Carbon Footprinting for the Apple Supply Chain

Project Summary

Sarah McLaren[1], Anthony Hume[1], Andrew Barber[2], Brent Clothier[3], Markus Deurer[3], Andrew East[4], Suzie Greenhalgh[1], Rod McDonald[3], John Palmer[3], Robyn Sinclair[1]

[1] Landcare Research
PO Box 40, Lincoln 7640, New Zealand

[2]AgriLINK New Zealand
PO Box 351, Kumeu 0841, Auckland, New Zealand

[3] Plant and Food Research
Private Bag 11030, Manawatu Mail Centre,
Palmerston North 4442, New Zealand

[4] Massey University
Private Bag 11222, Palmerston North 4442, New Zealand

Landcare Research Contract Report: LC0809/175

DATE: July 2009

ISO 14001

Reviewed by:	*Approved for release by:*
Jonathan King Research Leader Landcare Research	Michael Krausse Science Leader Landcare Research

Contents

1. Project Description 4
2. Research Methods 4
3. Main Project Findings 5
   3.1 Industry Guidance 7
   3.2 Reduction Opportunities 7
4. Concluding Remarks 8

1. Project Description

The project has developed a sector-specific method and guidance for measuring and reducing the carbon footprint of New Zealand apples. The aim is to support the New Zealand pipfruit industry to operate credibly in markets using internationally recognised and transparent product-focussed carbon footprinting methods. It is the most comprehensive study of the carbon footprint for New Zealand apples to date.

This report summarises the key results from the project. The work was carried out by Landcare Research in collaboration with AgriLINK, Plant and Food Research, and Massey University. It was undertaken for Pipfruit New Zealand and the Ministry of Agriculture and Forestry between November 2008 and July 2009, and was based on the 2007 export season to ensure all data were available.

2. Research Methods

A model was developed to quantify the carbon footprint for New Zealand apples. This included activities along the apple supply chain extending from production of agricultural inputs (such as fertilisers), through orchard activities, storage, distribution, retailing and on to final consumption in the UK. In particular, data were collected from sixty orchards and nine coolstores/packhouses in order to calculate GHG emissions at the orchard and coolstore/packhouse stages of the supply chain. Both integrated and organic Braeburn and Royal Gala varieties were studied during the project; together these varieties represent over 70 % of New Zealand's annual apple exports.

The UK's Publicly Available Specification for GHG emission measurement of goods and services (PAS 2050) was used to assess GHG emissions along the life cycle of New Zealand apples. The PAS 2050, published by the British Standards Institute (BSI) in October 2008, is the first widely available published standard for measuring GHG emissions generated by products. The study was peer reviewed by international experts from The Swedish Institute for Food and Biotechnology (SIK).

The modelling approach was underpinned by product-focused Life Cycle Assessment (LCA) based on ISO 14040 and 14044. LCA assesses a wider range of activities than those required when using the PAS 2050 approach. In particular, it differs by the inclusion of production and maintenance of orchard capital (such as tractors) and the inclusion of consumer transport. This wider assessment ensures that the industry can respond to future changes in the PAS 2050 as well as the final outcomes of international standards currently under development for carbon footprinting and communication (for example, in the International Standards Organisation).

A set of guidelines was developed that offer targeted advice for growers and coolstore/packhouse operators wanting to calculate their own carbon footprints. The guidance offers recommendations to help growers and coolstore/packhouse operators achieve PAS

2050 compliance. The guidelines were applied to three case study orchards to test their effectiveness. One of the orchards is certified organic and the other two are integrated fruit producers. Data from the orchards were supplemented with information from the life cycle study to calculate GHG emissions from the coolstore/packhouse, shipping, distribution, retailing and consumption stages of the life cycle.

A comprehensive review was also undertaken of alternative actions to reduce the carbon footprint at the orchard, coolstore and shipping stages of the apple supply chain. Reduction opportunities were assessed (using a life cycle perspective) for both integrated and organic apple varieties over the short-, medium- and long-term. The most feasible options were selected based on interviews with growers and coolstore/packhouse operators.

3. Main Project Findings

The carbon footprint was modelled for supply of '1 kg of Royal Gala or Braeburn apples produced in integrated or organic New Zealand orchards and sold in UK retail outlets in June.' GHG emissions listed below are calculated using the PAS 2050 approach unless stated otherwise (and measured in kg CO_2-eq).

