# Economy-wide Impacts of Proposed Policy Options for the TANK Catchments

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research

# Economy-wide Impacts of Proposed Policy Options for the TANK Catchments

## Prepared for

## Hawke's Bay Regional Council

# Contents

# Executive Summary

*Objective*

1.    The objective of this study is to estimate the flow-on economic impacts associated with changes to farm systems because of proposed policy options for managing water quality and quantity in the Tūtaekuri, Ahuriri, Ngaruroro and Karamu (TANK) catchments. The policy options are being developed in accordance with the National Policy Statement for Freshwater Management (NPS-FM).

*Policy Options*

2.    Two policy options, focuses on horticulture and pastoral farming, have been selected by the TANK stakeholder group for economic impact assessment. These options focus on horticultural irrigation restrictions plus sediment and nutrient mitigation on the Heretaunga Plains, and pastoral hill country sediment and nutrient mitigation.

3.    Three horticulture sub-scenarios are evaluated:
      a.    *Base case*: 79% of horticulture irrigated area have no bans and 21% of horticulture irrigated area are subject to current minimum flow restrictions related to Ngaruroro 2,400 l/s.
      b.    *Future B*: 74% of the irrigated area is subject to the 2013 reliability restriction, and 20% of irrigators are subject to water restrictions related to Ngaruroro 3,600 l/s and 6% related to the Tūtaekuri 2,500 l/s restrictions. Sediment and nutrient mitigations on the Heretaunga plains are also included.
      c.    *Future C*: 74% of irrigators are subject to 9 in 10-year reliability restrictions and 20% of irrigators are subject to water restrictions related to Ngaruroro 3,600 l/s and 6% to Tūtaekuri 2,500 l/s. Sediment and nutrient mitigations on the Heretaunga plains are also included.

4.    Three pastoral farming sub-scenarios are evaluated:
      a.    *Base case*: Business-as-usual pastoral farming without any forestry included.
      b.    *MS1*: Pastoral farms are modelled with a 30% reduction in sediment, with mitigations, including land use change to forestry, phased in over 10-years.
      c.    *MS2*: Pastoral farms are modelled with a 30% reduction in sediment plus 10% reduction in nitrogen nutrient loss and, again with mitigations, including land use change to forestry, phased in over 10-years.

5.    Using the above sub-scenarios other combinations are also evaluated, namely: Future B + MS1, and Future C + MS2.

*Direct Economic Impacts: AgFirst's Farm Systems Modelling and Nimmo-Bell's Discounted Cash Flows Analysis*

6.    Nimmo-Bell has worked with the AgFirst, Council officers, the TANK stakeholder group and science providers to develop a detailed set of Discounted Cashflows for horticulture and pastoral farming within the TANK under the above policy options and their sub-scenarios. The cashflows provide detailed line item information on revenue, expenditure and net surplus over a 30-year period i.e. 2021 (Year 0) to 2051. This information is a key input into the economy-wide (i.e. flow-on) assessment of economic impacts.

a. Ten farm systems were modelled covering five horticultural land uses (i.e. kiwifruit, pip fruit, grapes, summer fruit and vegetables). Expenditure is increased for agreed mitigations to reduce sediment and nutrients.

b. Five pastoral land uses (summer moist hill, summer dry breeder finishing, summer dry intensive finishing, part time and dairy). Nimmo-Bell also constructed a representative forestry farm, which allows for retirement of pastoral land when no other mitigations are viable. The Discounted Cashflows for forestry farming extend beyond 2051 (including some harvesting) and are not currently included in the Net Present Value estimates given in this summary.

*Economy-Wide Flow-On Impacts*

7. Market Economics has developed a Multi-Regional Input-Output (MRIO) framework for the year ending March 2016 which enables comprehensive assessment of the economy-wide (i.e. flow-on) impacts. This framework reports impacts at multiple scales. Specifically, this includes spatially for Hawke's Bay Region, rest of North Island and the rest of New Zealand, across time over the 30-year evaluation period, and by 106 economic industries.

8. Using Input-Output mathematics Market Economics has calculated the indirect and induced flow-on impacts associated with farm system changes in revenue, expenditure and surplus line items in the Nimmo-Bell discounted cashflows.
    a. Indirect impacts measure both backward (i.e. upstream) and forward (i.e. downstream) linkage supply chain impacts associated with the direct impacts.
    b. Induced impacts measure the changes associated with changes in household income within an economy.

9. Market Economics analysis includes the economy-wide flow-on impacts for the following directly felt effects: income from carbon (net of banking to pay back carbon liabilities), changes in purchases (expenses) including labour costs, changes in revenue (sales), changes in operating surplus, and changes in margins. The analysis considers not only demand-side, but also supply-side impacts.

*Results*

10. All results are presented in *net* economic terms i.e. net of the horticulture and pastoral base case sub-scenarios.

11. The results vary across the 30 years considered. Under the pastoral sub-scenarios, for example, the *net* cashflows (income less expenditure) recorded for forestry are negative for the first 27 years, but positive in the remaining three years as harvesting occurs. Similarly, while the horticulture sub-scenarios produce losses in the value of economic output, these losses are not experienced over the entire 30 years of analysis, and the sub-scenarios vary in terms of when the losses commence.

12. Table 1 removes some of the complexities relating to the variation in impacts over time by presenting the regional and national economic impacts as the 'average' yearly impacts experienced over the entire 30 years considered.

13. Under the horticulture sub-scenarios, Future C produces average impacts that are more than twice as large as Future B; this is regardless of whether we are considering regional or national impacts or whether we are considering the gross output and value added metrics.

14. Table 1 also shows the average annual employment impacts felt over the 30-year assessment period. Employment impacts are measured as a snapshot as at the end of February as per Statistics New Zealand's Business Frame. Importantly, employment, particularly in horticulture and fruit growing, has seasonal peaks and toughs and thus may be higher or lower at other times during a year.

15. While the pastoral sub-scenarios produce economic impacts that are much less than those calculated for the horticulture sub-scenarios, the variation between pastoral sub-scenario results is more substantial. For example, the average direct, indirect and induced value added impacts for New Zealand are around eight times higher for the MS2 sub-scenario compared to the MS1 sub-scenario ($_{2016}$ 17 million compared to $_{2016}$ 2 million).

16. When we consider the results across time by using the Net Present Value metric (NPV) (Table 2), rather than just the average result, the impacts for the MS1 sub-scenario in Hawke's Bay region change from a small positive value ($_{2016}$ 1 million - see Table 1) to a reasonably substantial negative value of $_{2016}$ 32 million. A key point to note about the NPV measure is that impacts occurring in the more distant future are given less weight than those that occur sooner through application of a discount rate.

17. A key positive outcome of the pastoral sub-scenarios is the receipt of new incomes from harvested timber and the flow-on benefits to the rest of the economy generated by way of additional jobs and incomes in wood processing. These positive outcomes are however not experienced until towards the end of the 30-year time frame (and as noted above, some impacts are experienced beyond this timeframe), which is able to be considered in the NPV metrics of Table 2, but not the average metrics of Table 1.

18. Table 2 demonstrates how impacts initially experienced by farm systems can magnify into significantly larger impacts when all direct and indirect effects of those changes are taken into consideration. For example, with Combined Scenario 3 (Future C + MS2), although the direct (NPV with 8% discount rate) value added change over the 30 years is estimated as a loss of $_{2016}$ 402 million, this increases to a loss of $_{2016}$ 1,282 million when indirect effects are taken into consideration (i.e. 3.2 times the direct impact), and a loss of $_{2016}$ 1,426 million when indirect and induced effects are considered (i.e. 3.5 times the size of the direct impact).

Table 1. Average Net Gross Output, Value Added and Employment (Direct, Indirect and Induced) Impacts by Horticulture (Fast Start – Yr3), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Scenarios, 2021-2051

| | Average Net | | | Change from 2016 | | |
|---|---|---|---|---|---|---|
| | Gross Output $_{2016}$m | Value Added $_{2016}$m | Employment MECs | Gross Output | Value Added | Employment |
| **Hawke's Bay Region** | | | | | | |
| *Horticulture (Fast Start - Year 3)* | | | | | | |
| Future B | -106 | -61 | -363 | -0.8% | -1.0% | -0.4% |
| Future C | -232 | -132 | -811 | -1.7% | -2.1% | -1.0% |
| *Pastoral (Start Year 1, 10 Year Spread)* | | | | | | |
| MS1 | -2 | 1 | 0 | 0.0% | 0.0% | 0.0% |
| MS2 | -22 | -6 | -60 | -0.2% | -0.1% | -0.1% |
| *Horticulture and Pastoral Combined* | | | | | | |
| Scenario 2 (Future B + MS1) | -108 | -60 | -363 | -0.8% | -1.0% | -0.4% |
| Scenario 3 (Future C + MS2) | -254 | -137 | -871 | -1.9% | -2.2% | -1.0% |
| **New Zealand** | | | | | | |
| *Horticulture (Fast Start - Year 3)* | | | | | | |
| Future B | -180 | -97 | -675 | 0.0% | 0.0% | 0.0% |
| Future C | -392 | -208 | -1,487 | -0.1% | -0.1% | -0.1% |
| *Pastoral (Start Year 1, 10 Year Spread)* | | | | | | |
| MS1 | -9 | -2 | -29 | 0.0% | 0.0% | 0.0% |
| MS2 | -50 | -17 | -175 | 0.0% | 0.0% | 0.0% |
| *Horticulture and Pastoral Combined* | | | | | | |
| Scenario 2 (Future B + MS1) | -189 | -98 | -705 | 0.0% | 0.0% | 0.0% |
| Scenario 3 (Future C + MS2) | -443 | -225 | -1,662 | -0.1% | -0.1% | -0.1% |

Table 2. Net Present Value of Value Added Impacts by Sub-Scenario, 2021-2051 (8% Discount Rate)

| | Value Added | | | Change from NPV 2016 Value Added | | |
|---|---|---|---|---|---|---|
| | Direct $_{2016}$m | Direct & Indirect $_{2016}$m | Direct, Indirect & Induced $_{2016}$m | Direct | Direct & Indirect | Direct, Indirect & Induced |
| **Hawke's Bay Region** | | | | | | |
| *Horticulture (Fast Start - Year 3)* | | | | | | |
| Future B | -181 | -559 | -622 | -0.3% | -0.8% | -0.9% |
| Future C | -370 | -1,195 | -1,336 | -0.5% | -1.7% | -1.9% |
| *Pastoral (Start Year 1, 10 Year Spread)* | | | | | | |
| MS1 | -19 | -33 | -32 | 0.0% | 0.0% | 0.0% |
| MS2 | -33 | -86 | -90 | 0.0% | -0.1% | -0.1% |
| *Horticulture and Pastoral Combined* | | | | | | |
| Scenario 2 (Future B + MS1) | -200 | -592 | -653 | -0.3% | -0.9% | -0.9% |
| Scenario 3 (Future C + MS2) | -402 | -1,282 | -1,426 | -0.6% | -1.9% | -2.1% |
| **New Zealand** | | | | | | |
| *Horticulture (Fast Start - Year 3)* | | | | | | |
| Future B | -181 | -776 | -982 | 0.0% | 0.0% | 0.0% |
| Future C | -370 | -1,662 | -2,116 | 0.0% | -0.1% | -0.1% |
| *Pastoral (Start Year 1, 10 Year Spread)* | | | | | | |
| MS1 | -19 | -67 | -77 | 0.0% | 0.0% | 0.0% |
| MS2 | -33 | -173 | -215 | 0.0% | 0.0% | 0.0% |
| *Horticulture and Pastoral Combined* | | | | | | |
| Scenario 2 (Future B + MS1) | -200 | -843 | -1,060 | 0.0% | 0.0% | 0.0% |
| Scenario 3 (Future C + MS2) | -402 | -1,835 | -2,331 | 0.0% | -0.1% | -0.1% |

19. Table 3 provides information on how the value added impacts are distributed among economic industries, both within the Hawke's Bay and New Zealand. Not surprisingly, in the Hawkes' Bay, the largest value added impacts are always experienced by the agricultural industry directly impacted under the sub-scenarios, and the key processing industries that are reliant on the outputs of those directly impacted agricultural industries. For example, in the Future B Horticulture sub-scenario, a loss of value added of $\$_{2016}$ 184 million is estimated for the horticulture and fruit growing industry (NPV with discount rate of 8%), and a further loss of $\$_{2016}$ 260 million is estimated for the other food manufacturing industries. Other industries are also impacted in the Hawke's Bay, particularly through losses in income, which have flow-on effects of reduced household spending e.g. on maintaining homes, retail goods.

20. Going against the general trends however, Hawke's Bay agriculture, forestry and fishery support services industry generally experiences increases in value added under the sub-scenarios. This occurs mainly because of the additional demands for services from this industry associated with undertaking farm mitigations, and because of the appearance of forestry (more demands for planting, pruning, harvesting etc).

21. For New Zealand, the principal impacts are also in key processing activities; but there are also quite wide-spread impacts across the services industries. The latter is a reflection particularly of changes in incomes and spending levels, but also the linkages of services to processing (e.g. fruit, wine, meat, textile) activities.

22. Overall, for Combined (Future B + MSI) Scenario 2, the value added impacts (NPV with 8% discount rate) in the Hawke's Bay are equivalent to a loss of 2.0% of the entire primary sector and 2.7% of the secondary sector. The regional-level losses are even more significant under Scenario 3, equivalent to 4.4% of the primary sector and approximately 5.9% of the secondary sector.

23. Table 4 provides a breakdown of the employment impacts associated with the policy options by aggregate economic industry. Under the Future B and Future C horticultural sub-scenarios, the direct employment impacts felt by the horticulture and fruit growing sector are low. This reflects the information provided to Nimmo-Bell and, in turn, to Market Economics from AgFirst. This information identified no substantive changes in farm expenditure (including labour) costs. The brunt of the impact is instead felt in terms of lost farm surplus, which at a regional scale is captured in value added (refer to Table 3). The value added impact in the horticulture and fruit growing industry is thus considerable, while the loss of employment is not. Importantly, if horticultural growers were faced with consecutive year-to-year bans or a mixture of consecutive bans and climatic events, then it is probable that they may simply fail. This possibility was not modelled, but would likely result in significant direct employment impacts. AgFirst notes that a key take-home message from their work is that by the time growers find out about ban situations (January / Feb / March) they are effectively unable to change their cost structure and the major impacts are the yields, and thus revenue and subsequently, farm income losses.

