Food Miles in Australia:

A preliminary study of Melbourne, Victoria.

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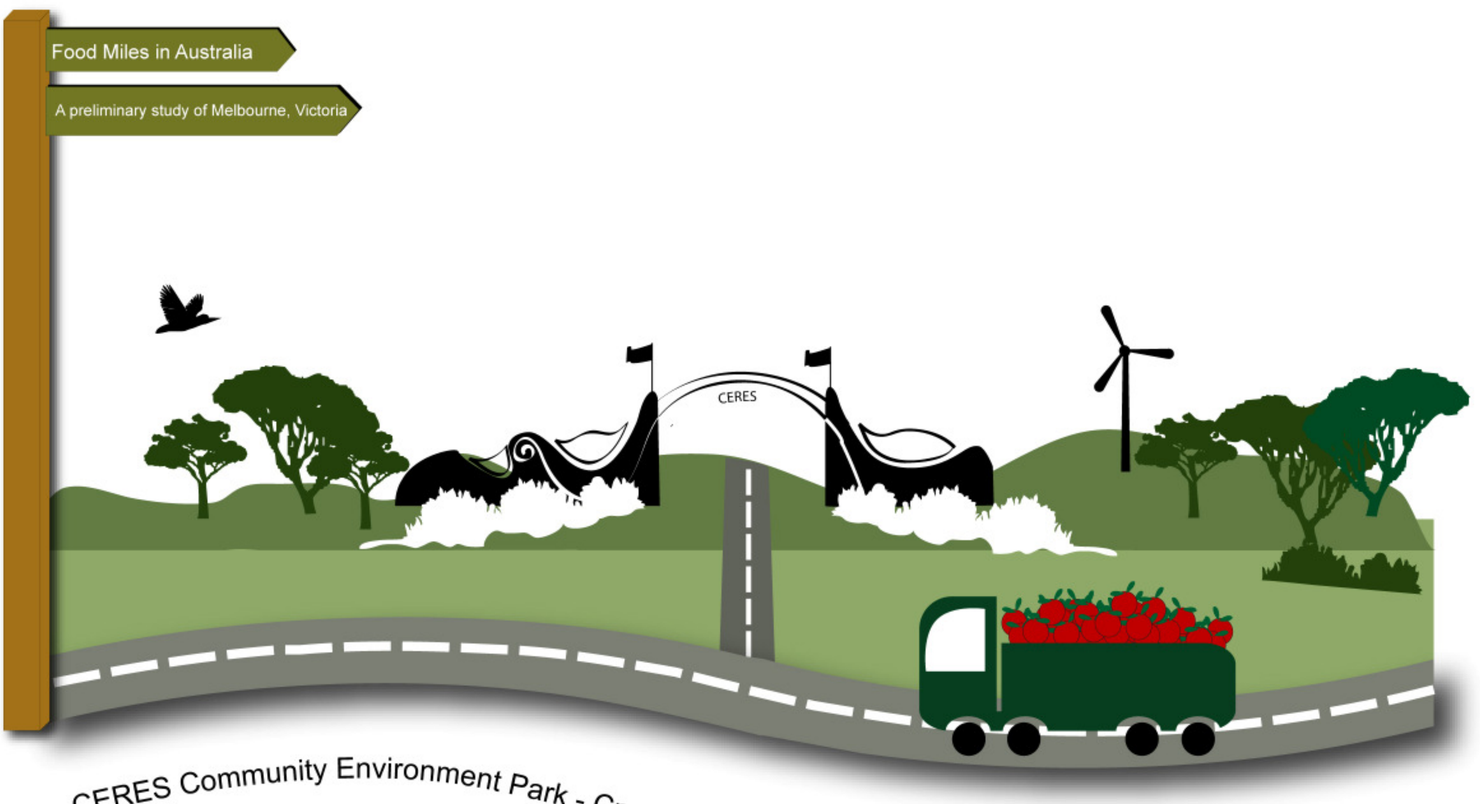

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Updates:

Greenhouse-gas emissions estimates have been updated to reflect a more representative assumption of food mass at 75% and truck mass at 25% of the transported weight. The July 2007 report had the assumption of food mass at 50 % of the transported weight. Please refer to Appendix 8.16 for details.

Readers should consider this March 2008 report to be the update and thus, the replacement of the previous July 2007 report.

ABSTRACT

'Food miles' is a term now commonly used to measure the transport distance travelled by food products between production and consumption. Food miles is one part of a larger complete life-cycle assessment required to compare the sustainability of individual items in food systems. Food miles must not be viewed independently of the energy used in each 'chain' in our food system.

As at the time of this report, the authors know of no Australian-specific food miles research.

This report seeks to contribute some preliminary research to encourage Australian dialogue on the growing issues of sustainability within our food systems.

Data was collected to establish food miles and greenhouse gas emissions estimates for a typical food basket in Victoria. The total distance of the road transportation in the food basket was estimated at 21,073 kilometres (km), almost the same distance to travel around Australia's coastline (25,760 km). The total distance for all transportation of the food basket was estimated at 70,803 km, equivalent to travelling nearly twice around the circumference of the Earth (40,072 km), or travelling around Australia's coastline three times.

The total greenhouse gas emissions estimate for all food trucks transporting all road-transported food items, over the total road transport distance, was 11, 327 tonnes (t) CO_2–e. If all the food trucks were transporting all food items on the same day, the emissions from this one day of transportation (11, 327 t CO_2–e), is equivalent to 2, 832 cars driving for one year.

The resulting total food miles and greenhouse gas emissions from this preliminary study, clearly indicate the need for Australia to respond accurately to the role our current food system plays within the issues of climate change and peak oil.

One such response involves education and empowerment of consumers in addressing these issues. This report will be used as the basis for a new CERES Food Education Program, that will aim to provide activities and resources that empower primary and secondary students to make more sustainable food choices. Further recommendations emphasise the need for Australian research into the sustainability of all aspects of our food systems.

Glossary

Articulated trucks: Motor vehicles constructed primarily for load carrying, consisting of a prime mover having no significant load carrying area, but with a turntable device which can be linked to one or more trailers[1].

Fuel consumption rates (FCR): Consumption of fuel by a vehicle in Litres per kilometre[2].

Gross Combination Mass (GCM): Tare weight (unladen weight) of the motor vehicle and attached trailers, plus its maximum carrying and towing capacity. GCM is the weight measurement used for trailer towing vehicles such as articulated trucks[1].

Gross Vehicle Mass (GVM): Tare weight (unladen weight) of the motor vehicle, plus its maximum carrying capacity excluding trailers[1].

Greenhouse Gases (GHG's): For the purpose of this study, GHG refer to CO_2 (carbon dioxide) and the global warming effect of the relatively small quantities of CH_4 (methane) and N_2O (nitrous oxide)[2].

Healthy Food Access Basket (HFAB): The food basket' used in this report representing a typical Victorian shopping basket. The range and types of foods included in the HFAB were selected by the Queensland Government to "represent commonly available and popular foods, rather than the nutritional ideal' (see Appendix 1).

Heavy rigid trucks: Rigid trucks of GVM greater than 4.5 tonnes[1].

Light rigid trucks: Rigid trucks of GVM greater than 3.5 tonnes and less than or equal to 4.5 tonnes[1].

Rigid trucks: Motor vehicles of GVM >3.5 tonnes, constructed with a load carrying area. Included are normal rigid trucks with a tow bar, draw bar or other non-articulated coupling on the rear of the vehicle. Rigid trucks are divided into two categories[1]:

i) Light rigid trucks of GVM >3.5 tonnes and ≤4.5 tonnes

ii) Heavy rigid trucks of GVM >4.5 tonnes

t CO_2–e : Emissions are expressed in tonnes of CO_2–e, which includes CO_2 (carbon dioxide) and the global warming effect of the relatively small quantities of CH_4 (methane) and N_2O (nitrous oxide)[2].

[1] As per Australian Bureau of Statistics (ABS) Motor Vehicle Census 9309.0 (March, 2006).

[2] Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December, 2006).

CONTENTS

1 Introduction

For the first time in human history, the industrialisation, commercialisation and globalisation of the food system, has allowed millions of people access to a vast array of food from all over the world. As food products travel along long food distribution chains, diets are no longer restricted by local environmental factors or seasonality of produce. Today, where food is grown for export in one region, food is simultaneously being imported for consumption. Otherwise, food sold as local produce may be grown locally but then shipped to different regions to be packaged or processed at a cheaper cost and then returned to the 'local' area. In other instances, food trade may involve the import and export of the exact same variety of food. Food, our most basic necessity, has been globalised at all levels of production.

As global concern mounts around climate change and peak oil, questions are being raised about the production, distribution and retail components of food systems. The current food and agricultural industry is recognised as a heavy user of fossil fuels. It is a contributor to climate change due to the production of the chemical inputs, use of heavy agro-machinery, and the emissions produced by food transportation.

While the term ‘food miles’ is used to describe the concept, this report uses the metric measurement of kilometres for food transport distances in Australia. ‘Food miles’ is used throughout the report, in keeping with global dialogue on this topic.

1.1 Food Miles

The term 'food miles' is now commonly used to measure the transport distance travelled by food products between production and consumption. The term is currently being used to catalogue a trend towards increasingly energy intensive transport of food - requiring the burning of more fossil fuels, and consequently increased levels of carbon dioxide and other greenhouse gas (GHG) emissions.

This food however, is conversely low in the nutrients it returns. Some studies have showed that, 'specialisation and standardisation, coupled with long distance transport is diluting the nutritional potency of our food. Some nutrient losses, in particular vitamin C, vitamin A, riboflavin and vitamin E, will occur even with excellent storage conditions' [3].

Food miles is now a very topical issue, receiving increasing attention from consumers, media, retailers and governments around the world. As an indication of the growing concern around food miles as part of a larger trend towards the consumption of more environmentally-friendly food, a number of large food retailers in the United Kingdom (UK) (such as Tesco and Marks & Spencer) have begun food miles labelling for products sold in their stores.

Growing consumer attention towards food miles in regions such as the European Union poses a significant threat to the export markets of other countries. New Zealand (NZ) is one such country under threat, with a significant export market to the EU and specifically the UK. New Zealand's Trade Minister for example, has shown resistance to UK food miles labelling, as a number of reports have emerged from NZ and the UK emphasising the need for a more complete life-cycle assessment of the food supply chain, rather than focusing solely on food transport distances [4 5].

A recent NZ study concluded that production and transport of sheep meat, dairy and apples from NZ to the UK is more energy efficient than producing these items in the UK[2], reflecting differences in soil quality and climate suitability.

Clearly, any analysis of the embodied energy of food must acknowledge that food miles are just one part of a food provision system which is dependent on fossil fuel input and produces GHG

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[3] Jones, A. (2001) 'Eating Oil ? Food Supply in a Changing Climate'. A Sustain & Elm Farm Research Centre joint report.

[4] Saunders, C., Barber, A. and Taylor, G. (2006) "Food Miles – Comparative Energy/Emissions Performance of New Zealand's Agriculture Industry, *Agribusiness and Economics Research Unit*, Research Report 285. Available http://www.lincoln.ac.nz/story9430.html [Accessed 3 June, 2007].

[5] DEFRA (2005) Department for Environment, Food and Rural Affairs, United Kingdom. *'The Validity of Food Miles as an Indicator of Sustainable Development: final report.* Watkiss et al., AEA Technology Environment for DEFRA.

emissions at many, if not all, stages[6]. Any food miles analysis must recognise that 'a single indicator based on food miles is an inadequate indicator of sustainability'[7], and should therefore be considered as only one factor of a more complete life-cycle assessment.

1.2 The Study

To date, research on food miles has been principally carried out in the UK[8], the USA[9] and Canada[10]. At the time of this report, the authors know of no previous Australian-based food miles research. A related study undertaken by the Australian Government report for the Rural Industries Research and Development Corporation (2005)[11], analysed the benefits of farmers' markets. However, this report only briefly mentioned low food miles as a benefit of three farmers' markets studied.

This paper outlines a preliminary study of the food miles and greenhouse gas emissions (for road transportation) associated with a typical basket of food purchased in a Melbourne supermarket.

1.3 Objectives

This study aims to provide:

- A contribution to an improved understanding and the development of sustainable food systems in Australia.
- Some preliminary research into food miles by calculating estimates of transport distances for food items and some packaging, from producer(s) to Melbourne, Australia.
- Estimates of the greenhouse gas emissions for food items transported by road in Australia.
- A basis for a new Food Education Program at CERES Community Environment Park.

[6] The breakdown of US agricultural energy consumption is: 31 percent for the manufacture of inorganic fertilizer, 19 percent for the operation of field machinery, 16 percent for transportation, 13 percent for irrigation, 8 percent for raising livestock (not including livestock feed), 5 percent for crop drying, 5 percent for pesticide production, and 8 percent miscellaneous (McLaughlin et al., 2000 cited Pfeiffer, 2004). These figures do not consider the energy costs for packaging, refrigeration and transportation to retail outlets, or household cooking.

