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Carbon Footprints, Life Cycle Analysis, Food Miles: Global Trade Trends and Market Issues

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CARBON FOOTPRINTS, LIFE CYCLE ANALYSIS, FOOD MILES: GLOBAL TRADE TRENDS AND MARKET ISSUES

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Abstract: *Growing international concern about the environment is a great threat to New Zealand access into high value markets. In particular the issue of climate change has grown in political importance as illustrated by the application of the Kyoto Protocol and public debate about issues such as 'food miles'. Whilst the paper concentrates upon the impact of the latter debates on United Kingdom and European Union markets, there is growing evidence that consumer concerns are not just an issue for those markets. Other markets are also showing increasing concern. Food miles is a concept which has gained traction with the popular press arguing that the further food travels, the more energy is used, and carbon emissions are greater. But what is the reality behind the political rhetoric? Using a food miles methodology, this paper compares New Zealand production shipped to the UK with a UK source. The study reported here found that, due to the different production systems, even when shipping was accounted for, New Zealand dairy products used half the energy of their UK counterparts, and in the case of lamb, a quarter of the energy. In the case of apples, the New Zealand source was 10 percent more energy efficient. In case of onions, whilst New Zealand used slightly more energy in production, the energy cost of shipping was less than the cost of storage in the UK, making New Zealand onions more energy efficient overall. In light of these findings, it is argued that climate change should be addressed through a trade policy focus on the more comprehensive task of reducing carbon footprints over time, rather than a narrower focus on carbon miles.*

Keywords: *energy, carbon footprints, food miles, market access*

INTRODUCTION

Historically, trade policy has been one of the major factors affecting New Zealand exports. This is still important, with New Zealand restricted by quotas, especially for access into high value markets. However growing consumer concern about the environment is also a great threat to New Zealand's access into high value markets. The issue of climate change has spurred public debate about food miles, for example. 'Food miles' is a relatively recent issue which has arisen in the United Kingdom, Germany and other countries over food transportation. The argument is that the longer the transport distance (food miles), the more energy is consumed and carbon emitted. New Zealand has attracted a lot of attention in the food miles debate, for three main reasons. First, due

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to its geographical location relative to the UK; second, the UK is an important high value market for New Zealand exports; and third, the similar climates of New Zealand and the UK means that in theory, imports can be substituted with home-grown produce. In this study, the energy and carbon emissions from key New Zealand products are calculated and compared to the next best alternative source for the UK market. The calculation of total energy use and CO_2 emissions uses life cycle assessment methodology from farm production to UK wholesaler, excluding packing and processing.[3]

The UK is an important export market for New Zealand products, taking 66 percent of sheep meat, 57 percent of apples, 33 percent of onions, 21 percent of butter, and 10 percent of cheese exports. Moreover, New Zealand is a significant supplier to the UK, providing 58 percent of apples, 18 percent of sheep meat, and 14 percent of butter. Imports of New Zealand sheep meat made up nearly 18 percent of the UK's total supply of sheep meat in 2002, while New Zealand butter contributed 14 percent.[4] Therefore, the four products chosen for this study were dairy, apples, onions and lamb. This paper first reviews the literature and methodology used in the food miles study and then presents the results for the dairy, apple, onion and lamb sectors. There are two major groups of literature relating to food miles: first, a limited literature concerned solely with food miles, and second, literature relating to energy use/life cycle assessment of products.

FROM FOOD MILES POLICY DEBATE TO PRODUCT LIFE CYCLES

In 2001 a joint international report on food miles[5] noted the possibility of more local and regional sourcing of goods to reduce energy use, however it did not consider the production part of the life cycle of a product. Garnett[6] examined food transport within the UK and the efficiency of various distribution networks including imported food. This study did not include energy use and emissions in the production phase of the product, just energy use in the packaging, marketing and delivery phase. This is recognised by Garnett who quotes a US study on the environmental costs of food transportation,[7] in which the contribution of transport to total food chain energy costs is about 11 percent. In a study evaluating the externality of transport, Pretty (et al.) calculated that in

[3] C.M. Saunders, A. Barber and G. Taylor, 'Food Miles – Comparative Energy/Emissions Performance of New Zealand's Agriculture Industry'. AERU *Research Report No. 285*, (Canterbury: Lincoln University 2006). The UK study was: J. Pretty, A. Ball, T. Lang and J. Morison, 'Farm costs and food miles: An assessment of the full cost of the UK weekly food basket', *Food Policy* Vol. 30, No. 1 (2005), pp. 1–19. The New Zealand report did raise considerable controversy and has been subject to critique. The report was typically very detailed and transparent. The main criticisms have included the fact the authors used a lowland system for the UK lamb production however we did this for New Zealand as well. The system in the UK we chose does account for significant production (lowland is nearly half of sheep and beef farms), and the tiered production system in the UK means many lambs are finished on the lowland. Of course it would be useful to undertake further research to compare the UK hill with New Zealand mountain systems. However, the New Zealand hill mountain system is much more extensive than the UK system. The results were biased towards the UK with missing data for parts of UK inputs ignored whereas data for New Zealand was much more comprehensive. The report also assumes that the UK could replace the New Zealand supply without increasing intensity, however that would not be the case.

[4] Global Trade Information Services, *World Trade Atlas* (Columbia, USA: GTI, 2005); Statistics New Zealand, *Key Statistics*, (Wellington: New Zealand, 2005); Department for Environment, Food and Rural Affairs (Defra), *United Kingdom Slaughter Statistics* (Slaughter statistics dataset: 26 May 2005), http://statistics.defra.gov.uk/esg/datasets/slaughm.xls (14 June 2005); MDC Datum. *Dairy Facts and Figures 2003*, Cirencester: Milk Development Council, 2004).

[5] OECD/IEA. *Saving Oil and Reducing CO_2 Emissions in Transport: Options & Strategies*, (Paris: OECD/IEA, 2001). http://www.iea.org/dbtw-wpd/Textbase/nppdf/free/2000/savingoil2001.pdf (10 April 2008).

