Quantifying the environmental performance of New Zealand avocados

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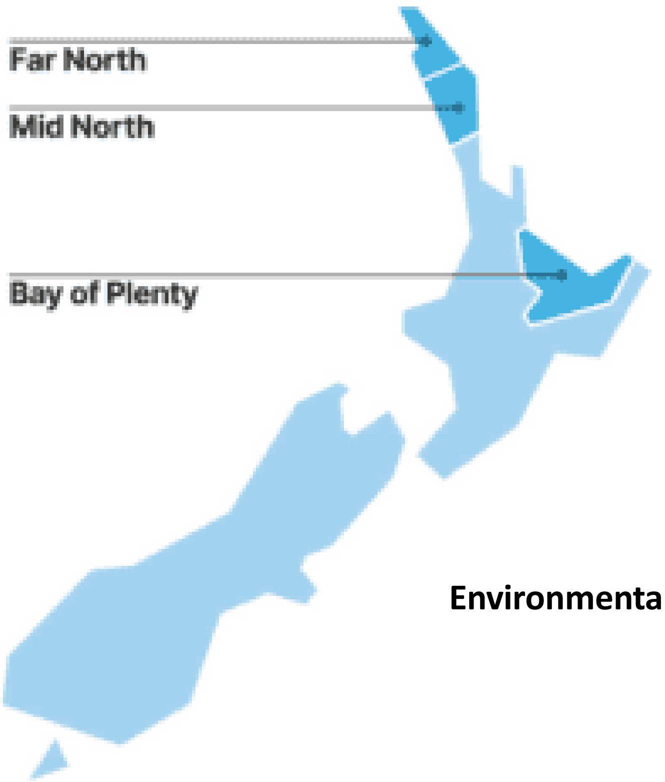
Background



- New Zealand avocado sector growing rapidly
- Driven by overseas demand
- > 1800 growers; > 4000 ha of planted avocados
- Mainly Hass variety; Mainly North Island

Environmental impacts of the New Zealand avocado supply chain unquantified

1) Understand the environmental impacts of conventional avocado production and packaging in New Zealand and distribution to local and international destinations
2) Identify the main contributors to environmental impacts (Climate Change, Water Use, Eutrophication, and Ecotoxicity (Freshwater and Terrestrial) in the New Zealand avocado value chain

Goal and Scope

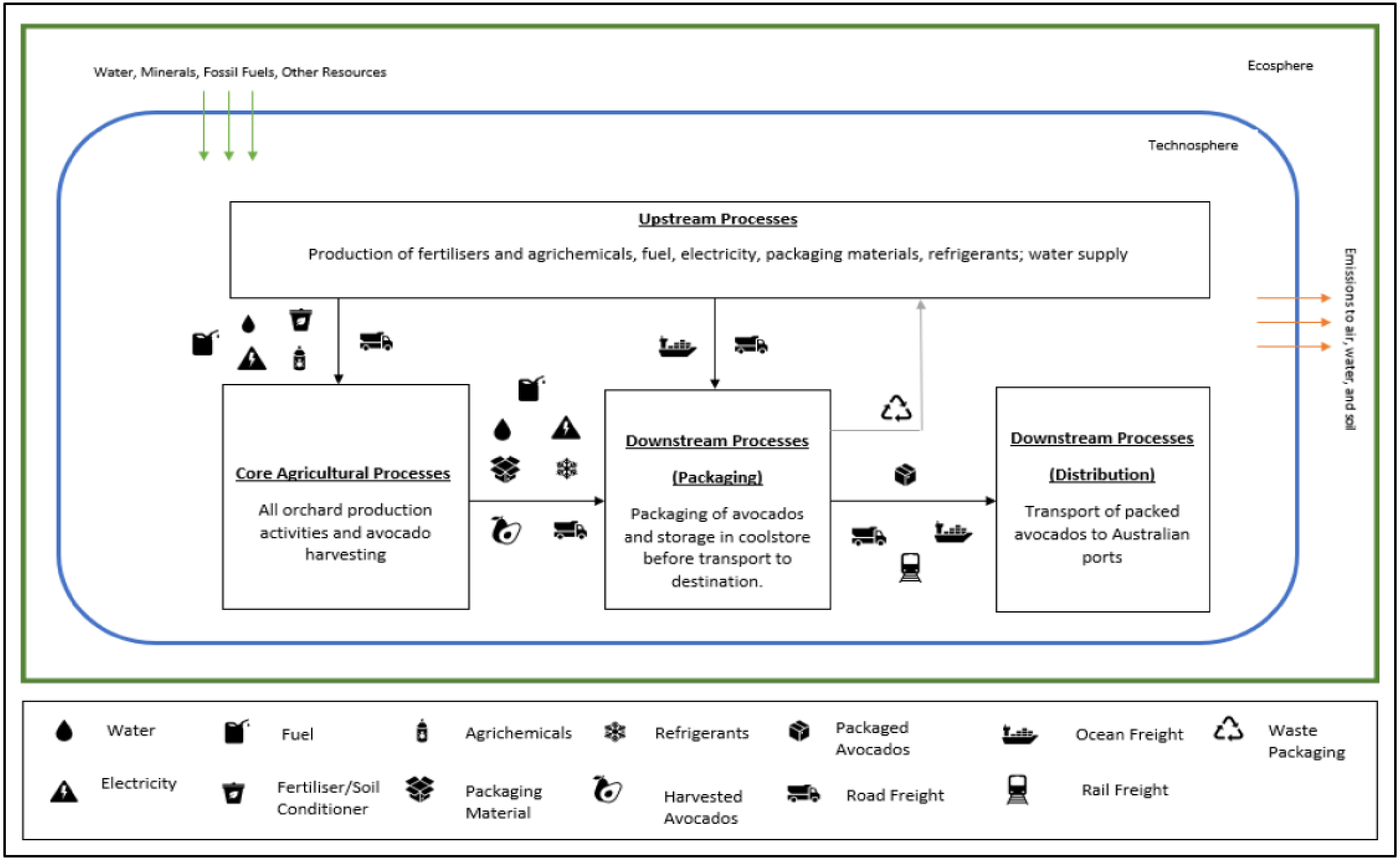


Figure 1 System boundaries of the product system life cycle for this LCA study

Functional unit: 1 kg Hass avocado grown and packaged in New Zealand and delivered to Australia (sensitivity scenarios modelled for other international and local destinations as well).