[7] Department for Environment, Food and Rural Affairs (DEFRA) (2005), United Kingdom. *'The Validity of Food Miles as an Indicator of Sustainable Development: final report.* Watkiss et al., AEA Technology Environment for DEFRA

[8] Pretty, J.N., Ball, A.S., Lang, T. and Morison, J.I.L (2005) "Farm Costs and Food Miles: An Assessment of the Full Cost of the UK Weekly Food Basket", *Food Policy*, 30: 1, pp. 1-19.

[9] Pirog, R. and Benjamin, A. (2003) "Checking the Food Odometer: Comparing Food Miles for Local versus Conventional Produce Sales to Iowa Institutions", Leopold Centre for Sustainable Agriculture, Iowa State University, Ames, Iowa, US.

[10] Lam, S. (2006) "Food Miles: Environmental Implications of Food Imports to the Kingston Region: Brief Summary of Findings and Comparison to Waterloo Region", Queen's University, School of Environmental Studies, Canada.

[11] Coster, M. and Kennon, N. (2005) " 'New Generation' Farmers' Markets in Rural Communities. Rural Industries Research and Development Corporation, Australian Government. Australia.

1.4 Organisation of the Report

This document is organized as follows:

Section 2: Methods.

Section 3: Methodological Limitations.

Section 4: Results.

Section 5: Discussion.

Section 6: Conclusion

Section 7: The Recommendations.

Section 8: Appendices

2 Methods

There is a need to view food miles as just one factor of the broader complete life-cycle assessment. This study does not attempt to provide full life-cycle analysis of energy used in food production and transportation, and therefore does not apply the same methods used in previous studies. Here we focus on food miles in an Australian context (using Melbourne, Victoria as the end point of transportation). Since no other Australian/Melbourne-based food miles research is currently available, it cannot be used comparatively at this time.

The methods detailed below reflect the information available to consumers if they were to conduct similar such enquiries. Given that Australia is in the early stages of addressing food miles and embodied energy issues, readers are encouraged to view additional material in the Appendices to engage with the wider framework and limitations of this study.

2.1 The Food Basket

The shopping basket of food used in this study is based on food items used in the 'Healthy Food Access Basket' (HFAB) survey[12], conducted by the Queensland Government Public Health Services (See Appendix 1). This Queensland HFAB was used for Victoria as there was no Victorian equivalent available. The range and types of foods included in the HFAB study were selected by the Queensland Government to, 'represent commonly available and popular foods, rather than the nutritional ideal'[12]. While the range of foods in the HFAB survey were selected to reflect Queensland consumption patterns, the selection of foods can be seen as representative of the typical Victorian basket of foods. With the exception of one food item (oysters), the HFAB has also been used by Victorian local councils.

For purposes of this study, the HFAB was adapted into a smaller shopping basket consisting of 29 items to minimise the listing of similar items. The selected items are collectively referred to as the 'food basket' throughout the report. Rump steak and beef mince, for example, were combined under the heading of 'beef'. Here, dairy products refer to fresh full cream milk; fresh reduced fat milk, powdered whole milk, powdered skim milk and long life milk were not included. While it is acknowledged that these different types of milk would present different food miles due to different processing requirements and locations, the study aims to calculate food miles across a

[12] Queensland Health (2000) *The Healthy Food Access Basket Survey 2000*, Queensland Government, Australia p.12.

range of different food types. It is beyond the scope of the study to calculate the food miles and greenhouse gas emissions estimate of variants within food types. A number of other food items such as tinned spaghetti, frozen vegetables and tinned ham, were excluded from the study altogether. Despite these exclusions, the shopping basket here is representative of a typical Australian shopping basket.

Items in the food basket come under the following categories:

Fruit and vegetables: Apples, oranges, orange juice, bananas, tomatoes, potatoes, pumpkin, lettuce, carrots, onions.

Meat and Dairy: Beef, chicken, eggs, sausages, fresh full-cream milk, cheese.

Cereals and Legumes: White bread, cereal biscuits, rolled oats, rice, instant noodles, savoury biscuits, tinned baked beans.

Non-core Food and Beverage: Unsaturated margarine, white sugar, canola oil, black tea, chocolate, potato chips/crisps.

2.2 Food Miles

The Weighted Average Source Distance (WASD)[13] calculation has been used in international food miles studies to calculate food miles. The WASD calculation was beyond the scope of this study. Here, the following methods were used to calculate the food miles:

The Melbourne CBD was used as the destination point when calculating the distance travelled by all foods. To estimate of how far food products travelled, contact with the industry bodies and companies provided the most common points of origin, along with any processing points, specifically for the Melbourne market. It was assumed that all domestic transport of foods in Australia (excluding Tasmania), involved road travel in rigid and articulated trucks along the simplest and most direct routes. One-way road distances within Australia were calculated using the Victorian Government Route Planner[14]. Imported goods were assumed to be shipped, rather than air-freighted so as to maintain a conservative food miles estimation. To calculate the port-to-port distances of international shipping routes, the Netpas Distance[15] maritime software program was used.

Information on domestic shipping distances was provided by the Australian Marine Safety Authority and the former Federal Department of Transport 'Marine Information Manual'[15].

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[13] Carlsson-Kanyama, Annika. (1997). Weighted average source points and distances for consumption origin-tools for environmental impact analysis. *Ecological Economics* 23(1997): 15-23.

[14] Available from the official Tourism Victoria website http://www.visitvictoria.com [Accessed April, 2007].

2.3 Fresh Fruit and Vegetable

To determine points of origin for fruit and vegetables, it was necessary to identify the most common growing regions for each item. Ten growers organisations (e.g. Australian Citrus Growers), market authorities (e.g. Melbourne Market Authority) and wholesalers associations (e.g. Victorian Chamber of Fresh Produce) were contacted to verify the growing regions (including any seasonal variations), for the different fruit and vegetable items in the food basket (see Appendix 2).

A point of origin (such as a city or town) was needed to calculate distances from a specified region. In some cases, sources were able to specify certain towns central to the growing regions. In cases where towns were not specified, towns central to the growing region were selected, or the closest and furthest towns in the growing region were selected. These towns were used to calculate an unweighted average of the shortest and longest distances travelled.

In most cases, there were several growing regions for each produce type. In cases where the growing regions are constant throughout the year, the estimated total distance travelled by the produce was calculated based on an unweighted average of the distances from each growing region to Melbourne. In cases of seasonal variation in growing regions, the estimated total distance accounted for the number of months during which the produce was sourced from the different regions (see Appendix 2).

In all cases, the most conservative assumptions were used in calculating distances travelled. For example, according to the orange juice manufacturer contacted, orange juice supplied to Melbourne would 'likely' be manufactured in Berri, however depending on demand, it could come from any of the factories in Lytton (QLD), Bentley (WA), Leeton (NSW), or Smithfield (NSW). To factor the higher probability of the orange juice being supplied by the Berri factory, orange juice was calculated to be sourced from Berri 50% of the time, while the other factories were given equal weight (see Appendix 2).

Because Californian oranges are often sold in Melbourne markets and supermarkets, the food miles of these oranges was calculated for comparison with the distance travelled by imported and domestically produced goods. The oranges imported from California were not included in the overall food miles results, but were calculated to compare the distance travelled by imported food with domestically produced food.

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[15] Available from http://www.netpas.net/ [Accessed April, 2007].

2.4 Meat and Dairy

Similar methods were used to calculate the food miles associated with meat and dairy products. In most cases, these products undergo a form of processing in between animal rearing and distribution in shops. In some such cases, processing companies in the specific industry, such as frozen chicken or sausages, were contacted in order to determine the locations of the factories used in processing products for the Melbourne market. The processing companies contacted were determined by the Retail World Australasian Grocery Guide 2006 listing of the companies holding the largest market shares in a product type, and the AC Nielson report on Australia's Top 100 Brands[16]. Appendix 3 details the brands used and companies contacted for meat and dairy products. The distance from the animal raising region to the processing point, and from the processing point to Melbourne were calculated using methods described above. Refer to Appendix 3 for details on calculations of food miles for meat and dairy products.

2.5 Cereals and Legumes

All products listed in this category of the basket were manufactured by companies. Again, the companies contacted were determined by the Retail World Australasian Grocery Guide 2006 and the AC Nielson report on Australia's Top 100 Brands. Aside from the rolled oats, all food products in the cereals and legumes category were produced using a number of different ingredients. To maintain a conservative estimate, the food miles calculation used only the one or two ingredients constituting the largest proportion of the food product.

In many cases the manufacturing companies were unable to disclose information regarding the source of their ingredients. In such instances, milling companies were contacted directly and were able to confirm whether they supplied the grains to the food manufacturers and where those grains are grown. The milling companies supplied grains blended together from a number of locations, or the manufacturing company may have sourced grain from a number of different suppliers.

To maintain a conservative estimate, the blending of grains was disregarded from the calculations and an average of the distances from the different regions was used. Refer to Appendix 4 for details on brands used and companies contacted for the cereals and legumes category.

[16] Available from the AC Nielsen website

According to the AC Nielson report of Australia's Top 100 Brands, Sunrise is identified as the most popular rice brand consumed in Australia. However, food miles estimates for imported rice were calculated in order to facilitate further discussion on assessing food miles in conjunction with other agriculture-related environmental concerns, such as water use. The distance travelled by the imported rice was not included in the overall food miles results.

2.6 Non-Core Food and Beverage

For processed goods in this category, the ingredient(s) constituting the largest proportion of the product were identified. Road distances were then calculated between growing regions of the main ingredients and the processing locations for the products and then to Melbourne.

In calculating the distances travelled by the food items, it was necessary in some instances, to follow the food miles of specific product brands. In such cases, the brands used were again determined by the Retail World Australasian Grocery Guide 2006 and the AC Nielson report on Australia's Top 100 Brands. Refer to Appendix 5 for details on food miles calculations for non-core food and beverage items.

2.7 Food Packaging

To demonstrate that the concept of food miles is not as simple as calculating the distance travelled by the food ingredients and products alone, calculation of the distance travelled by the food packaging of some food basket items were included. While it is beyond the scope of this study to calculate the distance travelled by all the different food packaging materials involved in the basket, the distance travelled by tin cans and milk cartons were selected as examples to show how food miles and associated greenhouse gas emissions may increase depending on the food packaging used. The distance travelled by the packaging items was not included in the food miles of the overall food basket.

The methods used to calculate the food miles of the basket items were also used to determine the distances travelled by the packaging materials. The companies producing the packaging were contacted and provided information about where they manufacture the packaging, and where the base materials used for the packaging come from (see Appendix 6).

http://au.acnielsen.com/trends/documents/AdNewsTop100lowres.pdf [Accessed April, 2007].

2.8 Greenhouse Gas Emissions Estimates

The following method was used to collate information used to calculate greenhouse gas (GHG) emissions estimate (see Appendix 7 for details).

2.8.1 Food Miles

Collection of food transport distances (food miles). Overseas transport distances with food items transported by ship/airplane, are omitted from the GHG emissions estimates as the scope of this study is for road transportation emissions only.

2.8.2 Number of Trucks

Most of the food items in the food basket were transported by road in trucks. Australian Bureau of Statistics (ABS) Motor Vehicle Census[17] data was used to obtain figures of rigid and articulated truck numbers for Victoria. Light commercial vehicles were excluded on the assumption that they are not used for long-haul transportation of food items, rather for metropolitan distribution (short distance) of food items.

Non-freight carrying trucks were excluded as it was assumed these vehicles would not be transporting freight. Only trucks were considered to be the mode of transportation for food items. This includes rigid trucks (light rigid and heavy rigid), and articulated vehicles with Gross Vehicle Mass (GVM)/Gross Combination Mass (GCM) of more than 3.5 tonnes as defined in the ABS Motor Vehicle Census (2006). To be conservative, we used a maximum of 20 tonnes GVM/GCM for rigid and articulated trucks, though truck weights were identified as being >20 tonnes for GVM and >100 tonnes for GCM. Only registered Victorian trucks were included on the assumption that trucks transporting food in Victoria would be registered in that state.

[17] Australian Bureau of Statistics (ABS) Motor Vehicle Census 9309.0 (March 2006).

2.8.3 Food Freight Trucks

To calculate how many of these Victorian trucks were carrying food freight, the ABS Freight Movement Survey[18] data was used. The data indicated approximately 10% of the total freight on a mass-uplift (i.e. tonnage) basis was transported by articulated trucks was food. This percentage was applied to the total number of articulated trucks to give the number of articulated trucks transporting food.

As there was no specified data for rigid truck transportation for the same year (2001), the ABS Survey of Motor Vehicle Use (2005)[19] indicated 15% of the total freight on a mass-uplift basis transported by road was food. This percentage was applied to give the number of rigid trucks transporting food[20].

2.8.4 Fuel Types for Articulated and Rigid Trucks

This study assumes that trucks are using diesel and unleaded petrol (ULP) fuels only. The number of articulated trucks and rigid trucks using diesel and unleaded petrol ULP were calculated by applying ABS national figures of fuel/registration rations or diesel/ULP[15] to Victorian figures as no specific figures for Victoria were available.