[6] T. Garnett. *Wise Moves: Exploring the relationship between food, transport and CO_2*, (London: Transport 2000, 2003)

[7] R. Pirog, T. Van Pelt, K. Enshayan and E. Cook, *Food, Fuel, and Freeways: An Iowa perspective on how far food travels, fuel usage, and greenhouse gas emissions*, (Ames, Iowa: Leopold Center for Sustainable Agriculture, Iowa State University, 2001); http://www.leopold.iastate.edu/pubs/staff/ppp/index.htm. (10 April 2008).

the case of imports, this was only 0.005p per person, per week compared to 75.7p per person, per week, for domestic supply.[8]

Smith (et al.)[9] assessed whether a valid indicator of sustainability based on food miles could be developed. They concluded that one single indicator could not be developed, but multiple ones were needed to model the complexity of the issue. They focussed on the transport component of the life cycle of food, but the authors recognised the issue is also not as simple as just minimising food transport. They acknowledged the production phase of food is also important and that if this is efficient, one product can be more sustainable environmentally than another which travels shorter distances.

An assessment of the environmental effects of a product or service during its lifetime, from cradle to grave, is known as life cycle assessment (LCA). Tan and Culaba[10] report that early forms of LCAs were used in the late 1960s in the United States, but it was not until the 1990s that they emerged in their current form when international standards were imposed, first by the Society for Environmental Toxicology and Chemistry in 1991, and later in the 1990s by the International Organization for Standardization (ISO). LCA studies were originally developed for industrial products but are now being conducted on the primary sector, and also for manufactured foods and beverages. Cederberg and Flysjö[11] in their LCA, assessed the environmental impact of Swedish milk production in terms of resource use and emissions. They surveyed 23 dairy farms in south-western Sweden, over three types: conventional high output farms, conventional medium output farms, and organic farms. They found that the total energy use of organic farms per unit of production was significantly less than each of the two conventional types of farms, while no significant difference was found between these conventional types. A similar picture emerged for CO_2 emissions.

Brentrup (et al.)[12] constructed an LCA approach for arable crop production which is applied to a theoretical system of winter wheat production in a companion paper.[13] They showed that at low production intensities (low levels of nitrogen fertiliser) the overall environmental effects were moderate, but the land use impact contributed more than one-half of the total effect, and aquatic eutrophication only a small amount. However, at high production intensities (high levels of nitrogen fertiliser) this situation was reversed, and the overall environmental impact was high.

In New Zealand, a number of energy-use studies into agricultural production were carried out between 1974 and 1984, following the first 'oil shock' in 1973.[14] But from that time until the mid 1990s, very little energy-use research into this sector was conducted. From the mid 1990s onwards the research programme resumed. Wells[15] surveyed the New Zealand dairy industry in terms of

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[8] J. Pretty, A. Ball, T. Lang and J. Morrison, 'Farm costs and food miles: An assessment of the full cost of the UK weekly food basket'.

[9] A. Smith, P. Watkiss, G. Tweddle, A. McKinnon, M. Browne, A. Hunt, C. Treleven, C. Nash and S. Cross. *The Validity of Food Miles as an Indicator of Sustainable Development*, (Harwell: AEA Technology, 2005) http://statistics.defra.gov.uk/esg/reports/foodmiles/final.pdf (8 April 2008).

[10] R. Tan and A. Culaba. *Environmental Life-Cycle Assessment: A Tool for Public and Corporate Policy Development*, (Manila: De la Selle University 2002) .http://www.lcacenter.org/library/pdf/PSME2002a.pdf (10 April 2008).

[11] C. Cederberg and A. Flysjö. *Life Cycle Inventory of 23 Dairy Farms in South-Western Sweden*, (Göteborg: Sik, 2004) http://www.sik.se/archive/pdf-filer-katalog/SR728(1).pdf (2 April 2008).

[12] F. Brentrup, J. Küsters, H. Kuhlmann and J. Lammel, 'Environmental impact assessment of agricultural production systems using life cycle assessment methodology I. Theoretical concept of a LCA method tailored to crop production' *European Journal of Agronomy* Vol. 20, (2004a), pp. 247–264.

[13] F. Brentrup, J. Küsters, J. Lammel, P. Barraclough and H. Kuhlmann, 'Environmental impact assessment of agricultural production systems using life cycle assessment (LCA) methodology II. The application to N fertiliser use in winter wheat production systems', *European Journal of Agronomy*, Vol. 20, (2004b), pp. 265–279.

[14] C. Wells. *Total Energy Indicators of Agricultural Sustainability: Dairy Farming Case Study*, (Wellington: Ministry of Agriculture and Forestry, 2001) and C. Wells and S. Scarrow, *Opportunities for Improving the Environmental Operations of the Post Harvest Sector in Kiwifruit* (Wellington: Zespri International and MAF Policy, 1997).

[15] Wells. *Total Energy Indicators of Agricultural Sustainability: Dairy Farming Case Study*

the production of milk solids and arrived at the average energy use and CO_2 emissions per kg of milk solids. In this study, 150 dairy farms were surveyed across the major dairying regions in New Zealand which included both irrigated and non-irrigated farms. The quantities of the various inputs on each farm were converted and aggregated into primary energy and CO_2 emissions. Barber[16] calculated the total energy and carbon indicators for arable and vegetable crops. Bassest-Mens (et al.)[17] undertook an LCA of New Zealand dairy farming and compared this with Swedish and German farms. In political terms, the conclusion of this study was important for the climate debate. They concluded that New Zealand had approximately half the energy use and around 60 percent lower global warming potential than conventional farms in Sweden or Germany.

METHODOLOGY

This study focuses on New Zealand's exports to the United Kingdom and the comparable UK product. It uses the on-farm methodology developed by Wells,[18] plus the inclusion of energy and emissions associated with transporting produce from New Zealand to the UK and storage. Wells separated energy inputs into three major components: direct, indirect, and capital. Each of these resource inputs must be quantified and then the respective coefficients applied to obtain the total primary energy use and CO_2 emissions. Farm inputs in this analysis include factors such as energy used to power tractors, the energy embodied in capital items such as the tractors themselves, as well as the use of fertilisers, pesticides and supplementary animal feed.

The Energy Component of Key Inputs into Agricultural Production

In agricultural production there are a number of inputs which are common. This section therefore calculates the energy component and CO_2 emissions associated with these common inputs and the values are then applied in later sections when estimating the energy and CO_2 emissions associated with agricultural output. Direct energy is that energy used directly by the operation, for example, diesel, petrol and electricity. The definition of direct energy includes the energy contained in the fuel/electricity (consumer energy), plus the energy for extracting, processing, refining and supplying (for example, transportation for diesel) the fuel, and losses which occur through the process. The values of these are illustrated in Table 1. The primary energy content, which includes an allowance for the fuels production and delivery, adds an extra 23 percent for all these types in New Zealand and 16 percent in the UK.[19]

The carbon emission for New Zealand and UK fuel is very similar. The carbon emissions for electricity are higher in the UK due to the greater proportion of fossil fuel used, whereas New Zealand generates 64 percent from renewable sources. Some of the UK farm budgets used to derive energy inputs had expenditure on contractors for such operations as mowing and cultivation. For the purposes of this study, the fuel was assumed to be 12 percent of the cost and this was then converted into litres of diesel.

