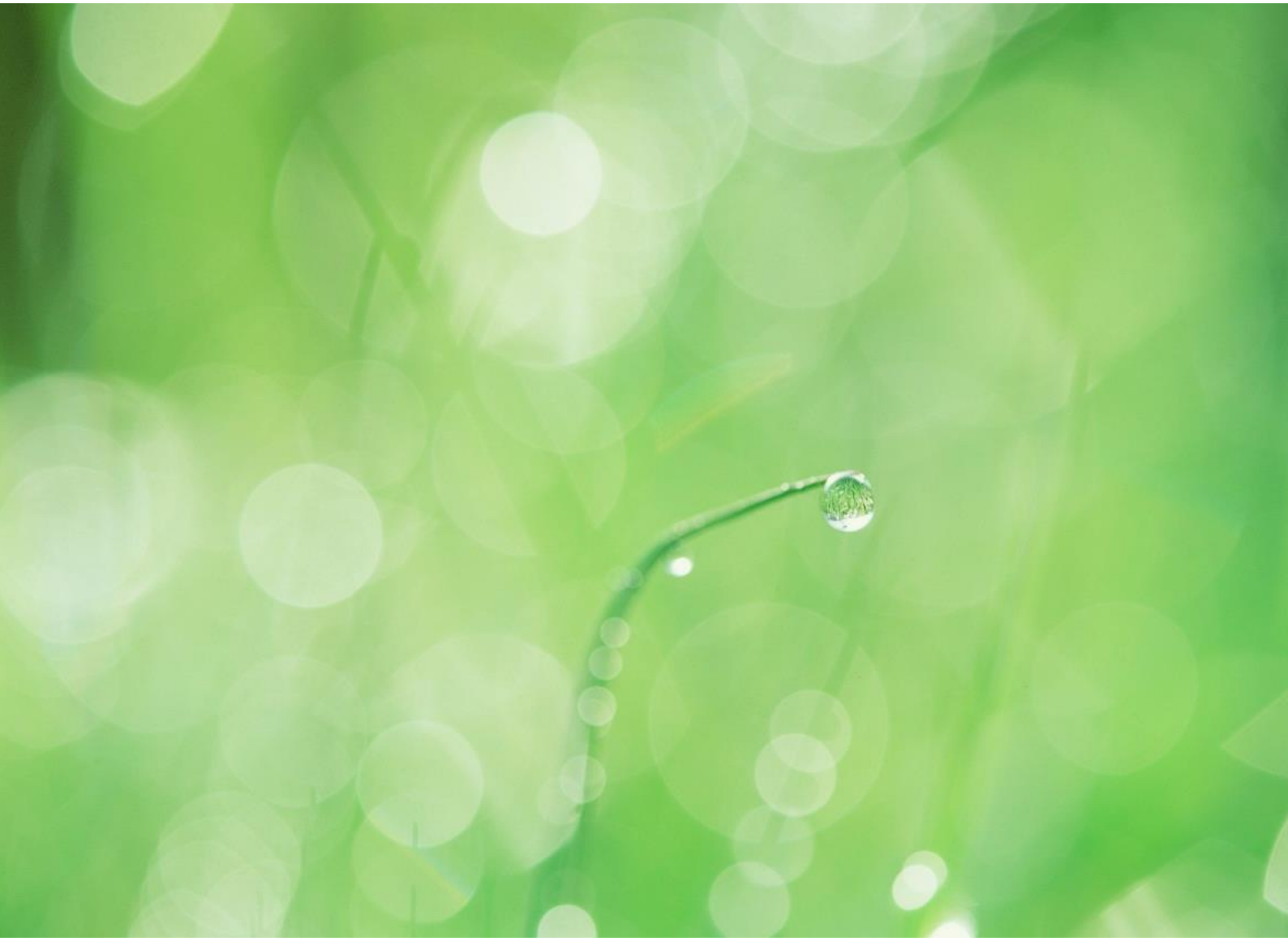

Value of irrigation in New Zealand

An economy-wide assessment

NZ Institute of Economic Research Inc and AgFirst Consultants NZ Ltd final report to the Ministry for Primary Industries

17 November 2014

About NZIER

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Authorship

This paper was jointly prepared at NZIER by Dr Erwin Corong and Mike Hensen, and by Phil Journeaux from AgFirst Consultants NZ Limited.

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The assistance of Alan Bristow and Bill Kaye-Blake is gratefully acknowledged.

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Key points

The Ministry for Primary Industries (MPI) has commissioned NZIER and AgFirst Consultants NZ Limited to quantify the economic contribution that irrigation makes to the New Zealand economy. In particular, MPI asked us to:

- update their 2004 economic value of irrigation report and
- use a computable general equilibrium (CGE) model to provide a reasonable approximation of the economic and flow-on impacts in the New Zealand economy as if irrigation had never occurred.

The 2004 report estimated the net farm gate GDP contribution of irrigation at $0.92 billion in 2002/03. Using the same methodology, we have estimated this net contribution at $2.17 billion in 2011/2012. This increased contribution resulted from improved farm gross margins and the expansion in irrigated land area (from 457,700 hectares to 721,400 hectares) during the last decade.

Note that our $2.17 billion estimates tend to undervalue irrigation due to the weather and prices in 2011/2012, and that the dairy pay out used was $6.59/kgMS.

Irrigation impacts the New Zealand economy through many channels

Irrigation contributes to New Zealand economic activity in a number of direct and indirect ways:

- it lifts agricultural production, which boost farm gate returns
- this additional production draws in additional inputs such as agricultural services and transport
- the extra on-farm volumes also lead to more activity in the primary processing sectors.

Irrigation is also felt more widely through higher employment, wages and returns to capital and land, all of which boost household spending on other goods and services.

We use a static CGE model to 'remove' irrigation from the economy

We have developed scenarios (central, plus high and low sensitivities that vary gross margins in Canterbury's irrigated industries) in consultation with MPI and then run them through NZIER's static CGE model to obtain a reasonable approximation of the New Zealand economy as if irrigation had never occurred.

CGE modelling captures the various inter-linkages between the primary and non-primary sectors, as well as their links to households (via the labour market), the government sector, capital markets and the global economy (via imports and exports). It is therefore useful for understanding structural differences such as an economy where irrigation had not developed at all.

In our static modelling framework, we simply compare the New Zealand economy with and without irrigation.

Some resources (casual labour, private sector capital and some land) would have been reallocated across the rest of the economy had irrigation never developed. This offsets, to a degree, the negative impacts on the agriculture sector (and its suppliers and downstream processors) of reducing its productive capacity.

However, some capital resources may not have been invested had irrigation never developed. Consultations with MPI suggest that in the absence of irrigation, private capital investments in agriculture would have been lower and could have gone to power generation or other industries.

In our modelling framework, we assume that this private investment goes elsewhere in search of a return. In a standard CGE approach, we let the model determine how capital stocks would move across industries based on rates of return. This assumption implies that private investors are profit-driven and would invest in the next best, profitable alternative if irrigation were not available.

Irrigation contributes to New Zealand GDP

In our central scenario, if irrigation had never occurred:[1]

- New Zealand's real GDP would be 2.4% lower (or $4.8 billion less)
- households would earn lower wages and receive lower returns to their capital investments (respectively, -2.1% and -1.8%)
- household consumption, which measures how 'well off' we are, would be 2.4% lower (or $2.7 billion less)
- total New Zealand exports would fall by $1 billion despite agricultural commodity exports falling by $5.7b. This is because the depreciation of the exchange rate (i.e., lower $NZ) and the reallocation of capital would result in increased productive capacity and export value of other export-intensive industries.

Our sensitivity analysis sees the GDP impacts range between $3.3 billion and $6.5 billion, depending on the magnitude of Canterbury farm gate irrigation gross margins, which are subject to some uncertainty.

These are large GDP impacts, but it is important to recognise that the modelling scenarios effectively destroy some capital and land that is unable to be reallocated to other parts of the agriculture sector: the productive capacity of the economy is permanently smaller. This contrasts with most other CGE modelling exercises where resources are reallocated (to less productive purposes), but none are destroyed.

In addition, the owners of irrigated farm land are 'sticky' – they do not simply sell up and move elsewhere had irrigation never developed. They see huge drops in income. This exacerbates the GDP impact (since returns to labour is one component of GDP).

The on-farm sector contributes $2.17 billion to GDP due to being irrigated

If irrigation had never occurred, some resources are effectively left idle and the remaining resources are put to their second-best, dry land alternative. The net effect remains negative – the on-farm sector sees its contribution to real GDP falling by $2.17 billion.

The impacts are larger for dairy and horticulture compared to sheep and beef, and other livestock farming.

[1] These changes are relative to 2011/12 GDP of $NZ199.1 trillion and aggregate household consumption of $NZ166.3 trillion. The average minimum wage during 2011/2012 was NZ$13.50 per hour. For estimates of rates of return to capital in New Zealand, see http://www.stats.govt.nz/~/media/Statistics/surveys-and-methods/methods/research-papers/working-papers/exogenous-vs-endogenous-10-03.pdf

Limitations of our study

Our updated estimates only provide a 'snapshot' of the overall value of irrigation for the production year 2011/2012. Our choice of 2011/12 season was driven by data availability. While using a five-year average would be preferable, this would have required more resources and involved more work on gross margin estimations due to financial data limitations outside of pastoral farming.

Moreover, we are not able to quantify the environmental or social impacts if irrigation had never occurred. We also do not attempt to investigate the relative merits of public versus private sector funding of the schemes.

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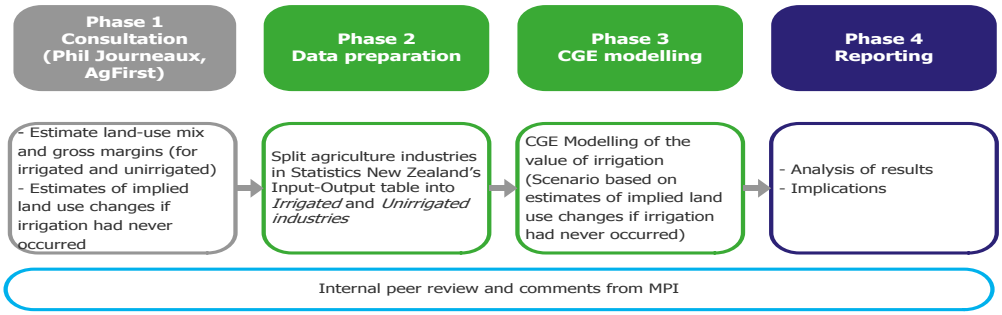
1. Introduction

The Ministry for Primary Industries (MPI) commissioned NZIER and AgFirst Consultants NZ Ltd (AgFirst) to quantify the economic contribution that irrigation makes to the New Zealand economy.

The research process consisted of a number of phases, as shown in Figure 1.

Figure 1 Research phases



Source: NZIER

The first phase, undertaken by AgFirst, involved estimating the land use mix and gross margins for both irrigated and non-irrigated farms. This was done by compiling farm budgets and land use data.

Another exercise was carried out to consider experts' views of the likely land use changes of the current irrigated land in each region, as if irrigation had never occurred. Workshops were then held in some key regions to road-test the original decisions around land use and gross margins used. The final estimates provided a 'snapshot' of the overall value of irrigation for the production year 2011/2012.

The second research phase involved updating Statistics New Zealand's 2007 Input-Output (I-O) table to 2011/2012 values using macroeconomic data, and then disaggregating irrigated and non-irrigated agriculture industries in the I-O table — to explicitly account for their economic contribution to the New Zealand economy.

The industry splits were made by using the estimated gross margins by farm type (Stage 1) and land data by irrigation type from Statistics New Zealand's 2012 Agricultural Production Statistics. The resulting database then reflects the initial structure of the economy, which by definition is assumed to be in equilibrium in all markets (i.e., all resources are fully employed).

The third and final stage involved using NZIER's static Computable General Equilibrium (CGE) model of the New Zealand economy — to quantify the economic contribution that irrigation makes to the New Zealand economy.

We do this by running a 'central scenario' that reflects experts' views (as compiled in Phase 1) of the likely land use and gross margins if irrigation had never occurred. The difference between the 2011/2012 and 'no irrigation' economy provides an estimate of the likely direct and flow-on contribution that irrigation makes to the New Zealand economy.