2.8.5 Food Mass Carried

As there was a lack of information on tonnage of food carried for specific food types, we applied an assumption that the trucks carry 75% of the GVM or GCM in food freight mass. It is also assumed that the trucks will be travelling at their maximum carrying capacity. Please note that the July 2007 report applied an assumption of 50% food freight mass. This percentage has been updated in an effort to be more representative of food mass carried by trucks.

As the truck mass is also moved in the process of transporting food, GVM or GCM was included as part of the calculations, however, the data does not include fuel mass. GVM and GCM figures were sourced from the ABS Motor Vehicle Census. Calculations assume that a food freight truck will be carrying its freight. Food miles and GHG emissions estimates were based on the truck travelling a single trip, eg. from producer to the Melbourne CBD.

[18] Australian Bureau of Statistics (ABS) Freight Movements Survey 92200.0 (2001).
[19] Australian Bureau of Statistics (ABS) Survey of Motor Vehicle Use 9208.0 (2005).

2.8.6 Fuel Consumption Rates

Fuel consumption rates (FCR) for articulated and rigid, diesel and ULP trucks were calculated using data from the Australian Greenhouse Office (AGO) Factors and Methods Workbook[21]. Weighted average FCR in litres per tonne-kilometre for the four different vehicle type/fuel type combinations were multiplied by the total GVM or GCM by truck type. This resulted in a FCR for both diesel and ULP fuels to be used in the emissions calculations formula. It is assumed that a truck loaded with food freight consumes an increased amount of fuel directly correlated with an increase in mass.

As there were no FCR figures for refrigerated vehicles (which could result in an increased FCR), it is assumed that all food trucks are transporting food without refrigeration.

2.8.7 Emission Factors

Emissions factors (EF) for diesel and ULP fuels were sourced from the AGO Factors and Methods Workbook[22]. To be conservative, full fuel cycle emission factors were not used as food miles by definition only considers transport emissions. Taking into account the indirect emissions from fuel extraction would be moving into a complete life-cycle analysis which is beyond the scope of this study.

2.8.8 Emission Formula

Formula for calculating emissions estimates was sourced following the guidelines in the AGO Factors and Methods Workbook[19]. Scope 1 factors were used in accordance with the AGO definition of Scope 1 emissions for transport fuels. Emissions formula is as follows:

Emissions (t CO2–e) = D (km) x FCR (L/km) x EF (t CO_2-e/kL) / 1000

Where D= distance travelled in kilometres, FCR = L per km, EF= emissions factor for fuel type, and division by 1000 converts L/km to kL/km

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[20] The authors are aware that some inaccuracies may result from using data from two separate years, however there is no other source information available.

[21] Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December, 2006).

Data outlined in the previous steps (see Appendix 7) was applied to this formula to calculate emission estimates for:

- Total food basket emissions estimate: All food trucks[22] engaged in transporting food (all truck and food mass) for 1 km.
- The proportion of total food basket road transport emissions, for 1 tonne of truck and food mass transported for 1 km
- The proportion of the total food transport emissions estimates, for each food item transported[23] for 1km
- An 'average food-transporting truck' transporting 1 tonne of mass (food and truck mass combined), and 1 tonne of food mass. Weighted averages were used to calculate average truck, average truck mass, average fuel consumption rate of an average fuel and an average emissions factor.

Results were tabulated and represented in several ways to increase the accessibility of this information to a broader range of readers. For example, emissions estimates are expressed in tonnes of CO_2–e, kilograms of CO_2–e and equivalent to 'Black Balloons'; Sustainability Victoria's education campaign where emissions are represented by balloons at 50g CO_2 per balloon. It was unclear whether the representation of emissions included CH_4 (Methane) and N_2O (Nitrous Oxide) (which are included in the measurement of CO_2–e in the AGO emissions formula), so conservative estimates were applied.

Expression of results in equivalent to cars is defined by 4 tonnes of CO_2–e, based on 15,000 km/year, this figure was sourced by correspondence with the AGO[24].

[22] The term 'food trucks' is used to indicate Victorian trucks transporting food.
[23] Based on the assumption that the transportation weight of food items is equal between the items and the food trucks are carrying the 25 food items between them.
[24] Mark Hunston, Australian Greenhouse Office (AGO), May 2007.

3 Methodological Limitations

In interpreting the information of this report, the following caveats should be taken into account.

3.1 Food Miles

All calculations of food miles were reliant on information supplied by organisations and companies. The research results are therefore vulnerable to any incomplete information supplied. This is especially true for company-supplied information, as many of the companies withheld information on their products and manufacturing processes that was deemed commercial in-confidence. In such cases, the most conservative assumptions were used to calculate the food miles for these products. For example, in calculating the food miles associated with teas, the company contacted stated that their teas were imported from India and Indonesia, however the teas were collected from any number of tea plantations within these regions. Distances travelled between tea plantations and these distribution points was disregarded as specific information was unavailable.

3.2 Greenhouse Gas Emissions Estimates

Emissions estimates were based on data from the ABS and the AGO. In some cases data was only available from 2001 and 2005. Consequently, there may be a degree of inaccuracy due to the lack of availability of required data within the same year.

The AGO data did not include figures for refrigerated vehicles, therefore emissions estimates should be considered as conservative. Lack of detailed food tonnage figures lead to a base assumption that food tonnage carried by food trucks is 75% of truck GVM or GCM, and food tonnage is equal for all food items. Please note that the July 2007 report applied an assumption of 50% food freight mass. This percentage has been updated in an effort to be more representative of food mass carried by trucks.

Calculation of numbers of food-transporting trucks in some cases required the application of national figures to Victorian figures, and some definitions of food in the ABS documents included 'tobacco and food for animals', therefore indicating possible inaccuracies.

4 Results

4.1 Table 1: Food Kilometres and Emissions Estimates for Fruit and Vegetable Food Items.

1	2	3	4	5	6	7	8
Food Category	**Food Item**	**Transport km**	**Emissions: a proportion of total food basket road transport emissions for each food item in t CO_2–e**[25] Road transport km x 0.53754[26] tCO_2–e	**Emissions: 1 tonne of food item transported by road** Road transport km x 0.0000653 t CO_2–e	**Emissions: 1 tonne of food item transported by road In kg of CO_2–e** column 5 x 1000	**Emissions: 1 kg of food item transported by road In grams of CO_2–e**	**Column 7 equivalent to the approx. number of 'Black Balloons'**[27] (50g CO_2 per balloon)
Fruit and Vegetables	Apples	112 km	60.20448	0.0073136	7.0	7g	0.15
	Oranges	567 km	304.78518	0.0370251	37.0	37g	0.75
	Orange Juice	2,024 km	1087.98096	0.1321672	132.0	132g	2.5
	Bananas	2,746 km	1476.08484	0.1793138	179.5	180g	3.5
	Tomatoes	1,618 km	869.73972	0.1056554	106.5	107g	2.0
	Potatoes	155 km	83.3187	0.0101215	10.0	10g	0.2
	Pumpkin	361 km	194.05194	0.0235733	23.5	24g	0.5
	Lettuce	54 km	29.02716	0.0035262	3.5	4g	0.1
	Carrots	311 km	167.17494	0.0203083	20.5	21g	0.5
	Onions	782 km	420.35628	0.0510646	51.0	51g	1.0
Food category Totals		8,730 km	4692.72 t CO_2–e	0.5700 t CO_2–e	570 kg CO_2–e	570 g CO_2–e	~11.5 'Black Balloons'
Total emissions equivalent to number of cars driving for 1 year[28]			1, 173 cars	0.14 cars			

[25] Emissions are expressed in tonnes of CO_2–e, which includes CO_2 (carbon dioxide) and the global warming effect of the relatively small quantities of CH_4 (methane) and N_2O (nitrous oxide) as defined by the Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December, 2006).

[26] See Appendix 7 for information on this data.

[27] Measurement in 'Black Balloons' refers to Sustainability Victoria's 'Black Balloons' campaign, where emissions are represented by balloons at 50g CO_2 per balloon. As this may not include CH_4 and N_2O (which are included in the measurement of CO_2–e as above), estimates have been used.

[28] Emissions equivalent to emissions per car are based on 4 tonnes CO_2–e per year based on 15, 000km. Source: correspondence: Mark Hunston, Australian Greenhouse Office (AGO), May 2007.

4.2 Table 2: Food Kilometres and Emissions Estimates for Meat and Dairy Food Items.

1	2	3	4	5	6	7	8
Food Category	**Food Item**	**Transport km**	**Emissions: a proportion of total food basket road transport emissions for each food item in t CO2–e** [29] Road transport km x 0.53754[30] t CO_2–e	**Emissions: 1 tonne of food item transported by road** Road transport km x 0.0000653 t CO_2–e	**Emissions: 1 tonne of food item transported by road In kg of CO_2–e** column 5 x 1000	**Emissions: 1 kg of food item transported by road In grams of CO_2–e**	**Column 7 equivalent to the approx. number of 'Black Balloons'** [31] (50g CO_2 per balloon)
Meat and Dairy products	Beef	298 km	160.18692	0.0194594	19.5	20g	0.5
	Chicken (fresh or frozen)	93 km	49.99122	0.0060729	6.0	6g	0.1
	Eggs	134 km	72.03036	0.0087502	9.0	9g	0.2
	Sausages	25,165	-	-	-	-	-
	Fresh full cream milk	348 km	187.06392	0.0227244	23.0	23g	0.5
	Cheese	688 km	369.82752	0.0449264	45.0	45g	1.0
Food category Totals		26,726 km	839.10 t CO_2–e	0.1019 t CO_2–e	103 kg CO_2–e	103 g CO_2–e	~2.0 'Black Balloons'
Total emissions equivalent to number of cars driving for 1 year[32]			210 cars	0.03 cars			

Note: All Data in Columns 4-8 is for road transported food items only, excluding food items that involve other modes of transport (Sausages).

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[29] Emissions are expressed in tonnes of CO_2–e, which includes CO_2 (carbon dioxide) and the global warming effect of the relatively small quantities of CH_4 (methane) and N_2O (nitrous oxide) as defined by the Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December, 2006).

[30] See Appendix 7 for information on this data.

[31] Measurement in 'Black Balloons' refers to Sustainability Victoria's 'Black Balloons' campaign, where emissions are represented by balloons at 50g CO_2 per balloon.
As this may not include CH_4 and N_2O (which are included in the measurement of CO_2–e as above), estimates have been used.

[32] Emissions equivalent to emissions per car are based on 4 tonnes CO_2–e per year based on 15, 000km. Source: correspondence: Mark Hunston, Australian Greenhouse Office (AGO), May 2007.

4.3 Table 3: Food Kilometres and Emissions Estimates for Cereal and Legume Food Items.

1	2	3	4	5	6	7	8
Food Category	**Food Item**	**Transport km**	**Emissions: a proportion of total food basket road transport emissions for each food item in t CO_2–e** [33] Road transport km x 0.53754t CO_2–e[34]	**Emissions: 1 tonne of food item transported by road** Road transport km x 0.0000653 t CO_2–e	**Emissions: 1 tonne of food item transported by road In kg of CO_2–e** column 5 x 1000	**Emissions: 1 kg of food item transported by road In grams of CO_2–e**	**Column 7 equivalent to the approx. number of 'Black Balloons'** [35] (50g CO_2 per balloon)
Cereals and Legumes	White bread	486 km	261.24444	0.0317358	32.0	32g	0.5
	Cereal	886 km	476.26044	0.0578558	58.0	58g	1.0
	Rolled oats	539 km	289.73406	0.0351967	35.0	35g	0.7
	Rice	381 km	204.80274	0.0248793	25.0	25g	0.5
	Instant noodles	582 km	312.84828	0.0380046	38.0	38g	0.75
	Savoury biscuits	1,802 km	968.64708	0.1176706	118.0	118g	2.5
	Tinned Baked Beans	3,132 km	-	-	-	-	-
Food category Totals		7,808 km	2513.54 t CO_2–e	0.3053 t CO_2–e	306 kg CO_2–e	306 g CO_2–e	~6.0 'Black Balloons'
Total emissions equivalent to number of cars driving for 1 year[36]			628 cars	0.08 cars			

Note: All Data in Columns 4-8 is for road transported food items only, excluding food items that involve other modes of transport (Baked Beans).

[33] Emissions are expressed in tonnes of CO_2–e, which includes CO_2 (carbon dioxide) and the global warming effect of the relatively small quantities of CH_4 (methane) and N_2O (nitrous oxide) as defined by the Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December, 2006).

[34] See Appendix 7 for information on this data

[35] Measurement in 'Black Balloons' refers to Sustainability Victoria's 'Black Balloons' campaign, where emissions are represented by balloons at 50g CO_2 per balloon. As this may not include CH_4 and N_2O (which are included in the measurement of CO_2–e as above), estimates have been used.

[36] Emissions equivalent to emissions per car are based on 4 tonnes CO_2–e per year based on 15, 000km. Source: correspondence: Mark Hunston, Australian Greenhouse Office (AGO), May 2007.