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[16] A. Barber, *Seven Case Study Farms: Total Energy & Carbon Indicators For New Zealand Arable & Outdoor Vegetable Production*, (AgriLINK New Zealand Ltd, http://www.agrilink.co.nz/Files/Arable per cent20Vegetable per cent20Energy per cent20Use per cent20 Main per cent20Report.pdf, 2004a).; A. Barber, Total Energy & Carbon Indicators for New Zealand Kiwifruit Orchards: A Pilot Survey, (AgriLINK New Zealand Ltd.. Not publicly released. 2004b). and A. Barber and D. Lucock, Total Energy Indicators: Benchmarking Organic, Integrated and Conventional Sheep and Beef Farms. ARGOS Research Report: Number 06/07, (Pukekohe.The AgriBusiness Group, 2006).

[17] C. Basset-Mens, S. Ledgard and A. Carran, 'First Life Cycle Assessment of Milk Production Systems for New Zealand Dairy Farm Systems', Paper presented to the Australia New Zealand Society for Ecological Economics Conference 11–13 December (Palmeston North: Massey University, 2005).

[18] Wells. *Total Energy Indicators of Agricultural Sustainability: Dairy Farming Case Study*

[19] Wells. *Total Energy Indicators of Agricultural Sustainability: Dairy Farming Case Study*

Indirect Energy Inputs

Indirect energy inputs used in agricultural production include fertilisers, agrichemicals and supplementary animal feed. Table 1 illustrates the energy and associated emissions for the main inputs into agricultural systems. Fertiliser is the most significant indirect energy input. The energy component in fertiliser comes mainly from its manufacture and transport. The energy component and the CO_2 emissions from fertilisers use the data presented by Wells. It is assumed here that these are the same for the UK and New Zealand.

As in the case of fertilisers, the energy component of agrichemicals is mainly from their manufacture and transport. The energy component and carbon dioxide emissions were adapted from a detailed study of the energy in chemical manufacture and use, Pimentel[20] and data on carbon dioxide emissions is from Wells and Barber.[21] The energy requirement to manufacture agrichemicals ranges considerably, as shown in Table 1.

Table 1: Energy Requirement for Key Inputs and the Associated CO2 Emissions

	Energy Use (MJ/kg)		CO2 Emissions (kg CO2/MJ)	
	NZ	UK	NZ	UK
Diesel (per litre)	43.6	41.2	68.7 a	65.1 c
Petrol (per litre)	39.9	37.7	67.0 a	61.3 c
Oil (per litre)	47.4	44.8	35.9 a	33.2 c
Electricity (per kWh)	8.14	10.37	19.2 b	41.5 c
N	65	65	0.05	0.05
P	15	15	0.06	0.06
K	10	10	0.06	0.06
S	5	5	0.06	0.06
Lime	0.6		0.72	
Herbicide (Paraquat, Diquat and Glyphosate) (kg ai)	550	550	0.06	0.06
Herbicide (other) (kg ai)	310	310	0.06	0.06
Insecticide (kg ai)	315	315	0.06	0.06
Fungicide (kg ai)	210	210	0.06	0.06
Plant Growth Regulator (kg ai)	175	175	0.06	0.06
Oil (kg ai)	120	120	0.06	0.06
Other (kg ai)	120	120	0.06	0.06
Concentrates (per tonne) (barley equiv)	3361	206.9		
Fodder	1.50		0.058	
Vehicles	65.5		0.09	
Implements	51.2		0.10	
Buildings (m2)	590		0.10	
Shipping (per tonne km)	0.114		0.007	

Concentrate feed is another important input into livestock systems in the UK, especially when compared to New Zealand. For the purposes of this study it is assumed that concentrates have the same energy profile as barley. This is likely to be an underestimate of the energy in the concentrate. A simple analysis of the energy and CO_2 emissions in producing barley feed was

[20] D. Pimentel, 'Energy Inputs for the Production, Formulation, Packaging, and Transport of Various Pesticides', in D. Pimentel, (ed.). *Handbook of Energy Utilisation in Agriculture*, (Boca Raton Florida: CRC Press Inc., 1980).

[21] Wells. *Total Energy Indicators of Agricultural Sustainability: Dairy Farming Case Study* and A. Barber, 'Total Energy & Carbon Indicators for New Zealand Kiwifruit Orchards: A Pilot Survey'.

therefore undertaken and reported in detail in Saunders (et al.).[22] This gave a lower bound on the embodied energy in barley concentrate of 3,361 MJ per tonne of barley. The associated emissions are 207 kg of CO_2 per tonne of barley. The energy emissions and carbon dioxide emissions for fodder were taken from Wells.[23]

The energy and carbon dioxide emissions associated with machinery include the embodied energy of the raw materials, construction energy, an allowance for repairs and maintenance, and international freight.[24] As Table 1 shows, the embodied energy of vehicles and implements used in this report is 65.5 MJ/kg and 51.2 MJ/kg respectively.[25] Table 1 also gives the energy coefficients and CO_2 emission rates for farm vehicles and implements. For both New Zealand and the UK a dairy shed model constructed by Wells[26] was used. The capital energy of the dairy shed is related to a single parameter, the number of sets of milking cups.

Transport

Due to the lack of data, the only transport distances for which analysis in this report were done, are on distances between countries for export of the products. For all of the New Zealand commodities this involves sea freight to the United Kingdom, a distance of 17,840 km.[27] A review of the literature on the energy and emission coefficients for refrigerated sea transport did show general consistency with one or two exceptions and the figure chosen here is the 0.114 MJ per tonne km. This has been calculated from shipping having carbon dioxide emissions of 0.007 $kgCO_2$/t-km and the carbon content of diesel being 2.68 $kgCO_2$/L.[28]

Energy and Carbon Dioxide Emissions in NZ and the UK

This section calculates the energy and carbon dioxide emissions associated with the production of New Zealand and UK dairy, apples, lamb and onions. This requires information on the outputs of the production system so that the energy and carbon dioxide emissions can be expressed as per unit of output enabling comparisons to be made between the two countries. In general, information on New Zealand production systems, including inputs, was available in more detail enabling a more thorough calculation of the energy embodied and emissions associated with production. However, this has led to the results underestimating the energy associated with production in the UK compared to that in New Zealand. Finally the shipping costs were calculated and added to the New Zealand production system.

