63.61
High Value Arable	281.51	168.91	115.80
Arable	456.23	273.74	187.66
Total	5070.07	3042.04	2085.51

Interestingly, the value of direct effects and the indirect induced effects are very similar across all industries and both scenarios. In all scenarios the direct effects account for 60 per cent of the value for dairy, 57 per cent for sheep & beef, 53 per cent for high value arable and 52 per cent for arable.

Overall, the total direct, indirect and induced effects on revenue from all land changes for scenario 1 are $5,070 million, $3,042 million for the second scenario, and $2,086 million for the third scenario.

Table 2.7: Employment effects for Canterbury by land use and scenario in 2031 (FTEs)

	Direct effects			Indirect & induced Effects		
	Scen. 1	Scen. 2	Scen. 3	Scen. 1	Scen. 2	Scen. 3
Dairy	6899	4139	2838	8298	4979	3413
Sheep & Beef	239	144	98	329	198	135
High Value Arable	1273	764	524	686	411	282
Arable	349	210	144	1032	619	425
Total	8761	5256	3604	10345	6207	4255

Table 2.8: Total employment effects for Canterbury by land use and scenario in 2031 (FTEs)

	Total Effects		
	Scenario 1	Scenario 2	Scenario 3
Dairy	15197	9118	6251
Sheep & Beef	569	341	234
High Value Arable	1959	1175	806
Arable	1382	829	568
Total	19106	11464	7859

In respect to employment, as shown in Tables 2.8 and 2.9, given modelled assumptions the dairy industry is again the largest provider of full time equivalent jobs with 6,899 direct full-time equivalent employments, and 8,298 indirect and induced for the 100 per cent irrigation scenario, 4,139 direct FTEs and 4,979 indirect and induced FTEs for the 60 per cent scenario, and 2,838 direct FTEs and 3,413 indirect and induced FTEs in the CWMS scenario. The next most valuable industry in regards to employment is high value arable going by the total effects, but looking at the direct effects and indirect and induced effects separately, a different story is shown. High value arable provides the second highest, 'direct' FTEs for both scenarios but the arable industry provides the second highest 'indirect' number of jobs across both scenarios. High value arable total effects are 1,959 FTEs for the 100 per cent scenario, 1,175 for the 60 per cent scenario, and 806 in the CWMS scenario. Arable total effects are 1,382 FTEs for the 100 per cent scenario, 829 for the 60 per cent scenario, and finally 568 for the CWMS scenario.

In contrast to revenue, the portion of jobs provided directly and indirectly across the industries for both scenarios is mixed. Notably, for employment coming from the arable industry in the 100 per cent scenario, only 25 per cent is direct effects. High value arable is at the other end of the scale with 65 per cent provided from direct effects.

Given the assumed land uses, the modelling shows that sheep and beef provide the lowest direct and indirect and induced effects across both revenue and employment in both scenarios.

The 100 per cent scenario produces total revenue effects across all land use changes in 2031 of $5 billion, almost 16,000 FTE jobs with full irrigation, while the more practical 60 per cent irrigation scenario has a more modest $3 billion total revenue impact and creates over 9,500 FTE jobs. The final CWMS 250,000 hectare scenario offers total revenue effects of over $2 billion and over 6,500 FTE jobs.

The comparisons in Figures 2.9 and 2.10 show the relative revenue and employment effects within each land use between each scenario. These figures illustrate the differences in magnitude between the scenarios, and the predominance of the effects from dairy in comparison to other land uses.

Figure 2.9: Comparison of total revenue effects for Canterbury by land use and scenario in 2031