4.4 Table 4: Food Kilometres and Emissions Estimates for Non-core Food and Beverage Food Items.

1	2	3	4	5	6	7	8
Food Category	**Food Item**	**Transport km**	**Emissions: a proportion of total food basket road transport emissions for each food item in t CO_2–e**[37] Road transport km x 0.53754[38] t CO_2–e	**Emissions: 1 tonne of food item transported by road** Road transport km x 0.0000653 t CO_2–e	**Emissions: 1 tonne of food item transported by road In kg of CO_2–e** column 5 x 1000	**Emissions: 1 kg of food item transported by road In grams of CO_2–e**	**Column 7 equivalent to the approx. number of 'Black Balloons'** [39] (50g CO_2 per balloon)
Non-core Food and Beverage	Unsaturated Margarine	1,464 km	786.95856	0.0955992	96.5	97g	2.0
	White Sugar	2,315 km	1244.4051	0.1511695	151.0	151g	3.0
	Canola oil	303 km	162.87462	0.0197859	20.0	20g	0.5
	Black Tea	8,259 km	-	-	-	-	-
	Chocolate	13, 174	-	-	-	-	-
	Potato Chips/ Crisps	2,024 km	1087.98096	0.1321672	132.0	132g	2.5
Food category Totals		27,539 km	3282.22 t CO_2–e	0.39872 t CO_2–e	400 kg CO_2–e	400 g CO_2–e	~8 'Black Balloons'
Total emissions equivalent to number of cars driving for 1 year[40]			820 cars	0.1 cars			

Note: All Data in Columns 4-8 is for road transported food items only, excluding food items that involve other modes of transport (Black Tea, Chocolate).

[37] Emissions are expressed in tonnes of CO_2–e, which includes CO_2 (carbon dioxide) and the global warming effect of the relatively small quantities of CH_4 (methane) and N_2O (nitrous oxide) as defined by the Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December, 2006).
[38] See Appendix 7 for information on this data.
[39] Measurement in 'Black Balloons' refers to Sustainability Victoria's 'Black Balloons' campaign, where emissions are represented by balloons at 50g CO_2 per balloon. As this may not include CH_4 and N_2O (which are included in the measurement of CO_2–e as above), estimates have been used.
[40] Emissions equivalent to emissions per car are based on 4 tonnes CO_2–e per year based on 15, 000km. Source: correspondence: Mark Hunston, Australian Greenhouse Office (AGO), May 2007.

4.5 Table 5: Summary of Results for Food Categories of Food Basket Items.

1	2	3	4	5	6	7	8
Food Category	**Total food transport km**	**Total food transport km: Road transportation only**	**Total Emissions (road transport only) for each food category in t CO_2–e** [41]	**Emissions: 1 tonne of food item transported by road in t CO_2–e**	**Emissions: 1 tonne of food item transported by road in kg CO_2–e**	**Emissions: 1 kg of all food items, in food category transported by road, in grams CO_2–e**	**Column 7 equivalent to the approx. number of 'Black Balloons'** [42]
Fruit and Vegetables (excl. imported oranges)	8, 730 km	8, 730 km	4, 692.72 t	0.5700 t	570 kg	570 g	~2.5
Meat and Dairy products	26, 726 km	1, 561 km (excl. Sausages)	839.10 t	0.1019 t	103 kg	103 g	~2.0
Cereals and Legumes (excluding imported rice)	7, 808 km	4, 676 km (excl. Baked Beans)	2, 513.54 t	0.3053 t	305 kg	305 g	~6.0
Non-core Food and Beverage	27, 539 km	6, 106 km (excl. Black Tea and Chocolate)	3, 282.22 t	0.3987 t	400 kg	400 g	~8.0
Total	**70, 803 km**	**21, 073 km**	**11, 327.6 t CO_2–e**	**1.38 t CO_2–e**	**1, 378 kg CO_2–e**	**1, 378 g CO_2–e**	**~27.5 'Black Balloons'**
Total emissions equivalent to number of cars driving for 1 year[43]			**2, 832 cars**	**0.3 cars**			

Note: All Data in Columns 3-8 is for road transported food items only, excluding food items that involve other modes of transport (Sausages, Baked Beans, Black Tea and Chocolate).

[41] Emissions are expressed in tonnes of CO_2–e, which includes CO_2 (carbon dioxide) and the global warming effect of the relatively small quantities of CH_4 (methane) and N_2O (nitrous oxide) as defined by the Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December. 2006).

[42] Measurement in 'Black Balloons' refers to Sustainability Victoria's 'Black Balloons' campaign, where emissions are represented by balloons at 50g CO_2 per balloon. As this may not include CH_4 and N_2O (which are included in the measurement of CO_2–e as above), estimates have been used.

[43] Emissions equivalent to emissions per car are based on 4 tonnes CO_2–e per year based on 15, 000km. Source: correspondence: Mark Hunston, Australian Greenhouse Office (AGO), May 2007.

4.6 Table 6: Packaging Kilometres.

Packaging Item	Transport Km
Tin Cans	17,108
Milk Cartons	8,035
Total distance	25,143

4.7 Table 7: Overseas Food Item Kilometres and Equivalent Australian Item Kilometres.

Food Item	Departure point from country of origin	Transport Km	Equivalent Australian Item Km
Oranges –'Californian'	Los Angeles, USA	12,879	567
Rice –Basmati	Karachi, India	12,840	381
Rice –Arborio	Naples, Italy	18,315	381
Rice –Jasmine	Bangkok, Thailand	9,709	381

4.8 Table 8: Other Greenhouse Gas Emissions Estimates.

Refer to Appendix 7 for information on the following emissions estimates:

a) Total food basket emissions estimate: All food trucks[44] engaged in transporting food (all truck and food mass) for 1 km

= 13.4358 t CO_2–e

b) The proportion of total food basket road transport emissions, for 1 tonne of truck and food mass transported for 1 km = 0.00049 t CO_2–e

i) Expressed in kg of CO2–e = 0.49kg CO_2–e

c) The proportion of the total food transport emissions estimates, for each food item transported[45] for 1km = 0.53754 t CO_2–e

d) An Average Food-transporting Truck:

i) Emissions estimate for 1 tonne of mass (food: 75% and truck tare: 25% of 1 tonne mass) transported by an average food-transporting truck for 1 km

= 0.000049 t CO_2–e

ii) Emissions estimate for 1 tonne of food transported by an average food-transporting truck for 1km = 0.000065 t CO_2–e

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[44] The term 'food trucks' is used to indicate Victorian trucks transporting food.

[45] Based on the assumption that the transportation weight of food items is equal between the items and the food trucks are carrying the 25 food items between them.

5 Discussion

5.1 Food Miles

The food miles for the different food products and packaging across the different food categories are listed in Tables 1-7. For fresh fruit and vegetables, the distance travelled varied from 54 km for lettuce to 2,746 km for bananas. Such substantial differences in this category reflect the different growing regions, along with any variations in point of origin according to growing seasons. It is important to compare both the estimates of total transport kilometres: 70,803 km (all modes of transportation), and the total road transport kilometres: 21,073 km (road transportation only). This clearly shows that the majority of transport kilometres is for items transported from a country other than Australia.

Food category results cannot be compared to each other due to the different number of individual items; comparison of items should be done individually. It must be noted however, that the results are vulnerable to any incomplete information provided by organisations and food companies.

The food miles results reflect conservative assumptions based on the information provided by all the organisations and companies and, the figures must be considered conservative. For example, the majority of the processed food included in the basket was manufactured using a large number of ingredients. This study only calculated the food miles for the one or two ingredients that constituted the largest proportion of the product. When taking into consideration the number of ingredients not included in the study, the food miles figures particularly for the processed food can be seen as conservative underestimates of the actual distance travelled by the food products.

When comparing domestically grown produce with imported produce, the difference in food miles can obviously be quite large (Table 7). Taking the example of oranges, domestically produced oranges travel 567 km, a relatively short distance in comparison with the 12,878 km travelled by the Californian oranges (often found in supermarkets). The example of rice is used to illustrate that a sustainable food supply requires a more comprehensive analysis than food miles calculation. While the consumption of domestic rice in Melbourne carries comparatively low mileage, it is well recognised that rice production, with its high water requirements, is not suited to the region within which it is grown in Australia.

This emphasises the need for a complete life-cycle assessment and suggests that this assessment include analysis of embodied water.

The total distance of the road transportation in the food basket was estimated at 21,073 km, almost the same distance to travel around Australia's coastline (25,760 km). The total distance for all transportation of the food basket was estimated at 70,803 km (see Table 5), equivalent to travelling nearly twice around the circumference of the Earth (40,072 km), or travelling around Australia's coastline three times.

5.2 Packaging

When the total food miles of the shopping basket is considered in conjunction with the packaging of the items included, the total distance rises sharply. The distance travelled by just two packaging items: tin cans (17,108 km) and milk cartons (8,035 km), is presented in Table 6. This indicates another aspect of a complete life-cycle assessment that needs to be explored; the impact of packing of processed and non-processed foods.

5.3 Greenhouse Gas Emissions Estimates

The resulting GHG emissions estimates are presented in Tables 1-5 and Table 8. Emissions estimates for each food category (road transportation only), range from 839 tonnes (t) CO_2–e for Meat and Dairy products, up to 4, 692 t CO_2–e for Fruit and Vegetables. It is important to reiterate that these results are for road transportation only, and the emissions for shipping food freight were not included.

The five lowest emissions estimate were from lettuce, apples, chicken, potatoes and beef. Given that all these items are sold in their original form (eg. no other ingredients added), the vegetable items require little or no processing, and the meat items require some processing, this suggest that in general, food requiring less processing produces less emissions.

The five highest emissions estimates were for bananas, white sugar, unsaturated margarine, potato chips/crisps and orange juice. This can be associated with the location of raw produce (bananas), sourcing produce from multiple locations and the level of processing (white sugar, unsaturated margarine, potato chips/crisps and orange juice). Three of the highest six emissions estimates were in the Non-core Food and Beverage category, which suggests that in general, food requiring more processing produces more emissions.

The total emissions for all food trucks transporting all road food items, over the total food basket transport distance, was estimated at 11, 327 t CO_2–e. If all the food trucks were transporting all food on the same day, the emissions from this one day of transportation (11, 327 t CO_2–e), is equivalent to 2, 832 cars driving for one year[46].

Overall, it was clear that there is insufficient complete information available for a complete life cycle assessment of food production and transportation. This may indicate the level of information available to consumers in their attempts to base product choices on food miles and energy use in food production.

[46] Based on 4 tonnes CO_2–e per year based on 15, 000km. Source: personal correspondence: Mark Hunston, Australian Greenhouse Office (AGO), May 2007.

6 Conclusion

'Food Miles' is a term now commonly used to measure the transport distance travelled by food products between production and consumption. Food miles is one part of a larger full life-cycle assessment required to compare the sustainability of individual items in food systems. Food miles must not be viewed independently of the energy use in each 'chain' in our food system. This study contributes to an improved understanding of the transport aspect of our current food system.

As at the time of this report, the authors know of no Australian-specific food miles research on a scale comparative to this study. This preliminary study is an attempt to contribute Australian data to the expanding area of sustainability of our food systems.
The results of this study needed to be viewed within the limitations of this preliminary report. Food miles distances were reliant on information supplied by organisations and companies, the research results are therefore vulnerable to any incomplete information supplied. Calculations of emissions estimates were also reliant on source data, and in some cases used data from two separate years, or applied national figures to state calculations as no current data was available; which indicates a degree of inaccuracy due to the lack of accurate information. These limitations, however, give an indication of the level of information available to the consumer undertaking such investigations.

The total food miles and greenhouse gas emissions estimates presented in this preliminary study, clearly indicate the need for Australia to respond accurately to role our current food system plays within the issues of climate change and peak oil.

One such response involves education of consumers in addressing these issues. This report will be used as the basis for a new Food Education Program to be design by CERES Education, aiming to provide activities and resources for primary and secondary students to make more sustainable food choices.

7 Recommendations

There is currently a lack of current statistical information required to fully assess the impacts and vulnerabilities of the Australian food system. Given the current challenges of climate change and peak oil, at a state and federal level, Australia needs to urgently review the role our current food system plays within these significant issues.

Further research is therefore required for Australia to respond accurately within these issues.

Future research may include:

- A comparative analysis of the food miles and emissions of similar food items produced: Imported conventional and organic products, domestically produced conventional and organic, locally produced in-season products, and locally produced in-season organic products.

- A complete life-cycle assessment of the impacts of food production and transportation methods.

- Analysis of these studies in conjunction with research on bush foods and regional suitability of food products to provide alternative and replacement foods for any food products deemed to have a high environmental impact.

- Analysis of labelling of food products. For example, labels indicating the embodied: environmental impacts, energy use, greenhouse gas emissions and water use. Labelling may include an assessment of the social impact of food items, likewise to the 'Fair Trade' campaign.

  This may link with the revised labelling campaign for the 'Australian Grown' logo, launched in June 2007 by the Minister for Agriculture, Fisheries and Forestry.

  Such as study may assess how consumers respond to food labelling.

- Analysis of how growing international concern about food miles may impact the Australian export market. This may include participating in an international discussion on the role of educating consumers and the role of food product labelling.

- Analysis of the possible health and economic outcomes (both positive and negative), of eating more locally produced, unprocessed foods.

- Analysis of alternative food transport options along with the wider impacts of expanding road transportation (and the role played by food transportation), on congestion, accidents, road maintenance and air quality (in addition to climate change and peak oil issues).