24. Table 4 shows that the employment impacts are mostly felt indirectly through impacts to processing and services, and, in turn, less spending (through reduced revenue to other industries) by households. In terms of employment impacts in processing, it is assumed that reductions in the value of output by processors will be matched by equivalent rates of employment loss.

Table 3. Net Present Value of Value Added (Direct, Indirect and Induced) Impacts of Horticulture (Fast Start – Yr3), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051 (8% Discount Rate)

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 Future B + MS1 | | Scenario 3 Future C + MS2 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m |
| 1 Horticulture and fruit growing | -184 | -190 | -376 | -389 | 0 | 1 | 0 | 1 | -184 | -189 | -376 | -388 |
| 2 Sheep, beef, dairy and grain farming | -3 | -11 | -7 | -24 | -36 | -46 | -66 | -87 | -39 | -57 | -72 | -111 |
| 3 Other farming | 0 | -1 | 0 | -3 | 0 | -1 | -1 | -2 | 0 | -2 | -1 | -5 |
| 4 Forestry and logging | -1 | -2 | -2 | -4 | 7 | 7 | 7 | 7 | 6 | 6 | 5 | 4 |
| 5 Other primary | 0 | -3 | 0 | -7 | 0 | 0 | 0 | -1 | 0 | -4 | 0 | -8 |
| 6 Agri., forestry and fish servs | 9 | 5 | 2 | -5 | 11 | 10 | 11 | 9 | 19 | 15 | 13 | 4 |
| 7 Meat manufacturing | 0 | -1 | 0 | -1 | -6 | -12 | -15 | -28 | -6 | -12 | -15 | -29 |
| 8 Other food product manufacturing | -260 | -315 | -558 | -676 | 0 | -1 | 0 | -2 | -260 | -316 | -558 | -678 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | 0 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 |
| 10 Other manufacturing | -10 | -38 | -22 | -82 | -2 | -5 | -6 | -16 | -12 | -43 | -28 | -98 |
| 11 Utilities | -9 | -24 | -19 | -51 | 0 | -1 | -1 | -6 | -9 | -25 | -20 | -57 |
| 12 Construction | -5 | -11 | -12 | -24 | 1 | 1 | 1 | -1 | -4 | -11 | -11 | -25 |
| 13 Wholesale and retail trade | -28 | -67 | -62 | -145 | -2 | -6 | -5 | -19 | -30 | -73 | -67 | -164 |
| 14 Transport | -7 | -28 | -14 | -62 | -1 | -3 | -2 | -9 | -7 | -31 | -16 | -71 |
| 15 Business services | -21 | -65 | -47 | -142 | 0 | -4 | -2 | -13 | -22 | -69 | -49 | -155 |
| 16 Local and central government | -5 | -10 | -10 | -21 | -1 | -1 | -1 | -2 | -6 | -11 | -11 | -23 |
| 17 Other services | -97 | -221 | -209 | -479 | -6 | -20 | -14 | -52 | -103 | -241 | -223 | -531 |
| **TOTAL** | **-622** | **-982** | **-1,336** | **-2,116** | **-32** | **-77** | **-90** | **-215** | **-653** | **-1,060** | **-1,426** | **-2,331** |
| **Change from NPV 2016 Value Added** | | | | | | | | | | | | |
| Primary | -1.8% | -0.1% | -3.9% | -0.3% | -0.2% | 0.0% | -0.5% | 0.0% | -2.0% | -0.1% | -4.4% | -0.3% |
| Secondary | -2.7% | -0.1% | -5.8% | -0.3% | 0.0% | 0.0% | -0.2% | 0.0% | -2.7% | -0.1% | -5.9% | -0.3% |
| Tertiary | -0.4% | 0.0% | -0.8% | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% | -0.4% | 0.0% | -0.8% | 0.0% |
| **Total** | **-0.9%** | **0.0%** | **-1.9%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.9%** | **0.0%** | **-2.1%** | **-0.1%** |

Table 4. Average Net Employment (Direct, Indirect and Induced) Impacts of Horticulture (Fast Start – Yr3), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 | | Scenario 3 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs |
| 1 Horticulture and fruit growing | -9 | -21 | -19 | -45 | 0 | 1 | -1 | 2 | -9 | -20 | -20 | -43 |
| 2 Sheep, beef, dairy and grain farming | -3 | -12 | -6 | -26 | -21 | -32 | -38 | -65 | -23 | -44 | -44 | -91 |
| 3 Other farming | 0 | -2 | -1 | -5 | 0 | -2 | -1 | -5 | -1 | -4 | -2 | -9 |
| 4 Forestry and logging | 0 | -1 | -1 | -2 | 9 | 10 | 9 | 10 | 9 | 9 | 8 | 8 |
| 5 Other primary | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 |
| 6 Agri., forestry and fish servs | 14 | 8 | 2 | -11 | 7 | 6 | 8 | 4 | 21 | 14 | 10 | -7 |
| 7 Meat manufacturing | 0 | -1 | 0 | -2 | -12 | -20 | -28 | -48 | -12 | -21 | -28 | -50 |
| 8 Other food product manufacturing | -139 | -165 | -299 | -353 | 0 | 0 | 0 | -1 | -139 | -165 | -299 | -354 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | -1 | 12 | 17 | 12 | 17 | 12 | 17 | 12 | 17 |
| 10 Other manufacturing | -12 | -34 | -26 | -73 | -1 | -3 | -5 | -13 | -13 | -37 | -31 | -86 |
| 11 Utilities | -2 | -4 | -4 | -9 | 0 | 0 | 0 | 0 | -1 | -4 | -4 | -10 |
| 12 Construction | -9 | -17 | -20 | -38 | 3 | 2 | 2 | 0 | -6 | -15 | -18 | -38 |
| 13 Wholesale and retail trade | -45 | -94 | -99 | -204 | 0 | -3 | -5 | -20 | -45 | -97 | -104 | -224 |
| 14 Transport | -7 | -27 | -16 | -60 | 1 | 1 | -1 | -6 | -6 | -26 | -17 | -65 |
| 15 Business services | -50 | -115 | -109 | -250 | 1 | -2 | -4 | -18 | -49 | -117 | -113 | -268 |
| 16 Local and central government | -7 | -12 | -14 | -25 | 0 | 0 | -1 | -2 | -7 | -12 | -15 | -27 |
| 17 Other services | -93 | -178 | -199 | -383 | 0 | -4 | -9 | -30 | -93 | -182 | -208 | -413 |
| **TOTAL** | **-363** | **-675** | **-811** | **-1,487** | **0** | **-29** | **-60** | **-175** | **-363** | **-705** | **-871** | **-1,662** |
| **Change from 2016 Employment** | | | | | | | | | | | | |
| Primary | 0.0% | 0.0% | -0.2% | -0.1% | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | 0.0% | -0.3% | -0.1% |
| Secondary | -1.4% | -0.1% | -3.1% | -0.2% | 0.0% | 0.0% | -0.2% | 0.0% | -1.4% | -0.1% | -3.3% | -0.2% |
| Tertiary | -0.4% | 0.0% | -0.8% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.4% | 0.0% | -0.8% | -0.1% |
| **Total** | **-0.4%** | **0.0%** | **-1.0%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.4%** | **0.0%** | **-1.0%** | **-0.1%** |

## Sensitivity Analysis

25. To better understand the scale of the impacts two sensitivity tests are undertaken in alignment with the Nimmo-Bell work. First, the results are analysed with not only the standard 8% Treasury discount rate, but also with lower 6% and 2% discount rates. Second, the speed of implementation of the policies is also analysed. This includes the medium (Year 5 onwards) and slow (Year 8 onwards) start options in addition to the fast start option (from the beginning of Year 3).

26. Changing the discount rate considerably affects the magnitude of the Present Values.

27. Changing the speed of implementation also has a major influence on outcomes. If land managers are given reasonable time to implement mitigations, then there is likely to be a high degree of adoption. Less resources will also be expended on monitoring and compliance.

## Assumptions and Caveats

28. All models are wrong as they are simplifications of reality. No model can predict the future. Models based on existing patterns and historical trends may not necessarily be a good guide to future outcomes. Human activities are increasingly pushing up against social, cultural and environmental limits, which are resulting in new and emergent system behaviours (e.g. tipping points) not seen before.

29. The modelling results presented here represent our best understanding of how the Hawke's Bay and New Zealand economies would respond to the proposed policy options and sub-scenarios. They have been developed to help us understand the likely scale and magnitude of the impacts associated with the proposed TANK policy options. They are indicative rather than predictive.

30. Input-output analysis assumes that the relative interrelationships (or interdependencies) between industries remain constant over time. Thus, the way in which industries produce their commodities (i.e. production mix) and generate their revenues (i.e. sales mix), does not change through the analysis.

31. Input-output analysis does not account for general equilibrium feedbacks that exist within an economy such as commodity and factor price dynamics, substitution and transformation effects, and the circular flow of money within an economy.

32. All the assumptions made in the AgFirst and Nimmo-Bell reports also apply to the results presented in this study. This includes:
    a. Exclusion of future growth aspirations from the analysis.
    b. No allowance is made in the Farm Systems modelling for changes in crop mix i.e. moving from high to low yield crops.
    c. The Future B and C sub-scenarios assumed no (substantive) reduction in horticulture expenditure, rather only revenue and operating surplus loses.

# Definitions

Value added and employment are the key economic aggregates measured. Value added impacts are measured in $\$_{2016}$ million, while employment impacts are measures in job (or Modified Employee Count (MEC) – see below) year equivalents, where one job year is equivalent to employing a single full-time equivalent worker for one year.

'Value added' is a measure of contribution made by capital and labour when making, or providing, a commodity i.e. the value of output after the cost of bought-in materials and services has been deducted. It includes the National Account categories of 'gross operating surplus', 'compensation of employees', 'other taxes on productions' and 'subsidies'. Value added is equal to Gross Domestic Product (GDP) less taxes on products and import taxes net of subsidies.

Importantly, while value added is related to the Net Revenue expenditure reported in the Nimmo-Bell study, there are important differences. Value added seeks to measure the value of income being generated each year from the resources held in a given geographic area. Resources include capital (e.g. land, farm machinery) as well as labour. Value added thus include labour income received by farm workers, while Nimmo-Bell's Discounted Cashflow analysis excludes labour income from Net Revenue metrics.

Statistics New Zealand reports employment data using the Employee Count (EC) measure. ECs are a head count of all salary and wage earners for a given period. This includes most employees but does not capture all working proprietors (i.e. individuals who pay themselves a salary or wage). Market Economics measures employment impacts using a MEC based on ECs which also accounts for working proprietors.

# 1 Introduction

## 1.1 Background

The Tūtaekuri, Ahuriri, Ngaruroro and Karamu (TANK) project began in 2012 when the Hawke's Bay Regional Council formed a stakeholder group representing the wider community to look at the best way to manage waterways. At the heart of the TANK stakeholder group is a commitment to keep rivers running healthily, protect water supply to homes along with for swimming, fishing, cultural values, crop security, industry and other uses of water. A TANK plan has been developed to give clear direction to consent holders and other water users. It is a challenging balancing act between water use and protection.

## 1.2 Objective

The objective of this study is to estimate the flow-on economic impacts associated with changes to farm systems because of proposed policy options for managing water quality and allocation in the TANK catchments. The policy options are being developed in accordance with various legislative requirements including *inter alia* the National Policy Statement for Freshwater Management (NPS-FM).

## 1.3 Policy Options

Two policy options have been selected by the TANK stakeholder group for economic impact assessment. These options focus on horticultural irrigation restrictions plus sediment and nutrient mitigation on the Heretaunga Plains, and pastoral hill country sediment and nutrient mitigation. Full details of these policy options, and their associated sub-scenarios, may be found in Archer and Brookes (2018) and Bell (2018). A summary follows.

Three horticulture sub-scenarios are evaluated:

- *Base case (baseline)*: 79% of horticulture irrigated area have no bans and 21% of horticulture irrigated area are subject to current minimum flow restrictions related to Ngaruroro 2,400 l/s.
- *Future B*: 74% of the irrigated area is subject to the 2013 reliability restriction, and 20% of irrigators are subject to water restrictions related to Ngaruroro 3,600 l/s and 6% related to the Tūtaekuri 2,500 l/s restrictions. Sediment and nutrient mitigations on the Heretaunga plains are also included.
- *Future C*: 74% of irrigators are subject to 9 in 10-year reliability restrictions, and 20% of irrigators are subject to water restrictions related to Ngaruroro 3,600 l/s and 6% to Tūtaekuri 2,500 l/s. Sediment and nutrient mitigations on the Heretaunga plains are also included.

Three pastoral farming sub-scenarios are evaluated:

- *Base case (baseline)*: Business-as-usual pastoral farming.
- *MS1*: Pastoral farms are modelled with a 30% reduction in sediment, with mitigations, including land use change to forestry, phased in over 10-years.

- MS2: Pastoral farms are modelled with a 30% reduction in sediment plus 10% reduction in nitrogen nutrient loss and, again with mitigations, including land use change to forestry, phased in over 10-years.

Using the above sub-scenarios other combinations are also evaluated, namely: Future B + MS1, and Future C + MS2.

# 2 Methodology

## 2.1 Selection of Appropriate Modelling Framework

Input-Output (IO) analysis has been selected as the core analytical framework for this study. Alternative methodologies for assessing economic impacts do exist; the most notable being the use of Computable General Equilibrium (CGE) modelling. The authors of this report are experts in the application of both input-output and general equilibrium techniques (see, for example, McDonald and Smith (2010, 2013), Yeoman *et al.* (2009), Zhang *et al.* (2008), Smith and McDonald (2011, 2014), Fairgray *et al.* (2014) Smith *et al.* (2015) and McDonald *et al.* (2017)). Key water-related studies undertaken by the authors include the 2010 Waikato River Independent Scoping Study Economic Impact Assessment (EIA) (NIWA, 2010, 2010a), the Rotorua Lakes EIA study (Smith and McDonald, 2015; McDonald and Smith, 2011), Waikato Healthy Rivers Wai-Ora study (McDonald and Smith, 2015), Horizon's One Plan (McDonald and Smith, 2015), Environment Southland Economic Project (Smith *et al.*, 2015), Gisborne District Makauri Aquifer Recharge study (Ayers and McDonald, 2017), among many others.