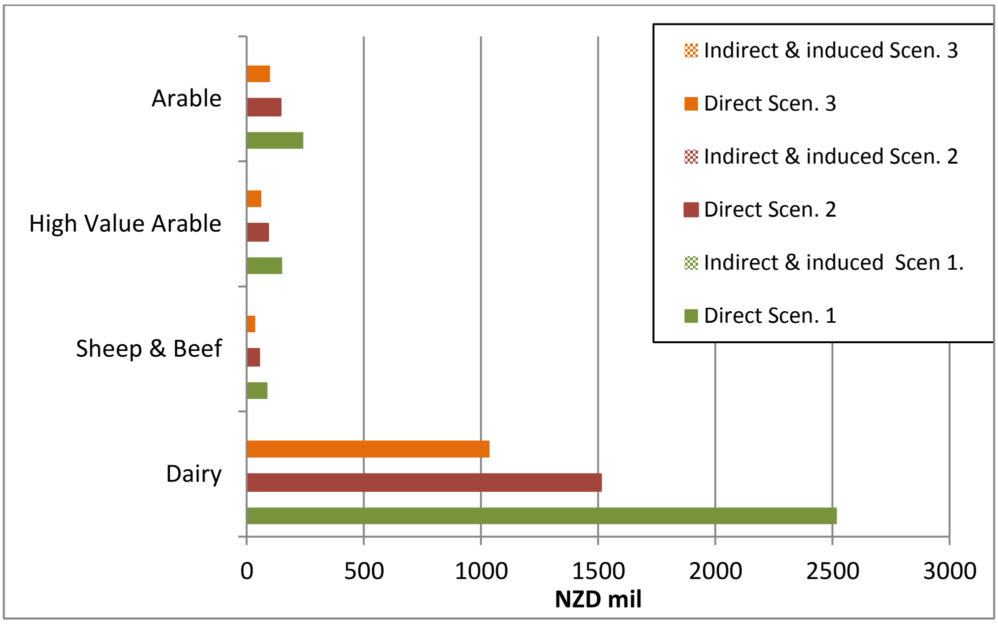
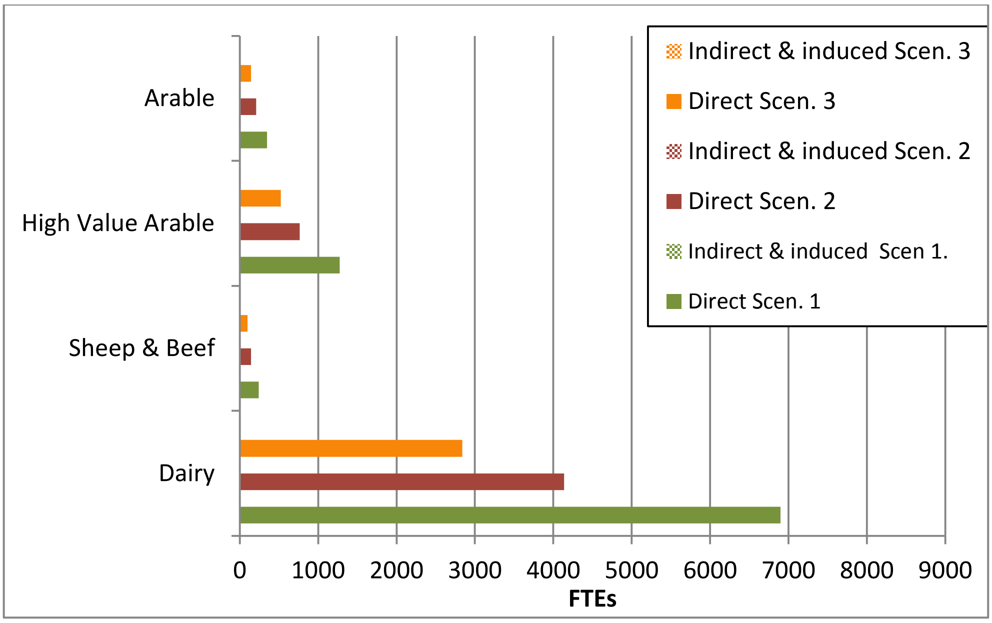


Figure 2.10: Comparison of employment effects for Canterbury by land use and scenario in 2031



Figures 2.11 and 2.12 show the additional revenue and employment each scenario generates on top of the revenue given by the current irrigated land in Canterbury.