2. Objective and scope

Our focus is on estimating the likely economic contribution that irrigation makes to the New Zealand economy. In particular, MPI asked us to follow up on their 2004 economic value of irrigation[2] report by:

- summarising the best estimate of economic contribution of irrigation to the New Zealand economy, including flow-on impacts
- presenting economic impact in terms of GDP (value-added), exports, private and public consumption (welfare) and wages/employment
- tabulating the contribution of irrigation across the regions
- documenting the associated methodology and limitations
- conducting sensitivity analysis (e.g., high and low scenarios) that highlights how the overall results change with different input assumptions.

We tabulate the contribution of irrigation across the regions via farm budget estimations.

The remaining study objectives are addressed using NZIER's static CGE model to consider: *What would the New Zealand economy have looked like if irrigation had never occurred?*

2.1. Static CGE modelling caveats

Before and after only

Our static modelling approach does not explicitly capture the timing of changes in the economy. Instead, we analyse the impacts once the economy has moved from one equilibrium point to another — i.e., after the process of adjustment has taken place.

Public investment unchanged; private investment shifts

We do not have any empirical information on how public and private investments in the primary and processing industries would have evolved if irrigation had never occurred. Therefore, we needed to make some simplifying assumptions for our counterfactual scenario.

Consultations with MPI suggest that *public* infrastructure investments supplying water would still have been made; these investments were driven by the need for energy generation, for stock water, and for household purposes. Therefore, we do not reallocate this capital elsewhere in the economy for other public infrastructure (or broader public spending) purposes.

On the other hand, MPI suggests that in the absence of irrigation, private capital investment in agriculture would have been lower (e.g., less farm-level infrastructure and equipment and investments in processing). In our modelling framework, we assume that this private investment goes elsewhere in search of a return.[3] In a

[2] Ministry of Agriculture and Forestry (2004). The Economic Value of Irrigation to New Zealand. MAF Technical Paper No: 04/01 http://ecan.govt.nz/publications/Reports/cwms-tech-rpt-3b-Economic-value-of-Irrigation-Apr-04-final.pdf

[3] This means that we let the model determine how capital would be reallocated across the economy. It would be difficult to predict how capital investments intended for irrigation would have evolved had irrigation never occurred. It may be possible that it may have gone to investments on electricity generation or mining.

standard CGE approach, we let capital stocks move across industries based on rates of return. This assumption implies that private investors are profit-driven and would invest in the next best, profitable alternative if irrigation were not available.

Farm owners cannot move; casual labour can seek new jobs

As is standard in static CGE modelling exercises, the aggregate employment level is held constant in all scenarios. The labour market adjusts through changes in real wages.

Our model distinguishes between casual and self-employment in farming industries. We allow casual labour to move across industries after irrigation is removed and the demand for on-farm labour drops. But we assume that self-employed workers would have carried out similar activities in the absence of irrigation since they are typically family farm owners who would have developed their farms in other ways and accepted lower returns.

We are not able to consider the potential impacts of a 'no irrigation' scenario on international labour (roughly 10,000 seasonal agricultural workers per year). This is because there is no immigration component in our model: we cannot distinguish between domestic and foreign workers. However, these are relevant considerations in a broader analysis of the contribution of irrigation.

Wide range of net farm gate contributions requires sensitivity analysis

As will be explained in Section 3, the gross margins for irrigated and non-irrigated farms were estimated by compiling farm budgets across regions based on expert opinion. A similar exercise was carried out to consider the likely land use and gross margins of the current irrigated land in each region as if irrigation had never occurred.

Past estimates suggest that the net farm gate contribution (i.e., returns to land and capital, but excluding payments to labour) of irrigation in Canterbury is:

- $335 million (=$1,170 x 287,200 irrigated ha) in 2002 as per the economic value of irrigation report[4]
- $800 million (=$1,500 x 500,000 irrigated ha) in 2008 as per the Canterbury Water Management Strategy report[5]

Our estimates shown in Section 3 suggest a net farm gate contribution of $1. 4 billion ($3,134 x 444,777 irrigated ha) in 2012 for Canterbury. As explained in Section 3.2, 2011/12 season was a good year — both climatically and financially — for dairy and (particularly) sheep and beef farmers.

Given the inherent uncertainty in estimates of gross margins and since Canterbury accounts for 64 percent of the estimated value of irrigation, we also explore 'high' and 'low' scenarios in our CGE modelling. We do this via sensitivity analysis that changes margins in Canterbury by +/- 50 percent relative to our 'central' scenario.

Should any updated gross margins or land use change estimate become available in the future, there would be value in re-running our modelling.

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[4] Ministry of Agriculture and Forestry (2004). The Economic Value of Irrigation to New Zealand. MAF Technical Paper No: 04/01 http://ecan.govt.nz/publications/Reports/cwms-tech-rpt-3b-Economic-value-of-Irrigation-Apr-04-final.pdf

[5] Canterbury Water (2009). Canterbury Water Management Strategy. http://ecan.govt.nz/publications/Plans/cw-canterbury-water-wanagement-strategy-05-11-09.pdf

3. Farm gate value of irrigation

As shown in Figure 1, the first phase in the research process involved AgFirst estimating the land use mix and gross margins for different irrigated and non-irrigated farms.

This was achieved via a comparison of gross margins on a with and without basis — that is, we considered the land use of the currently irrigated land in each region as if irrigation had never occurred, and then compared the gross margin for the non-irrigated land use versus the gross margin for the irrigated land use.

It is important to note that the 'net farm gate value' of irrigation reported here is not the same as gross GDP contribution. The net farm gate value is the sum of returns to land and capital. GDP or value added is the sum of net farm gate value plus compensations paid to labour and indirect taxes net of subsidies.

3.1. Gross margin

A gross margin is the net cash income for the farming system, less the direct variable costs involved in generating that income. Examples of gross margins can be found in Appendix C.

The area under irrigation, by land use, was based on Statistics New Zealand's Agricultural Production Statistics 2012 (Appendix F). The financial data used to determine the gross margins were based on the Ministry for Primary Industries' Farm Monitoring data 2012.

While the irrigation statistics often gave a land use at a higher level of aggregation (e.g., outdoor vegetables), the Agricultural Production Statistics also provided more detailed information on areas grown in specific crops (e.g., in relation to outdoor vegetables; onions, potatoes, cabbages, carrots, etc.). We used this data to proportion the gross margins to give a weighted gross margin at the more aggregated level.

Additional gross margins for a number of horticultural crops were provided by Horticultural NZ, and the gross margins used for the Hawke's Bay were largely based on those derived by MacFarlane Rural Business for the Ruataniwha irrigation proposal (HBRC 2013).

Overall, the use of the Agricultural Production Statistics and the Farm Monitoring data means that the resultant figures are essentially a snap-shot of the value of irrigation as at 2012. For a range of the relatively minor crops, no gross margin was available; in this case a 'next best option' approach was used whereby the gross margin for a similar crop was used.

The determination of land use without irrigation was based on expert opinion. Discussions were held with a number of people within each region, mostly consultants, as to their opinion on land use in the absence of irrigation. The people we spoke to are listed in Appendix B. The key question posed was: "if irrigation had never occurred, what would the land use be on currently irrigated areas?"[6]

[6] This is different to "If irrigation stopped tomorrow, what would the land use evolve to be?" because it takes into account historic price movements and economic conditions, rather than projected ones.

Once the difference in land use was developed, the with/without irrigation gross margins were applied, with the resultant total for each region being the farm gate value of irrigation. The assumptions for each region are outlined in Appendix J.

Once the initial discussions and calculations were made for each region, workshops were held in some key regions to critique the original assumptions around land use and gross margins used.

These workshops were held in:

- Hamilton – for the Waikato
- Hastings – for Hawke's Bay
- Palmerston North – for Horizons
- Christchurch – for Canterbury
- Dunedin – for Otago.

Following these workshops the with/without land use and gross margin calculations were adjusted accordingly, and then double-checked again with the workshop participants.

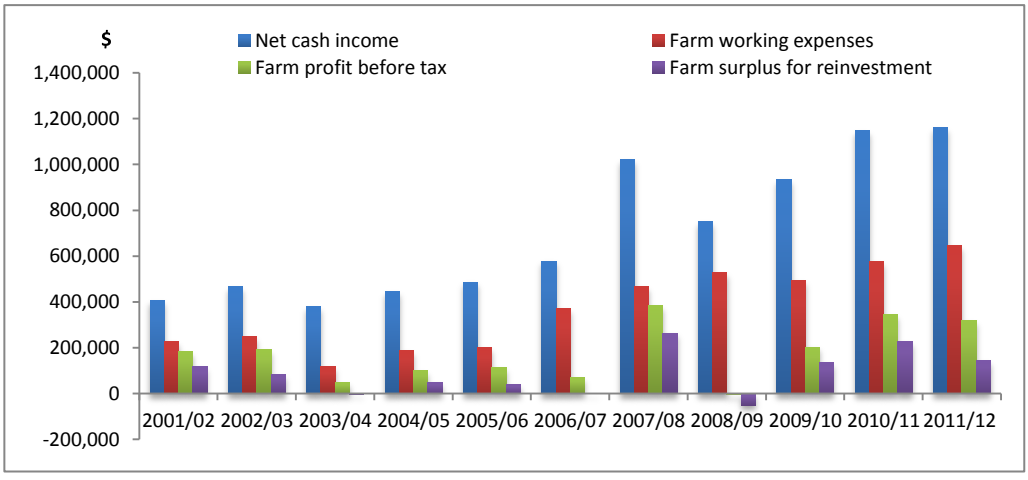
3.2. Use of 2011/2012 production year data

The use of the 2012 Agricultural Production Statistics and the Farm Monitoring data gave a consistent data source for both irrigated land use and farm level financial data. As noted though, this gives a snapshot indication of the value of irrigation.

Farm incomes fluctuate on a year-by-year basis due to a variety of factors, particularly seasonal influences, and pay-outs. This is illustrated in the figures below.

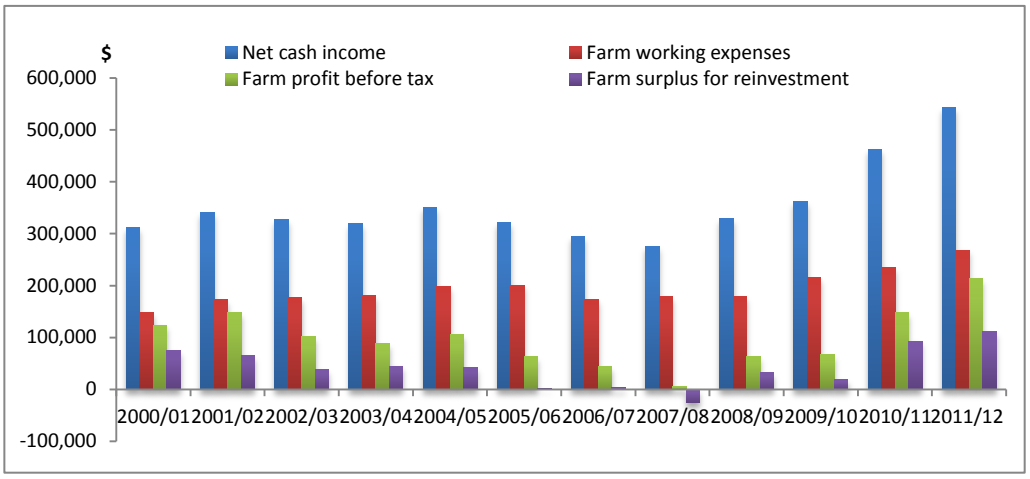
As can be seen from these figures, the 2011/12 season was financially a good one for dairy and (particularly) sheep & beef farmers. A significant part of this was as a result of a climatically good year, especially the wet summer in many areas. While the wet summer was a boon for pastoral farmers, it had the opposite effect in a number of regions on a range of horticultural crops.

Figure 2 Dairy profitability trends



Source: MPI Farm Monitoring

Figure 3 Sheep and beef profitability trends



Source: MPI Farm Monitoring

The implication of this 'good' climatic year is that it has improved the gross margins for pastoral farms, and depressed it for a number of horticultural and vegetable crops, essentially depressing the 'with irrigation' gross margins for some horticultural and vegetable crops and boosting the 'without irrigation' gross margins for pastoral systems, and hence tending to under-value the value of irrigation in a general sense.

Possibly a better approach to valuing irrigation at the farm gate would be to average margins over (say) a five-year period. Unfortunately, the financial data outside of pastoral farming is not sufficient to allow for this.

3.3. Experts' comments on irrigation

The use of irrigation has resulted in the significant expansion of a range of farming systems, with irrigation giving a greater reliability of production, increased yields, and improved quality of production (e.g., larger and more consistent fruit size). In a number of industries, particularly cropping and horticulture, financial margins and market demands are tight, and irrigation is the only means of ensuring a viable system.