Key reasons for adopting an input-output rather than CGE framework for use in this study are:

- *Disaggregation* – The input-output approach readily produces results that are disaggregated by study regions (in this case the Hawke's Bay region, the rest of the North Island and the rest of New Zealand) and economic industries (altogether 106 economic industries are reported in the model), thus providing important information on the distribution of economic impacts.
- *Paucity of data* – Creation of a multi-regional CGE model that reports down to the level of TANK would necessitate the construction of a Social Accounting Matrix (SAM) for the TANK catchments. There is a lack of information pertaining to interregional investment flows for transfers between economic agents (e.g. from government to households), upon which to complete this task.
- *Full analysis of 'circular flow of income'* – Although based on input-output, a concerted attempt has been made in this study to take full consideration of the 'circular flow of income' within an economy, much like an analysis based on a SAM or CGE. Both backward and forward linkages are considered[1] as well as the opportunity costs of funding alternative policy options.
- *Timeframe and budget* – While it was feasible to couple a multi-regional input-output based model to the selected farm system models, linking a CGE model to the outputs of the farm system models would involve a substantial body of work, particularly around pricing dynamics[2], that was considered well beyond the given timeframe and budget.

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[1] Backward linkage effects are those experienced by suppliers, or in other words, organisations situated upstream within the supply chain. This includes, for example, the loss in demand for products of fertiliser manufacturers because of a reduction in farming activities. By contrast, forward linkage effects are experienced by those who purchase goods or are situated 'downstream' within a supply chain. This includes the loss in dairy product manufacturing necessitated by a fall in the supply of raw milk from farms.

[2] Price dynamics would also need to be built into the AgFirst farm systems modelling. Moreover, to capture pricing impacts, the farm system and regional economic impact models would need to be dynamically coupled i.e. the implications of price change in one model would need to be captured in the other and vice versa through time.

## 2.2 An Introduction to Input-Output Analysis

Prior to describing the specifics of the methodology, it is helpful to provide readers, particularly those not familiar with input-output analysis, with a brief introduction to the input-output framework.[3] The remaining sections of the methodology describe the way the different policy options and their sub-scenarios are incorporated into an input-output framework, including the major assumptions applied in the TANK analysis.

At the core of any input-output analysis is a set of data that measures the flows of money or goods among various industrial groups within an economy for a given year. These flows are recorded in a matrix or 'input-output table' by arrays that summarise the purchases made by each industry (its inputs) from and the sales of each industry (its outputs) to all other industries. By using the information contained within such a matrix, input-output practitioners may calculate mathematical relationships that describe the interdependencies that exist between the economic industries that comprise the economy under investigation. These relationships describe the interactions between industries – specifically, the way in which each industry's production requirements depend on the supply of goods and services from other industries. With this information it is possible to calculate, given a proposed alteration to a selected industry (i.e. a given sub-scenario), all the necessary changes in production that are likely to occur throughout supporting industries within the wider economy. For example, if one of the changes anticipated for the Hawke's Bay region were to be a loss in the amount of pastoral farming, the input-output model would calculate all the losses in output that would also occur in industries supporting pastoral farming (e.g. fertiliser production, fencing contractors, farm machinery suppliers), as well as the industries that in turn support these industries.

As with all modelling approaches, input-output analysis relies on certain assumptions for its operation. Among the most important is the assumption that the input structures of industries (i.e. the mix of commodities or industry outputs used in producing output for a specific industry) are fixed.[4] However, in the real world these 'technical coefficients' will change over time because of new technologies, relative price shifts causing substitutions, and the introduction of new industries. For this reason, input-output analysis is generally regarded as the most suitable for short-run analysis, where economic systems are unlikely to change greatly from the initial snapshot of data used to generate the base input-output tables.

## 2.3 Overview of Impacts Assessed

*Assessment of Direct Farm System Impacts*

Nimmo-Bell has worked with the AgFirst, Council officers, the TANK stakeholder group, and science providers to develop a detailed set of Discounted Cashflows for horticulture and pastoral farming within the TANK under the above two policy options and their associated sub-scenarios. The cashflows provide detailed line item information on revenue, expenditure and net surplus over a 30-year period i.e. 2021

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[3] Those who wish to learn more about input-output analysis please refer to Miller and Blair (2009).

[4] In this analysis the assumption does not apply where there has been specific analysis of changes in industrial production reflecting new regulatory and other situational conditions – i.e. as undertaken for the rural sector.

(Year 0) to 2051. This information is a key input into the economy-wide (i.e. flow-on) assessment of economic impacts.

- Ten farm systems were modelled covering five horticultural land uses (i.e. kiwifruit, pip fruit, grapes, summer fruit and vegetables). Expenditure is increased for agreed mitigations to reduce sediment and nutrients.

Five pastoral land uses (summary moist hill, summer dry breeder finishing, summer dry intensive finishing, part time and dairy). Nimmo-Bell also constructed a representative forestry farm, which allows for retirement of pastoral land when no other mitigations were viable. The Discounted Cashflows for forestry farming (including some harvesting) extend beyond 2051 and are not currently included in the Net Present Value estimates given in this report.

*Assessment of Regional Level Economic Impacts*

The study of economy-wide economic impacts commenced with identifying six major categories of likely economic effects associated with the proposed policy options and their sub-scenarios:

1. *Changes to farming systems within the TANK – backward linkage supply chain impacts*. There are operational expenditure changes associated with the horticultural and pastoral farms and were largely focused around nutrient, sediment and water allocation mitigations. These measures resulted in changes to the purchase patterns of horticultural and pastoral farms, creating flow-on upstream impacts through economic supply chain linkages.
2. *Changes to farming systems within the TANK – forward linkage supply chain impacts*. Changes in horticultural and pastoral sales also resulted in changes to the overall output of farms. With less output (e.g. meat, vegetables, fruit) produced per hectare, the supply to downstream processors (meat works, food and beverage manufacturers, other food manufacturing etc.) will be reduced, ultimately leading to a reduction in sales by these industries.
3. *Conversion between land uses – backward supply chain impacts*. Changes in pastoral land use across the TANK will create additional impacts for industries that would otherwise be involved in supplying goods and services to the existing agricultural industries. Conversely, where there is an increase in land used for an activity (e.g. forestry), businesses that are responsible for providing direct inputs to that activity (e.g. pruning contractors, accountants etc.) will be positively impacted by conversion of land.
4. *Conversion between land uses – forward linkage supply chain impacts*. Like the forward linkage effects resulting from changes in farming systems, the conversion of land from one use to another will result in changes to the supply of key products to downstream processors (for example, more timber to processors, but less meat to meat works).
5. *Changes in incomes for land owners*. For each of the policy options and particularly for the horticultural sub-scenarios evaluated, there were substantial changes in income for landowners in the form of reduced profits. This will cause changes in expenditure patterns of these land owners, hence creating impacts throughout the rest of the economy.

6.	*Income from carbon credits and its flow on effects*.[5] In line with the recommendations of Statistics New Zealand (Statistics New Zealand, 2010), acquisition/surrender of emission rights are considered a subsidy/tax flow between industry and government, while trading of emission rights are considered capital transfers. Because subsidies are considered part of value added, there will be additions to value added while carbon credits accrue (trees growing) and a large loss when they are surrendered (trees cut down). When tracing the flow on effects on capital investment from the carbon credits, we consider the *net* gain in carbon credits i.e. excluding those credits they would need to pay back later.

## 2.4 Incorporation of the Scenarios within the Modelling Framework

A summary of the method used to calculate the regional and national economic impacts is provided in Figure 2.1, while full details of the methodology followed is given in Steps 1 to 6 below. Information obtained from the farm systems modelling that flows in as inputs to the modelling exercise is depicted in the light blue boxes. The primary components of the input-output framework are depicted in the light grey boxes. The results produced by the model (depicted in pink at the centre of the diagram) are the value added and employment impacts associated with each sub-scenario. All results are reported in terms of the *net* change from the baseline sub-scenario.

It is also important to note that the methodological steps have been fully programmed in the R Statistical Computing Package – this enables additional policy options and sub-scenarios to be rapidly evaluated if required. The R Statistical Computing Package code is the proprietary property of Market Economics and has been made available, and tailored as appropriate, for Hawke's Bay Regional Council's sole use in this study' it may not however be used for other studies.

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[5] The TANK policy options only consider a 30-year time horizon. This makes forestry look better in value added terms than it is. Some of the planted forestry will not be at the end of the rotation by 2051, so our analysis ends up catching all the periods over which carbon credits are accruing, but not all periods over which carbon credits must be surrendered.
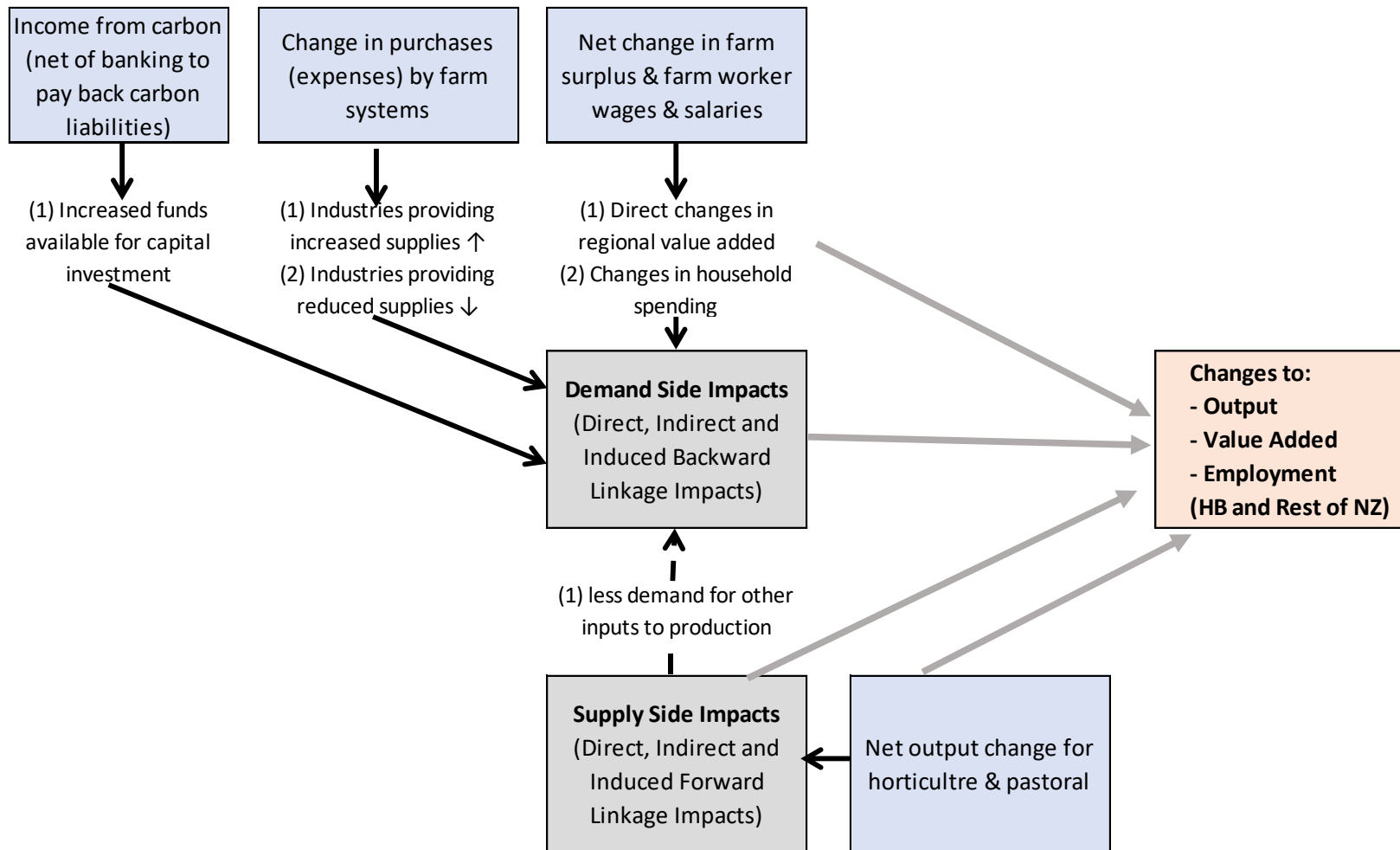
Figure 2.1      Summary of Modelling Approach

**Step 1: Production of multi-regional input–output table**

At the core of an input-output modelling framework is a matrix recording transactions between different actors within an economy. Each column of the matrix reports the monetary value of an industry's inputs, while each row represents the value of an industry's outputs. Sales by each industry to final demand categories (i.e. households, local and central government, gross fixed capital formation, etc.) are also recorded, along with each industry's expenditure on primary inputs (i.e. wages and salaries, consumption of fixed capital, gross operating surplus, etc.). The data requirements for constructing input-output matrices are vast; and this is part of the reason input-output tables are produced in New Zealand on an irregular basis. The latest available input-output table for the New Zealand economy produced by Statistics New Zealand is based on data for the year ending March 2013. Market Economics has updated these tables to the year ending March 2016 using the procedures outlined in Smith *et al*. (2015). This means that except in the case of the horticulture and pastoral (including forestry) which are considered in detail through the farm system modelling, the industry production mixes used in this study are based on the year ending March 2016 information. Changes in technology and/or production techniques that have occurred subsequently are not considered. Note, however, that when determining the likely destination of agriculture/forestry output for processing, Nimmo-Bell provide information based on their discussions with AgFirst and Council. This information was cross-checked by Market Economics using available Business Directory data. Where necessary the allocation coefficients determining the destination of output were adjusted.

The first major step required for the assessment of economy-wide effects is regionalisation of the national table to produce tables for the Hawke's Bay region, rest of the North Island, and rest of New Zealand areas. For each region or study area, 106 different economic industries are defined (refer to Appendix A). The 106 industries are as per Statistics New Zealand's latest release of the national input-output table and are directly reconcilable with the Australian and New Zealand Standard Industrial Classification (ANZSIC) system.

The process adopted to disaggregate the latest available input-output tales from Statistics New Zealand into input-output tables covering New Zealand's 16 regional councils is described in Smith *et al*. (2015).[6] The GRIT method consists of a series of mechanical steps that reduce national input-output coefficients to sub-national (or sub-regional) equivalents with reference to available regional data. In this case, reference was made particularly to employment by industry, population and household income data for each of the study areas. A gravity modelling approach partly based on big-data obtained for EFT-POS and credit card transactions but also New Zealand Transport Agency (NZTA) interregional freight flows modelling is also applied to estimate the magnitude of trade between different study areas. The general idea behind a gravity model is that the flow of goods between locations is a function of the supply or production at the origin location, the demand or consumption at the destination location, and some measure of the impedance (usually in distance or time terms) that exists between locations.