Figure 2.11: Total additional revenue for Canterbury from each scenario

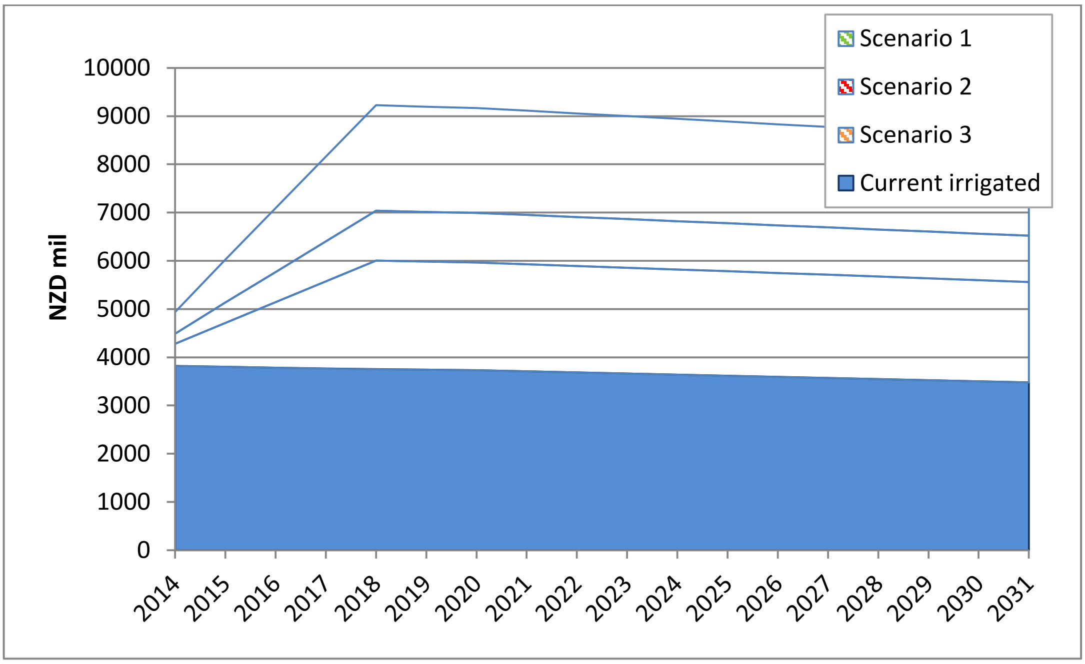
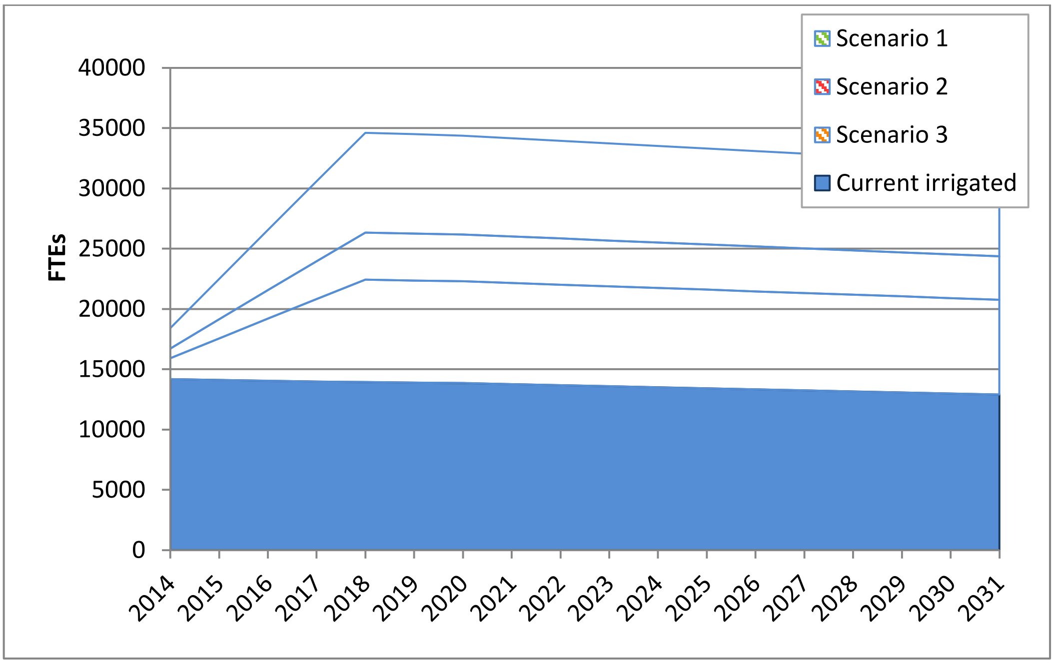


Figure 2.12: Total additional employment for Canterbury from each scenario



2.7 Effects on NZ

Tables 2.10 through 2.13 present the effects of the various scenarios on New Zealand as a whole. The results show trends similar to the impacts on Canterbury. The total effects for the 100 per cent irrigation scenario are $7,335 million for New Zealand and over 20,000 FTEs. The 60 per cent irrigation scenario has lesser effects with an increase of $4,401 million and about 12,000 FTEs. Lastly the CWMS scenario yields effects for New Zealand of a total increase in revenue of $3,017 million and over 8,000 FTEs. Of these effects dairy provides the largest benefit, accounting for about 80 per cent of the total additional revenue and additional employment.

Table 2.9: Revenue effects for New Zealand by land use and scenario in 2031 (NZD million)

	Direct effects			Indirect & induced Effects		
	Scen. 1	Scen. 2	Scen. 3	Scen. 1	Scen. 2	Scen. 3
Dairy	2519.52	1511.71	1036.37	3571.45	2142.87	1469.07
Sheep & Beef	88.20	52.92	36.28	125.03	75.02	51.43
High Value Arable	151.49	90.90	62.31	226.72	136.03	93.26
Arable	241.32	144.79	99.26	411.39	246.83	169.22
Total	3000.54	1800.32	1234.23	4334.59	2600.75	1782.98

Table 2.10: Total revenue effects for New Zealand by land use and scenario in 2031 (NZD million)

	Total Effects		
	Scenario 1	Scenario 2	Scenario 3
Dairy	6090.97	3654.58	2505.45
Sheep & Beef	213.23	127.94	87.71
High Value Arable	378.22	226.93	155.57
Arable	652.71	391.63	268.48
Total	7335.12	4401.07	3017.21

Table 2.11: Employment effects for New Zealand by land use and scenario in 2031 (FTEs)