Sampling and Data Collection

- Stratified sampling – Three regions, three production practices, three sizes; 49 sampled orchards in the baseline
- Baseline - ‘Tier 1’ and ‘Tier 2’ categories based on data quality (CQI score)
- Input data – agrichemicals (pesticides), fertilisers/soil conditioners, water, electricity and fuel

- 14 registered packhouses; data received from two in the Bay of Plenty
- 3 different grades of fruit; small portion of reject fruit returned to orchard; small portion of waste packaging material sent to recycling

- Export and domestic data obtained from AVOCO
- Export sensitivity analysis for shipping by sea to South Korea, and air freighting to Australia and South Korea.
- Domestic data also obtained from AVOCO for domestic sensitivity analysis – 9 ‘first points-of-sale’ locations in the North Island and 3 in the South Island

LCIA Results – Climate Change

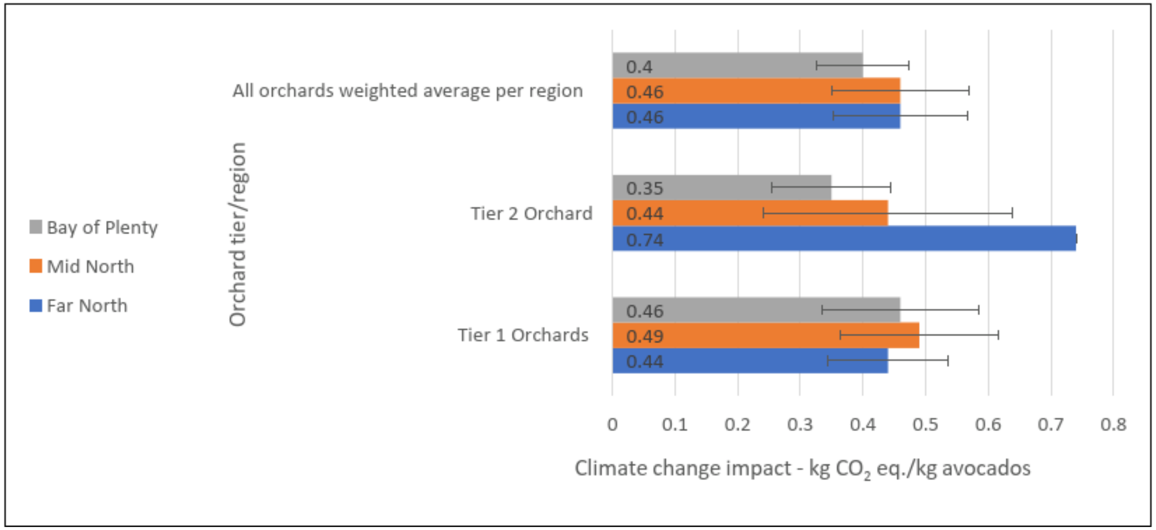


Figure 2 Weighted averages of climate change impacts by orchard tier and region. The error bars represent the 95% confidence interval of the climate change impact values of the orchards in each region

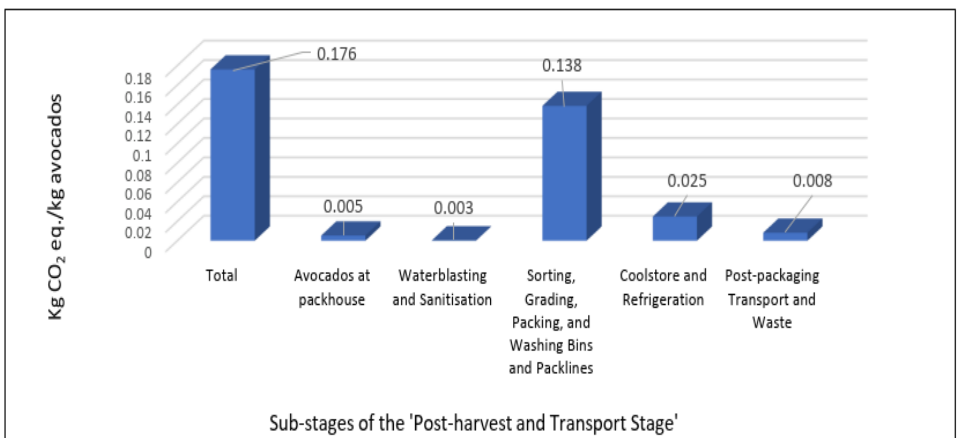


Figure 3 Climate change impact of the 'Post-harvest and Transport' stage – average of the two studied packhouses