  Further Australian food miles research could include the emissions associated with air freight and shipping.

- Exploring opportunities for reducing the distance between food production and consumption. This may include assessment of urban food production.

The research suggested above will enable greater understanding of the environmental and social impacts of our food systems. Furthermore, such research will assist policy makers to forecast future emissions and assist in decisions regarding the impacts of growing emissions on our greater society and the environment. This in turn, can assist with compliance to national and international emissions measurements and emissions treaties, while ensuring a food secure future, in light of the dual challenges of climate change and peak oil.

8 List of Appendices

8.1 Appendix 1: Healthy Food Access Basket.

8.2 Appendix 2: Fruit and Vegetables.

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8.6 Appendix 6: Packaging.

8.7 Appendix 7: Calculations for Greenhouse Gas Emissions Estimates.

8.8 Appendix 8: Data for Fuel Consumption Rates (Litres per tonne-kilometre).

8.9 Appendix 9: Data for Weighted Average truck Mass.

8.10 Appendix 1: Healthy Food Access Basket, Queensland Health (2000)

Table 1: The Healthy Food Access Basket 2000 – Foods And Quantities

Basket Item	Unit size surveyed	Total amount in HFAB	Basket Item	Unit Size Surveyed	Total amount in HFAB
Cereal Group			*Meat/ Meat Alternatives Group*		
loaves of white bread	680g	6800g	tinned corned beef	340g	340g
loaves of wholemeal bread	680g	6800g	tinned meat & onion/vegetables	400g-425g	820g
white flour	2kg	2.5kg	beef mince	1kg	1 kg
wholemeal flour	1kg	2.5kg	rump steak	1kg	1 kg
Weet-bix	750g	1500g	frozen chicken	size 11	2 kg
rolled oats	1kg	750g	tinned smoked oysters	85g-105g	170g
white rice	1kg	5kg	large eggs (min 50g)	660g	1320g
tinned spaghetti	420g-425g	1275g	sausages	1kg	1 kg
instant noodles	85g	1020g	tinned ham	450g	1 kg
Sao biscuits	250g	1kg	*Dairy Group*		
Fruit, Vegetable & Legume Group			fresh full cream milk	2L	8L
apples	1kg	6 kg	fresh, reduced fat milk	1L	1L
oranges	1kg	11 kg	powdered milk, whole	1kg	1kg
bananas	1kg	5 kg	powdered skim milk	1kg	1kg
tinned fruit salad, in natural juice	400g-450g	3520g	long life milk	1L	4L
orange juice (100%)	2L	4L	cheese	500g	2kg
tomatoes	1kg	5 kg	*Non-Core Foods*		
potatoes	1kg	10 kg	unsaturated margarine	500g	1500g
pumpkin	1kg	1.5 kg	white sugar	2kg	3 kg
cabbage	half	1.5kg	canola oil	750ml	750ml
lettuce	whole	1.5			
carrots	1kg	2 kg			
onions	1kg	2 kg			
frozen vegetables	500g	2.5 kg			
tinned peas	420g-440g	880g			
tinned baked beans	420g-425g	1700g			
tinned beetroot	425g-450g	450g			

g = grams; kg = kilogram; L = litre;

Source: Queensland Health (2000) *The Healthy Food Access Basket Survey 2000*, Queensland Government, Australia p.12.

8.11 Appendix 2: Fruit and Vegetables

APPLES
Average distance travelled = 112.01km
Information source: Apple & Pear Australia Limited.
Assumptions: Victoria produces 33% of Australia's apples. 95% of Melbourne's apples would come from the Yarra Valley, Gippsland and the Goulburn Valley (Shepparton). The other 5% comes from Tasmania – this was disregarded from the calculations.
Distance Calculations:

Yarra Valley (used Healesville) to Melbourne = 64.75km
Goulburn Valley (Shepparton) to Melbourne = 178.74km
Gippsland to Melbourne (average of Officer (52.35km) & Childers (132.7km)) = 92.53km
Unweighted average distance = 112.01km

ORANGES - AUSTRALIAN
Average distance travelled = 567.65km
Information source: Australian Citrus Growers
Assumptions: The majority of Melbourne's oranges are grown in the Riverland (SA), Murray Valley (Vic/NSW) and the Riverina (NSW) regions. Oranges are also grown in Central Burnett (QLD) but because Navel and Valencia oranges have back-to-back seasons, these closer regions are able to supply oranges throughout the year.
Distance Calculations:

Riverina, NSW
- Leeton to Melbourne = 456.23km
- Griffith to Melbourne = 456.71km

Average to Melbourne = 456.47km

Riverland, SA
- Waikerie to Melbourne = 738.52km
- Renmark to Melbourne = 675.23km
- Berri to Melbourne = 694.33km

Average to Melbourne = 702.70km

Murray Valley, Vic & NSW
- *Mildura to Melbourne = 543.77km*

Unweighted average distance = 567.65km

ORANGES - CALIFORNIA
Average distance travelled = 12,878.81km
Assumptions: It was assumed that Californian oranges are shipped from Los Angeles direct to Melbourne, and disregarding any US domestic distance travelled.
Shipping route and distance obtained by Netpas Distance program.
Distance Calculations:

Los Angeles to Melbourne = 6,954 nautical miles x 1.852 = 12,878.81km

ORANGE JUICE
Average distance travelled = 2,023.74km
Information source: Berri Juice
Assumptions: Orange juice is sourced from the main citrus grown regions (Riverina, Riverland and Murray Valley). Juice is manufactured in Lytton (QLD), Leeton (NSW), Smithfield (NSW), Berri (SA), Bentley (WA). It was stated that the juices sold in Melbourne would most likely be manufactured in Berri, but they could also come from manufacturing plants as far as Bentley (WA). While this information was not very precise, we felt it important to factor the probability in to the calculations. To do so, we assumed that 50% of Melbourne's orange juice would have come from Berri, while the other 50% comes from each other factory stated in equal amounts.
Distance Calculations:

Berri, SA from:
- Riverina (Griffith) area = 600.50km
- Riverland area (Waikerie) = 61.75km
- Murray Valley (Mildura) area = 160.72km

Unweighted average distance to Berri = 274.32km
Berri to Melbourne = 694.33km
Total unweighted average distance to and from Berri = 968.65km

Lytton, QLD from:
- Riverina (Griffith) area = 1,295.75km
- Riverland (Berri) area = 1,846.22km
- Murray Valley (Mildura) area = 1,685.24km

Unweighted average to Lytton = 1,609.07km
Lytton to Melbourne = 1,697.51km
Total unweighted average distance to and from Lytton = 3,306.58km

Leeton, NSW from:
- Riverina (Griffith) area = 58.08km
- Riverland (Berri) area = 616.39km
- Murray Valley (Mildura) area = 455.41km

Average to Leeton = 376.63km
Leeton to Melbourne = 456.93km
Total unweighted average distance to and from Leeton = 833.56km

Smithfield, NSW from
- Riverina (Griffith) area = 546.30km
- Riverland (Berri) area = 1,145.70km
- Murray Valley (Mildura) area = 984.71km

Average to Smithfield = 892.24km
Smithfield to Melbourne = 844.71km
Total Distance = 1,736.95km

Bentley, WA from
- Riverina (Griffith) area = 3,364.46km
- Riverland (Berri) area = 2,771.68km
- Murray Valley (Mildura) area = 2,924.68km

Average to Bentley = 3,020.27km
Bentley to Melbourne = 3,417.98km
Total Distance = 6,438.25km

Unweighted average distance from other factories (not including Berri) to Melbourne = 3,078.84km

Total weighted average distance (average of distance from Berri and distance from others) = 2,023.74km

BANANAS
Average distance travelled = 2,746.20km
Information source: Victorian Chamber of Fresh Produce Wholesalers Inc,
Assumptions: 85% of Melbourne's bananas would come from the Tully & Inesvale regions in Northern Queensland, and 15% would come from Coffs Harbour (NSW), Carnarvon (WA), and the Northern Territory. Bananas from the Northern Territory were disregarded from the calculation as no specific production region was determined. This offers a conservative figure.
Distance Calculations:

Northern Queensland

- Innisfail to Melbourne = 2,764.33km
- Tully to Melbourne = 2,713.2km

Average to Melbourne = 2,738.77km

Coffs Harbour and Carnarvon

- Coffs Harbour to Melbourne = 4,186.74km
- Carnarvon to Melbourne = 1,389.83km

Average to Melbourne = 2,788.29km

Weighted average distance from Northern Queensland (85%) and Coffs Harbour and Carnarvon (15%) = 2746.20km

TOMATOES
Average distance travelled = 1,618.37km
Information Source: Freshstate
Assumptions: Melbourne's tomato sources vary seasonally. During summer we source most of our tomatoes within Victoria, but during winter we get them from as far as Queensland (Bundaberg, Bowen) or WA (Geraldton, Carnarvan), or we import hydroponically grown tomatoes from New Zealand. To ensure a conservative figure, we disregarded the tomatoes imported from New Zealand.
Distance Calculations:

Summer

- Shepparton to Melbourne = 178.74km
- Bendigo to Melbourne = 150.43km

Summer average to Melbourne = 164.59km

Winter

- Bundaberg (QLD) to Melbourne = 1,889.86km
- Bowen (QLD) to Melbourne = 2,504.24km
- Geraldton (WA) to Melbourne = 3,707.68km
- Carnavan (WA) to Melbourne = 4,186.77km

Winter average to Melbourne = 3,072.14km

Unweighted average distance = 1618.37km

POTATOES
Average distance travelled = 155.00km
Information source: Victorian Potato Growers Council
Assumptions: Melbourne sources its potatoes from within Victoria from areas such as Thorpdale, Gembrook, Leongatha and East Gippsland throughout the year.
Distance Calculations:

Thorpdale to Melbourne = 135.38km
Gembrook to Melbourne = 78.98km
Leongatha to Melbourne = 133.32km
East Gippsland (Lindenow) to Melbourne = 272.30km
Unweighted average distance = 155.00km

PUMPKINS
Average distance travelled = 361.23km
Information source: Australian Vegetable and Potato Growers Federation,
Assumptions: The majority of our pumpkins would come from the Shepparton and Mildura regions.
Distance calculations:

Mildura to Melbourne = 543.71km
Shepparton to Melbourne = 178.74km
Unweighted average distance = 361.23km

LETTUCE
Average distance travelled = 54.55km
Information source: Australian Vegetable and Potato Growers Federation
Assumptions: The majority of our lettuces would come from Werribee, Mornington Peninsula and Cranbourne. It was stated that a small proportion would come from the NSW border, but this was considered insignificant and was disregarded from the calculations.
Distance calculations:

Werribee to Melbourne = 33.52km
Mornington Peninsula (Balnarring) to Melbourne = 79.01km
Cranbourne to Melbourne = 51.11km
Unweighted average distance = 54.55km

CARROTS
Average distance travelled = 311.36km
Information source: Australian Vegetable and Potato Growers Federation
Assumptions: The majority of carrots consumed in Melbourne are grown around Mildura and the Mornington Peninsula.
Distance calculations:

Mildura to Melbourne = 543.71km
Mornington Peninsula (Balnarring) to Melbourne = 79.01km
Unweighted average distance = 311.36km

ONIONS
Average distance travelled = 782.30km
Information source: Onions Australia
Assumptions: Some onions are produced in Werribee, Victoria, but these are not enough to supply the Melbourne market. During spring and early summer (Sept-Jan) Melbourne is supplied by onions from QLD (the Lockyer Valley near Toowoomba, and some from St George). During Summer season (Dec-Feb) Melbourne also is supplied by onions from Werribee, the Murray Mallee area in SA (Murray Bridge, Swan Reach, Mannum, Virginia), and from NSW in the Griffith and Jerilderie regions (during Nov-Feb).
Distance calculations: In order to factor seasonal variations into the Food Kms calculation, the following equation was used:
Unweighted average distance = Sum of [Distance from town x (months town supplies onions/16 (total months described))]

Victoria (3 months)
- Werribee to Melbourne = 33.29km

33.29 x (3/16) = 6.24

NSW (4 months)
- Griffith to Melbourne = 456.71km
- Jerilderie to Melbourne = 319.55km

Average to Melbourne = 388.13km
388.13 x (4/16) = 97.03

SA (4 months)
- Murray Bridge to Melbourne = 653.97km
- Mannum to Melbourne = 679.51km
- Swan Reach to Melbourne = 759.33km
- Virginia to Melbourne = 754.81km

Average to Melbourne = 711.91km
711.91 x (4/16) = 177.98

QLD (5 months)
- *Lockyer Valley (Gatton) to Melbourne = 1,603.37km*

1,603.37 x (5/16) = 501.05

Unweighted average distance = 6.24 + 97.03 + 177.98 + 501.05 = 782.30km

8.12 Appendix 3: Meat and Dairy

FULL CREAM MILK
Average distance = 347.78km
Information source: Parmalat, Rowville (According to the Retail World Australasian Grocery Guide 2006, National Foods is Australia's largest milk company, holding 17.6% of Australia's milk market. National Foods was unable to provide any information relevant to calculating the Food Kms attached to their milk. The second largest company, Parmalat, holding 17.2% of the milk market, was therefore contacted).
Assumptions: Parmalat processes at Rowville and Bendigo and is sourced from places such as Kiewa, Corryong, Campaspe, Daytura, Kyabrum, Stanhope, Cobrum, Strathmurton, Finley (NSW), and Tocumwal (NSW). (It was stated that milk produced in Finley (NSW) could be trucked to Rowville, processed and packaged, and trucked to the shops by the same evening)
Distance calculations:

Kiewa to Bendigo = 326.09km
Kiewa to Rowville = 372.09km
Corryong to Bendigo = 426.99km
Corryong to Rowville = 472.99km
Tatura to Bendigo = 108.00km
Tatura to Rowville = 214.56km
Kyabram to Bendigo = 103.70km
Kyabram to Rowville = 256.98km
Stanhope to Bendigo =83.51km
Stanhope to Rowville = 215.36km
Cobram to Bendigo = 189.31km
Cobrum to Rowville = 291.34km
Finley (NSW) to Bendigo = 221.41km
Finley (NSW) to Rowville = 325.24km
Tocumwal (NSW) to Bendigo = 202.06km
Tocumwal to Rowville = 305.88km
Average to milk manufacture plant = 257.22km

Bendigo manufacture plant to Melbourne = 150.45km
Rowville manufacture plant to Melbourne = 30.67km
Average distance = 90.56km

Total unweighted average distance = 347.78km

CHEESE
Average distance = 688.99km
Information source: Bega (According to the Retail World Australasian Grocery Guide 2006, Bega and Mainland cheese both hold an equal majority of the Australian cheese market).
Assumptions: Bega cheese is manufactured in the Bega Valley. Approximately 90% of the milk used is sourced from the Bega Valley, and some from around Bairnsdale and Gerringong. This milk may also be supplemented from the regions around Sydney and Canberra, and may even use cheese produced in New Zealand. The distances from Sydney, Canberra and New Zealand have been disregarded from the calculations. Mainland cheese is also produced in New Zealand, and has been disregarded from the study so as to maintain a conservative estimate.

Distance calculations:

Bega Valley to Bega
- Jellat Jellat to Bega = 7.85km
- Timbillica to Bega = 93.57km

Unweighted average of the shortest and longest distances = 50.71km

Others regions to Bega
- Gerringong to Bega = 296.24km
- Bairnsdale to Bega = 331.18km

Unweighted average distance = 313.71km

Weighted average of milk from within Bega Valley (90%) and others (10%) = 77.01km

Bega to Melbourne = 611.98km

Total unweighted average distance = 688.99km

FRESH/FROZEN CHICKEN

Total distance = 93.02km

Information source: Victorian Farmers Federation- Chicken Meat Group and Inghams (According to both the AC Nielson report on Australia's Top 100 Brands and the Retail World Australasian Grocery Guide 2006, Ingham produces the majority of Australia's chicken).

Assumptions: Chicken consumed in Melbourne is predominantly raised in the Somerville region, Mornington peninsula (e.g. Moorooduc, Balnarring, Redhill etc). It was stated that a small proportion also comes from Geelong, Werribee and Yarra Valley but much more from Mornington Peninsula. The Inghams processing plants are located in Somerville (for fresh and frozen chicken products) and Thomastown (for cooked and pre-cooked chicken products).

Distance calculations:
- Balnarring to Somerville = 19.76km
- Moorooduc to Somerville = 7.43km
- Redhill to Somerville = 30.45km

Average from areas in Mornington Peninsula to Somerville = 28.28km

Somerville to Melbourne = 64.74km

Total average distance = 93.02km

EGGS

Average Distance = 134.38km

Information source: Australian Egg Corporation,

Assumptions: The majority of the eggs consumed in Melbourne would be produced around Melbourne (e.g. Tullamarine, Mornington Peninsula, or Gippsland). It was also indicated that some may come from as far as Queensland (e.g. Toowoomba) or NSW (e.g. Young, West Wyalong). It was estimated that eggs from Queensland and New South Wales account for at least 10% of the Melbourne egg market, and calculations were made using this conservative estimation.

Distance calculation:

Unweighted average distance from around Melbourne region = 48.73km
- Tullamarine to Melbourne = 18.37km
- Mornington Peninsula (Balnarring) to Melbourne = 79.09km

Unweighted average distance from other states = 905.22km
- Toowoomba to Melbourne = 1,547.91km

- Young to Melbourne = 603.03km
- West Wyalong to Melbourne = 564.73km

Weighted average distance from around Melbourne region (90%) and other states (10%) = 134.38km

BEEF
Average distance = 297.79km
Information source: Meat & Livestock Australia
Assumptions: The majority of Melbourne's beef comes from around Victoria - from the western border to Mildura and Swan Hill, and out to Gippsland. (Some beef also comes from New South Wales, Queensland, and Western Australia, though these distances were disregarded in the calculations as the information provided was not substantive).
Distance Calculations: As the beef cattle raising regions are extensive throughout Victoria, the estimate is based on the unweighted average of the shortest and longest distances to Melbourne, assuming equal quantities from the different regions.

Longest distance (Mildura) to Melbourne = 543.22km
Shortest distance (Whittlesea) to Melbourne = 52.36km
Unweighted Average distance = 297.79km

PORK SAUSAGES
Average distance = 25,165.49km
Information source: Hans Melbourne (According to both the AC Nielson report on Australia's Top 100 Brands and the Retail World Australasian Grocery Guide 2006, Hans is Australia's top smallgoods company).
Assumptions: It was stated that the pork used in Hans' sausages are sourced domestically in Queensland and imported (shipped) from Denmark (and sometimes the US and Canada, though these were disregarded as it was stressed that Denmark is the first choice for pork imports) because Australia's pork industry is not large enough to match the demand. The sausages are manufactured in Wacol (QLD), Colmslie (QLD), Blacktown (NSW) and Kingaroy (QLD).
Distance calculations:

Denmark (Copenhagen) to Brisbane = 12,640 nautical miles x 1.852 = 23,409.28km

Unweighted average distance from port to factory = 294.52km

- Brisbane to Wacol = 20.65km
- Brisbane to Colmslie = 8.90km
- Brisbane to Kingaroy = 208.66km
- Brisbane to Blacktown = 939.88km

Unweighted average distance from factory to Melbourne = 1,461.69km

- Wacol to Melbourne = 1,660.39km
- Colmslie to Melbourne = 1,684.33km
- Kingaroy to Melbourne = 1,645.12km
- Blacktown to Melbourne = 856.91km

Total Average Distance = 25,165.49km

8.13 Appendix 4: Cereal and Legumes

RICE – AUSTRALIAN
Average Distance = 381.29km
Information source: Sunrice (According to the Retail World Australasian Grocery Guide 2006, Sunrice dominates the Australian rice market).
Assumptions: The vast majority of Australian rice is grown around the Riverina region.
Distance calculations:

Leeton to Melbourne = 456.93km
Deniliquin to Melbourne = 305.65km
Unweighted average distance = 381.29km

RICE - IMPORTED
Information source: Rice Distributors Australia
Assumptions: Most basmati rice comes from the Indus Valley (Punjab, Haryana, Uttar Pradesh, Uttaranchal) and is shipped from Karachi, Pakistan to them in Port Botany, NSW and then distributed to Melbourne. Jasmine is shipped from Bangkok, Thailand. Arborio from Naples, Italy. The calculations below disregard domestic/regional transport of rice before import to Australia.
Distance calculations: The shipping distances were obtained using the Netpas Distance program.

BASMATI RICE
Average distance = 12,840.76km

- Karachi, India to Sydney = 6,463 nautical miles x 1.852 = 11,969.48km
- Sydney to Melbourne = 871.28km

Total distance = 12,840.76km

JASMINE RICE
Average distance = 9,709.02km

- Bangkok, Thailand to Sydney = 4,772 nautical miles x 1.852 = 8,837.74km
- Sydney to Melbourne = 871.28km

Total distance = 9,709.02km

ARBORIO RICE
Average distance = 18,314.76km

- Naples, Italy to Sydney = 9,419 nautical miles x 1.852 = 17,443.48km
- Sydney to Melbourne = 871.28km

Total distance = 18,314.76km

ROLLED OATS
Average distance = 538.95km
Information source: Dr. Pamela Zwer, South Australian Research and Development Institute. According to the Retail World Australasian Grocery Guide 2006, Uncle Toby produces vast majority of rolled oats consumed in Australia.
Assumptions: Most oats are grown in Southern NSW (e.g. Griffith), and Uncle Toby's rolled oats would be processed in their Wahgunyah mill. During drought, oats may be sourced from WA (Williams to Katanning). Drought period was disregarded from the calculations.
Distance calculations:

Griffith to Wahgunya = 252.73km
Wahgunya to Melbourne = 286.22km
Total distance = 538.95km

BREAD
Average distance = 486.14km
Information source: Tip Top and Western Milling (According to the AC Nielson report on Australia's Top 100 Brands, Tip Top is the top bread manufacturing brand in Australia).
Assumptions: According to Tip Top, their Dandenong factory supplies bread to Melbourne. The wheat is sourced from the Western Milling North Melbourne mill. According Western Milling, the North Melbourne mill sources its wheat from the Mallee region, e.g. Swan Hill, Piangil, Murrayville areas.
Distance calculations:

Wheat producers to mill

- Swan Hill to North Melbourne = 334.85km
- Piangil to North Melbourne = 374.04km
- Murrayville to North Melbourne = 534.46km

Unweighted average distance = 414.45km

Mill (North Melbourne) to factory (Dandenong) = 37.00km
Dandenong to Melbourne = 34.69km
Total average distance = 486.14km

CEREAL BISCUITS (Weet-Bix)
Average distance (not including distance from growers to manufacturers) = 885.94km

Information source: Sanitarium,

Assumptions: Melbourne's Weet-bix is manufactured in Adelaide (SA), Cooranbong (NSW), or Berkeleyvale (NSW). The wheat used was said to be grown around those areas, though they were unable to be more specific. The distance from the wheat producers to the mill was therefore disregarded. As CSR stated that the majority of Australia's sugar is grown in the Mackay region, it was assumed that the sugar used in Weet-bix was transported from Mackay.

Distance calculations:

Sugar to Weet-bix factories

- Mackay to Adelaide = 2,274.13km
- Mackay to Cooranbong = 1,621.99km
- Mackay to Berkeleyvale = 1,655.47km

Factories to Melbourne

- Adelaide to Melbourne = 725.50km

- Cooranbong to Melbourne = 978.54km
- Berkeleyvale to Melbourne = 953.79km

Average distance (not including growers to manufacturers)= 885.94km

SAVOURY BISCUITS (Sao)
Average distance for wheat only = 1,802.48km
Information source: Arnotts and Allied Mills
Assumptions: Sao biscuits are manufactured in Huntingwood, NSW. Allied mills confirmed that their Summer Hill mill supplies wheat for Sao biscuits, and they source their wheat from the Northern Victorian wheat-belt - assumed to be the Swan Hill & Birchip region.
Distance calculations:

Wheat to mill

- Swan Hill to Summer Hill = 896.57km
- Birchip to Summer Hill = 944.64km

Average distance = 920.61km

Summer Hill to Huntingwood = 29.07km
Huntingwood to Melbourne = 852.80km
Total average distance = 1,802.48km

INSTANT NOODLES
Average distance for wheat only = 582.27km
Information source: Nestle (According to the Retail World Australasian Grocery Guide 2006, Maggi (Nestle) produces the vast majority of instant noodles consumed in Australia)
Assumptions: Maggi instant noodles are manufactured in Pakenham, Victoria, though sometimes (around three times a year) high demand on instant noodles forces Nestle to import the Maggi instant noodles manufactured at their factory in Fiji (this was disregarded from the calculations to maintain a conservative estimate). The wheat used in the instant noodles is supplied by the Allied mills Kensington mill which sources the wheat from the Murrumbidgee Irrigation Area (M.I.A.) in Victoria.
Distance calculations:

M.I.A. (Griffith) to Kensington = 464.76km
Kensington to Pakenham = 66.75km
Pakenham to Melbourne = 60.76km
Total distance = 582.27km

BAKED BEANS
Estimated distance = 3,131.73km
Information source: Heinz (According to both the AC Nielson report on Australia's Top 100 Brands and the Retail World Australasian Grocery Guide 2006, Heinz produces the majority of Baked Beans consumed in Australia).
Assumptions: The baked beans are processed in Hastings, New Zealand. The main ingredients (navy beans, tomatoes, and sugar) are said to be grown around New Zealand, but Heinz was unable to state where. The transport of ingredients to the Hastings factory was therefore disregarded. The figure can therefore be considered a conservative estimate
Distance calculations: Shipping route and distance was calculated using the Netpas Distance program.