	Direct effects			Indirect & induced Effects		
	Scen. 1	Scen. 2	Scen. 3	Scen. 1	Scen. 2	Scen. 3
Dairy	6899	4139	2838	9381	5629	3859
Sheep & Beef	239	144	98	450	270	185
High Value Arable	1273	764	524	1251	751	515
Arable	349	210	144	563	338	232
Total	8761	5256	3604	11645	6987	4790

Table 2.12: Total employment effects for New Zealand by land use and scenario in 2031 (FTEs)

	Total Effects		
	Scenario 1	Scenario 2	Scenario 3
Dairy	16280	9768	6697
Sheep & Beef	689	414	284
High Value Arable	2524	1514	1038
Arable	913	548	375
Total	20406	12244	8394

Figures 2.15 and 2.16 illustrate the comparative effects of Scenarios 1 and 2 on New Zealand. As can be seen, with the assumed land uses entered into the model, dairy has the largest effect for New Zealand. Interestingly, arable and high value arable have larger indirect and induced effects than direct effects on employment.

Figure 2.13: Comparison of total revenue for New Zealand by land use and scenario in 2031

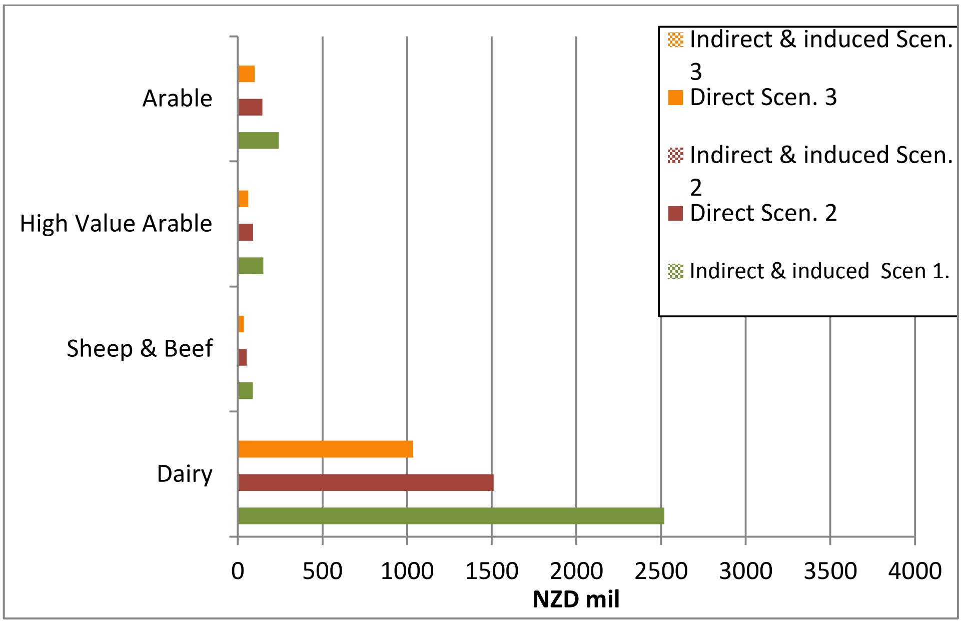
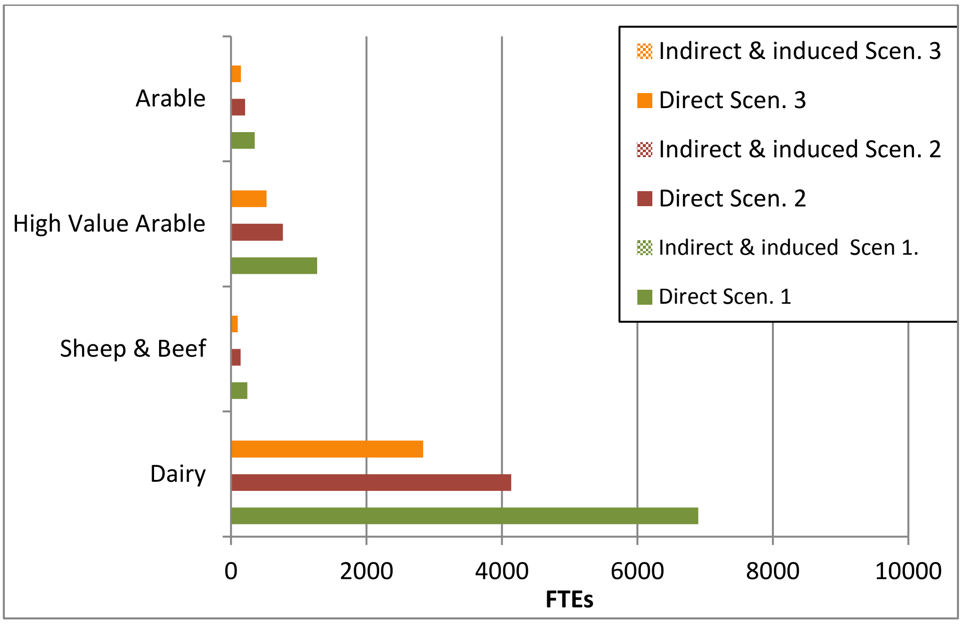


Figure 2.14: Comparison of employment effects on New Zealand by land use and scenario in 2031



Results by value add

The benefits from irrigation were also calculated to assess their value added. Value added is the difference between the total value of production and the cost of production. This was calculated using the sources identified earlier in particular the MAF Farm Monitoring Reports and the MAF (2004) study. The CEDM was then used to determine the upstream impacts. These results are presented below.