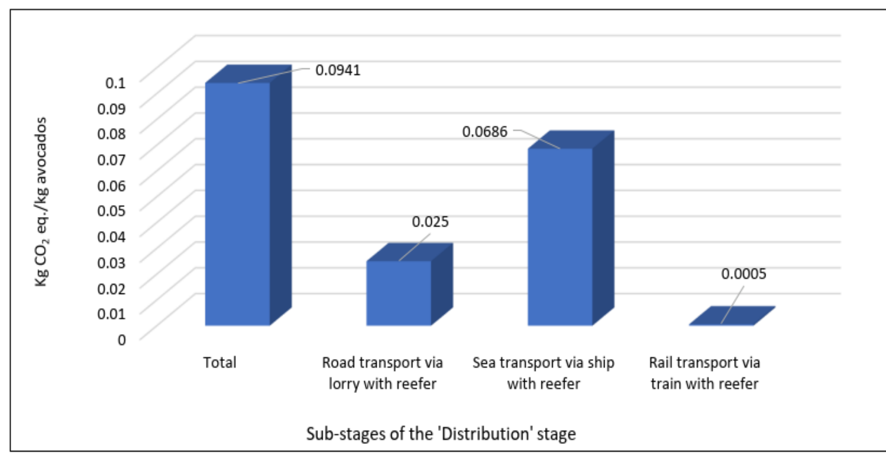


Figure 4 Climate change impact of the 'Distribution' stage

LCIA Results – Eutrophication

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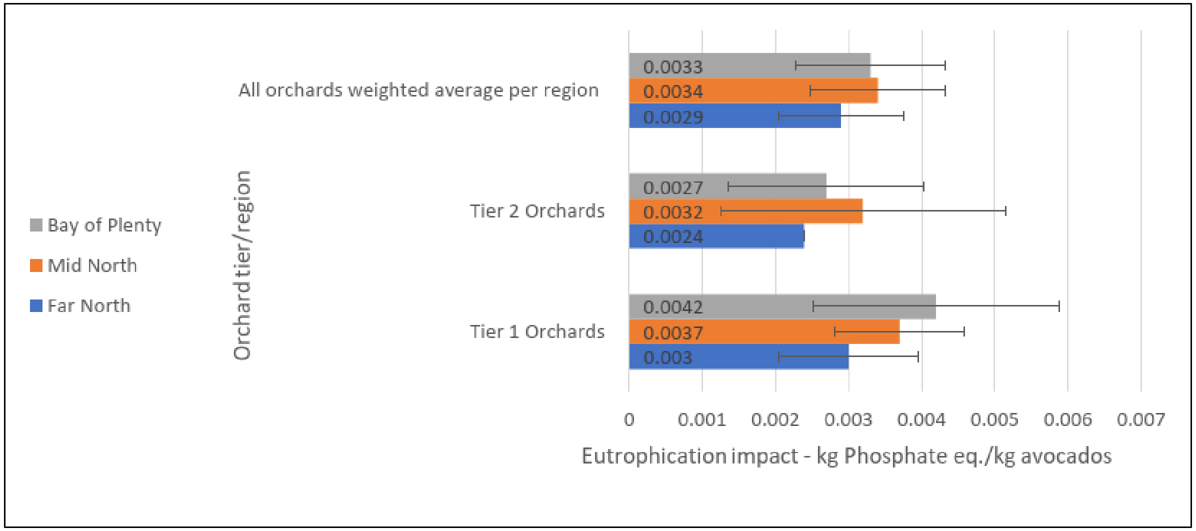

Figure 5 Weighted averages of eutrophication impacts by orchard tier and region. The error bars represent the 95% confidence interval of the climate change impact values of the orchards in each region

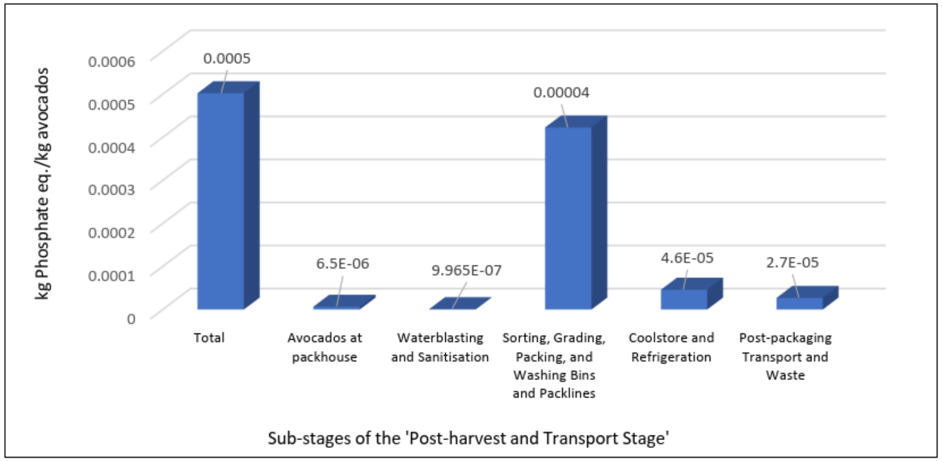

Figure 6 Eutrophication impact of the 'Post-harvest and Transport' stage – average of the two studied packhouses