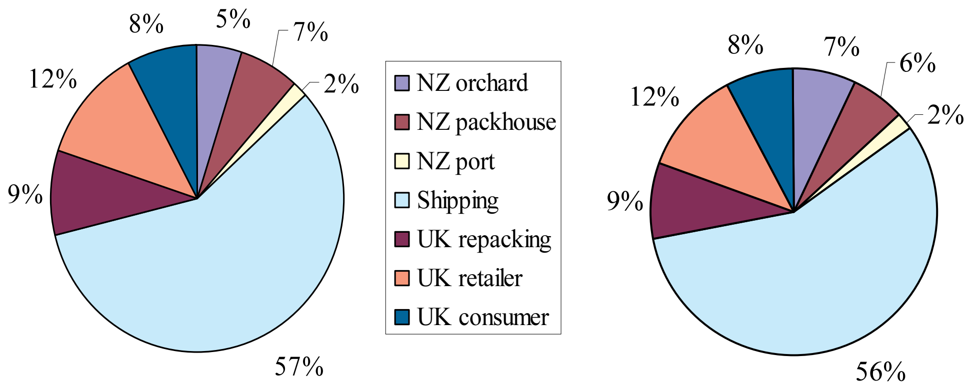
3.1 Results for Integrated Varieties

Total GHG emissions modelled for Braeburn and Royal Gala integrated apples are 0.9 kg CO_2-eq per kg apples consumed in the UK (using the PAS 2050 approach).

Figure 1 provides a breakdown of emissions for the integrated apple varieties. Shipping emissions are the biggest single contributor to total emissions, accounting for 54% and 57% of the total emissions for Braeburn integrated and Royal Gala integrated export apples respectively. However, the magnitude of shipping emissions vary widely depending on the datasets and assumptions used for the analysis; this study used data from approximately the middle of the range available.

The New Zealand orchard, packhouse and port life cycle stages contribute between 15% and 19% of the total carbon footprint for the integrated apple varieties. At the orchard stage, fuel use in orchard operations is the biggest contributor to GHG emissions. At the coolstore/packhouse stage, electricity use is the biggest contributor to GHG emissions.

Figure 1. GHG emissions for New Zealand integrated apples consumed in the UK in June (using PAS 2050 approach)



(a) Braeburn (b) Royal Gala

Using the more comprehensive LCA approach, the results are 22% higher for both integrated apple varieties compared with the results calculated using the PAS 2050 approach. Most of the additional emissions are associated with the consumer's travel between the home and retailer; orchard capital equipment contributes less than 1% to the total carbon footprint. Shipping constitutes a relatively smaller proportion of the total carbon footprint (44 to 45% for Royal Gala and Braeburn respectively) using this approach.

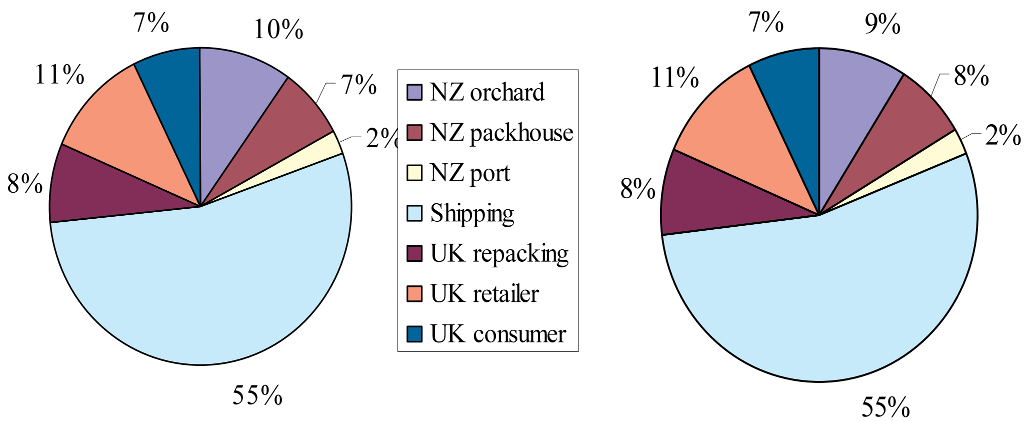
3.2 Results for Organic Varieties

Total GHG emissions modelled for Braeburn and Royal Gala organic apples are 1.0 kg CO_2-eq per kg apples consumed in the UK (using the PAS 2050 approach).

Figure 2 provides a breakdown of emissions for organic apples. Shipping emissions are the largest contributor to total emissions, accounting for 52% and 54% of the total emissions for Braeburn organic and Royal Gala organic apples respectively. The New Zealand orchard, coolstore/packhouse and port life cycle stages contribute just under 20% of total GHG emissions for the organic apple varieties. At the orchard stage, fuel use in orchard operations is the biggest contributor to GHG emissions. At the coolstore/packhouse stage, electricity use is the biggest contributor to GHG emissions.

Using the more comprehensive LCA approach, the results are 20% and 22% higher for the Braeburn and Royal Gala organic varieties respectively compared with the results calculated using the PAS 2050 approach. Most of the additional emissions are associated with the consumer's travel between the home and retailer; orchard capital equipment contributes less than 1% to the total carbon footprint. Shipping constitutes a relatively smaller proportion of the total carbon footprint (42% and 43% for Royal Gala and Braeburn respectively) using this approach.

