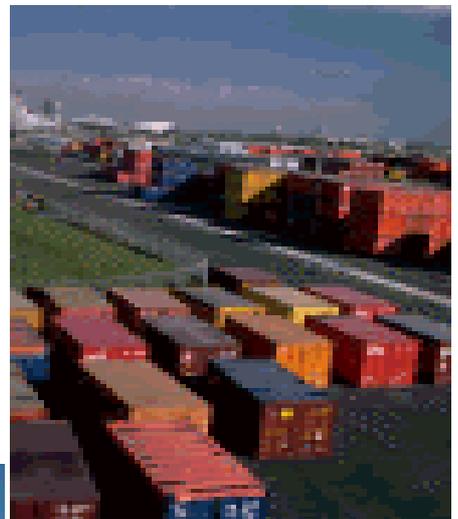


The Validity of Food Miles as an Indicator of Sustainable Development

Final Report produced for DEFRA



JULY 2005

Title	The Validity of Food Miles as an Indicator of Sustainable Development: Final report
Customer	DEFRA
Customer reference	DU1947
Confidentiality, copyright and reproduction	This document has been prepared by AEA Technology plc in connection with a contract to supply goods and/or services.
File reference	m:\envfes\projects\policy group\live projects\Defra food miles\reports\final\Food Miles final report issue 6
Report number	ED50254
Report status	Issue 7

Contact details

Paul Watkiss
 AEA Technology Environment
 Harwell B154
 Didcot
 Oxon OX11 0RA
 Telephone +44 (0)870 190 6592
 Facsimile +44 (0)870 190 6327
 paul.watkiss@aeat.co.uk

AEA Technology is the trading name of AEA Technology plc
 AEA Technology is certificated to BS EN ISO9001:(1994)

	Name	Signature	Date
Author	Alison Smith Paul Watkiss Geoff Tweddle Prof. Alan McKinnon Prof. Mike Browne Alistair Hunt Colin Treleven Prof. Chris Nash Sam Cross		
Reviewed by	Paul Watkiss		
Approved by	Paul Watkiss		

Executive Summary

Study Objectives

Over the last fifty years, there have been dramatic changes in the food production and supply chain in the UK. The most striking changes have been:

- ◆ Globalisation of the food industry, with an increase in food trade (imports and exports) and wider sourcing of food within the UK and overseas;
- ◆ Concentration of the food supply base into fewer, larger suppliers, partly to meet demand for bulk year-round supply of uniform produce;
- ◆ Major changes in delivery patterns with most goods now routed through supermarket regional distribution centres, and a trend towards use of larger Heavy Goods Vehicles (HGVs);
- ◆ Centralisation and concentration of sales in supermarkets, with a switch from frequent food shopping (on foot) at small local shops to weekly shopping by car at large out of town supermarkets.

These trends have led to a large increase in the distance food travels from the farm to consumer, known as “food miles”. Indeed, since 1978, the annual amount of food moved in the UK by HGVs has increased by 23%, and the average distance for each trip has increased by over 50%.

The rise in food miles has led to increases in the environmental, social and economic burdens associated with transport. These include carbon dioxide emissions, air pollution, congestion, accidents and noise. There is a clear cause and effect relationship for food miles for these burdens – and in general higher levels of vehicle activity lead to larger impacts. Growing concern over these impacts has led to a debate on whether to try to measure and reduce food miles.

Against this background, DEFRA have commissioned this study to assess whether a practical and reliable indicator based on food miles can be developed, and whether this would be a valid indicator of progress towards the objectives of the government’s Sustainable Farming and Food Strategy and the proposed Food Industry Sustainability Strategy. The study has undertaken four key tasks:

1. To compile a **food miles dataset** covering the supply chain from farmer (both UK and overseas) to consumer for 1992, 1997 and 2002.
2. To assess the **main trends** leading to increases in food miles around the UK and overseas.
3. To identify and quantify the **economic, environmental and social impacts** of food miles.
4. To develop a **set of key indicators** which relate food miles to their main impacts on sustainability.

The main criteria for the validity of a progress indicator based on food transport include:

- ◆ It should be based on easily available statistics which are updated annually;
- ◆ Any data gaps can be filled with reasonable estimates;

- ◆ It should be possible to structure a food miles indicator so that the indicator is directly correlated with food transport (and the associated negative externalities) and any exceptions can be dealt with;
- ◆ The indicator should have strong links to the aims and outcomes of the proposed Food Industry Sustainability strategy, such that progress towards the aims of the strategy will have a noticeable effect on food transport km (and levels of negative externalities);
- ◆ The indicator will have a reasonably quick response to policy measures;
- ◆ It will be accepted as a valid indicator by all stakeholders;
- ◆ It is consistent with the other indicators for the Food Industry Sustainability strategy.

Study Findings

The four key findings of the study are summarised below.

1. **A single indicator based on total food kilometres is an inadequate indicator of sustainability.** The impacts of food transport are complex, and involve many trade-offs between different factors. A single indicator based on total food kilometres travelled would not be a valid indicator of sustainability. To capture the complexities of the issue, we recommend **a suite of indicators** which reflect the key adverse impacts of food transport (see below).
2. **Data is available to provide and update a meaningful set of indicators on an annual basis.** A spreadsheet system for collating the data and calculating the indicators accompanies the report. The key transport stages (HGV and LGV transport in the UK, car shopping trips for food and international sea and air freight) are covered by good quality DfT and HM Customs and Excise statistics gathered annually. Areas where the data quality is poor are either of less policy interest to DEFRA (road transport overseas), or currently have a negligible role in UK food transport (rail, inland waterway). A summary of the data sources and quality is provided in Table E2.
3. **Food transport has significant and growing impacts.** Food transport accounted for an estimated 30 billion vehicle kilometres in 2002, of which 82% are in the UK. Road transport accounts for most of the vehicle kilometres, split between cars, HGVs and LGVs (see figure E1).
 - ◆ Food transport accounts for **25% of all HGV vehicle kilometres in the UK.**
 - ◆ Food transport produced **19 million tonnes of carbon dioxide** in 2002, of which 10 million tonnes were emitted in the UK (almost all from road transport), representing 1.8% of the total annual UK CO₂ emissions, and 8.7% of the total emissions of the UK road sector.
 - ◆ **Transport of food by air has the highest CO₂ emissions per tonne, and is the fastest growing mode.** Although air freight of food accounts for only 1% of food tonne kilometres and 0.1% of vehicle kilometres, it produces 11% of the food transport CO₂ equivalent emissions (see figure E2).
4. **The direct environmental, social and economic costs of food transport are over £9 billion each year, and are dominated by congestion.** Using standard government methodology, the social cost of congestion, associated with

food transport is estimated at £5 billion. This is over 50% of the social costs associated with food transport, and arises from the use of HGVs, LGVs, and cars are associated with food transport in the UK. Accidents lead to social costs of £2 billion per year (Table E1). Greenhouse gas emissions, air pollution, noise, and infrastructure cost a further £2 billion. The total costs are very significant compared with the gross value added of the agriculture sector (£6.4 billion), and the food and drink manufacturing sector (£19.8 billion) in 2002. It should be noted that these cost estimates depend on the assumptions and methodology used. For example, the congestion costs are marginal costs, as the impact of an extra kilometre travelled depends on the existing level of traffic. The use of average costs, although not recommended, would give lower values. Also, the costs reflect only immediate impacts. For congestion, these impacts are short term and reversible, whereas climate change impacts are long term and irreversible. It should be stressed that not all impacts are included in this assessment (for example noise, infrastructure and congestion costs from air transport are not quantified).

Figure E1. UK food vehicle-kilometres by transport mode (2002)

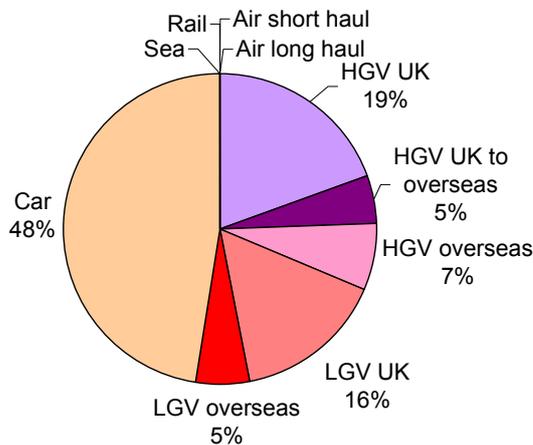


Figure E2. CO₂ emissions associated with UK food transport (2002)

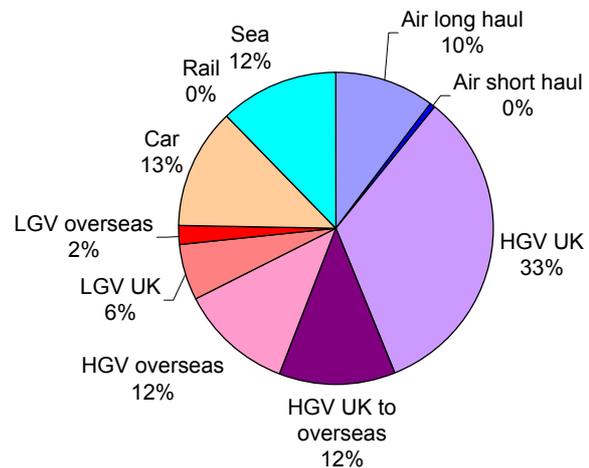


Table E1: Social cost estimates for UK-generated food transport (2002)

£M	CO ₂	Air quality	Noise	Congestion	Accidents	Infrastructure	Total costs
UK HGV	120	165	123	1359	327	387	2480
UK LGV	21	48	27	1056	148	4	1303
UK car	46	24	42	2576	965	9	3662
UK to overseas road	43	54	39	52	115	141	443
Overseas HGV	42	58	43	90	304	272	809
Overseas LGV	7	18	9	54	147	3	239
Rail	0	15	0	0	0	0	16
Deep sea	43	32	0	0	26	nq	106
Short sea	3	22	0	0	3	nq	32
Air long haul	38	1	nq	nq	nq	nq	39
Air short haul	2	0	nq	nq	nq	nq	2
Total	364	439	283	5187	2036	815	9123

nq=not quantified

Table E2: Summary of data sources, assumptions and data quality for food transport dataset components

Data component	Data sources and assumptions	Data quality	Estimated % of CO ₂ emissions	Estimated % of vehicle km	Timing of data
UK HGV	Annual Continuing Survey of Road Goods Transport (CSRGT) from DfT – data compiled from monthly surveys of thousands of transport operators.	Good. Can disaggregate food types but not imports and exports.	33%	19%	May
UK LGV	DfT survey of private and company van use (2004).	Good.	6%	16%	August
UK car	Annual DfT survey of personal travel. Car travel for food shopping is identified separately.	Vehicle km well defined. Urban/rural split for food shopping not available – the split for all car travel purposes is used.	13%	48%	September
UK sea, rail, inland waterway, air	DfT statistics available for total UK sea and rail freight, but not split out by food transport.	Little data which separates out food from other freight, but insignificant	Very low	Very low	N/a
International air	HM C&E database for non-EU countries. Assumed insignificant for EU countries – expert opinion is that most food commodities from the EU travel by road or ship (cheaper and just as fast).	Good for non-EU countries. Not available for EU countries but thought to be insignificant.	11%	0.1%	March
International HGV	HM C&E database gives total tonne km for road and sea. Split between road and sea depends on assumptions.	Good for total tonne-km. Assumptions for split between road and sea are reasonably well informed.	12%	5%	March
International sea	HM C&E database gives total tonne km for road and sea. Split between road and sea depends on assumptions.	Good for total tonne-km. Assumptions for split between road and sea are reasonably well informed.	12%	0.04%	March
International rail, inland waterway	Not available.	Not available but thought to be insignificant.	Low?	Low?	N/a
Overseas HGV	Estimate based on country size and handling factor	Poor. May be an underestimate, but of less policy interest to DEFRA.	12%	7%	N/a
Overseas LGV	Estimate based on overseas HGV estimate and ratio of HGV to LGV food transport in the UK.	Poor, but of less policy interest to DEFRA.	2%	5%	N/a
Overseas rail, air, inland waterway	Not available.	Not thought to be very significant.	Very low?	Very low?	N/a

How to measure food miles: complexities and trade-offs

The relationship of food transport to overall sustainability is complex. We have established that the transport of food has significant direct environmental, economic and social impacts. Therefore, in like for like systems, where food supply chains are identical except for transport distance, reducing food transport will improve sustainability. However, differences between food supply systems often involve trade-offs between various environmental, social and economic effects. These must be taken into account when designing an indicator to measure the impacts of food transport, and when formulating associated policies. Some of the main issues are summarised below.

- 1. Transport mode.** The impacts of food transport are highly dependent on the transport mode. Air transport has a very high climate change impact per tonne carried, whereas sea transport is relatively efficient. Transport by HGV accounts for most of the infrastructure (road maintenance), noise and air pollution costs, yet shopping for food by car accounts for a high proportion of the congestion and accident impacts. For this reason, we propose a set of key indicators which focus on the main direct impacts of food transport, taking account of transport mode, rather than a single aggregate indicator of total food miles (see below).
- 2. Transport efficiency.** There is a trade-off between transport distance, vehicle size and transport efficiency. The current dominant system of food supply in the UK involves large HGVs travelling long distances between suppliers and shops via centralised distribution centres. However, this system enables very efficient loading of vehicles, which reduces the impacts per tonne of food. More local sourcing can greatly reduce the distance travelled by food, but the reduction in transport impacts may be offset to some extent by the use of smaller vehicles or lower load factors. We recommend further research into this issue.
- 3. Differences in food production systems.** The impact of food transport can be offset to some extent if food imported to an area has been produced more sustainably than the food available locally. For example, a case study showed that it can be more sustainable (at least in energy efficiency terms) to import tomatoes from Spain than to produce them in heated greenhouses in the UK outside the summer months. Another case study showed that it can be more sustainable to import organic food into the UK than to grow non-organic food in the UK. However, this was only true if the food was imported by sea, or for very short distances by road. Finally we considered whether there could be a net energy saving from centralised mass-production of food (ready meals) compared to home cooking. On the whole, we found that any exceptions related to food production systems did not relate to a significant proportion of food transport, and were also often covered by other indicators and policies (e.g. the DEFRA targets for increasing UK supply of organic produce, and government policies to increase the energy efficiency of UK food production).
- 4. Wider economic and social costs and benefits.** The term "food miles" has come to signify more than the transport of food and the direct physical impacts of this transport. A number of other economic and social issues are bound up in the food miles debate. Firstly, issues surrounding the international trade of food are part of the debate on globalisation. It is clear that transport and trade of food has the potential to lead to economic and social benefits, for example through economic gains for both developed and developing nations, reduced prices for consumers and increased consumer choice. However, the realisation of these benefits depends on a number of complex political, social and economic factors, such as global trade rules and trends in commodity markets. At the individual

level, food trade and the consolidation of food supply chains can lead to both winners and losers. Secondly, there are issues related to UK agriculture and rural communities. Food miles are often discussed in the context of decreasing farm gate prices, the disappearance of local shops and detrimental effects on rural economies and farming communities in the UK.

Our analysis indicates that the wider environmental, social and economic effects associated with different food supply chains are complex and very system specific. Consideration of these effects does not lead to a clear case for a move to either higher or lower food miles systems. What is clear is that the complex trade-offs between different social, environmental and economic costs and benefits cannot be evaluated, and policies cannot be formulated, unless food miles and their impacts are monitored and measured. It is also clear that policies directed at reducing food transport should consider these wider effects, and be integrated with policies and initiatives in other key areas, such as rural development, trade, international development, agriculture, transport and environment. A correctly structured food miles indicator would allow continuous analysis of the trade-off between different environmental, social and economic factors.

Key Indicators and Trends

Based on an analysis of the key impacts of food transport, the most important trends, and the complexities and trade-offs involved, we propose a set of four “key indicators” (Table E3). These indicators focus on the direct impacts of food transport, such as congestion, accidents and pollution. Wider economic and social issues such as local sourcing of food are not addressed directly by this indicator set.

Table E3. Key indicators.

Indicator	Notes
Urban food km in the UK, split by car, LGV, HGV.	Urban food km account for most of the accident and congestion costs. The impact of air pollution is also much higher in urban areas. At present, this indicator relies on the assumption that the urban/rural travel ratio is the same for food transport as for all other transport. An alternative proxy for congestion and accident costs would be car food km.
HGV food km	This covers HGV transport both in the UK and overseas. HGV transport is responsible for the majority of infrastructure, noise and air pollution costs.
Air food km	Air freight of food is rapidly growing and has a higher environmental impact than any other transport mode.
Total CO₂ emissions from food transport	Emissions of CO ₂ from the transport sector are highly significant and are growing. This indicator includes estimated CO ₂ from transport fuel use both in the UK and other countries. Currently excludes CO ₂ and other greenhouse gas emissions from refrigeration during transport, although it would be desirable to include this in future.

In addition to the four headline indicators above, we also identified other areas where supplementary indicators are desirable, to capture some of the complexities and trade-offs discussed above. However, for most of these areas, related indicators or policies already exist as part of other government strategies. For example, the UK share of the organic food market is covered in DEFRA’s action plan for organic food and farming, live animal transport is covered by the animal health and welfare strategy, and ethical trading is an indicator in the food industry sustainability strategy.

Table E4 compares the four key indicators and some supplementary indicators (including exports) for 1992, 1997 and 2002. The data shows that:

- ◆ **Urban food vehicle km** are estimated to have increased by 27% since 1992, due largely an increase in shopping for food by car. This has been driven by an increase in car ownership together with changes in shopping patterns (from frequent visits to local shops towards weekly visits to large out-of-town supermarkets).
- ◆ **HGV food tonne km have increased dramatically in the UK, but this has not been accompanied by an increase in HGV food vehicle km because of efficiency improvements.** HGV tonne kms have increased by 36% since 1991 and by over 100% since 1974. This is due to concentration of food sales in supermarkets, concentration of the food supply base, and associated changes in food delivery patterns. However, this rise in tonne kilometres has been partially offset by a switch to larger vehicles and improvement in load factors, resulting in a proportionally lower increase in vehicle km. HGV food vehicle km increased by 8% between 1992 and 1998, but then declined by 7% to 2002, giving a net increase of only 1% from 1992 to 2002. It is not clear how long this trend can be sustained. When opportunities for further improvements in load factor are fully exploited, HGV food vehicle km could begin to rise again if there are continuing increases in food movements.
- ◆ **Overseas HGV transport associated with UK food supply has declined slightly since 1992.** This is due to a recent trend to increase food trade with nearer EU countries (France, the Netherlands and Ireland) at the expense of Spain, Italy and Greece, which has decreased HGV vehicle km for the international stage of transport. However, as the overall level of food imports have increased, the road transport associated with food production *within* overseas countries has increased steadily (although there is a high uncertainty in these estimates), partially offsetting this trend. We estimate that overseas HGV transport associated with UK food supply has decreased by 8% overall since 1992. Future changes in food sourcing, perhaps due to EU enlargement for example, could reverse this trend.
- ◆ **Air freight has increased by 140% since 1992,** although it still accounts for only 0.1% of total vehicle km. However, it now accounts for 11% of CO₂ –equivalent emissions. The increase in air freight is largely due to increased globalisation of food supply, together with a relative decrease in the real cost of air freight compared to other transport modes.
- ◆ **CO₂ emissions from food transport increased by 12% from 1992 to 2002.** In contrast, air pollutant emissions (e.g. PM₁₀, NO_x) have decreased over this period, despite the increase in overall vehicle kilometres, because of the introduction of European emission standards for road vehicles.

Use of the indicator set

It is envisaged that the indicator set would be updated yearly, following publication of the key underlying datasets (HM Customs and Excise data and the DfT CSRGT surveys for HGVs and LGVs).

Because of the complex relationship between food transport and sustainability, great care must be exercised in interpreting any changes observed in the indicators or in the setting of any associated targets. It will be important to establish the underlying causes and statistical significance of such changes and to consider all the economic, social and environmental implications before drawing conclusions or formulating policy responses.

Again we emphasise that this indicator set focuses on the direct adverse impacts of food transport: congestion, pollution and accidents. It is not designed to directly measure wider economic and social impacts, or to detect trends such as changes in food sourcing and food retailing, although policy initiatives in these areas may well have detectable impacts on the indicators.

Study Conclusions and Research Priorities

Food transport has been increasing steadily over the last few decades. This has direct negative impacts on sustainability (congestion, accidents, road maintenance costs, greenhouse gas emissions, noise and air pollution), and these impacts are significant at a national level. Many of these impacts are not included in existing indicator sets (e.g. international air and shipping).

Food miles have a complex relationship to sustainability, and there can be trade-offs between environmental, social and economic factors. For this reason, a single indicator based on total food miles is not appropriate. A correctly structured indicator will enable the key impacts of food transport to be targeted, and allow appropriate policies to be formulated to ensure that a balance is maintained between economic, social and environmental sustainability.

Adequate data exists to compile an annual food transport indicator. The proposed indicator suite is consistent with the approach and objectives of DEFRA's Sustainable Farming and Food Strategy and the proposed Food Industry Sustainability Strategy.

Several recommendations for further work have been identified:

Dataset improvements

1. Improvement of the estimates of urban food transport (currently food transport cannot be distinguished from other transport on urban / rural roads);
2. Improved estimates of load factors for international air and sea transport;
3. Improved estimates of the burden arising from SO₂ and NO_x emissions from shipping;
4. Improvement of estimates of overseas transport using national datasets from other countries if available;
5. Inclusion of estimated CO₂ and other emissions associated with refrigeration during transport;
6. Possible identification of indicators on a regional basis.

Validity of indicator

7. Further assessment of the statistical validity of the indicator (e.g. confidence limits for the four main headline indicators);
8. Further investigation of the wider social and economic impacts of a reduction in food transport;
9. Research into the change in transport efficiency or energy efficiency which might result from a switch towards more locally produced food, (including the investigation of the potential for increases in local delivery traffic), and measures to improve this efficiency.

Policies

10. A study of potential policies to reduce the impacts of food transport.

Table E4: Trends in Key Indicators 1992-2002 (Headline indicators in bold)

Including exports		Total			In UK			Overseas		
		1992	1997	2002	1992	1997	2002	1992	1997	2002
Total tonne kilometres	billion tonne km	203	222	234	39	49	50	164	173	183
Total vehicle kilometres	billion vehicle km	27	29	30	21	23	25	5.7	5.5	5.3
Urban road food km	million vehicle km				9,847	11,015	11,778			
Car	million vehicle km				5,178	6,108	6,975			
LGV	million vehicle km				2,974	2,974	2,974			
HGV	million vehicle km				1,696	1,932	1,828			
HGV food km	million vehicle km	9,325	10,026	9,425	5,391	6,145	5,812	3,933	3,881	3,613
	million tonne km	62,745	75,270	76,871	36,278	46,131	47,400	26,467	29,139	29,471
Air food km	million vehicle km	11	22	27	0	0	0	11	22	27
Total CO₂ emissions	million tonnes	16.9	18.7	19.1	8.9	9.9	9.7	7.9	8.7	9.2
Total PM ₁₀ emissions	thousand tonnes	9.5	7.3	5.3	5.6	4.1	2.5	3.8	3.1	2.8
Total NO _x emissions	thousand tonnes	206	201	158	105	102	72	101	98	85
Total SO ₂ emissions	thousand tonnes	51	42	41	8.81	2.51	0.25	43	40	41
Live animal food km	million tonne km				870	884	764	NK	NK	NK
Imports of indigenous foods	million tonnes				13.55	14.20	16.15			
Retail sales of ethically traded foods	million £				0	13	63			
% of indigenous organic food grown in the UK	%				NK	NK	62%			

NK=Not known

Contents

1	Introduction	1
1.1	WHAT ARE FOOD MILES?	1
1.2	BACKGROUND TO THE PROJECT	2
1.3	TASKS	4
1.4	STRUCTURE OF THE REPORT	4
2	Factors driving food miles	6
2.1	INCREASE IN FOOD TRADE	6
2.2	TRENDS IN TRANSPORT LOGISTICS AND RETAILING	8
2.3	GROWTH IN FOOD SHOPPING BY CAR	14
2.4	DEMAND FOR LOCAL FOOD	15
3	Food miles dataset	19
3.1	THE UK FOOD SUPPLY CHAIN	19
3.2	DERIVATION OF THE DATASET	20
3.3	ANALYSIS AND DISCUSSION	29
3.4	DATA QUALITY	34
4	The direct impacts of food transport	36
4.1	DIRECT ENVIRONMENTAL COSTS OF FOOD TRANSPORT	37
4.2	DIRECT SOCIAL COSTS OF FOOD TRANSPORT	41
4.3	DIRECT ECONOMIC COSTS OF FOOD TRANSPORT	43
4.4	SOCIAL COST ESTIMATES	46
5	Wider social and economic issues	48
5.1	INTRODUCTION	48
5.2	FOOD PRICES	49
5.3	CONSUMER CHOICE, NUTRITION AND FOOD CULTURE	53
5.4	TRENDS AFFECTING UK SUPPLIERS	55
5.5	EFFECTS OF CHANGES IN FOOD RETAILING	61
5.6	INTERNATIONAL TRADE AND DEVELOPING COUNTRIES	62
6	Case studies	64
6.1	CASE STUDY 1 – ENERGY BALANCE FOR SPANISH VS UK TOMATOES	66
6.2	CASE STUDY 2 - SOCIAL COSTS OF IMPORTED ORGANIC WHEAT	68
6.3	CASE STUDY 3 - ENERGY BALANCE FOR PROCESSED CHICKEN	74
6.4	ARE FOOD MILES A VALID INDICATOR OF SUSTAINABLE DEVELOPMENT?	77
7	Key food miles indicators	82
7.1	DERIVATION OF A SET OF KEY INDICATORS	82
7.2	TRENDS 1992-2002	88
7.3	CONSISTENCY WITH OTHER GOVERNMENT POLICIES AND OBJECTIVES	91

8	Conclusions	95
	References	98

Annexes

1 Introduction

1.1 WHAT ARE FOOD MILES?

Over the last fifty years, there have been dramatic changes in the way food is produced, sourced, processed, packaged, delivered and marketed in the UK. The most striking changes have been:

1. Globalisation of the food industry and increase in food trade. In the UK there has been a steady increase in imports and exports of food, especially imports of fresh fruit and vegetables, with more produce sourced from further afield (Africa, Far East, New Zealand).
2. Concentration of sales in supermarkets, accompanied by loss of small shops, markets and wholesalers. Parallel concentration of supply base into fewer, larger suppliers, partly to meet supermarket preferences for bulk year-round supply of uniform produce.
3. Switch from frequent food shopping on foot at small local shops to weekly shopping by car at large out of town supermarkets.
4. Intensification of agriculture and increase in processing and packaging of food.
5. Dramatic changes in transport logistics, with most goods now delivered to the supermarket's own regional distribution centres and taken from there to the shops in large HGVs, replacing local deliveries direct to the store in smaller vehicles.

These changes have contributed to a significant increase in the transport of food within the UK and to, from and within our food trading partners overseas (Figure 1).

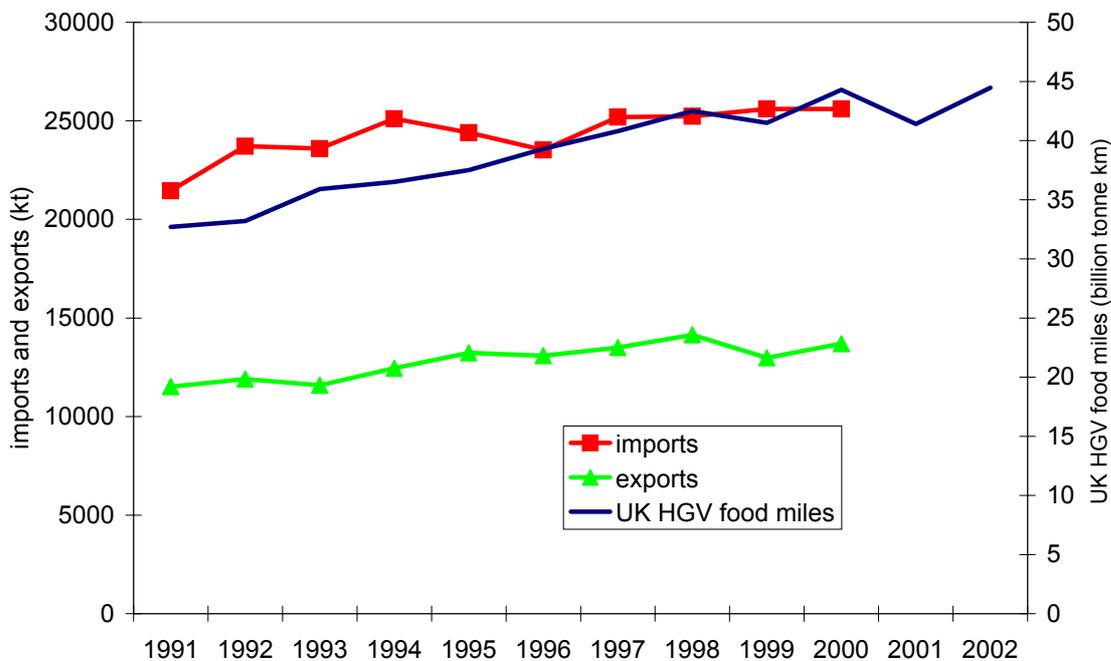


Figure 1: Trends in food trade and HGV food transport in the UK, 1991-2002

Since 1978, the annual amount of food moved in the UK by HGVs has increased by 23%, and the average distance for each trip has increased by over 50%¹. Food transport accounts for 30% of all road freight transport tonne kilometres within the UK. Food shopping trips by car have also increased in frequency and length, due largely to the replacement of local shops by out of town supermarkets. This increase in the distance travelled by food is associated with environmental, social and economic impacts.

The term "Food Miles" was first coined almost ten years ago in a report by the SAFE Alliance, now Sustain, which highlighted concerns over the negative environmental and socio-economic impacts of increasing transport of food². Food miles are simply the distances travelled by foodstuffs from farm gate to consumer. They are generally measured as tonne-kilometres, i.e. the distance travelled in kilometres multiplied by the weight in tonnes for each foodstuff. However, to measure the environmental impact of food miles it is necessary to convert them into vehicle kilometres, i.e. the sum of the distances travelled by each vehicle carrying food.

One might ask why food is considered separately to other goods in this context. Why worry about "food miles" but not "other product miles"? Transport of all goods obviously causes the same direct environmental impacts, and some of the issues discussed in this paper do apply equally to other goods. The reason why food miles have attracted so much concern is because transport and trade of food is connected to several wider issues: the issues discussed in Section 5 (Wider social and economic effects) in this report.

1.2 BACKGROUND TO THE PROJECT

The rise in food miles has led to increases in the environmental, social and economic burdens associated with transport. These include carbon dioxide emissions, air pollution, congestion, accidents and noise. There is a clear cause and effect relationship for these burdens, and in general, higher vehicle activity leads to larger impactsⁱ. Growing concern over these impacts has led to a debate on whether to try to measure and reduce food miles.

This debate has been part of a discussion on the wider environmental, social and economic effects associated with the trends in the food supply chain identified in the previous section. For example:

- ◆ Studies by NGOs such as Sustain and IEED^{2,3,8,11,34} have argued that the trends in the food supply chain listed in the previous section have led to social and economic impacts in the UK, through downward pressure on farm gate prices, the disappearance of local shops and detrimental effects on rural economies and farming communities. These studies have argued the need to increase the demand for food produced closer to the point of sale, and strengthen the position of local suppliers and retailers. It is argued that this would reduce food miles, as well as leading to other potential sustainability benefits (economic benefits for UK farmers, local shops and suppliers). This would be consistent with government objectives to strengthen rural communities and assist small and medium sized enterprises.
- ◆ Others argue that the current food supply system is well tailored to meeting the needs of today's consumer, with the convenience of a weekly supermarket shopping trip. They argue that centralisation and consolidation of food production and retailing operations, along with global sourcing, have led to lower prices and also

ⁱ Though the nature and level of the environmental and social costs associated with food transport vary widely depending on the mode, technology, time and load efficiencies.

meet consumer expectations for a year-round supply of a wide range of produce from around the world. Although most food in the UK is transported long distances in large HGVs, improved transport logistics have largely offset the rise in vehicle kilometres. They argue that current logistics operations are highly optimised and there are practical constraints on some options for reducing food miles (e.g. supermarkets are no longer equipped to handle large numbers of direct or small-scale deliveries, and local suppliers using greater numbers of smaller vehicles with lower load factors could actually increase congestion). Furthermore, they argue that local food production may not be the most efficient approach for strengthening rural communities and assisting small and medium sized enterprises, and it might cut across other policy aims, such as the need for higher levels of productivity and a more liberal international trading system. It is also argued that policies to reduce food miles through a move towards local production could lead higher costs for consumers, or reduced choice of produce at certain times of year, and that there could be economic disadvantages for developing countries which currently export to the UK.