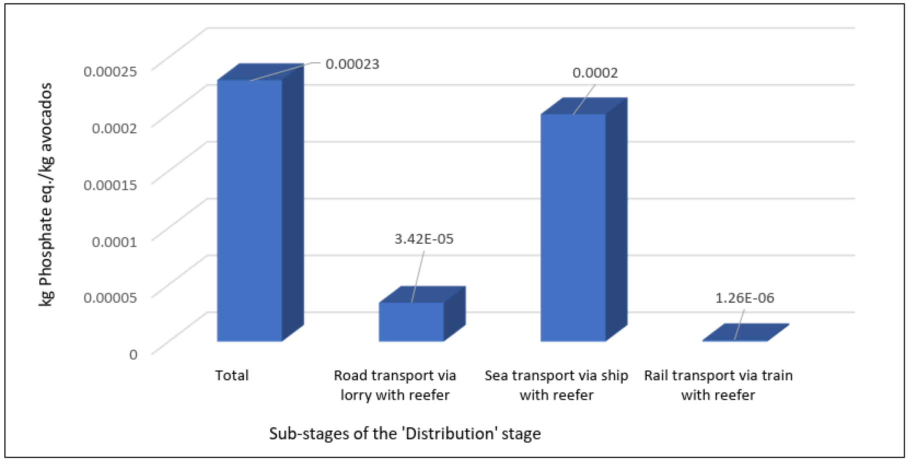

Figure 7 Eutrophication impact of the 'Distribution' stage

LCIA Results – Water Use

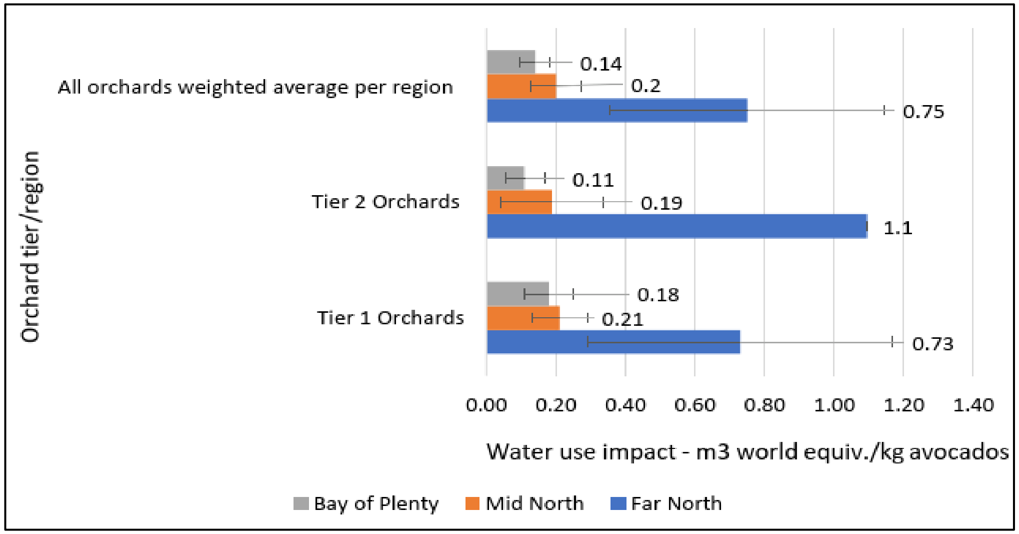

Figure 8 Weighted averages of total water use impacts by orchard tier and region. The error bars represent the 95% confidence interval of the water use impact values of the orchards in each region

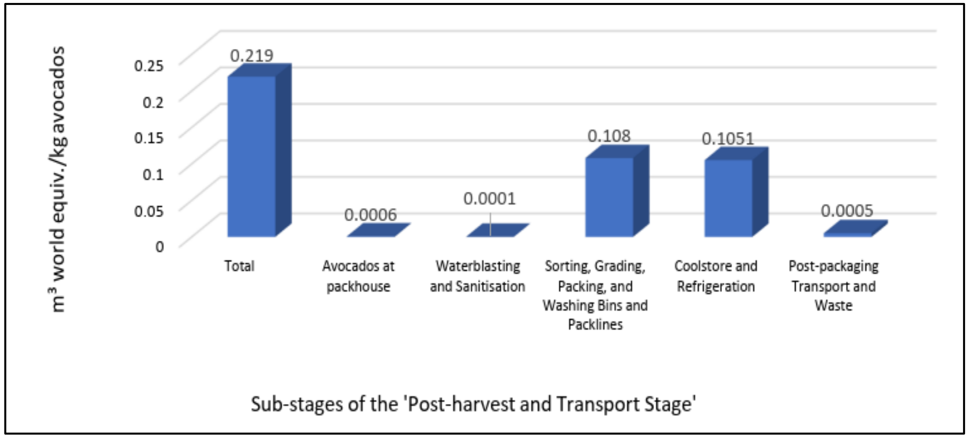

Figure 9 Water use impact of the 'Post-harvest and Transport' stage – average of the two studied packhouses