Importantly, the input-output framework used in this study is multi-regional. This means that the model considers not only the relationships between economic actors within any given study area, but also the

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[6] To be precise, our regionalisation processes generates multi-regional supply and use tables. These are then translated into the symmetric industry-by-industry input output format utilising the 'Industry Technology' assumption (ITA). For more information on the difference between supply-use and input-output tables and the ITA assumption, refer to Smith and McDonald (2011).

relationships between economic actors across the study areas. This multi-regional approach provides a means to evaluate not only regional impacts, but also the nation-wide implications.

### Step 2: Calculation of technical coefficients and allocation coefficients tables

The multi-regional input-output tables created for the regions or study areas were in turn translated into tables of technical coefficients (i.e. the **A** matrix in input-output terms) and tables of allocation coefficients (**B** matrix). The technical coefficients indicate for each industry how much input is required to produce one dollar's worth of output and are derived from the base multi-regional input-output table assuming continuous, linear relationships between inputs and outputs of each industry. Allocation coefficients can also be calculated from input–output tables in a similar manner to the calculation of technical coefficients. However, whereas technical coefficients describe the value of inputs purchased from each industry per unit of output, allocation coefficients detail the value of outputs sold to each industry per unit of output. In this study, the allocation coefficients are used solely for the purposes of determining the likely shares of primary commodities produced within the TANK and then distributed to key processing activities i.e. fruit processing, meat processing, timber processing and so on.

### Step 3: Calculation of output change vectors (Y and M)

The purpose of this step is to devise a set of industry output change vectors for which we wish to trace the backward-linkage (i.e. vector **Y**) and forward linkage (i.e. vector **M**) impacts.  The first of these set of output vectors, **Y**, is a summation of:

- *Net changes in purchases by farming activities within the TANK.*  These changes in input purchases include changes brought about by switching from one type of farming activity to another (points 3 and 6 in Section 2.3) and undertaking mitigation measures (point 1 in Section 2.3). The magnitude of these input changes is derived directly from the results of the farm system modelling. Importantly, the outlays required for mitigation measures fall on landowners. The revenue/expenditure line items from the farm system modelling accounts are matched to the input categories (i.e. different types of commodities/services as well as primary inputs such as wages and salaries) specified in the multi-regional input-output table.
- *Net changes in expenditure resulting from loss or gain in household income within the TANK.*  The outputs of the farm system modelling are used to determine the net changes in income for primarily land owners, but also employees. This includes changes in income resulting from changes to the nature and extent of different types of farm systems (point 5 in Section 2.3) as well as revenues and expenditures associated with land conversion (point 3 in Section 2.3). Thus, if classified as a current expenditure in accounting terms, a direct adjustment to the value add of the relevant industry is required. The value added (income) loss/gain will also result in a corresponding loss/gain in household expenditure. To translate income changes into spending changes, average household expenditures shares generated from the National Social Accounting Matrix (see Smith *et al*. 2015) are used. In generating these average household expenditures shares, consideration is given to the proportion of household income that is used to purchase goods and services overseas and is thus effectively lost from the New Zealand economy.
- *Additional purchases and sales of goods and services necessary to undertake land conversion (point 3 in Section 2.3).* This information is derived from the forestry and farm-level system modelling and is matched to the input-output categories.

- *Net changes in demand for goods and services used as inputs to agriculture processing (an outcome of points 2 and 4 in Section 2.3)*. The changes in output produced by agriculture and forestry within the catchment will impact the industries directly responsible for processing these commodities (e.g. fruit, vegetable, meat, wood and other food processing) and in turn the industries responsible for supplying goods to these processing industries. These additional backward linkage effects are also included in vector **Y**.

Note that as the multi-regional input-output table is expressed entirely in 2016 prices, it is necessary for all values to be translated into 2016 prices prior to input into the model. For these purposes a combination of price index series produced by SNZ are used i.e. the Farm Expenses Price Index Series, Producers Price Index – Output Series, and Implicit Price Deflator (GDP) Series. The outputs of the multi-regional input-output model (in value added terms) are thus in 2016 prices in the reported results tables.

Finally, the other output vector, **M**, is an estimate of the change in production of agricultural/forestry commodities for the TANK under each of the policy options and their sub-scenarios. This information is derived directly from the farm-system modelling revenue line items as summarised by Nimmo-Bell.[7]

### Step 4: Calculation of backward linkage impacts

As previously explained, the direct changes in output occurring in each industry will create indirect economic impacts that flow through the wider New Zealand economy. For example, reductions in fertiliser use by farmers is a reduction in demand for fertiliser manufacturers. In turn, the industries that supply fertiliser manufacturers will experience some loss in demand, and so on. Very simply, the vector of direct and indirect output effects by industry, **X**, is calculated according to the following equation:

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{Y} \tag{1}$$

where **A** is the matrix of technical coefficients (refer to Miller and Blair (2009) for further explanation), **I** is an identity matrix, and the vector **Y** is a set of exogenous output changes by industry – the impacts of which are sought to be measured. The inverse matrix $(\mathbf{I} - \mathbf{A})^{-1}$ is termed the Leontief Inverse Matrix, which shows the direct and indirect (and induced – once an additional household income row and expenditure column are added to the **A** matrix) requirements necessary to produce a unit of final demand. Some debate exists within the input-output literature on the degree to which an input-output model should be 'closed' i.e. to capture induced impacts brought on by relationships between household income and expenditure (Miller and Blair, 2009). Note also that in some cases an input-output approach can overestimate impacts, primarily due to the absence of price-related feedbacks that help regulate economies.

### Step 5: Calculation of forward linkage impacts

In most examples of regional economic impact analysis, the focus is on estimating backward linkage or demand-side effects. In this study, we have endeavoured to also capture the important supply-side or forward linkage effects associated with changes in horticulture and pastoral (including forestry) output under each sub-scenario, such as supply of produce to food manufacturers. The basic assumption in applying this supply-side approach is that the output distributions within the economic system are stable. This means that if the output of a sector is, say, doubled, sales from that industry to all other industries

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[7] To avoid double-counting of economic interlinkages, it is necessary to adjust the estimates of output change to account for output changes that are already included as a backward linkage effect.

that purchase from that industry will also be doubled. Although this assumption is unlikely to hold for many economic situations (see, for example, Giarrantani, 1980, 1981), it is a reasonable assumption for changes in output for horticulture and pastoral industries. This is because the industries that will be primarily affected by the supply-side effects are those that use the horticulture and pastoral commodities to manufacture products i.e. fruit and vegetable processing, beverage manufacture, other food processing, meat product manufacturing, textile manufacturing, wood product manufacturing and so on. For these industries, a relatively constant relationship between the availability of commodities for processing and the value of manufactured products produced is likely.

It is assumed that a change in supply of an agricultural/forestry commodity to a processor will result in a proportional change in processing output. For example, if the supply of animals to a meat processor in the Hawke's Bay reduces by 10%, then total output of the meat processing industry also reduces by 10%. Additional backward linkage effects associated with loss of processing are then included in the calculation of vector $Y$.

### Step 6: Translation of output impacts into value added and employment impacts

The final stage of the analysis is to transform estimates of net output change into value added and employment impacts. This occurs by multiplying the output change for each industry by the industry's ratio of (1) value added per unit of output, and (2) employment per unit of output.

## 2.5 Limitations and Caveats

All models are wrong as they are simplifications of reality. No model can predict the future. Models based on existing patterns, historical trends, may not necessarily be a good guide to future outcomes. This is particularly the case with human activities that increasingly push up against social, cultural and environmental limits; these may result in new and emergent system behaviours (e.g. tipping points) not seen before.

The regional level economic modelling undertaken in this study represents our best understanding of how the Hawke's Bay and New Zealand economies currently operate, and how these economies would respond to the proposed policy options and their sub-scenarios. They have been developed to help us understand the likely scale and magnitude of the impacts associated with the proposed TANK policy options. They are indicative rather than predictive.

As noted above, input-output analysis assumes that the relative interrelationships (or interdependencies) between industries remain constant over time. Furthermore, input-output analysis does not account for general equilibrium feedbacks such as commodity and factor price dynamics, substitution and transformation effects, and the circular flow of money within an economy.

All the assumptions made in the AgFirst and Nimmo-Bell also apply to the results presented in this study. This includes:

- Exclusion of future growth aspirations from the analysis.
- No allowance is made in the farm systems modelling for changes in crop mix i.e. moving from high to low yield crops.

- The Future B and C horticulture sub-scenarios assumed no (substantive) reduction in horticulture expenditure, rather only change in revenue i.e. lower yields.

# 3 Results

## 3.1 Headline Results

All results are presented in *net* economic terms i.e. net of the horticulture and pastoral base case sub-scenarios. The results vary across the 30 years considered. Under the pastoral sub-scenarios, for example, the net cashflows (income less expenditure) recorded for forestry are negative for the first 27 years, but positive in the remaining three years as harvesting occurs. Similarly, while the horticulture sub-scenarios produce losses in the value of economic output, these losses are not experienced over the entire 30 years of analysis, and the sub-scenarios vary in terms of when the losses commence.

Table 3.1 removes some of the complexities relating to the variation in impacts over time by presenting the regional and national economic impacts as the *net* average yearly impacts experienced over the entire 30 years considered. Under the horticulture sub-scenarios, Future C produces average impacts that are more than twice as large as Future B. This is regardless of whether we are considering impacts at the level of the Hawke's Bay region or the nation, or whether we are considering the gross output, value added or employment metrics. While the pastoral sub-scenarios produce economic impacts that are much less than those calculated for the horticulture sub-scenarios, the variation between pastoral sub-scenario results is more substantial. For example, the average direct, indirect and induced value added impacts for New Zealand are around eight times higher for the MS2 sub-scenario compared to the MS1 sub-scenario ($_{2016}$ 17 million compared to $_{2016}$ 2 million).

When we consider the results across time by using the Net Present Value metric (NPV) (Table 3.2) rather than just the average or mean result, the impacts for the MS1 sub-scenario in the Hawke's Bay region change from a small positive value ($_{2016}$ 1 million - see Table 3.1) to a reasonably substantial negative value of $_{2016}$ 32 million. A key point to note about the NPV measure is that impacts occurring in the more distant future are given less weight than those that occur sooner through application of a discount rate. A key positive outcome of the pastoral sub-scenarios is the receipt of new incomes from harvested timber, and the flow-on benefits to the rest of the economy generated by way of additional jobs and incomes in wood processing. However, these positive outcomes are not experienced until towards the end of the 30-year time frame, which is able to be considered in the NPV metrics of Table 3.2, but not the net average metrics of Table 3.1.

Table 3.2 demonstrates how impacts initially experienced by farm systems, can magnify into significantly larger impacts when all direct and indirect effects of those changes are taken into consideration. For example, with Scenario 3, although the direct (NPV with 8% discount rate) value added change over the 30 years is estimated as a loss of $_{2016}$ 402 million, this increases to a loss of $_{2016}$ 1,282 million when indirect effects are taken into consideration (i.e. 3.2 times the direct impact), and a loss of $_{2016}$ 1,426 million when indirect and induced effects are considered (i.e. 3.5 times the size of the direct impact).

Table 3.1. Average Net Gross Output, Value Added and Employment (Direct, Indirect and Induced) Impacts by Horticulture (Fast Start – Yr3), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051

| | Average Net | | | Change from 2016 | | |
|---|---|---|---|---|---|---|
| | Gross Output $_{2016}$m | Value Added $_{2016}$m | Employment MECs | Gross Output | Value Added | Employment |
| **Hawke's Bay Region** | | | | | | |
| *Horticulture (Fast Start - Year 3)* | | | | | | |
| Future B | -106 | -61 | -363 | -0.8% | -1.0% | -0.4% |
| Future C | -232 | -132 | -811 | -1.7% | -2.1% | -1.0% |
| *Pastoral (Start Year 1, 10 Year Spread)* | | | | | | |
| MS1 | -2 | 1 | 0 | 0.0% | 0.0% | 0.0% |
| MS2 | -22 | -6 | -60 | -0.2% | -0.1% | -0.1% |
| *Horticulture and Pastoral Combined* | | | | | | |
| Scenario 2 (Future B + MS1) | -108 | -60 | -363 | -0.8% | -1.0% | -0.4% |
| Scenario 3 (Future C + MS2) | -254 | -137 | -871 | -1.9% | -2.2% | -1.0% |
| **New Zealand** | | | | | | |
| *Horticulture (Fast Start - Year 3)* | | | | | | |
| Future B | -180 | -97 | -675 | 0.0% | 0.0% | 0.0% |
| Future C | -392 | -208 | -1,487 | -0.1% | -0.1% | -0.1% |
| *Pastoral (Start Year 1, 10 Year Spread)* | | | | | | |
| MS1 | -9 | -2 | -29 | 0.0% | 0.0% | 0.0% |
| MS2 | -50 | -17 | -175 | 0.0% | 0.0% | 0.0% |
| *Horticulture and Pastoral Combined* | | | | | | |
| Scenario 2 (Future B + MS1) | -189 | -98 | -705 | 0.0% | 0.0% | 0.0% |
| Scenario 3 (Future C + MS2) | -443 | -225 | -1,662 | -0.1% | -0.1% | -0.1% |

Table 3.2. Net Present Value of Value Added Impacts by Sub-scenario, 2021-2051 (8% Discount Rate)

| | Value Added | | | Change from NPV 2016 Value Added | | |
|---|---|---|---|---|---|---|
| | Direct $_{2016}$m | Direct & Indirect $_{2016}$m | Direct, Indirect & Induced $_{2016}$m | Direct | Direct & Indirect | Direct, Indirect & Induced |
| **Hawke's Bay Region** | | | | | | |
| *Horticulture (Fast Start - Year 3)* | | | | | | |
| Future B | -181 | -559 | -622 | -0.3% | -0.8% | -0.9% |
| Future C | -370 | -1,195 | -1,336 | -0.5% | -1.7% | -1.9% |
| *Pastoral (Start Year 1, 10 Year Spread)* | | | | | | |
| MS1 | -19 | -33 | -32 | 0.0% | 0.0% | 0.0% |
| MS2 | -33 | -86 | -90 | 0.0% | -0.1% | -0.1% |
| *Horticulture and Pastoral Combined* | | | | | | |
| Scenario 2 (Future B + MS1) | -200 | -592 | -653 | -0.3% | -0.9% | -0.9% |
| Scenario 3 (Future C + MS2) | -402 | -1,282 | -1,426 | -0.6% | -1.9% | -2.1% |
| **New Zealand** | | | | | | |
| *Horticulture (Fast Start - Year 3)* | | | | | | |
| Future B | -181 | -776 | -982 | 0.0% | 0.0% | 0.0% |
| Future C | -370 | -1,662 | -2,116 | 0.0% | -0.1% | -0.1% |
| *Pastoral (Start Year 1, 10 Year Spread)* | | | | | | |
| MS1 | -19 | -67 | -77 | 0.0% | 0.0% | 0.0% |
| MS2 | -33 | -173 | -215 | 0.0% | 0.0% | 0.0% |
| *Horticulture and Pastoral Combined* | | | | | | |
| Scenario 2 (Future B + MS1) | -200 | -843 | -1,060 | 0.0% | 0.0% | 0.0% |
| Scenario 3 (Future C + MS2) | -402 | -1,835 | -2,331 | 0.0% | -0.1% | -0.1% |