In addition, the advent of irrigation often leads to a complex level of inter-dependencies between farms, such as the supply of supplementary feed, grazing opportunities (e.g., dairy support), and linkages between store and finishing farms.

In the absence of irrigation, much of this is lost. The experts felt that if irrigation had never occurred, a number of the farm systems would have developed differently, without the same degree of reliability or level of production (e.g., dairy farms buying in supplementary feed in place of irrigated pasture). However, in the absence of irrigation a large number of production systems would most probably not be established, as the initial risk would be quite high, and farmers could not absorb the volatility in returns during this establishment phase.

Given the development of irrigation in New Zealand, particularly in recent decades, it can be hard to envisage what land use would be in the absence of irrigation. In many instances, it was felt that the land would have largely stayed in pastoral use, and

farming systems would be more extensive/conservative to allow for the risk of fluctuating incomes.

In many instances, it was felt that the vegetable and horticultural industries would only be sufficient for domestic supply; in the absence of irrigation, New Zealand would not be competitive in international markets with regard to volume, consistency of supply, and consistency of product.

Nevertheless it was also felt that some industries could well have expanded to some degree, e.g., dairying into some of the higher rainfall bands (i.e., in Canterbury – towards the foothills), and via the use of supplementary feeds – which in turn would have presented opportunities for the arable cropping industry.

Similarly, it was felt that the likelihood of mixed farming systems, e.g., sheep and beef, with some cropping, would be very likely in the absence of irrigation, and some opportunistic cropping depending on prevailing prices.

There was no robust basis on which to model changes to industry structure in the absence of irrigation. The expectation is that the cropping and horticultural sectors would have largely remained domestically focused, and hence much smaller. In the pastoral scene, the expectation was for more extensive farming systems with farmers in the drier areas needing to sell a reasonable proportion of animals' store to other farmers to finish. The general opinion was that there would be sufficient demand for farmers in summer wet areas to allow this to happen.

3.4. Net farm gate value of irrigation

As can be seen from Table 1, the net overall value of irrigation at the farm gate is $2.17 billion (i.e., 'with irrigation' of $3.26 billion less 'without irrigation' scenario of $1.09 billion). Canterbury contributes the major share with $1.39 billion (64 percent).

This compares with the estimated farm gate value in 2002/03 of $920 million (MAF, 2004), of which Canterbury accounted for $335 million (36.4 percent). The total area of land under irrigation in 2011/12 was 721,400 hectares, an increase of 52 percent over 2002/03 (475,700 hectares). The average increase in profitability due to irrigation was $3,000/hectare.

The significant increase in the value of irrigation compared to the 2002/03 study was a combination of the increase in irrigated land area and improvement in the profitability of a range of farming systems. Irrigated land area in Canterbury increased by 157,300 hectares (55%), of which 121,800 hectares are devoted to dairying. This increased area represents 64% of the total increase in irrigated land in New Zealand between 2003 and 2012. Within Canterbury, dairying makes up 66% of the irrigated land area. The 2011/2012 gross margin for Canterbury dairying is $6,293 per hectare compared to $2,397 per hectare in 2002/2003 (i.e., a 163% increase). Note that the dairy pay out used was $6.59/kgMS.

Within the 2012 irrigation statistics, there was a discrepancy between the total figure given for a region, and the sum of the individual land use figures, due to some individual figures being suppressed for confidentiality reasons. Nationally this added up to 7,332 hectares.

In addition, there were a number of areas of land use that were excluded from the analysis due to lack of financial data, for example, covered crops, pigs, forestry,

'other'. The total area involved in this was 1,076 hectares. (Refer Appendix K for details).

If the margin between the Canterbury sheep and beef with/without gross margin is applied to these areas, this adds an extra $6.3 million to the farm gate value of irrigation.

Table 1 Farm gate value of irrigation, by region

In million NZ$ and percent

Region	(A) Current Farm gate value of irrigation	(B) Farm gate value if irrigation never occurred	(C) = A - B Net farm gate value of irrigation	% of total Net farm gate value of irrigation
Northland	$41.0	$21.2	$19.8	0.9%
Auckland	$34.4	$20.6	$13.7	0.6%
Waikato	$112.9	$81.5	$31.4	1.4%
Bay of Plenty	$120.5	$64.5	$56.0	2.6%
Gisborne	$10.8	$1.3	$9.4	0.4%
Hawke's Bay	$109.7	$30.8	$78.9	3.6%
Taranaki	$35.6	$23.3	$12.2	0.6%
Manawatu-Wanganui	$99.2	$56.1	$43.1	2.0%
Wellington	$76.7	$53.6	$23.2	1.1%
Marlborough	$185.9	$37.4	$148.6	6.8%
Nelson	$ 0.2	$0.0	$0.2	0.0%
Tasman	$77.0	$18.2	$58.8	2.7%
Canterbury	$1,950.2	$556.1	$1,394.1	64.1%
West Coast	$5.9	$ 3.0	$2.8	0.1%
Otago	$338.5	$74.1	$264.4	12.2%
Southland	$69.7	$50.4	$19.3	0.9%
Total	**$3,268.1**	**$1,092.3**	**$2,175.8**	

Source: AgFirst Consultants NZ

3.5. Conversion to CGE modelling shocks

NZIER then used these farm gate estimates to develop modelling scenarios for the CGE modelling task.

The next section explains more about the modelling framework, how the model and database were tailored for this specific project, and how the AgFirst values were translated into modelling scenarios.

4. Modelling methodology

We used NZIER's static Computable General Equilibrium (CGE) model to obtain a reasonable approximation of the New Zealand economy as if irrigation had never occurred.

4.1. ORANI-NZ CGE model

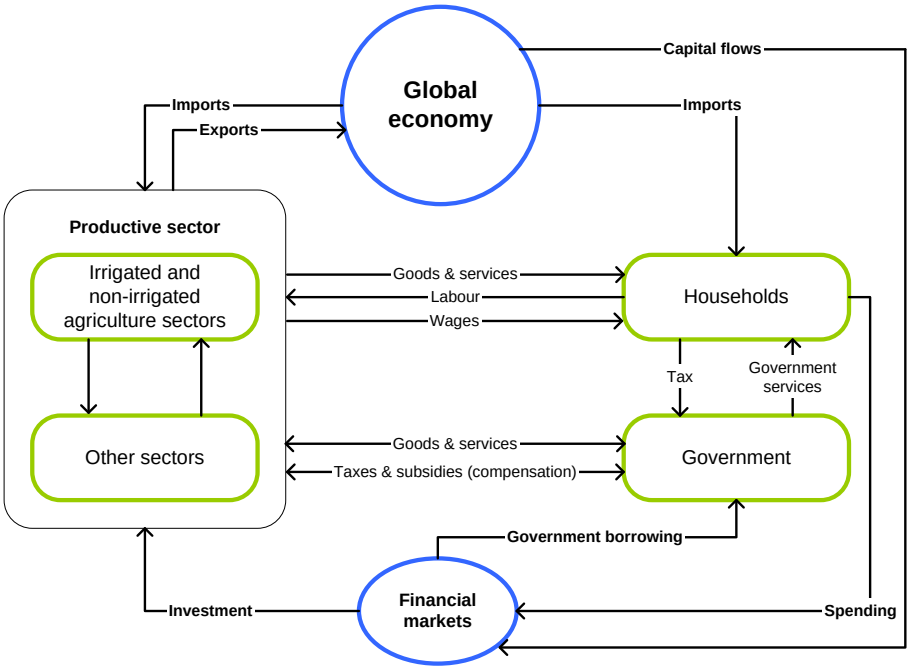
The ORANI-NZ CGE model used in the analysis is a static CGE model that contains information on 110 industries (including 8 irrigated and non-irrigated agriculture industries) and 206 commodities.

The model captures the various inter-linkages between these sectors, as well as their links to households (via the labour market), the government sector, capital markets, and the global economy (via imports and exports).

A visual representation of the model is shown in Figure 4. It highlights the complex and multidirectional relationships between the various parts of an economy.

A key benefit of using a CGE model is that it is based on an empirical, government-produced database (Statistics New Zealand's Input-Output table) that identifies the structure of the industries involved.

Figure 4 Components of our irrigation CGE model



Source: NZIER

A second key benefit of a CGE model is that it considers both the first round effects of the removal of irrigation – e.g., decreased agricultural production and export volumes – and the flow-on impacts that this first round effects of the absence of irrigation has on the rest of the New Zealand economy. For example, it explicitly

calculates the flow-on impacts on suppliers to agricultural industries; and to households by way of wages that come from the demand for labour and rates of return to productive capital.

The agricultural sector interacts with the rest of the economy by generating exports and employment, using intermediate inputs such as fertilizer, and competing for use of labour and capital.

4.2. Tailoring the model and database

We modified our standard CGE database for this analysis. In particular, we have disaggregated the four agricultural sectors (horticulture; sheep and beef farming; dairy, cattle and beef farming; and other livestock farming) in Statistics New Zealand's Input-Output table into their irrigated and non-irrigated components. We did this by apportioning input and output flows based on farm budgets provided by AgFirst.

This allowed us to explicitly account for their economic contribution to the New Zealand economy and the interaction between the irrigated and non-irrigated sectors (since they effectively compete for land, labour, and capital).

We calibrated the database to 2012 levels using Statistics New Zealand's macroeconomic data.

Appendix H explains in detail the approach used to apportion the agriculture inputs and outputs in the CGE model between irrigated and non-irrigated industries using the farm budgets provided by AgFirst, discussed in Section 3. These budgets provide an estimate of the revenue, input costs and gross margins by hectare for selected types of farms in selected regions.

To convert these budgets to estimated national shares of revenues and costs by irrigated and non-irrigated land we have used the following approach:

- use data from Statistics New Zealand on the area (in hectares) of land use by farm type from the Agricultural Production Survey 2012. Farms are classified by ANZSIC06 code, land type[7] is grouped by the categories 'grass land', 'tussock and danthonia', 'grain seed and fodder crop land', and 'horticultural land' and reported by region
- use data from MPI on the area in hectares of irrigated land use by farm type. This data was also obtained from the Agricultural Production Survey 2012 completed by Statistics New Zealand. Farms are classified by ANZSIC06 code and land areas are reported by region
- multiply the revenue, input cost and gross margin per hectare by the number of hectares for that use of farmland for each regional budget to estimate total regional revenue, cost and gross margin for each of the regional farm budgets (farm use and irrigated versus non-irrigated land)
- add-up the regional budgets for each farm use type to give national totals for the estimated revenue, input costs and gross margins for irrigated and non-irrigated land

[7] The Agricultural Production Survey also includes the following land use categories: 'plantations of exotic trees intended for harvest', 'harvested exotic forest area awaiting restocking', 'mature native bush', 'native scrub and regenerating native bush' and 'all other land'. To avoid diluting the importance of production from irrigated land we have excluded land related to forestry, native bush and other land form our analysis.

- calculate the shares of national irrigated and non-irrigated farm revenue, input costs and gross margins for each of the farm use types covered by the regional farm budgets
- use these shares of national irrigated and non-irrigated to separate the farming activities included in the CGE model into irrigated and non-irrigated components.

We have also revised the structure of some agricultural industries to account for self-employment and casual employment in farming industries. Statistics New Zealand's Linked Employer Employee Data (LEED) suggests that 54% of the beef farming workforce, and 37% of the dairy farm workforce are self-employed. We assume these self-employed workers are effectively tied to their land, and therefore would be farming whether or not irrigation had developed.

4.3. CGE modelling of the value of irrigation

We estimate the likely economic contribution of irrigation by running a 'Central Scenario' that reflects experts' views (as compiled in Phase 1) of the likely land use and gross margins if irrigation had never occurred.

In the modelling, we reduce profitability of irrigated industries by using AgFirst's estimates of gross margin changes. We also let the model determine the degree of technical regress associated with resources becoming less productive and effectively being 'stranded' following removal of irrigation (i.e., water as input to production).

The absence of irrigation means that some resources (casual labour, private sector capital and some land) would be reallocated across the rest of the economy, including non-irrigated agriculture. This means that to a degree, the negative impacts on the agriculture sector may be offset by slight expansions in non-irrigated industries.

However, not all resources can be employed elsewhere. For example, currently irrigated land would not be as productive or intensely farmed. Capital within irrigated industries and food processing industries would also become less productive following its reallocation in the model to other sectors. Finally, self-employed farmers would still be employed on non-irrigated farms but at lower returns: they are tied to their land, and therefore would be farming whether or not irrigation had developed.