Hastings, NZ to Melbourne = 1691 nautical miles x 1.852 = 3,131.73km

8.14 Appendix 5: Non-core Food and Beverage

SUGAR
Average distance = 2,315.66km
Information source: CSR (According to the Retail World Australasian Grocery Guide 2006, CSR produces the majority of Australia's sugar).
Assumptions: According to CSR, the majority of their sugar is grown around Mackay, and refined in either Mackay or Yarraville, Melbourne.
Distance calculations:

Mackay to Melbourne = 2,315.66km

CANOLA OIL
Average distance = 303.62km
Information source: Goodman Fielder and Cargill (According to the Retail World Australasian Grocery Guide 2006, Goodman Fielder is the largest canola oil producer in Australia.
Assumptions: According to Goodman Fielder, their largest canola oil manufacturing plant is located in West Footscray. They also have smaller plants in Mascot (NSW) and Brisbane (QLD), though distances from these plants were disregarded from the current study. Cargill's Brooklyn crushing plant supplies some of the Canola to the West Footscray plant. Cargill's receiver points are listed below.
Distance calculations:

Receiving points to crushing plant

- Yarrawonga (Vic) to Brooklyn (Melbourne) = 281.26km
- Echuca (Vic) to Brooklyn = 224.71km
- Borung (Vic) to Brooklyn = 229.40km
- Horsham (Vic) to Brooklyn = 289.68km
- Oaklands (NSW) to Brooklyn = 356.99km
- The Rock (NSW) to Brooklyn = 421.87km

Unweighted average distance = 300.65km

Crushing plant (Brooklyn) to Goodman Fielder oil manufacturer (West Footscray) = 2.97km

Total unweighted average distance = 303.62km

MARGARINE
Average distance = 1,464.40km
Information source: Goodman Fielder and Cargill (According to the Retail World Australasian Grocery Guide 2006, Goodman Fielder is the leading margarine producing company.)
Assumptions: According to Goodman Fielder, their margarine is manufactured in Mascot, NSW. They source their Canola from Cargill (Kooragang Island, Newcastle) and Riverland Oilseeds. The Cargill receiver points for their Newcastle crushing plant are listed below.
Distance calculations:

Receiving points to crushing plant

- Temora (NSW) to Newcastle = 574.02km
- Cowra (NSW) to Newcastle = 429.72km
- Forbes (NSW) to Newcastle = 495.65km
- Balladoran (NSW) to Newcastle = 398.9km
- Willow Tree (NSW) to Newcastle = 209.21km
- Moree (NSW) to Newcastle = 502.71km

Unweighted average distance = 435.04km
Crushing Plant (Kooragang Is, Newcastle) to Margarine manufacture plant (Mascot) = 168.02km
Mascot to Melbourne = 861.34km
Total average distance = 1,464.40km

CHOCOLATE
Average distance = 14,479.01km
Information source: Cadbury (According to both the AC Nielson report on Australia's Top 100 Brands, Cadbury is Australia's leading chocolate producing company).
Assumptions: Cadbury Australia imports their cocoa beans from Singapore. According to Cadbury Singapore they get their cocoa beans from Indonesia - it was assumed that this was from South East Sulawesi, Indonesia. The milk chocolate bar is manufactured in Claremont, Tasmania, sourcing milk from Burnie, Tasmania, and sugar from Mackay, Queensland.
Distance calculations:

Cocoa beans
- Kolaka, Sulawesi to Makassar, Sulawesi = 250 nautical miles x 1.853 = 463.00km
- Makassar, Sulawesi to Singapore = 1,040nm x 1.852 = 1,926.08km
- Singapore to Melbourne = 3,868nm x 1.852 = 7,163.54km
- Melbourne to Hobart = 474nm x 1.852 = 877.90km
- Hobart to Claremont, Tasmania = 14.22km

Total distance (Sulawesi to Claremont) = 10,444.72km

Milk
- Burnie, Tasmania to Claremont, Tasmania = 283.26km

Sugar
- Mackay, Qld to Hobart (assumed to be shipped from Mackay) = 1536nm x 1.852 = 2,844.67km
- Hobart to Claremont = 14.22km

Total distance (Mackay to Claremont) = 2,858.89km

Chocolate bars
- Claremont to Hobart = 14.22
- Hobart to Melbourne = 877.90km

Total distance (Claremont to Melbourne) = 892.12km

Total average distance for chocolate bars = 14,479.01km

BLACK TEA
Average distance = 8,259.00km
Information source: Lipton
Assumptions: According to Lipton, the teas are processed, blended and packaged in India and Indonesia, though the tea may be imported to these processing points from tea plantations anywhere in the world. They were unable to be more specific on this point, so to maintain a conservative estimate, the pre-processing distances travelled by the tea was disregarded from the calculations.
Distance calculations:

Mumbai, India to Melbourne = 5,531nm x 1.852 = 10,243.41km
Jakarta, Indonesia to Melbourne = 3,388nm x 1.852 = 6,274.58km
Unweighted average distance to Melbourne = 8,259.00km

POTATO CHIPS/CRISPS
Average distance = 2,023.76km
Information source: Smiths (According to both the AC Nielson report on Australia's Top 100 Brands, Smiths is the largest potato chip/crisps company in Australia)
Assumptions: Smiths crisps are manufactured in Regency Park (SA), Caningvale (WA) and Tingalpa (QLD). Each of these factories would send crisps to their Dandenong (VIC) distribution centre. Smiths was unable to tell me where they source their potatoes from so the pre-factory distances have been disregarded from the calculations.
Distance calculations:

Factory to distribution point

- Regency Park (SA) to Dandenong = 768.43km
- Canning Vale (WA) to Dandenong = 3,455.70km
- Tingalpa (QLD) to Dandenong = 1,743.07km

Unweighted average distance = 1,989.07km

Dandenong to Melbourne = 34.69km

Total unweighted average distance = 2,023.76km

8.15 Appendix 6: Packaging

TIN CANS
Average distance = 17,107.74km
Information source: National Can Industries
Assumptions: In the production of tin cans iron ore and coke (coal) are mined in Western Australia and then sent to Japan for the manufacture of tin plates. Sheets of tin plates are then sent back to Melbourne to be turned into cans. The cans are then sent to the various canning points for the different foods. For food tinned in other countries the food kms would be higher still.
Distance calculations:

Perth to Japan (Hidaki Port) = 4,204 nautical miles x 1.852 = 7,785.81km
Japan (Hidaki Port) to Melbourne = 5,014nautical miles x 1.852 = 9,285.93km
Total distance = 17,107.74km

MILK CARTONS
Average distance = 8,035.56km
Information source: Tetrapak
Assumptions: Tetrapak's long life milk packaging is produced in Singapore, and their standard milk packaging is produced in Taiwan. The packaging is said to be made of recycled paper imported to these factories from around the world. Because Tetrapak was unable to be more specific on where the base materials come from, these distances have been disregarded from the calculations.
Distance calculations:

Singapore to Melbourne = 7,163km
Taiwan to Melbourne = 8,908.12km
Average distance = 8,035.56km

8.16 Appendix 7: Calculations for Greenhouse Gas Emissions Estimates

To calculate greenhouse emissions, there are several questions that need to be answered:

1. The contents of the food basket have been transported from producers to Melbourne. How far have the food basket contents travelled (transportation distances)?

a) Distance of food road transportation: see Tables 1-5

2. The majority of food is transported by road in trucks. How many trucks are there in Victoria[47]?

a) Number of rigid and articulated trucks registered in Victoria (this total excludes non-freight carrying trucks)[48].
i) Rigid = 92,158
Articulated = 21,508
Total = 113,666

3. Not all of these trucks are transporting food freight. How many Victorian trucks are transporting food[49]?

a) According to the ABS Freight Movements Survey (2001), approx. 10% of the total freight on a mass-uplift (i.e. tonnage) basis transported by articulated trucks was food.
10 % of 21,508 = 2,151 articulated trucks transporting food freight.

b) As there is no specified data for rigid truck transportation for the same year of 2001, we have used the ABS Survey of Motor Vehicle Use (2005), which states that approx. 15% of the total freight on a mass-uplift basis transported by road was food[50].
15% of 92,158 = 13,824 rigid trucks transporting food freight.

c) Total trucks transporting food = 15,975

4. Not all trucks transporting food use the same fuel, and different transport fuels produce different emissions. What type of fuels are these trucks using?

a) Number of vehicles by fuel type for Victoria[51]

i) Total vehicles in Victoria = 3,740,726
Proportion of the total vehicles in Victoria registered as using diesel fuel is 10.6%[2]
= 396,517 vehicles in Victoria registered as using diesel fuel

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47 For the purpose of this study vehicles are now referred to as trucks, as this is the vehicle category used for food road transportation.

48 Australian Bureau of Statistics (ABS) Motor Vehicle Census 9309.0 (March 2006)

49 The term 'food trucks' is used in this document to indicate Victorian trucks transporting food.

50 We are aware that some inaccuracies may result from using data from two separate years, however there is no other source of information available.

51 Number of vehicles by fuel type percentages are from applying ABS national figures of fuel/registration ratios or diesel/ULP to Victorian figures as Victorian figures are not specified. To make this study applicable for future use, knowing there is a prohibition on leaded petrol engines, we have assumed that trucks are using diesel and ULP fuels only.

ii) Number of diesel-using trucks out of all vehicles using diesel:

- Number of rigid trucks using diesel = 22.2% [52] of 396,517 = 88,027
- Number of articulated trucks using diesel = 4.6% [5] of 396,517 = 18,240

iii) Number of Unleaded Petrol (ULP)-using vehicles per vehicle type

- Number of rigid trucks using ULP

Total rigid trucks registered in Victoria – number of rigid trucks using diesel
92,158 – 88,027 = 4,132

- Number of articulated trucks using ULP

Total articulated trucks registered in Victoria – number of articulated trucks using diesel 21,508 – 18,240 = 3,268

iv) Total trucks transporting food by fuel type:

- Number of rigid trucks transporting food using diesel fuel

Percentage of road freight that is food[53] x number of rigid trucks using diesel
15% x 88,027 = 13,204

- Number of rigid trucks transporting food using ULP

Percentage of road freight that is food[6] x number of rigid trucks using ULP
15% x 4,132 = 620

- Number of articulated trucks transporting food using diesel

Percentage of road freight that is food[6] x number of articulated trucks using diesel
10% x 18,240 = 1,824

- Number of articulated trucks transporting food using ULP

Percentage of road freight that is food[6] x number of articulated trucks using ULP
10% x 3,268 = 327

5. We need to know the Fuel Consumption Rate (FCR) for the trucks transporting food. The FCR depends on the mass carried by the trucks; including truck and food mass. What is the mass of the food?

a) It is assumed that the food trucks are travelling at the maximum capacity, Gross Vehicle Mass (GVM) or Gross Combination Mass (GCM).
b) The assumption is made that the trucks are carrying 75% of the GVM or GCM in food, without distinguishing by food items in the food basket (this is due to the lack of information of food tonnage transported by food item).
As the GVM or GCM of the truck is also being moved in the process of transporting the food, we have assumed the tare truck weight (un-laden weight) is 25% of the GVM or GCM. For example, a truck with GVM of 10 tonnes (t) transporting food has 7.5t food mass and 2.5t truck tare mass.

[52] Number of vehicles by fuel type percentages are from applying ABS national figures of fuel/registration ratios or diesel/ULP to Victorian figures as Victorian figures are not specified.
[53] See section 3 of Appendix 7.

5.1. The Fuel Consumption Rate (FCR L/km)[54] varies with truck type, truck mass and the type of fuel consumed. How much fuel is being consumed over 1km travelled, per truck type and fuel type?

The AGO provides fuel consumption rates per truck type and fuel type, and this implies the tonnage of truck mass. We have used the FCR to calculate fuel consumption per tonne over 1 kilometre travelled. This is used in turn, to calculate fuel consumption of all food transportation over 1 kilometre. Which is in turn, used to calculate emission from this transportation of food in Victoria.

a) Fuel Consumption Rates in Litres per tonne-km (L/t-km) for truck type and fuel type[55]:
   - Rigid diesel FCR (L/t-km) = 0.0268
   - Rigid ULP FCR (L/t-km) = 0.0224
   - Articulated diesel FCR (L/t-km) = 0.009
   - Articulated ULP FCR (L/t-km) = 0.0063

b) Total amount of fuel consumed for all food trucks transporting 1 tonne over 1 kilometre;
   - The general formula for calculating total fuel consumption for all trucks is stated below[56] [57]:

Total fuel consumed for rigid or articulated trucks by fuel type, transporting food over 1 km = FCR (L/t-km) x total GVM or GCM by truck type and fuel type

Where FCR L per tonne-km = FCR L/km for fuel type/average GVM or GCM (t) of truck by truck type[58], multiplication by total GVM or GCM by truck type and fuel type factors in total truck tonnage carried[59].

c) i) Total mass of rigid trucks transporting food proportionate to diesel and ULP:
   - Number of rigid trucks transporting food using diesel, 13,204 = 95.5%
   - Number of rigid trucks transporting food using ULP, 620 = 4.5%

   Proportion of total GVM of rigid trucks for fuel type:
   - 95.5% of 147,208 t = 140, 584 tonnes for diesel rigid trucks
   - 4.5% of 147,208 t = 6, 624 tonnes for ULP rigid trucks

   ii) Average GVM for rigid trucks[60]:
   Total GVM of rigid trucks / number of rigid trucks
   147,208 t / 13,824= 10.65 t

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54 FCR calculations are based on data and guidelines from the Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December, 2006).