The wider issues above can be considered in relation to a food miles data set. The impacts will depend on the policies used to reduce food miles and on the response of consumers and industry to these policies. There is no direct correlation between food miles and, for example, food prices or the strength of rural economies. However, food miles are a potential indicator for the trends above (e.g. the move towards more global sourcing is reflected in increasing food miles, just as a move towards more local sourcing would show through decreasing food miles). Similarly, policies which can reduce food miles can also have a wider social and economic impact in the areas listed above.

What is clear is that food miles are a complex issue, and must be considered in the context of a host of other indicators of sustainability. In like for like systems (i.e. where the only differences in the food supply chain are with transport distance), reducing food miles will have a beneficial effect on sustainability, by reducing the environmental and social burdens of transport. However, when all activities across the food supply chain are considered, there are often differences that involve trade-offs between various environmental, social and economic effects. For example, can there be benefits for sustainability when importing organic food, or importing crops which require less energy to produce in more favourable climates overseas?

Thus, whilst food miles have impacts in all three areas of sustainability: economic, environmental and social, it is not always clear whether a decrease in food transport would necessarily lead to an increase in sustainability, and there may be some cases where the reverse is true. DEFRA therefore commissioned this study to assess whether a practical and reliable indicator based on food miles can be developed, and whether this would be a valid indicator of progress towards the objectives of the government's Sustainable Farming and Food Strategy⁴. and the proposed Food Industry Sustainability Strategy.

The main criteria for validity of food miles as a progress indicator include⁵:

- ◆ The indicator should be based on easily available statistics which are updated on an annual basis;
- ◆ Any data gaps can be filled with reasonable estimates;
- ◆ It should be possible to structure a food miles indicator so that the indicator is directly correlated with sustainability and any exceptions can be dealt with;

- ◆ The indicator should have strong links to the aims and outcomes of the proposed Food Industry Sustainability strategy, such that progress towards the aims of the strategy will have a noticeable effect on food miles;
- ◆ The indicator will have a reasonably quick response to policy measures;
- ◆ It will be accepted as a valid indicator by all stakeholders;
- ◆ It is consistent with the other indicators for the Food Industry Sustainability strategy.

1.3 TASKS

The study addressed the following tasks.

1. **Food miles dataset.** Compile a dataset covering the supply chain from farmer (both UK and overseas) to consumer, including the retail to home stage, for 1992, 1997 and 2002. Assess the validity of the data and the practicality of compiling the dataset on an annual basis.
2. **Factors driving food miles.** Assess the main trends, including the increase in imports and exports of food, changes in logistical systems and retail structure leading to increased movement of food around the UK, and the increase in car use for food shopping.
3. **Impacts of food miles.** Identify and quantify (where possible) the positive and negative economic, environmental and social impacts of food miles. These include both direct transport impacts, including congestion, pollution, greenhouse gas emissions, accidents and infrastructure costs, and also wider social and economic effects including the impact on rural communities, and links between food miles, food prices and consumer choice. Determine to what extent social costs are already internalised through road user charges. Consider the ways in which the economic impacts of reductions in food miles might be distributed across different sectors of the food and farming industry.
4. **The validity of food miles as an indicator of sustainable development.** Summarise the arguments for and against using food miles as an indicator of sustainable development, using case studies to illustrate key issues
5. **Develop key indicators.** Develop a set of indicators that allow food miles to be expressed in ways related to their main negative impacts on sustainability, ensuring that the validity of the indicator is not compromised by those cases where a reduction in food miles would not lead to increased sustainability. Calculate the indicators for 1992, 1997 and 2002 and analyse trends. Set these indicators in the context of the proposed Food Industry Sustainability Strategy, reflecting economic, environmental and social impacts in a balanced way.

1.4 STRUCTURE OF THE REPORT

Section 2 presents an assessment of the **factors driving food miles**, including increased trade, consumer demand, and changes in logistical systems and food retail structure within the UK.

Section 3 describes the derivation of a **database of food miles**, and presents and discusses the results for the years 1992, 1997 and 2002.

Section 4 gives an assessment of the **direct economic, environmental and social impacts** arising from UK-generated food miles both in the UK and in other countries, including pollution, congestion, accidents and greenhouse gas emissions.

Section 5 assesses the **wider social and economic effects** of food supply systems, including the implications of a food miles indicator for rural communities and developing countries, food prices, consumer choice and nutrition, and the distribution of economic benefits between different sectors of the food and farming industry.

Section 6 addresses key issues through a set of case studies which explore the question “when might a reduction in food miles **not** result in enhanced sustainability?”

Section 7 develops a set of Key Indicators which reflect the major impacts of food miles and account for some potential exceptions to the link between food miles and sustainability, and sets these indicators in the context of the Food Industry Sustainability Strategy.

Section 8 summarises the **conclusions** of the study.

Further technical details of the derivation of the dataset, analysis of factors driving food miles and assessment of impacts are to be found in the Annexes.

2 Factors driving food miles

The rising trend in food transport can be attributed to changes in three major areas:

1. **Increase in food trade:** large increase in exports, steady increase in imports. Retailers, particularly supermarket chains, now source their supplies from more distant locations (both in the UK and overseas).
2. **Trends in transport logistics and retail operations** have acted to increase the distance travelled by food freight within the UK,
3. **The use of cars for food shopping**, and distances driven, have increased.

Counteracting this there have been various attempts to reduce food miles and stimulate demand for local food. These areas are addressed in turn below.

2.1 INCREASE IN FOOD TRADE

Exports of food from the UK have increased greatly since 1961, from 2 million tonnes to 15 million tonnes in 2000 (Figure 2). Total exports in 2002 for food and drink came to £8.9bn of which 62.6% went to EU members. Around 62% of the UK’s consumption of food and drink (and 75% of indigenous food) is met by domestic production⁶. Imports are valued at £18.9 billion. Although the UK has been a net importer of food for a long time, imports are currently growing significantly. DEFRA statistics show that imports in tonnes increased by 38% from 1988 to 2002 (35% for indigenous foods, 43% for non-indigenous foods)⁷.

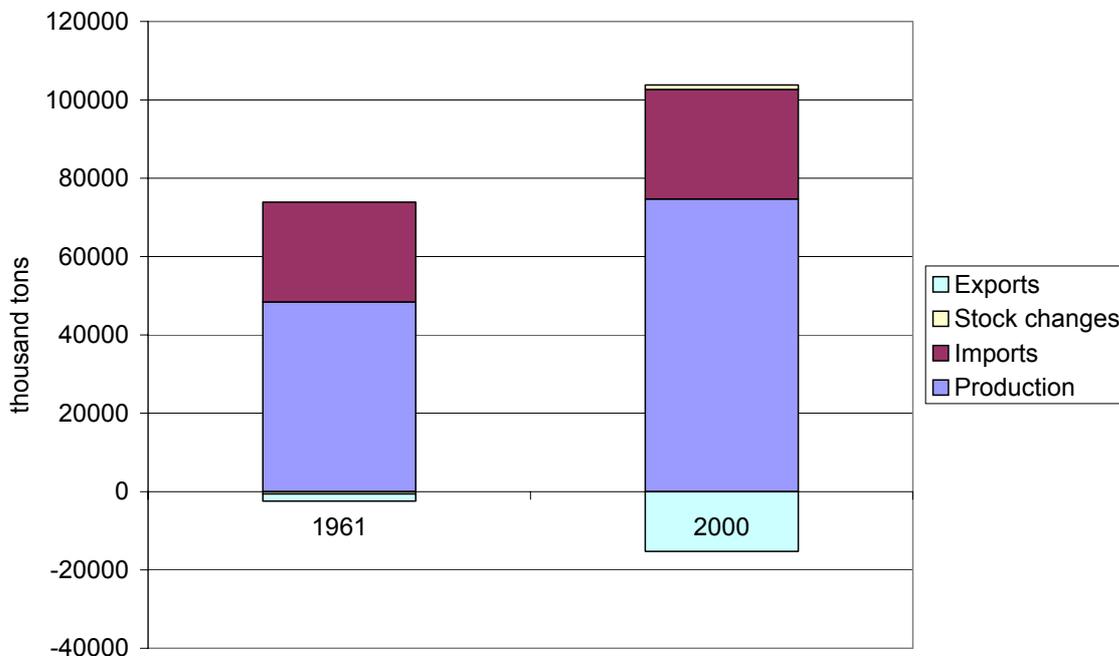


Figure 2 Changes in food trade since 1961

Source: FAO³⁵

Overall imports of food have increased by 10% since 1961 (from 25 million tonnes to 28 million tonnes in 2000), but for some food types the increase has been more dramatic. Imports of fruit have doubled and imports of vegetables have tripled. Half of all vegetables and 95% of all fruit consumed in the UK now come from overseas. This has been counterbalanced by a large decrease in imports of cereal³⁵.

These changes have been driven by a number of factors:

Long distance transport and trade is cheaper and easier...

- ◆ Reduction in international trade barriersⁱ;
- ◆ Availability of cheaper (in real terms), faster national and international road, sea and air transport (sea freight unit costs have fallen by 70% during the past 20 years, while air freight costs have decreased by 3-4% per year)⁸;
- ◆ Availability of more efficient packaging and mobile refrigeration technologies to allow longer transport of fresh produce;
- ◆ Advances in IT have increased the 'visibility' of long supply chains and made them easier to manageⁱⁱ;
- ◆ Development of e-commerce, including e-marketplaces for food products such as Transora, has enabled companies to extend geographically their search for suitable suppliers.

Overseas produce is more in demand...

- ◆ Some overseas produce may be cheaper and / or better quality than UK produce, and the season of availability can be extended;
- ◆ Increased demand from consumers for imported food not generally available in the UK (e.g. exotic fruit, out-of-season produce, wine, rice and pasta). This diversification of consumer demand has been influenced to some extent by cookery programmes, foreign travel and restaurants specialising in foreign cuisine.

Globalisation and concentration of supply and retail structures...

- ◆ Greater regional specialisation in agriculture at both national and international scales, meaning that retailers need to source produce from further afield (e.g. English orchard fruit production is now concentrated in Kent; onions and carrots in East Anglia etc.);
- ◆ Opportunity for wider sourcing from smaller suppliers created by the development of retailers' distribution centres (see section 2.5 in Annex 2);
- ◆ Large food manufacturers and retailers have adopted global procurement strategies.

Consumer demand or supermarket demand?

Although one of the drivers for increasing imports is consumer demand for non-indigenous or out of season foods, over half of the food imported in 2002 was indigenous produce, i.e. at the time when it was imported, it could have been sourced from the UK⁷ (though this does not take into account price issues). Sometimes this is partly attributed to consumer preference for certain varieties (e.g. it is claimed that consumers today prefer sweeter varieties of apple such as Braeburns which are not grown in the UK). However, other things being equal, consumers do not specifically demand to buy onions or apples from New Zealand in preference to UK produce – in fact many would prefer to buy British food⁹. In these cases, an important driver is the supermarket chains' own preference for dealing with suppliers who can supply large quantities of produce of a uniform quality and appearance year-round¹⁰. Often these suppliers are located

ⁱ Although agricultural tariffs still remain high – see later section.

ⁱⁱ Supply chain visibility software enables suppliers, retailers and distributors to access certain information on sales forecasts, warehouse stock levels, stock in transit and so on to enable better management of the supply chain.

overseas, where more favourable climatic conditions and lower labour costs allow a year round supply of produce at low prices to be produced more easily¹¹.

2.2 TRENDS IN TRANSPORT LOGISTICS AND RETAILING

A full analysis of the trends in food transport logistics and retailing which have contributed to the growth in food miles is presented in Annex 2. Below we summarise the key trends.

1. **Restructuring of logistical systems:** changes to the number, location and capacity of factories, warehouses and terminals:

- 1.1 Spatial concentration of production:
 - a) reduction in production locations
 - b) increased specialisation at production location ('focused production')
- 1.2 Spatial concentration of inventory (warehouses and in-store storage)
- 1.3 Development of local break-bulk operations
- 1.4 Creation of hub-satellite networks
- 1.5 Primary consolidation

Food processing companies have been concentrating their production capacity in fewer locations to take advantage of economies of scale. Others have adopted a 'focused production' strategy, retaining the same number of plants but concentrating the manufacture of particular items in particular locations. Agricultural specialisation has also been taking place. There has been a parallel concentration of warehouse capacity. By reducing the number of stockholding points in their production and distribution systems companies exploit the so-called 'square root law' of inventory, cutting the amount of safety stock required to maintain a given level of customer service. The associated transport cost penalty is usually quite small relative to the savings in inventory and storage costs (Figure 3).

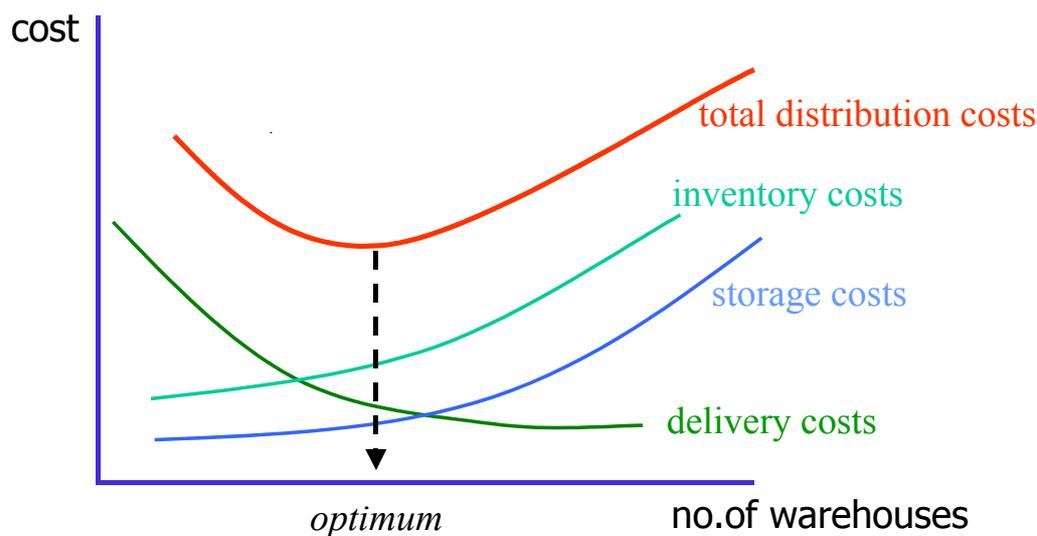


Figure 3: Logistical Cost Trade-offs in the Inventory Centralisation Decision

By increasing the average distance between the point of production and the final consumer, centralisation generates additional tonne-kms. It can result in a less than proportional increase in vehicle-kms, however, where centralisation is accompanied by an increase in vehicle load factors.

New distribution systems such as local break-bulk operations, hub-satellite networks and primary consolidation (Annex 2) also have the effect of increasing tonne kms through more circuitous routing of products. In hub-satellite networks, pallets of food products are collected from several suppliers and aggregated at local 'satellite' depots. They are then trunked to a central hub, in most cases located in the Midlands, where they are sorted for onward trunking to the local depot closest to their destination (Figure 4). The operator of this local depot arranges final delivery. The main advantages of this system lie in the speed and efficiency of centralised sorting at the hub and the high vehicle load factors achieved on the radial, trunk movements to and from the hub. The effect on vehicle kms is less pronounced than the increase in tonne kms.

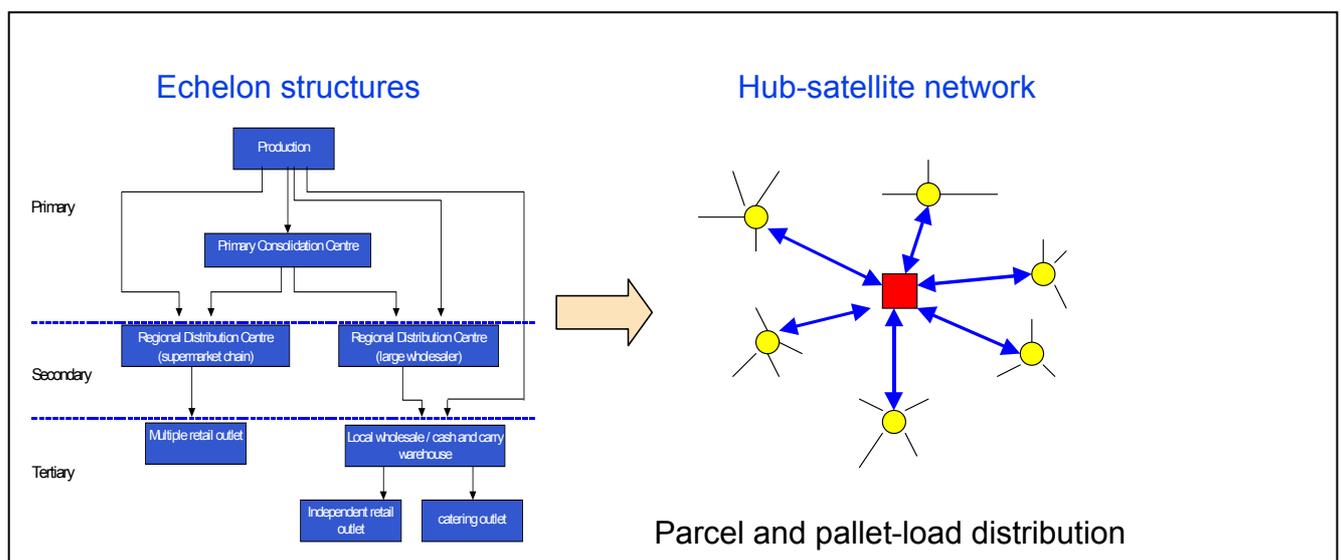


Figure 4: Shift from Echelon to Hub-Satellite Networks

2. **Realignment of supply chains:** affected by commercial decisions on sourcing, sub-contracting and distribution channels. These decisions determine the pattern of freight flow between a company's premises and those of its trading partners.
 - 2.1 Creation of more complex production networks (through greater processing and packaging of food)
 - 2.2 Vertical disintegration of production (contracting out ancillary functions which can be performed more cheaply and effectively by other companies)
 - 2.2 Increase in single sourcing
 - 2.3 Wider sourcing of supplies
 - 2.4 Increase in retailer's control over the supply chain

- 3.5 Concentration of international trade on hub ports. (Direct deep-sea container services have been withdrawn from regional ports, forcing longer overland transport of consignments to hub ports).

An increase in the processing and packaging of food has led to more links in the food supply chain. Contracting out of operations to other companies has a lesser effect as it is less pronounced in the food and drink industry.

Single sourcing is an important trend. Many food producers have been cutting the number of suppliers – for example, some supermarkets are now aiming to have no more than three suppliers for each produce line⁸. In the past, companies often preferred to buy the same materials from several suppliers to spread the risk of disruption and promote competition among vendors. The rationalisation of the supply base is closely associated with the adoption of just-in-time (JIT) and total quality management, techniques which require close supply chain integration.

Single sourcing can benefit the transport operation by consolidating inbound flows of supplies, allowing firms to achieve higher load factors and lower delivery costs per unit. This is particularly important where firms are operating within a JIT regime. Had JIT not been accompanied by a reduction in supplier numbers, its impact on the transport system would undoubtedly have been much greater. However, where single sourcing is adopted at a national level it has the effect of cutting out a large number of more local suppliers, thus increasing the tonne kms travelled significantly.

Wider sourcing of supplies is generally regarded as the main cause of the increase in 'food miles'. Manufacturers, wholesalers and retailers are sourcing more of their supplies from further afield for many reasons, already discussed in Section 2.1. However, another crucial trend is the huge increase in multiple retailers' control over the supply chain over the past 30 years. This is discussed in Box 1.

3. Rescheduling of product flow: Over the past decade the scheduling of production and distribution operations has been transformed by the introduction of new management systems designed to minimise inventory levels.

3.1 Adoption of just-in-time / quick response replenishment

3.2 Growth of 'nominated day' deliveries

Firms operating on a just-in-time (JIT) basis minimise inventory by sourcing supplies in small quantities at frequent intervals. 'Quick response' (QR) can be regarded as the application of the JIT principle to retail distribution. As the ratio of total sales to inventory (ie. the 'stock turn rate') is critical to retail profitability, retailers have a strong incentive to minimise stock levels.

As JIT is associated with smaller, more frequent deliveries it would be expected to lead to a decrease in vehicle payloads, increasing the ratio of vehicle kms to tonne kms. However, payloads have in fact increased over the last two decades (by over 30% between 1982 and 1997)¹². The fact that average payloads have risen suggests that the potentially adverse effects of JIT / QR on vehicle utilisation have been avoided as a result of structural changes in the grocery logistics system, in particular primary consolidation and the centralisation of distribution operations in RDCs. It is likely, however, that in the absence of JIT / QR pressures, the degree of load consolidation would have been even greater, permitting a larger reduction in vehicle-kms.

Box 1. How supermarket influence on supply chains affects food miles

Over the past 30 years there has been a huge increase in multiple retailers' influence over the food supply chain. While expanding their share of the retail market, they have been assuming greater responsibility for food distribution from the factory and farm. They initially moved into 'secondary distribution', channelling supplies through their own regional distribution centres (RDCs) and consolidating deliveries to shops. This centralisation of distribution was closely associated with the centralisation of purchasing. Shop managers ceased to have any responsibility for buying, sales representatives no longer visited shops and purchasing negotiations were thereafter confined to the retailer's head office. Any links that had previously existed between shop managers and local suppliers were severed and managers were unable to exert much influence on the product range available in their stores.

The transfer of responsibility for shop delivery from supplier to retailer diverted flows of food products from manufacturers' distribution depots (and wholesale warehouses) to retailers' RDCs. There are currently around 70 RDCs in the UK. As the RDCs were much more centralised and served wider hinterlands, this considerably lengthened the last link in the chain from warehouse to shop, and increased food tonne-kms, though the consolidation of retailer-controlled deliveries in much larger vehicles may well have reduced total vehicle-kms¹³.

Any reduction in lorry traffic at the secondary distribution level must be set against increases in traffic volumes upstream of the RDC, including the centralised sourcing of food supplies from smaller producers. Prior to the development of retailers' distribution systems, small suppliers lacked the means of distributing their products to all the shops in a retail chain. This either prevented them from securing a contract with the retailer or confined their sales to branch stores in a particular region. By channelling their products through retailers' RDCs, smaller producers can gain access to national chains of shops, substantially expanding their market areas. For products sourced from small regional producers, the development of retailers' distribution systems has, therefore, greatly increased 'food miles' measured by both tonne-kms and vehicle-kms. The market dominance and centralised distribution systems of UK supermarket chains also make it easier for foreign food producers to penetrate the UK market. Bulk deliveries to a relatively small number of RDCs can give them wide exposure across major supermarket chains. In other countries with much more fragmented retail and wholesale sectors, importers face much greater logistical constraints.

Ironically, the large, highly centralised retail logistics system which enabled small producers to hugely extend their market areas made it virtually impossible for them to deliver directly to local chain stores. Over the past thirty years, supermarket chains have greatly increased the proportion of supplies channelled through their RDCs, leaving only a few lines of 'morning goods' (e.g. milk, bread and eggs) to be delivered directly to the shop by suppliers. Back store reception facilities and storerooms have been redesigned to handle the arrival of supplies in large consolidated loads palletised on articulated vehicles. Companies replenishment systems are based on centralised ordering and receipt of goods at the RDCs where they are checked and sorted for onward distribution. These systems make it impossible for all but a few product lines to penetrate the retailer's supply chain anywhere but the RDC. To the layman, this creates logistical anomalies. A sandwich company in Derbyshire, for example, supplies its products to a major supermarket chain and has a plant within a few hundred metres of one of its shops. The sandwiches arriving on this shop's shelves, however, have to be routed through one of the retailer's RDCs on a round-trip of approximately 160 kms. At an aggregate level, however, the centralised systems are more efficient and achieve higher levels of vehicle utilisation.

The 'nominated day' principle also improves vehicle payloads and thus reduces vehicle km. Customers are informed that a vehicle will be visiting their area on a 'nominated' day and that to receive a delivery on that day, they must submit their order a certain period in advance. By concentrating deliveries in particular areas on particular days, suppliers can achieve higher levels of load consolidation, drop density and vehicle utilisation. A significant proportion of food deliveries were subject to nominated day constraints during the 1970s and early 1980s when suppliers controlled much of the secondary distribution to shops. With the decline in small-scale grocery retailing and supplier-controlled delivery, this practice has declined in importance in the food sector, though continues to be widely used by food wholesalers and in the food service sector where catering outlets and hotels typically get deliveries on particular days of the week.

Changes in the management of transport resources: Decisions made at the previous three levels dictate a company's overall demand for freight transport. Operational decisions made by transport and distribution managers determine how much vehicle movement is required to meet this demand.

- 4.1 Modal shift
- 4.2 Outsourcing of the transport / logistics function
- 4.3 Changes in vehicle size, weight and type
- 4.4 Changes in handling systems
- 4.5 Increased use of computerised vehicle routing and scheduling (CVRS)
- 4.6 Increase in return loading

Several changes to the way in which food is transported, including the use of larger vehicles, and multi-compartment vehicles combining products moved at different temperature regimes, have contributed to a substantial increase in load factors. The use of computerised vehicle routing packages, now widely adopted, can cut transport costs and distance travelled by between 5 and 10%, depending on the quality of the previous manual load planning¹⁴. However, new roll (or cage) pallets designed to improve ease of handling take up around 40% more space than wooden pallets¹⁵. The volume of primary and secondary packaging has also been increasing, further augmenting vehicle space requirements.

Overall effect on food freight miles

The growth of freight traffic is the result of a complex interaction between decisions made at these different levels. Decisions at levels 1 and 2 determine the quantity of freight movement measured in tonne-kms while decisions at levels 3 and 4 translate this movement into vehicle traffic, measured in vehicle-kms

The logistical trends affect three key ratios that link the weight of food produced or consumed to vehicle traffic levels. These ratios are:

1. Handling factor: ratio of tonnes-lifted to product weight.

Government surveys of freight tonnes lifted record the weight of goods loaded onto vehicles at the start of a journey. As the average product makes several discrete journeys between raw material source and final point of sale, the tonnes-lifted statistic substantially exceeds the total weight of goods produced or consumed in a given time period. The handling factor effectively measures the degree of multiple-counting and can be considered a crude indicator of the

number of separate links in the supply chain. Several studies in the UK have estimated that the average handling factor for food products is between four and five^{18,16}. This suggests that the UK food supply chain comprises 4-5 links.

2. Average length of haul: ratio of road tonne-kms to tonnes-lifted.

This ratio indicates the average length of each link in the supply chain.

3. Average payload weight: ratio of road tonne-kms to vehicle-kms.

This ratio translates the volume of freight movement, measured in tonne-kms, into vehicular traffic by taking account of the average loading of the vehicles. A distinction can be made between the average **load factor** on laden trips (measured by the ratio of tonne-kms to laden-kms) and **empty running** (proportion of vehicle-kms run empty).

Table 1 shows the relationship between the key ratios and the list of eighteen logistical trends. Up and down arrows, bold or plain, have been used to indicate the direction and strength of the relationship.

Table 1 Effects of the Dominant Logistical Trends on Key Freight Transport Ratios (adapted from REDEFINE analysis¹⁶)

Key Logistics Trends	Key Ratios			
	Handling factor	Avg. length of haul	Load factor	Empty running
1 Restructuring of logistics systems				
1.1 Spatial concentration of production; either through Reduction in no. of product locations or Increased specialisation ('focused production')		↑	↑	
1.2 Spatial concentration of inventory		↑		
1.3 Development of local break-bulk operations	↑	↓		
1.4 Creation of hub-satellite networks	↑	↓		
2 Realignment of supply chains				
2.1 Insertion of more production stages	↑			
2.2 Vertical disintegration of production	↑			
2.3 Increase in single sourcing			↑	
2.4 Wider sourcing of supplies		↑		
2.5 Increase in retailer's control over supply chain		↑	↑	
2.6 Concentration of international trade on hub ports		↑		
3 Rescheduling of product flows				
3.1 Adoption of JIT / quick response replenishment			↓	
3.2 Growth of 'nominated day' deliveries			↑	
4 Changes in management of transport resources				
4.1 Modal shift	↑			
4.2 Outsourcing of transport / logistics function			↑	
4.3 Changes in vehicle size, weight and type			↑	
4.4 Changes in handling systems / packaging			↓	
4.5 Use of computerised vehicle routing / scheduling			↓	↓
4.6 Increase in return loading				↓

↑= strong positive impact
 ↑= weak positive impact

↓= strong negative impact
 ↓= weak negative impact

Sources: Three empirical studies (McKinnon and Woodburn, 1996¹⁸, NEI et al, 1999¹⁶ and Technical University of Berlin et al., 2002¹⁷), supplemented by expert judgement

The table shows that the trends combine to increase the number of handling stages in the supply chain, and also to increase the average length of haul. These trends will both act to increase food miles when expressed as tonne kilometres. However, the corresponding growth in food vehicle kilometres is offset by trends to increase the

efficiency of food freight, which increase the load factor and decrease the amount of empty running (despite the growth in just-in-time logistics).

These trends are also revealed by an analysis of growth in UK food transport for 1983-1991, which showed that the average number of links in the food supply chain rose by around 13%, while their average length increased by 26%, resulting in a 39% increase in tonne-kms¹⁸. Vehicle-kms grew by a significantly smaller margin because average payload weight also increased by around 14%.

In summary, the growth in food miles is not simply the result of retailers buying their supplies from further afield. It is caused by the complex interaction of numerous logistical and supply chain trends, some of which are mutually reinforcing and others counteracting. Over the last few decades the trend has been to transport food over longer distances and through a greater number of handling stages. This has been driven mainly by:

- ◆ the consolidation of food retailing into a few multiple retail chains, accompanied by central purchasing policies and routing of produce via regional distribution centres,
- ◆ greater processing and packaging of food
- ◆ growth in imports.

At the same time, the growth in just-in-time delivery has exerted a pressure to decrease load factors. However, the impact of this has been offset to some extent by an increase in transport efficiency. The use of larger vehicles, routing of produce via regional distribution centres to allow consolidation of loads and use of logistics software has allowed food freight operations to typically achieve load factors of around 70%, and empty running of only 23%. Therefore vehicle kilometres have not grown as fast as tonne kilometres.

2.3 GROWTH IN FOOD SHOPPING BY CAR

Over the last 10 years there has been a slight decrease in the number of shopping trips per person per year, from 227 in 1990 to 216 in 2000, despite the decrease in average household size which would tend to cause an increase in trips per person. In 2000, 55% of these trips were for food (data split into food and non-food shopping is only available from 2000). However, the average distance driven to shop increased from 3.3 miles to 4.2 miles, and the total distance travelled to shop increased from 747 miles per person per year to 898¹⁹. Trips for food are significantly shorter than trips for non-food shopping, with an average of 3 miles compared to 5.6 for non-food in 2000. Between 1985 and 1998 there was a 57% increase in the distance of shopping trips by car⁸.

Over the same period there has been a huge increase in the number of out-of-town stores and decrease in the number of local shops. The construction of out-of-town superstores began in the 1970s, and their numbers increased from 20 in 1976 to 50 in 1986, 719 in 1992 and 960 in 2000. The number of independent grocers in the UK fell from 116,000 in 1961 to only 20,900 in 1997²⁰. Villages and market towns lost half their small shops between 1991 and 1997, with more than 1,000 village shops closing down over the last decade¹¹. The decline in local shops is directly linked to competition from supermarkets²⁰.

The construction of out-of-town superstores is currently less favoured by planning guidelines, due to problems such as the closure of many local shops, decline of town centres, loss of green space, reduction of shopping opportunities for the less mobile, creation of food "deserts" and an increase in traffic congestion on the outskirts of towns^{20,21}. However, opinion is divided over whether the out-of-town location itself contributes to additional vehicle kilometres.