The difference between the economy with and without irrigation allows us to approximate the likely contribution that irrigation makes to the New Zealand economy.

We then carry out two sensitivity analyses by varying gross margins in Canterbury, which accounts for 64 percent of the overall value of irrigation.

- High scenario: +50 percent gross margins in Canterbury
- Low scenario: -50 percent gross margins in Canterbury.

The choice of +/- 50 percent is arbitrary, but could be refined in the future if more detailed data is available.

In the next section, we present the results as either percent or value changes from the initial database of the economy.

5. Modelling results

We report the results as percentage changes from the with irrigation (actual) economy. Dollar values are also reported relative to their initial values.

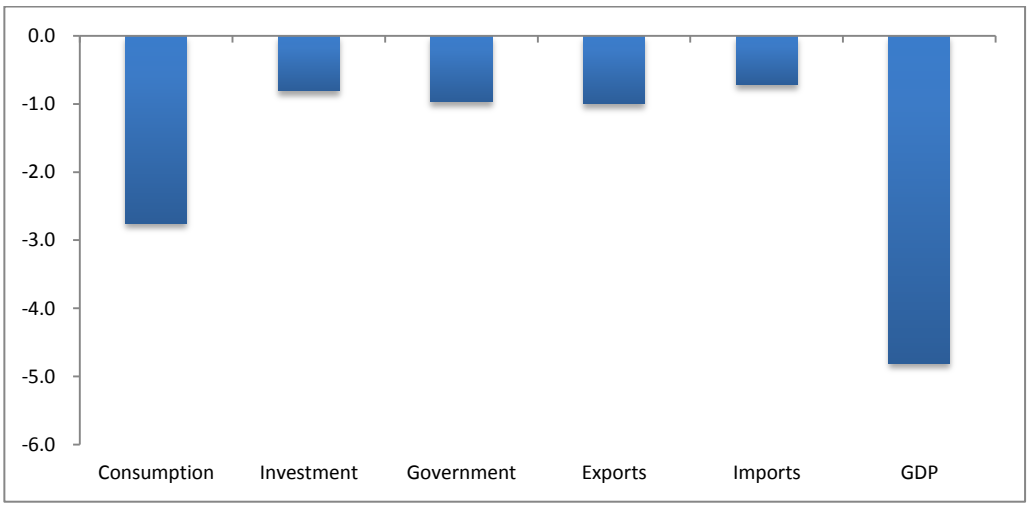
5.1. Macroeconomic effects

We focus on key macroeconomic variables such as Gross Domestic Product (GDP), exports, real exchange rate, real wages, and returns to capital. GDP is a widely used metric and reflects the total value of goods and services produced in the economy in a given year. We also pay attention to household consumption, which we use as a measure of national economic welfare (how 'well off' we are). Household consumption allows us to measure the amount that New Zealanders spend on goods and services.[8] The real exchange rate measures the relative price of our aggregate exports and imports.[9]

Figure 5 presents the real value impacts (in billion $NZ per annum) on each component of expenditure-side GDP. It shows that GDP, household consumption (household welfare), and total New Zealand exports would have been smaller by $4.8, $2.7 and $1 billion, respectively. Consumption falls more relative to other GDP components due to lower household incomes (i.e., falling wages and returns to capital) and the depreciation of the real exchange rate, which pushes up imported consumables' prices.

Figure 5 Impacts on GDP aggregates

Real value change (in billions, $NZ) relative to 'with irrigation' economy



Source: NZIER

[8] Our measure of household welfare only accounts for consumption of goods and services. This is different from NZIER's (2010) "The Economic Impact of Increased Irrigation" report, in which the measure of household welfare accounts for households forgoing part of their current consumption to repay overseas debt and/or finance investments.

[9] This is different from financially determined foreign (nominal) exchange rates being reported in newspapers—i.e., monetary value of domestic currency ($NZ) relative to an international currency ($US). The real exchange rate in a CGE model reflects the average price (purchasing power parity) of all exports relative to all imports.

Aggregate investment falls due to reduced profitability, production and exports. The reduction in aggregate exports is partly driven by reduced production capacity of the agriculture sector to expand beyond dry land farming conditions. In turn, the real exchange rate, which measures the relative price of aggregate exports and imports, depreciates by 2.6%.[10] Currency depreciation increases the domestic price of imports, reducing imports. Government expenditure also falls as we assume that public sector services follow movements in household consumption.

In short, the macroeconomic impacts suggest that the New Zealand economy would have been smaller if irrigation had never occurred. Total output and exports would have been lower due to the constrained capacity of primary industries to expand beyond dry land farming conditions. This negative impact reverberates to food processing industries, which then affect other downstream industries.

Without irrigation, currently irrigated lands would have remained at lower production levels while both on-farm irrigation capital and employed labour would reallocate towards other industries. Table 2 shows that this reallocation would drive down wages and capital returns, thereby resulting in further impacts to the rest of the economy.

Table 2 shows that if irrigation had never occurred:

- factor owners would earn lower wages (-2.1%) and receive lower returns to their capital investments (-1.8%).
- Lower exports results in a 2.6% depreciation of the real exchange rate. This currency depreciation also increases the domestic price of imports.

Table 2 Key indicators

Percentage and real value change relative to 'with irrigation' economy

Metric	% change
Real wage	-2.1
Return to capital	-1.8
Real exchange rate	-2.6

Source: NZIER

The fall in wages is partly driven by our standard static CGE modelling assumption in which real wages adjust to keep aggregate employment level constant. This means that casual farm labourers who are seeking off-farm employment would be willing to accept a pay cut to find employment in the rest of economy. On the other hand, lower returns to capital investments results from the impacts of capital becoming less productive, following its reallocation in the model to other sectors.

[10] This means that in general, it now costs more for New Zealand to buy a unit of import relative to a unit of export. Nonetheless, as will be explained in the industry results, currency depreciation also benefits other exported commodities due to increased competitiveness abroad.

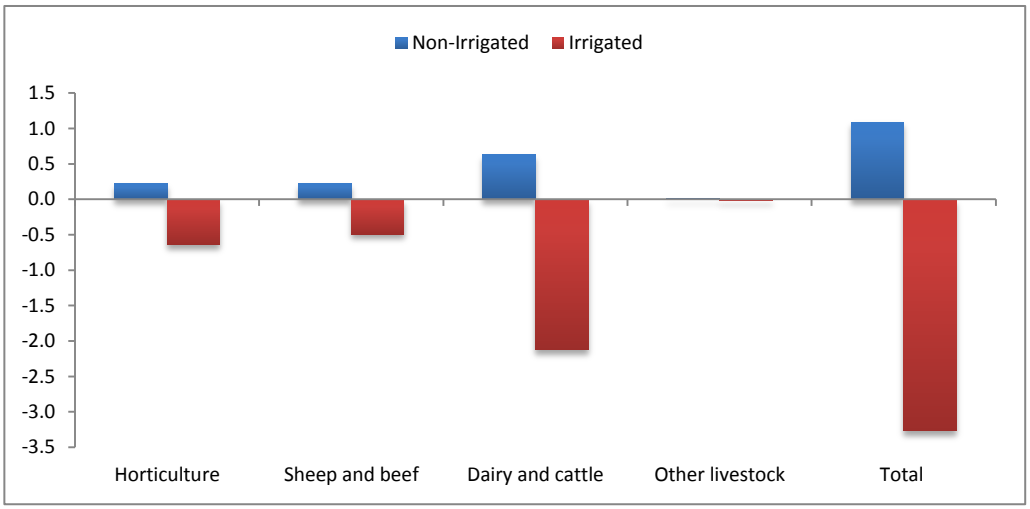
5.2. Impact on on-farm industries

Figure 6 shows the direct impacts of removing irrigation on the on-farm sector. If irrigation had never occurred, some resources are effectively left idle and the remaining resources are put to their second-best dry land alternative uses. The net effect remains negative – the on-farm sector sees its net contribution to real GDP falling by $2.17 billion.[11]

The impacts are larger for dairy and horticulture compared to sheep and beef and other livestock farming.

Figure 6 Production impacts on irrigated and non-irrigated industries

Value change (in billions $NZ) relative to 'with irrigation' economy, in billions ($NZ)



Source: NZIER

Figure 7 shows the impacts on exports of key agricultural and processed food commodities. Meat exports increase by $0.1 billion. This is because as explained in Section 3.3, farmers shift their land use towards intensive sheep and beef farming. The combined exports of milk powder and other dairy products fall by $4.2 billion.[12] Exports of plants and seeds,[13] vegetables, Kiwifruit and apples are also significantly affected ($0.04, $0.4, $0.8 and $0.4 billion, respectively).

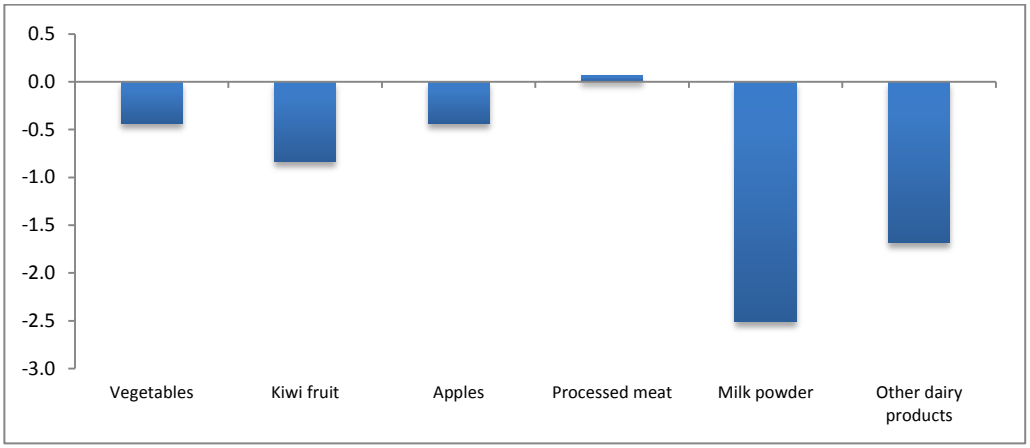
11 As explained in Section 3.4, the net overall value of irrigation at the farm gate is $2.17 billion (i.e., 'with irrigation' of $3.26 billion less 'without irrigation' scenario of $1.09 billion).

12 Note that this is larger than the $1 billion reduction in total New Zealand exports reported in Section 5.1. This is because of offsetting impacts associated with the depreciation of the NZ dollar which in turn increases the competitiveness of other (manufacturing and services) exports.

13 In Statistics New Zealand's IO table, seed exports are aggregated with plants, buds, spiced and aromatic crops. Seed exports are an important part of irrigated arable farming in Canterbury.

Figure 7 Impacts on exports of key agricultural commodities

Real value change (in billions $NZ) relative to 'with irrigation' economy



Source: NZIER

5.3. Flow-on effects

The previous section analysed the **direct** impacts on both irrigated and non-irrigated industries. We now analyse the flow-on or **indirect** impacts as shown in Table 3.[14] It can aid understanding to split indirect impacts into the following categories.

- **Dependent** industries – these are industries that depend on the output of primary industries for further processing. Meat manufacturing expands due to increased activity in sheep and beef farming (due to land use shift) while dairy processing contract due to lower input supply from the primary industries on which they depend. At the same time, they are hurt by the exchange rate depreciation, which now makes imported inputs, such as fuel, relatively more expensive
- **Supplying** industries – industries that supply the on-farm primary industries are negatively affected. This is because, despite the non-irrigated industries' expansion, the net impact is a contraction in farm output. Such industries include warehousing, electricity, machinery and equipment, other transport, and rail transport services
- **Household** expenditure industries – industries that households spend money on are likely to lose from decreased income that comes through employment and wages, and decreased returns to capital from the shrinking irrigated industries. Such industries include supermarkets and services provided by the public sector
- **Expanding export** industries – industries that gain due to cheaper labour and capital inputs as a result of resource reallocation effects. These industries include mining and wood manufacturing industries.

[14] We show the results for just a few of the 110 industries to highlight the main thematic outcomes.

Table 3 Impacts on industry-level output

Percentage change relative to 'with irrigation' economy, selected industries.

Industry	Output
Dependent industries	
Meat manufacturing	1.5
Dairy processing	-26.0
Supplying industries	
Warehousing	-5.7
Electricity	-8.0
Machineries and Equipment	-6.8
Other transport	-3.2
Rail transport services	-2.7
Household industries	
Supermarkets	-0.3
Central government	-2.3
Expanding export industries	
Mining	1.2
Wood manufacturing	6.7

Source: Simulation results (NZIER)

6. Sensitivity analysis

In our 'without irrigation' scenario development, the most uncertain factor is the magnitude of Canterbury's gross margins. Table 4 shows the results of our sensitivity analysis when we vary Canterbury gross margins by +/- 50%.