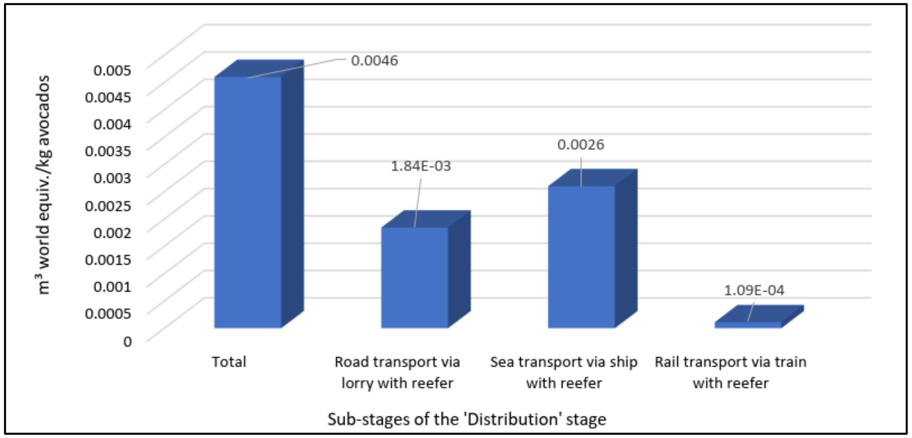

Figure 10 Water use impact of the 'Distribution' stage

LCIA Results – Freshwater Ecotoxicity

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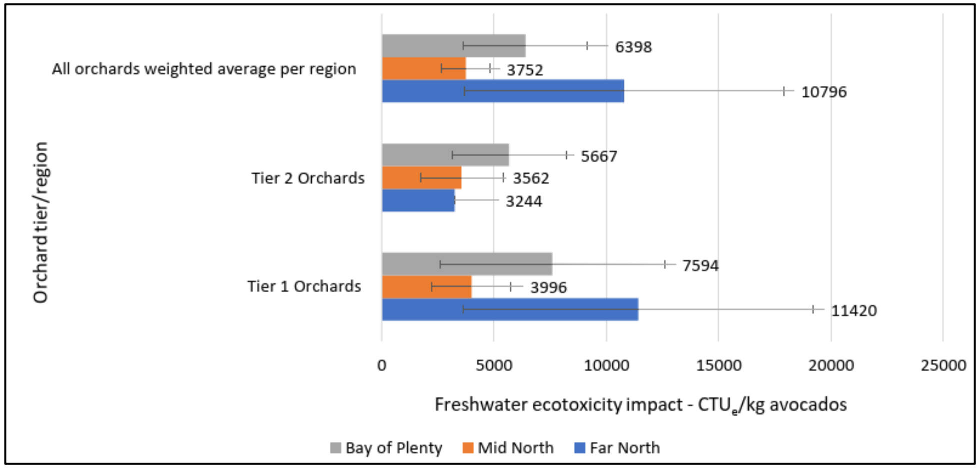

Figure 11 Weighted averages of total freshwater ecotoxicity impacts by orchard tier and region. The error bars represent the 95% confidence interval of the water use impact values of the orchards in each region

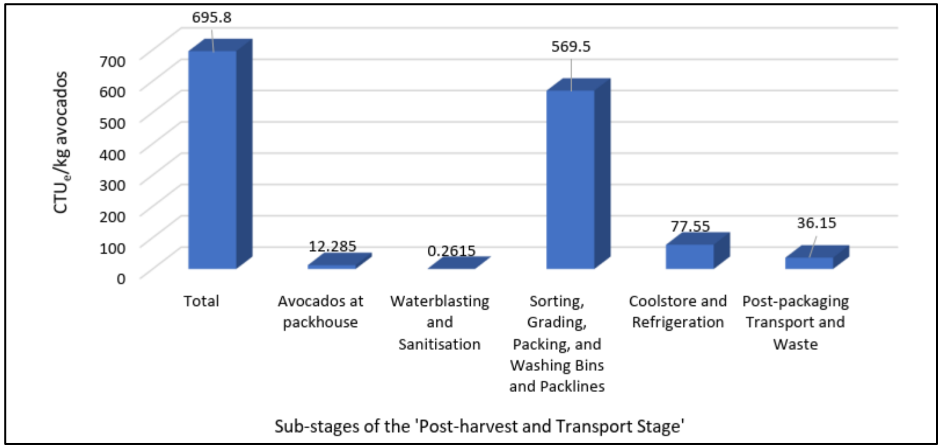

Figure 12 Freshwater ecotoxicity impact of the 'Post-harvest and Transport' stage – average of the two studied packhouses

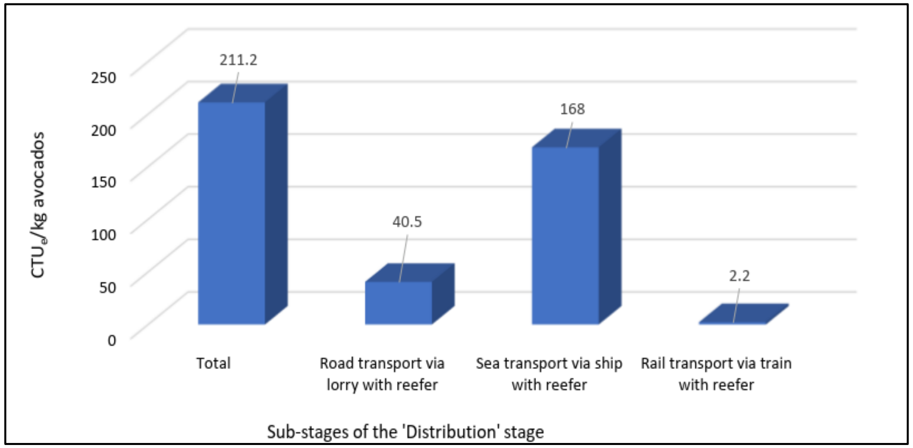

Figure 13 Freshwater ecotoxicity impact of the 'Distribution' stage

LCIA Results – Terrestrial Ecotoxicity

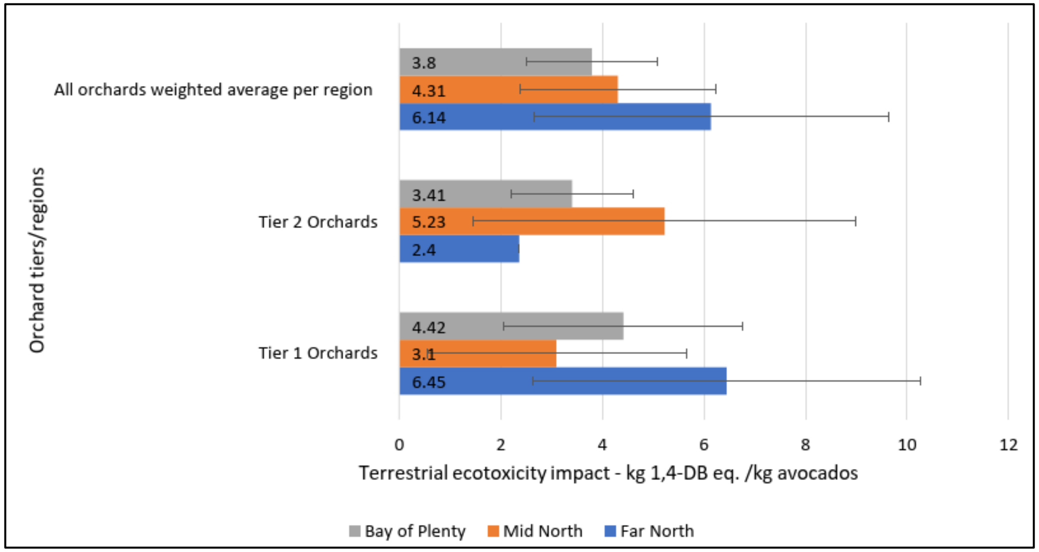

Figure 14 Weighted averages of total terrestrial ecotoxicity impacts by orchard tier and region. The error bars represent the 95% confidence interval of the water use impact values of the orchards in each region