Ironically, the out-of-town superstore was originally seen partly as a solution to the increasing traffic problems of town centres. Some studies have assessed the traffic impacts of superstores compared to town centre shopping and have found an increase in the distance travelled and associated emissions for out-of-town shopping²². However, others have claimed that out-of-town superstores can reduce the total distance travelled through allowing less frequent trips²¹. Out of town superstores only became viable with the increase in car ownership and affluence during the 1960s. The popularity of "one-stop shopping" has been further driven by the increase in the number of women working outside the home, increase in working hours for employed people, and increased ownership of freezers and fridges permitting larger amounts of food to be purchased in one trip. Today, most shoppers with access to a car choose to drive to the shops regardless of location, simply because the car is the easiest means of transporting large quantities of shopping home.

As the infrastructure is already in place, out of town superstores are not going to go away. For affluent, mobile consumers the provision of easy car parking next to the store allows quick and convenient access to a wide variety of food products. However, alternative means of food supply can offer solutions to some of the disadvantages of out of town superstores listed above. Home delivery can reduce vehicle kilometres by 70%²³. Local shops are also important to reduce car food miles for "top-up" shopping. If no local shop exists, consumers may be forced to drive several miles to a superstore to buy a pint of milk or a loaf of bread. Support for local shops can also stimulate the local economy (see Section 5.5.1) and give access to quality food for the less mobile, or those living in deprived areas where some studies argue the economic incentive for opening new supermarkets is low¹¹.

2.4 DEMAND FOR LOCAL FOOD

The growth of market share of the supermarkets with the associated decline in local shops and markets, and the increase in international food trade, have led to a move away from locally produced food in the UK.

To address this, there have been a variety of recent initiatives aimed at stimulating the market for local food. These have included:

- ◆ General national level campaigns aimed at the consumer, such the "Eat the View" campaign²⁴.
- ◆ Locally run farmers' markets, farm shops and vegetable box schemes, all increasingly popular in recent years and often offering organic products.
- ◆ Community-led initiatives such as community growing projects.
- ◆ Formation of producer co-operatives.

There are also an increasing number of networking and co-operative schemes such as East Anglia Food Link²⁶. These link together local communities, farms, food producers, local shops, wholesalers, markets and box schemes to stimulate demand for a variety of local produce within a whole region. As well as marketing local food to the general public, these schemes can also encourage local schools, hospitals or businesses to adopt a policy of sourcing food more locally²⁷. Local food organisations have adopted a

definition of "local food" which goes beyond simple transport distance to cover other aspects of sustainability (see Box 2).

Box 2. Definitions of Local Food

The members of Food Links UK have the following vision for sustainable local food systems:

"Systems of producing, processing and trading, foods from sustainable production systems including organic where the physical and economic activity is controlled within the locality or region where it was produced, which delivers health, economic, environmental and social benefits to the people in those areas".

The study categorises characteristics of sustainable local food sector as:

- ◆ Proximate – originating from the closest practicable source or the minimization of energy use
- ◆ Healthy as part of a balanced diet and not containing harmful biological or chemical contaminants
- ◆ Fairly or co-operatively traded between producers, processors, retailers and consumers
- ◆ Non-exploiting of employees in the food sector in terms of pay and conditions
- ◆ Environmentally beneficial in its production (e.g. organic)
- ◆ Not genetically modified
- ◆ Accessible both in terms of geographic access and affordability
- ◆ High animal welfare standards in both production and transport
- ◆ Socially inclusive of all people in society/building social capital
- ◆ Encouraging knowledge and understanding of food, food culture, and local distinctiveness.

However, these definitions do not address how far food can be transported before it ceases to be local. The Curry Commission Report recommended that an enforceable definition of "local" be developed once the sector had become more established. In response to this, the Food Standards Agency is considering the feasibility of producing guidelines on the use of the term "local" in marketing. It intends to consult on this initiative.

At present, although many local food initiatives have been successful in capturing niche markets, strong demand for local food has yet to penetrate the mass market. A 2002 IGD survey found that most consumers cite price, appearance and freshness of the produce as being their main buying criteria²⁸. Nevertheless, there are signs that a wider demand for local food is beginning to emerge. The IGD survey showed that 59% of people said they were interested in local foods, 38% said they would usually look for local foods in their supermarkets and a further 35% would occasionally look.²⁹ In a recent IGD consumer tracker survey, when consumers were asked how shopping could be improved, "availability of locally produced food" was the most requested item after "prices should not increase" and "more special promotions"³⁰.

The proportion of food sold through supermarkets in the UK has steadily increased over the last few decades, to reach around 85%. Modern lifestyles make it likely that this high proportion of supermarket sales will continue in future – busy families where both parents work find it quicker and more convenient to do a weekly "one-stop-shop" with easy parking and long opening hours than to visit a number of different local shops within normal opening hours. Busy lifestyles also favour mass produced convenience food at the expense of fresh produce. Also, competition with supermarkets has led many

local shops, wholesalers and markets to close, so there is less choice of independent outlets. The current move of multiple retailers into smaller town centre shops is further increasing the market share of the large retailers.

One way for local food to break out of its current niche market status would be for the multiples to increase their own local food offering. There are signs that they are doing this, in response to growing consumer demand for local food. However, as discussed in Box 1 (Section 2.2), the logistical and commercial systems of large supermarkets present barriers for local food sales. Although supermarkets have expressed an interest in local food sales, one of the largest retailers recently estimated that only 1% of their turnover was from local food, and another was aiming for a 2% turnover from local food items⁸⁸. Local independent retailers, wholesalers and markets are the traditional outlets for local produce. It is estimated that 55% of local food is sold through local shops and markets³².

There have been recent government-sponsored moves aimed at assisting small local producers to supply stores on a regional, or even an individual, basis. The Institute of Grocery Distribution (IGD), partly assisted by Defra, organised a series of workshops around the country in 2003 to bring together local producers with the large retailers and food service companies to discuss how to promote local sourcing and overcome barriers to it. Later that year Defra helped fund a Business in The Community (BiTC) and (IGD) guide for small businesses looking to work with large food retailers and foodservice companies. This guide, "*Local Sourcing – Opening the Door for Small Business*", includes instructions to help farmers and producers comply with supermarket requirements. Following on from this work, Food From Britain working with IGD produced a best practice guide to distribution, published in October 2004 and funded by Defra under their Regional Food Strategy. It aims to help address one of the main barriers to the encouragement of more local sourcing and highlights a number of successful initiatives some of which have been part-funded under the England Rural Development Programme.

In addition to this work, Food from Britain, funded by Defra under their Regional Food Strategy, has been facilitating meetings between a number of retailers and the Regional Food Groups aimed at getting more regional food on to supermarket shelves. A number of successful local sourcing initiatives have resulted from this work, which is continuing.

However, many of the schemes for promoting local food bypass the supermarkets completely (e.g. vegetable boxes, farmers markets etc). Indeed, promoters of local food often prefer not to deal with supermarkets, as sales through local retail outlets are seen as contributing to the local economy and fitting in better with the aims of the organisation. DEFRA recognise and support the benefits to producers of direct sales initiatives (see below).

To be successful, local food schemes have to fit in with modern lifestyles and consumer trends. Interest in local food (especially organic local food) has been fuelled by growing awareness of some of the potential negative impacts of mass produced food, such as animal welfare issues, pesticide residues, food safety scares such as salmonella, BSE and e-coli, and the enhanced spread of diseases such as the foot and mouth epidemic which can result from increased transport of food. Some consumers are now becoming more interested in tracing the origin of their food, and place increased confidence in local foods which can be traced to a specific farm. Some schemes tap into the demand for time-saving shopping, e.g. internet sales, or home delivery of vegetable boxes (although these do sacrifice some consumer convenience as there is little choice over the contents of the boxes). Others, e.g. some farm shops and pick-your-own outlets, tap into the trend for shopping as a family leisure activity by offering activities for children such as play areas and animals to feed.

In recognition of the benefits that direct sales outlets can bring to both producers and consumers, Defra has made funding available to support activities such as the establishment of farmers' markets, the development of regional and local branding of foodstuffs, the formation of collaborative groups to market quality products and to support public procurement initiatives.

Policy options and tools to stimulate the market for local food are also discussed in recent NGO reports such as "Feeding the Future"³⁴.

3 Food miles dataset

3.1 THE UK FOOD SUPPLY CHAIN

Figure 5 shows the balance between imported and exported food and food produced for consumption in the UK. Imports of food have been increasing over the last twenty years, and now account for 32% of the food consumed in the UKⁱ. Imports are almost twice the level of exports.

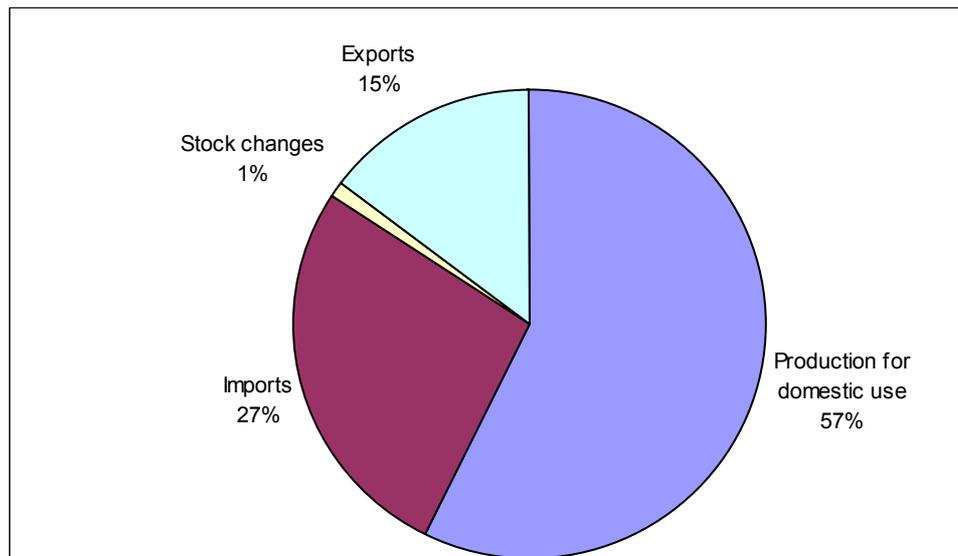


Figure 5 UK Food Balance in 2000 (by weight)

Source: FAO database³⁵

The food miles dataset includes estimates of food miles associated with each of the following links of the supply chain:

Overseas produce

1. Overseas producer to overseas processor
2. Overseas processor to overseas distribution centre
3. Overseas distribution centre to overseas port or airport
4. Overseas port or airport to UK port or airport
5. UK port or airport to UK processor
6. UK processor to UK distribution centre

UK produce

7. UK producer to UK processor
8. UK processor to UK distribution centre

All produce

9. UK distribution centre to UK retailer or caterer
10. UK retailer to consumer

This is of course a simplistic representation of the supply chain. Depending on the product, some stages may be omitted (e.g. overseas produce may not go to an overseas processor, if it is processed in the UK). Some produce may have a more complex

ⁱ Note: Imports are 32% of food consumed in the UK. This differs from the 27% shown in Figure 2 because Figure 2 includes exports.

transport route (e.g. via more than one processor or distribution centre, perhaps through several countries).

Both imports and exports are included in the dataset, as they all have impacts (positive or negative) on sustainability. However, in order to reflect other government policy objectives we have also (in Section 6) provided estimates of food miles excluding exports.

For exports, stages 4, 5 and 6 above are reversed. However, for exports we do not assess the stages from the overseas port or airport onwards to the overseas shops and consumers. It could be that this transport would occur anyway, with substitute produce from a different country, even if UK exports were reduced. Alternatively domestic production could increase, thus reducing food miles. However, this is outside the influence of UK policy.

3.2 DERIVATION OF THE DATASET

We have aimed to base the food miles database on readily available, reliable national statistics, supplemented by simple assumptions. Some parts of the supply chain and some transport modes are reasonably well characterised (e.g. HGV and LGV transport in the UK), whereas others are based on very poor data supplemented by assumptions (overseas transport from producer to port or airport). We assess the quality of data for each part of the food chain in Section 3.4, and discuss the implications of this for the validity of food miles as an indicator.

Full details of the derivation of the data are contained in Annex 1 but the main data sources and assumptions are outlined below:

1. **UK HGV distances** are from the Department for Transport's Continuing Survey of Road Goods Transport (CSRGT)¹ – an annual survey of a sample of UK registered HGV owners which identifies tonne km and vehicle km split by type of goods carried. A separate estimate was made to cover transport by foreign registered lorries (which are not included in the survey).
2. **UK LGV distances** are now collected via a similar method to the CSRGT. Only data for the year 2003 is currently available, so this is used as an estimate for the year 2002 in the indicator dataset. Private vans and company vans are surveyed separately. Vehicle km are collected in the survey. This has been converted to tonne km using an assumption of a typical load of 0.7 tonnes. Total food-related vehicle km were estimated assuming empty running of 37%. In the absence of better data, the same value has also been used in the dataset for the years 1997 and 1992. It would have been possible to scale the 2003 estimate based on HGV km, but this is not necessarily a valid approach, as HGV transport may displace LGV transport to some extent.
3. **UK domestic air, sea and inland waterway transport** of food is assumed to be negligible. National statistics do not generally identify food as a separate category of freight for these transport modes.
4. **Transport from overseas to the UK** is based on HM Customs and Excise statistics for tonnages imported or exported by country, split into different food categories³⁷. Supplementary data and assumptions were used to identify the transport mode. Distances by air are straight line distances between London and the capital city of each country, road distances are the distance on major roads, and shipping distances are used for sea transport.

5. **Transport overseas** is a very approximate estimate based on the typical distance travelled from the overseas producer to the port or airport – assumed to be approximately half the radius of the country. This was then multiplied by a handling factor of 2 for developed countries and 1.5 for developing countries, to reflect extra distance travelled related to processing, packing and transport logistics. This may be an underestimate, but the constraints of the study did not permit a more detailed assessmentⁱ. In the absence of other data, we assumed the same load factor as for the UK. This will also lead to an underestimate of vehicle kilometres for most countries as the UK has relatively efficient transport logistics. A corresponding LGV distance was based on the ratio of UK HGV to LGV tonne kilometres and was even more uncertain. There may well be some transport of food by rail or inland waterway overseas but it is unlikely to be significant. Although overseas transport is of less policy interest to the UK government, it is important that it is not neglected in the assessment as overseas transport displaces UK transport.
6. **Car transport** from shop to home is based on a DfT survey of shopping travel³⁸, which identifies the annual distance travelled for food shopping per UK inhabitant. This was multiplied by the UK population to give estimated vehicle kilometres, and combined with assumptions concerning the average weight of shopping carried in each car to give tonne kilometresⁱⁱ.
7. **CO₂ emissions** for road vehicles are derived from fleet-average emission factors in the NAEI database³⁹. It should be noted that within the scale of this project we were unable to include an estimate of CO₂ emissions generated by fuel used for refrigeration in HGVs – this is an area for further work. Air, rail and sea freight CO₂ emissions are based on the updated 2002 DEFRA Company Guidelines for Environmental Reporting⁴⁰, supplemented by many other sources (see Annex 3).

This approach excludes international transport of food for manufacturing food products before they reach the country from which they are exported to the UK. For example, if jam made in France for export to the UK contains apricots from Greece and sugar from Mauritius, the transport of the apricots and sugar from Greece and Mauritius to France is excluded from our database (simply for lack of data). Also, the customs and excise data identifies only the country of dispatch, i.e. the last shipping point. Therefore for foodstuffs which are shipped in more than one stage, the earlier stages of transshipment are not included. International food miles are thus likely to be underestimated in our database. However, year by year trends should be fairly consistent.

Our estimates of food miles split by transport mode and location for 2002 are shown in Table 2. The different modes and locations are expressed as percentages of the total in Table 3. We also assessed two previous years, where possible, so that trends can be established. Data for the years 1997/98ⁱⁱⁱ and 1992 are shown in Tables 4-7.

ⁱ The study did not investigate in detail the data available from other countries for overseas food miles. Preliminary investigations indicated that, whilst some limited data was available (e.g. for France we found total tonnes of food moved by HGV, but not vehicle km), it was not possible to identify the proportion of food miles related to food destined for export to the UK. However, a more detailed study might be able to identify further data which could be used to improve our crude estimates.

ⁱⁱ Note: the accuracy of estimates of tonne kilometres for car transport are limited by the lack of data on the average weight of shopping carried per trip. However, vehicle kilometres are fairly well known and are of far more significance in estimating impacts.

ⁱⁱⁱ We aimed to assess the years 1997 and 1992 in addition to 2002. However, UK HGV data was not available for 1997 due to an error in the DfT database. Therefore we used 1998 data for UK HGV transport, but 1997 data for all other transport.

We have presented the data in three formats: tonne kilometres, vehicle kilometres and carbon dioxide emissions. Of these:

- ◆ **tonne kilometres** are generally the most reliable measure, as the tonnages of food imported or exported are reasonably well known.
- ◆ **Vehicle kilometres** are well defined for UK LGVs, HGVs and cars, but for other transport modes they rely on assumptions for typical vehicle loads and are thus significantly less reliable than the estimate of tonne kilometres. Nevertheless it is necessary to have an estimate of vehicle kilometres in order to estimate environmental impacts.
- ◆ The estimation of **carbon dioxide emissions** for each transport mode is described in full in Section 4 of this report, but is presented here alongside the tonne km and vehicle km in order allow appreciation of the significant differences in energy efficiency between transport modes.

Table 2: Estimated total Food Transport split by transport mode (2002)

		Air		Road			Rail	Sea	Inland waterway	Total
		Long haul	Short haul	HGV	LGV	Car				
Tonne km (M)	UK		0	47,400	2,092	158	0	400	100	50,149
	UK overseas to	1,280	21	12,866			33	151,914		166,114
	Overseas		0	16,605	733					17,338
Total		1,280	21	76,871	2,824	158	33	152,314	100	233,602
Vehicle km (M)	UK		0	5,812	4,743	14,340	0	0	3	24,897
	UK overseas to	26	0.4	1,577			0.2	14		1,619
	Overseas		0	2,036	1,662					3,698
Total		26	0	9,425	6,404	14,340	0	15	3	30,214
CO ₂ (kt)	UK		0	6,274	1,076	2,392	0	0	0	9,742
	UK overseas to	1,971	88	2,269			1	2,297		6,625
	Overseas		0	2,198	391		0		0	2,589
Total		1,971	88	10,740	1,467	2,392	1	2,297	0	18,956

Notes:

1. Figures in red are **very** approximate estimates.
2. Full details of data sources and assumptions are in Annex 1 (Annex 3 for CO₂).

Table 3: Estimated Food Transport split by transport mode as percentages of total (2002)

		Air		Road			Rail	Sea	Inland waterway	Total
		Long haul	Short haul	HGV	LGV	Car				
Tonne km (M)	UK		0.0%	20.3%	0.9%	0.1%	0.0%	0.2%	0.0%	21.5%
	UK to overseas	0.5%	0.0%	5.5%			0.0%	65.0%		71.1%
	Overseas		0.0%	7.1%	0.3%		0.0%		0.0%	7.4%
Total		0.5%	0.0%	32.9%	1.2%	0.1%	0.0%	65.2%	0.0%	100.0%
Vehicle km (M)	UK		0.0%	19.2%	15.7%	47.5%	0.0%	0.0%	0.0%	82.4%
	UK to overseas	0.1%	0.0%	5.2%			0.0%	0.05%		5.4%
	Overseas		0.0%	6.7%	5.5%		0.0%		0.0%	12.2%
Total		0.1%	0.0%	31.2%	21.2%	47.5%	0.0%	0.05%	0.0%	100.0%
CO ₂ (kt)	UK		0.0%	33.1%	5.7%	12.6%	0.0%	0.0%	0.0%	51.4%
	UK to overseas	10.4%	0.5%	12.0%			0.0%	12.1%		35.0%
	Overseas		0.0%	11.6%	2.1%		0.0%		0.0%	13.7%
Total		10.4%	0.5%	56.7%	7.7%	12.6%	0.0%	12.1%	0.0%	100.0%

Table 4: Estimated total Food Transport split by transport mode (1997/98)

		Air		Road			Rail	Sea	Inland waterway	Total
		Long haul	Short haul	HGV	LGV	Car				
Tonne km (M)	UK		0	46,131	2,092	138	0	400	100	48,861
	UK overseas to	1,059	13	14,151			5	142,433		157,661
	Overseas		0	14,988	680					15,668
Total		1,059	13	75,270	2,771	138	5	142,833	100	222,190
Vehicle km (M)	UK		0	6,145	4,743	12,557	0	0	3	23,447
	UK overseas to	22	0.3	1,885			0.0	14		1,920
	Overseas		0	1,996	1,541					3,537
Total		22	0	10,026	6,284	12,557	0	14	3	28,905
CO ₂ (kt)	UK		0	6,187	1,337	2,361	0	0	0	9,885
	UK overseas to	1,629	57	2,370			0	2,153		6,210
	Overseas		0	2,010	453		0		0	2,463
Total		1,629	57	10,568	1,790	2,361	0	2,153	0	18,558

Notes:

1. HGV UK data is for 1998, all other data for 1997 (1997 data was not available for UK HGVs).

Table 5: Estimated Food Transport split by transport mode as percentages of total (1997/98)

		Air		Road			Rail	Sea	Inland waterway	Total
		Long haul	Short haul	HGV	LGV	Car				
Tonne km (M)	UK		0.0%	20.8%	0.9%	0.1%	0.0%	0.2%	0.0%	22.0%
	UK to overseas	0.5%	0.0%	6.4%			0.0%	64.1%		71.0%
	Overseas		0.0%	6.7%	0.3%		0.0%		0.0%	7.1%
Total		0.5%	0.0%	33.9%	1.2%	0.1%	0.0%	64.3%	0.0%	100.0%
Vehicle km (M)	UK		0.0%	21.3%	16.4%	43.4%	0.0%	0.0%	0.0%	81.1%
	UK to overseas	0.1%	0.0%	6.5%			0.0%	0.05%		6.6%
	Overseas		0.0%	6.9%	5.3%		0.0%		0.0%	12.2%
Total		0.1%	0.0%	34.7%	21.7%	43.4%	0.0%	0.05%	0.0%	100.0%
CO ₂ (kt)	UK		0.0%	33.3%	7.2%	12.7%	0.0%	0.0%	0.0%	53.3%
	UK to overseas	8.8%	0.3%	12.8%			0.0%	11.6%		33.5%
	Overseas		0.0%	10.8%	2.4%		0.0%		0.0%	13.3%
Total		8.8%	0.3%	56.9%	9.6%	12.7%	0.0%	11.6%	0.0%	100.0%

Table 6: Estimated total Food Transport split by transport mode (1992)

		Air		Road			Rail	Sea	Inland waterway	Total
		Long haul	Short haul	HGV	LGV	Car				
Tonne km (M)	UK		0	36,278	2,092	117	0	400	100	38,987
	UK to overseas	533	8	12,871			0	136,603		150,015
	Overseas		0	13,596	784					14,380
Total		533	8	62,745	2,875	117	0	137,003	100	203,382
Vehicle km (M)	UK		0	5,391	4,743	10,644	0	0	3	20,781
	UK to overseas	11	0.2	1,913			0.0	13		1,937
	Overseas		0	2,021	1,777					3,798
Total		11	0	9,325	6,520	10,644	0	13	3	26,516
CO ₂ (kt)	UK		0	5,429	1,337	2,129	0	0	0	8,895
	UK to overseas	820	36	2,405			0	2,062		5,324
	Overseas		0	2,035	522		0		0	2,557
Total		820	36	9,869	1,859	2,129	0	2,062	0	16,776

Notes:

1. Figures in red are **very** approximate estimates.
2. Full details of data sources and assumptions are in Annex 1 (Annex 3 for CO₂).

Table 7: Estimated Food Transport split by transport mode as percentages of total (1992)

		Air		Road			Rail	Sea	Inland waterway	Total
		Long haul	Short haul	HGV	LGV	Car				
Tonne km (M)	UK		0.0%	17.8%	1.0%	0.1%	0.0%	0.2%	0.0%	19.2%
	UK to overseas	0.3%	0.0%	6.3%			0.0%	67.2%		73.8%
	Overseas		0.0%	6.7%	0.4%		0.0%		0.0%	7.1%
Total		0.3%	0.0%	30.9%	1.4%	0.1%	0.0%	67.4%	0.0%	100.0%
Vehicle km (M)	UK		0.0%	20.3%	17.9%	40.1%	0.0%	0.0%	0.0%	78.4%
	UK to overseas	0.0%	0.0%	7.2%			0.0%	0.05%		7.3%
	Overseas		0.0%	7.6%	6.7%		0.0%		0.0%	14.3%
Total		0.0%	0.0%	35.2%	24.6%	40.1%	0.0%	0.05%	0.0%	100.0%
CO ₂ (kt)	UK		0.0%	32.4%	8.0%	12.7%	0.0%	0.0%	0.0%	53.0%
	UK to overseas	4.9%	0.2%	14.3%			0.0%	12.3%		31.7%
	Overseas		0.0%	12.1%	3.1%		0.0%		0.0%	15.2%
Total		4.9%	0.2%	58.8%	11.1%	12.7%	0.0%	12.3%	0.0%	100.0%

3.3 ANALYSIS AND DISCUSSION

3.3.1 Comparison of tonne kilometres, vehicle kilometres and CO₂ emissions

Figures 6, 7 and 8 show the split of food miles by transport mode in terms of tonne kilometres, vehicle kilometres and CO₂ emissions for 2002. Some immediate observations can be made.

1. Sea transport accounts for 65% of **tonne kilometres**, due to the large distances travelled. Road transport by HGV is next at 33%, of which around two thirds is in the UK. Air accounts for less than 1% of food tonne kilometres travelled.
2. In terms of **vehicle kilometres**, the picture is completely different. HGV transport accounts for 31% of vehicle kilometres, but car transport from shop to home now accounts for 48%. LGVs are much more prominent, accounting for 21% of vehicle kilometres (though only one percent of tonne kilometres). Air vehicle kilometres are less than one percent, and sea vehicle kilometres are less than 1%. This is because of the much smaller loads carried in cars and LGVs than in HGVs, aircraft and especially ships.
3. In terms of **CO₂ emissions**, the picture changes yet again, with the burden split more evenly between modes. Road transport of food by HGV accounts for 57% of the CO₂ emissions arising from food transport. Sea transport is relatively energy-efficient and accounts for only 12% of CO₂ emissions (compared to 65% of tonne kilometres). Air transport is energy-intensive, accounting for 11% of CO₂-equivalent emissions (when the radiative forcing effect of other emissions apart from CO₂ are taken into account¹), though only 1% of tonne kilometres. Car transport accounts for a significant proportion of CO₂ emissions (13%) although it accounts for less than 1% of tonne kilometres. This is because of the low loads carried – although HGVs produce five times the emissions of cars per kilometre travelled, over 1000 car journeys will be made to carry home the contents of one HGV. LGVs account for 8% of CO₂ emissions.

¹ It is estimated that the radiative forcing effect of aircraft emissions is a factor of 2.7 greater than the CO₂ emissions alone, due to the impact of NO_x, water and particulate emissions in the stratosphere.

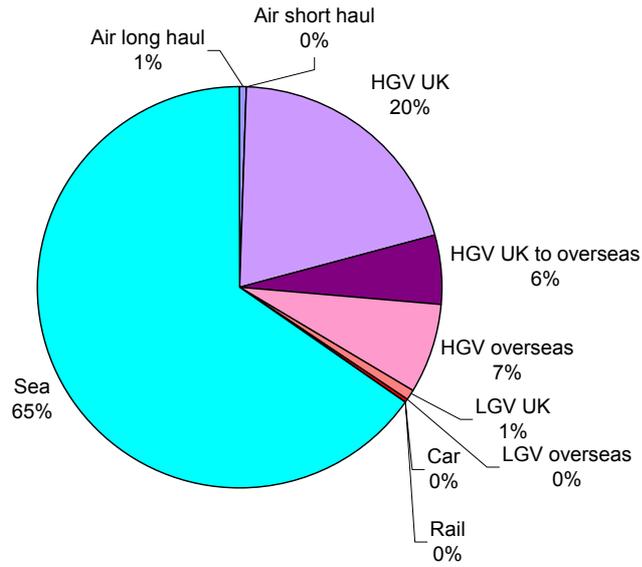


Figure 6 UK food tonne-kilometres by transport mode (2002)

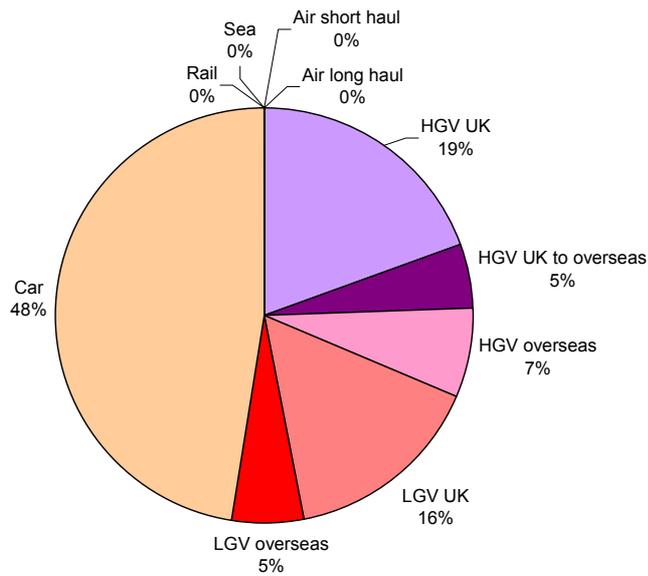


Figure 7 UK food vehicle-kilometres by transport mode (2002)

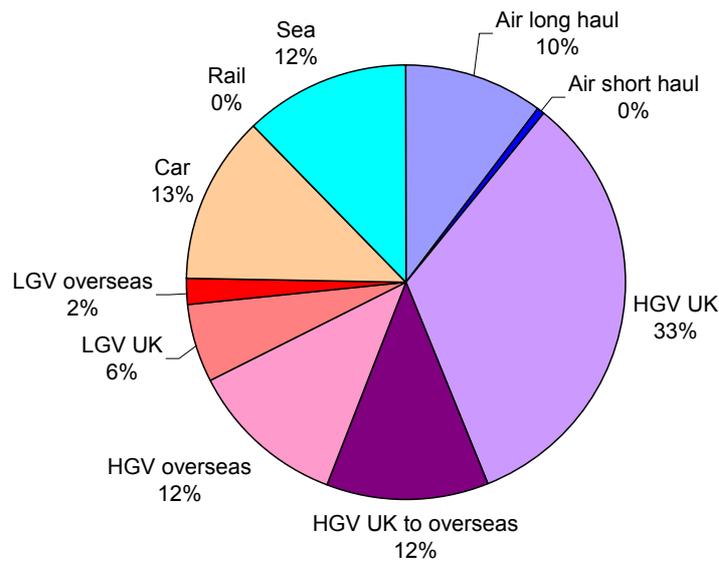


Figure 8 CO₂ emissions associated with UK food transport (2002)

The differences between the various metrics show that it is misleading to focus on food transport only (and to only use the metric of 'food miles'. To properly address the problem it is necessary to focus on the sources of the external costs associated with (but not reflected in the price of) food transport. This is discussed in a later section. The following section provides more specific information by mode.

3.3.2 Split of food miles by commodity and mode

UK Road Freight

Figure 9 shows the breakdown of UK HGV tonne kilometres by food type.

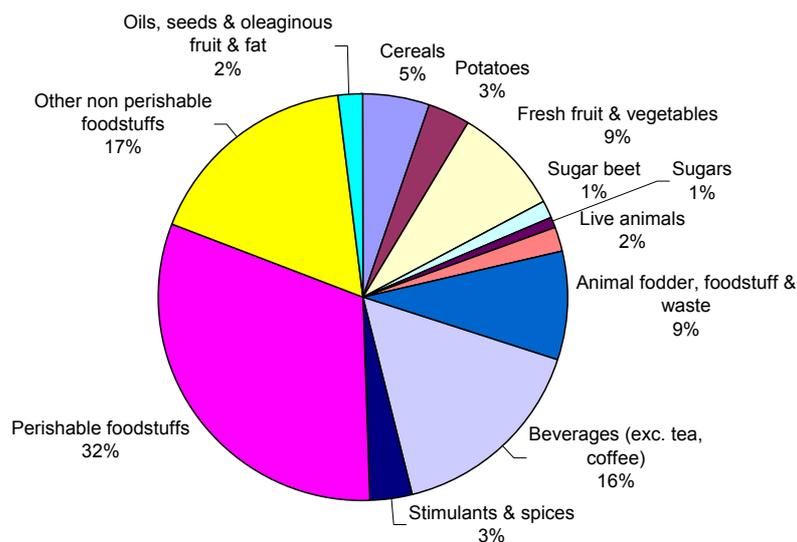


Figure 9: UK HGV tonne kms split by food type

Air freight

There is no data on the transport mode of goods imported from the EU. However, we assume that air freight of food from the EU is negligible (based on expert opinion). For transport within the EU, "air freight" is often actually carried by HGV, even though it is labelled and recorded as being air freighted⁴¹.