Figure 2. Carbon footprint for organic apples exported to the UK for sale in June (using PAS 2050 approach)



(a) Braeburn (b) Royal Gala

3.3 Industry Guidance

The guidelines were successfully used to calculate GHG emissions associated with 1 kg Royal Gala exported apples from three case study orchards. GHG emissions vary between 0.5 and 0.8 kg CO_2-eq (using the PAS 2050 approach). The majority of emissions are associated with distribution (including shipping and truck transport). In one of the case studies, the relative proportion of shipping was less than in the other two (39% compared with greater than 50%). This reflects the fact that its export markets are mainly in Asia rather than Europe - and so shipping emissions make up a lower proportion of the life cycle.

3.4 Reduction Opportunities

The carbon footprint study provides both a baseline against which to measure future reductions and identifies “hotspots” for focusing effort to reduce GHG emissions along the apple supply chain – with a particular focus on the orchard, coolstore and shipping life cycle stages.

New Zealand apple growers have developed a highly eco-efficient production system and this life cycle stage results in only 7-10% of the total emissions along the supply chain depending on variety and production techniques. Many of the reduction opportunities identified in the orchard will lead to reduced fuel and electricity costs without the need for capital investment. For example, improved management for spraying agrichemicals could reduce the GHG emissions in integrated orchards by about 20% and save costs of up to NZ $80 per ha, while participation in the Apple Futures programme could reduce the GHG emissions in integrated orchards by about 10% and save costs of up to NZ $140 per ha.

Electricity use for the cold storage of apples is a major source of emissions in coolstore/packhouse activity. Implementing reduction options in the refrigerated storage of apples requires capital investment, but can then lead to substantial cost savings. For instance, using a floating head instead of a static head pressure control for the refrigeration system would reduce the electricity and associated GHG emissions for storing apples by between

10% and 25%, and saves costs of up to NZ $8.10 per pallet of apples stored for one week in a coolstore (depending upon factors such as total storage time, size and age of coolstore, refrigeration system, and management practices).

The shipping stage comprises more than 50% of GHG emissions along the supply chain of apples. There is considerable potential for reducing shipping emissions. Options include better shipping capacity utilisation, slower shipping speeds, improved refrigeration efficiency and new ship designs. It has to be recognised, however, that international shipping is currently optimised on financial costs, and that the shipping schedules used by the apple industry are finely tuned to accommodate the needs of production and market windows.

4. Concluding Remarks

This is a summary of the major findings from a comprehensive research project aimed at identifying, understanding and addressing GHG emissions associated with New Zealand apples along their supply chains. There are potential international market access benefits to be gained by engaging in a progressive and enlightened sector approach to addressing these emissions.

The results establish a baseline for the carbon footprint of the apple supply chain for two major export apple varieties. Although based on export to a UK market, changes in the magnitude of the carbon footprint associated with export to alternative markets such as the USA and Asia has also been investigated; shipping is reduced by 25 to 57% in these alternative markets – but still remains the life cycle stage making the largest contribution to the overall carbon footprint.

Most importantly, this work has identified opportunities for reducing GHG emissions across the whole life cycle of apples. Orchard, packhouse and port operations account for between 10% and 20% of total emissions depending on variety and production method. Implementing all of the most feasible short-term orchard reduction options that require minimal capital investment could lead to cost savings of as much as NZ $650 per ha. However, most orchards will only be able to adopt some of these reduction options. For example, approximately half of integrated orchards already participate in the Apple Futures programme.

At the coolstore/packhouse stage, reductions in the carbon footprint require capital investment. After implementation, a reduction option would typically save between NZ $0.50 and NZ $6.50 per pallet of apples stored for one week in a coolstore (depending upon factors such as storage time, size and age of coolstore, refrigeration system, and management practices).

In summary the project has:

- Extended our understanding of the GHG emission hotspots in the life cycle of New Zealand apples consumed in the UK. These are: shipping, onward truck distribution to retail outlets in the destination country, and consumer transport between the home and retailer (although the latter is not included when using the PAS 2050 approach).
- Prioritised a set of feasible GHG emission reduction options at the orchard. The nine most

feasible options simultaneously reduce the use of fuel and electricity, the GHG emissions and the orchard operating expenses without the need for additional capital investment. These options focus on reducing the fuel use for spraying, mowing and hydraladas; and decreasing electricity use for irrigation.

- Prioritised two feasible GHG emission reduction options at the packhouse/coolstore. They both focus on reducing electricity use for the storage of apples, and can be implemented with a relatively low additional capital investment. They are: (1) introducing a floating head pressure control for the refrigeration system, and (2) a three-pronged strategy for making coolstores more energy efficient (separation of coolstore in functional zones, hot-gas defrost, operations of fans only when needed).
- Produced a set of guidelines that will enable industry players to produce transparent and robust data for their customers.
- Established a baseline against which to measure future GHG emission reductions, and to further differentiate the New Zealand apple industry as a responsible, eco-efficient international market player.