## 3.2 Detailed Results

Table 3.3 provides information on how these impacts are distributed among economic industries both within the Hawke's Bay and New Zealand as-a-whole. Not surprisingly, in the Hawke's Bay, the largest value added impacts are experienced by the agricultural industry directly impacted under the sub-scenarios, and the key processing industries that are reliant on the outputs of those directly impacted agricultural industries. For example, in the Future B Horticulture sub-scenario, a loss of value added of $\$_{2016}$ 184 million is estimated for the horticulture and fruit growing industry (NPV with discount rate of 8%), and a further loss of $\$_{2016}$ 260 million is estimated for the other food manufacturing.  Other industries are also impacted in the Hawke's Bay, particularly through losses in income, which have flow-on effects of reduced household spending (e.g. on maintaining homes, retail goods). Going against the general trends, however, Hawke's Bay agriculture, forestry and fishery support services industry generally experiences increases in value added under the sub-scenarios. This occurs mainly because of the additional demands for services from this industry associated with undertaking farm mitigations, and because of the appearance of forestry (more demands for planting, pruning, harvesting etc). For the rest of New Zealand, the principal impacts are also in key processing activities; but there are also quite wide-spread impacts across the services industries. The latter is a reflection particularly of changes in incomes and spending levels, but also the linkages of services to processing (e.g. fruit, wine, meat, textile) activities. Overall, for Combined (Future B + MSI) Scenario 2, the value added impacts (NPV with 8% discount rate) in the Hawke's Bay are equivalent to a loss of 2% of the entire primary sector and 2.7% of the secondary sector. The regional-level losses are even more significant under Scenario 3, equivalent to 4.4% of the primary sector and just under 6% of the secondary sector.

Table 3.4 provides a breakdown of the employment impacts associated with the policy options and associated sub-scenarios by aggregate economic industry. The direct employment impacts felt by the horticulture and fruit growing sector are relatively low. This reflects the information provided to Nimmo-Bell and, in turn, to Market Economics from AgFirst. Under the Future B and C horticultural sub-scenarios, AgFirst's modelling identified no substantive changes in farm expenditure (including labour) costs. The brunt of the impact is instead felt in terms of lost farm surplus, which in input-output terms, is captured in value added (see Tables 3.3). The value added impact in the horticulture and fruit growing industry is thus considerable, while the loss of employment is not. Importantly, if horticultural growers were faced with consecutive year-to-year bans or a mixture of consecutive bans and climatic events, then it is probable that they may simply fail. This possibility was not modelled but would likely result in significant direct employment impacts. AgFirst notes that a key take-home message from their work is that by the time growers find out about ban situations (January / Feb / March) they are effectively unable to change their cost structure and the major impacts are the yields, and subsequently, farm income losses.

Employment impacts are mostly felt indirectly through impacts to processing and services, and, in turn, less spending (through reduced revenues in other industries) by households. In terms of employment impacts in processing, it is assumed that reductions in the value of output by processors will be matched by equivalent rates of employment loss.

Table 3.3. Net Present Value of Value Added (Direct, Indirect and Induced) Impacts of Horticulture (Fast Start – Yr3), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051 (8% Discount Rate)

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 Future B + MS1 | | Scenario 3 Future C + MS2 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m |
| 1 Horticulture and fruit growing | -184 | -190 | -376 | -389 | 0 | 1 | 0 | 1 | -184 | -189 | -376 | -388 |
| 2 Sheep, beef, dairy and grain farming | -3 | -11 | -7 | -24 | -36 | -46 | -66 | -87 | -39 | -57 | -72 | -111 |
| 3 Other farming | 0 | -1 | 0 | -3 | 0 | -1 | -1 | -2 | 0 | -2 | -1 | -5 |
| 4 Forestry and logging | -1 | -2 | -2 | -4 | 7 | 7 | 7 | 7 | 6 | 6 | 5 | 4 |
| 5 Other primary | 0 | -3 | 0 | -7 | 0 | 0 | 0 | -1 | 0 | -4 | 0 | -8 |
| 6 Agri., forestry and fish servs | 9 | 5 | 2 | -5 | 11 | 10 | 11 | 9 | 19 | 15 | 13 | 4 |
| 7 Meat manufacturing | 0 | -1 | 0 | -1 | -6 | -12 | -15 | -28 | -6 | -12 | -15 | -29 |
| 8 Other food product manufacturing | -260 | -315 | -558 | -676 | 0 | -1 | 0 | -2 | -260 | -316 | -558 | -678 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | 0 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 |
| 10 Other manufacturing | -10 | -38 | -22 | -82 | -2 | -5 | -6 | -16 | -12 | -43 | -28 | -98 |
| 11 Utilities | -9 | -24 | -19 | -51 | 0 | -1 | -1 | -6 | -9 | -25 | -20 | -57 |
| 12 Construction | -5 | -11 | -12 | -24 | 1 | 1 | 1 | -1 | -4 | -11 | -11 | -25 |
| 13 Wholesale and retail trade | -28 | -67 | -62 | -145 | -2 | -6 | -5 | -19 | -30 | -73 | -67 | -164 |
| 14 Transport | -7 | -28 | -14 | -62 | -1 | -3 | -2 | -9 | -7 | -31 | -16 | -71 |
| 15 Business services | -21 | -65 | -47 | -142 | 0 | -4 | -2 | -13 | -22 | -69 | -49 | -155 |
| 16 Local and central government | -5 | -10 | -10 | -21 | -1 | -1 | -1 | -2 | -6 | -11 | -11 | -23 |
| 17 Other services | -97 | -221 | -209 | -479 | -6 | -20 | -14 | -52 | -103 | -241 | -223 | -531 |
| **TOTAL** | **-622** | **-982** | **-1,336** | **-2,116** | **-32** | **-77** | **-90** | **-215** | **-653** | **-1,060** | **-1,426** | **-2,331** |
| **Change from NPV 2016 Value Added** | | | | | | | | | | | | |
| Primary | -1.8% | -0.1% | -3.9% | -0.3% | -0.2% | 0.0% | -0.5% | 0.0% | -2.0% | -0.1% | -4.4% | -0.3% |
| Secondary | -2.7% | -0.1% | -5.8% | -0.3% | 0.0% | 0.0% | -0.2% | 0.0% | -2.7% | -0.1% | -5.9% | -0.3% |
| Tertiary | -0.4% | 0.0% | -0.8% | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% | -0.4% | 0.0% | -0.8% | 0.0% |
| **Total** | **-0.9%** | **0.0%** | **-1.9%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.9%** | **0.0%** | **-2.1%** | **-0.1%** |

Table 3.4. Average Net Employment (Direct, Indirect and Induced) Impacts of Horticulture (Fast Start – Yr3), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 | | Scenario 3 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs |
| 1 Horticulture and fruit growing | -9 | -21 | -19 | -45 | 0 | 1 | -1 | 2 | -9 | -20 | -20 | -43 |
| 2 Sheep, beef, dairy and grain farming | -3 | -12 | -6 | -26 | -21 | -32 | -38 | -65 | -23 | -44 | -44 | -91 |
| 3 Other farming | 0 | -2 | -1 | -5 | 0 | -2 | -1 | -5 | -1 | -4 | -2 | -9 |
| 4 Forestry and logging | 0 | -1 | -1 | -2 | 9 | 10 | 9 | 10 | 9 | 9 | 8 | 8 |
| 5 Other primary | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 |
| 6 Agri., forestry and fish servs | 14 | 8 | 2 | -11 | 7 | 6 | 8 | 4 | 21 | 14 | 10 | -7 |
| 7 Meat manufacturing | 0 | -1 | 0 | -2 | -12 | -20 | -28 | -48 | -12 | -21 | -28 | -50 |
| 8 Other food product manufacturing | -139 | -165 | -299 | -353 | 0 | 0 | 0 | -1 | -139 | -165 | -299 | -354 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | -1 | 12 | 17 | 12 | 17 | 12 | 17 | 12 | 17 |
| 10 Other manufacturing | -12 | -34 | -26 | -73 | -1 | -3 | -5 | -13 | -13 | -37 | -31 | -86 |
| 11 Utilities | -2 | -4 | -4 | -9 | 0 | 0 | 0 | 0 | -1 | -4 | -4 | -10 |
| 12 Construction | -9 | -17 | -20 | -38 | 3 | 2 | 2 | 0 | -6 | -15 | -18 | -38 |
| 13 Wholesale and retail trade | -45 | -94 | -99 | -204 | 0 | -3 | -5 | -20 | -45 | -97 | -104 | -224 |
| 14 Transport | -7 | -27 | -16 | -60 | 1 | 1 | -1 | -6 | -6 | -26 | -17 | -65 |
| 15 Business services | -50 | -115 | -109 | -250 | 1 | -2 | -4 | -18 | -49 | -117 | -113 | -268 |
| 16 Local and central government | -7 | -12 | -14 | -25 | 0 | 0 | -1 | -2 | -7 | -12 | -15 | -27 |
| 17 Other services | -93 | -178 | -199 | -383 | 0 | -4 | -9 | -30 | -93 | -182 | -208 | -413 |
| **TOTAL** | **-363** | **-675** | **-811** | **-1,487** | **0** | **-29** | **-60** | **-175** | **-363** | **-705** | **-871** | **-1,662** |
| **Change from 2016 Employment** | | | | | | | | | | | | |
| Primary | 0.0% | 0.0% | -0.2% | -0.1% | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | 0.0% | -0.3% | -0.1% |
| Secondary | -1.4% | -0.1% | -3.1% | -0.2% | 0.0% | 0.0% | -0.2% | 0.0% | -1.4% | -0.1% | -3.3% | -0.2% |
| Tertiary | -0.4% | 0.0% | -0.8% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.4% | 0.0% | -0.8% | -0.1% |
| **Total** | **-0.4%** | **0.0%** | **-1.0%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.4%** | **0.0%** | **-1.0%** | **-0.1%** |

## 3.3 Sensitivity Analysis

To better understand the scale of the impacts, two sensitivity tests are undertaken in alignment with the Nimmo-Bell work. First, the results are analysed with not only the standard 8% Treasury discount rate, but also with lower 6% and 2% discount rates. Second, the speed of implementation of the policies is also analysed. This includes the medium (Year 5 onwards) and slow (Year 8 onwards) start options in addition to the fast start option (from the beginning of Year 3).

Changing the discount rate considerably affects the magnitude of the Present Values.

Changing the speed of implementation also has a major influence on outcomes. If land managers are given reasonable time to implement mitigations, then there is likely to be a high degree of adoption. Less resources will also be expended on monitoring and compliance.

The detailed results for the sensitivity analysis are provided in Appendix B.

# 4 Recommendations

This study represents a first attempt to assess the regional and national level economic consequences associated with the proposed policy options for the TANK catchments. These policy options are being developed in accordance with various legislative requirements including *inter alia* the National Policy Statement for Freshwater Management (NPS-FM). The work is based on the farm systems work undertaken by AgFirst and, in turn, summarised into Discounted Cashflows by Nimmo-Bell for use in this study.

Throughout the course of the study we have noted several possible avenues for further research. These are outlined below:

- *Modelling the impacts of water quality vs allocation mitigations separately*. Under the Horticultural sub-scenarios (Future B and Future C), mitigations for water quality and allocation have been modelled jointly. At the TANK stakeholder group presentation, it was highlighted that understanding the impacts separately of mitigations that achieve water quality vs water allocation would be useful. While this seems a relatively straightforward exercise, it would require a meeting between AgFirst and Nimmo-Bell to ensure that that the modelling would play out at a farm system scale in the same manner as under the existing sub-scenarios i.e. that mitigations related expenses would still be borne solely by the landowners resulting in reduced revenues and, in turn, profits. Also, that all existing operational expenditures would remain constant across the scenarios. If this is not the case, then it is likely that further modelling by all parties (AgFirst, Nimmo-Bell and Market Economics) would be necessary.
- *Modelling the impacts of alternative farm system response scenarios*. This includes modelling, for example, the impacts of changes in farm system operation, including moving to crops with different yields, changes in farm system expenditure mix, or simply existing system failure and, in turn, land use conversion to next best alternatives. These alternative scenarios are likely to result in significantly different regional and national value added and employment impacts. Unfortunately, it is likely that modelling alternative farm system response scenarios would be a considerable exercise. In terms of the regional and national economic impacts, this would be less of a burden as most of the dynamics that would play out have already been coded.
- *Understanding alternative transition pathways*. The scenario impacts evaluated to date have only crudely considered transition pathways associated through staged fast, medium and slow start horticulture sub-scenario implementations. Depending on the scale and extent of the impacts, and how palatable these are to the TANK communities/stakeholders, it may be necessary to consider alternative staged implementations. It is likely that these could be modelled with relative ease by both Nimmo-Bell and Market Economics. Additional farm system modelling might be required, depending on the implementation strategy, to assess adoption curves of different mitigation bundles. Importantly, prioritisation and scheduling of mitigations can result in very significant effects on the size of regional and national impacts felt through time.
- *Cost Benefit Analysis*. It is recommended that the economic costs associated with the regional and national level impact assessment be presented alongside the wider societal, environmental and cultural benefits that the policy options provide. Economic impact assessment is usually only a component of a wider Cost-Benefit Analysis, or as per Treasury guidelines, part of the Better Business Cases framework. It is certainly easier for stakeholders to understand what values they

may be trading off if they understand the holistically economic, social, environmental and cultural impacts.