[22] Saunders (et al.), *Food Miles – Comparative Energy/Emissions Performance of New Zealand's Agriculture Industry*

[23] This was 1.50 MJ/kg dry matter (DM) for grass silage and hay with an emission rate of 0.058 kg CO_2/MJ

[24] Wells. *Total Energy Indicators of Agricultural Sustainability: Dairy Farming Case Study*

[25] A. Barber and D. Lucock, 'Total Energy Indicators: Benchmarking Organic, Integrated and Conventional Sheep and Beef Farms'. This is based on a simplification of the approach used by Audsley et al. and incorporates New Zealand data for steel and rubber, see: E. Audsley (coord.), S. Alber, R. Clift, S. Cowell, P. Crettaz, G. Gaillard, J. Hausheer, O. Jolliet, R. Kleijn, B. Mortensen, D. Pearce, E. Roger, H. Teulon, B. Weidema, H. Van Zeijts. *Harmonisation of Environmental Life Cycle Assessment for* Agriculture. *Final Report Concerted Action AIR3-CT94-2028*, (European Commission. DG VI Agriculture, 1997). This figure is lower than the figure reported in Wells but more akin to that used by Doering who estimated a value of around 70 MJ/kg. See: O.C. Doering, 'Accounting for energy in farm machinery and buildings'. *in*: D. Pimentel (ed.) *Handbook of Energy Utilisation in Agriculture,* (1980). (Boca Raton, Florida: CRC Press Inc., 1980) and EU. Council regulation (EC) N0 1782/2003 of 29 September 2003.

[26] Wells. *Total Energy Indicators of Agricultural Sustainability: Dairy Farming Case Study*

[27] Department for Transport. UK, *Life cycle modelling CO2 emissions for lettuce, apples and cherries*, (UK Department for Transport, 2003) http://www.dft.gov.uk/stellent/groups/dft_freight/documents/page/dft_freight_508272.hcsp

[28] Department for Transport. UK, *Life cycle modelling CO2 emissions for lettuce, apples and cherries*, Dividing the shipping emissions by the carbon content per litre of diesel equals 0.0026 L/t-km. Multiplying this figure by the primary energy content of New Zealand diesel (43.6 MJ/L), given that the ships refill in New Zealand, gives a rate of 0.114 MJ/t-km.

Dairy

Table 2: Energy & Carbon Dioxide Indicators for NZ and UK dairy production

Item	Quantity/hectare		Energy MJ/Tonne MS		CO2 Emissions kg CO2/Tonne MS	
	NZ	UK	NZ	UK	NZ	UK
Direct						
Fuel use (L of Diesel) (incl. contracting)		245		10,429		679.0
Diesel (L) (including contracting)	56.2		2,990		205.4	
Petrol (L)	22.4		1,093		73.2	
Lubricants (L)	0.9		50		1.8	
Electricity use (kWh)	545.4	378	5,425	4,053	104.0	163.5
Direct sub total	–	–	9,558	14,482	384.5	847.1
Indirect						
Nitrogen (kg)	72.0	149	5,712	10,003	263.7	500.1
Phosphorus (kg)	57.6	14	1,055	209	63.3	12.6
Potassium (kg)	56.0	38	684	394	41.0	23.7
Sulphur (kg)	62.4		381		22.9	
Lime (kg)	288.9	175	212	109	151.7	78.2
Pesticides (kg ai)	3.0	1.75	1,136	560	68.2	33.6
Cleaning Chemicals (kg)	3.1	3.1	458	384	27.5	23.1
Animal remedies (kg)	0.5		64		3.8	
Other chemicals (kg)	1.3	1.6	193	182	11.6	10.9
Forage, Fodder and Bedding (kg silage)	389	4,954	662	7,674	38.5	445.1
Cereals/concentrate (kg dry matter)	83	3,849	231	13,362	13.5	822.6
Grazing-off (ha)	0.2	–	413	0	24.8	0
Aggregate (kg)	1,072		131		9.0	
Indirect sub total	–	–	11,331	32,877	739.2	1,949.8
Capital						
Vehicles (kg)	4.6		368		29.4	
Implements (kg)	5.4		336		30.2	
Dairy shed (cups)	–		527	549	52.7	54.9
Other farm buildings (m2)	0.3	–	185	458	18.5	68.8
Fences (m)	3.9	–	169		17.0	
Races (m)	1.2	0.4	110	1	7.6	0.1
Stock water supply (ha)	0.0		85		7.1	
Irrigation (ha)	0.0		120		3.7	
Effluent disposal system (m3)			123		7.7	
Capital sub total			2,023	1,009	173.9	123.8
Total Production	–	–	22,912	48,368	1,297.6	2,920.7
Yield (kg Milk Solids)	819	968				
Shipping (NZ to UK) (17,840 km)	–	–	2,030		124.9	
Total Production Energy Input/Emissions	–	–	24,942	48,368	1,422.5	2,920.7

This section presents results for dairy; the unit for the dairy sector was tonnes of milk solids (tMS). The New Zealand dairy information presented here involved the comprehensive survey of

150 dairy farms in New Zealand.[29] No single source of information on dairy production systems in the UK was available to give the detailed information required to compare energy use in this sector with that in New Zealand. Therefore a number of sources have been used to obtain and verify the information used. The key sources were the report on the Economics of Milk Production, by Colman (et al.), supplemented by Nix's Farm Management.[30] The energy and carbon dioxide emissions associated with dairy production in New Zealand and the UK are summarised in Table 2.

Table 2 highlights the different production systems in the two countries with the first two columns of data identifying the quantity of input per hectare. The total energy use is presented in the third and fourth columns and shows that the UK uses considerably more energy per tonne of milk solids. In particular the UK uses 50 percent more fuel per tonne of milk solids than New Zealand does, although less electricity is used in the UK than in New Zealand. The major difference in energy input however is in the use of concentrates and forage feed which in the UK is significantly higher than that used in New Zealand, reflecting the different production systems.