For transport from non-EU countries, data split by transport mode is available⁴². This shows that air freight is currently small compared to sea and road freight (less than 1% of both tonne kilometres and vehicle kilometres). However, it has a much greater environmental impact per tonne carried. It is reserved for highly perishable goods (e.g. seafood), high value goods (tobacco, alcohol) or for exports from countries where the road / sea route is less convenient (exotic fruit and vegetables from sub-saharan Africa). 80% of all cargo is currently carried as belly freight on passenger planes, but there is a trend towards more use of air freighters. Indeed, a recent report states that in fact most food freight is now carried on dedicated freighters, because this allows easier handling of pre-packed containers with special storage requirements, and also can provide a more reliable and potentially a cheaper service⁴³.

Figure 10 shows the split of goods imported or exported by air. The single largest category is vegetables from Africa (green beans, baby corn, mangetout and so on imported from Kenya, Gambia, Egypt etc). In all, vegetable imports account for 40% of food air freight in or out of the UK, fruit imports for 21% and fish imports for 7%.

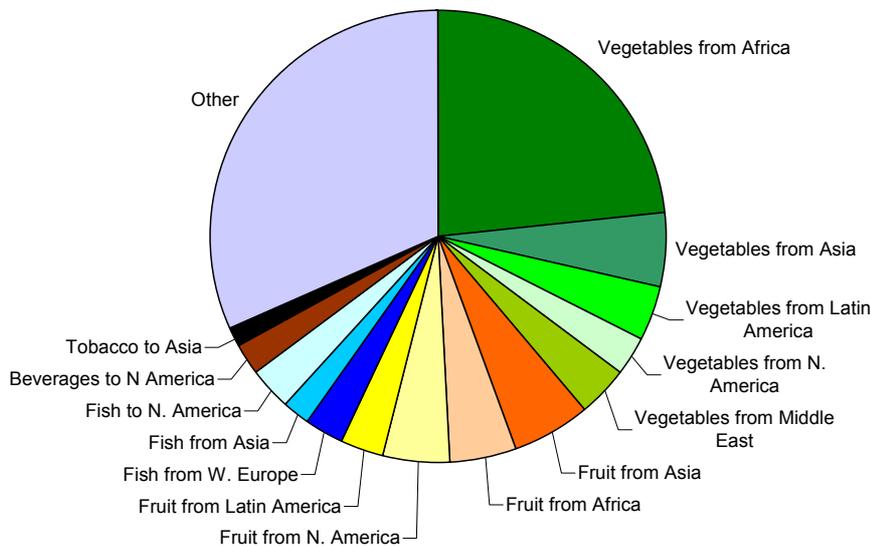


Figure 10: Split of air imports by food type and source / destination.

3.3.3 Significance of CO₂ emissions in terms of UK totals

Table 8 below presents the contribution of food transport to the UK's CO₂ emissions. Food miles generated by the UK produce around 19 Mt of CO₂. Of this, 10 Mt (52%) is

produced in the UK (nearly all by road vehicles), and therefore contributes to the UK's reported total CO₂ emissionsⁱ.

The total emissions arising from UK-generated food transport represent 3.4% of the UK reported total CO₂ emissions of 551 Mt, and 16.3% of the 116 Mt arising from road transport. The final column of the table shows that food transport in the UK produces 1.8% of the total reported UK CO₂ emissions from all sectors, and 8.4% of the total UK emissions from road transport.

Table 8: Contribution of food transport to UK CO₂ emissions (2002)

	kt	% from UK-generated food transport (UK and overseas)	% from road food transport in the UK
Total food transport CO ₂	18,956		51.4%
Food transport CO ₂ emitted in the UK	9,742		
Total UK CO ₂ (from all sources)	551,500	3.4%	1.8%
Total UK road transport CO ₂	116,600	16.3%	8.4%

Source: NAEI, AEAT estimates

3.3.4 Food transport energy as part of total food industry energy consumption

Table 9 shows energy consumption from food transport as a proportion of the energy consumed by the entire food production and distribution industry in the UK – estimated by adding the total final energy consumption of the agriculture and food and beverage industry sectors to our own estimates of food transport and retailing energy consumption. Our analysis estimates that food production, retailing and transport represent 8% of the UK's final energy consumption, and food transport accounts for **47%** of this. As mentioned above, 52% of the energy used to transport food is consumed within the UK. (Note that this analysis excludes energy related to packaging, and also preparation of food at home or by caterers. INCPEN has estimated packaging energy consumption to be 115,000 TJ, and AEA Technology has estimated food preparation and catering to consume 88,000 and 151,000 TJ respectively. If these categories were included in total energy use, food transport would represent 29% of the total).

ⁱ International air, sea and road emissions are excluded from the UK's reported totals (with the exception of air emissions up to a height of 1000m, but our dataset does not explicitly identify this amount)

Table 9: Food transport as a proportion of the energy consumed by food production and distribution in the UK (2002)

Ktoe						total	total TJ	% of total
	coal	petroleum products	gas	renewables and waste	electricity			
Food & beverage industry	136	326	2339	0	1048	3849	161,158	27%
Agriculture	4	557	130	72	358	1121	46,936	8%
Food transport								
<i>UK HGV</i>		2184				2184	91,425	16%
<i>UK LGV</i>		388				388	16,261	3%
<i>UK car</i>		834				834	34,932	6%
<i>Overseas</i>		3231				3231	135,296	23%
Total food transport		6638				6638	277,914	47%
Distribution centres			10		89	99	4,140	1%
Retailing			468		1871	2339	97,925	17%
Total food related energy	140	7521	2947	72	3366	14045	588,073	100%
Total UK final energy consumption	2615	77606	61081	765	28282	172305	7,214,410	8%

Source: DUKES (2003)⁴⁴, AEAT estimates⁴⁵

Excludes packaging, catering, and domestic cooking

3.4 DATA QUALITY

The data used to derive the food transport dataset is of varying reliability. The table below illustrates the differences in data quality between the different components of the dataset, together with the relative contribution of each component to estimated CO₂ emissions and vehicle kilometres (as a proxy for the significance of that component in terms of sustainability).

We believe that the data and methodology developed appears to be sufficiently robust to permit the development of a valid indicator. Data is of good quality and available on an annual basis in the most significant sectors. There are two main areas of uncertainty:

- ◆ **Overseas food transport** (i.e. food miles for production, processing and transport of food from the overseas producer to the dispatch port or airport). These are based on very uncertain estimates. However, DEFRA have stated that the overseas food transport are of lesser policy significance than the UK food miles, as obviously the opportunities for reduction through UK government actions are very limited. Proposals for satellite tracking of lorries in the EU may provide some useful data at least for the EU countries over the next few years.
- ◆ **Emission factors for sea freight** are uncertain because the average size of load carried by sea is poorly known. Further research could help to clarify this issue.

Table 10: Summary of data quality for food transport dataset components

Data component	Data quality	Estimated % of CO₂ emissions	Estimated % of vehicle km
UK HGV	Good (annual CSRGT survey). Can disaggregate food types but not imports and exports.	33%	19%
UK LGV	Good (DfT LGV survey).	6%	16%
UK car	Vehicle km fairly well defined – tonne km uncertain (data for average loads carried per car is poor).	13%	48%
UK sea, rail, inland waterway, air	Little data which separates out food from other freight, but insignificant	Very low	Very low
International air	Good for non-EU countries (HM C&E database). Not available for EU countries but thought to be insignificant.	11%	0.1%
International HGV	Total tonne km for road and sea is available (HM C&E database). Split between road and sea depends on reasonably well-constrained assumptions.	12%	5%
International sea	Total tonne km for road and sea is available (HM C&E database). Split between road and sea depends on reasonably well-constrained assumptions.	12%	0.04%
International rail, inland waterway	Not available but thought to be insignificant.	Low?	Low?
Overseas HGV	Poor – estimate based on country size and handling factor. May be an underestimate.	12%	7%
Overseas LGV	Very poor – based on very poorly constrained estimates but thought to be insignificant.	2%	5%
Overseas rail, air, inland waterway	Not available but not thought to be very significant.	Very low?	Very low?

4 The direct impacts of food transport

We have assessed the environmental, social and economic impacts of food miles – both costs and benefits. The evaluation covers two types of impact:

1. A quantitative evaluation of the direct impacts of food transport with an estimate of the social costs in monetary terms, as short-run marginal costs*.
2. A qualitative assessment and discussion of wider social and economic effects (see Section 5).

The impacts covered are summarised below. More details of the data sources and assumptions are to be found in Annex 3.

Cost category	Type of assessment	Notes
Direct environmental costs of food transport		
Climate change	Short run marginal costs	CO ₂ from transport fuel use. Excludes refrigeration during transport
Air quality	Short run marginal costs	Emissions of NO _x , SO ₂ , particulate matter (PM ₁₀) and volatile organics (VOCs).
Noise	Short run marginal costs	Road transport only (not air). Amenity costs, based on property prices. Excludes health impacts.
Other environmental costs	Listed but not assessed	
Direct social costs of food transport		
Accidents	Average costs (insufficient data for marginal costs)	Quantitative assessment for road transport and partial evaluation for other modes
Animal welfare	Brief discussion	
Direct economic costs of food transport		
Congestion	Short run marginal costs	Quantitative assessment for road transport and partial evaluation for other modes
Infrastructure	Short run marginal costs	
Wider social and economic issues		
Food prices	Qualitative assessment	
Consumer choice	Qualitative assessment	Includes nutrition and food culture
Rural communities	Qualitative assessment	Socio-economic issues and access to food
Developing countries	Qualitative assessment	Socio-economic and environmental issues

* Short-run marginal cost: the cost of an additional unit of burden (e.g. pollution) assuming that infrastructure remains fixed.

4.1 DIRECT ENVIRONMENTAL COSTS OF FOOD TRANSPORT

Table 11 shows the estimated CO₂ emissions, air pollutant emissions and fuel use for all the UK generated food transport in 2002. Full details are in Annex 3 but the main data sources and assumptions are listed below.

4.1.1 Greenhouse gases

We have assessed CO₂ emissions from fuel used during transport of food by all modes. We have not assessed emissions from energy used for refrigeration during transport, nor emissions of non-CO₂ greenhouse gases from refrigeration systems (i.e. HFCs). Emission factors for road transport were based on the UK National Atmospheric Emissions Inventory, and for other modes were based on the DEFRA Company Environmental Reporting Guidelines⁴⁰ supplemented by other sources (see Annex 3). The results have already been presented in Section 3 of this report (see pie chart in Figure 8). Around 19 million tonnes of carbon dioxide are produced from UK food transport each year, 10 million tonnes of which are in the UK (1.8% of total reported UK CO₂ emissions).

Greenhouse gas emissions are dominated by road transport, with HGV transport alone accounting for over half of all emissions, and cars and vans accounting for another 21%. However, the contribution of air and sea transport is also significant, and is growing. It is worth noting that international air and sea transport are not included under the Kyoto protocol targets, are not reported in national greenhouse gas inventories and they also benefit from untaxed fuel. Air transport may have a disproportionate greenhouse gas impact due to the location of emissions in the stratosphere, with potentially severe consequences for both climate change and ozone depletion (Box 4). Recent indications are that most food freight is now transported in dedicated freighters, rather than as belly freight in passenger planes (see Section 3.3.2). Freighters tend to be converted from retired passenger aircraft, and therefore would be less efficient and more polluting than modern aircraft.

Valuation of greenhouse gases is based on the Government Economic Service (GES) paper *Estimating the Social Cost of Carbon Emissions*ⁱ, which recommends the use of a value of £70 per tonne of carbon.

4.1.2 Air quality

Transport activities produce a number of pollutants that have potential health effects. These include nitrogen oxides (NO_x), particulate matter (PM₁₀), sulphur dioxides (SO₂), volatile organic compounds (VOCs), benzene, butadiene and organo-metallic compounds. We have assessed the first four of these pollutants (NO_x, PM₁₀, SO₂ and VOCs), as these dominate the known and quantifiable adverse health impacts of transport air pollutants⁵².

The evidence for the health impacts of transport emissions is strongest for PM₁₀. This includes direct emissions of PM₁₀ and also secondary particulates formed from NO_x and SO₂ emissions in the atmosphere. Ground level ozone is also important, formed by reactions involving NO_x and VOCs in the presence of sunlight. These pollutants may result in premature mortality (deaths brought forward), hospital admissions, and possibly exacerbation of asthma, other respiratory symptoms and loss of lung function⁴⁶. Recent studies also suggest that long-term exposure to these pollutants, especially particles (PM₁₀), may also damage health and may reduce life expectancy (so called chronic mortality) and that these effects are substantially greater than the acute effects above.

ⁱ http://www.hm-treasury.gov.uk/documents/taxation_work_and_welfare/taxation_and_the_environment/tax_env_GESWP140.cfm

As well as health impacts, emissions cause damage to crops and buildings, and SO₂ and NO_x emissions cause acid rain which damages ecosystems. We have assessed building damage and crop damage from ozone, but not acid rain effects on ecosystems. We have also not assessed eutrophication of surface water.

Table 11: CO₂, air pollutant emissions and fuel use for UK Food Transport (2002)

Emissions and fuel use in kilotonnes	Mvkm	Mtkm	CO ₂	PM ₁₀	NO _x	VOCs	SO ₂	Fuel
UK HGV	5,812	47,400	6274	1.62	59.46	4.21	0.16	1,996
UK LGV	4,743	2,092	1076	0.71	4.77	0.98	0.03	355
UK car	14,340	158	2392	0.21	8.04	3.51	0.06	763
UK to overseas road	1,577	12,866	2269	0.51	20.49	0.85	0.06	712
Overseas HGV	2,036	16,605	2198	0.57	20.83	1.47	0.06	699
Overseas LGV	1,662	733	391	0.27	1.73	0.31	0.01	124
Overseas rail	0	33	1	0.26	0.01	0.00	0.00	0
UK rail								0
Deep sea	13	146,669	2249	0.84	35.85	1.69	37.95	716
Short sea	2	5,245	154	0.06	2.46	0.12	2.60	49
UK sea								0
Air long haul	26	1,280	1971	0.22	3.81	1.02	0.25	626
Air short haul	0	21	88	0.01	0.05	0.05	0.00	28
Total	30,211	233,102	19,062	5	158	14	41	6,069
Total UK emissions (2001)			564,667	208	1,984	1,587	1,220	
% of 2001 UK emissions			3.4%	2.5%	7.9%	0.9%	3.4%	
Cost (£M)			364	247	133	8	50	

Table 11 shows emissions of the major air pollutants arising from UK generated food transport in 2002, together with the UK reported totals (note these reported totals will not include emissions from international air and sea transport and overseas road transport).

We have applied social costs per tonne of pollution to the emission estimates, based on previous work⁵² and recent updates for Defra⁴⁷. The values are consistent with current recommendations and best practice. In reality, the location of air pollutant emissions is important in determining their impact. For road transport, emissions in towns and cities have a higher impact than those in rural areas because of the population exposed. Application of different social cost factors to emissions in urban and rural areas will reduce the costs of HGV transport relative to car and van transport. Although HGVs account for over half of all the air pollutant emissions, we estimate that only 30% of the HGV mileage is in urban areas where the impact is greatest, compared to 50% for cars and 60% for vans. However, as the social costs of air pollution are not one of the key indicators selected for use in the study, and as preliminary investigation implied that the overall effect of differentiating between different locations would not affect the main conclusions of the study, we did not differentiate social costs by emission location.

For sea transport, emissions in mid-ocean will have relatively little impact, whereas emissions near the coast will have some impact. We do not have reliable estimates of how much of the sea emissions are close to the coast, and how much are mid-ocean, although shipping routes often tend to follow the coast where possible. For this report

we have estimated that 10% of deep sea emissions of air pollutants occur in coastal regions, and therefore have health impacts, and the remaining 90% have zero social costs. All short sea emissions are assumed to have health impacts. However, the potential effects of SO₂ emissions from ships, including acidification, are significantly underestimated with this approach.

Box 4. How Do Aircraft Affect Climate and Ozone?

Aircraft emissions include the greenhouse gases carbon dioxide and water vapour (H₂O), nitric oxide (NO) and nitrogen dioxide (NO₂) (which together are termed NO_x), sulphur oxides (SO_x), and soot. Aircraft emit gases and particles directly into the upper troposphere and lower stratosphere where they have an impact on atmospheric composition. These gases and particles alter the concentration of atmospheric greenhouse gases, including carbon dioxide (CO₂), ozone (O₃), and methane (CH₄); trigger formation of condensation trails (contrails); and may increase cirrus cloud formation - all of which contribute to climate change.

The climate impacts of the gases and particles emitted and formed as a result of aviation are difficult to quantify. Because carbon dioxide has a long atmospheric residence time (≈100 years) and so becomes well mixed throughout the atmosphere, the effects of its emissions from aircraft are indistinguishable from the same quantity of carbon dioxide emitted by any other source. The other gases (e.g., NO_x, SO_x, water vapour) and particles have shorter atmospheric residence times and remain concentrated near flight routes, mainly in the northern mid-latitudes. These emissions can lead to radiative forcing that is regionally located near the flight routes for some components (e.g., ozone and contrails) in contrast to emissions that are globally mixed (e.g., carbon dioxide and methane). It has been estimated that the indirect radiative forcing from aircraft nitrogen oxide emissions and other emissions is a factor of 2.7 times the effect of the CO₂ emissions^{48, 49}.

Ozone is a greenhouse gas. It also shields the surface of the earth from harmful ultraviolet (UV) radiation. Aircraft-emitted NO_x participates in ozone chemistry. Subsonic aircraft fly in the upper troposphere and lower stratosphere (at altitudes of about 9 to 13 km). Ozone in the upper troposphere and lower stratosphere is expected to increase in response to NO_x increases, and methane (a greenhouse gas) is expected to decrease. Water vapour, SO_x (which forms sulphate particles), and soot play both direct and indirect roles in climate change and ozone chemistry.

Source: IPCC⁵⁰

For air transport, the situation is even more complex. A significant portion of air pollutant emissions occur high in the air, where impacts on human health are minimal. However, aircraft have disproportionately high emissions on take-off and landing (including a high level of emission of particulates from brake wear), and NO₂ pollution levels are often of concern around major airports. Some of these emissions will have an impact on human health. Aircraft emissions in the stratosphere also have complex impacts on climate change and ozone (see Box 4). For this report we have estimated that 10% of short haul and 5% of long haul aircraft emissions of air pollutants occur close to the ground, and therefore have health impacts, and the remaining 90% have zero social costs. These estimates are thought to be an upper bound to the potential impacts. We have adopted the IPCC recommended value of 2.7 as the radiative forcing factor of all aircraft emissions relative to the CO₂ emissions.

The values used for the valuation of health impacts and deaths in this study are taken from a recent analysis for Defra⁴⁷. The social cost of an acute premature death from air pollution is valued using a range of £3,000 to £110,000. This value is adjusted down

from a full value of statistical life to take account of the short period of life lost and in some cases the existing low quality of life experienced by people who are chronically ill. The value also includes chronic mortality effects (the change in life expectancy from long term air pollution exposure, which is valued using a years of life lost approach, using a value for a life year of £31,500 to £65,000)). Acute morbidity effects from air pollution are also included.

On the basis described above, the social costs of air pollution from UK food transport in 2002 are estimated at around £439 million. The major health impact arises from particulate and NO_x emissions, through their role in respiratory disease and mortality. The estimates are shown in Table 11 and 18. HGV transport dominates the social costs of air pollution, and this arises roughly equally from PM₁₀ and NO_x pollution. These values may be underestimates as they do not adjust for the higher impacts of urban emissions and do not include a number of other potential health and environmental impacts (chronic morbidity effects and impacts on ecosystems). It should be noted that the analysis excludes the impact of acid rain from SO₂ and NO_x emissions. This would be most significant for ships, and would increase the social cost of sea transport.

4.1.3 Noise

Data on the distribution of noise outside dwellings shows that over half the homes in England and Wales are exposed to noise levels exceeding the World Health Organisation recommended daytime level of 55dB(A), above which noise levels cause annoyance. It also found that 7 per cent of homes were above the qualifying level at which sound insulation improvements must be provided if there is an increase in noise resulting from the development of a new road. Most of this noise comes from road and air transport.

The health effects of noise are mostly limited to cases of hearing loss and tinnitus caused by long periods of (occupational) exposure. These effects are generally not important at the typical levels of noise arising from transport. However, a number of studies also point to potential physiological and psychological impacts from the noise levels associated with transport (from road, rail and aircraft), including:

- Speech interference,
- Annoyance,
- Sleep disturbance,
- Performance,
- Cardiovascular and physiological effects,
- Mental health effects.

Overall, while there is general agreement that noise is a source of annoyance, there is still debate about potential effects on health. It is stressed that much of the evidence in support of actual health effects other than annoyance and some indicators of sleep disturbance is quite weak.

Within the UK, the current position is that it is not possible to determine what the possible health effects of noise are, let alone quantify and value these impacts⁵¹. However noise does have a major impact on amenity (not health), which can be measured directly in economic terms through hedonic pricing studies. Previous studies including the STCC project have used the relationship between noise levels and property prices to estimate a monetary value for the social cost of noise.

The study has taken the marginal social costs of the noise generated by road and rail transport in the UK from marginal cost data in pence per vehicle km for different vehicle classes estimated by the STCC project⁵². The results are shown in Table 18.

Noise from air transport causes considerable nuisance to people living in the vicinity of airports. The total costs of noise impacts for all UK airports has been estimated at around £25 million/year⁵³. However, we do not have sufficient data to determine what proportion of these costs should be allocated to food freight.

It was not possible to estimate noise impacts for sea transport within the scope of this project, but the impacts of noise from sea transport will be negligible.

The social costs of noise from road and rail transport are estimated to be £283 million per year, similar in magnitude to the climate change and air pollution costs.

4.1.4 Other environmental impacts

Other impacts not assessed here include:

- ◆ Emissions associated with fuel extraction, processing and distribution and other environmental impacts across the fuel lifecycle (including oil discharges to sea).
- ◆ Depletion of oil resources.
- ◆ Environmental costs of road and air infrastructure, e.g. loss of amenity and damage to wildlife habitatsⁱ.
- ◆ Extra packaging required for long distance transport of food.

4.2 DIRECT SOCIAL COSTS OF FOOD TRANSPORT

4.2.1 Accidents

The social costs of accidents in the UK were estimated from data on the involvement rates of different vehicle types in accidents of different severities on different road types, multiplied by the costs of preventing these accidents. For accident costs, data on a Europe-wide basis was not adequate to support the marginal cost approach, so average costs were used instead.

Our estimates of the social costs of accidents are shown in Table 12 and Table 13. We estimate that food transport in the UK cause over 280,000 accidents each year, two thirds of which are by cars, and including 300 deaths and over 2000 serious injuries. The estimated social cost of accidents arising from UK food transport is £1.4 billion.

Cars and LGVs cause more accidents than HGVs due to the higher number of vehicle kilometres travelled and the location of the journeys in urban areas. However, accidents involving HGVs are more severe, resulting in more fatalities per km driven. HGVs are involved in 35% of the 300 fatal accidents. In undertaking food transport they only cover 18% of their vehicle kilometres on urban roads but incur 36% of the food related fatal accidents on this class of road. On the other hand cars are involved in 73% of the food transport related accidents on rural roads.

In the case of both cars and LGVs a relatively high proportion of fatal accidents occur on rural roads. This pattern of accidents is the same as that observed for traffic in general. LGVs carrying food appear to be relatively safe compared with cars, but this is in part a reflection of the fact that cars carrying food shopping are assumed not to travel

ⁱ These impacts are not included under the section on "infrastructure" as this is based on short run marginal costs which assume that infrastructure capacity is fixed. Also, there is inadequate data to assess the relationship of food miles to the demand for new or expanded road or air infrastructure.

significantly on motorways, which is the road class with the lowest accident rates. Reducing the number of HGVs entering urban areas should in theory reduce fatalities. However, in practice this depends on the alternative transport of food in those areas and the additional vehicle kilometres generated.

Table 12: Estimated Number of Food Transport related Accidents in UK 2002

Category	Fatal	Serious	Slight	DoA	Total
HGV	109	435	2394	37930	40867
LGV	26	248	1731	31671	33676
Cars	166	1549	11793	199275	212783
Total	301	2232	15917	268877	287327

Source: ITS estimates.

DoA is "damage only" accident

Table 13: Estimated marginal cost of food transport related accidents in UK 2002 (£m).

Category	Fatal	Serious	Slight	DoA	Total
HGV	155	74	42	58	327
LGV	36	40	28	45	148
Cars	232	253	191	289	965
Total	422	367	260	391	1440

Source: ITS estimates.

For accidents overseas, figures from the RECORDIT study⁵⁴ were used. This gave the monetary values of accidents (on a willingness to pay basis) and the involvement rates of articulated lorries.

Applying these accident rates to overseas food miles by road gives the estimated number of accidents, including over 270 fatalities. The social cost of accidents overseas is estimated as £566m. Therefore the total cost of accidents from food transport is assessed as **£2 billion**.

Accidents at sea have also been included (see Annex 3 for details). Accidents for rail are insignificant. We have not been able to quantify accidents during air transport.

4.2.2 Animal welfare

Transport of live animals as part of the food chain raises issues of animal welfare. There are welfare controls in the UK, which implement EU directives and apply throughout the 25 members of the EUⁱ. In some non-EU countries, the conditions in which live animals are transported (and reared) may be subject to less control than in the EU, and animal welfare impacts may therefore be higher in cases where live animals are imported from these countries (for the part of production and transport chain within that country).

DEFRA state that "UK policy would be best summed up as a preference for slaughter close to the place of production and an end to long distance transport solely for slaughter at the destination (this has to be balanced by the demands of the single market and commercial/economic decisions)". Transport of meat rather than live animals would also lead to a reduction in vehicle kilometres as meat is a more compact load than live

ⁱ However, animal welfare groups such as the RSPCA express concern that many of the ten million animals transported in the EU each week "suffer acute and chronic stress, injury, dehydration and fatigue". They campaign for controls to be improved (for example to give a shorter journey times, less crowded conditions and to reduce the number of violations that occur).

animals. Live animal transport is often carried out for commercial reasons, for example animals may be transported around several markets to obtain a better price. However, there may also be some economic and commercial benefits from reducing live animal transport. A recent RSPCA report points out that certain stressors encountered during live animal transport can lead to a reduction in meat quality or increased susceptibility to disease, which can lead to commercial losses for the producer⁵⁵.

Over 6 million tonnes of live animals were transported by HGV within the UK in 2002, travelling 764 million tonne km and 118 million vehicle km¹. When discussing the animal welfare impacts of live animal transport, numbers of each types of animal are more relevant than tonnes or vehicle kilometres. This data is not available for animal transport within the UK, but numbers of animals exported and imported are recorded. In 2002, 5 million live animals were imported to the UK and 41 million exported. Most of these were poultry, but there were also imports of 23,000 bovine animals and 230,000 swine, and exports of 32,000 swine and 114,000 sheep³⁷.

Distances over which live animals are transported within the UK have increased due to the recent closure of many small local abattoirs (and some larger ones), partly as a result of charging systems for hygiene inspections⁵⁶. The increased movement of stock around the country was implicated in the spread of the recent foot and mouth epidemic, which resulted in large economic losses to rural communities⁵⁷. Reductions in live animal movements could help to reduce the rates of spread of animal diseases.

Additional issues may arise when meat or live animals are traded with other countries which have differing welfare standards to the UK. For example, the use of sow stalls is banned in the UK and some other European countries. Therefore reduction of pig meat imports from certain European producers could achieve a potential animal welfare benefit. However in other cases, meat may be imported from farms which exceed the minimum EU animal welfare requirements, for example by providing outdoor access and less intensive stocking densities.

No methodology has yet been developed for valuing animal welfare. One approach would be to use the premiums paid by some consumers for meat produced by systems representing higher animal welfare standards than the minimum (e.g. free range, organic or freedom foods)⁵⁸ to indicate their "willingness to pay" for avoidance of animal suffering. However, this approach has several flaws, for example there is a "suppressed demand" for animal welfare from consumers who would like to buy free range meat but cannot afford to. Also there is no direct relationship between price premiums and willingness to pay. Some economists now believe that it is more appropriate to consider certain minimum standards of animal welfare as a "public good" which should be obtained regardless of price. The problem then lies in defining this minimum standard. Of course there are already a set of minimum standards in the UK and EU, but it is not clear whether this would be identical to that determined by consumers. More consumer research is required in this area.

4.3 DIRECT ECONOMIC COSTS OF FOOD TRANSPORT

4.3.1 Congestion

The cost of congestion within the UK is based on data from the STCC study⁵². This estimates marginal social congestion costs based on the time lost by all traffic when an extra vehicle joins the traffic flow, multiplied by the "value of time" as defined in the Highways Economic Note.

The use of marginal costs to estimate congestion costs follows standard government methodology. This method is recommended because the impact of an additional vehicle will depend on the level of traffic already present on the road. The use of “average” costs, in which total congestion costs are distributed evenly between all vehicles on the road, would give lower cost values, although this method is not recommended.

Congestion impacts are highly dependent on time. For the cost evaluation, we split traffic into time bands (based on DfT data) and applied different costs to each time band.

For congestion costs in Europe, the source was the UNITE study⁵⁹. Although these values were on a different basis to those for the UK generated from STCC, it was clear that congestion costs were generally lower in continental Europe.

The total estimated costs for congestion in the UK are shown in Table 14.

Table 14: Estimated food transport congestion costs in the UK, 2002 (£M)

Vehicle category	Motorway	Rural	Urban	All roads
HGV Artic	313	136	469	919
HGV Rigid	62	72	306	440
LGV	40	70	946	1056
Car	0	430	2146	2576
Total	415	709	3866	4991

Clearly the costs generated by cars on shopping trips in the UK dominate this category of costs, particularly in urban areas, with over half the UK total of £4900m. LGV congestion is also estimated to be high, related to the assumption that 60% of LGV mileage is on urban roads. Congestion costs in overseas countries are much lower at only £196m (see Annex 3), and are dominated by the international stage of HGV transport on European motorways. This is partly because roads are less congested overseas, so that costs per additional vkm are lower, but mainly because overseas UK-related food transport do not include car food shopping, which dominates congestion costs in the UK.

4.3.2 Infrastructure

The marginal costs produced in the STCC study⁵² were used as the basis for estimating infrastructure costs in the UK. These are short run marginal costs, so assume capacity is fixed. Therefore they exclude the cost of building new transport infrastructure, and include only maintenance and operating costs. For infrastructure costs in Europe the source of data was the EU RECORDIT study. Full details are in Annex 3.

The costs of infrastructure per kilometre are higher in Europe, reflecting road networks that receive better maintenance, especially in northern Europe, when compared to the UK, and, with the exception of the Netherlands, generally have lower density of traffic. On the other hand, infrastructure costs in developing countries are generally lower reflecting poor or zero maintenance. Poorly maintained roads generate costs to commercial vehicle operators in the form of repairs (especially to tyres and suspension units), loss of vehicle utilisation and unreliable service to shippers, but these are outside the scope of the current study.

The results are shown in Table 15 and Table 16. HGVs are the major source of road infrastructure costs. The application of the ‘fourth power law’ to the wear caused by the passage of a vehicle axle means that those vehicles with high axle weights (as a result of

carrying the heaviest payloads) are allocated the largest share of the cost of maintaining the road pavement. The outcome is that articulated HGVs account for 72% of the food transport-related infrastructure costs in the UK, and 90% of that on motorways. Most of the remaining costs are caused by rigid HGVs. The overseas infrastructure costs arising from transport of UK food follow a similar pattern, with articulated vehicles being allocated 84% of the total.

Table 15: Total Food Transport Related Infrastructure Costs in UK, 2002 (£m)

Vehicle category	Motorway	Rural	Urban	All roads
HGV Artic	86.1	109.7	91.4	287.2
HGV Rigid	8.7	43.9	46.7	99.3
LGV	0.1	1.0	2.4	3.5
Car	0.0	4.8	4.6	9.4
Total	94.9	159.4	145.1	399.5

Source: ITS Estimates.