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# Appendix A

| 106 Input-Output Industry | Reporting Industry |
|---|---|
| 1 Horticulture and fruit growing | 1 Horticulture and fruit growing |
| 2 Sheep, beef cattle and grain farming | 2 Sheep, beef, dairy and grain farming |
| 3 Dairy cattle farming | 2 Sheep, beef, dairy and grain farming |
| 4 Poultry, deer and other livestock farming | 3 Other farming |
| 5 Forestry and logging | 4 Forestry and logging |
| 6 Fishing and aquaculture | 5 Other primary |
| 7 Agriculture, forestry and fishing support services | 6 Agriculture, forestry and fishing support services |
| 8 Coal mining | 5 Other primary |
| 9 Oil and gas extraction | 5 Other primary |
| 10 Metal ore and non-metallic mineral mining and quarrying | 5 Other primary |
| 11 Exploration and other mining support services | 5 Other primary |
| 12 Meat and meat product manufacturing | 7 Meat manufacturing |
| 13 Seafood processing | 7 Meat manufacturing |
| 14 Dairy product manufacturing | 8 Other food product manufacturing |
| 15 Fruit, oil, cereal and other food product manufacturing | 8 Other food product manufacturing |
| 16 Beverage and tobacco product manufacturing | 8 Other food product manufacturing |
| 17 Textile and leather manufacturing | 8 Other food product manufacturing |
| 18 Clothing, knitted products and footwear manufacturing | 8 Other food product manufacturing |
| 19 Wood product manufacturing | 9 Wood and paper manufacturing |
| 20 Pulp, paper and converted paper product manufacturing | 9 Wood and paper manufacturing |
| 21 Printing | 10 Other manufacturing |
| 22 Petroleum and coal product manufacturing | 10 Other manufacturing |
| 23 Basic chemical and basic polymer manufacturing | 10 Other manufacturing |
| 24 Fertiliser and pesticide manufacturing | 10 Other manufacturing |
| 25 Pharmaceutical, cleaning and other chemical manufacturing | 10 Other manufacturing |
| 26 Polymer product and rubber product manufacturing | 10 Other manufacturing |
| 27 Non-metallic mineral product manufacturing | 10 Other manufacturing |
| 28 Primary metal and metal product manufacturing | 10 Other manufacturing |
| 29 Fabricated metal product manufacturing | 10 Other manufacturing |
| 30 Transport equipment manufacturing | 10 Other manufacturing |
| 31 Electronic and electrical equipment manufacturing | 10 Other manufacturing |
| 32 Machinery manufacturing | 10 Other manufacturing |
| 33 Furniture manufacturing | 10 Other manufacturing |
| 34 Other manufacturing | 10 Other manufacturing |
| 35 Electricity generation and on-selling | 11 Utilities |
| 36 Electricity transmission and distribution | 11 Utilities |
| 37 Gas supply | 11 Utilities |
| 38 Water supply | 11 Utilities |
| 39 Sewerage and drainage services | 11 Utilities |
| 40 Waste collection, treatment and disposal services | 11 Utilities |
| 41 Residential building construction | 12 Construction |
| 42 Non-residential building construction | 12 Construction |
| 43 Heavy and civil engineering construction | 12 Construction |
| 44 Construction services | 12 Construction |
| 45 Basic material wholesaling | 13 Wholesale and retail trade |
| 46 Machinery and equipment wholesaling | 13 Wholesale and retail trade |
| 47 Motor vehicle and motor vehicle parts wholesaling | 13 Wholesale and retail trade |
| 48 Grocery, liquor and tobacco product wholesaling | 13 Wholesale and retail trade |
| 49 Other goods and commission based wholesaling | 13 Wholesale and retail trade |
| 50 Motor vehicle and parts retailing | 13 Wholesale and retail trade |
| 51 Fuel retailing | 13 Wholesale and retail trade |
| 52 Supermarket and grocery stores | 13 Wholesale and retail trade |

| 106 Input-Output Industry | Reporting Industry |
|---|---|
| 53 Specialised food retailing | 13 Wholesale and retail trade |
| 54 Furniture, electrical and hardware retailing | 13 Wholesale and retail trade |
| 55 Recreational, clothing, footwear and personal accessory retai | 13 Wholesale and retail trade |
| 56 Department stores | 13 Wholesale and retail trade |
| 57 Other store based retailing; non-store and commission based | 13 Wholesale and retail trade |
| 58 Accommodation | 17 Other services |
| 59 Food and beverage services | 14 Transport |
| 60 Road transport | 14 Transport |
| 61 Rail transport | 14 Transport |
| 62 Other transport | 14 Transport |
| 63 Air and space transport | 14 Transport |
| 64 Postal and courier pick up and delivery services | 14 Transport |
| 65 Transport support services | 14 Transport |
| 66 Warehousing and storage services | 17 Other services |
| 67 Publishing (except internet and music publishing) | 17 Other services |
| 68 Motion picture and sound recording activities | 17 Other services |
| 69 Broadcasting and internet publishing | 17 Other services |
| 70 Telecommunications services including internet service provi | 17 Other services |
| 71 Library and other information services | 17 Other services |
| 72 Banking and financing; financial asset investing | 17 Other services |
| 73 Life insurance | 17 Other services |
| 74 Health and general insurance | 17 Other services |
| 75 Superannuation funds | 17 Other services |
| 76 Auxiliary finance and insurance services | 17 Other services |
| 77 Rental and hiring services (except real estate); non-financial a | 17 Other services |
| 78 Residential property operation | 17 Other services |
| 79 Non-residential property operation | 17 Other services |
| 80 Real estate services | 17 Other services |
| 81 Owner-occupied property operation | 17 Other services |
| 82 Scientific, architectural and engineering services | 15 Business services |
| 83 Legal and accounting services | 15 Business services |
| 84 Advertising, market research and management services | 15 Business services |
| 85 Veterinary and other professional services | 15 Business services |
| 86 Computer system design and related services | 15 Business services |
| 87 Travel agency and tour arrangement services | 15 Business services |
| 88 Employment and other administrative services | 15 Business services |
| 89 Building cleaning, pest control and other support services | 15 Business services |
| 90 Local government administration | 16 Local and central government |
| 91 Central government administration and justice | 16 Local and central government |
| 92 Defence | 16 Local and central government |
| 93 Public order, safety and regulatory services | 16 Local and central government |
| 94 Preschool education | 17 Other services |
| 95 School education | 17 Other services |
| 96 Tertiary education | 17 Other services |
| 97 Adult, community and other education | 17 Other services |
| 98 Hospitals | 17 Other services |
| 99 Medical and other health care services | 17 Other services |
| 100 Residential care services and social assistance | 17 Other services |
| 101 Heritage and artistic activities | 17 Other services |
| 102 Sport and recreation activities | 17 Other services |
| 103 Gambling activities | 17 Other services |
| 104 Repair and maintenance | 17 Other services |
| 105 Personal services; domestic household staff | 17 Other services |
| 106 Religious services; civil, professional and other interest grour | 17 Other services |

# Appendix B: Sensitivity Analysis

In this Appendix results of the sensitivity analysis are provided. Specifically, these tables cover all sub-scenarios by all implementation (i.e. fast (3 year start), medium (5 year start) and slow (8 year start) for horticultural sub-scenarios) and discount (i.e. 8%, 6% and 2%) rates not reported elsewhere in this report. Tables B.1 through to B.8 cover value added impacts, while Tables B.9 and B.10 cover employment impacts.

Table B.1. Net Present Value of Value Added (Direct, Indirect and Induced) Impacts of Horticulture (Medium Start - Yr 5), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051 (8% Discount Rate)

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 Future B + MS1 | | Scenario 3 Future C + MS2 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m |
| 1 Horticulture and fruit growing | -154 | -121 | -315 | -326 | 0 | 1 | 0 | 1 | -154 | -121 | -315 | -325 |
| 2 Sheep, beef, dairy and grain farming | -2 | -7 | -5 | -20 | -36 | -46 | -66 | -87 | -39 | -53 | -71 | -107 |
| 3 Other farming | 0 | -1 | 0 | -2 | 0 | -1 | -1 | -2 | 0 | -2 | -1 | -5 |
| 4 Forestry and logging | -1 | -1 | -1 | -3 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 4 |
| 5 Other primary | 0 | -2 | 0 | -6 | 0 | 0 | 0 | -1 | 0 | -2 | 0 | -7 |
| 6 Agri., forestry and fish servs | 7 | 3 | 2 | -4 | 11 | 10 | 11 | 9 | 18 | 13 | 13 | 5 |
| 7 Meat manufacturing | 0 | 0 | 0 | -1 | -6 | -12 | -15 | -28 | -6 | -12 | -15 | -29 |
| 8 Other food product manufacturing | -218 | -201 | -468 | -567 | 0 | -1 | 0 | -2 | -218 | -202 | -468 | -569 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | 0 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 |
| 10 Other manufacturing | -9 | -24 | -19 | -69 | -2 | -5 | -6 | -16 | -10 | -29 | -24 | -85 |
| 11 Utilities | -8 | -15 | -16 | -43 | 0 | -1 | -1 | -6 | -7 | -17 | -17 | -49 |
| 12 Construction | -4 | -7 | -10 | -20 | 1 | 1 | 1 | -1 | -3 | -7 | -9 | -21 |
| 13 Wholesale and retail trade | -24 | -43 | -52 | -122 | -2 | -6 | -5 | -19 | -26 | -49 | -57 | -141 |
| 14 Transport | -5 | -18 | -12 | -52 | -1 | -3 | -2 | -9 | -6 | -21 | -14 | -61 |
| 15 Business services | -18 | -42 | -39 | -119 | 0 | -4 | -2 | -13 | -18 | -46 | -41 | -132 |
| 16 Local and central government | -4 | -6 | -9 | -17 | -1 | -1 | -1 | -2 | -5 | -7 | -10 | -19 |
| 17 Other services | -81 | -141 | -175 | -401 | -6 | -20 | -14 | -52 | -87 | -161 | -190 | -453 |
| **TOTAL** | **-521** | **-627** | **-1,120** | **-1,775** | **-32** | **-77** | **-90** | **-215** | **-553** | **-705** | **-1,210** | **-1,990** |
| **Change from NPV 2016 Value Added** | | | | | | | | | | | | |
| Primary | -1.5% | -0.1% | -3.3% | -0.2% | -0.2% | 0.0% | -0.5% | 0.0% | -1.7% | -0.1% | -3.8% | -0.3% |
| Secondary | -2.2% | -0.1% | -4.8% | -0.2% | 0.0% | 0.0% | -0.2% | 0.0% | -2.3% | -0.1% | -5.0% | -0.2% |
| Tertiary | -0.3% | 0.0% | -0.6% | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% | -0.3% | 0.0% | -0.7% | 0.0% |
| **Total** | **-0.8%** | **0.0%** | **-1.6%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.8%** | **0.0%** | **-1.8%** | **-0.1%** |

Table B.2. Net Present Value of Value Added (Direct, Indirect and Induced) Impacts of Horticulture (Slow Start - Yr 8), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051 (8% Discount Rate)

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 Future B + MS1 | | Scenario 3 Future C + MS2 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m |
| 1 Horticulture and fruit growing | -118 | -121 | -240 | -249 | 0 | 1 | 0 | 1 | -117 | -121 | -240 | -247 |
| 2 Sheep, beef, dairy and grain farming | -2 | -7 | -4 | -16 | -36 | -46 | -66 | -87 | -38 | -53 | -70 | -102 |
| 3 Other farming | 0 | -1 | 0 | -2 | 0 | -1 | -1 | -2 | 0 | -2 | -1 | -4 |
| 4 Forestry and logging | 0 | -1 | -1 | -2 | 7 | 7 | 7 | 7 | 7 | 6 | 6 | 5 |
| 5 Other primary | 0 | -2 | 0 | -5 | 0 | 0 | 0 | -1 | 0 | -2 | 0 | -5 |
| 6 Agri., forestry and fish servs | 6 | 3 | 1 | -3 | 11 | 10 | 11 | 9 | 16 | 13 | 13 | 6 |
| 7 Meat manufacturing | 0 | 0 | 0 | -1 | -6 | -12 | -15 | -28 | -6 | -12 | -15 | -28 |
| 8 Other food product manufacturing | -166 | -201 | -356 | -432 | 0 | -1 | 0 | -2 | -166 | -202 | -356 | -434 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | 0 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 |
| 10 Other manufacturing | -7 | -24 | -14 | -53 | -2 | -5 | -6 | -16 | -8 | -29 | -20 | -68 |
| 11 Utilities | -6 | -15 | -12 | -33 | 0 | -1 | -1 | -6 | -6 | -17 | -13 | -38 |
| 12 Construction | -3 | -7 | -7 | -15 | 1 | 1 | 1 | -1 | -2 | -7 | -7 | -17 |
| 13 Wholesale and retail trade | -18 | -43 | -39 | -93 | -2 | -6 | -5 | -19 | -20 | -49 | -45 | -112 |
| 14 Transport | -4 | -18 | -9 | -39 | -1 | -3 | -2 | -9 | -5 | -21 | -11 | -49 |
| 15 Business services | -14 | -42 | -30 | -91 | 0 | -4 | -2 | -13 | -14 | -46 | -32 | -104 |
| 16 Local and central government | -3 | -6 | -7 | -13 | -1 | -1 | -1 | -2 | -4 | -7 | -8 | -15 |
| 17 Other services | -62 | -141 | -134 | -306 | -6 | -20 | -14 | -52 | -68 | -161 | -148 | -358 |
| **TOTAL** | **-397** | **-627** | **-853** | **-1,352** | **-32** | **-77** | **-90** | **-215** | **-429** | **-705** | **-943** | **-1,567** |
| **Change from NPV 2016 Value Added** | | | | | | | | | | | | |
| Primary | -1.2% | -0.1% | -2.5% | -0.2% | -0.2% | 0.0% | -0.5% | 0.0% | -1.4% | -0.1% | -3.0% | -0.2% |
| Secondary | -1.7% | -0.1% | -3.7% | -0.2% | 0.0% | 0.0% | -0.2% | 0.0% | -1.8% | -0.1% | -3.8% | -0.2% |
| Tertiary | -0.2% | 0.0% | -0.5% | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% | -0.2% | 0.0% | -0.5% | 0.0% |
| **Total** | **-0.6%** | **0.0%** | **-1.2%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.6%** | **0.0%** | **-1.4%** | **-0.1%** |

Table B.3. Net Present Value of Value Added (Direct, Indirect and Induced) Impacts of Horticulture (Fast Start - Yr 3), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051 (6% Discount Rate)