In the UK, a total of 48,368 MJ of energy is used per tonne of milk solid compared to 22,912 MJ in New Zealand, over twice as much. Including shipping at 2,030 MJ per tonne, milk solids still makes New Zealand production much more energy efficient at 24,942 MJ, just over half that in the UK. When the carbon dioxide emissions associated with dairy production in the UK are compared to that in New Zealand, even when transport is included from New Zealand to the UK, the UK emits over twice that of New Zealand. Thus, the UK emits 2,921 kilograms of carbon dioxide per tonne of milk solids compared to just 1,423 in New Zealand (including transport to the UK).

Apples

The data used to determine New Zealand's total energy and carbon dioxide emissions was prepared with the assistance of horticultural consultant Greg Dryden (Fruition Horticulture), MAF Policy and the CAE Guide.[31] In the case of the United Kingdom a number of sources of data were used to calculate the production system. As in case of sheep meat (see below) the main source of data was Nix, but this was supplemented by Tanton and Williams, Chalmers (et al.) and the UK pesticide survey by Garthwaite (et al.).[32]

To be able to meet the same market window as New Zealand apples, British apples are assumed to be stored for six months. For these storage periods the apples are chilled to around 2°C, in a refrigerated environment. No energy or emission coefficients were found for the UK, thus to estimate the energy associate with this storage the Wells and Scarrow cold storage estimate

[29] Wells. *Total Energy Indicators of Agricultural Sustainability: Dairy Farming Case Study*

[30] D. Colman, J. Farrar and Y. Zhuang. *Economics of Milk Production in England and Wales 2002/03*, Special Study in Agricultural economics No 58, (Manchester,UK: Farm Business Unit, University of Manchester, UK 2004: J. Nix. *Farm Management Pocketbook: Thirty-Fifth Edition 2005,* (2004). (Melton Mowbray Leicestershire UK: The Andersons Centre, 2004).

[31] MAF Policy. *Pipfruit Monitoring Report*. (Wellington: Ministry of Agriculture and Forestry, 2005). http://www.maf.govt.nz;Centre for Advanced Engineering, *Energy Efficiency: A Guide to Current and Emerging Technologies. Volume 2: Industry and Primary Production,* Centre for Advanced Engineering, University of Canterbury, Christchurch, 2004. http://www.caenz.com/caeindex.html, (2 April, 2008)

[32] J. Nix. *Farm Management Pocketbook: Thirty-Fifth Edition 2005:* A. Chalmers, B. Hounsome and C. Rush. *The British Survey of Fertiliser Practice: Fertiliser Use on Farm Crops for Crop Year 2000*, (01). (London : Crown, 2001); http://www.defra.gov.uk/environ/pollute/bsfp/2000/index.htm (2 April): D. Garthwaite, M. Thomas and S. Dean. *Pesticide Usage Survey Report 172: Orchards & Fruit Stores in Great Britain 2000*, (York: Central Science Laboratory, 2001); A. Chalmers, B. Hounsome and C Rush, The British survey of fertiliser practice: Fertiliser use on farm crops for crop year 2000. (Crown, 2000) http://www.defra.gov.uk/environ/pollute/bsfp/2000/index. htm (1 July 2006).

of New Zealand kiwifruit is used, which is 169 kWh/tonne, for pre-cooling and storage over 5 months.[33]

Comparison of New Zealand and United Kingdom Apple Production

Table 3: Total energy and carbon dioxide indicators for NZ and UK apple production

Item	Quantity/hectare		Energy MJ/Tonne apples		CO_2 Emissions $kgCO_2$/Tonne apples	
	NZ	UK	NZ	UK	NZ	UK
Direct						
Fuel, Electricity and Oil (L of Diesel equivalent)		794		2,337		152.1
Fuel use - Orchard (L of Diesel)	436		380		26.1	
Electricity Use (kWh)	1,180		192		3.7	
Direct subtotal	–	–	**573**	**2,337**	**29.8**	**152.1**
Indirect						
Nitrogen (kg)	80	78	104	362	4.8	18.1
Phosphorus (kg)	8	11	2	12	0.1	0.7
Potassium (kg)	60	55	12	39	0.7	2.3
Lime (kg)	1,042		13		9.0	
Herbicide (kg ai)	3.2	1.46	20	57	1.2	3.4
Fungicide (kg ai)	15.6	6.21	65	93	3.9	5.6
Insecticide - General (kg ai)	2.2	1.24	14	28	0.8	1.7
Insecticide – Oil (kg ai)	29.0	3.51	70	30	4.2	1.8
Plant Growth Regulator (kg ai)		0.17		2		0.1
Indirect subtotal	–	–	**300**	**624**	**24.7**	**33.8**
Capital subtotal	–	–	**78**	–	**5.6**	–
Total Production	–	–	**950**	**2,961**	**60.1**	**186.0**
Yield (tonnes)	**50**	**14**				
Post Harvest						
Cold storage (UK 6 months)	–	–		2,069		85.8
Shipping (NZ- UK) (17,840 km)	–	–	2,030		124.9	
Post Harvest subtotal	–	–	**2,030**	**2,069**	**124.9**	**85.8**
Total Energy Input/Emissions	–	–	**2,980**	**5,030**	**185.0**	**271.8**

The energy and carbon dioxide emissions associated with apple production in New Zealand and the UK are summarised in Table 3. The table highlights the difference in energy content in production of apples for direct and indirect inputs; no data was available for the UK for capital expenditure. However, New Zealand's capital component is relatively insignificant and we would

[33] Wells and Scarrow, *Opportunities for Improving the Environmental Operations of the Post Harvest Sector in Kiwifruit.* Of this 16 kWh/t were attributed to pre-cooling and 153 kWh/t to storage. Keeping the pre-cooling the same and increasing the storage component from five to six months equates to 200 kWh/tonne. The British electricity coefficients of 10.4 MJ per kWh (Table 1) and 41.5 gCO_2 per MJ (Table 1) is applied to the energy use. The total energy is: 199.5 * 10.37 = 2,069 MJ per tonne of apples. The corresponding CO_2 emissions are: 2,069*41.5/1,000 = 85.8 kg CO_2 per tonne of apples.

expect this to be similar in the UK. As Table 3 shows, the direct energy in apple production in the UK is considerably higher, at 2,337 MJ/t, compared to 573 MJ/t in New Zealand. The New Zealand indirect energy is also lower at 300 MJ/t compared to 624 MJ/t in the UK. When the total energy component is calculated, including transport and storage costs, New Zealand apples remain lower than their UK equivalent at 2,980 MJ/t compared to 5,030 MJ/t for UK apples.