Although our choice of +/-50% is arbitrary, it allows us to understand the likely upper and lower bound impacts arising from uncertainty in gross margin calculations. Our estimates of economic impacts fall within the range of +48 to -47 percent.

Table 4 Sensitivity analysis on GDP and household consumption

Percentage and indicative real value change relative to baseline

Indicator	Central scenario		High (+50%)		Low (-50%)	
	%	NZ$	%	NZ$	%	NZ$
GDP	-2.4	-4.8	-3.3 (+36%)	-6.5 (+36%)	-1.7 (-31%)	-3.3 (-31%)
Consumption	-2.4	-2.7	-3.3 (+38%)	-3.8 (+38%)	-1.6 (-34%)	-1.8 (-34%)

Source: NZIER

7. Caveats and limitations

Our estimates only provide a 'snapshot' of the overall value of irrigation for the production year 2011/2012. The choice of 2011/12 season was driven by data availability, especially financial data limitations outside of pastoral farming. Although a five-year average estimate of gross margins would be ideal, this would have required more resources and involved more work.

Our estimates of economic and flow-on effects were based on static CGE modelling approach, which simply compares the New Zealand economy with and without irrigation. In our modelling, we reduced the profitability of irrigated industries based on AgFirst's estimates of gross margin changes. We also let the model determine the degree of technical regress associated with resources becoming less productive and effectively being 'stranded' following removal of irrigation (i.e., water as input to production).

The absence of irrigation means that some resources (casual labour, private sector capital, and some land) would be reallocated across the rest of the economy, including non-irrigated agriculture. This means that to a degree, the negative impacts on the agriculture sector may be offset by slight expansions in non-irrigated industries.

However, not all resources can be employed elsewhere. For example, currently irrigated land would not be as productive or intensely farmed. Capital within irrigated industries and food processing industries would also become less productive following its reallocation in the model to other sectors. Finally, self-employed farmers would still be employed in non-irrigated farms but at lower returns; they are tied to their land, and therefore would be farming whether or not irrigation had developed.

Finally, we are not able to quantify the environmental or social impacts if irrigation had never occurred. We also do not attempt to investigate the relative merits of public versus private sector funding of the schemes.

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Appendix C Examples of gross margins

C.1 Canterbury dairy

Table 5 Farm area and production

	Non-irrigated	Per ha	Irrigated	Per ha
Eff Area (ha)	210	-	-	-
Cows Milked	525	-	711	-
Milk solids (kg)	190,000	905	336,000	1,600

Source: Regional farm budget workshop commissioned by MPI

Table 6 Revenue, costs and net cash income

	Non-irrigated	Per ha	Irrigated	Per ha
Milk solids	$1,252,100	$5,962	$2,214,240	$10,544
Dividend on wet shares	$58,900	$280	$104,160	$496
Cattle	$73,128	$348	$114,898	$547
Other farm income	$8,245	$39	$8,245	$39
Less:				
Cattle purchases	$4,720	$22	$7,080	$34
Net cash income	**$1,387,653**	**$6,608**	**$2,434,463**	**$11,593**

Source: Regional farm budget workshop commissioned by MPI

Table 7 Farm working expenses

	Non-irrigated	Per ha	Irrigated	Per ha
Permanent wages	$156,975	$748	$212,589	$1,012
Casual wages	$18,375	$88	$24,885	$119
ACC	$6,013	$29	$8,023	$38
Total labour expenses	$181,363	$864	$245,497	$1,169
Animal health	$48,825	$233	$66,123	$315
Breeding	$24,150	$115	$32,706	$156
Dairy shed expenses	$10,500	$50	$14,220	$68
Electricity	$17,325	$83	$55,458	$264
Feed (hay and silage)	$157,500	$750	$165,000	$786
Feed (grazing)	$52,500	$250	$235,590	$1,122
Feed (other)	$25,000	$119	$25,000	$119
Fertiliser	$86,625	$413	$159,975	$762
Lime	$3,675	$18	$4,977	$24
Freight (not elsewhere deducted)	$7,875	$38	$10,665	$51
Re-grassing costs	$10,500	$50	$14,220	$68
Weed and pest control	$4,725	$23	$6,399	$30
Vehicle & fuel	$33,600	$222	$34,608	$228
Water charges	$0	$0	$29,151	$139
Gross farm working expenses		**$3,224**		**$5,300**
Gross margin		**$3,383**		**$6,293**

Source: Regional farm budget workshop commissioned by MPI

C.2 Canterbury arable

Table 8 Revenue, expenses and gross farm revenue

Revenue	Non-irrigated	Per ha	Irrigated	Per ha
Cereals	$288,146	$960	$411,637	-
Small seeds	$253,773	$846	$362,533	-
Other crop	$67,163	$224	$95,948	-
Process/fresh vegetables	$0	$0	$54,275	-
Land leased for cropping	$0	$0	$14,076	-
Crop residues	$33,880	$113	$48,400	-
Change in value of crop on hand	$59,917	$200	$99,862	-
Total crop revenue	**$702,879**	**$2,343**	**$1,086,731**	**$3,622**
Sheep income (incl wool)	$243,177	$811	$243,177	$811
Grazing income	$0	$0	$45,304	$151
Other farm income	$13,200	$44	$13,200	$44
Less:				
Sheep purchases	$127,000	$423	$127,000	$423
Stock value adjustment	$10,700	$36	$10,700	$36
Gross farm revenue	**$821,556**	**$2,739**	**$1,272,112**	**$4,240**

Source: Regional farm budget workshop commissioned by MPI

Table 9 Farm working expenses

Revenue	Non-irrigated	Per ha	Irrigated	Per ha
Permanent wages	$49,800	$166	$49,800	$166
Casual wages	$0	$0	$6,000	$20
ACC – employees	$1,224	$4	$1,224	$4
Total labour expenses	$51,024	$170	$57,024	$190
Contracting (including harvesting/drying)	$22,800	$76	$28,500	$95
Animal health	$4,500	$15	$4,500	$15
Electricity	$5,000	$17	$18,000	$60
Feed (hay and silage)	$9,000	$30	$9,000	$30
Feed (grazing)	$5,400	$18	$5,400	$18
Feed (other)	$1,800	$6	$1,800	$6
Fertiliser	$82,907	$276	$110,543	$368
Lime	$7,560	$25	$7,560	$25
Freight	$16,800	$56	$24,000	$80
Seed dressing	$18,000	$60	$36,000	$120
Seeds	$24,000	$80	$30,000	$100
Shearing costs	$6,930	$23	$6,300	$21
Weed and pest control	$66,150	$221	$94,500	$315
Water costs	$0	$0	$16,800	$63
Vehicle & fuel	$54,435	$181	$57,300	$191
Gross farm expenses		**$1,254**		**$1,698**
Gross margin		**$1,484**		**$2,543**

Source: Regional farm budget workshop commissioned by MPI

Appendix D Summary of gross margins

D.1 Difference in with/without gross margins

Table 10 Sheep and beef

	$/ha
Upper North Island	$283
Lower North Island	$403
South Island	$745

Source: Regional farm budget workshop commissioned by MPI

Table 11 Deer

	$/ha
North Island	$903
South Island	$880

Source: Regional farm budget workshop commissioned by MPI

Table 12 Canterbury arable

	$/ha
Canterbury arable	$1,059

Source: Regional farm budget workshop commissioned by MPI

D.2 Horticultural gross margins (irrigated)

Table 13 Kiwifruit

	$/ha
Kiwifruit	$23,408

Source: Regional farm budget workshop commissioned by MPI

Table 14 Pipfruit

	$/ha
Hawke's Bay	$9,743
Nelson	$6,056

Source: Regional farm budget workshop commissioned by MPI

Table 15 Viticulture

	$/ha
Hawke's Bay	$9,743
Nelson	$6,056

Source: Regional farm budget workshop commissioned by MPI

Table 16 Northland/Bay of Plenty

	$/ha
Avocados	$2 920

Source: Regional farm budget workshop commissioned by MPI

Table 17 Northland/Gisborne

	$/ha
Persimmons	$9 580

Source: Regional farm budget workshop commissioned by MPI

Table 18 Auckland/Waikato

	$/ha
Blueberries	$28 350
Blueberries	$9 320
Strawberries	$22 425

Source: Regional farm budget workshop commissioned by MPI

Table 19 Canterbury/Nelson

	$/ha
Blackcurrants	$800

Source: Regional farm budget workshop commissioned by MPI

Table 20 Central Otago

	$/ha
Apricots	$17 200
Cherries	$35 580

Source: Regional farm budget workshop commissioned by MPI

Appendix E Vegetable gross margins

E.1 South Auckland/Waikato (irrigated)

Table 21 Rotation 1

Vegetable	$/ha
Summer Potato	$3,050
Onion	$4,050
Carrot	$4,415
Squash	$2,538
Barley	$1,409

Source: Regional farm budget workshop commissioned by MPI

Table 22 Rotation 2

Vegetable	$/ha
Squash	$2,538
Broccoli	$1,980
Lettuce	$4,995
Onion	$4,050
Autumn/Winter Potato	$6,245

Source: Regional farm budget workshop commissioned by MPI

Table 23 Traditional market garden

Vegetable	$/ha
Broccoli	$1,980
Lettuce	$4,987
Cabbage	$1,390
Spinach	$3,610
Cauliflower	$1,390
Cabbage	$1,390

Source: Regional farm budget workshop commissioned by MPI

Appendix F Region irrigation areas by land use (hectares)

Table 24 Irrigation areas by land use 1

Northland to Wellington

Land use	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawke's Bay	Taranaki	Manawatu-Wanganui	Wellington
Nursery Production (Under Cover)	35	53	16	5	-	4	-	17	-
Nursery Production (Outdoors)	55	112	155	43	-	83	-	62	-
Floriculture Production (Under Cover)	28	32	17	5	-	-	-	13	-
Floriculture Production (Outdoors)	9	26	-	-	-	-	-	-	-
Vegetable Growing (Under Cover)	22	92	46	-	-	12	-	-	-
Vegetable Growing (Outdoors)	418	2,861	3,167	34	-	4,276	-	1,315	257
Grape Growing	-	27	-	-	114	4,046	-	-	774
Kiwifruit Growing	668	275	292	3,371	373	192	-	8	-
Berry Fruit Growing	-	119	25	-	-	84	-	-	-
Apple and Pear Growing	-	14	51	21	-	4,834	-	43	146
Stone Fruit Growing	-	-	-	-	-	498	-	-	22
Citrus Fruit Growing	88	32	6	11	254	39	-	-	-
Olive Growing	-	84	-	-	-	246	-	16	105
Other Fruit and Tree Nut Growing	1,211	131	133	370	45	43	-	-	52
Sheep Farming (Specialised)	-	10	-	-	-	2,345	-	531	937
Beef Cattle Farming (Specialised)	665	100	727	302	30	1,945	283	1,108	306
Sheep-Beef Cattle Farming	-	-	220	-	579	2,049	-	788	378

Land use	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawke's Bay	Taranaki	Manawatu-Wanganui	Wellington
Grain-Sheep or Grain-Beef Cattle Farming	-	-	-	-	-	77	-	-	-
Other Grain Growing	-	-	-	-	-	454	-	-	319
Other Crop Growing n.e.c.	-	66	56	-	-	270	103	229	435
Dairy Cattle Farming	4,171	1,477	15,706	7,128	-	4,144	6,058	16,605	12,515
Deer Farming	-	C	-	C	-	226	-	-	-
Horse Farming	18	46	52	15	-	71	-	43	-
Pig Farming	-	-	-	-	-	C	-	-	-
Other Livestock Farming n.e.c.	-	-	191	-	-	17	-	-	-
Forestry	-	-	-	-	-	-	-	-	4
Other	-	-	-	-	-	32	-	-	41
Total	**7,794**	**5,734**	**20,990**	**11,610**	**4,461**	**26,036**	**6,505**	**21,716**	**16,638**