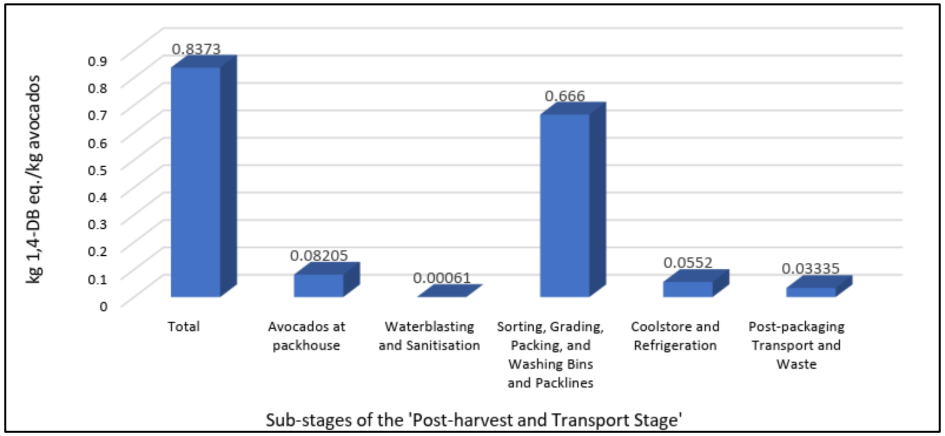

Figure 15 Terrestrial ecotoxicity impact of the 'Post-harvest and Transport' stage – average of the two studied packhouses

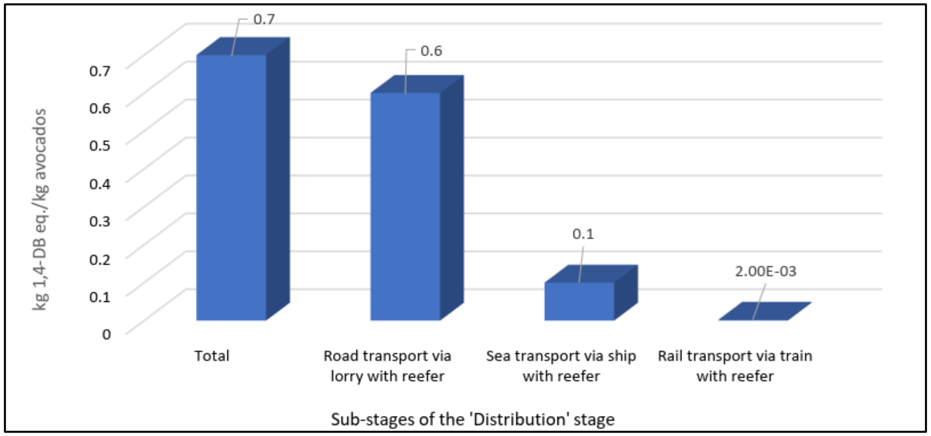

Figure 16 Terrestrial ecotoxicity impact of the 'Distribution' stage

Life Cycle Impact Assessment Results – National Scores Baseline Model

Impact Categories	Total	Production (Orchard) Stage	% of Total	Post-Harvest Transport and Packaging Stage	% of Total	Distribution Stage	% of Total
Climate Change (kg CO_2 eq./kg avocados	**0.7**	0.43	61%	0.176	25%	0.0941	13%
Eutrophication (kg Phosphate eq./kg avocados)	**0.004**	0.0033	82%	0.0005	12%	0.00023	6%
Water Use (m^3 world equiv./kg avocados)	**0.54**	0.31	58%	0.22	41%	0.005	1%
Ecotoxicity (Freshwater) (CTU_e/kg avocados)	**7837.8**	6930.8	88%	695.8	9%	211.2	3%
Ecotoxicity (Terrestrial) (kg 1,4-DB eq./kg avocados)	**6.02**	4.48	75%	0.8373	14%	0.7	12%

Sensitivity Analysis Post-harvest Transport and Packaging Stage

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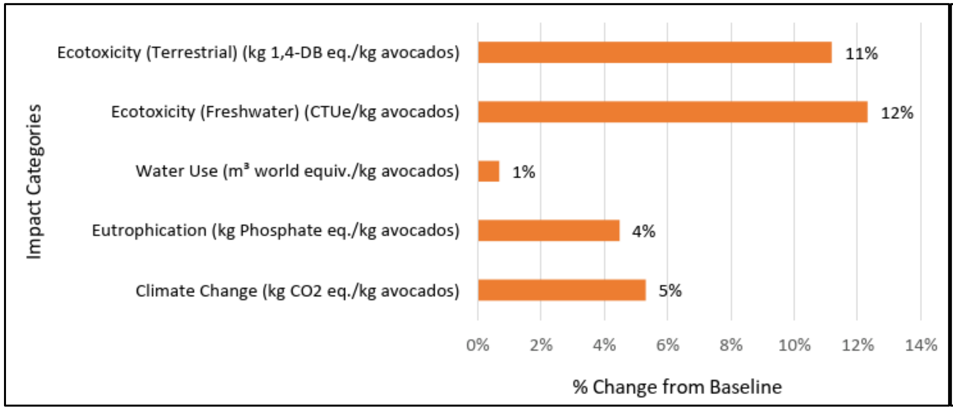