Table 16: Total Food Transport Related Infrastructure Costs overseas, 2002 (£m)

	Artic	Rigid	LGV	Totals
International (UK to overseas)	141	0	0	141
Western Europe				
Motorway	32	3	0	34
Rural	28	12	0	40
Urban	48	17	1	66
Total	107	32	1	140
Other developed countries				
Motorway	24	3	0	26
Rural	21	9	0	30
Urban	36	13	1	50
Total	81	25	1	107
Developing countries				
Motorway	7	0	0	7
Rural	5	3	0	8
Urban	9	4	0	13
Total	21	7	0	28
Total overseas	209	63	3	275
Total international + overseas	349	63	3	416

Non-road modes

It was difficult to find good sources of data for estimating the congestion, accident and infrastructure costs of rail, sea and air transport. Estimates were made for the costs of accidents at sea, and for rail congestion, infrastructure and accident costs. However it was not possible to estimate costs for air transport. The results for non-road modes are shown in Table 17.

Table 17: Cost of Food Transport by Non-road Modes in the UK (£m)

Cost item	Sea	Rail	Air Long haul	Air Short haul
Accidents	29.4	Negligible	n/a	n/a
Congestion	Negligible	0.2	n/a	n/a
Infrastructure	n/a	0.2	n/a	n/a
Total	-	0.4	-	-

Sources: UNITE D8. ITS Estimates.

N/a = not available.

4.4 SOCIAL COST ESTIMATES

Allocation of social costs was described in the preceding sections for carbon dioxide emissions, air pollution, noise, accidents, congestion and infrastructure. Table 19 and Figure 11 summarise our estimates of those social costs which we have been able to quantify, split by transport mode. The estimates are for short run marginal social costs (except for accidents, see section 4.2.1). The total cost estimate is over nine billion pounds. Of this, congestion accounts for £5 billion and accidents for £2 billion. The dominance of congestion costs over environmental effects reflects the high "value of time" recommended in the evaluation.

While there is considerable uncertainty attached to social cost estimates, the estimate of £9 billion is significant by comparison with the gross value added of the agriculture sector (£6.4 billion), and the gross value added of the food and drink manufacturing sector (£19.8 billion in 2002). It is important to remember that the estimation of social costs is highly uncertain, not all impacts are included and these figures are only indicative of the order of magnitude of the social costs.

Important caveats are:

- ◆ no account is taken of the split between urban and rural road air pollutant emissions;
- ◆ crude estimates are made of the proportion of sea and air pollutant emissions which are close enough to areas of population to have health impacts (10%), and no account is taken of the complex effects of air emissions on ozone depletion;
- ◆ it was not possible to assess noise, accident, infrastructure or congestion costs for air transport;
- ◆ many impact categories are excluded (e.g. animal welfare, wider economic and social impacts, acid rain, new transport infrastructure).

Because of the large uncertainty attached to social costs for air transport, this mode has been excluded from Figure 13. The figure and table show the dominance of congestion above all the other social costs, followed by accidents. UK car transport for food shopping accounts for most of the congestion and accident costs. UK HGV transport is the next highest category, with high congestion, accident and infrastructure costs. Sea and air transport appear to have relatively low total social costs, although the air transport social costs are incomplete. However, note that air transport does have high environmental impacts per tonne of food transported.

Table 18: Social cost estimates for UK-generated food transport (2002)

£M	CO ₂	Air quality	Noise	Congestion	Accidents	Infrastructure	Total costs
UK HGV	120	165	123	1359	327	387	2480
UK LGV	21	48	27	1056	148	4	1303
UK car	46	24	42	2576	965	9	3662
UK to overseas road	43	54	39	52	115	141	443
Overseas HGV	42	58	43	90	304	272	809
Overseas LGV	7	18	9	54	147	3	239
Rail	0	15	0	0	0	0	16
Deep sea	43	32	0	0	26	nq	106
Short sea	3	22	0	0	3	nq	32
Air long haul	38	1	nq	nq	nq	nq	39
Air short haul	2	0	nq	nq	nq	nq	2
Total	364	439	283	5187	2036	815	9123

nq=not quantified

Sources: various (see Annex 3)

Notes

1. Air and sea transport air quality costs are incomplete.
2. Assumes that 10% of short haul air, 5% of long haul air, all short sea and 10% of deep sea emissions of air pollutants are close to land and therefore attract social costs.
3. Social cost estimates are uncertain and this should only be taken as a guide to possible trends and patterns of cost allocation.

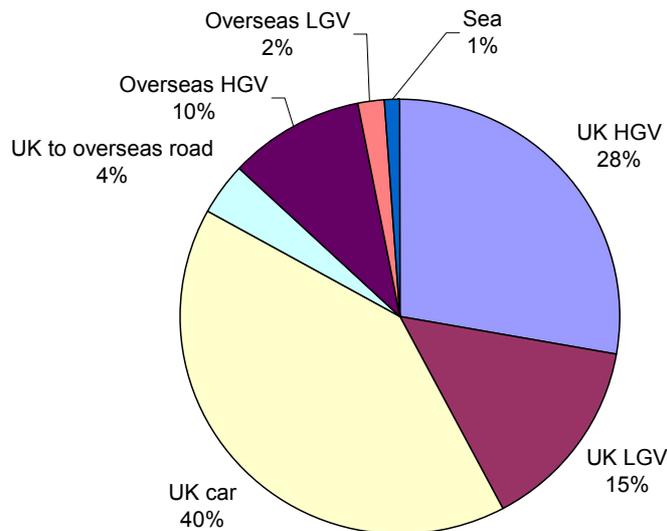


Figure 11. Approximate social costs from UK-generated food transport, 2002 (Excluding air transport, and not differentiated by location of emissions)

5 Wider social and economic issues

5.1 INTRODUCTION

In addition to the direct impacts of food transport identified in Section 4 (pollution, congestion, etc.), food supply is associated with wider social and economic issues. These include:

- ◆ food prices;
- ◆ consumer choice and nutrition;
- ◆ trends affecting UK suppliers;
- ◆ changes in food retail structure and accessibility;
- ◆ international trade and developing countries.

These are highly complex and controversial issues. A detailed investigation is outside the scope of this project. In this section we list the main points of debate, briefly examine the available evidence, and assess the need for further research.

To set the analysis in context, Box 5 presents a brief description of food supply chains in the UK. Below we also summarise economic activity in the food and drink sector. Unless stated, the measures do not include food and drink transport carried out by logistics companies based outside the sector.

Table 19 shows the economic activity in the food and drink sector. Sales revenue from the sector amounted to £133 billion in 2002, of which almost half was from the catering sector. This was around one fifth of consumers' total expenditure. The food chain accounts for 8% of the UK's GDP. Gross value added by each sector is also shown in the table, together with the level of exports and imports.

Table 19 Economic activity in the UK Food Chain

	£bn	Employment
Total expenditure on food and drink	133	
<i>Catering</i>	62	
<i>Household</i>	71	
Gross value added		
<i>Retailers</i>	17.6	1,147,000
<i>Caterers</i>	16.5	1,404,000
<i>Wholesalers</i>	6.9	191,000
<i>Manufacturers</i>	19.8	454,000
<i>Agricultural wholesalers</i>	0.7	23,000
<i>Farmers and primary producers</i>	6.4	550,000
<i>Fishing</i>	0.4	15,000
Total	68	3,784,000*
Imports	18.2	
Exports	8.5	

Source: Food Industry Sustainability Strategy (DEFRA, 2003)

*Plus around 300,000 jobs in the freight and logistics industry (see below)

Employment

The food and drink sector (manufacturing, agriculture and retailing) employs approximately 3.8 million people (13% of total employment in the UK). A breakdown (excluding food freight by third parties) is shown in Table 19. Catering and retail account for around one third of all jobs each, the remaining third being split between farming and manufacturing. In the agricultural sub-sector, employment was approximately 350,000 full-time-equivalent in 2000 - representing 1.2% of UK employment⁶⁰. The freight and logistics industry employs over 1 million people. We do not have data on the proportion of these jobs related to food freight. However, as food is responsible for around 25% of HGV vehicle kilometres, an approximate estimate would be that around 200,000 to 300,000 of these jobs might be related to food freight.

Small and medium sized (less than 50 employees) food businesses represent 10% of the turnover and 10% of the employment in the UK food and drink sector, as well as providing a vital element of innovation and specialisation in the food and drink industry⁶¹.

5.2 FOOD PRICES

Food prices are influenced by a number of factors including:

- ◆ the cost of production, packaging and processing;
- ◆ the cost of distribution, including transport fuel, warehousing and logistics;
- ◆ cost of retail operations, including staff costs, land and property costs, and related to company size and turnover;
- ◆ profit margins at each stage;
- ◆ market price support (tariffs, quotas, export subsidies) within Common Agricultural Policy (CAP).

“Food miles” are directly related to food prices in two ways:

1. **Sourcing.** Wider (global) sourcing of food offers the potential to decrease the production element of costs, due to cheaper labour or more favourable climatic conditions. However, imports typically involve higher transport costs, due to increased transport distances, and in some cases the need for refrigeration or air freight. Packaging and processing costs will generally also be higher, due to the need to preserve food quality during transport.
2. **Transport and distribution costs.** Different transport and distribution systems have different associated costs. We examine the impact of transport and distribution costs on food prices in Section 5.2.1, below.

It is difficult to isolate these direct effects of food transport on food prices from other factors, such as retail costs and the CAP. We consider these complexities in Section 5.2.2.

Box 5: Food Supply Chains in the UK

The food sector is large, diverse and complex, but can be crudely characterised by a division between "local" and "supermarket" supply chains.

- ◆ 85% of food is sold through supermarket chains⁷⁵ with global supply systems, and with efficient, highly centralised distribution systems based on large HGVs travelling long distances to and from suppliers, regional distribution systems and stores. The dominance of multiple retailers is likely to increase with their move into the convenience store market.
- ◆ A parallel system of more local or regional food supply exists, where small to medium suppliers sell their produce either to wholesalers (who sell on to local shops, markets or caterers), local shops, caterers, or direct to consumers via farm shops, farmers markets or box schemes. Transport is mainly in smaller vehicles and load factors are lower.
- ◆ There is little interface between the two systems except that there are some limited sales of local and regional produce to supermarkets. Highly centralised supermarket distribution systems are currently not suited to accept large numbers of direct deliveries from the local food sector.
- ◆ There is competition between the two systems, in that smaller shops compete against large superstores, wholesalers are being displaced by supermarket regional distribution centres (RDCs), and smaller suppliers are affected by the reduced numbers of small independent shops and wholesalers.
- ◆ Consumers may use any combination of the two supply chains. Many purchase most of their food at supermarkets, using local shops or supermarket-owned convenience stores to "top-up" during the week. However, some use mainly local shops or markets, due to lack of access to a car, personal preference or price considerations (for markets).

The amount of local food stocked by local retail outlets is highly variable. Some outlets, such as farmers markets and some farm shops, stock almost exclusively local produce, whereas some convenience stores (especially those which supply little fresh produce) may stock very little. However, it is much easier for small to medium scale suppliers to sell their produce to local shops than to large multiple retailers, and many local shops and businesses do source much of their fresh produce locally. The Countryside Agency estimates that 55% of local food sales are through local outlets⁶², although these outlets account for only 20% of all food sales. This indicates that the proportion of food sold which is locally sourced is on average five times higher in local outlets than in multiple retailers.

The high degree of concentration in the UK grocery retail sector (large proportion of sales through a few companies) coupled with the large proportion of supplies channelled through retailers' RDCs (93.2% by value in 2002), makes it relatively easy for foreign food suppliers to penetrate the UK consumer market. Distributing imported food products through around 70 major RDCs in the UK offers very wide exposure across the UK market. In countries with more fragmented retail sectors and more complex wholesale structure, it would be more difficult to achieve this degree of retail exposure.

5.2.1 The impact of transport and distribution costs on food prices in the UK

The logistical systems of UK supermarket chains are regarded as very efficient by comparison with those of firms in other sectors and grocery retailers in other countries. This is not directly reflected in lower prices for food in UK supermarkets, where prices are 12-16% higher than in Europe³³. However, other factors may be more significant in this

price differential, such as the price of land and the price of fuel, both of which are higher in the UK³³.

Transport costs comprise only a very low proportion of food prices. An annual Institute of Grocery Distribution survey of the logistics operations of major UK food retailers reveal that (unweighted) average expenditure on distribution represents around 3.5% of sales revenue (Table 20). The range between companies with the highest and lowest distribution cost % has steadily widened, however, mainly as a result of some companies experiencing an increase in this critical KPI.

Table 20. Distribution Cost as a % of Sales Revenue

	Average	Range
1998	3.46	2.10-5.10
1999	3.29	2.20-5.90
2000	3.71	2.30-5.00
2001	3.86	2.17-6.00
2002	3.44	2.05-6.40

Source: Institute of Grocery Distribution (2002)⁶³

It is surprising that the average proportion of revenue spent on distribution has not dropped over this period, because management of the main logistical activities has become more efficient. Average days of inventory in the retailers' supply chains fell by approximately 18% between 1996 and 2002. Inventories of all the main grocery product groups fell over this period, reflecting the tightening of order lead times and growth of sales based ordering and cross-docking (Figure 12). Between 1993 and 1998 average space utilisation in retailers' distribution centres increased from 82.2% to 87.9%. The average size of distribution centres has also been rising allowing companies to take advantage of economies of scale in warehousing and related activities (Figure 13). Transport efficiency is also likely to have improved by a significant margin as a result of:

- ◆ Integration of primary and secondary distribution: involving the backloading of shop delivery vehicles and recent move to factory gate pricing*.
- ◆ Growth of primary consolidation upstream of the RDC, particularly for frozen and chilled product.
- ◆ Relaxation of company restrictions on the use of dedicated contract vehicles: allowing contractors to use them to carry other companies' products
- ◆ Adoption of new computerised vehicle routing and scheduling systems and vehicle tracking.
- ◆ Increases in the 'delivery day': with many vehicles operating over a 24 hour cycle
- ◆ Improvements in vehicle technology and materials handling equipment.

These efficiency gains may not be reflected in the average distribution cost % for several reasons:

- ◆ The quality and complexity of the distribution service has improved over this period: for example, product ranges have expanded, an increasing proportion of grocery sales requires refrigeration, product availability in shops may have improved (though there is no hard data available to confirm this).
- ◆ Retailers have taken on new logistical responsibilities for primary distribution upstream of the distribution centre: their role in the food supply chain has expanded

* Factory gate pricing: goods are purchased direct from the factory by retailers, who then arrange collection, replacing the previous system where manufacturers delivered to retailers and included delivery costs in the prices of the goods.

- ◆ The average distribution cost % is not weighted by the turnover of the supermarket chains: it, therefore, does not adequately report the improvements in distribution efficiency achieved by the largest and most successful supermarket chains.

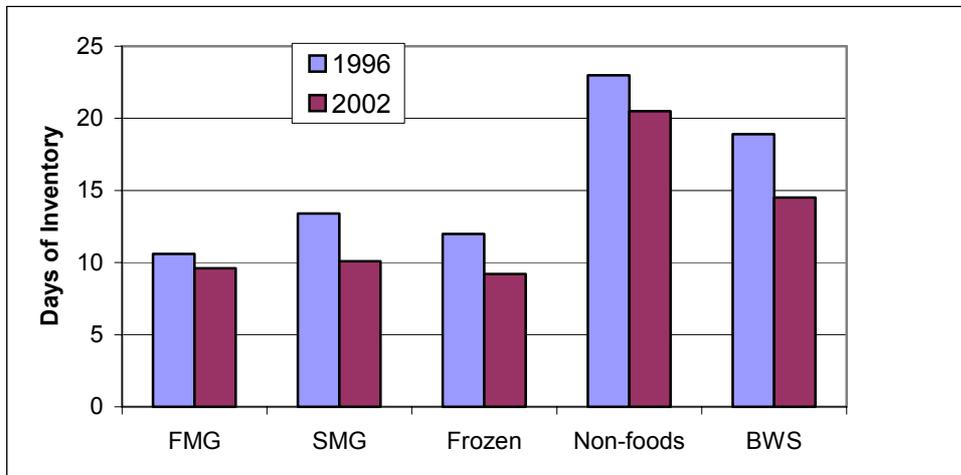


Figure 12. Changes in the Number of Days of Inventory in Grocery Retailers' Supply Chains 1996-2002

source: Institute of Grocery Distribution, 2002⁶⁴
 (FMG – fast moving goods SMG slow moving goods BWS beers, wines and spirits)

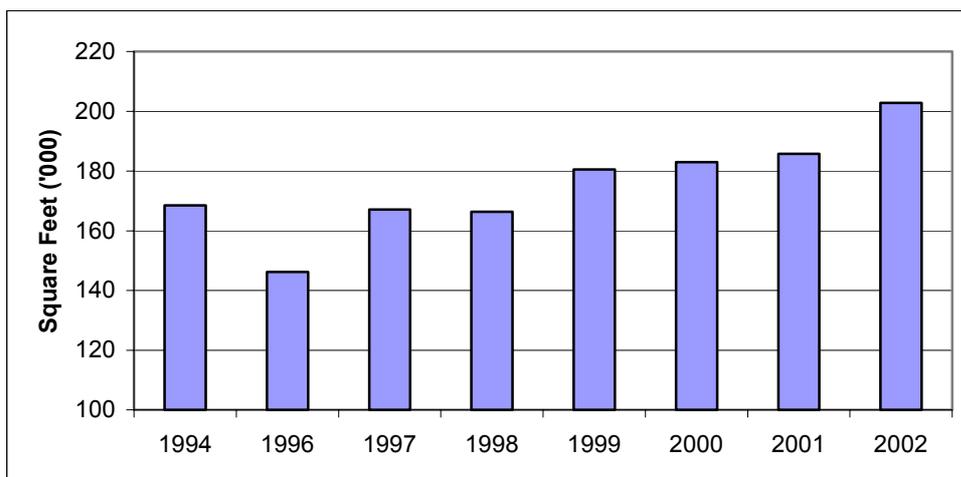


Figure 13. Average Size of Grocery Retail Distribution Centres: 1994-2002

Source: Institute of Grocery Distribution, 2002⁶⁴

5.2.2 Other factors influencing food prices

As well as food sourcing and food transport, food prices are influenced by different retail costs. These are related to many factors, such as land prices, property rental and maintenance costs, company size and turnover, business rates, utility bills and labour costs.

Prices are also influenced by export subsidies and import tariffs see Table 21. The OECD estimates the cost of higher food prices to EU consumers, as a result of the CAP, at around €50billion (source: OECD: Agricultural Policies in OECD Countries: Monitoring and Evaluation 2003, Paris).

Table 21: EU Tariff Equivalents on Major Commodities

Commodity	Import Tariff	Commodity	Import Tariff
Durum wheat	62%	Butter	143%
Beef*	86%	Milled rice	83%
Low & Medium Quality Wheat	60%	Cheese	60%
Pigmeat*	23%	Broken Rice	47%
Rye	107%	Eggs	43%
Sheepmeat*	67%	Sorghum	94%
Barley	74%	Cocoa Paste	10%
Lamb	58%	Triticale	48%
Oats	82%	Tomatoes	9%
Poultrymeat*	25%	Raw sugar	66%
Maize	84%	Apples	9%
Skimmed milk powder	68%	White sugar	168%
Husked rice	61%	Bananas	82%

Representative tariff line except * (average from selected bundle of most sensitive tariff lines)
Source: Defra⁶⁵.

5.2.3 Conclusions

The relationship between food miles and food prices is complex:

- ◆ There is a trade-off between transport costs and production costs. Global sourcing can reduce production costs but this is offset by increased transport costs.
- ◆ For major retailers, transport and distribution costs comprise around 3.5% of food prices. Improvements in the efficiency of centralised distribution systems should have reduced transport costs, but it is difficult to discern any effect on food prices, because of the influence of other factors.

Further research would be required to establish whether there is any clear price differential between “local” food and “high food miles” food. Prices in some local outlets, e.g. markets and discount shops, may be cheaper than supermarkets. However, staple foods may be more expensive in convenience stores, which have lower economies of scale than supermarkets. Supermarkets also compete to offer the lowest prices for “known value items” such as bread and milk.

There may be a trade-off effect between food prices and food miles: some policies to reduce food miles could potentially lead to higher food prices. One example would be the internalisation of the social costs of food transport. However, any food price impacts will depend on the combination of policies used and on responses to those policies by consumers, producers and industry.

5.3 CONSUMER CHOICE, NUTRITION AND FOOD CULTURE

Food miles are related to the issues of consumer choice, nutrition and food culture:

- ◆ Global sourcing of food contributes to improved consumer choice, e.g. out-of-season and exotic produce. This may have a beneficial impact on nutrition (see below).
- ◆ There may be loss of freshness during storage and transport. This varies depending on the source, distribution system, processing/packing and turnover of the retail outlet.

- ◆ Consumers may also value the availability of local food varieties, and the availability of organic and free-range produce.

First we examine the impact of global sourcing on nutrition. Current government policy promotes increased consumption of fruit and vegetables for health reasons (the 5-a-day policy). Consumption of fruit has increased significantly since 1961 (Table 22). The availability of non-indigenous fruit such as oranges and bananas (typically transported by sea) makes a significant contribution to nutrition and health in the UK. In this case, there is some trade-off between food transport and nutrition / choice. There is less impact on nutrition for imported indigenous fruit such as apples, although there may be differences in nutritional value depending on the different varieties available and relative storage times and conditions.

Table 22 Per capita consumption of fruit (kg/year) in the UK

	1961	2000
Oranges, Mandarines	9.4	23.2
Lemons, Limes	0.6	1.0
Grapefruit	1.8	1.9
Citrus, other	0.6	0.2
Bananas	6.7	11.8
Plantains	0.0	0.2
Apples - excl. Cider	10	15.9
Pineapples	1.0	1.4
Dates	0.2	1.3
Grapes - excl. Wine	9.2	9.4
Fruit, other	15.2	17.6
Total	54.7	83.9

Source: FAO³⁵

The freshness of food varies depending on the source, distribution system and turnover of the retail outlet. Several vitamins and minerals are depleted during storage and transport of food, especially vitamins C and A⁸. Long transport times (e.g. when shipping produce from New Zealand) may require use of chemical coatings to preserve the produce. In comparison with food which has been transported a long distance, locally produced food may be fresher (e.g. at farmers markets or farm shops) or less fresh (e.g. at a store with a slow turnover).

There are other issues relating to consumer choice. The small/local food sector comprises a wide variety of retail outlets, from "budget" stores, markets, and convenience stores to speciality food shops or box deliveries. Each individual outlet will offer less choice than a supermarket, but conversely they may offer products which are not available in supermarkets. These could include local varieties of fruit or vegetables, organic and home-baked products and speciality foods. Supermarkets have also responded to consumer interest in locally produced and organic / free range foods.

Related to this, another benefit claimed for locally produced food is that it can enhance food culture and the local food heritage, providing consumers with opportunities to experience local varieties of produce, and improving knowledge of the seasonality of produce and the origins of food.

Locally produced food is sometimes equated with less processing. Over dependence on processed food has nutritional implications as such food is generally lower in vitamins and minerals and higher in salt, sugar and fat compared to fresh produce (with some exceptions, e.g. frozen peas can be higher in vitamin C than fresh ones, depending on the length of time between picking and eating the fresh peas). However, it is not clear

that local fresh produce would displace purchases of more processed food, as many consumers who choose processed food do so for reasons of convenience.

In summary, the relationship between food miles and consumer choice is complex. A move towards more locally sourced food, whether through local or multiple retail outlets, could have benefits for consumers in terms of increased choice of local varieties of produce, increased freshness and improved contact with local food culture. However, global sourcing of food contributes to consumer choice, and this can have a beneficial effect on nutrition. Key issues for further research would involve work to investigate the trade-offs between sourcing local and global produce, nutrition and consumer choice.

5.4 TRENDS AFFECTING UK SUPPLIERS

Food miles are often discussed in the context of problems currently faced by many UK farmers and small food supply businesses. The key trends are:

- ◆ Increased consolidation in food retailing and much of the food and drink manufacturing industry. Multiple retailers account for over 85% of retail food sales in the UK.⁷⁵
- ◆ Increased ease of sourcing produce from other countries, due to technological changes such as the increased use of internet technology, together with modest agricultural trade liberalisation and declining transport costs.
- ◆ Decline of alternative outlets for UK farm produce (e.g. local shops and wholesale markets).

These changes, which are correlated with increased food transport, have led to a position where large retailers are able to choose from thousands of suppliers worldwide, but suppliers are restricted to a small number of potential buyers. It is claimed that this situation allows large retailers to exert downward pressure on prices paid to UK farmers and other suppliers for their produce.

Below we examine the evidence for these claims. However, the issue is complicated by a number of other factors which affect agriculture and farm gate prices in the UK. These include:

- ◆ oversupply in some sectors;
- ◆ the BSE and foot and mouth problems;
- ◆ exchange rate fluctuations;
- ◆ trends in commodity markets.

At first sight, a number of headline statistics appear to confirm the impression of an agricultural sector under pressure:

- ◆ Declining employment: 65,000 jobs lost in UK farming between 1996 and 2002⁶⁶.
- ◆ Low incomes: total income from farming per full time equivalent worker in 2002 was £11,107⁶⁷, compared to a national average per capita income of £23,400.
- ◆ Effect on rural economies: agriculture now accounts for less than 15% of rural businesses⁶⁸. Although many rural communities are prosperous, there are serious problems in some communities. Eight out of the 10 counties in England with the lowest GDP per capita are rural⁶⁹.
- ◆ Suicide rates among farmers were 75% higher than the average population from 1982 to 1992⁷⁰ and there are high levels of stress in the farming community⁷¹. Because of their way of life and the passing down of farms through generations, farmers experience much closer ties to their profession than workers in other sectors, and the threat of losing the business is a major source of stress⁷².

The issues should be examined in the context of long term trends in UK agriculture (Box 6). The decline in employment can be considered as part of a normal and expected process of structural change in the agricultural sector. In particular, a combination of technical change and rising off-farm incomes have been driving the release of labour out of the agricultural sector and into the broader economy for several decades. To the extent that agricultural incomes lag behind incomes in the rest of the economy, this can be explained by the process of structural adjustment lagging behind market developments. But it is also the case that many farmers are part-time or semi-retired. Official measures of agricultural income are very partial, and do not include income from farm diversification, off-farm income, pensions and social security. A more appropriate comparator would be total agricultural household income. However, social and environmental aspects must also be considered. It may be that the balance of environmental impacts differs between large and small farms (e.g. use of intensive farming techniques, pesticide application, fertiliser run-off, soil degradation, water abstraction, loss of wildlife habitats) although the evidence is unclear and further research is required to assess the social and environmental impacts of different farming styles.

Locally produced food may have a higher labour requirement than mass-produced food. In the UK, farms under 100 acres provide five times more jobs per acre than those over 500 acres⁷³. A recent survey showed that farms in the South West producing food which is sold locally employ an average of one additional employee per farm⁷⁴. This could be a benefit in rural areas with surplus labour. However, it should be noted that these jobs may be relatively low wage and low productivity. Also, rural communities are highly heterogeneous, with varying degrees of reliance on the food and farming sectors (though on average, rural employment in farming is around 6%). Some of these communities may have surplus labour, but others may have tight labour markets – in fact rural areas generally have a lower level of unemployment than urban areas.

DEFRA have identified, through the Local Food Working Group and the Sustainable Food and Farming Strategy, that initiatives to promote local food can have important benefits for rural communities. For example, farmers' markets enable closer links between producers and their markets, bring life to town centres, and provide a bigger share of the retail price for producers^{75, 4}. Other initiatives with benefits include increased co-operation amongst suppliers, and an increased local food offering from multiple retailers.

There may also be other social and environmental benefits associated with local food: a recent survey showed that local food producers are more likely to be certified organic, make more use of local suppliers, make more use of waste reduction practices and introduce more traditional breeds and varieties than non-local enterprises⁷⁶.

Box 6: Social and economic trends in UK agriculture

- ◆ The UK's agricultural sector accounts for a relatively small proportion of total national employment and income generation compared to other Member States: agriculture's share of national GVA (at market prices) is 0.4% (compared to an EU15 average of 1.4%) and agricultural employment is 1.4% (compared to an EU average of 4.0%). Agricultural employment in the UK has declined from 876,000 (full time equivalents) in 1960 to 533,000 in 2003 (of which 63,000 were seasonal or casual workers and 228,000 were classified as part-time).
- ◆ The structure of agriculture is constantly responding to technological change and the rising level of non-farm incomes. These trends have increased labour productivity in agriculture across Europe, resulting in the migration of labour out of agriculture into manufacturing and service sectors. Migration may accelerate during cost-price squeezes. Agricultural employment in the UK has declined from 876,000 (full time equivalents) in 1960 to 533,000 in 2003 (of which 63,000 were seasonal or casual workers and 228,000 were classified as part-time).
- ◆ An increasing number of farmers are classified as being part-time. 41% of UK farmers are classified by Eurostat as full time, compared to 23% across the EU.
- ◆ The age profile of farmers is climbing gradually, although the number of older farmers is disproportionately large amongst smaller holdings. Many farmers are semi-retired and drawing a pension whilst they farm. In the UK 51.5% of farmers are aged 55 or over.
- ◆ Across the EU, even in agricultural households (defined as households where the main income of the reference person comes from farming), between one third and one half of total household income comes from outside agriculture (although there are significant differences between Member States and between years).
- ◆ Only just over a third of UK farmland is currently rented (in 1914, the figure was 89%).
- ◆ The UK has been a structural net importer of food for many decades. Over recent years the UK's food self sufficiency levels (for 'indigenous type food') have declined to around 75%, although this compares favourably to the early part of the 20th Century. In 2003, three quarters of the UK's food imports came from other parts of the EU: France (15%), the Netherlands (12%), the Irish republic (9%), Germany (8%), and Spain (5%)ⁱ.
- ◆ Over 80% of UK food production now comes from just one quarter of all farms, with the largest 10% of farms producing over half of total food output, and around 50% of farms considered part time and producing less than 3% of total UK agricultural output. In 2000 in the UK, 10.4% of farmers received 55% of (production related) direct subsidies and 26% of farmers received 81% of the paymentsⁱⁱ.
- ◆ There is a very wide range in production costs between different farmers. For example, weighted average costs in the dairy sector in 2002/03 ranged from 28.8 ppl (for herds of 10 to 40 cows) and 20.33 ppl (for herds of 40 – 70 cows) to 16.68 ppl (for herds of more than 150 cows). Other studies have found costs of lamb production varying from 80p to 174p per kilo liveweight, and costs in the beef sector varying by around 55% from the top quartile to the bottom quartile. In the arable and dairy sectors, costs are related to scale of production, but in other sectors this is not the case.

ⁱ Defra, 2004. Agriculture in the UK.

ⁱⁱ In the EU as a whole, in 2000, 1.26% of farmers received 25.4% of CAP direct payments, and 5.3% of farmers received 50.2% of direct payments.

5.4.1 Farm gate prices

Farm gate prices in the UK fell by 33% over the period 1990 to 2002⁸⁰, although yields have also increased over the same period (between 1992/4 and 2003, average milk yields per dairy cow rose by 26%, wheat yields increased by 8%, and the sugar content per hectare of beet production rose by 29%). Between 2001 and 2002 the average price of UK agricultural outputs fell by 3% whilst the price of inputs remained constant⁷⁷.

Farmers also receive a decreasing share of the retail price for their produce – DEFRA figures show that farmers' share of the retail price decreased by 27% from 1988 to 2003⁷⁹ (see Table 20). The DEFRA figures show that farmers received 41% of retail prices in 2003, for a basket of produce weighted by its importance to farmers, compared to 57% in 1988. A recent study by London Economics has also investigated trends in the spread between farm gate and retail prices across the EU (see Table 24), and shows that UK farmers did relatively well compared to their counterparts in the EU, receiving 12% of retail prices for potatoes, 18% for eggs, 22% for onions and 44% for beef and pork in 2001. More limited surveys by farming groups include estimates by FARM that only 7.5% of end prices go to farmers compared to 50% 50 years ago²⁶, and a recent NFU survey which showed that for a basket of lightly processed produce (beef, milk, eggs, tomatoes, apples, bread) only 26% of checkout prices go to farmers⁷⁸.