As shown in Tables 2.14 and 2.15, dairy has the largest value added of all land uses, accounting for almost 85 per cent of total effects in both scenarios. The total value added is $2.7 billion under the 100 per cent irrigated scenario and about $1.6 billion with only 60 per cent irrigation. The CWMS scenario gives over $1.1 billion in value added.

Table 2.13: Value added for Canterbury by land use and scenario in 2031 (million NZD)

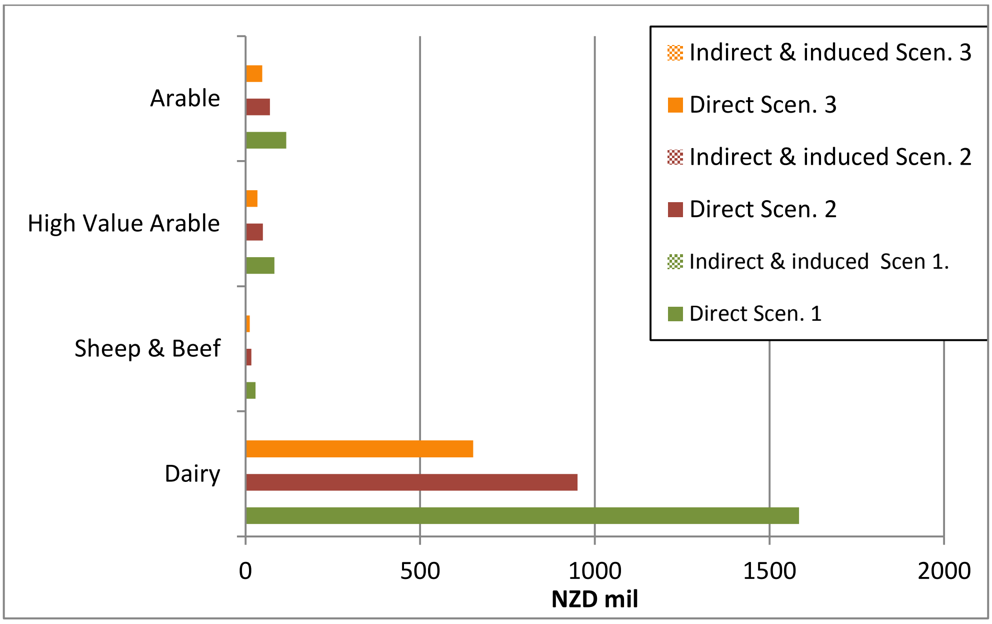
	Direct effects			Indirect & induced Effects		
	Scen. 1	Scen. 2	Scen. 3	Scen. 1	Scen. 2	Scen. 3
Dairy	1584.79	950.87	651.88	715.95	429.57	294.50
Sheep & Beef	28.51	17.10	11.73	28.61	17.16	11.77
High Value Arable	83.13	49.88	34.19	57.10	34.26	23.49
Arable	117.11	70.26	48.17	95.48	57.29	39.27
Total	1813.54	1088.12	745.98	897.14	538.29	369.03

Table 2.14: Total value added for Canterbury by land use and scenario in 2031 (NZD million)

	Total Effects		
	Scenario 1	Scenario 2	Scenario 3
Dairy	2300.74	1380.44	946.38
Sheep & Beef	57.12	34.27	23.49
High Value Arable	140.24	84.14	57.68
Arable	212.59	127.55	87.45
Total	2710.68	1626.41	1115.00

Figure 2.17 illustrates the added value across the scenarios, with dairy having the largest impacts, both direct, indirect and induced, by a large margin. The greatest value added being direct for dairy in all scenarios

Figure 2.15: Comparison of total value added for Canterbury by land use and scenario in 2031