Notes: C - confidential

Source: Statistics NZ 2012 Agricultural Production Census

Table 25 Irrigation areas by land use 2

Tasman to Southland

Land Use	Tasman	Nelson	Marlborough	West Coast	Canterbury	Otago	Southland	New Zealand
Nursery Production (Under Cover)	-	-	-	-	26	-	-	**156**
Nursery Production (Outdoors)	488	-	35	-	1,652	62	260	**3,007**
Floriculture Production (Under Cover)	C	-	-	-	34	-	-	**129**
Floriculture Production (Outdoors)	14	-	6	-	-	18	-	**73**
Vegetable Growing (Under Cover)	31	-	-	-	82	-	-	**285**
Vegetable Growing (Outdoors)	450	-	899	-	19,348	265	-	**33,290**
Grape Growing	768	21	21,436	-	1,302	1,685	-	**30,173**
Kiwifruit Growing	511	-	-	-	-	-	-	**5,690**
Berry Fruit Growing	652	-	-	-	2,032	65	-	**2,977**
Apple and Pear Growing	2,868	-	8	-	659	274	-	**8,918**
Stone Fruit Growing	23	-	110	-	82	1,362	-	**2,097**
Citrus Fruit Growing	-	-	-	-	-	-	-	**430**
Olive Growing	54	-	79	-	141	21	-	**746**
Other Fruit and Tree Nut Growing	36	-	21	-	379	74	-	**2,495**
Sheep Farming (Specialised)	745	-	1,853	-	36,777	36,586	2,379	**82,163**
Beef Cattle Farming (Specialised)	452	-	514	446	35,165	4,927	395	**47,365**
Sheep-Beef Cattle Farming	371	-	789	-	16,395	6,343	-	**27,912**
Grain-Sheep or Grain-Beef Cattle Farming	-	-	-	-	35,383	1,323	-	**36,783**
Other Grain Growing	-	-	314	-	45,025	1,319	-	**47,431**
Other Crop Growing n.e.c.	222	-	1,308	-	9,785	3,220	416	**16,110**
Dairy Cattle Farming	4,106	-	2,208	1,583	231,835	32,253	12,451	**352,240**
Deer Farming	67	-	104	-	5,474	3,456	-	**9,327**
Horse Farming	19	-	-	-	1,101	231	718	**2,314**

Land Use	Tasman	Nelson	Marlborough	West Coast	Canterbury	Otago	Southland	New Zealand
Pig Farming	-	-	-	-	989	250	-	**1,239**
Other Livestock Farming n.e.c.	-	-	-	-	220	-	-	**428**
Forestry	33	-	-	-	-	46	-	**83**
Other	-	-	-	-	101	-	-	**174**
Total	**11,969**	**21**	**29,790**	**2333**	**444,777**	**93,874**	**17,146**	**721,394**

Source: Statistics NZ 2012 Agricultural Production Census

Appendix G Non-irrigated farmland area by land use

Note that non-productive land is included the following tables and this may result in overestimation of total farmed area.

Table 26 Non-irrigated farmland area by land use – North Island horticulture by region

Area of 'grass land', 'tussock and danthonia', 'grain seed and fodder crop land', 'horticultural land' less the area that is irrigated

Land use	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawke's Bay	Taranaki	Manawatu-Wanganui	Wellington	North Island Total
Nursery Production (Under Cover)	84	191	48	85	5	18	91	62	5	**589**
Nursery Production (Outdoors)	144	392	564	295	113	103	254	185	78	**2,128**
Floriculture Production (Under Cover)	410	327	157	38	0	0	3	12	0	**947**
Floriculture Production (Outdoors)	70	50	0	72	0	10	14	60	0	**276**
Vegetable Growing (Under Cover)	45	202	152	16	0	6	9	29	10	**469**
Vegetable Growing (Outdoors)	2,821	3,865	3,686	283	4,867	6,606	230	5,937	406	**28,701**
Grape Growing	125	451	44	0	1,655	2,286	0	0	281	**4,842**
Kiwifruit Growing	326	376	1,080	13,498	476	-47	0	-8	0	**15,701**
Berry Fruit Growing	11	96	537	192	3	24	0	65	9	**937**
Apple and Pear Growing	86	330	244	52	158	1,780	0	105	53	**2,808**
Stone Fruit Growing	129	45	53	5	0	430	0	0	10	**672**
Citrus Fruit Growing	259	109	59	108	1,781	19	0	0	0	**2,335**
Olive Growing	311	467	71	86	0	90	0	63	175	**1,263**
Other Fruit and Tree Nut Growing	1,638	445	316	2,873	122	9	99	151	31	**5,684**

Source: Statistics NZ 2012 Agricultural Production Census

Table 27 Non-irrigated farmland area by land use – North Island pastoral and arable by region

Area of 'grass land', 'tussock and danthonia', 'grain seed and fodder crop land', 'horticultural land' less the area that is irrigated

Land use	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawke's Bay	Taranaki	Manawatu-Wanganui	Wellington	North Island
Sheep Farming (Specialised)	18,588	9,745	55,590	11,140	18,727	122,722	21,051	348,819	139,433	**745,815**
Beef Cattle Farming (Specialised)	175,223	48,506	174,527	31,482	26,536	77,294	43,052	75,684	22,418	**674,722**
Sheep-Beef Cattle Farming	85,285	26,873	272,979	39,915	288,941	407,091	64,795	492,695	96,383	**1,774,957**
Grain-Sheep or Grain-Beef Cattle Farming	498	340	2,851	0	905	2,089	360	7,359	3,282	**17,684**
Other Grain Growing	231	1,255	2,227	3,353	2,676	3,513	24	4,105	1,692	**19,076**
Other Crop Growing n.e.c.	4,688	3,441	28,028	4,740	99	2,209	6,119	10,256	2,535	**62,115**
Dairy Cattle Farming	175,544	44,800	581,941	99,211	5,160	18,012	192,237	167,365	33,869	**1,318,139**
Deer Farming	700	2,240	10,487	12,131	2,737	12,029	757	12,318	2,957	**56,356**
Horse Farming	3,017	3,566	6,994	485	259	941	984	1,857	771	**18,874**
Pig Farming	24	79	373	184	0	104	302	998	0	**2,064**
Other Livestock Farming n.e.c.	438	394	3,166	542	0	21	198	332	182	**5,273**
Forestry	7,794	2,405	11,724	3,121	6,578	4,528	1,176	6,815	4,270	**48,411**
Revised Other[1]	1,644	469	1,167	560	0	-5	27	1,103	108	**5,073**
Total	**480,892**	**153,225**	**1,166,809**	**225,760**	**362,860**	**665,621**	**332,737**	**1,136,869**	**317,683**	**4,842,456**

Note: 1. 'Revised Other' includes the following farmland use categories: 'Turf Growing', 'Mushroom Growing', 'Poultry Farming (Eggs)' and 'Other'.

Source: Statistics NZ 2012 Agricultural Production Census

Table 28 Non-irrigated farmland area by land use – South Island horticulture by region

Area of 'grass land', 'tussock and danthonia', 'grain seed and fodder crop land', 'horticultural land' less the area that is irrigated

Land use	Tasman	Nelson	Marlborough	West Coast	Canterbury	Otago	Southland	South Island	New Zealand
Nursery Production (Under Cover)	7	0	3	9	11	9	0	39	**589**
Nursery Production (Outdoors)	124	0	28	0	1,286	90	547	2,075	**2,128**
Floriculture Production (Under Cover)	6	0	0	0	65	26	0	0	**1,044**
Floriculture Production (Outdoors)	20	0	3	0	375	-2	0	0	**672**
Vegetable Growing (Under Cover)	71	0	0	2	81	39	0	193	**662**
Vegetable Growing (Outdoors)	91	0	-650	0	5,482	249	886	6,058	**34,759**
Grape Growing	286	12	9,238	0	1,179	1,585	0	12,300	**17,142**
Kiwifruit Growing	184	0	0	0	0	0	0	184	**15,885**
Berry Fruit Growing	968	0	0	0	-649	44	0	363	**1,300**
Apple and Pear Growing	980	0	-8	0	398	152	0	1,522	**4,330**
Stone Fruit Growing	18	0	39	0	365	1,113	0	1,535	**2,207**
Citrus Fruit Growing	0	0	0	0	0	0	0	0	**2,335**
Olive Growing	203	0	53	0	223	-7	0	472	**1,735**
Other Fruit and Tree Nut Growing	118	0	151	86	471	49	16	891	**6,575**

Source: Statistics NZ 2012 Agricultural Production Census

Table 29 Non-irrigated farmland area by land use – South Island pastoral and arable

Area of 'grass land', 'tussock and danthonia', 'grain seed and fodder crop land', 'horticultural land' less the area that is irrigated

Land use	Tasman	Nelson	Marlborough	West Coast	Canterbury	Otago	Southland	South Island	New Zealand
Sheep Farming (Specialised)	25,429	22	113,839	1,482	1,022,401	1,202,125	490,884	**2,856,182**	**3,601,997**
Beef Cattle Farming (Specialised)	13,357	259	12,043	27,527	132,969	49,497	58,949	**294,601**	**969,323**
Sheep-Beef Cattle Farming	15,394	871	133,924	14,922	551,138	515,999	158,961	**1,391,209**	**3,166,166**
Grain-Sheep or Grain-Beef Cattle Farming	0	0	0	0	53,195	5,163	7,713	**66,071**	**83,755**
Other Grain Growing	0	0	202	0	44,074	4,362	4,408	**53,046**	**72,122**
Other Crop Growing n.e.c.	1,188	0	237	3,544	20,463	9,182	17,035	**51,649**	**113,764**
Dairy Cattle Farming	24,170	0	8,527	71,229	100,934	95,205	235,125	**535,190**	**1,853,329**
Deer Farming	2,785	0	870	0	79,241	45,109	46,644	**174,649**	**231,005**
Horse Farming	152	0	141	275	4,853	2,064	760	**8,245**	**27,119**
Pig Farming	59	0	0	0	3,480	401	547	**4,487**	**6,551**
Other Livestock Farming n.e.c.	96	0	153	0	689	425	0	**1,363**	**6,636**
Forestry	2,744	980	5,375	1,044	35,146	10,072	2,694	**58,055**	**106,466**
Revised Other[1]	159	0	15	0	1,666	530	338	**2,708**	**7,781**
Total	**89,060**	**3,164**	**353,225**	**129,962**	**2,074,333**	**1,947,208**	**1,026,338**	**5,623,290**	**10,465,746**

Source: Statistics NZ 2012 Agricultural Production Census

Appendix H Linking the model to the data

This section explains the approach used to apportion the agriculture inputs and outputs in the CGE model between irrigated and non-irrigated production using the farm budgets provided by AgFirst. These budgets provide an estimate of the revenue, input costs and gross margins by hectare for selected types of farms in selected regions. To convert these budgets to estimated national shares of irrigated and non-irrigated and agricultural revenues and costs we have used the following approach:

- obtained data from Statistics New Zealand on the area in hectares of land use by farm type from the Agricultural Production Survey 2012. Farms are classified by ANZSIC06 code, land type[15] is grouped by the categories 'grass land', 'tussock and danthonia', 'grain seed and fodder crop land', and 'horticultural land' and reported by region
- data from MPI on the area in hectares of irrigated land use by farm type. Our understanding is that this data was also obtained from the Agricultural Production Survey 2012 completed by Statistics New Zealand. Farms are classified by ANZSIC06 code and land areas are reported by region
- multiplied the revenue, input cost and gross margin per hectare by the number of hectares for that use of farmland for each regional budget to estimate total regional revenue, cost and gross margin for each of the regional farm budgets (farm use and irrigated versus non-irrigated land)
- added-up the regional budgets for each farm use type to give national totals for the estimated revenue, input costs and gross margins for irrigated and non-irrigated land
- calculated the shares of national irrigated and non-irrigated farm revenue, input costs and gross margins for each of the farm use types covered by the regional farm budgets
- used these shares of national irrigated and non-irrigated to separate the farming activities included in the CGE model into irrigated and non-irrigated components.

The application of this process has varied depending on the coverage of the farm budgets provided. Also the land use reported by Statistics New Zealand indicate less reliance on irrigated land for some of the horticultural industries than was implied by the farm budgets. The following tables contain the land areas used for each of the farm budgets provided by MPI.

[15] The Agricultural Production Survey also includes the following land use categories: 'plantations of exotic trees intended for harvest', 'harvested exotic forest area awaiting restocking', 'mature native bush', 'native scrub and regenerating native bush' and 'all other land'. To avoid diluting the importance of production from irrigated land we have excluded land related to forestry, native bush and other land form our analysis.