Figure 17 Change (%) in impact scores for each impact category in Scenario A (baseline, with 'business transport'), with respect to the 'post-harvest transport and packaging' stage of the baseline model

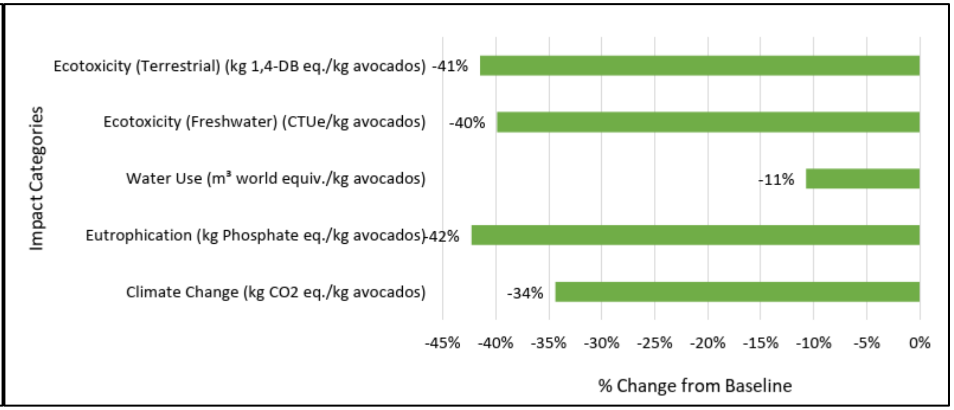

Figure 18 Change (%) in impact scores for each impact category in Scenario B (domestic distribution, loose fill cardboard boxes, no pocket packs), with respect to the 'post-harvest transport and packaging' stage of the baseline model

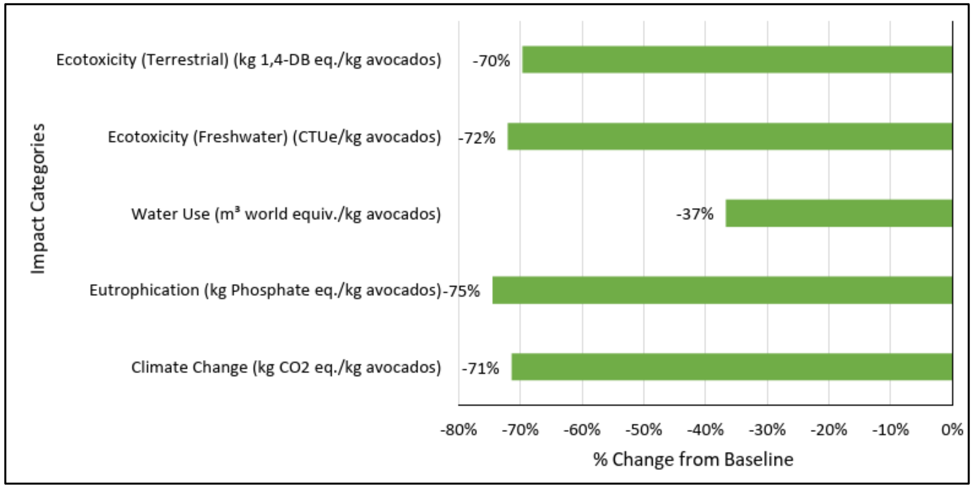

Figure 19 Change (%) in impact scores for each impact category in Scenario C (domestic distribution, bulk loose fill, plastic crates, no boxes, no trays, no pocket packs) with respect to the 'post-harvest transport and packaging' stage of the baseline model

Sensitivity Analysis Distribution Stage

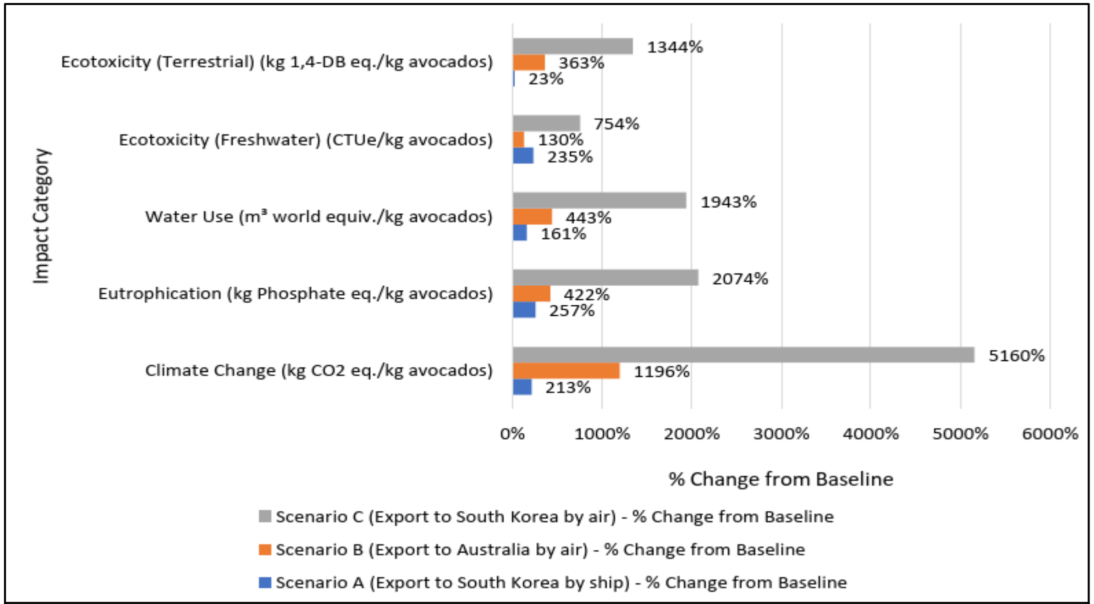

Figure 20 Changes in impact scores (%) of Scenario A, B, and C, from the distribution stage levels of the baseline model