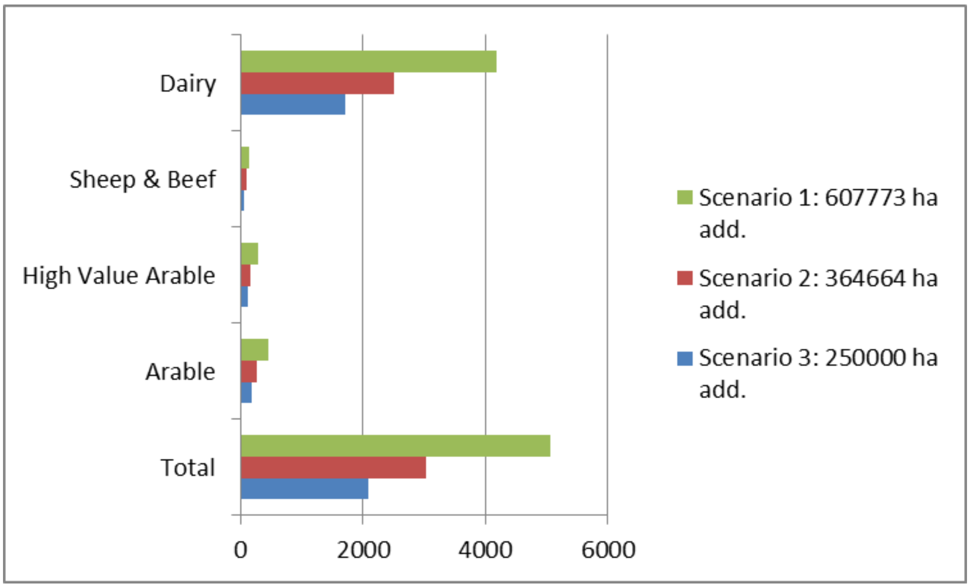


2.8 Conclusion

Total benefits of irrigation

This study estimates that the additional direct, indirect and induced effects across all land use changes for the 100 per cent irrigated land scenario in 2031 are $5 billion in revenue, adding over 19,000 FTE jobs and $2.7 billion in value added with full irrigation, while the more practical 60 per cent irrigation scenario gives a more modest $3 billion total revenue, over 11,000 FTE jobs and $1.6 billion in value added. The 250,000 scenario from the CWMS would give $2 billion, almost 8,000 FTEs and $1.1 billion in value added. These figures represent the additional value of irrigating all areas of Canterbury with land suitable to production under irrigation (in addition to the 500,000 hectares of total existing irrigated land in Canterbury in the CWMS)

Figure 2.16: Total additional output (million NZD by scenario) in 2031



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Appendix
Canterbury Agriculture

A.1 Agriculture in Canterbury and its contribution to the NZ economy.

This section outlines agriculture and land use statistics of the Canterbury Region. Where appropriate, it compares regional data with New Zealand data.

Comparisons of Canterbury's farming patterns and land use can be made using Agricultural Production Census (Statistics New Zealand 2002, 2007) and Agricultural Production Statistics data (Statistics New Zealand, 2009). A high proportion of the land of the Canterbury region is devoted to agricultural activities as shown in Table 1. Approximately 41 per cent of Canterbury is grassland and another 41 per cent is tussock, with arable 6 per cent. This highlights the importance of the pastoral sector to Canterbury, especially when compared to the rest of New Zealand.

Table 1: Land use in Canterbury and New Zealand, 2002 and 2007
(area in hectares at 30 June)

	2002		2007	
	Canterbury	**New Zealand**	**Canterbury**	**New Zealand**
Tussock and danthonia used for grazing (whether oversown or not)	1,372,793	3,322,224	1,324,288	2,900,463
Grassland	1,212,694	8,242,695	1,364,779	8,086,160
Grain, seed and fodder crop land, and land prepared for these crops	205,724	424,466	205,636	367,404
Horticultural land and land prepared for horticulture	12,267	109,397	16,770	132,892
Plantations of exotic trees intended for harvest	108,388	1,827,596	98,569	1,708,282
Mature native bush	58,200	483,465	65,251	448,247
Native scrub and regenerating native bush	103,444	789,735	98,674	625,981
Other land	77,381	390,306	109,789	431,467
Total Land	3,150,891	15,589,885	3,303,965	14,700,897

Source: Statistics New Zealand, 2007 Agricultural Production Census

The 2007 Agricultural Census shows land use in Canterbury divided by farm type. As Table 2 shows, the large majority of farmed land in Christchurch (97 per cent) is used for livestock. Of this, 83 per cent is used for sheep and/or beef farming, being the largest combined type of farming in Canterbury by area, sheep farms accounting for the largest share of land use. Dairy farming accounts for 7 per cent of total farming land-use in 2007, forestry only 1.45 per cent. Fruit, arable, viticulture and all other farm types combined used one per cent of the total land use in Canterbury.

Table 2: Farm type in Canterbury, 2007
(area in hectares at 30 June)

Farm Type	2007
Nursery Production	2325
Floriculture Production	317
Vegetable Growing	24820
Grape Growing	2682
Berry Fruit Growing	376
Apple and Pear Growing	460
Stone Fruit Growing	379
Olive Growing	468
Other Fruit and Tree Nut Growing	1182
Sheep Farming (Specialised)	1123583
Beef Cattle Farming (Specialised)	271878
Sheep-Beef Cattle Farming	1013601
Grain-Sheep and Grain-Beef Cattle Farming	83618
Other Grain & Crop Growing	114665
Dairy Cattle Farming	241244
Deer Farming	125688
Horse Farming	6390
Pig Farming	6146
Other Livestock Farming n.e.c.	2005
Forestry	44493
Total	3067309

Source: Statistics New Zealand, Agricultural Production Census 2007

There are a range of arable crops produced in the Canterbury region as shown in Table 3. Wheat and barley are the dominant crops in terms of tonnes harvested. This is consistent with the national scale of arable farming. Between 2002 and 2010 the maize grain and wheat and production increased by 25 per cent and 14 per cent, respectively. In contrast, the largest loss was identified for the barley production with a decrease of 25 per cent.