Table 23: Comparison of farm gate and retail prices

	Farmgate share in 1988	Farmgate share in 2003	Change In Share	Weight in basket in 2003	
Farmers' share of basket	57%	41%	-27%		
Farm gate product					
Retail product					
Apples	dessert apples per kg	54%	41%	-23%	9
Beef	untrimmed beef (b) per kg	67%	46%	-31%	153
Carrots	carrots per kg	30%	44%	46%	16
Cabbages	cabbage, hearts, per kg	38%	42%	9%	8
Chicken	oven ready roasting chicken, fresh or chilled per kg	47%	30%	-37%	115
Eggs	size 2 eggs per dozen	29%	23%	-22%	71
Lamb	untrimmed lamb (b) per kg	65%	51%	-20%	87
Onions	onions per kg	26%	25%	-4%	3
Pork	untrimmed pork (b) per kg	57%	45%	-20%	90
Potatoes	old loose white potatoes per kg	24%	17%	-28%	65
Tomatoes	tomatoes per kg	48%	60%	26%	11
Wheat	white loaf sliced, 800g	23%	14%	-39%	25
Milk	whole milk (c)	66%	50%	-25%	347

(a) Farm gate prices from Defra, retail prices from the Office for National Statistics and the Meat and Livestock Commission (MLC).

(b) Retail prices for beef, lamb and pork are untrimmed MLC prices adjusted for drip loss.

(c) The average price of one pint of delivered milk and one pint of shop milk (the shop milk based on a two pint purchase).

Source: DEFRA⁷⁹

Table 24. Farm gate prices as a % of retail prices in EU Member States (2001)

Country	AP	CA	PO	ON	CB	TO	BE	LA	PI	BR	FL	EG	CH
UK	36	45	12	22	43	52	44	41*	44	13	20	18	
Austria	20	22	10	18	25	3	15	39	53				
Denmark													
France							33	58	45	4		24	
Germany	23	30	5	25	24	57	43	68	36	3		68	41
Ireland		41		22		43	35	63		9		27	
Italy													
Netherlands			14				24		24	7		39	25
Spain			38							9		70	

Source: after London Economics⁸⁰

Notes: AP Apples, CA Carrots, PO Potatoes, ON Onions, CB Cabbage, TO Tomatoes, BE Beef, LA Lamb, PI Pork, BR Bread, FL Flour, EG Egg, CH Chicken.

* In 2002 the figure is 48%.

There are several possible reasons for these trends. One is an increase in processing and packing beyond the farm gate. However, the trend is apparent even for unprocessed and lightly processed produce. For some commodities, there is over-supply in international markets and this has been linked to a long term decline in global commodity prices.⁸¹ Finally, there are the claims that the trend is partly due to the strong position of buyers compared to suppliers³. The issues are complex and a full investigation is outside the scope of this report. However, two recent studies have investigated the issue.

The London Economics study for DEFRA⁸⁰ performed econometric modelling which failed to establish a statistically significant relationship, for a number of broad food groups, between concentration in UK food retailing, used as a proxy for market power, and the farm-retail price spread, with the exception of fruit and vegetables. The period analysed was 1990 to 2002. LE also examined the influence of other factors, such as exchange rates, CAP, supply chain costs and supply and demand profiles on the farm – retail price spread, and concluded that the £ - Euro exchange rate was the most significant determinant of the spread over the period examined. However, LE theorised that their results were not inconsistent with the ability of the supermarkets to exercise market power over suppliers under conditions where the former compete with each other aggressively in selling to the consumer. Price reductions extracted from suppliers are passed on in the form of lower retail prices.

The Competition Commission report on supermarkets examined whether declining farm gate prices were adequately reflected in retail prices³³. The report stated that *“We were satisfied that cost reductions at the farm gate had either been passed through to retail prices or, where they had not, that there had been cost increases elsewhere in the supply chain. In a competitive environment, we would expect most or all of the impact of various shocks to the farming industry to have fallen mainly on farmers rather than on retailers; but the existence of buyer power among some of the main parties has meant that the burden of cost increases in the supply chain has fallen disproportionately heavily on small suppliers such as farmers.”* There is therefore some evidence that buyer power affects farm gate prices to some extent.

5.4.2 Trading practices

The claims of unfair trading practices have been investigated by the Competition Commission report on supermarkets³³. The study found that the buyer power of the five largest multiples was sufficiently strong that their behaviour was adversely affecting the competitiveness of some of their suppliers (see Box 7).

The concerns over the impact of buyer power on suppliers, both in terms of farm gate prices and trading practices, were reflected in recommendations for a code of conduct for

supermarkets' relationships with suppliers. A recent review by the Office of Fair Trading found that the code which was implemented in response to these concerns is not currently effective, and investigations are continuing⁸².

Box 7. Competition Commission Report into Supermarkets⁸³

"... we received many allegations from suppliers about the behaviour of the main parties in the course of their trading relationships. Most suppliers were unwilling to be named, or to name the main party that was the subject of the allegation. There appeared to us to be a climate of apprehension among many suppliers in their relationship with the main parties. We therefore put a list of 52 alleged practices to the main parties and asked them to tell us which of them they had engaged in during the last five years. We found that a majority of these practices were carried out by many of the main parties. They included requiring or requesting from some of their suppliers various non-cost-related payments or discounts, sometimes retrospectively; imposing charges and making changes to contractual arrangements without adequate notice; and unreasonably transferring risks from the main party to the supplier. We believed that, where the request came from a main party with buyer power, it amounted to the same thing as a requirement.

We conclude that five multiples (the major buyers—Asda, Sainsbury, Somerfield and Tesco), each having at least an 8 per cent share of grocery purchases for resale from their stores, have sufficient buyer power that 30 of the practices identified, when carried out by any of these companies, adversely affect the competitiveness of some of their suppliers and distort competition in the supplier market—and in some cases in the retail market—for the supply of groceries. We find that these practices give rise to a second complex monopoly situation.

These practices, when carried on by any of the major buyers, adversely affect the competitiveness of some of their suppliers with the result that the suppliers are likely to invest less and spend less on new product development and innovation, leading to lower quality and less consumer choice. This is likely to result in fewer new entrants to the supplier market than otherwise. Certain of the practices give the major buyers substantial advantages over other smaller retailers, whose competitiveness is likely to suffer as a result, again leading to a reduction in consumer choice. We took into account the advantages that can result from buyer power in relation to those suppliers with market power, and other offsetting benefits in relation to certain of the practices. We nonetheless conclude that the exercise of 27 of these practices by the five major buyers meeting the 8 per cent criterion operates against the public interest."

The correlation of food miles with supplier relationships is complex. For example, if the competitiveness of UK suppliers could be improved (for example through an effective code of conduct for supplier relationships with retailers), they could compete more effectively with suppliers in other countries, and food miles from imported produce could be reduced. However, if (as might be expected) a code of conduct applies equally to all suppliers, in the UK and in other countries, then there might not be any net effect on the ability of UK farmers to compete globally, and food miles would not be affected (although there would still be social and economic benefits for farmers). A strengthening of the UK supplier base could also lead to an increase in exports from the UK, and hence an increase in food miles. To assist in monitoring these effects, we recommend that food miles resulting from exports are identified separately within a food miles indicator set.

5.5 EFFECTS OF CHANGES IN FOOD RETAILING

Food miles are also linked to changes in the structure of food retailing in the UK. The main issues are:

- ◆ The current trends in food retailing are for an expansion in the market share of large multiple retailers and a decline in the numbers of smaller, independent shops (Box 8).
- ◆ This has effects on employment and local economies (discussed below in Section 5.5.1).
- ◆ The distance travelled to shops and the use of cars for food shopping increase when local food shops close. In addition, there are impacts on food accessibility. This is discussed in Section 5.5.2.
- ◆ DEFRA have identified that initiatives to promote local food can have important benefits for rural communities.

5.5.1 Employment and local economies

Changes in retail structure can result in a redistribution of local employment. One study has suggested that there will be a net loss of 276 jobs in the catchment area of each new supermarket.⁸⁴ (However, note that employment is less of an issue in areas with tight labour markets). In addition, many of the new jobs created in supermarkets are low productivity, unskilled and low paid. If independent food shops close, the jobs being lost may be more skilled (specialist butchers, bakers, fruiterers etc) and job satisfaction may be higher, especially where the shop owners are self-employed. A recent survey showed that those involved in the local food sector were nearly four times more likely to have received training than those involved in comparable non-local enterprises.⁷⁶

Several studies suggest that more of the money spent in local shops or directly with local farmers is passed to the local community than for money spent in supermarkets. One study of the multiplier effects of shopping for fruit and vegetables in a supermarket compared to a local organic 'box scheme' showed that every £10 spent with the box scheme was worth £25 for the local area, compared with £14 when the same amount was spent in a supermarket⁸⁵. Of course the same £10 spent in supermarkets on domestic produce would have generated multiplier effects (over and above the £14 generated locally) elsewhere in the UK economy.

5.5.2 Access to food and community services

The average distances travelled for food shopping have increased over the last few years, for both car users and non car users¹⁹. This is due to the closure of many local shops and markets, and also the loss of van sales services such as local farmers or fishmongers who drove around an area.

For mobile consumers the "one-stop-shop" aspect of supermarkets, with easy parking nearby, is very convenient. However, the closure of local shops can lead to problems for non car-owners, especially the elderly, disabled or those with young children. Low income groups without access to cars and living in deprived areas are more likely to end up in "food deserts", where the only local shops within reach do not sell a good range of fresh, healthy and affordable produce. In some cases, the arrival of a new supermarket can considerably improve access to nutritious food for these consumers⁸⁶.

However, even mobile consumers value the presence of local shops, which are convenient for "top-up" shopping and also can act as a focal point and meeting place for the community. A survey by Spar found that 80% of people felt it was important to have a general store within 10 minutes walk⁸⁸. Some small local shops provide additional

community services such as a post-office counter, notice boards and free delivery for elderly customers⁸⁷.

Box 8. Decline in small shops in the UK

There is a long term trend towards closure of small shops in the UK. From 1980 to 2000, the number of VAT registered retail outlets fell from 273,000 to 201,000⁸⁸. Between 1994 and 2001, the number of businesses selling food, drink and tobacco fell by 37%, from 68,000 to 43,000⁸⁸. These figures do not include businesses too small for VAT registrations.

Closures are highest in rural areas. Between 1991 and 1997 a total of 4,000 food shops closed in rural areas. The Rural Shops Alliance estimates that there are fewer than 12,000 rural shops left in Britain, and they are closing at a rate of 300 a year. In rural counties monitored between 1965 and 1990, each year 1 or 2% of small settlements experienced closure of their last general store or food shop, representing a loss for around 15% of rural communities over this period. It is claimed that seven out of ten English villages have no shop⁸⁸.

A study by the New Economics Foundation (NEF) has suggested that the decline in local shops is linked to a general trend towards loss of local services. Apart from shops, the numbers of, pubs, schools, post offices and banks in rural areas are all decreasing significantly. The NEF study argues that the closure of a local shop results in a loss of money within the local economy, which has knock-on effects for other local businesses and services. This study also highlights the social importance of a local shop to the community.

Source: DEFRA, Rural White Paper⁸⁹, NEF⁸⁸

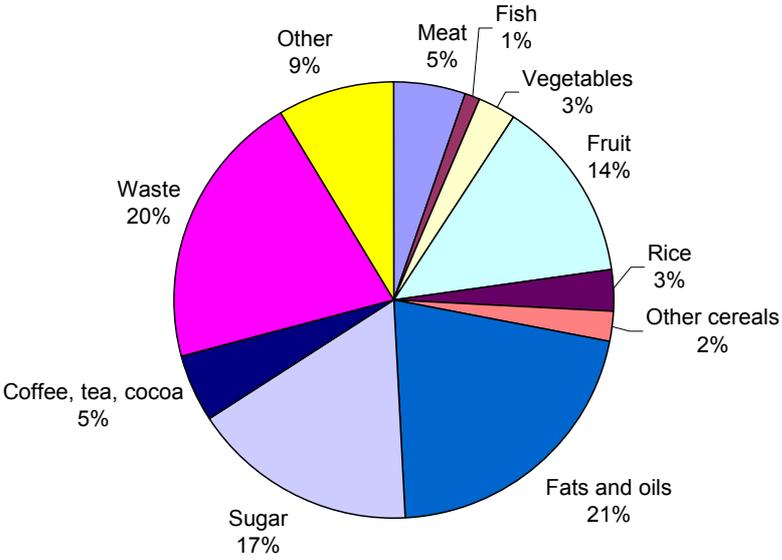
5.6 INTERNATIONAL TRADE AND DEVELOPING COUNTRIES

Food miles are often linked to the issues of international trade, globalisation, and impacts on developing countries. The issues are very complex and controversial and beyond the scope of this report. Recent reports^{90,91,92,93} have raised some of the issues, both positive and negative, in terms of development, socio-economic and environmental effects. For this report, we note that only 3.1% of food miles are due to imports from developing countries. We also estimate that around 70% of the imports from developing countries are non-indigenous foodsⁱ (see Figure 14). Much of these imports will be transported by sea, which has relatively low external costs – however, a proportion is airfreighted which has disproportionately high environmental costs.

ⁱ This is not a rigorous definition of “indigenous” and takes little account of seasonality. Sugar is classed as indigenous as it can be produced in the UK from beet, though current levels of production are dependent on the EU “sugar regime” trade rules. We class all meat, animal fats and vegetables as indigenous. Fruit is broken down into indigenous (apples and pears), non-indigenous (bananas, citrus etc) and seasonal (strawberries, apricots and other soft fruit) where half is classed as indigenous to allow for out-of-season imports. Oils and cereals are broken down into indigenous (wheat, maize, oats, rapeseed oil etc) and non-indigenous (palm oil, soya oil, rice, sorghum etc). All waste is classed as non-indigenous.

ⁱⁱⁱ There are both existing government-funded activities as part of the Carbon Trust’s ActionEnergy programme, and industry efforts. See for example the website of the British Tomato Growers’ Association, for information on how energy impacts have been reduced through uptake of CHP (combined heat and power), switch to natural gas instead of oil for heating, and recycling of CO2 from exhaust gases to stimulate growth in the greenhouse. <http://www.britishtomatoes.co.uk/health/greenhouse.shtml>.

Figure 14. Imports from developing countries, by food type



Further work is needed to address the issues of food transport from developing countries, within the context of wider social-economic and environmental effects

6 Case studies

There are three main issues to address in determining the validity and suitability of food miles as an indicator of sustainable development:

1. Is there adequate data of sufficient quality to readily construct an annual dataset which will accurately reflect changes in food miles arising from the UK food system?
2. Does a decrease in food miles always lead to an increase in sustainability?
3. Is the proposed indicator consistent with other government strategies and objectives?

In Section 3.4 we demonstrated that data quality is adequate to compile a meaningful annual indicator. In this section we use three case studies to explore in detail some of the arguments for and against food miles as an indicator of sustainable development. The last point, consistency with other strategies, is addressed in Section 6.3.

There are many obvious ways in which an increase in food transport has negative environmental and social impacts – particularly through air pollution, climate change and congestion. These impacts have been discussed and quantified where possible in Section 4.

However, it is also argued that the food supply systems which generate high food miles can have some positive impacts on other aspects of sustainability. These benefits include the profitability of the food retailing sector, consumer choice of a wide range of food, and positive health impacts where imported fresh produce not available in the UK can contribute to health (Section 5).

If food miles are to be adopted as an indicator of sustainable development, it is necessary to be confident that the exact indicator used is directly related to sustainability. In other words, a decrease in the indicator should result in an overall increase in sustainability. If there are exceptions to this rule, then either the indicator should be adapted (for example by excluding certain produce types or transport stages from the indicator), or it is necessary to demonstrate with reasonable certainty that the exceptions are insignificant.

When comparing similar food production systems, e.g. conventional European arable crop production on similarly sized farms, then clearly food miles give an accurate indicator of sustainability. Other things being equal, greater transport distances are associated with higher environmental, social and economic impacts. However, where food production systems are significantly different, this can change the balance of sustainability.

To explore the validity of the indicator further, we selected three of the most significant issues for further investigation through a set of case studies:

1. **Case Study 1. Energy balance for imported greenhouse crops.** Does it require more energy to grow unseasonal produce in the UK than to import it from overseas? We investigated this through a case study examining the energy balance for tomatoes imported from Spain compared to those grown under glass in the UK.
2. **Case Study 2. Organic vs local foods.** Is it better to import organic produce or use conventional foods grown in the UK? We attempted to assess the social costs for a sample case of importing organic wheat via three different transport modes.
3. **Case Study 3. Energy balance for processed foods.** Does the energy saved through reheating ready meals instead of cooking fresh produce at home outweigh the extra energy used in processing and transporting the food by the industry? We used data on chicken processing to investigate the issue further.

6.1 CASE STUDY 1 – ENERGY BALANCE FOR SPANISH VS UK TOMATOES

The aim of this case study was to answer the question: “Does it take more energy and produce more emissions to grow tomatoes in the UK than to import them from Spain?”

Around 100,000 tonnes of tomatoes are grown in the UK each year, and 320,000 tonnes are imported, of which 190,000 tonnes are from Spain and the Canary Islands⁹⁴. Tomatoes in the UK are grown mostly in glasshouses, allowing the growing season to be extended from February to November. This extends the outdoor season which is July to October.

The optimum temperature for tomato growth is 16 to 21°C. Glasshouses are heated to this level by mainly natural gas fuelled systems. British tomato growers reduced their energy use by 25 to 30% in the 10 years to 1995, and during this period most of the UK glasshouses were converted to natural gas⁹⁴. Production of tomatoes in the UK now requires 11 kWh of energy per kg of tomatoes⁹⁵. 90% of this energy is required for heating⁹⁶, we assume using natural gas. We assume that the remaining 10% is electricity for lighting, ventilation and irrigation.

Tomatoes in Spain are grown outdoors but under plastic sheeting. We assume that no heating is required, but we assume that the electricity use per kg is the same as in the UK, as energy will still be required for irrigation.

We assume that the energy used in transport, processing and packaging of the tomatoes is identical between Britain and Spain, except for the transport from Spain to the UK, which we assume is by road. (Some of the transport is by sea, but road is taken as a worst case).

Based on these assumptions, we have estimated emissions of carbon dioxide, NOx and PM10 for tomato production in the UK and in Spain, and for the additional transport involved in importing Spanish produce. The emission factors used are shown in Table 25 and the results of the analysis are shown in Table 26.

Table 25 Emission factors used for the tomato energy balance

		CO2	NOx	PM10
Gas	kt/Mth	5.5	4.88E-03	3.25E-04
	kg/Mth	5500000	4880	325
UK electricity	kt/TWh supplied	487	1.17	0.06
	kg /TWh	487000000	1170000	60000
	kg /kWh	0.487	0.00117	0.00006
Spanish electricity	t/TJ	131	0.344	
	t/GWh	472	1.24	
	kg /kWh	0.472	0.001	0.00003

Source: NAEI, AEAT calculations, IEA energy statistics.

Table 26 Emissions from energy used for production and transport of tomatoes

	British	Spanish	
Gas for production	9.9	0	kWh/kg
	0.0003	0	Mth/t
CO2 from gas use	1858	0	kg/t
NOx from gas use	1.65	0.00	kg/t
PM10 from gas use	0.11	0.00	kg/t
Electricity for production	1.1	1.1	kWh/kg
CO2 from electricity use	536	519	kg/t
NOx from electricity use	1.29	1.36	kg/t
PM10 from electricity use	0.07	0.03	kg/t
Additional transport to UK	0	1079	km by road
	0	182	km by short sea
CO2 from additional transport	0	111	kg/t
NOx from additional transport	0	1.38	kg/t
PM10 from additional transport	0	0.04	kg/t
Total CO2	2394	630	kg/t
Total NOx	2.94	2.74	kg/t
Total PM10	0.18	0.07	kg/t

The energy balance implies that the energy used for growing tomatoes in the UK significantly outweighs the energy used in importing tomatoes from Spain by road, resulting in over three times the CO₂ emissions. NOx emissions from both cases are similar, as HGV transport by road is a major source of NOx. PM₁₀ emissions are roughly double in the UK case.

From this case study we can conclude that there are certainly cases where it is better in energy terms to import non-indigenous produce or out of season produce than to grow it in the UK, where growing in the UK requires significant amounts of energy. This conclusion might also apply to other salad crops grown under glass.

However, the analysis has focussed only on the energy balance, and has not taken other sustainability factors into account. These include:

- ◆ UK tomatoes on average are grown using fewer pesticides than tomatoes grown overseas, and an increasing number are produced organically. In the UK, natural predators are often used to control pests.
- ◆ Closed irrigation systems are increasingly used in the UK to minimise release of excess nutrients to the environment.
- ◆ CHP systems are being installed which will further reduce the energy requirements of UK crops in future years. Also in some cases, some CO₂ from the gas heating systems is recycled into the glasshouse to stimulate growth.
- ◆ Socio-economic impacts – tomato growing in the UK employs 3,500 people, mainly in rural areas, and has a sales value of £120 million. Reduction in imports would benefit UK producers, at the expense of course of Spanish producers.

A full life cycle analysis would be required to compare the two systems accurately. This would include for example the different use of materials in the two systems (glasshouses vs plastic sheeting).

In addition there are some areas of uncertainty in the analysis. We do not have any figures on the use of electricity in Spanish tomato production. It is claimed that yields

are lower, so it is possible that more electricity would be used per kg of product. However, it is also possible that less electricity is required for lighting.

The caveats above emphasise that this case study is not intended to suggest that purchase of tomatoes from Spain is preferable in sustainability terms to purchase of tomatoes from the UK. However, the case study does suggest that it would be better to focus policies for reducing food miles firstly on produce which is imported even when it is in season in the UK.

The issue of energy efficiency applies only to protected crops such as salad or soft fruit which are produced using additional heating. This accounts for a relatively small proportion of total food miles. Therefore we conclude that this issue does not invalidate the indicator.

6.2 CASE STUDY 2 - SOCIAL COSTS OF IMPORTED ORGANIC WHEAT

A potential criticism of using food miles as an indicator of sustainability is that they do not distinguish between types of food being transported and the relative sustainability of different products.

Organic production considerably reduces many of the negative environmental impacts of conventional intensive food production. Ethically traded produce can also reduce some negative social impacts associated with supply of food from developing countries.

Demand for organic produce in the UK is growing strongly. The retail market for organic food reached £1 billion in 2003, increasing by 10% in the year ending March 2003, and sales of organic food in the UK are the second highest in Europe. However, much of the organic produce consumed in the UK is imported. In 2001/2002, imports accounted for 65% of UK organic food sales. The UK share of the market is improving as the quality of UK organic food improves. In 2002/2003, imports declined to 56% of all organic food, and 38% of indigenous organic food. The government has an objective to increase the UK share of the indigenous organic market to 70% by 2010. There is still much scope for improvement – for example a recent survey showed that less than half the organic onions on sale in UK supermarkets were sourced from the UK during November 2003⁹⁷. There have recently been reports that some organic farmers in the UK are planning to switch back to conventional farming as their margins are too low⁹⁸.

As transport of food has negative impacts on sustainability, it would be useful to know whether imported organic produce has a lower overall impact than home-grown non-organic produce. If this is the case, then it could be argued that policies to reduce food miles which reduce imports of organic food (without increasing production of UK organic food) could have a negative impact on sustainability.

Organic production has benefits in a wide variety of areas, e.g. biodiversity, landscape, water supply, and energy use. These are compared against transport impacts below.

Table 27 The relative impacts of organic production and transport

Impact	Benefit of Organic impact	Disbenefit of transport impact
Acid rain	-	Low impact
Biodiversity/Wildlife	High benefit	Low impact
Employment	Small benefit	(High benefit)
Energy Use	High benefit	High impact
Eutrophication/nitrate run-off	High benefit	-
Landscape/Aesthetics	Moderate benefit	Moderate impact
Accidents/congestion	-	High impact
Noise	-	High impact
Particulates	-	High impact
Pesticides/pollution of water	High benefit	-
Pharmaceuticals in food	Small benefit	-
Soil quality	High benefit	-
Waste	High benefit	Small impact

We first carried out a simple energy balance analysis for several crops, to illustrate the trade-off between the energy savings which can be achieved with organic production and the energy required to transport organic produce. We then carried out a more detailed comparison of the social costs of imported organic wheat vs conventional UK wheat.

Several crops are shown in the left column of Table 28 below. The second column shows the difference between the energy consumption of producing a kg of each crop in organic agriculture and in non-organic agriculture⁹⁹. The right column of Table 28 calculates the road and air freight distances which would consume the same amount of energy as the saving from organic production in the second column.

Table 28 Road freight distance equivalent to energy savings in organic agriculture

Crop	Energy saving in production (MJ/kg)	Freight distance (km) equivalent to energy saving*	
		Road	Air
Winter Wheat	0.9	782	11
Potatoes	0.4	347	5
Cabbages	0.6	521	7
Onions	0.4	347	5
Leeks	0.5	434	6

*Assuming road freight consumes 1.2 MJ per tonne km and air freight (short haul) 84 MJ/tkm. Source: Emission factors from DETR Guidelines¹⁰⁰ and NAEI⁹⁹. Organic energy savings from ADAS report⁹⁹. Note the units, i.e. $1.2\text{MJ/tkm}=0.0012\text{MJkg}^{-1}\text{km}^{-1}$.

The table shows that producing a kilogramme of winter wheat organically can save 0.9 MJ of fuel. However, this energy saving is lost if the organic wheat is transported over an additional distance (compared to UK conventional wheat) of more than 782 km by road, or 11 km by air. This illustrates that after a fairly short transport distance, the energy savings of organic agriculture are cancelled out by energy used for transport. Imports from further away than the Benelux countries or northern France would be associated with a net energy penalty compared to using locally sourced conventional

wheat. The equivalent transport distances for other crops are even lower, from 340 to 520 km by road.

However, the simple energy balance above does not take into account the other benefits of agricultural production, e.g. biodiversity, water use, landscape etc. In order to compare these impacts directly, they must be converted into monetary terms. We have based our analysis on a study by Pretty et al¹⁰¹, which attempts to estimate the total social costs arising from UK agriculture. We have adapted the analysis to estimate equivalent costs for organic agriculture, by omitting costs such as those arising from artificial fertiliser and pesticide use. We focused on arable agriculture. The cost analysis is shown in Table 29. Pretty et al estimate the external costs of UK agriculture (arable and permanent grassland) to be £208 per hectare, or £229 for arable only. We estimate equivalent costs of £65 for all organic farming, or £62 for arable only.

It is important to note that the estimates contain acknowledged areas of uncertainty, and some of the categories assessed are known to be underestimates. The main caveats of relevance to this study are that:

1. The costs are not on a willingness-to-pay basis – they are generally the financial costs to the UK of efforts to rectify the damage caused by agriculture. For example, the water quality costs represent the financial costs of cleaning the water to a standard suitable for drinking.
2. The assessment of biodiversity costs is based on the cost of biodiversity action plans in the UK. Not only will this be an underestimate compared to a willingness to pay measure, but also the action plans do not aim to restore habitats to their full pre-damage state, only to partially mitigate the damage.
3. Health impacts from pesticides represent the cost to the NHS of hospital admissions and GP consultations related to acute pesticide harm. They do not include a willingness-to-pay measure for avoidance of health impacts, which would be much greater. They do not include cases where the link to pesticides is unreported, or cases not resulting in a trip to the doctor (e.g. headaches). There is also no assessment of chronic pesticide effects, in particular cancer, as the links are poorly understood. Therefore the figure for pesticide health impacts is a considerable underestimate.
4. Antibiotic resistance has not been costed. This would increase the costs of conventional livestock farming, although it is not relevant to arable crops.

All the points above tend to increase the costs of conventional farming relative to organic farming.

We applied an estimate of the typical yield of organic and conventional winter wheat to the costs per hectare, to obtain social costs per tonne of wheat. Yields of wheat reported in the literature vary widely, typically averaging 8 to 10 tonnes per hectare for conventional wheat and 3 to 8 t/ha for organic wheat¹⁰². Wheat appears less suited to organic agriculture than some other cereal crops such as oats, as commercial varieties of wheat bred for conventional agriculture have poor disease resistance¹⁰³. However it appears that for well managed organic farms with successful crop rotation schemes, yields of 60-70% of those of conventional wheat can be achieved¹⁰⁴. We have assumed a typical yield of 8t/ha for conventional wheat, and 60% of that for organic wheat. This resulted in estimated social costs of £28.6 per tonne of conventional wheat, and £12.6 per tonne of organic wheat.

Table 29 Social costs of conventional and organic agriculture

Category	Impact	Arable and pasture		Arable only	
		£m Conventional	£m Organic	£m Conventional	£m Organic
1	Water				
a	Pesticides	120	0	96	0
b	Nitrate	16	8	8	0
c	Phosphate and soil	55	37	27.5	19
d	Zoonoses	23	23	0	0
e	Eutrophication and pollution	6	3	3	1.5
f	Monitoring and advice	11	0	5.5	0
2	Air				
a	Methane	280	280	140	140
b	NH3	48	48	0	0
c	N2O	738	0	590	0
d	CO2	47	47	23.5	23.5
3	Soil				
a	Erosion	14	14	7	7
b	Organic matter and carbon losses	82	0	41	0
4	Biodiversity and landscape				
a	Biodiversity and wildlife	25	0	12.5	0
b	Hedgerows and walls	99	99	49.5	49.5
c	Bee colonies	2	0	1	0
d	Agricultural biodiversity	?	?	?	?
5	Health - pesticides				
a	Acute	1	0	0.5	0
b	Chronic	?	0?		0
6	Health - nitrate	0	0		0
7	Health - disease				
a	Bacterial	169	169	42.25	42.25
b	Antibiotic resistance	?	0	0	0
c	BSE and nvCJD	607	0	0	0
	Total	2343	728	1048	282
	mha	11.28	11.28	4.58	4.58
	£ Per hectare	208	65	229	62
	yield of wheat (t/ha)			8	4.8
	£/t wheat			28.6	12.8

Source: Pretty et al¹⁰¹ plus AEAT calculations

We combined the social costs of production per tonne of wheat with the estimated social costs of transport from this study in order to compare the total social costs of imported organic wheat with those of conventional UK wheat (Table 30).

Table 30: Comparison of social environmental costs of imported organic wheat and conventional UK wheat

Import route	USA By sea	USA By air	Italy By road
TRANSPORT IMPACTS			
Distance (km)	6189	5585	1444
Pollution			
<i>Emission factors (g/tkm)</i>			
CO2	15.3	570.0	98.15
PM10	0.01	0.17	0.03
NOx	0.24	2.98	1.20
VOCs	0.01	0.80	0.06
SO2	0.26	0.20	0.00
<i>Emissions (kg/t wheat imported)</i>			
CO2	95	3183	142
PM10	0	1	0
NOx	2	17	2
VOCs	0	4	0
SO2	2	1	0
<i>Social costs (£/ t wheat imported)</i>			
CO2	1.8	60.8	2.7
PM10	0.1	1.6	1.5
NOx	0.1	0.7	4.9
VOCs	0.0	0.1	0.0
SO2	0.5	0.2	0.0
Congestion, accidents, infrastructure and noise			
<i>Social cost factor (£/tkm)</i>			
Congestion	0.000	n/a	0.003
Accidents	0.000	n/a	0.008
Infrastructure	n/a	n/a	0.008
Noise	0.000	n/a	0.002
<i>Social costs (£/ t wheat imported)</i>			
Congestion	0	n/a	4.4
Accidents	1.2	n/a	11.3
Infrastructure	n/a	n/a	11.9
Noise	0	n/a	3.3
Transport social cost summary	£/t wheat	£/t wheat	£/t wheat
CO2	1.8	60.8	2.7
Air quality	0.7	2.6	6.4
Congestion, accidents, infrastructure and noise	1.2	n/a	30.9
Total	3.7	63.4	40.0
Net social costs	16.5	76.2	52.8

Summary: social costs of winter wheat production and transport to UK

Source	£/t wheat
USA by sea	16.5
USA by air	76.2
Italy by road	52.8
UK conventional	28.6
UK organic	12.8

Note that the social costs of transport do not currently take account of the location of the emissions. As described in Section 4, we make the crude assumption that 5% of long haul air and 10% of deep sea emissions attract social costs at the same rate as land transport, with the exception of particulate emissions at sea which are assigned zero costs.

The table shows that the social costs of the imported organic wheat vary enormously depending on the transport mode and origin of the wheat. Wheat imported from the USA by ship has a lower social cost than conventional UK wheat. However, organic wheat imported from Italy by road has social costs around a factor of two greater than conventional UK wheat. Wheat transported by air (not that this would normally happen for wheat, but organic vegetables and fruit are a major component of food air freight) has social costs three times greater than conventional UK wheat.