55 See Appendix 8 for data required for these figures.

56 Formula is based on guidelines from the Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December, 2006).

57 See Appendix 8 for data required for these figures.

58 See Appendix 9 for data required for these figures.

59 As there was insufficient data of food mass transported, the assumption is that tonnage of food is based on a proportion of the weighted average GVM for rigid trucks and GCM for articulated trucks.

60 See Appendix 9 for data required for these figures.

iii) Total mass of articulated trucks transporting food proportionate to diesel and ULP:

- Number of articulated trucks transporting food using diesel fuel, 1,824 = 85%
- Number of articulated trucks transporting food using ULP, 327 = 15%

Proportion of total GCM of articulated trucks for fuel type:

- 85% of 126,841 t = 107, 815 tonnes for diesel articulated trucks
- 15% of 126,841 t = 19, 026 tonnes for ULP articulated trucks

iv) Average GCM for articulated trucks[12]:
Total GCM of articulated trucks / number of articulated trucks
126,841 t / 2, 151 = 59 t

c) Fuel consumed for rigid trucks:
i) Total fuel consumed for all rigid diesel trucks transporting food over 1 km =
Rigid diesel FCR (L/t-km) x proportion of total GVM of rigid trucks for diesel:
0.0268 x 140,584 = 3,767.65 Litres

ii) Total fuel consumed for all rigid ULP trucks transporting food over 1 km =
Rigid ULP FCR (L/t-km) x proportion of total GVM of rigid trucks for ULP:
0.0224 x 6,624 = 148.38 Litres

d) Fuel consumed for articulated trucks:
i) Total fuel consumed for articulated diesel trucks transporting food over 1 km =
Articulated diesel FCR (L/t-km) x proportion of total GCM of articulated trucks for diesel:
0.009 x 107, 815 = 970.34 Litres

ii) Total fuel consumed for articulated ULP trucks transporting food over 1 km =
Articulated ULP FCR (L/t-km) x proportion of total GCM of articulated trucks for ULP:
0.0063 x 19,026 = 119.86 Litres

e) Fuel consumption rates to be used in emissions formula:
i) FCR L per km[61] for all food transporting diesel trucks is the sum of c) i) and d) i)
3,767.65 + 970.34 = 4,738 Litres

ii) FCR L per km[14] for all food transporting ULP trucks is the sum of c) ii) and d) ii)
148.38 + 119.86 = 268 Litres

[61] FCR is now expressed in L per km (not L per t-km), as truck and food tonnage is now factored into this figure

6. The combustion of different transport fuels produces different emissions factors. What are the Emissions Factors (EF) for diesel and ULP?

a) Fuel combustion emissions factors (EF) in tonnes of CO_2-e per kilolitre of fuel, for Diesel and ULP fuels[62]:
   - Diesel EF: 2.7 t CO_2-e/kL
   - ULP EF: 2.4 t CO_2-e/kL

7. Calculating Emissions Estimates

- The above information is applied to the following formula to calculate emissions estimates for all food trucks transporting food for 1 km.

Emissions Formula[15]:
Emissions (t CO_2–e) = D (km) x FCR (L/km) x EF (t CO_2-e/kL) / 1000

Where D= distance travelled in kilometres, FCR = L per km, EF= emissions factor for fuel type, and division by 1000 converts L/km to kL/km

a) Diesel emissions (t CO_2–e) for 1 km:
Emissions (t CO_2–e) = D (km) x FCR (L/km) x EF (t CO_2-e/kL) / 1000
= 1 x 4,738 x 2.7 / 1000 = 12.7926 t CO_2–e

b) ULP emissions (t CO_2–e) for 1 km:
Emissions (t CO_2–e) = D (km) x FCR (L/km) x EF (t CO_2-e/kL) / 1000
1 x 268 x 2.4 / 1000 = 0.6432 t CO_2–e

c) **Total emissions estimates:**

i) All food trucks[63] engaged in transporting food (all truck and food mass) for 1 km:
Diesel emissions for 1 km + ULP emissions for 1 km
12.7926 + 0.6432 = **13.4358 t CO_2–e**

ii) Proportion of 13.4358 t CO_2–e for 1 tonne of truck and food mass over 1 km:
Total emissions estimate of all food trucks engaged in transporting food (all truck and food mass) over 1 km / total mass (t) transported (all truck and food mass)
13.4358 tonnes CO_2–e / 411,074[64] = 0.0000327 t CO_2–e

iii) Expressed in kg of CO_2–e:
All food trucks engaged in transporting food (all truck and food mass) over 1 km
= 0.0327 kg CO_2–e

[62] Sourced from the Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December, 2006).
[63] The term 'food trucks' is used to indicate Victorian trucks transporting food, as previously stated.
[64] See Appendix 8 for data required for these figures.

8. Total emissions estimate: a proportion of total food basket road transport emissions estimates for each food item.

- We know total emissions from the food trucks transporting truck and food mass for 1 km. We need to know what proportion of these emissions is allocated to each of the food items[65].

a) Proportion of total emissions estimate for each food item for 1km of transportation[66]:
Total emissions for food basket (road transportation only) / the number of food items (items transportation by road only)
13.4358 t CO_2–e / 25 = 0.53754 t CO_2–e per food item for 1km

b) Each food item is transported a different distance.
i) Emissions estimate for each food item = transport km for food item x proportion of total emissions estimate for each food item for 1km of transportation:
Number of transport kms for each food item x 0.53754 t CO_2–e

ii) Applying this to food miles results:
For all the food trucks transporting food, a proportion of these are transporting apples. If all these trucks transporting apples travelled 1km,
the emissions estimate = 0.53754 t CO_2–e

Food miles for Apples is 112km. If all these trucks transporting apples travelled 112km, the emissions estimate would be: 112km x 0.53754 t CO_2–e = 60.2 t CO_2–e

9. For future food miles studies, it is useful to have an emissions formula for an 'average food-transporting truck' so that we have an overall formula to apply to a known mass of food transported.

- The emissions formula for an average food-transporting truck is based on the formula outlined previously, with different calculations for each formula section:

a) Emissions Formula for an Average Food-transporting Truck:

Emissions (t CO2–e) = D (km) x FCR (L/tonne-km) x EF (t CO_2-e/kL) / 1000

Where D= distance travelled in kilometres, FCR L per tonne-km = a weighted average fuel consumption rate for both fuel types / weighted average GVM or GCM (t) of truck by truck type, EF= weighted average emissions factor for an average truck, and division by 1000 converts L/km to kL/km.

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[65] 'Food items' indicates all food items in the food basket transported by road (25 items in total).
[66] Based on the assumption that the transportation weight of food items is equal between the items and the food trucks are carrying the 25 food items between them.

9.1. To calculate an emissions estimates for an average food-transporting truck, we need to know an average truck mass, average FCR of an average fuel, and average EF:

a) Weighted average truck mass:

i) Average rigid truck GVM x number of rigid food trucks

10.65t x 13,824 = 147,225.6

ii) Average articulated truck GCM x number of articulated food trucks

59t x 2,151 = 126,909

iii) Sum of total rigid and articulated truck mass:

147,225.6 + 126,909 = 274,134.6 t

iv) Weighted average truck mass:

Sum of total rigid and articulated truck mass / total trucks transporting food

274,134.6 / 15,975 = 17.2 t

v) Weighted average truck mass = 17.2 tonnes

b) Weighted average FCR: rigid food trucks

i) Rigid trucks: diesel

FCR x number of rigid food trucks using diesel

0.285 x 13,204 = 3,763.14

ii) Rigid trucks: ULP

FCR x number of rigid food trucks using ULP

0.239 x 620 = 148.18

iii) Weighted average FCR for all rigid food trucks:

Sum of rigid diesel and rigid ULP:

3,763.14 + 148.18 = 3,911.32

iv) Weighted average FCR for rigid trucks

Sum of rigid diesel and rigid ULP / total number of rigid food trucks

3, 911.32 / 13, 824 = 0.2829 L/km

c) Weighted average FCR: articulated food trucks

i) Articulated trucks: diesel

FCR x number of articulated food trucks using diesel

0.546 x 1,824 = 995.90

ii) Articulated trucks: ULP

FCR x number of articulated food trucks using ULP

0.368 x 327 = 120.34

iii) Sum of articulated diesel and rigid ULP:

995.90 + 120.34 = 1,116.24

iv) Weighted average FCR for articulated trucks:

Sum of articulated diesel and rigid ULP / total number of articulated food trucks

1,116.24 / 2, 151= 0.5189 L/km

d) Weighted average of FCR for all food trucks:
Weighted average rigid FCR x number of rigid food trucks +
Weighted average articulated FCR x number of articulated food trucks / total number of food trucks
0.2829 x 13,824 + 0.5189 x 2, 151 / 15,975 = 0.3147 L/km

e) Weighted average Emissions Factor (EF) for diesel and ULP trucks:
EF for diesel x number of rigid & articulated diesel trucks[67] +
EF for ULP x number of rigid & articulated ULP trucks[16] /total number of food trucks
2.7 x 15,028 + 2.4 x 947 / 15,975 = 2.68 t CO_2-e

9.2. Applying the Emissions Formula for an Average Food-transporting Truck:

Emissions (t CO2–e) = D (km) x FCR (L/tonne-km) x EF (t CO_2-e/kL) / 1000

a) Emissions estimate for 1 tonne of mass (food: 75% and truck: 25% of 1 tonne of mass) transported by an average food-transporting truck for 1 km:
1 (km) x 0.0182965 x 2.68 / 1000 = 0.000049 t CO_2–e

b) Emissions estimate for 1 tonne of food transported by an average food-transporting truck for 1km:
Multiply the result of 9.a) (75% 1 tonne of food mass), by 4/3 (to equal 1 tonne of food mass)
0.000049 t CO_2–e x 4/3 = 0.000065 t CO_2–e

i) Applying this formula to a scenario: An apple supplier tells us that they receive an apple delivery of 1,000 kg (apple mass) and the truck travels 200km from the producer to the supplier shop.

- Formula: 1 (km) x 0.0182965 x 2.68 / 1000
- 200 (km) x 0.0182965 x 2.68 / 1000 = 0.0098069 t CO_2–e (750 kg apple mass)
- Multiply by 4/3 to equal ~1000 kg of apple mass:
  0.0098069 t CO_2–e x 4/3 = 0.013076 t CO_2–e

The emissions estimate from the food miles of this average food transporting truck travelling 200km to deliver 1000kg of apples = 0.013076 t CO_2–e

[67] Diesel and ULP EF for rigid and articulated trucks is the same figure, as per Australian Greenhouse Office (AGO) Factors and Methods Workbook, Department of Environment and Heritage (December, 2006).

8.17 Appendix 8: Data for Fuel Consumption Rates (Litres per tonne-kilometre).

Table 9: Data for Fuel Consumption Rates: Diesel.

1	2	3	4	5
Vehicle type	**FCR L/km Diesel**	**Average mass (t) of truck type**	**2 / 3 = FCR L per tonne-km**	**Total mass (t) for trucks type using Diesel**[68]
Rigid trucks	0.285	10.65	0.0268	140,584
Articulated trucks	0.546	59	0.009	107,815
Total	0.831	69.65	0.0358	248,399

Table10: Data for Fuel Consumption Rates: ULP.

1	2	3	4	5
Vehicle type	**FCR L/km ULP**	**Average mass (t) of truck type**	**2 /3 = FCR L per tonne-km**	**Total mass (t) for trucks type using ULP**[36]
Rigid trucks	0.239	10.65	0.0224	6,624
Articulated trucks	0.368	59	0.0063	19,026
Total	0.607	69.65	0.0287	25,650

Table11: Data for Total Truck Mass.

a) Total mass of trucks:
Total mass (t) for trucks using Diesel + Total mass (t) for trucks using ULP
248,399 + 25,650 = 274,049

Total mass (t) transported (all truck and food mass) = 274,049 t

[68] See Appendix 9 for information on truck mass calculations.

8.18 Appendix 9: Data for Weighted Average truck Mass.

Table 12: Weighted average of rigid truck mass.

GVM interval (tonnes) [69]	GVM interval average	15% of the number of rigid vehicles in GVM interval[70]	Weighted average truck mass
3.5 – 4.5	4	3,042	12,168
4.5 – 8	6.25	2,874	17,962
8 – 12	10	3,187	31,870
12 – 20	16	2,298	36,768
> 20	20	2,422	48,440
Total	56.25	13,824	147,208

Table 13: Weighted average of articulated truck mass.

GCM interval (tonnes) [37]	GCM interval average	10% of the number of articulated trucks in GCM interval[38]	Weighted average truck mass
3 – 20	11.5	39.9	459
20 – 40	30	347.5	10,425
40 – 60	50	837.7	41,885
60 – 100	80	924.9	73,992
> 100	100	0.8	80
Total	271.50	2, 151	126,841

[69] Data from Australian Bureau of Statistics (ABS) Motor Vehicle Census 9309.0 (March 2006).

[70] See Methods: Greenhouse Gas Emissions Estimates for information on the percentage applied here.