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 Future B + MS1 | | Scenario 3 Future C + MS2 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Horticulture and fruit growing | -231 | -239 | -473 | -490 | 0 | 1 | 0 | 2 | -231 | -238 | -473 | -488 |
| 2 Sheep, beef, dairy and grain farming | -4 | -14 | -8 | -31 | -44 | -56 | -82 | -109 | -48 | -70 | -90 | -140 |
| 3 Other farming | 0 | -1 | -1 | -3 | 0 | -1 | -1 | -3 | -1 | -3 | -1 | -6 |
| 4 Forestry and logging | -1 | -2 | -2 | -5 | 14 | 15 | 14 | 15 | 13 | 13 | 12 | 10 |
| 5 Other primary | 0 | -4 | 0 | -9 | 0 | 0 | 0 | -1 | 0 | -5 | 0 | -10 |
| 6 Agri., forestry and fish servs | 11 | 6 | 2 | -7 | 11 | 10 | 12 | 9 | 22 | 17 | 14 | 2 |
| 7 Meat manufacturing | 0 | -1 | 0 | -2 | -8 | -15 | -19 | -36 | -8 | -16 | -19 | -37 |
| 8 Other food product manufacturing | -327 | -397 | -702 | -852 | 0 | -1 | 0 | -2 | -327 | -398 | -702 | -854 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | 0 | 5 | 7 | 5 | 7 | 5 | 7 | 5 | 7 |
| 10 Other manufacturing | -13 | -48 | -28 | -104 | -2 | -6 | -7 | -20 | -15 | -53 | -35 | -124 |
| 11 Utilities | -11 | -30 | -25 | -65 | 0 | -1 | -1 | -7 | -11 | -31 | -25 | -71 |
| 12 Construction | -7 | -14 | -15 | -30 | 2 | 1 | 1 | -1 | -5 | -13 | -14 | -32 |
| 13 Wholesale and retail trade | -36 | -84 | -78 | -183 | -2 | -7 | -7 | -23 | -38 | -92 | -84 | -206 |
| 14 Transport | -8 | -36 | -18 | -78 | 0 | -3 | -2 | -11 | -9 | -39 | -20 | -89 |
| 15 Business services | -27 | -82 | -59 | -179 | 0 | -5 | -2 | -16 | -27 | -87 | -62 | -195 |
| 16 Local and central government | -6 | -12 | -13 | -26 | -1 | -1 | -1 | -3 | -7 | -14 | -14 | -28 |
| 17 Other services | -122 | -279 | -263 | -603 | -6 | -22 | -17 | -63 | -128 | -301 | -280 | -666 |
| **TOTAL** | **-782** | **-1,237** | **-1,682** | **-2,665** | **-31** | **-85** | **-106** | **-262** | **-813** | **-1,322** | **-1,788** | **-2,927** |
| **Change from NPV 2016 Value Added** | | | | | | | | | | | | |
| Primary | -1.9% | -0.1% | -4.1% | -0.3% | -0.2% | 0.0% | -0.5% | 0.0% | -2.1% | -0.1% | -4.5% | -0.3% |
| Secondary | -2.8% | -0.1% | -5.9% | -0.3% | 0.0% | 0.0% | -0.2% | 0.0% | -2.8% | -0.1% | -6.1% | -0.3% |
| Tertiary | -0.4% | 0.0% | -0.8% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.4% | 0.0% | -0.8% | -0.1% |
| **Total** | **-0.9%** | **0.0%** | **-2.0%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-1.0%** | **0.0%** | **-2.1%** | **-0.1%** |

Table B.4. Net Present Value of Value Added (Direct, Indirect and Induced) Impacts of Horticulture (Medium Start - Yr 5), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051 (6% Discount Rate)

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 Future B + MS1 | | Scenario 3 Future C + MS2 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m |
| 1 Horticulture and fruit growing | -199 | -164 | -408 | -423 | 0 | 1 | 0 | 2 | -199 | -163 | -408 | -421 |
| 2 Sheep, beef, dairy and grain farming | -3 | -10 | -7 | -27 | -44 | -56 | -82 | -109 | -47 | -66 | -89 | -136 |
| 3 Other farming | 0 | -1 | -1 | -3 | 0 | -1 | -1 | -3 | -1 | -2 | -1 | -6 |
| 4 Forestry and logging | -1 | -1 | -2 | -4 | 14 | 15 | 14 | 15 | 14 | 14 | 13 | 11 |
| 5 Other primary | 0 | -3 | 0 | -8 | 0 | 0 | 0 | -1 | 0 | -3 | 0 | -9 |
| 6 Agri., forestry and fish servs | 9 | 5 | 2 | -6 | 11 | 10 | 12 | 9 | 21 | 15 | 14 | 3 |
| 7 Meat manufacturing | 0 | -1 | 0 | -1 | -8 | -15 | -19 | -36 | -8 | -15 | -19 | -37 |
| 8 Other food product manufacturing | -282 | -272 | -606 | -735 | 0 | -1 | 0 | -2 | -282 | -273 | -606 | -737 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | 0 | 5 | 7 | 5 | 7 | 5 | 7 | 5 | 7 |
| 10 Other manufacturing | -11 | -33 | -24 | -89 | -2 | -6 | -7 | -20 | -13 | -39 | -31 | -109 |
| 11 Utilities | -10 | -20 | -21 | -56 | 0 | -1 | -1 | -7 | -9 | -22 | -22 | -62 |
| 12 Construction | -6 | -10 | -13 | -26 | 2 | 1 | 1 | -1 | -4 | -9 | -12 | -27 |
| 13 Wholesale and retail trade | -31 | -58 | -67 | -158 | -2 | -7 | -7 | -23 | -33 | -65 | -74 | -181 |
| 14 Transport | -7 | -25 | -15 | -67 | 0 | -3 | -2 | -11 | -7 | -28 | -18 | -78 |
| 15 Business services | -23 | -56 | -51 | -154 | 0 | -5 | -2 | -16 | -23 | -61 | -53 | -170 |
| 16 Local and central government | -5 | -8 | -11 | -22 | -1 | -1 | -1 | -3 | -6 | -10 | -12 | -25 |
| 17 Other services | -105 | -191 | -227 | -520 | -6 | -22 | -17 | -63 | -112 | -213 | -244 | -584 |
| **TOTAL** | **-675** | **-848** | **-1,452** | **-2,300** | **-31** | **-85** | **-106** | **-262** | **-706** | **-933** | **-1,558** | **-2,563** |
| **Change from NPV 2016 Value Added** | | | | | | | | | | | | |
| Primary | -1.6% | -0.1% | -3.5% | -0.2% | -0.2% | 0.0% | -0.5% | 0.0% | -1.8% | -0.1% | -4.0% | -0.3% |
| Secondary | -2.4% | -0.1% | -5.1% | -0.2% | 0.0% | 0.0% | -0.2% | 0.0% | -2.4% | -0.1% | -5.3% | -0.2% |
| Tertiary | -0.3% | 0.0% | -0.7% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.3% | 0.0% | -0.7% | 0.0% |
| **Total** | **-0.8%** | **0.0%** | **-1.7%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.8%** | **0.0%** | **-1.8%** | **-0.1%** |

Table B.5. Net Present Value of Value Added (Direct, Indirect and Induced) Impacts of Horticulture (Slow Start - Yr 8), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051 (6% Discount Rate)

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 Future B + MS1 | | Scenario 3 Future C + MS2 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m |
| 1 Horticulture and fruit growing | -159 | -164 | -324 | -336 | 0 | 1 | 0 | 2 | -159 | -163 | -325 | -334 |
| 2 Sheep, beef, dairy and grain farming | -2 | -10 | -6 | -21 | -44 | -56 | -82 | -109 | -47 | -66 | -87 | -130 |
| 3 Other farming | 0 | -1 | 0 | -2 | 0 | -1 | -1 | -3 | -1 | -2 | -1 | -5 |
| 4 Forestry and logging | -1 | -1 | -1 | -3 | 14 | 15 | 14 | 15 | 14 | 14 | 13 | 12 |
| 5 Other primary | 0 | -3 | 0 | -6 | 0 | 0 | 0 | -1 | 0 | -3 | 0 | -7 |
| 6 Agri., forestry and fish servs | 7 | 5 | 2 | -5 | 11 | 10 | 12 | 9 | 19 | 15 | 14 | 5 |
| 7 Meat manufacturing | 0 | -1 | 0 | -1 | -8 | -15 | -19 | -36 | -8 | -15 | -19 | -37 |
| 8 Other food product manufacturing | -224 | -272 | -481 | -584 | 0 | -1 | 0 | -2 | -224 | -273 | -481 | -586 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | 0 | 5 | 7 | 5 | 7 | 5 | 7 | 5 | 7 |
| 10 Other manufacturing | -9 | -33 | -19 | -71 | -2 | -6 | -7 | -20 | -11 | -39 | -26 | -91 |
| 11 Utilities | -8 | -20 | -17 | -44 | 0 | -1 | -1 | -7 | -7 | -22 | -18 | -51 |
| 12 Construction | -5 | -10 | -10 | -21 | 2 | 1 | 1 | -1 | -3 | -9 | -9 | -22 |
| 13 Wholesale and retail trade | -25 | -58 | -53 | -126 | -2 | -7 | -7 | -23 | -26 | -65 | -60 | -149 |
| 14 Transport | -6 | -25 | -12 | -53 | 0 | -3 | -2 | -11 | -6 | -28 | -15 | -65 |
| 15 Business services | -19 | -56 | -41 | -122 | 0 | -5 | -2 | -16 | -19 | -61 | -43 | -139 |
| 16 Local and central government | -4 | -8 | -9 | -18 | -1 | -1 | -1 | -3 | -5 | -10 | -10 | -20 |
| 17 Other services | -84 | -191 | -181 | -413 | -6 | -22 | -17 | -63 | -90 | -213 | -197 | -477 |
| **TOTAL** | **-537** | **-848** | **-1,153** | **-1,827** | **-31** | **-85** | **-106** | **-262** | **-567** | **-933** | **-1,259** | **-2,090** |
| **Change from NPV 2016 Value Added** | | | | | | | | | | | | |
| Primary | -1.3% | -0.1% | -2.8% | -0.2% | -0.2% | 0.0% | -0.5% | 0.0% | -1.5% | -0.1% | -3.3% | -0.2% |
| Secondary | -1.9% | -0.1% | -4.1% | -0.2% | 0.0% | 0.0% | -0.2% | 0.0% | -1.9% | -0.1% | -4.2% | -0.2% |
| Tertiary | -0.2% | 0.0% | -0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.3% | 0.0% | -0.6% | 0.0% |
| **Total** | **-0.6%** | **0.0%** | **-1.4%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.7%** | **0.0%** | **-1.5%** | **-0.1%** |

Table B.6. Net Present Value of Value Added (Direct, Indirect and Induced) Impacts of Horticulture (Fast Start - Yr 3), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051 (2% Discount Rate)

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 Future B + MS1 | | Scenario 3 Future C + MS2 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m |
| 1 Horticulture and fruit growing | -394 | -408 | -809 | -838 | 0 | 1 | 0 | 3 | -395 | -407 | -809 | -835 |
| 2 Sheep, beef, dairy and grain farming | -6 | -24 | -14 | -53 | -70 | -91 | -138 | -187 | -76 | -115 | -152 | -239 |
| 3 Other farming | 0 | -3 | -1 | -6 | -1 | -2 | -2 | -6 | -1 | -5 | -3 | -11 |
| 4 Forestry and logging | -1 | -3 | -3 | -8 | 48 | 50 | 48 | 50 | 47 | 47 | 45 | 42 |
| 5 Other primary | 0 | -7 | -1 | -16 | 0 | 0 | 1 | -1 | 0 | -7 | 0 | -17 |
| 6 Agri., forestry and fish servs | 17 | 10 | 3 | -13 | 12 | 11 | 13 | 8 | 29 | 21 | 16 | -4 |
| 7 Meat manufacturing | 0 | -1 | 0 | -3 | -14 | -27 | -34 | -64 | -14 | -28 | -34 | -67 |
| 8 Other food product manufacturing | -561 | -680 | -1,204 | -1,460 | 0 | -2 | 0 | -4 | -561 | -682 | -1,204 | -1,464 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | -1 | 16 | 22 | 16 | 22 | 16 | 22 | 16 | 21 |
| 10 Other manufacturing | -22 | -82 | -48 | -178 | -3 | -9 | -12 | -34 | -25 | -90 | -60 | -212 |
| 11 Utilities | -19 | -51 | -42 | -111 | 2 | 0 | 0 | -9 | -18 | -51 | -42 | -120 |
| 12 Construction | -11 | -24 | -25 | -52 | 4 | 3 | 3 | -1 | -8 | -21 | -23 | -53 |
| 13 Wholesale and retail trade | -61 | -145 | -133 | -314 | -1 | -8 | -10 | -37 | -63 | -153 | -143 | -351 |
| 14 Transport | -14 | -61 | -31 | -133 | 1 | -1 | -3 | -16 | -13 | -63 | -33 | -150 |
| 15 Business services | -46 | -141 | -101 | -306 | 1 | -5 | -3 | -26 | -46 | -146 | -105 | -332 |
| 16 Local and central government | -11 | -21 | -22 | -44 | 0 | -1 | -1 | -3 | -11 | -22 | -24 | -48 |
| 17 Other services | -209 | -478 | -451 | -1,033 | -4 | -23 | -22 | -98 | -213 | -501 | -474 | -1,131 |
| **TOTAL** | **-1,341** | **-2,120** | **-2,882** | **-4,568** | **-10** | **-82** | **-146** | **-402** | **-1,351** | **-2,202** | **-3,028** | **-4,970** |
| **Change from NPV 2016 Value Added** | | | | | | | | | | | | |
| Primary | -2.0% | -0.1% | -4.3% | -0.3% | -0.1% | 0.0% | -0.4% | 0.0% | -2.1% | -0.1% | -4.7% | -0.3% |
| Secondary | -2.9% | -0.1% | -6.2% | -0.3% | 0.0% | 0.0% | -0.2% | 0.0% | -2.9% | -0.1% | -6.4% | -0.3% |
| Tertiary | -0.4% | 0.0% | -0.8% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.4% | 0.0% | -0.9% | -0.1% |
| **Total** | **-1.0%** | **0.0%** | **-2.1%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-1.0%** | **0.0%** | **-2.2%** | **-0.1%** |

Table B.7. Net Present Value of Value Added (Direct, Indirect and Induced) Impacts of Horticulture (Medium Start - Yr 5), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051 (2% Discount Rate)