From this case study we conclude that:

1. The full environmental costs of producing organic arable crops can be less than half those of conventional crops.
2. If organic arable crops are imported, there is a social cost penalty relative to locally produced conventional crops, arising from the environmental impacts of transport (pollution, accidents, congestion etc). However this can be offset by the other benefits of organic food. The net environmental costs depend on the transport mode and distance.
3. Imports of organic produce by air do not provide a net environmental benefit.
4. Imports by sea could well provide a net benefit.
5. Our analysis shows no benefit from imports by road, but if the full costs of biodiversity and wildlife loss and pesticide effect on health were included in the analysis, imports by road from Europe could possibly provide a net benefit.
6. In all cases, it is of course far preferable to source organic wheat from the UK.

The implications of this for our study are:

1. The size and rapid growth of the organic food market in the UK, the high level of imports and the significant differences in sustainability between organic and non-organic food mean that there is a need to ensure that the validity of an indicator based on food miles is not compromised by treating organic and non-organic food miles in the same way.
2. In practical terms, it is unlikely to be possible to separate out organic and non-organic food miles in a food miles indicator.
3. Organic production is covered by other indicators in the sustainable farming and food strategy.
4. There is of course no difference in the impacts of transporting organic and non-organic food.
5. The food miles indicator would only be compromised if imported organic produce declined and was NOT replaced by UK-produced organic food.

For these reasons we do not recommend producing separate estimates of organic and non-organic food miles as part of the final indicator. However, policies to reduce food miles should be designed carefully to ensure that there are no adverse effects on the UK organic food market.

6.3 CASE STUDY 3 - ENERGY BALANCE FOR PROCESSED CHICKEN

The examples in this study so far, and in many other food miles studies, have focussed largely on fresh, unprocessed produce. However, part of the reason for the increase in food miles over the last decades has been the increase in processing and packaging of food, resulting in the transport of many different ingredients and packaging materials between factories to make the final product. The classic example of this is "The well-travelled yoghurt pot"¹⁰⁵, a study of the movement of materials around Europe to make a pot of yoghurt.

However, the food processing industry has argued that it is more efficient to cook food in a factory and simply reheat it at home than to cook it at home. Therefore the aim of this case study was to examine a more highly processed food, and to ascertain whether the additional energy used to transport and process the food in the factory is outweighed by the savings in cooking energy in the home.

We used a study of the energy balance of the chicken supply chain supplied to us by DEFRA¹⁰⁶.

Two types of chicken for domestic consumption are considered:

- a) Fresh whole chicken – bought chilled and cooked using a conventional electric oven
- b) Chicken ready meals – bought chilled and cooked in a microwave

The parameters of the model as supplied assumed that there was no difference in the transport of the fresh chicken or the chicken ready meal. This would be a reasonable assumption for the chicken component of the meal, if the chicken processing was carried out at the same factory as the preparation of fresh chicken (as is often the case). However, the other ingredients of the meal have been transported an extra distance to the chicken processing factory. Our approach was therefore to calculate the energy difference between the fresh and processed chicken, and then to convert this energy difference into an equivalent transport distance to find the "break-even" amount of additional transport of added ingredients which would give an equal energy consumption for each type of chicken. This would illustrate whether processed foods could offer any energy savings relative to fresh home cooked foods.

Other assumptions are that:

- a) No account is taken of the non-chicken ingredients of chicken ready meals and the energy inputs in their life cycle;
- b) Chicken lost to wastage is not used for any other product.

The calculated energy input required for the production of each kilo of chicken are as follows:

	Energy input per kg of product (kWhe/kg)
Whole chicken	13.23
Chicken ready meal	9.67
<i>Difference</i>	3.37

Note: kWhe = one kilowatt hour of electricity (or energy equivalent for a different fuel)

The difference of 3.37kWhe/kg equates to an additional 9.4 tonne km of transport (assuming transport energy usage to be 0.3583kWhe/tkm). Thus for example if 1 kg of chicken ready meal required the transport of 1 kg of additional ingredients and packaging

materials, these ingredients could be transported a total distance of 9400 km before the energy benefits of factory processing were lost.

For the two types of chicken product the energy inputs split as follows:

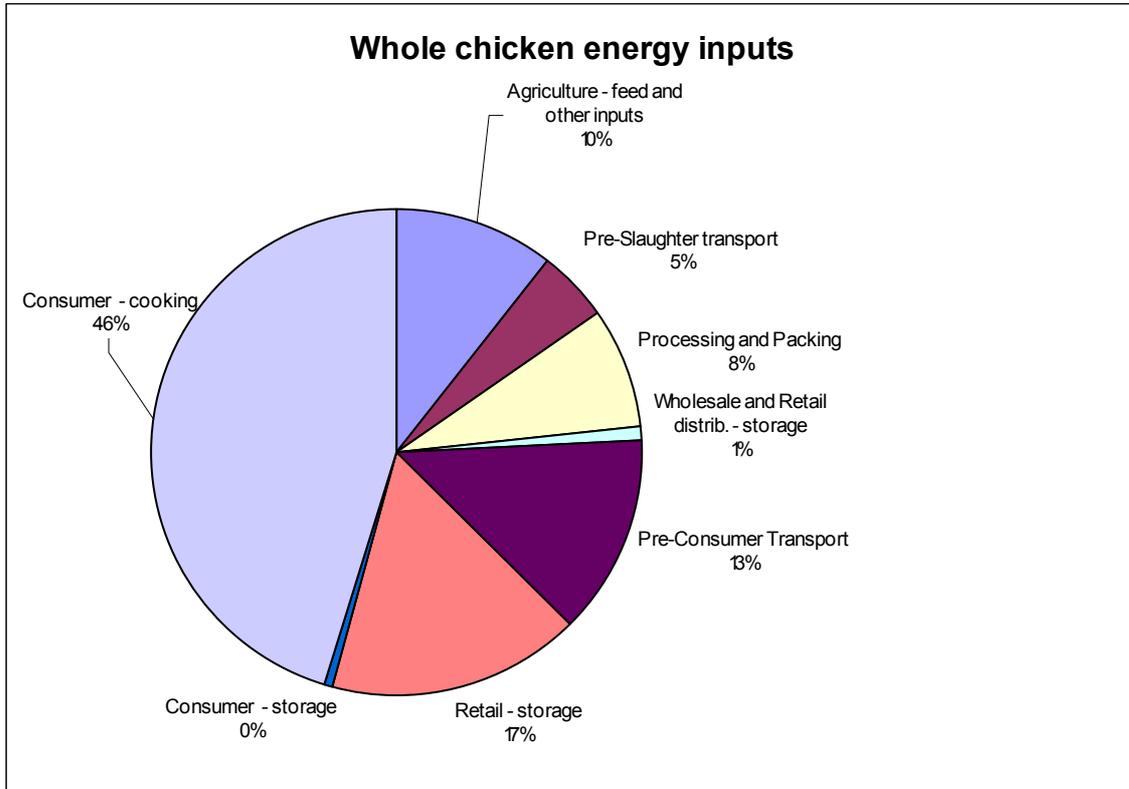


Figure 15 Breakdown of energy inputs: Whole chicken

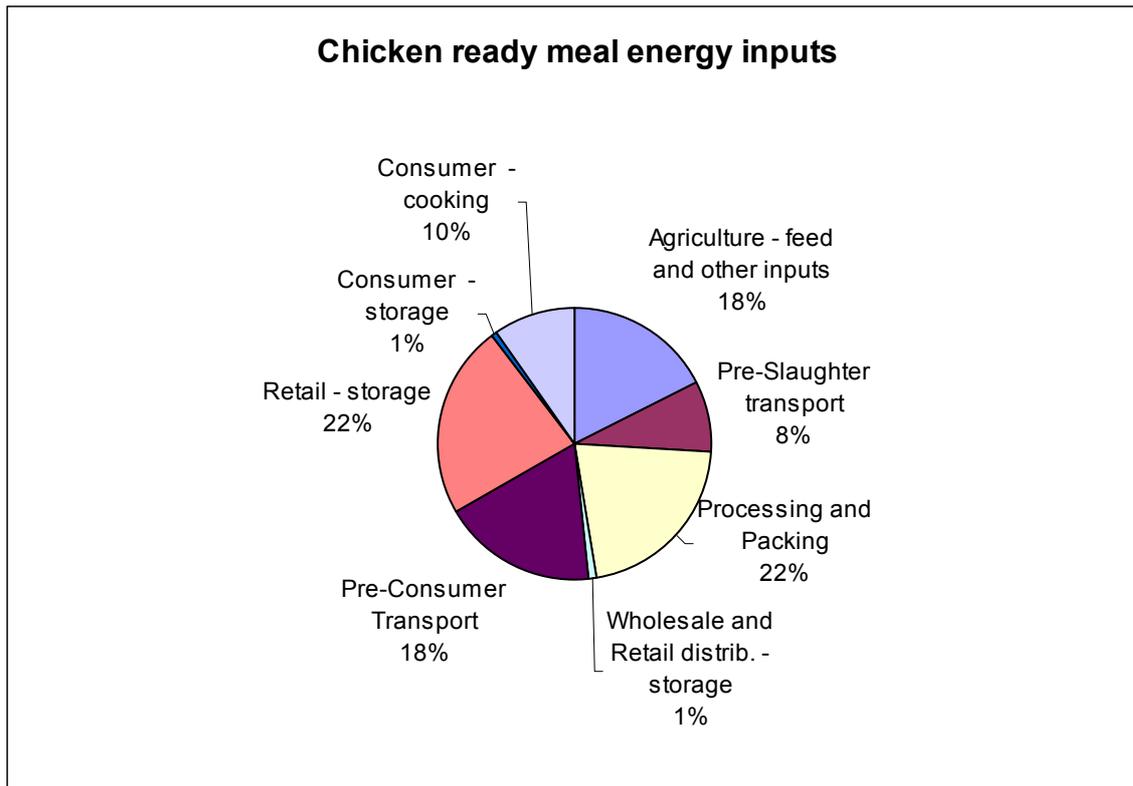


Figure 16 Breakdown of energy inputs: Chicken Ready Meals

It is clear from the above breakdown of energy inputs that energy consumption in cooking a whole chicken at home is a substantial proportion of the total – 46% of total energy inputs. For chicken ready meals the cooking energy at home is only 10% of total inputs. However, this assumes that the home cooked chicken is cooked in an electric oven – the most energy intensive way of cooking. If a less energy intensive cooking method was chosen, such as separating the chicken into portions for grilling or frying, and using gas instead of electricity, this could well alter the balance between the two scenarios. Also, ready meals may often be cooked in an electric oven, which would significantly increase the impact of the ready meal.

There are also health impacts to be considered when evaluating processed food against freshly cooked food. Processed food is generally higher in salt, additives, and often in fat and sugar, than home cooked food. Nutrients are also lost during the preparation and storage processes.

We conclude that it may be possible in some cases that overall energy savings are achieved through manufacture of processed “ready meals” which require only reheating in the home. However, this depends on the cooking method used for the fresh produce. Also the nutritional implications of consumption of processed food need to be considered.

The implications of this finding for a food miles indicator are not significant. Only those additional food miles related to transport of ingredients for manufacturing microwaveable ready meals, over and above the food miles for bringing an unprocessed equivalent to the shop, would be affected by this finding, and this would be a small proportion of all food miles. However, there is a wider issue related to the energy efficiency of production of foods in small local enterprises compared to in large factories, and this would require appropriate monitoring and supporting policies (e.g. to improve energy efficiency of smaller enterprises) should a food miles indicator be introduced.

6.4 ARE FOOD MILES A VALID INDICATOR OF SUSTAINABLE DEVELOPMENT?

Here we summarise the arguments for and against food miles as an indicator of sustainable development (Box 9), and consider whether it is possible to design a valid indicator taking account of the issues identified in the box.

Box 9. Arguments For and Against a Food Miles Indicator

For

Data is adequate for compilation of a valid indicator on an annual basis.

Social costs of congestion, accidents, infrastructure, CO₂, noise and air pollution related to food miles are estimated as over £9 billion per year.

CO₂ emissions in the UK are 1.8% of the UK total, and **NO_x emissions** in the UK are 4% of the UK total, with additional emissions overseas

Some impacts are not covered by other indicators or policies, e.g. CO₂ emissions from international air and sea transport are not in the UK inventory and fuels are untaxed.

Against

Energy intensive horticulture: It could take more energy to produce some crops in the UK than to import them from warmer countries.

If imports decrease, some overseas road transport associated with food manufacture may be replaced by **additional UK road transport**.

Possible increased **van congestion** if local deliveries increase. Also, **reductions in transport efficiency** (using smaller vehicles and lower load factors) could offset the decreases in distances travelled by food. Potential decreases in **food production energy efficiency** as economies of scale are lost.

Wider effects (dependent on policy)

Social and economic benefits: Some lower food miles systems could help to strengthen local economies and communities, improve access to food for non car-owners, improve the competitiveness of UK farmers, build closer links between consumers and producers, reduce transport of live animals and improve food awareness and consumption of fresh produce.

Some options for reducing food miles could reduce **consumer choice** or increase **food prices**. This could lead to reduced consumption of fruit and vegetables, with possible **health impacts**.

Organic and ethically traded food could have net sustainability benefits even if imported.

Possible economic costs – a reduction in food miles could possibly lead to a loss of profitability for large retailers and the transport industry, or economic losses for developing countries.

A certain amount of food transport will always be necessary in order to supply consumers with a good range of healthy, nutritious and affordable food. However, if all other factors are equal, reducing food miles will generally have a beneficial effect on sustainability through reducing the environmental burdens associated with road, sea, air and rail transport.

However, food supply and consumption is a complex system and often other differences between higher and lower food miles options (e.g. transport mode, geographical location of food source, method of food production, distribution of sales through alternative outlets) have a bearing on the net sustainability of the system. This gives rise to cases where a decrease in food miles is not necessarily directly linked to a sustainability benefit. Some of the exceptions we have identified include import of non-indigenous or out-of-season foods where production in the UK would entail excessive energy consumption, or (in some cases) transport of organic food where it displaces non-organic food from a nearer source.

Wider economic effects are hard to assess. Where reducing food miles means sourcing food from a different supplier, or selling it through a different retail outlet, there will be implications in terms of the price paid by consumers and the profitability and employment levels of producers, processors, packers, retailers, caterers, wholesalers and the freight and logistics industry. The magnitude and distribution of positive or negative effects depend on a number of factors which can be influenced by the policies selected to encourage a reduction in food miles.

Finally, moving to a lower food miles system has possible implications for transport efficiency and energy efficiency. If there is a growth in business for smaller producers and retailers, there could be an increase in energy consumption or congestion as smaller vehicles are used and economies of scale in production are lost.

We need to consider whether a food miles indicator and supporting policies can be designed in such a way as to take account of these considerations. The areas of concern identified above and in Box 9 will be addressed in turn below.

6.4.1 Energy balance issues

We have shown that for some protected crops such as tomatoes, production in the UK may entail higher energy consumption than import and transport from a warmer country such as Spain. However, our analysis did not take into account other factors affecting the relative sustainability of the two systems, such as use of pesticides, which is claimed to be lower for British tomatoes⁹⁴. Also, food miles associated with import of salad crops are a relatively small proportion of total food miles, so we do not believe this issue would invalidate the indicator as a whole. For example, tomatoes form only around 1% of total food consumption in the UK³⁵.

Potential measures to address this issue include further support for measures to improve the energy efficiency and increase use of renewable energy in the UK protected crops sector, such as use of combined heat and power plants or biofuelsⁱⁱⁱ. Other measures to improve sustainability could include further reduction in agrochemical input or water use.

An alternative is to encourage consumers to substitute seasonal indigenous produce for out of season and non-indigenous produce. This might be reasonable up to a point (e.g. do we need air freighted cherries and strawberries all year round?) but consumers are unlikely to drastically reduce their consumption of favourite imported foods, and there could possibly be an impact on health if less nutritious varieties were substituted, e.g. apples for bananas or oranges.

6.4.2 Import of organic foods

Our case study showed that, in some cases, it can be more sustainable to import organic foods than to source non-organic foods in the UK, because benefits of organic production can offset transport impacts. The study suggested that there might be a net benefit in cases where organic food is imported by sea or for short distances by road, but that these benefits were lost for air transport or long distance road transport. However, the most sustainable option is to choose organic food produced in the UK. There is already a government objective to expand organic production in the UK, with DEFRA's Action Plan for Organic Food and Farming in the UK and the target of increasing the UK share of the organic market for indigenous food to 70% by 2010. We propose that the UK share of the organic market for indigenous food is included as part of the suite of food miles indicators. One caveat is that there should be accompanying research into consumer demand to avoid situations of over-supply when developing the UK organic market.

6.4.3 Impact on developing countries

Concern has been expressed that policies to reduce food miles could have an adverse impact on imports from developing countries, and for some policy scenarios and some countries and commodities this could be true. However, in Section 5.6 we showed that imports from developing countries account for a relatively small proportion of total food miles (3%), and over 90% of these imports would probably be unaffected by policies to reduce food miles. To address any further concern, it would be possible to monitor the value of imports from developing countries to ensure that policies are not having any adverse economic impact. Policies that affected developing country imports (i.e. to reduce food miles) could also be accompanied by other policies (e.g. trade reform, development assistance and encouragement of more sustainable productionⁱ).

6.4.4 Consumer choice and food prices

Concern has been expressed that some policies associated with a reduction in food miles could reduce consumer choice or increase food prices, and that this could lead to reduced consumption of fruit and vegetables, with associated health impacts.

Several key avenues for reducing food miles, such as reducing car food shopping, would have no impact on consumer choice or food prices. Others, such as improving freight transport logistics, could even reduce food prices (see Annex 4). However, in some cases it is possible that food prices could increase:

1. If policies to internalise the social costs of transport were implemented, for example through road user charging or fuel tax increases, this could directly increase transport costs and therefore food costs.
2. Locally sourced food can be more expensive than globally sourced food, perhaps because economies of scale are lost (in cases where the local source involves smaller scale production, distribution or retailing), or due to differences in climatic conditions or labour costs.

Distribution costs are currently only 3.5% of food prices. It therefore seems unlikely that any policies to reduce food miles through internalising the social costs of transport would

ⁱ More sustainable production has the potential to reduce food miles through reducing oversupply of commodities, and focusing on value-added produce. This can be done in a number of ways, for example through demanding minimum social standards of production such as those often used in ethical trading agreements (e.g. no forced labour, workers have the right to form a trade union, no child labour). Environmental standards can also be set, e.g. to protect key ecosystems, conserve fish stocks and reduce pollution

have a significant effect on food prices in general. However, there might be an impact for certain goods and certain modes of transport. For example, there might be noticeable price increases for some very low-priced "value" brands where transport is a higher proportion of the overall price. Also, the price of air-freighted goods might increase significantly if the full environmental impact of air transport is reflected in the fuel price.

If the main thrust of the policy framework is aimed at raising consumer awareness of the impacts of food miles, and stimulating demand for more local foods, then any increases in cost arising from more local sourcing could be largely passed on to the consumer. It seems unlikely that consumer choice would be adversely affected if a demand for more local foods originates with the consumer. Indeed, local food sourcing can increase consumer choice by making more local varieties of fresh produce available in addition to the relatively small number of standardised varieties currently available in supermarkets.

We conclude that policies to address food miles would not be invalidated by concerns over consumer choice or food prices. However it would be important to design supporting policies in such a way that choice, accessibility and affordability are enhanced, not diminished.

6.4.5 Economic impacts

The economic implications depend on a number of factors such as the distribution of sales through different retail outlets, and the choice of policies selected. For example, if sales through local outlets increase, there could be a slight decrease in turnover for the large retailers. A significant decrease seems unlikely as the convenience of shopping at large superstores will almost certainly maintain the current large proportion of food sales through these outlets. The impact on the freight industry is not clear – there could be a reduction in long distance haulage, but an increase in local and regional transport. Some overseas freight associated with production of imported foods could be displaced to the UK. Further work would be required to evaluate economic impacts in more detail.

6.4.6 Exports

Any reduction in exports resulting from policies to reduce food miles would lead to reduced economic benefits for the UK, but increased benefits for whichever country substituted its products for the UK products. Most policies to reduce food miles, such as increasing consumer awareness of the impacts or strengthening local food initiatives, would have no effect on food exports. However, to enable this issue to be monitored, the food miles indicators can be presented both with and without exports.

6.4.7 Decrease in transport energy efficiency and production energy efficiency

Again, impacts depend on the choice of policies to reduce the impacts of food miles. Some policies (such as improvements to freight logistics or reduced car shopping miles) would have a beneficial impact on transport energy efficiency. Policies which resulted in greater consumer demand for UK food compared to imported food would probably not have a dramatic effect on transport efficiency, which would still be orientated around the supermarket regional distribution centres. However, concern has been expressed that increased activity in the "local" food economy, typically defined as foods originating from around 30 miles from their point of sale, could lead to increased congestion if single deliveries in large vehicles are replaced by many deliveries in smaller vehicles. Also there could be a general decrease in transport energy efficiency associated with more use of smaller vehicles, lower load factors and more empty running.

It is possible that any increase will be mainly on rural roads where noise, congestion and pollution impacts are less significant, although CO₂ impacts will be no less important. However, this issue still has the potential to be significant and to offset some of the environmental benefits of a lower food miles system. We therefore recommend further research into these issues, and monitoring of local traffic patterns to assess whether any effects are significant at the local level. Also, it is important that any efforts to boost local food initiatives are accompanied by policies to improve the transport efficiency of local food distribution systems, such as co-operative distribution amongst local producers and retailers to maximise load factors.

There are similar concerns over energy efficiency in food production. It is possible that processing of some local foods might be less energy efficient than for large centralised factories. On the other hand, there is some indication that businesses involved in local food production are also more aware of environmental issues and more likely to be involved in, for example, waste reduction initiatives than comparable non-local businesses⁷⁴.

It has also been argued that highly processed foods such as ready meals may save energy overall, due to reduced home cooking energy. However, this depends on cooking method, and the nutritional value of the food must also be considered. Also, a relatively small proportion of food miles is related to transport of ingredients for ready meals.

As for transport, it is therefore desirable that efforts to improve local food systems are accompanied by measures to promote energy efficiency, waste reduction and use of renewable energy amongst these businesses. Further research and monitoring could also be worthwhile.

6.4.8 Summary

The findings of the study suggest that it would be possible to construct a food miles indicator which is a valid indicator of sustainable development. In general it appears that an increase in food miles is correlated with negative sustainability impacts. The exceptions to this can be dealt with in one of three ways:

1. If the exception is valid and significant, it might be possible to deal with it through a modification to the indicator. For example, different transport modes can be separated and food miles could be expressed both including and excluding exports. We recommend a structure for the indicator set in the next chapter.
2. Alternatively, the exceptions can be catered for through the policy measures selected to encourage reduction of food miles. For example, a reduction in consumer choice can be avoided through focusing the policy framework on encouraging consumers and retailers to seek local sources of indigenous seasonal produce, especially organic produce.
3. Issues which continue to cause concern and which cannot be resolved without experience of the way in which a food miles indicator is implemented should be carefully monitored, and policies put in place to minimise any adverse effects. For example, concerns over a loss of transport efficiency should be addressed through surveys of local food distribution efficiency and supporting measures to improve local food logistics and use of cleaner vehicles.

7 Key food miles indicators

7.1 DERIVATION OF A SET OF KEY INDICATORS

This study has shown that the relationship of food miles to sustainability is complex. Two important findings are:

1. The direct impacts of food transport are highly dependent on transport mode.
2. The wider social and economic impacts of food miles are difficult to quantify, and are highly dependent on social, political and economic factors.

It is clear that a simple numerical measure of food miles based on total tonne kilometres would not necessarily be directly correlated with sustainability. We have therefore selected a number of potential indicators, divided into two categories:

1. **Direct indicators**, which reflect the major direct impacts of food transport (congestion, accidents, greenhouse gas emissions, noise, pollution, and infrastructure costs).
2. **Supplementary indicators** which address some of the wider social and economic impacts, and take account of some potential exceptions to the link between decreasing food miles and increased sustainability.

Below we describe how the indicators were selected, we assess their limitations, and we evaluate the potential indicators for the years 1992, 1997 and 2002 to assess the prevailing trends. Finally we select four key "headline" indicators that encapsulate the most significant direct impacts of food transport.

7.1.1 Should indicators be physical or monetary?

We considered two possible ways of measuring the impacts of food transport:

1. As a physical quantity, e.g. amount of pollution emitted.
2. As a monetary cost, derived from the physical quantity.

The monetary cost translates the physical quantities into a measure of the actual damage to society, and also allows different impacts to be compared to each other. However, using social cost estimates, such as those presented in Section 4, to reflect the impacts of food transport is problematic. The degree of uncertainty associated with estimation of the impacts is considerably greater than that associated with quantifying the food miles in terms of vehicle km, particularly when the impacts are monetarised. There is considerable uncertainty involved in costing impacts such as congestion or the health effects of air pollution. Also, inclusion of social cost estimates would make the annual updating of the indicators considerably more complicated, labour intensive and prone to error.

Accordingly, a set of indicators based on impact-related physical quantities is proposed.

7.1.2 Selection of indicators

It is rarely possible to measure the direct impact of food transport in physical terms. Instead, we use proxy indicators to represent the most important negative impacts of food transport. For example, HGV transport is responsible for almost all the social costs of infrastructure maintenance, and so total HGV km have been used as a proxy for infrastructure costs. On the other hand, urban road traffic is largely responsible for

congestion, and so total urban food transport km have been used as a proxy for congestion. Air food miles are also included as air transport has the greatest climate change impact per tonne kilometre of any transport mode. The list of potential indicators is shown below.

Direct indicators

- ◆ **Urban road vehicle km** as a proxy for accidents and congestion costs (separated into car, LGV and HGV vehicle km).
- ◆ **HGV vehicle km** on all road types, as a proxy for infrastructure costs, which arise mainly from HGVs.
- ◆ **Air km** important as this is disproportionately environmentally damaging per tonne of food carried (in terms of climate change).
- ◆ **CO₂ emissions** proxy for climate change impacts, measured in tonnes.
- ◆ **Atmospheric pollution** proxy for health impacts, in tonnes of NO_x, SO_x and PM₁₀.
- ◆ **Live animal tonne km** as a partial proxy for animal welfare.

Supplementary indicators

- ◆ **Imports of indigenous foods** – to indicate scope for expansion of UK market share
- ◆ **Ethically traded foods** related to socio-economic effects in developing countries
- ◆ **UK organic market** Proportion of (indigenous) organic food consumed in the UK which is grown in the UK.

The advantage of this approach is that the indicators are relatively simple to quantify, and the data sources and parameters used are relatively reliable. Year-on-year trends will be related to changes in sustainability. The disadvantage is that some detailed information is lost by using proxies. For example, if road safety measures reduce accident rates, thus reducing the impact of food transport to some extent, this will not be reflected in the indicator set, which simply uses urban food km as a proxy for accidents. However, we do not believe that this loss of detailed accuracy will significantly affect policy decisions. Reducing urban food transport will always be beneficial for sustainability (providing this is done through sensible policy initiatives which do not reduce access to food for consumers or supply of food to shops).

7.1.3 Assessment of indicator quality, caveats and limitations

The main caveats relating to the use of the proxy indicators as a measure of sustainability are presented below.

Urban road vehicle km

Urban food transport has been used as a proxy for accidents and congestion costs in the current version of the indicator set. This study has estimated that urban food transport accounts for 68% of all food-miles-related accidents in the UK (see Table 31) and 77% of congestion costs. However, there are two problems with this indicator. Firstly, urban traffic accounts for only 37% of the fatal accidents, with travel on rural roads accounting for 52% of fatal accidents. Secondly, and more seriously, the proportion of travel on different road types is currently estimated using fixed percentages which apply to all travel in the UK. Therefore, changes in urban food km relative to food km on other road types may not be detected by the indicator using the current database methodology.

In order to increase transparency and to allow car shopping effects to be separated out from food delivery operations, we propose to separate urban food km into car, LGV and HGV km. This will allow policies to be targeted more effectively at these different sources of impacts.

It is worth noting that cars account for 75% of all food transport-related accidents in the UK and 54% of all congestion costs, so an alternative proxy for congestion and accident costs could be total car food km. Car food km are estimated from the annual DfT personal shopping survey, and thus annual changes are detected, It would then be useful to monitor LGV transport separately, to establish whether there has been any increase in van traffic (and related congestion and accidents) arising from more local sourcing of food (see Section 5.4.7).

Table 31. Food-miles related accidents in the UK by road and vehicle type

	Fatal	Serious	Slight	Total
urban %	37%	59%	70%	68%
rural	52%	37%	26%	27%
motorway	11%	4%	4%	4%
car %	57%	71%	76%	75%
LGV	8%	10%	10%	10%
HGV	35%	19%	14%	15%

Another limitation with the use of urban food km as a proxy for congestion costs is that no account is taken of the time of travel, which is important when measuring congestion impacts. Current statistics show that car food shopping peaks in the mid-morning, with less during morning or evening rush-hours and little during the evening off-peak period. Time of travel was taken into account in our estimation of the social costs of congestion in monetary terms. However, the use of total urban travel as a proxy for congestion will not detect any changes in travel patterns, such as a switch to shopping at less busy times, which will affect congestion.

HGV vehicle km

We have estimated that HGVs account for 97% of all infrastructure costs arising from food transport on UK roads (see Annex 3). HGV vehicle km are therefore a good proxy for road infrastructure costs. Our social cost estimates are purely the financial costs incurred for maintaining and repairing roads. They do not include the pressure on capacity which may lead to building new roads or widening existing roads, and associated social costs related to loss of countryside, wildlife habitat and visual impact. However, HGV vehicle km are related to these impacts also and so in this case the proxy measure may be more accurate than the social cost estimate. In order to illustrate trends in HGV load factors, HGV food tonne km can also be included.

Air km

This is the most environmentally damaging mode of transport in terms of climate change. Moreover, its impacts cannot be fully quantified as there is little data relating to noise, congestion, infrastructure or accidents arising from air transport. Therefore air km is an important proxy. Air food transport is directly related to pollution (for a given set of assumptions about typical load and aircraft emission factors). The other impacts (noise, congestion, infrastructure and accidents) will depend on the location and timing of the air movements. However, reducing air miles will always reduce these impacts. One problem with this indicator is that there is no data on air miles for imports and exports to the EU. We have currently assumed zero food trade by air with the EU (see Annex 1). However, if air transport activity to or from the EU begin to increase in future, this will not be captured by the indicator. We therefore recommend that efforts are made to gather data related to transport of food by air to and from the EU. The accuracy of the indicator would also be improved by better data on average air freight loads, which are used to convert tonne km to vehicle km for the indicator.

CO₂ emissions

This is a good proxy for climate change impacts as CO₂ emissions are directly related to climate change, and will have the same impact regardless of where, when or how they are emitted.

Atmospheric pollution

We consider only NO_x, SO_x and PM₁₀. However, emissions of other pollutants (dioxins, VOCs etc) will to some extent tend to rise or fall in line with these major pollutants. A more accurate analysis would identify separately the urban and rural emissions, as urban emissions affect a greater number of people. However, reducing air pollution will always reduce these impacts.

Live animal tonne km

Live animal tonne km are used as a partial proxy for animal welfare in transport. There are several limitations with this approach. The most obvious one is that transport of live animals is only one aspect of animal welfare related to the food and farming industry. Other impacts may be related to different welfare standards, both within the UK and in countries which trade meat with the UK. Finally, the welfare impact will be related to the transport conditions, not just the transport distance. Nevertheless, a reduction in live animal tonne km would seem to be a valid aim. The consideration of an indicator for live animal transport would be consistent with UK policy, which would be best summed up as a preference for slaughter close to the place of production and an end to long distance transport solely for slaughter at the destination (though this has to be balanced by the demands of the single market and commercial/economic decisions)

Imports of indigenous foods

Imports of indigenous foods are examined for two reasons: firstly in order to establish a realistic potential for increasing sourcing of food from the UK. Secondly, this is to some extent related to socio-economic impacts on UK farmers and growers (see section 5.4).

Ethically traded foods

Measures to reduce food miles are unlikely to reduce the demand from consumers for staple imports such as bananas, coffee and cocoa. However, alternative sourcing from ethically traded food suppliers can have significant socio-economic benefits for producers in developing countries without increasing food miles, thus increasing sustainability overall. The price increases to consumers need not be noticeable. For example, the cocoa in a bar of ethically traded chocolate may cost less than one penny more than that in a standard bar of chocolate, yet that small amount (out of 5 pence) makes a significant difference to the producer. It was therefore felt useful to include a separate indicator for annual sales of ethically traded foods in the UK. The aim, obviously, is for this indicator to increase.