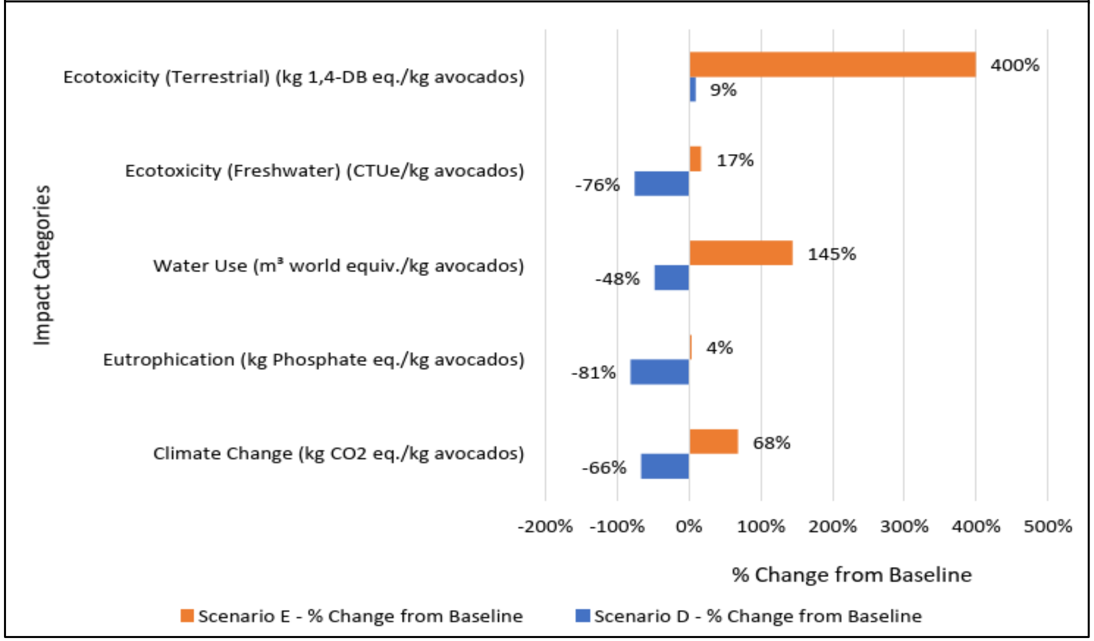

Figure 21 Change (%) in impact scores for each impact category in Scenarios D (North Island) and E (South Island), with respect to the distribution stage levels of the baseline model

Interpretation – Potential AoPs

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- Biggest contributor
- Main contributing inputs – fertiliser/soil conditioners, fuel, and agrichemicals (for freshwater ecotoxicity)
- Water use impacts: Far North ~ 4 and 5 times the values of the Mid North and Bay of Plenty respectively

- Packline sub-stage main contributor.
- Carboard manufacturing biggest contributor in packline sub-stage.

- Transoceanic container ship main contributor
- For export, biggest change in climate change impact when air freighting
- Local distribution to North Island all impact scores except terrestrial ecotoxcity.
- Transport to South Island all impact scores

Where next? Recommendations for Future Research

Improve temporal and spatial resolution for toxicity and water use impact categories

+ Impact categories

Improved primary data quality for important inputs

- Account for carbon sequestration in avocado orchards

Supporting Circularity with LCA

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*' Life Cycle Analysis can be used to **identify impact hotspots** within the life cycle of a specific solution and then help assess how well different options for that part of the lifecycle address those impacts. LCA is also most likely to be able **to give a clear answer when most parts of the system remain the same.** For example, LCA could be used to compare the carbon emissions of two different packaging material choices, when all other parts of the business model are the same.'~ Ellen Macarthur Foundation*

*By combining principles of the circular economy with LCA methodologies, product developers can **measure the environmental performance** of various product and supply chain configurations, compare circular strategies and ensure a positive environmental balance from the design of new circular products or services. ~ Emilia* Ingemarsdotter and Marina Dumont, PRé Sustainability

LCA – a tool to support and complement the CE concept

*En route to the circular economy (CE), LCA will make sure that circularity is accompanied by **decreasing overall environmental impacts**. ~ Maartje Sevenster, President, Australian LCA Society, 2019*

*'LCA and other assessment tools should be used **to evaluate options for CE** solutions to ensure a positive balance of efforts and benefits in both new product designs and increased recycling.' ~ Maleanie Haupt and Mischka Zschokke, 'How can LCA support the circular economy?—63rd discussion forum on life cycle assessment, Zurich, Switzerland, November 30, 2016'*

Supporting Circularity in the Avocado Value Chain

The circular economy model:
less raw material, less waste, fewer emissions

Eliminate waste and pollution

Circulate products and materials (at their highest value)

Regenerate nature

'The obvious place to start when shifting to an economy that regenerates nature is the food industry. The way we produce food today is a significant driver of both climate change and biodiversity loss. It relies upon ever-increasing quantities of synthetic fertilisers, pesticides, fossil fuels, fresh water, and other finite resources. These are a source of pollution and damage to ecosystems and human health.' ~ Ellen McArthur Foundation

- **Waste fruit or packaging not a major contributor**
- **Not closing the cycle, but reducing input use, e.g., water, fuel, and fertilisers**
- **Considering growing, transport, and packaging options based on the LCA study**
- **Conducting further studies to understand impacts better**
- **Conducting further research to determine more sustainable options and considering these options for environmental performance improvement**

Thank You

For enquiries regarding this project,
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