Table 3: Grain and seed crops in Canterbury and New Zealand[1] in 2002 and 2007 (year ended June)

Amount harvested		2002		2007	
		Canterbury	New Zealand	Canterbury	New Zealand
Wheat[2]	Tonnes	253,191	301,499	302,129	344,434
	Hectares	35,261	42,187	35,301	40,538
Barley	Tonnes	298,349	440,883	248,587	335,627
	Hectares	51,567	78,097	36,869	51,481
Oats	Tonnes	20,827	34,987	12,988	27,531
	Hectares	4,631	7,353	2,925	5,773
Other cereal grains	Tonnes	9,552	13,162	13,102	13,709
	Hectares	1,689	2,587	2,129	2,267
Maize grain	Tonnes	4,659	148,847	5,410	185,627
	Hectares	404	14,166	432	17,030
Field / seed peas	Tonnes	22,251	29,457	17,329	22,053
	Hectares	8,518	10,925	5,063	6,273
Other pulses	Tonnes	2,606	3,302	656	847
	Hectares	1,424	1,804	352	420

Notes:
(1) Figures may not add to the totals due to rounding.
(2) Wheat grain for bread and other users.
Year ended June

Source: Statistics New Zealand, Agricultural Production Census 2007 and 2002

In terms of the horticulture production the harvested area of outdoor vegetables and the areas planted of outdoor fruit in 2007 and 2009 for Canterbury and New Zealand are shown in Table 4. In 2009 the largest harvested area was used for growing potatoes in Canterbury. In 2009 an area of 4,340 hectares was used for the potatoes harvest. This indicates a small increase of 1.5 per cent from the year 2007, compared to a national increase of 13 per cent for the same period. With regards to the planted area for fruits between 2007 and 2009 there was a significant increase in the areas planted for cherries and blackcurrants growing by 123 and 31 per cent, respectively. This is significantly higher than the national growth of 15 and 10 per cent, respectively.

Table 4: Harvested area of outdoor vegetables and area planted of outdoor fruit in Canterbury and New Zealand, 2007 and 2009 (in ha)

		Canterbury			New Zealand		
		2007	**2009**	**% change**	**2007**	**2009**	**% change**
Harvested area	Onions	690	670	-2.1	4,590	4,510	-1.8
	Potatoes	4,270	4,340	1.5	10,050	11,400	13
	Peas	4,700	3,800	-19.3	6,790	5,990	-11.8
	Sweet Corn	940	440	-53	6,210	5,060	-18.5
Area planted	Apples	250	180	-27.7	9,250	9,280	0.4
	Wine Grapes	1,680	1,600	-5.0	29,620	33,420	13
	Blackcurrants	660	860	30.8	1,160	1,270	9.8
	Cherries	20	50	122.7	520	600	14.8

Notes. Estimates have been rounded to the nearest 10 hectares. Percentages are calculated on unrounded numbers.

Source: Statistics New Zealand, Agricultural Production Statistics June 2009 and June 2007.

Animal production is an important agricultural sector in Canterbury with sheep, dairy cattle and beef cattle being the main livestock for the region. Livestock numbers by type and region are presented in Table 5. In 2010 17 per cent of sheep in New Zealand are located in the Canterbury region, 16 per cent of dairy cattle and 12 per cent of beef cattle. There is a downward trend in numbers of total sheep. During the period of 2002 to 2010 the number of total sheep decreased by 27 per cent in the Canterbury region, compared to a drop of 18 per cent in New Zealand. In contrast, dairy cattle increased significantly during the same period. In 2002 there were 543,000 in Canterbury, rising by 395,000 animals to a total of 938,000 in 2010. This rise of 73 per cent was significantly higher than the national increase, which was 15 per cent (753,000 animals).

Table 5: Livestock Numbers, Canterbury and New Zealand, 2002 and 2010

Subsector	**No. of Livestock (000s) Canterbury**			**No. of Livestock (000s) New Zealand**		
	2002	**2010**	**% change**	**2002**	**2010**	**% change**
Beef cattle	505	486	-3.8%	4,491	3,949	-12.1%
Dairy cattle	543	938	72.7%	5,162	5,915	14.6%
Sheep	7,758	5,652	-27.1%	39,571	32,563	-17.7%
Deer	411	320	-22.1%	1,647	1,123	-31.8%
Pigs	152	178	17.1%	342	335	-2.0%

Notes: Data are for years ended June.