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 Future B + MS1 | | Scenario 3 Future C + MS2 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m | $_{2016}$m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Horticulture and fruit growing | -359 | -318 | -735 | -761 | 0 | 1 | 0 | 3 | -359 | -317 | -736 | -759 |
| 2 Sheep, beef, dairy and grain farming | -6 | -19 | -13 | -48 | -70 | -91 | -138 | -187 | -76 | -110 | -151 | -235 |
| 3 Other farming | 0 | -2 | -1 | -5 | -1 | -2 | -2 | -6 | -1 | -4 | -2 | -11 |
| 4 Forestry and logging | -1 | -3 | -3 | -7 | 48 | 50 | 48 | 50 | 47 | 48 | 45 | 43 |
| 5 Other primary | 0 | -6 | -1 | -14 | 0 | 0 | 1 | -1 | 0 | -6 | 0 | -15 |
| 6 Agri., forestry and fish servs | 16 | 8 | 3 | -12 | 12 | 11 | 13 | 8 | 28 | 19 | 16 | -3 |
| 7 Meat manufacturing | 0 | -1 | 0 | -3 | -14 | -27 | -34 | -64 | -14 | -28 | -34 | -67 |
| 8 Other food product manufacturing | -510 | -530 | -1,094 | -1,327 | 0 | -2 | 0 | -4 | -510 | -532 | -1,094 | -1,331 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | -1 | 16 | 22 | 16 | 22 | 16 | 22 | 16 | 21 |
| 10 Other manufacturing | -20 | -64 | -43 | -162 | -3 | -9 | -12 | -34 | -23 | -72 | -56 | -196 |
| 11 Utilities | -18 | -40 | -38 | -101 | 2 | 0 | 0 | -9 | -16 | -39 | -39 | -110 |
| 12 Construction | -10 | -19 | -23 | -48 | 4 | 3 | 3 | -1 | -7 | -16 | -20 | -48 |
| 13 Wholesale and retail trade | -56 | -113 | -121 | -285 | -1 | -8 | -10 | -37 | -57 | -121 | -131 | -322 |
| 14 Transport | -13 | -48 | -28 | -121 | 1 | -1 | -3 | -16 | -12 | -49 | -31 | -137 |
| 15 Business services | -42 | -110 | -92 | -278 | 1 | -5 | -3 | -26 | -41 | -115 | -96 | -304 |
| 16 Local and central government | -10 | -16 | -20 | -40 | 0 | -1 | -1 | -3 | -10 | -17 | -22 | -44 |
| 17 Other services | -190 | -372 | -410 | -939 | -4 | -23 | -22 | -98 | -194 | -395 | -432 | -1,037 |
| **TOTAL** | **-1,218** | **-1,650** | **-2,620** | **-4,151** | **-10** | **-82** | **-146** | **-402** | **-1,229** | **-1,732** | **-2,766** | **-4,553** |
| **Change from NPV 2016 Value Added** | | | | | | | | | | | | |
| Primary | -1.8% | -0.1% | -3.9% | -0.3% | -0.1% | 0.0% | -0.4% | 0.0% | -1.9% | -0.1% | -4.3% | -0.3% |
| Secondary | -2.6% | -0.1% | -5.7% | -0.3% | 0.0% | 0.0% | -0.2% | 0.0% | -2.6% | -0.1% | -5.8% | -0.3% |
| Tertiary | -0.3% | 0.0% | -0.7% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.3% | 0.0% | -0.8% | 0.0% |
| **Total** | **-0.9%** | **0.0%** | **-1.9%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.9%** | **0.0%** | **-2.0%** | **-0.1%** |

Table B.8. Net Present Value of Value Added (Direct, Indirect and Induced) Impacts of Horticulture (Slow Start - Yr 8), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051 (2% Discount Rate)

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 Future B + MS1 | | Scenario 3 Future C + MS2 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | $2016m | $2016m | $2016m | $2016m | $2016m | $2016m | $2016m | $2016m | $2016m | $2016m | $2016m | $2016m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Horticulture and fruit growing | -307 | -318 | -630 | -653 | 0 | 1 | 0 | 3 | -308 | -317 | -631 | -650 |
| 2 Sheep, beef, dairy and grain farming | -5 | -19 | -11 | -41 | -70 | -91 | -138 | -187 | -75 | -110 | -149 | -228 |
| 3 Other farming | 0 | -2 | -1 | -4 | -1 | -2 | -2 | -6 | -1 | -4 | -2 | -10 |
| 4 Forestry and logging | -1 | -3 | -3 | -6 | 48 | 50 | 48 | 50 | 47 | 48 | 45 | 44 |
| 5 Other primary | 0 | -6 | 0 | -12 | 0 | 0 | 1 | -1 | 0 | -6 | 0 | -13 |
| 6 Agri., forestry and fish servs | 14 | 8 | 3 | -10 | 12 | 11 | 13 | 8 | 26 | 19 | 16 | -1 |
| 7 Meat manufacturing | 0 | -1 | 0 | -2 | -14 | -27 | -34 | -64 | -14 | -28 | -34 | -66 |
| 8 Other food product manufacturing | -437 | -530 | -937 | -1,137 | 0 | -2 | 0 | -4 | -437 | -532 | -937 | -1,140 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | -1 | 16 | 22 | 16 | 22 | 16 | 22 | 16 | 22 |
| 10 Other manufacturing | -17 | -64 | -37 | -138 | -3 | -9 | -12 | -34 | -20 | -72 | -50 | -172 |
| 11 Utilities | -15 | -40 | -33 | -86 | 2 | 0 | 0 | -9 | -13 | -39 | -33 | -95 |
| 12 Construction | -9 | -19 | -20 | -41 | 4 | 3 | 3 | -1 | -5 | -16 | -17 | -42 |
| 13 Wholesale and retail trade | -48 | -113 | -104 | -244 | -1 | -8 | -10 | -37 | -49 | -121 | -114 | -281 |
| 14 Transport | -11 | -48 | -24 | -104 | 1 | -1 | -3 | -16 | -10 | -49 | -27 | -120 |
| 15 Business services | -36 | -110 | -79 | -238 | 1 | -5 | -3 | -26 | -35 | -115 | -82 | -264 |
| 16 Local and central government | -8 | -16 | -17 | -34 | 0 | -1 | -1 | -3 | -9 | -17 | -19 | -38 |
| 17 Other services | -163 | -372 | -351 | -805 | -4 | -23 | -22 | -98 | -166 | -395 | -374 | -902 |
| **TOTAL** | **-1,044** | **-1,650** | **-2,244** | **-3,556** | **-10** | **-82** | **-146** | **-402** | **-1,054** | **-1,732** | **-2,390** | **-3,958** |
| **Change from NPV 2016 Value Added** | | | | | | | | | | | | |
| Primary | -1.6% | -0.1% | -3.3% | -0.2% | -0.1% | 0.0% | -0.4% | 0.0% | -1.6% | -0.1% | -3.7% | -0.3% |
| Secondary | -2.3% | -0.1% | -4.9% | -0.2% | 0.0% | 0.0% | -0.2% | 0.0% | -2.3% | -0.1% | -5.0% | -0.2% |
| Tertiary | -0.3% | 0.0% | -0.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.3% | 0.0% | -0.7% | 0.0% |
| **Total** | **-0.8%** | **0.0%** | **-1.6%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.8%** | **0.0%** | **-1.7%** | **-0.1%** |

Table B.9. Average Net Employment (Direct, Indirect and Induced) Impacts of Horticulture (Medium Start - Yr 5), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 | | Scenario 3 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs |
| 1 Horticulture and fruit growing | -9 | -21 | -19 | -45 | 0 | 1 | -1 | 2 | -9 | -20 | -20 | -43 |
| 2 Sheep, beef, dairy and grain farming | -3 | -12 | -6 | -26 | -21 | -32 | -38 | -65 | -23 | -44 | -44 | -91 |
| 3 Other farming | 0 | -2 | -1 | -5 | 0 | -2 | -1 | -5 | -1 | -4 | -2 | -9 |
| 4 Forestry and logging | 0 | -1 | -1 | -2 | 9 | 10 | 9 | 10 | 9 | 9 | 8 | 8 |
| 5 Other primary | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 |
| 6 Agri., forestry and fish servs | 14 | 8 | 2 | -11 | 7 | 6 | 8 | 4 | 21 | 14 | 10 | -7 |
| 7 Meat manufacturing | 0 | -1 | 0 | -2 | -12 | -20 | -28 | -48 | -12 | -21 | -28 | -50 |
| 8 Other food product manufacturing | -139 | -165 | -299 | -353 | 0 | 0 | 0 | -1 | -139 | -165 | -299 | -354 |
| 9 Wood and paper manufacturing | 0 | 0 | 0 | -1 | 12 | 17 | 12 | 17 | 12 | 17 | 12 | 17 |
| 10 Other manufacturing | -12 | -34 | -26 | -73 | -1 | -3 | -5 | -13 | -13 | -37 | -31 | -86 |
| 11 Utilities | -2 | -4 | -4 | -9 | 0 | 0 | 0 | 0 | -1 | -4 | -4 | -10 |
| 12 Construction | -9 | -17 | -20 | -38 | 3 | 2 | 2 | 0 | -6 | -15 | -18 | -38 |
| 13 Wholesale and retail trade | -45 | -94 | -99 | -204 | 0 | -3 | -5 | -20 | -45 | -97 | -104 | -224 |
| 14 Transport | -7 | -27 | -16 | -60 | 1 | 1 | -1 | -6 | -6 | -26 | -17 | -65 |
| 15 Business services | -50 | -115 | -109 | -250 | 1 | -2 | -4 | -18 | -49 | -117 | -113 | -268 |
| 16 Local and central government | -7 | -12 | -14 | -25 | 0 | 0 | -1 | -2 | -7 | -12 | -15 | -27 |
| 17 Other services | -93 | -178 | -199 | -383 | 0 | -4 | -9 | -30 | -93 | -182 | -208 | -413 |
| **TOTAL** | **-363** | **-675** | **-811** | **-1,487** | **0** | **-29** | **-60** | **-175** | **-363** | **-705** | **-871** | **-1,662** |
| **Change from 2016 Employment** | | | | | | | | | | | | |
| Primary | 0.0% | 0.0% | -0.2% | -0.1% | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | 0.0% | -0.3% | -0.1% |
| Secondary | -1.4% | -0.1% | -3.1% | -0.2% | 0.0% | 0.0% | -0.2% | 0.0% | -1.4% | -0.1% | -3.3% | -0.2% |
| Tertiary | -0.4% | 0.0% | -0.8% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.4% | 0.0% | -0.8% | -0.1% |
| **Total** | **-0.4%** | **0.0%** | **-1.0%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.4%** | **0.0%** | **-1.0%** | **-0.1%** |

Table B.10. Average Net Employment (Direct, Indirect and Induced) Impacts of Horticulture (Slow Start - Yr 8), Pastoral (Start Yr 1, 10 Yr Spread) and Combined Sub-scenarios, 2021-2051

| | Horticulture Scenarios | | | | Pastoral Scenarios | | | | Horticulture + Pastoral Scenarios | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Future B | | Future C | | MS1 | | MS2 | | Scenario 2 | | Scenario 3 | |
| | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand | Hawke's Bay Region | New Zealand |
| | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs | MECs |
| 1 Horticulture and fruit growing | -7 | -17 | -16 | -37 | 0 | 1 | -1 | 2 | -8 | -16 | -17 | -35 |
| 2 Sheep, beef, dairy and grain farming | -2 | -13 | -5 | -22 | -21 | -32 | -38 | -65 | -23 | -45 | -43 | -87 |
| 3 Other farming | 0 | -10 | -1 | -4 | 0 | -2 | -1 | -5 | -1 | -11 | -2 | -8 |
| 4 Forestry and logging | 0 | -7 | -1 | -2 | 9 | 10 | 9 | 10 | 9 | 3 | 8 | 8 |
| 5 Other primary | 0 | -6 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | -6 | 0 | -1 |
| 6 Agri., forestry and fish servs | 12 | -4 | 2 | -9 | 7 | 6 | 8 | 4 | 19 | 2 | 10 | -5 |
| 7 Meat manufacturing | 0 | -3 | 0 | -1 | -12 | -20 | -28 | -48 | -12 | -24 | -28 | -50 |
| 8 Other food product manufacturing | -114 | -20 | -246 | -290 | 0 | 0 | 0 | -1 | -114 | -20 | -246 | -291 |
| 9 Wood and paper manufacturing | 0 | -18 | 0 | 0 | 12 | 17 | 12 | 17 | 12 | 0 | 12 | 17 |
| 10 Other manufacturing | -10 | -19 | -21 | -60 | -1 | -3 | -5 | -13 | -11 | -22 | -26 | -73 |
| 11 Utilities | -2 | -17 | -3 | -8 | 0 | 0 | 0 | 0 | -1 | -17 | -3 | -8 |
| 12 Construction | -7 | -17 | -16 | -31 | 3 | 2 | 2 | 0 | -5 | -15 | -14 | -31 |
| 13 Wholesale and retail trade | -37 | -22 | -81 | -167 | 0 | -3 | -5 | -20 | -37 | -25 | -86 | -188 |
| 14 Transport | -6 | -22 | -13 | -49 | 1 | 1 | -1 | -6 | -5 | -20 | -14 | -55 |
| 15 Business services | -41 | -27 | -90 | -205 | 1 | -2 | -4 | -18 | -40 | -29 | -93 | -224 |
| 16 Local and central government | -6 | -26 | -12 | -21 | 0 | 0 | -1 | -2 | -6 | -26 | -12 | -22 |
| 17 Other services | -76 | -33 | -164 | -315 | 0 | -4 | -9 | -30 | -76 | -37 | -172 | -345 |
| **TOTAL** | **-298** | **-279** | **-666** | **-1,221** | **0** | **-29** | **-60** | **-175** | **-298** | **-308** | **-726** | **-1,396** |
| **Change from 2016 Employment** | | | | | | | | | | | | |
| Primary | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | 0.0% | -0.3% | -0.1% |
| Secondary | -1.2% | 0.0% | -2.5% | -0.1% | 0.0% | 0.0% | -0.2% | 0.0% | -1.2% | 0.0% | -2.7% | -0.2% |
| Tertiary | -0.3% | 0.0% | -0.6% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.3% | 0.0% | -0.7% | 0.0% |
| **Total** | **-0.4%** | **0.0%** | **-0.8%** | **-0.1%** | **0.0%** | **0.0%** | **-0.1%** | **0.0%** | **-0.4%** | **0.0%** | **-0.9%** | **-0.1%** |