Table 30 North Island dairy farming land use and gross margin by region

For regions with budgets 5 percent of farm area is irrigated and accounts for 7 percent of regional gross margin

Description	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawke's Bay	Taranaki	Manawatu-Wanganui	Wellington	North Island Total	New Zealand Total
Farm area (ha)											
Irrigated area	4,171	1,477	15,706	7,128	0	4,144	6,058	16,605	12,515	**67,804**	**352,240**
Non-irrigated area	175,544	44,800	581,941	99,211	5,160	18,012	192,237	167,365	33,869	**1,318,319**	**1,853,329**
Total	**179,715**	**46,277**	**597,647**	**106,339**	**5,160**	**22,156**	**198,295**	**183,970**	**46,384**	**1,385,943**	**2,205,569**
Gross margin ($m)											
Irrigated area	17		145			14	35	89	67	**366**	**1,883**
Non-irrigated area	534		2,312			42	838	697	141	**4,932**	**7,664**
Total	**551**		**2,457**			**57**	**873**	**786**	**208**	**5,298**	**9,546**

Source: NZIER analysis and aggregation of regional budgets commissioned by MPI

Table 31 South Island dairy farming land use and gross margin by region

For regions with budgets 56 percent of farm area is irrigated and accounts for 73 percent of regional gross margin

Land use	Tasman	Nelson	Marlborough	West Coast	Canterbury	Otago	Southland	South Island	North Island	New Zealand
Farm area (ha)										
Irrigated area	4,106	0	2,208	1,583	231,835	32,253	12,451	**248,436**	**67,804**	**352,240**
Non-irrigated area	24,170	0	8,527	71,229	100,934	95,205	235,125	**535,190**	**1,318,319**	**1,853,329**
Total	**28,276**	**0**	**10,735**	**72,812**	**332,769**	**127,458**	**247,576**	**819,626**	**1,385,943**	**2,205,569**
Gross Margin ($m)										
Irrigated area					1,459		57	**1,516**	**366**	**1,883**
Non-irrigated area					342		874	**2,732**	**4,932**	**7,664**
Total					**1,800**		**931**	**4,248**	**5,298**	**9,546**

Source: NZIER analysis and aggregation of regional budgets commissioned by MPI

Table 32 North Island sheep and beef farming land use and gross margin by region

Description	Northland	Auckland	Waikato	Bay of Plenty	Gisborne	Hawke's Bay	Taranaki	Manawatu-Wanganui	Wellington	North Island Total	New Zealand Total
Farm area (ha)											
Irrigated area	665	110	947	302	609	6,416	283	2,427	1,621	**13,380**	**194,223**
Non-irrigated area	279,594	85,464	505,947	82,537	335,109	609,196	129,258	924,557	261,516	**3,213,178**	**7,821,241**
Total	**280,259**	**85,574**	**506,894**	**82,839**	**335,718**	**615,612**	**129,541**	**926,984**	**263,137**	**3,226,558**	**8,015,464**
Gross Margin ($m)											
Irrigated area						7			2	**8**	
Non-irrigated area	147		355	58		385		941	165	**2,052**	
Total	**147**		**355**	**58**		**392**		**941**	**167**	**2,060**	

Source: NZIER analysis and aggregation of regional budgets commissioned by MPI

Table 33 South Island sheep and beef farming land use and gross margin by region

Land use	Tasman	Nelson	Marlborough	West Coast	Canterbury	Otago	Southland	South Island Total	North Island Total	New Zealand Total
Farm area (ha)										
Irrigated area	1,568	0	3,156	446	123,720	49,179	2,774	**180,843**	**13,380**	**194,223**
Non-irrigated area	54,180	1,152	259,806	43,931	1,759,703	1,772,784	716,507	**4,608,063**	**3,213,178**	**7,821,241**
Total	**55,748**	**1,152**	**262,962**	**44,377**	**1,883,423**	**1,821,963**	**719,281**	**4,788,906**	**3,226,558**	**8,015,464**
Gross Margin ($m)										
Irrigated area			2		133	17	1	**153**	**8**	**161**
Non-irrigated area			139		794	234	341	**1,507**	**2,052**	**3,559**
Total			141		927	251	341	**1,660**	**2,060**	**3,719**

Source: NZIER analysis and aggregation of regional budgets commissioned by MPI

Appendix I Pattern of farming without irrigation

The analysis of budgets commissioned by MPI provided estimates by region of the use of farmland in the absence of irrigation. Approximately half of the land that is currently irrigated would be used for the same purpose but would generate a lower gross margin. Most of the remaining land would be have been used for pastoral farming rather than the current use (usually horticulture or crops).

Table 34 Use of land in the absence of the irrigation – nursery and vegetables

Land use	Current irrigated land			Same use but non-irrigated			Different use if non-irrigated		
	Land area (ha)	Implied GM $/ha	GM Total ($m)	Land area (ha)	Implied GM $/ha	GM Total ($m)	Land area (ha)	Implied GM $/ha	GM Total ($m)
Nursery Production (Under Cover)	156		0.0	0		0.0	0		0.0
Nursery Production (Outdoors)	3,009	22,267	67.0	305	15,318	4.7	0		0.0
Floriculture Production (Under Cover)	129		0.0	0		0.0	0		0.0
Floriculture Production (Outdoors)	73	22,331	1.6	2	16,684	0.0	0		0.0
Mushroom Growing	0		0.0	0		0.0	0		0.0
Vegetable Growing (Under Cover)	285		0.0	0		0.0	0		0.0
Vegetable Growing (Outdoors)	33,290	3,015	100.4	6,793	2,122	14.4	0		0.0

Source: NZIER analysis and aggregation of regional budgets commissioned by MPI

Table 35 Use of land in the absence of the irrigation – horticulture and sheep and beef

Land use	Current irrigated land			Same use but non-irrigated			Different use if non-irrigated		
	Land area (ha)	Implied GM $/ha	GM Total ($m)	Land area (ha)	Implied GM $/ha	GM Total ($m)	Land area (ha)	Implied GM $/ha	GM Total ($m)
Grape Growing	30,173	6,568	198.2	4,153	5,080	21.1	0		0.0
Kiwifruit Growing	5,690	23,408	133.2	2,101	16,292	34.2	0		0.0
Berry Fruit Growing	2,977	2,743	8.2	372	2,826	1.1	0		0.0
Apple and Pear Growing	8,918	8,168	72.8	1,864	5,375	10.0	0		0.0
Stone Fruit Growing	2,097	17,200	36.1	473	13,648	6.5	0		0.0
Citrus Fruit Growing	430	2,920	1.3	107	2,166	0.2	0		0.0
Olive Growing	746	8,285	6.2	73	6,501	0.5	0		0.0
Other Fruit and Tree Nut Growing	2,495	3,517	8.8	394	2,303	0.9	0		0.0
Sheep Farming (Specialised)	82,163	1,511	124.2	82,163	748	61.4	379	55	0.0
Beef Cattle Farming (Specialised)	47,365	1,494	70.8	47,365	768	36.4	27,735	256	7.1
Sheep-Beef Cattle Farming	27,912	1,493	41.7	27,912	766	21.4	204,485	794	162.3
Grain-Sheep or Grain-Beef Cattle Farming	36,783	2,542	93.5	36,398	1,484	54.0	1,764	1,604	2.8

Source: NZIER analysis and aggregation of regional budgets commissioned by MPI

Table 36 Use of land in the absence of the irrigation – arable, dairy, deer and other types of farming

Land use	Current irrigated land			Same use but non-irrigated			Different use if non-irrigated		
	Land area (ha)	Implied GM $/ha	GM Total ($m)	Land area (ha)	Implied GM $/ha	GM Total ($m)	Land area (ha)	Implied GM $/ha	GM Total ($m)
Other Grain Growing	47,431	2,538	120.4	24,113	1,488	35.9	10,423	1,258	13.1
Other Crop Growing n.e.c.	16,110	2,566	41.3	9,489	1,469	13.9	68,627	1,484	101.9
Dairy Cattle Farming	352,240	6,017	2,119.3	122,570	3,698	453.2	8,062	3,868	31.2
Poultry Farming (Eggs)	0		0.0	0		0.0	0		0.0
Deer Farming	9,327	1,528	14.2	9,282	648	6.0	0		0.0
Horse Farming	2,345	2,223	5.2	1,442	1,535	2.2	0		0.0
Pig Farming	1,239	2,543	3.2	682	1,600	1.1	0		0.0
Other Livestock Farming n.e.c.	428	1,451	0.6	428	931	0.4	0		0.0
Forestry	83		0.0	0		0.0	0		0.0
Other	174		0.0	0		0.0	0		0.0
Totals	**721,373**	**4,530**	**3,268.0**	**378,479**	**2,060**	**779.6**	**321,474**	**991**	**318.4**

Source: NZIER analysis and aggregation of regional budgets commissioned by MPI

Appendix J Assumptions used in calculating impacts

J.1 Northland

Impact if irrigation had never occurred.

Dairy: Land currently irrigated would still have been developed into dairying, but would have a lower average production and be more vulnerable to dry summers.

Beef: Similar to dairying – would still be in beef but at a lower/more variable profitability.

Horticulture: Area in horticulture around Kerikeri would be much smaller – basically confined to citrus in the heavier soils around Kerikeri.

Without water, it would be difficult to establish crops, fruit size would be smaller, and yields would be less.

Mangatapere: Likely to remain in pasture. The lower area likely to be in dairying, higher area in sheep and beef.

Similar situation with other tree crops, e.g., avocadoes, need water to establish.

Table 37 Northland

Assumptions		Alternative land use	
	Area out	Dairy	Sheep and beef
Horticulture (except citrus)	100%	75%	25%
Dairy/Beef	0%	-	-
Citrus	0%	-	-

Source: Regional farm budget workshop commissioned by MPI

J.2 Auckland

Impact if irrigation had never occurred

Crops: Much of the vegetable land would still be developed into vegetables, but at a lower level of production/higher variability.

Horticulture: Water is critical for yields, and hence this land would be in dairying.

Livestock: This land would still be in livestock, albeit at a lower level of production/higher variability.

Table 38 Auckland

Assumptions		Alternative land use
	Area out	Dairy
Vegetables	75%	100%
Horticulture	90%	100%
Dairy/Sheep and beef	0%	-

Source: Regional farm budget workshop commissioned by MPI

J.3 Waikato

Impact if irrigation had never occurred.

Most land uses would still be predominantly in the same use, but with a 20-25% lower level of production plus higher variability between years.

Area in vegetables would reduce by 50%. Most of this would be a reduction in potatoes and onions (main crop requiring irrigation). The only growers making a profit have scale, and are exporting to niche markets. Land use would shift into dairying.

Table 39 Waikato

Assumptions		Alternative land use
	Area out	Dairy
Vegetables	50%	100%
Horticulture	0%	-
Sheep and beef	0%	-
Dairy	0%	-

Source: Regional farm budget workshop commissioned by MPI

J.4 Bay of Plenty

Impact of no irrigation

Horticulture: East of Te Puke/Kaituna – irrigation very important for establishment / development of orchards. Irrigation very important to enhance yields, and particularly size of fruit.

Dairy: Area still likely to be in dairy farming, with average production levels down 15%.

Drystock: Area will remain in drystock, with stocking rates down 2SU/ha (from 12SU to 10SU).

Table 40 Bay of Plenty

Assumptions		Alternative land use
	Area out	Dairy
Vegetables	100%	100%
Horticulture	50%	100%
Pastoral	0%	-

Source: Regional farm budget workshop commissioned by MPI

J.5 Gisborne

Impact if irrigation had never occurred

Horticulture: Need irrigation to achieve high/economic yields. In the absence of irrigation it would be difficult to establish trees/vines and profitability would be very variable – risk would be much higher. In the absence of irrigation – land use would have remained in pastoral farming (drystock), and some cropping, e.g., sweetcorn

Sheep & Beef: More extensive, stocking rate down by 25% (i.e., 12SU/ha to 9SUlha).

Table 41 Gisborne

Assumptions		Alternative land use	
	Area out	Cropping	Sheep & Beef
Horticulture	100%	50%	50%
Pastoral	0%	-	-

Source: Regional farm budget workshop commissioned by MPI

J.6 Hawke's Bay

Impact if irrigation had never occurred

Horticulture: Need irrigation to achieve high/economic yields. In the absence of irrigation, it would be difficult to establish trees/vines and profitability would be very variable – risk would be much higher.

Very likely that areas in trees/vines would decrease by 50%, and profitability of the remainder drops by 40-50% - water needed to increase yields (number of fruit), and size of fruit.

Few growers are likely to sustain such low production levels - hence reduction in area likely to be 80-90% - land use would be a mix of cropping and pastoral use.

Vegetables: High value crops such as onions need irrigation and would not be viable.