The carbon dioxide emissions per tonne of apples produced are also higher in the UK than in New Zealand, reflecting the higher energy use. Thus New Zealand apples delivered to the UK have emissions of 185 kgCO_2/t compared to local UK apples at 272 kgCO_2/t.

Onions

There are some serious questions about the feasibility of the United Kingdom being able to supply the market with onions during its winter, due to technical issues around storage. Therefore whilst this has been assumed possible here, as mentioned below, whether it is feasible to replace imports is questionable. The New Zealand and UK onion crop has been compared based on supplying a crop into the same window of time, June to August, during the UK winter. The only way the UK onion crop can achieve this is by using cold and controlled atmosphere (CA) storage.

The key New Zealand source of information was the NZ onion industry report.[34] The key source of information on the production system for UK onions was Nix as well as Chalmers (et al.) for fertiliser use.[35]

In post-production, onions are subjected to cold and controlled atmosphere storage. British onions are assumed to be stored for a minimum of nine months using a mixture of cold and controlled atmosphere environment. The onions used for storage are harvested in August and stored through to July. The best data that was available for evaluating the energy cost of storage was the study conducted by Wells and Scarrow[36] on the storage of kiwifruit. This is likely to underestimate the energy cost as the kiwifruit stores an ever decreasing volume of kiwifruit, hence decreasing energy load, over the five months that the stores are typically operated for. By contrast the volume of stored UK onions will remain the same over the nine months required to get them into the same customer window in July.[37]

A comparison of New Zealand and UK onion production and the energy and carbon dioxide emission associated with onion production in New Zealand and the UK is summarised in Table 4. The table highlights the difference in energy content in production of onions for direct and indirect inputs, as yet no data is available for the UK for capital expenditure. Likewise no energy data was found on UK onion curing in drying sheds. As a result, the UK onions' energy input and associated CO_2 emissions are likely to be underestimated. As Table 4 shows, New Zealand onions, compared to the UK equivalent, have a higher direct energy input at 342 MJ/t compared to 245 MJ/t, although the UK figure does not include heating the onion drying sheds. The indirect energy inputs are also higher in New Zealand at 427 MJ/t compared to 367 MJ/t in the UK. Thus the energy associated with onion production in New Zealand is higher at 821 MJ/t compared with 678

[34] A. Barber, *Seven Case Study Farms: Total Energy & Carbon Indicators For New Zealand Arable & Outdoor Vegetable Production(Pukekohe: Agrilink 2004) http://www.agrilink.co.nz/TechnicalReports/tabid/1545/language/en-NZ/Default.aspx (18 April 2008).*

[35] A. Chalmers, B Housome, and C. Rush, *The British Survey of Fertiliser Practice: Fertiliser Use on Farm Crops for Crop Year* 2000. http//www.defra.gov.uk/environ/pollute/bsfp/2000/ (1 January 2006); J. Nix, *Farm Management Pocketbook: Thirty Fifth Edition.*

[36] C. Wells and S. Scarrow, *Opportunities for Improving the Environmental Operations of the Post Harvest Sector in Kiwifruit.*

[37] Wells and Scarrow found that it took 0.614 kWh/tray, or 169 kWh/tonne, for pre-cooling and storage over five months. Of this 16 kWh/t were attributed to pre-cooling and 153 kWh/t to storage. Keeping the pre-cooling the same and increasing the storage component from five to nine months equates to 291 kWh/tonne. Based on the energy and carbon dioxide emission coefficients in Table 1, total energy use was 3,020 MJ/tonne onions. Carbon dioxide emissions were 125 kg CO_2/tonne

MJ/t in the UK. When shipping costs are included, the New Zealand total rises to 2,889 MJ per tonne. However, when storage is included for the UK, so they can supply the same window in market as New Zealand, the UK energy costs rise 30 percent higher than those in New Zealand, to 3,760MJ per tonne. UK CO_2 emissions are lower compared to New Zealand, at 170 kg/t compared to 185 kg/t. The apparent anomaly of New Zealand having lower energy but higher CO_2 emissions is due to the different mix of energy sources.

Table 4: Total Energy and Carbon Indicators for NZ and UK onion production

Item	Quantity/hectare		Energy MJ/Tonne onions		CO_2 Emissions kgCO_2/Tonne onions	
	NZ	UK	NZ	UK	NZ	UK
Direct						
Fuel, Electricity and Oil (L of Diesel equivalent)		208		245		16.0
Diesel Use (L)	332		322		22.1	
Lubricants (L Oil)	6		6		0.2	
Electricity Use (kWh)	78		14		0.3	
Direct subtotal	–	–	**342**	**245**	**22.6**	**16.0**
Indirect						
Nitrogen (kg)	135	104	195	193	9.0	9.7
Phosphorus (kg)	134	37	45	16	2.7	1.0
Potassium (kg)	105	86	23	25	1.4	1.5
Sulphur (kg)	77		9		0.5	
Lime (kg)	977		13		9.3	
Herbicide (kg)	10.9	8.17	80	72	4.8	4.3
Fungicide (kg)	8.9	9.04	42	54	2.5	3.3
Insecticide (kg)	3.0	0.40	21	4	1.2	0.2
Plant Growth Regulator (kg)		0.52		3		0.2
Indirect subtotal	–	–	**427**	**367**	**31.5**	**20.1**
Capital						
Farm buildings (m^2)	0.9	0.9	12	15	1.2	1.5
Tractors and implements (kg)	31.3	31.3	39	51	3.7	4.7
Capital subtotal	–	–	**51**	**66**	**4.9**	**6.2**
Total Production	–	–	**821**	**678**	**58.9**	**42.3**
Yield (tonnes)	**45**	**35**				
Post harvest						
Grading	215	215	39	62	0.7	2.6
CA Storage (UK 9 months)	–	–		3,020		125.2
Shipping (NZ -UK) (17,840 km)	–	–	2,030		124.9	
Post harvest subtotal	–	–	**2,069**	**3,082**	**125.6**	**127.8**
Total Energy Input/Emissions	–	–	**2,889**	**3,760**	**184.6**	**170.0**

Lamb

In the case of New Zealand, most of the lamb information was gathered from a database developed by Andrew Barber during 2004/05.[38] In mixed output farms (sheep and beef meat, wool and crops), a way of allocating energy use and carbon dioxide emissions is needed. Two common methods are to either allocate as a proportion of output weight or on the share of revenue. In this study sheep production has been allocated according to its contribution to revenue, which was 47 percent.