Source: Statistics New Zealand: Agricultural Production Stats, June 2010 (final) and Agricultural Production Census, June 2002

In all numbers the dairy herd production of Canterbury is higher than the production in New Zealand as shown in Tables 6 and 7. In 2007/08 and 2009/10 the highest average per herd, average per hectare and average per cow production was recorded in Canterbury. In 2009/10 the cows in Canterbury produced the highest average kg milksolids (378kg), followed by Southland (376kg). The national average was 327kg in the same year. In 2009/10 in Canterbury an average amount of 275,833 kg milksolids was produced per herd this is 17 per cent more than in 2007/08. The national increase was only 11 per cent.

Table 6: Herd analysis of dairy cattle in Canterbury and New Zealand in 2007/08

		Canterbury	New Zealand
Total herd	2007/08	729	11,436
	2009/10	891	11,691
	% change	***22.2%***	***2.2%***
Total cows	2007/08	517,925	4,012,867
	2009/10	651,330	4,396,675
	% change	***25.8%***	***9.6%***
Total effective hectares	2007/08	158,272	1,436,549
	2009/10	194,862	1,563,495
	% change	***23.1%***	***8.8%***
Average herd size	2007/08	710.5	351
	2009/10	730	376
	% change	***2.7%***	***7.1%***
Average effective hectares	2007/08	219.5	126
	2009/10	218.5	134
	% change	***-0.5%***	***6.3%***
Average cows per hectares	2007/08	3.26	2.83
	2009/10	3.34	2.81
	% change	***2.5%***	***-0.7%***

Source: Livestock Improvement Corporation (LIC) NZ Dairy Statistics 2007/ 2008 and Livestock Improvement Corporation (LIC) NZ Dairy Statistics 2009/ 2010

Table 7: Herd production analysis of dairy cattle in Canterbury and New Zealand in 2007/08 and 2009/10

		Canterbury	New Zealand
Average litres per herd	2007/08	2,771,680	1,289,337
	2009/10	3,122,564	1,409,875
	% change	***12.7%***	***9.3%***
Average kg milk fat per herd	2007/08	132,785	63,158
	2009/10	154,598	69,859
	% change	***16.4%***	***10.6%***
Average kg protein per herd	2007/08	103,669	47,876
	2009/10	121,235	53,184
	% change	***16.9%***	***11.1%***
Average kg milk solids per herd	2007/08	236,454	111,033
	2009/10	275,833	123,043
	% change	***16.7%***	***10.8%***
Average kg milkfat per effective ha	2007/08	658	498
	2009/10	708	522
	% change	***7.6%***	***4.8%***
Average kg protein per effective ha	2007/08	513	375
	2009/10	555	398
	% change	***8.2%***	***6.1%***
Average kg milksolids per effective ha	2007/08	1,170	873
	2009/10	1,262	920
	% change	***7.9%***	***5.4%***
Average kg milkfat per cow	2007/08	210	175
	2009/10	212	186
	% change	***1.0%***	***6.3%***
Average kg protein per cow	2007/08	164	132
	2009/10	166	141
	% change	***1.2%***	***6.8%***
Average kg milksolids per cow	2007/08	373	307
	2009/10	378	327
	% change	***1.3%***	***6.5%***

Source: Livestock Improvement Corporation (LIC) NZ Dairy Statistics 2007/ 2008 and Livestock Improvement Corporation (LIC) NZ Dairy Statistics 2009/ 2010

The growth in the dairy industry in Canterbury is also reflected in the increasing in numbers of dairy farms in the region. As shown in Table 8 the number of farms in dairy cattle farming increased by 46 per cent, compared to a national decrease of 17 per cent. This is in contrast, to the regional decline of Sheep, Beef Cattle and Grain Farming farms. Over the past ten years the number declined by 13 per cent on a regional level and by 12 per cent nationwide.

Table 8: Number of farms in sheep, beef cattle and grain farming and dairy cattle farming in Canterbury and New Zealand, 2000 - 2010

Sector/ Area	Sheep, Beef Cattle and Grain Farming		Dairy Cattle Farming	
	New Zealand	Canterbury	New Zealand	Canterbury
2000	32,094	5,786	20,113	930
2001	31,848	5,770	20,193	991
2002	31,688	5,758	20,340	1,039
2003	31,041	5,663	19,713	1,053
2004	30,774	5,690	19,121	1,100
2005	30,760	5,638	18,896	1,129
2006	31,506	5,841	18,803	1,178
2007	31,618	5,881	18,059	1,167
2008	30,363	5,468	16,464	1,201
2009	28,627	5,096	16,693	1,271
2010	28,257	5,034	16,670	1,353
% change 2000 -2010	**-12.0%**	**-13.0%**	**-17.1%**	**45.5%**

Source: Statistics New Zealand (2011) Table Builder. Business Demographics