But some cropping would remain on the heavier soils, and mix of crops would change – move towards earlier maturing crops (e.g., peas) and other crops (e.g., winter cereals and maize).

Sheep and Beef: The current irrigated area would still be in sheep and beef, but the system would be more extensive – move to more extensive breeding/finishing systems rather than the current more intensive finishing.

Stocking rates likely to drop; from 16-18SU/ha on irrigated areas down to 9SU/ha. A number of hill country properties would still have their flat land areas (sold off for irrigation), and would use these to crop/finish stock.

Dairy: Farms on heavier soils would remain in dairying, but those on lighter soils would have stayed in sheep and beef. They could also possibly have some dairy development, with farms using supplementary feeds (e.g., cereals, maize) to meet summer deficits.

Deer: Current margins are tight, so in the absence of irrigation, likely to be either a more extensive breeding system rather than finishing yearlings or stayed in sheep and beef.

Table 42 Hawke's Bay

Assumptions		Alternative land use		
	Area out	Maize	Sheep and beef	Vegetables
Horticulture	90%	35%	30%	35%
Vegetables	70%	50%	50%	-
Sheep and beef	0%	-	-	-
Dairy	85%	-	100%	-
Deer	20%	-	100%	-
Cropping	70%	50%	50%	-

Source: Regional farm budget workshop commissioned by MPI

J.7 Taranaki

Impact if irrigation had never occurred

Most irrigated land uses would still be in the same land use, but at a lower level of production/higher variability. Main irrigated dairy units are on sandy soils along the south/western coastline.

Lack of irrigation on these units would see production drop 20-40%. Between 5-10% of these units would never have been developed into dairying without irrigation

On approximately 33% of the farms, irrigation is only on part of that farm and irrigation used for 1-2 months. On these farms, lack of irrigation would mean a 10% drop in production.

Table 43 Taranaki

Assumptions	Area
Proportion of dairy farms no longer exist	10%
Dairy farms partially affected	33%
Dairy farms significantly affected	57%
Other farms have remained in a more extensive system	100%

Source: Regional farm budget workshop commissioned by MPI

J.8 Manawatu-Wanganui

Impact if irrigation had never occurred

Vegetables: Would still grow some crops on the heavier silt soils (e.g., around Opiki), but lower production/profitability, higher variability. Need irrigation for higher value crops, e.g., onions.

On lighter soils generally lower intensity of production, but need irrigation. Without – switch to cereals, maize.

Dairy: Lighter sandy soils (e.g., Himitangi/Bulls) – need irrigation. Without – would have developed different systems: e.g., early calving, split calving, winter milk production.

Estimate that 50-75% would stay in dairying - production down 10-15%, plus higher variability. Many dairy farms adopted irrigation rather than convert from dryland – so would still be in dairying.

Sheep and Beef: No irrigation would mean a loss of intensification, and inability to readily finish lambs. would have developed as more extensive breeding/finishing system.

Table 44 Manawatu-Wanganui

Assumptions		Alternative land use		
	Area out	Cereal / Maize	Sheep and Beef	Dairy
Dairy	20%	20%	80%	-
Vegetables	25%	80%	20%	-
Horticulture	100%	-	30%	70%
Sheep and beef	0%	-	-	-
Cropping	0%	-	-	-

Source: Regional farm budget workshop commissioned by MPI

J.9 Wellington

Impact if irrigation had never occurred

Vegetables: Range of speciality crops - high risk without irrigation.

Horticulture: Mostly grapes in Wairarapa - need irrigation to establish, maintain yields, plus for frost protection.

Sheep and Beef: Would still be in sheep and beef, but on a more extensive system - lower stocking rate, less finishing/more store sales.

Dairy: Most would still be in dairying, with lower performance; 20% down on heavier soils, 40% down on lighter soils.

Table 45 Wellington

Assumptions		Alternative land use		
	Area out	Cereal / Maize	Sheep and Beef	Dairy
Vegetables	100%	100%	-	-
Horticulture	85%	100%	-	-
Sheep and beef	0%	-	-	70%
Dairy	10%	-	-	-
Cropping	20%	-	100%	-

Source: Regional farm budget workshop commissioned by MPI

J.10 Tasman

Impact if irrigation had never occurred

Vegetables/Horticulture: Could still grow most crops, but would be very marginal - yields would be down 50% in a dry year - small fruit and uneven quality. Water also needed for frost protection, although there are other methods of frost protection

Viticulture: Would be Ok if established, although yields could be 40-50% lower and variability higher - generally high risk. Probably still grow some crops for local consumption, but most areas would still be in pasture (Sheep and Beef).

Pipfruit: On Moutere Hills marginal, even with the heavier soils.

Sheep and beef / Deer: would still be in the same land use under more extensive/lower profitability systems.

Dairy: Some areas (e.g., Golden Bay) OK without irrigation, although a number of farmers there still getting gains from irrigation. Other areas (e.g., Waimea plains) too dry for dairy without irrigation.

Table 46 Tasman

Assumptions		Alternative land use
	Area out	Sheep and Beef
Vegetables	85%	100%
Horticulture	85%	100%
Pipfruit	60%	100%
Sheep and beef	0%	-
Deer	0%	-
Dairy	75%	100%

Source: Regional farm budget workshop commissioned by MPI

J.11 Marlborough

Impact if irrigation had never occurred

Vegetables: Being pushed further out by grapes. Generally very marginal without water - could grow winter crops.

Grapes: Need water for establishment – once established, can survive dry weather due to long tap roots - but yields down and more variable. Some grapes could survive on the heavier soils. Very risky in the Awatere and Waihou valleys without water.

Other horticulture: Needs water to maintain yields.

Sheep and Beef: Would still be in sheep and beef, but running a more extensive dryland system.

Dairy: Very largely needs water. In the absence of grapes, some dryland dairying possible (currently dairying being pushed out by grapes).

Cropping: Still possible, but yields down 10-30% and greater variability between years.

Table 47 Marlborough

Assumptions		Alternative land use	
	Area out	Cereals	Sheep and Beef
Vegetables	90%	50%	50%
Grapes	85%	20%	80%
Other Horticulture	100%	-	100%
Sheep and beef	0%	-	-
Dairy	80%	-	100%
Crops	30%	-	100%
Deer	-	-	-

Source: Regional farm budget workshop commissioned by MPI

J.12 West Coast

Impact if irrigation had never occurred

Farming systems (beef, dairy) would still be as is, but at a less intensive level.

Table 48 West Coast

Assumptions	
	Area out
Dairy	0%
Beef	0%

Source: Regional farm budget workshop commissioned by MPI

J.13 Canterbury

Impact if irrigation had never occurred

Current irrigation has resulted in a complex situation of inter-dependency, e.g., dairy support, provision of supplementary feed.

No irrigation: Would result in much more conservative management practices, as irrigation crucial to yields and reliability for production.

Vegetables: Some still grown on heavier soils, with lower yields/higher variability.

Horticulture: Would not have developed.

Sheep and Beef: Land in sheep and beef would still be in sheep and beef, but with much more conservative farming systems. Stocking rates down ~35% (e.g., 16SU/ha down to 10). Move away from finishing systems to more breeding/finishing, with lambs sold store/lighter slaughter weights.

Cropping: Some still possible, e.g., on heavier soils on southern sides of rivers, but yields down. Most areas would still be in dryland sheep and beef. But significant areas grown prior to irrigation - without irrigation, would get opportunistic plantings (e.g., on Sheep and Beef farms) depending on price. Most of the high value crops (e.g., small seeds) would not have developed.

Dairy: Mostly gone - still in arable/sheep and beef. Again still some on heavier soils. Quite probably would still have got dairy development on land closer to foothills, with higher rainfall pattern.

Deer: Would be running a more conservative system – e.g., breeding system at lower stocking rate selling weaners and some yearlings rather than a finishing (e.g., yearlings) system.

Horses/Pigs: Land assumed to be growing crops for feed – treated as same as cropping land.

Table 49 Canterbury

Assumptions		Alternative land use			
	Area out	Cereals	Sheep and Beef	Dairy	Deer
Nursery	90%	50%	50%	-	-
Vegetables	90%	20%	80%	-	-
Horticulture	90%	25%	55%	20%	-
Sheep and beef	0%	-	100%	-	-
Cropping	50%	-	100%	-	-
Dairy	80%	30%	65%	-	5%
Deer	0%	-	-	-	100%

Source: Regional farm budget workshop commissioned by MPI

J.14 Otago

Impact if irrigation had never occurred

Nursery production: Would still be as is, but with lower profitability.

Vegetables: Still be grown on good soils around Oamaru, albeit lower production levels (down 25-33%) and higher variability.

Viticulture: Need irrigation to establish, and maintain yields. Central Otago remained with merinos (1Su/ha). Queenstown area, remained with sheep & beef (4Su/ha). Number would grow lucerne for lamb finishing.

Berryfruit: Still would be some grown (25%?), around Taieri/Kakanui, and Teviot.

Pipfruit/Stonefruit: 50% likely to still be in production, with lower yields.

Other horticulture: Unlikely to have been developed - would be in S&B (2-4SU/ha). Without irrigation, corporate investment into horticulture would be unlikely – too risky.

Table 50 Otago

Assumptions		Alternative land use				
	Area out	Cereal	Sheep and Beef 1	Sheep and Beef 2	Sheep and Beef 3	Sheep and Beef 4
Nursery	0%	-	-	-	-	-
Vegetables	50%	50%	-	-	50%	-
Viticulture	90%	-	25%	75%	-	-
Berryfruit	60%	-	-	100%	-	-
Pipfruit/Stone fruit	70%	-	-	-	50%	50%
Other horticulture	90%	-	-	100%	-	-
Sheep and beef	0%	-	-	-	100%	-
Cropping	25%	-	-	100%	-	-
Dairy	95%	25%	-	75%	-	-
Deer	0%	-	-	-	-	-
Pigs/Horses	25%	-	-	100%	-	-

Source: Regional farm budget workshop commissioned by MPI

Sheep and Beef: Would still be in sheep and beef, but with much more extensive system - lower stocking rates, selling stores/longer to finish lambs.

Cropping: Still would have been developed as cropping country (e.g., North Otago Down Lands), but with lower yields/higher variability. Likely to get more spec cropping on sheep & beef farms, depending on prices.

Dairying: Without water, very unlikely to have developed; central Otago/Ranfurly - likely to be in S&B (6-8SU/ha). Waikati valley - in S&B, 3SU/ha.

Deer: Would still be in deer, but without water SR down ~40%, & breeding/selling weaners rather than finishing yearlings.

Horses/Pigs: Land assumed to be growing crops for feed – treated as same as cropping land.

J.15 Southland

Impact if irrigation had never occurred

Nursery: Generally, high value crops that need irrigation. No water - no crops. Into dairying & S&B

Sheep and Beef: Would still be in sheep and beef, at a lower stocking rate (25% less). More extensive system, e.g., finishing lambs later.

Dairy: Would still be in dairying, at lower stocking rate/production. Irrigated farms 3.6 cows/Ha. Dryland - 2.5-2.8 cows/ha.

Other crops: Mostly cereals, and would still be in cereals, with farmers accepting a lower return/higher variability.

Horses: Assumed as cropping land.

Table 51 Southland

Assumptions		Alternative land use	
	Area out	Sheep and Beef	Dairy
Nursery	100%	50%	50%
Sheep and beef	0%	-	-
Cropping	0%	-	-
Dairy	0%	-	-
Horse	0%	-	-

Source: Regional farm budget workshop commissioned by MPI

Appendix K Land areas not included in the analysis

Within the irrigation statistics provided by Statistics New Zealand, there was a discrepancy between the regional total area of land irrigated, and the sum of the individual land use area. This is due to a number of smaller areas being suppressed due to confidentiality reasons.

In addition, a number of minor land uses were excluded from the analysis due to a lack of financial data to allow for a with/without comparison. These land uses include: covered crops, pigs, poultry, forestry, and 'other'.

The breakdown of these areas by region is shown below.

Table 52 Land area not included in analysis

Region	Missing areas (Hectares)	Minor areas left out of the analysis (hectares)
Northland	406	103
Auckland	177	223
Waikato	130	131
Bay of Plenty	305	25
Gisborne	3066	0
Hawke's Bay	49	104
Taranaki	938	0
Manawatu-Wanganui	59	73
Wellington	347	45
Marlborough	59	31
Nelson	0	0
Tasman	81	52
Canterbury:	790	243
West Coast	304	0
Otago	94	46
Southland	527	0
Total	**7,332**	**1,076**

Source: Statistics New Zealand