All outputs are either per hectare or tonne of carcass weight.[39] In the case of sheepmeat production, finding sources of data on farm production systems was difficult given the fact there are few specialist sheep farms in the UK which do not have other stock or crops. Therefore the production system data for sheepmeat relied on Nix Farm Management Pocketbook data.[40] There are also a number of sheepmeat production systems in the UK ranging from hill and upland to lowland farms. However, as typically it is the lowland farms where sheep are finished for meat, this is used as the system in the current report. This also closely matched the farming type modelled in New Zealand which was also the lowland farms.

As for dairy, to assess the energy and emission levels per unit of output, in this case tonnes of meat carcass, the level of output has to be obtained and then the inputs. The average stocking rate and output from a lowland spring lambing operation, is 11 ewes per forage hectare with 1.45 lambs are reared per ewe. The average lamb carcass in the UK weighed 19.3kg in 2004.[41] Therefore, the output of meat per ewe is the number of lambs produced at 1.45 multiplied by the average weight of lamb carcass produced, at 19.3 kg, giving 28 kg of meat per ewe, (1.45*19.3 = 28.0 kg). This is equivalent (assuming a stocking rate of 11 ewes per hectare) to 308 kg of meat per hectare.

The next section calculates the energy and emissions associated with sheepmeat production. However, when calculating energy and emissions from sheepmeat, the rates calculated need to be discounted further to allow for the fact that not just meat is being produced but also co-products in the system (for example, wool).[42] These authors allocated the products from sheep production according to their contribution to revenue. Therefore in this study the energy consumed by the various elements will also be attributed according to revenue (as will CO_2 emissions). The level of revenue per ewe is £55.10 for lamb sales, £1.80 for wool and £5.80 for culling of ewes and rams, which comes to a total of £62.70.[43] Lamb sales are therefore 87.9 percent of revenue and therefore it will be assumed that 87.9 percent of energy and emissions will be attributed to meat production. This will henceforth be referred to as the 'co-product discount rate', and will be used to adjust all the calculations below.

[38] Andrew Barber collected this data as part of the ARGOS Project (www.argos.org.nz); A. Barber, 'Total Energy & Carbon Indicators for New Zealand Kiwifruit Orchards: A Pilot Survey' and A. Barber and D. Lucock, 'Total Energy Indicators: Benchmarking Organic, Integrated and Conventional Sheep and Beef Farms'.

[39] In order to estimate the carcass weight it was assumed that each lamb and ewe sold weighted 55 kg and that the dressing-out percentage, the percentage of carcass weight to live weight, was 42 percent. See: E. Burtt, 'Financial Budget Manual', *Monograph: Farm Management Group*,(Canterbury: Lincoln University, 2004).

[40] Nix, *Farm Management Pocketbook: Thirty-Fifth Edition 2005.*

[41] Department for Environment, Food and Rural Affairs, (Defra), UK, National Statistics, (2005a) http://statistics.defra.gov.uk (2 April 2008)

[42] R. Keedwell, L. Robertson and J. Barnett. *Energy Use and Greenhouse Gases for New Zealand Meat* (Confidential to Meat New Zealand), (Palmeston North: Fonterra Research Centre, 2002).

[43] Nix, *Farm Management Pocketbook: Thirty-Fifth Edition 2005.*

COMPARISON OF NEW ZEALAND AND UNITED KINGDOM LAMB PRODUCTION

Table 5 compares the production, energy and carbon dioxide emissions for lamb production in the UK and New Zealand. This shows that New Zealand has considerably lower direct energy inputs per tonne of carcass at 4,158 MJ compared to 17,156 MJ in the UK. In case of indirect energy use the energy input in New Zealand are also significantly lower at 3,698 MJ per tonne of carcass weight compared to 27,452 MJ in the UK. When the energy embodied in capital is included, New Zealand energy inputs are lower still with total energy associated with production 8,588 MJ in New Zealand compared with 45,859MJ in the UK. Including transport to the UK market increases the energy used in New Zealand production, but just to 10,618 MJ which is under a quarter of that in the UK. This reflects the extensive production system in New Zealand compared with the UK. In the case of emissions New Zealand carbon dioxide emissions are lower at 688 kg CO_2/Tonne carcass compared to 2,849 in the UK.

Table 5: Total Energy and Carbon Dioxide Indicators for NZ and UK lamb production

Item	Quantity/hectare		Energy MJ/Tonne carcass		CO_2 Emissions kg CO_2/Tonne carcass	
	NZ	UK	NZ	UK	NZ	UK
Direct						
Fuel, Electricity and Oil (L of Diesel Equiv.)		128		17,156		1,116.9
Fuel use (L of Diesel) (including contracting)	15.5		3,565		244.9	
Electricity use (kWh)	13.8		594		11.4	
Direct sub total	–	–	**4,158**	**17,156**	**256.3**	**1,116.9**
Indirect						
Nitrogen (kg)	5.7	76	1,953	16,147	90.1	807.4
Phosphorus (kg)	12.5	7	985	336	59.1	20.2
Potassium (kg)	0.5	15	29	498	1.7	29.9
Sulphur (kg)	12.3		323		19.4	
Lime (kg)	22.3	87	71	170	50.6	122.7
Agri-chemicals (L ai)	0.6	1.5	338	1,549	20.3	92.9
Concentrate (kg of dry matter)		681		7,432		457.5
Forage, fodder and bedding (kg grass silage)		271		1,319		76.5
Indirect sub total	–	–	**3,698**	**27,452**	**241.3**	**1,607.1**
Capital						
Vehicles and machinery (kg)	0.8		273		25.4	
Farm buildings (m^2)	0.1	13.1	198	1,251	19.8	125.1
Fences (m)	1.9		194		17.5	
Stock water supply	–		66		3.0	
Capital sub total	–	–	**731**	**1,251**	**65.6**	**125.1**
Total Production	–	–	**8,588**	**45,859**	**563.2**	**2,849.1**
Yield (kg lamb carcass)	**190**	**308**				
Post Production						
Shipping NZ -UK (17,840 km)	–	–	2,030	–	124.9	–
Total Production Energy Input/Emissions	–	–	**10,618**	**45,859**	**688.0**	**2,849.1**

In the case of emissions New Zealand carbon dioxide emissions are lower at 688 kg CO_2/Tonne carcass compared to 2,849 in the UK.

POLICY IMPLICATIONS OF SHIFTING EMPHASIS FROM 'FOOD MILES' TO 'LIFE CYCLE ASSESSMENT'

This study aimed to compare, using the same methodology, production systems in the UK with those in New Zealand; specifically to assess the validity of the food mile argument. There are a number of areas where this research could be expanded. First, comparison across different production systems and different sources of supply to the UK would be of value. The inclusion of internal transport costs and processing would enable a more complete LCA to be undertaken. The lack of data on the UK was an issue leading us to underestimate resource use and emissions in the UK systems. The analysis also assumed that the UK would be able to meet the shortage of supply if New Zealand did not supply this market which would mean diverting land from other uses. This additional land is also likely to be poorer quality and therefore may require greater inputs.

The food miles debate has highlighted the importance of the issue of climate change in consumers and politicians minds and the growing importance of reducing carbon emissions, hence the movement towards carbon footprinting of individuals, supply chains and products. In the UK, recent surveys have found that 94 percent of respondents are concerned about the climate. This is an issue which is continuing to grow in importance. In the UK there is political consensus over this issue, moreover the UK has taken the lead in this area in the EU with the Climate Change Bill aiming to reduce emissions by 60 percent from 1990 to 2050, (13 percent of UK emissions come from food). The UK has been able to take this lead due to change over from coal to gas fired power stations and also the commitment of Tony Blair to this is important (which is continuing under Gordon Brown). And the EU is following this lead. Other countries are also following suit, even countries (such as the United States) which are not part of Kyoto agreement. Japan also has announced a 50 percent reduction in emissions by 2050.

The UK has taken the lead in carbon labelling and carbon ratings. For example, The Carbon Trust, an independent body whose aim is to help companies to reduce their carbon emissions, has launching a trial carbon labelling scheme. Products have labels stating the carbon dioxide emitted during the full life-cycle of an item. The scheme also requires the firm producing the product to commit to reducing their carbon footprint. Furthermore, the UK Supermarket chain Tesco has stated that all products in its store will receive a carbon rating and are investing £500 million pounds to do this. Marks and Spencer are investing £200 million to reduce its carbon footprint by 80 percent over five years. Both Marks and Spencer and Tesco have airplane symbols on all food products freighted to the UK.

A number of other issues have arisen from the general concern about the environment and climate change. One of these is the risk to general consumption of meat and dairy products which generally have a high carbon footprint (mainly through methane and nitrous oxide emissions) and so it is argued that their consumption should be reduced. This can be seen in the growth of individual carbon footprinting which highlights the higher carbon footprint if eating meat.

Other issues which have arisen are the rise in the debate about seasonal consumption and the debate of consuming locally produced foods. Studies in the US show that locally grown food labels play a great influence on consumers. In the US the issue of COOL labelling (Country of Origin Labelling) is rising in importance as are food miles. Recent studies predict that the US market for local food will grow from $2 billion in 2002 to $7 billion by 2011. Given a choice, consumers are more likely to purchase locally grown over organic foods produced in a distant region, even if the local foods were produced using some pesticides.[44] This trend is given impetus by the rise in popularity of local food markets.

Clearly, it is important for New Zealand agri-businesses to show they are 'carbon-friendly' and reducing their footprint. Interestingly it was the reduction which is being stressed rather than offsetting. Offsetting had lost some credibility in the UK firstly because it was seen as dodging the problem but also some schemes had been shown to be spurious and verging on fraudulent.

Another very important factor potentially to affect the issue of carbon footprinting and other environmental and social aspects of food production which may affect New Zealand's market access is the interdiction of the Single Farm Payment (SFP) in the EU. This is a huge change in policy from market based support (which has historically, and still, causes New Zealand hardship) to direct payments to farmers based on environmental criteria. The budget for this is huge with 75 billion Euros per year; almost equivalent to New Zealand's national income.

The Common Agricultural Policy (CAP) 2003 reform includes a Single Farm Payment in which subsidies are decoupled from production. That is, farmers receive a payment irrespective of what and how much they choose to produce. The EU commission has recently announced that climate change issues will be included as part of these payments. This potentially means that individual farms in the EU will measure their carbon footprint and access to the payment will depend upon reducing this footprint. Consequently this may well mean we have to do the same in New Zealand and individually carbon footprint all farms. Whilst this may seem a huge undertaking, it does have the advantage that farmers here are generally better place to do his than many of New Zealand's competitors. Moreover, farmers generally find financial savings when these audits are undertaken.

The CAP reform of 2003 also brings the importance of environment, quality and safety issues into the EU agricultural support. To benefit from the SFP, farmers will have to comply with existing legislation on those issues (cross-compliance). Assistance in the form of advisory services for farmers is foreseen to help EU farmers to meet the standards. In addition the support for voluntary agri-environmental measures has increased. Incentives are foreseen for farmers who join food quality certification schemes and consumer information campaigns. The introduction of the SFP and also the agri-environmental schemes in the EU has lead to greater emphasis on other environmental factors including biodiversity, water quality and wildlife. The payments will help to subsidise farmers to meet environmental requirements on their farms and market requirements may also increase for these environmental factors.[45]

CONCLUSION

In conclusion, New Zealand exporters have growing opportunities in the world market as export subsidies are reduced and removed. However, this opportunity may well rely on production meeting various environmental criteria especially to access high-value markets. Strategies to combat climate change are the most recent example of these environmental criteria. The politically charged food miles concept which grew from this however is clearly erroneous. It ignores the full energy and carbon emissions from production as the Lincoln AERU Food Miles report showed.[46]

[44] Pirog (et al.), *Food, Fuel, and Freeways: An Iowa perspective on how far food travels, fuel usage, and greenhouse gas emissions.*

[45] This can already be seen in the growth of such schemes as EureGAP which include requirements or recommendations for environment and hygiene, environmental management including wildlife policy, groundwater, staff facilities, training and health and safety. Whilst not all of these are 'must dos' at present, the subsidisation of EU farmers to meet these requirements will enable them to become 'must dos' soon.

[46] C.M. Saunders, A. Barber and G. Taylor, 'Food Miles – Comparative Energy/Emissions Performance of New Zealand's Agriculture Industry'.

Food miles, whist still having traction with the popular media and maybe consumers, has lost credibility with the supermarkets and government agencies which have turned their attention to carbon footprinting. The emphasis now must be on measuring the carbon footprint of products. Currently in the UK, significant institutions including DEFRA, the Carbon Trust and British Standards Institution, are developing a method to do this. The key factor in addressing climate change through trade policy is not therefore a focus on the narrow concept of food miles but attention to the more comprehensive policy task of reducing carbon footprints over time.