UK organic market

Case Study 2 (Section 5.2) demonstrated that imports of organic food can in some cases be more sustainable than consumption of non-organic UK produce. However, far preferable in sustainability terms would be more consumption of organic UK produce. Therefore another important indicator is the proportion of indigenous organic food consumed in the UK which is grown in the UK. The aim is for this indicator to increase. In the past, estimates have been provided by the Soil Association. However, as increasing the UK share of the organic market is now an objective of DEFRA's Action Plan on organic farming, we assume that a reliable annual estimate will be provided by DEFRA.

7.1.4 Selection of four headline indicators

From consideration of all the potential indicators, we propose a set of four key “headline” indicators (see Table 33). The key indicators focus on the most important direct impacts of food transport: congestion, accidents, infrastructure costs and greenhouse gas emissions. Air pollution impacts were not included separately as the HGV and urban food km indicators will also be good proxies for air pollution effects, and also emissions are declining due to adoption of improved Euro standards.

The supplementary indicators capture some of the complexities and trade-offs discussed in previous sections of this report. However, for most of these areas, related indicators or policies already exist as part of other government strategies. For example, the UK share of the organic food market is covered in DEFRA’s action plan for organic food and farming, live animal transport is covered by the animal health and welfare strategy, and ethical trading is an indicator in the food industry sustainability strategy. Therefore these have not been included as key indicators.

Table 32: Four key headline indicators

Indicator	Notes
Urban food km in the UK, split by car, LGV, HGV.	Urban food km account for most of the accident and congestion costs. The impact of air pollution is also much higher in urban areas. (As discussed in section 7.1.3, this indicator relies on the assumption that the urban/rural travel ratio is the same for food transport as for all other transport. An alternative proxy for congestion and accident costs would be total car food km).
HGV food km	This covers HGV transport both in the UK and overseas. HGV transport is responsible for the majority of infrastructure, noise and air pollution costs.
Air food km	Air freight of food is rapidly growing and has a higher environmental impact than any other transport mode.
Total CO₂ emissions from food transport	Emissions of CO ₂ from the transport sector are highly significant and are growing. This indicator includes estimated CO ₂ from transport fuel use both in the UK and other countries. Currently excludes CO ₂ and other greenhouse gas emissions from refrigeration during transport, although it would be desirable to include this in future.

7.1.5 Use of the indicator set

It is envisaged that the indicator set would be updated yearly, following publication of the key underlying datasets. The timing of the data releases are as follows:

- ◆ HM Customs and Excise data on imports and exports is released on a monthly basis, typically with a 2-3 month delay, so data for a calendar year would be available from around March onwards in the next year.
- ◆ The CSRGT data (for HGVs) is published in May the following year.
- ◆ The van survey data is split into private and company vans. The private van survey was a one-off study, which may or may not be repeated in the future. After 2003, therefore, this part of the dataset will have to be estimated based on the ratio between company and private van food km for 2003, until the private van survey is repeated. Private vans account for about one third of the total van food mileage. The company van survey is due to be published in August each year.

- ◆ Data on car food shopping is collected on a rolling basis, but only published every 3 years as part of the Personal Travel Survey (the next report is due in February) 2005. However, the data is available from DfT on an ad-hoc basis. Data for 2003 has been available since September 2004.

Updates for a calendar year can therefore be made in October the following year, after release of the personal travel survey data.

Because of the complex relationship between food transport and sustainability, great care must be exercised in interpreting any changes observed in the indicators. It will be important to establish the underlying causes and statistical significance of such changes and to consider all the economic, social and environmental implications before drawing conclusions or formulating policy responses.

We emphasise that this indicator set focuses on the direct adverse impacts of food transport: congestion, pollution and accidents. It is not designed to directly measure wider economic and social impacts, or to detect trends such as changes in food sourcing and food retailing, although policy initiatives in these areas may well have detectable impacts on the indicators.

7.1.6 Evaluation of indicators for 2002

Table 33 shows the key indicators estimated for 2002. The indicators are shown with and without the food km related to the export of food. This is to enable the government to take into account the economic benefits to the UK of food exports when evaluating the impacts of food transport.

Table 33: Food Transport Key Indicators for 2002 (Headline indicators in bold)

		Including exports			Excluding exports		
		Total	In UK	Overseas	Total	In UK	Overseas
Total tonne kilometres	billion tonne km	234	50	183	197	43	154
Total vehicle kilometres	billion vehicle km	30	25	5	29	24	5
Urban road food km	million vehicle km		11,778			11,306	
	HGV mvkm		6,975			6,975	
	LGV mvkm		2,974			2,697	
	Car mvkm		1,828			1,633	
HGV food km	million vehicle km	9,425	5,812	3,613	8,284	5,193	3,091
	million tonne km	76,871	47,400	29,471	67,565	42,352	25,212
Air food km	million vehicle km	27	0	27	23	0	23
Total CO₂ emissions	million tonnes	19	10	9	17	9	8
Total PM₁₀ emissions	thousand tonnes	5	3	3	4	2	2
Total NO_x emissions	thousand tonnes	158	72	85	137	65	72
Total SO₂ emissions	thousand tonnes	41	0.25	41	34	0.23	34
Live animal food miles	million tonne km	764	764	NK			
Imports of indigenous foods	million tonnes	16.15	16.15				
Retail sales of ethically traded foods	million £	63	63				
% of indigenous organic food grown in the UK		62%	62%				

NK=Not known

7.2 TRENDS 1992-2002

Table 34 shows the key indicators (including exports) for 1992, 1997 and 2002.

The key trends to note are:

- ◆ **Tonne kilometres** have increased by 15% since 1992 and food transport vehicle kilometres by 21%. The increase in vehicle kilometres is largely due to the increase in car shopping for food.
- ◆ **HGV food km** increased by 8% between 1992 and 1998, but then declined by 7% to 2002, giving a net increase of only 1% from 1992 to 2002. This is due to a slower increase in tonne kilometres, and an increase in vehicle load factor. This trend is observed both for UK and overseas food kilometres, although it should be noted that we have assumed the same increase in load factor for overseas transport as for the UK, and this is not necessarily the case. In recent years there has been a trend to increase food trade with nearer EU countries (France, the Netherlands and Ireland) at the expense of Spain, Italy and Greece, and this has decreased vehicle km for the international stage of transport. However, as food imports have increased, the associated road transport within overseas countries has also increased steadily.
- ◆ **Air freight** has increased by 140% since 1992, although it still accounts for only 0.1% of total vehicle km. However, it accounts for 12% of CO₂ –equivalent emissions, when the effect of non-CO₂ aircraft emissions in the stratosphere is taken into account.

- ◆ **CO₂ emissions** from food transport increased by 12% from 1992 to 2002.
- ◆ **Pollutant emissions** (e.g. PM₁₀ and NO_x) have decreased over this period, despite the increase in vehicle kilometres. This is because of the introduction of Euro standards for all vehiclesⁱ, and also because the increase in vehicle kilometres is dominated by cars, which pollute less per vehicle km than other vehicles. Nevertheless, pollution from food transport is still significant – NO_x food miles emissions in the UK are 4% of the UK total.
- ◆ **Live animal food km** increased from 1992 to 1997. The 2002 figure is lower than the 1997 figure, perhaps due to the impact of foot and mouth disease in 2001.
- ◆ **Imports of indigenous foods** are growing steadily.
- ◆ **Sales of ethically traded food** are growing rapidly, although they still form a very small proportion of the market.
- ◆ **The UK share of the organic food market** is improving, up from 35% in 2001/2002 to 44% in 2002/2003, and taking 62% of the indigenous organic food sales.

ⁱ Estimates of CO₂ and pollutant emissions for 1992 and 1997 are currently underestimates as they use 2002 emission factors. These will be replaced by the appropriate emission factors in the final version of this report.

Table 34: Trends in Key Indicators 1992-2002 (Headline indicators in bold)

Including exports		Total			In UK			Overseas		
		1992	1997	2002	1992	1997	2002	1992	1997	2002
Total tonne kilometres	billion tonne km	203	222	234	39	49	50	164	173	183
Total vehicle kilometres	billion vehicle km	27	29	30	21	23	25	5.7	5.5	5.3
Urban road food km	million vehicle km				9,847	11,015	11,778			
Car	million vehicle km				5,178	6,108	6,975			
LGV	million vehicle km				2,974	2,974	2,974			
HGV	million vehicle km				1,696	1,932	1,828			
HGV food km	million vehicle km	9,325	10,026	9,425	5,391	6,145	5,812	3,933	3,881	3,613
	million tonne km	62,745	75,270	76,871	36,278	46,131	47,400	26,467	29,139	29,471
Air food km	million vehicle km	11	22	27	0	0	0	11	22	27
Total CO₂ emissions	million tonnes	16.9	18.7	19.1	8.9	9.9	9.7	7.9	8.7	9.2
Total PM ₁₀ emissions	thousand tonnes	9.5	7.3	5.3	5.6	4.1	2.5	3.8	3.1	2.8
Total NO _x emissions	thousand tonnes	206	201	158	105	102	72	101	98	85
Total SO ₂ emissions	thousand tonnes	51	42	41	8.81	2.51	0.25	43	40	41
Live animal food km	million tonne km				870	884	764	NK	NK	NK
Imports of indigenous foods	million tonnes				13.55	14.20	16.15			
Retail sales of ethically traded foods	million £				0	13	63			
% of indigenous organic food grown in the UK	%				NK	NK	62%			

NK=Not known

7.3 CONSISTENCY WITH OTHER GOVERNMENT POLICIES AND OBJECTIVES

Any proposed food miles indicator should be consistent with the approach and objectives of two main government strategies:

- ◆ The Sustainable Farming and Food Strategy
- ◆ The proposed Food Industry Sustainability Strategy (FISS)

In its Strategy for Sustainable Farming and Food, the Government set principles for a sustainable food chain. In Box 10, we compare our proposed indicator set against those objectives to ensure consistency. The effects of a food miles indicator depend considerably on the selection of policies for reducing food miles, which are addressed in Section 7. The comments in Box 10 show that our Key Indicators are almost entirely consistent and strongly synergistic with the principles on which both the Sustainable Farming and Food Strategy and the draft Food Industry Sustainability Strategy are based. There are some potential exceptions which require special policy measures or monitoring. These include the less informative labelling of some local foodstuffs, the potential for net energy penalties if UK production of greenhouse crops increases, and the possible decrease in transport efficiency and increase in van miles through increased local sourcing.

The draft FISS strategy takes a more detailed look at the impacts of the food chain beyond the farm gate. Indicators for the FISS have been categorised within a set of priority areas (see Table 35).

Table 35. Priority Areas of the draft Food Industry Sustainability Strategy

Primarily environmental	Primarily social	Primarily economic
Sustainable Consumption & Production	Food safety	Educating consumers
Energy use and climate change	Equal opportunities	Better regulation
Water	Health & Safety	Science-based innovation
Waste	Ethical trading	Workforce skills
Emissions from Transport – including food miles	Tackling retail crime	
	Corporate Social Responsibility	

Those which interact with the Food Transport (Food Miles) indicators are highlighted in bold type. Below we assess the interactions between the two sets of indicators.

Box 10. Principles for a sustainable food chain

- ◆ *Produce safe, healthy products in response to market demands, and to ensure that all consumers have access to nutritious food, and to accurate information about food products.*

Progress against a food miles indicators should not compromise access to nutritious food, and may improve access where, for example, consumption of fresh local produce replaces processed or less fresh food. Measures to reduce car food miles may improve access for non-car owners (see Section 7). The indicator should encourage better country- of-origin labelling, but local foods may present less labelling information to consumers. For example, local bread or jam sold through a farmers market may not be labelled with a full list of ingredients or nutritional information, even though such food is less likely to contain additives.

- ◆ *Support the viability and diversity of rural and urban economies and communities.*

This is entirely consistent – more local sourcing of food will boost UK farming communities (especially smaller farms), encourage more diverse food enterprises, strengthen local economies, especially rural economies, and support valuable local services such as local shops.

- ◆ *Enable viable livelihoods to be made from sustainable land management, both through the market and through payments for public benefits.*

This is consistent – local sourcing of food will improve the market for organic and other forms of sustainable agriculture, through offering more market opportunities for smaller producers, who tend to use less intensive methods. The current system whereby the bulk of food is sourced from very large farms, whether in the UK or overseas, encourages intensification of agriculture. This arises from the demands of supermarkets for large quantities of consistent and cosmetically perfect produce, which can lead to more use of fertilisers, pesticides, herbicides and fungicides.

- ◆ *Respect and operate within the biological limits of natural resources (especially soil, water and biodiversity).*

Consistent (see above). Although this is not an explicit aim of the indicator, this objective will be encouraged by the component which measures UK share of the organic market.

- ◆ *Achieve the highest standards of environmental performance by reducing energy consumption, minimising resource inputs, and using renewable energy wherever possible.*

Transport energy consumption will be minimised, although if increased UK production of greenhouse crops (e.g. salad crops) is a result then there may also be energy penalties. Therefore it is important to also continue efforts to increase energy efficiency and use of renewable energy in these sectors (see Section 7). It is also necessary to monitor any increase in van miles and consequent reduction in transport efficiency which could offset the benefits of the indicator.

- ◆ *Ensure a safe and hygienic working environment and high social welfare and training for all employees involved in the food chain, here and overseas.*

Consistent through the indicator relating to ethically traded food.

- ◆ *Achieve the highest standards of animal health and welfare, compatible with society's right to access to food at a fair price.*

Consistent through the live animals food miles indicator, although trade-offs with welfare production standards should be monitored.

- ◆ *Sustain the resource available for growing food and supplying other public benefits over time, except where alternative land uses are essential to meet other needs of society.*

Consistent through support for smaller, more sustainable producers (see above).

These principles should apply to all food which is grown and processed overseas, and consumed here, as well as all food which is grown and processed in this country.

Yes, we have included the whole food chain including food produced overseas in our indicator.

Energy and climate change

The FISS indicators are:

- ◆ Total energy use by the food, drink (& tobacco) manufacturing industry;
- ◆ Energy use per unit of output in the food, drink (& tobacco) manufacturing industry;
- ◆ CO₂ saved under food and drink sector Climate Change Agreements;
- ◆ CO₂ per unit of output saved under food and drink sector Climate Change Agreements.

A reduction in food miles, if implemented through appropriate policies, should lead to a reduction in transport energy use and CO₂ emissions. As transport accounts for a significant proportion of total food and farming industry energy consumption (48% according to our estimates) this should contribute significantly to the FISS objectives for energy and climate change. However, there are two caveats. Firstly, it will be important to monitor any decrease in transport efficiency resulting from a move to more local sourcing of food, and to assess the extent to which this offsets the CO₂ reductions from reduction of transport distance. Secondly, the effect of more local sourcing on the energy efficiency of food production is not clear. Some small scale food production might be more energy efficient (e.g. as more preparation might be done by hand instead of by machine) and some might be less efficient (e.g. as economies of scale are lost for cooking and baking). It will therefore be important to continue to encourage energy efficiency and use of renewable energy where possible in the local food sector, as well as promoting improved transport logistics and use of cleaner vehicles for local food distribution.

Water use

The FISS indicator will be total water consumption per tonne of product by the food, drink (& tobacco) manufacturing industry per year.

As above, it is not clear what effect more local sourcing of food will have on water consumption. Smaller producers could be either more or less water-efficient. It will be important to monitor any changes in the pattern of water use and to continue to offer support and encouragement to improve water management in the local food sector through the Envirowise programme and other initiatives.

Waste

The FISS indicators will be paper and card waste used by the food, drink (& tobacco) manufacturing industry; and the level of "food waste" across all sectors

On the whole, it is hoped that a reduction of food transport will also reduce the need for packaging. Food which is transported short distances and sold on the same day (such as through a farm shop, farmers market or box scheme) requires little packaging. Vegetables, for example, may be sold in a paper bag or delivered in a cardboard box, whereas food transported a long distance and sold in a supermarket tends to be packaged in plastic trays, film or bags. Obviously a full life cycle analysis comparing plastic

packaging and paper bags is outside the scope of this project. However, paper and cardboard originate from renewable resources (if the wood comes from a managed plantation and recycled paper is used as much as possible). To reduce impacts still further, it would be worth encouraging more use of recycled paper and cardboard in the local food sector.

Emissions from transport

The FISS proposes a set of indicators of transport logistical efficiency derived from the recent benchmarking study of Key Performance Indicators for food freight:

- ◆ vehicle fill
- ◆ empty running
- ◆ time utilisation
- ◆ deviations from schedule
- ◆ fuel consumption.

The output of the present study is intended to contribute to development of indicators based on the impacts of food miles on sustainability.

Ethical trading

The FISS indicator is the percentage of firms which follow a recognised ethical trading code of practice. These codes encourage suppliers to meet certain standards, such as avoidance of child labour, payment of "a living wage" and no cruel or inhumane treatment.

Our proposed indicator is annual sales of ethically traded produce in the UK. The FISS and Food Miles indicators are complementary, and there is good synergy between the two strategies. The FISS initiatives to promote ethical trade should be extremely helpful in reducing the adverse social impacts related to imports from developing countries, and should boost sales of ethically traded produce in the UK, thus contributing to the objective of the food transport indicator.

Educating consumers

The FISS has identified that consumers do not always exert their purchasing power in such a way as to encourage more sustainable practices in the food chain, for example through purchases of locally sourced food. FISS initiatives to improve food labelling, raise awareness of regional food and drink, and the launch of the Sustainable Development Action Plan for Education will all complement and support progress towards the Food Transport indicators.

Summary

In summary, there is generally very good synergy between the Food Transport indicators, the objectives of the Sustainable Farming and Food Strategy and the proposed indicators for the Food Industry Sustainability Strategy. In most areas, the policies and indicators will reinforce each other strongly. There are some potential areas of conflict, where additional monitoring, research and policy measures may be needed. These are:

1. Effect of more local sourcing of food on energy efficiency of food production (and possibly water consumption, packaging use and waste management).
2. Effect of more local sourcing of food on transport efficiency.

We recommend that these areas are carefully monitored and that significant efforts are devoted to improving the sustainability of the local food sector through measures to improve energy efficiency, improve transport logistics, encourage use of cleaner vehicles and renewable energy, encourage use of recycled, low impact packaging materials and improve water management.

8 Conclusions

Food transport has been increasing steadily over the last few decades, due mainly to three factors:

- ◆ Wider sourcing of foods, both within the UK and overseas;
- ◆ Centralisation and consolidation of food production and retailing operations in order to improve economic efficiency;
- ◆ Increased use of cars for food shopping.

This increase in food transport has significant negative impacts on sustainability including increased congestion, road infrastructure costs, pollution and greenhouse gas emissions, which we have estimated as giving rise to social costs of over £9 billion per year. Many of these impacts are not included in existing indicator sets (e.g. international air and shipping).

Food transport has a complex relationship to sustainability, and there can be trade-offs between environmental, social and economic factors. The case studies we investigated showed that, in general, the exceptions to the link between decreasing food miles and increasing sustainability are either marginal or can be accommodated through an appropriate indicator set. They can also be addressed through careful and integrated design of policies. In other cases, such as the issues surrounding the social and economic benefits of food trade, we conclude that further work would be necessary for a full evaluation. We stress that even if social or economic benefits offset the direct impacts of food transport in some cases, it is valid (indeed desirable) to monitor the direct negative effects of food transport. This will enable appropriate policies to be formulated to ensure that there is a balance between economic, social and environmental sustainability.

We have also demonstrated that adequate data exists to compile an annual food transport indicator. However, because of the complexities and trade-offs involved, a single indicator based on total food miles is not appropriate. We propose four key indicators based on the main direct impacts of food transport on sustainability: urban food km (split into cars, HGV and LGV); HGV food km; air food km and total CO₂ emissions from food transport. This indicator set is not designed to directly measure the wider social and economic impacts of food transport.

We recommend further investigation of the potential economic impacts and any redistribution of benefits through a switch towards more local food sources. We also recommend careful monitoring of any increase in congestion from increased deliveries and decrease in overall transport efficiency as a result of a switch to more local food. Policies to increase the distributional efficiency of the local food sector will be important in maximising the benefits of a switch towards more localised food production.

Various recent studies have proposed policies to reduce the adverse impacts of food miles^{34,43,8}. Potential policies tackle food miles in various ways:

1. Sourcing food more locally where appropriate (e.g. consumer awareness, public procurement, support for local food initiatives, strengthening UK suppliers)
2. Reducing car food shopping (e.g. home delivery, support for local and in-town shops, provision of safe cycle and pedestrian access)
3. Reducing transport impacts (cleaner vehicles, improved logistics, rail freight)
4. Internalising the social costs of transport

5. Improving the wider sustainability of the food chain (e.g. ethical trading to maximise the social benefits of imported food, improved energy efficiency in the local food sector)

Many potential policies tie in with existing government objectives and initiatives, e.g. for improving transport logistics, encouraging cleaner modes of transport, stimulating local and regional food initiatives and boosting UK organic farming. The proposed indicator is consistent with the approach and objectives of DEFRA's Sustainable Farming and Food Strategy and the proposed Food Industry Sustainability Strategy.

Recommendations for further work

There are several areas where more research would be beneficial to investigate some of the more complex areas of the food miles debate. These include improvements to the dataset, further work into the validity of the indicator and appropriate supporting policies.

Dataset improvements

1. Improvement of the estimates of the key indicator of urban food transport (currently food transport cannot be distinguished from other transport on urban / rural roads). This would require new surveys to be conducted.
2. Improved estimates of the burden arising from SO₂ and NO_x emissions from shipping. Marine fuel oil is very high in sulphur and several recent studies have suggested that shipping emissions account for a much higher proportion of European sulphur and nitrogen deposition than previously thought. The contribution of shipping is also becoming increasingly important, given the decrease from land-based sources due to existing legislation. As well as revising estimates of total SO₂ emissions, it will be necessary to improve our estimate of the percentage of sea transport which is close enough to land to cause a significant impact on terrestrial ecosystems or human health. This can be done through a study of shipping routes, perhaps together with atmospheric dispersion modelling.
3. Improved estimates of average vehicle loads for air and sea transport. Assessment of the environmental impacts of air and sea transport is strongly dependent on assumptions concerning the average load size carried by ships and aircraft. More detailed investigation of the typical spread of food freight across different types and sizes of ship and aircraft, typical load factors, and the percentage of food wasted during transport over long distances would help to refine estimation of the impacts. Improved emission factors, if better data become available, would also be useful.
4. Emissions of CO₂ and other greenhouse gases (HFCs) are associated with refrigeration during transport. It would be useful to estimate the magnitude of these emissions so that they could be included in the database.
5. Estimates of transport overseas are very crude. These estimates could be refined through a more detailed study, focusing on the main countries exporting to the UK. Although it is not expected that national statistics from overseas countries would necessarily identify food miles, let alone explicitly identify food miles related to exports to the UK, some estimates could be made based on the ratio of available data (e.g. tonnes lifted) to comparable UK data, and the proportion of food produced which is exported to the UK. Any available country specific data on load factors, emission factors and typical journey lengths would also be valuable (at present we use UK load factors and emission factors for all countries, although this is known to be inaccurate).

6. DEFRA has indicated that it might be useful for policy purposes to identify indicators on a regional basis. This would be constrained by the available data. It might be possible to split UK HGV, LGV and car food shopping estimates into geographical regions, but it is less likely that the impacts of imported food can be differentiated regionally.

Validity of indicator

7. Further assessment of the statistical validity of the indicator (e.g. confidence limits for the four main headline indicators).
8. Further investigation of the wider social and economic impacts of a reduction in food miles. As mentioned above, the economic impacts of a decrease in food miles are still unclear, as is the size and nature of any redistribution of economic benefits which may occur. Further investigation could help to clarify this issue and enable the correct design of policies to maximise the benefits, and minimise any adverse economic impacts on particular sectors of the food and drink manufacturing, retail and freight industry.
9. Further research is needed to investigate the effect of a switch to more local or regional sourcing of food on the overall transport efficiency of UK food distribution. A switch to using smaller vehicles and less consolidated loads may offset some of the environmental benefits of a reduction in food miles. In particular, opportunities for improving the transport and logistics distribution of the local food sector need to be explored, perhaps drawing lessons from other countries such as France where distribution of local food is often carried out in a more co-operative manner, thus potentially achieving efficiency savings.

Policies

10. The impacts of any changes in food sourcing or food transport depend to a large extent on the policy framework, and on the response of consumers, producers and industry to those policies. A study of potential policies to reduce the impacts of food transport would help to examine the advantages and disadvantages of different policies, and design a suitable integrated framework to reduce the adverse impacts of food transport. Potential policies include:
 - ◆ Sourcing food more locally where appropriate (e.g. consumer awareness, public procurement, support for local food initiatives, strengthening UK suppliers);
 - ◆ Reducing car food shopping (e.g. home delivery, support for local and in-town shops, provision of safe cycle and pedestrian access);
 - ◆ Reducing transport impacts (cleaner vehicles, improved logistics, rail freight);
 - ◆ Internalising the social costs of transport (to reflect the costs to society of pollution, congestion, accidents, noise and so on in the prices paid by transport users);
 - ◆ Improving the wider sustainability of the food chain (e.g. ethical trading, improved energy efficiency in the local food sector).

References

- ¹ Department for Transport (2003), *Transport of Goods by Road in Great Britain 2002*, a National Statistics publication, <http://www.transtat.dft.gov.uk/tables/2003/csrgt/csrgt.htm>
- ² SAFE Alliance (1994), *The Food Miles Report: The dangers of long distance food transport*.
- ³ Bill Vorley, 2003, *Food, Inc. Corporate concentration from farm to consumer*, UK Food Group, International Institute for Environment and Development, www.iiied.org.uk.
- ⁴ DEFRA (2002), *Sustainable Farming and Food Strategy*, www.defra.gov.uk
- ⁵ Roberts, Sion (2002), *Sustainable Development Beyond the Farm Gate*, scoping study for DEFRA.
- ⁶ DEFRA, *Agriculture Statistics*, <http://statistics.defra.gov.uk/esg/quick/agri.asp>
- ⁷ DEFRA, 2003, *UK trade data in food, feed and drink including indigeneity and degree of processing*, MAFF Food Trade Data 2003.xls, spreadsheet supplied by DEFRA
- ⁸ Andy Jones (2001), *Eating Oil: Food supply in a changing climate*, Sustain and the Elm Farm Research Centre. ISBN 1-903060-18-4. e-mail sustain@sustainweb.org.
- ⁹ IGD, 1999, *The Food Project: Consumer attitudes to British meat and fresh produce*, www.igd.com
- ¹⁰ IGD, 2003, *Global Sourcing*, IGD Fact Sheet, www.igd.com
- ¹¹ Hawkes, C et al (2000), *A battle in store? A discussion of the social impact of the major UK supermarkets*, Sustain, London.
- ¹² McKinnon, A.C. and Marchant, C. (1999), *The Effects of Just-in-Time on Freight Traffic Levels*, Report for TRL / Highways Agency, Logistics Research Centre, Heriot-Watt University, Edinburgh.
- ¹³ McKinnon, A.C. and Woodburn, A. (1994), *The Consolidation of Retail Deliveries: Its Effect on CO₂ Emissions*, Transport Policy, 1, 2, 1994.
- ¹⁴ Freight Transport Association (2000), *Computerised Routing and Scheduling for Efficient Logistics* Energy Efficiency Best Practice Programme Good Practice Guide 273, Harwell.
- ¹⁵ A.T. Kearney (1997), *The Efficient Unit Loads Report*
- ¹⁶ NEI et al. (1999), *REDEFINE: Final Report*, Rotterdam.
- ¹⁷ Technical University of Berlin (2002), *EU SULOGTRA Project: Final Report*, Berlin.
- ¹⁸ McKinnon, A.C. and Woodburn, A. (1996), *Logistical Restructuring and Freight Traffic Growth: An Empirical Assessment*, Transportation, 23, 2, 1996
- ¹⁹ Department for Transport (2001), *Focus on Personal Travel*, www.dft.gov.uk.

- ²⁰ Select Committee on Environment, Transport and Regional Affairs, 2000, *Second report: Environmental impact of supermarket competition*, <http://www.parliament.the-stationery-office.co.uk/pa/cm199900/cmselect/cmenvtra/120/12006.htm#n7>
- ²¹ Cairns, Sally (1995), *Travel for shopping: the fourth solution*. Traffic engineering and control, July/August 1995.
- ²² Whitelegg, J, (1995), *Driven to Shop*, A report for the SAFE Alliance, London, ISBN 1 899779 00 0.
- ²³ Cairns, Sally (2003), *Delivering supermarket shopping: more or less traffic?*, e-mail sally@transport.ucl.ac.uk.
- ²⁴ The Countryside Agency (2003), *Eat the View*, www.eat-the-view.org.uk
- ²⁶ East Anglia Food Link (2004), *Local links in a global chain*, www.eafl.org.uk
- ²⁷ Local food works, *Case Study 10: Producer co-operative supplies fresh produce to schools and environment centre*, www.localfoodworks.org.
- ²⁸ IGD, 2002, *One in three shoppers will look for local food in supermarkets*, IGD press release 20/03/02. www.igd.com
- ²⁹ Rached, Omar (2002), *Logistics and supply chain of the UK fresh fruit trade*, MSc thesis, University of Westminster, London, UK.
- ³⁰ IGD, 2003, *Locally produced foods are a key ingredient to making shopping better*, IGD press release 25/02/03. www.igd.com
- ³² Delow, E and Watson, S, 2002, *Flair 2001: The National Survey*, The Foundation for Local Food Initiatives, Bristol.
- ³⁴ James Petts, 2003, *Feeding the Future: Policy options for local food*. Sustain and Food Links UK, London. ISBN 1 903060 34 6.
- ³⁵ Food and Agriculture Organisation (2003), *FAOSTAT database*, Food balance datasheet for the UK for the year 2000, see <http://apps.fao.org>.
- ³⁷ HM Customs and Excise, *Uktradeinfo database*, <http://www.uktradeinfo.com>
- ³⁸ Department for Transport / National Statistics (January 2003), *Travel to the shops in GB*, Personal travel factsheet 2.
- ³⁹ National Atmospheric Emissions Inventory (2002), www.naei.org.uk
- ⁴⁰ DEFRA (2002), *Company Guidelines for Environmental Reporting*
- ⁴¹ DfT (2001), *UK Air Freight Study Report*, www.dft.gov.uk
- ⁴² Dataset purchased ad-hoc from HM Customs and Excise, 2003
- ⁴³ Garnett, T. (2003), *Wise Moves: Exploring the relationship between food, transport and CO₂*. Transport 2000 report, 12-18 Hoxton Street, London N1 6NG. www.transport2000.org.uk.

- ⁴⁴ DTI (2002), *Digest of UK Energy Statistics 2002*.
- ⁴⁵ Estimates of food transport from this study; estimates of distribution and retail energy use from AEA Technology refrigeration expert (Roger McCaldin), as compiled by Mike Doble of AEAT and communicated to Christine Jarvis of DEFRA, 6 January 2004.
- ⁴⁶ COMEAP (1998), *Quantification of the Effects of Air Pollution on Health in the UK*. Department of Health. London. The Stationary Office.
- ⁴⁷ Watkiss et al., forthcoming, *Evaluation of the air quality strategy*, report to DEFRA.
- ⁴⁸ IPCC (1999), *IPCC Special Report: Aviation and the Global Atmosphere*, www.ipcc.ch
- ⁴⁹ Andy Jones (2001), *Eating Oil: Food supply in a changing climate*, (Op cit.), page 29, referencing a study *European Aviation Emissions: trends and attainable reductions*, by JMW Dings, WJ Dijkstra and RCN Wit from the Centre for Energy Conservation and Environmental Technology, Delft, the Netherlands.
- ⁵⁰ Intergovernmental Panel on Climate Change (1999), *How do aircraft affect climate and ozone?*, www.ipcc.ch
- ⁵¹ Watkiss, P (2003), *Noise Data and Analysis in the UK*, unpublished note, AEA Technology.
- ⁵² Sansom T, Nash C.A, Mackie P.J., Shires J, and Watkiss P. (2001). *Surface Transport Costs and Charges GB 1998*. Institute for Transport Studies, University of Leeds, Leeds.
- ⁵³ DfT (2003), *Aviation and the Environment: Using Economic Instruments*, www.dft.gov.uk
- ⁵⁴ RECORDIT (2000-2001). *Real Cost Reduction of Intermodal Transport*. Deliverables 1, 3 and 4. (www.recordit.org)
- ⁵⁵ RSPCA, 2003, *Standing Room Only: Science and suffering in European live animal transport*, www.rspca.org
- ⁵⁶ Chris Southgate (2003), *The role of small and medium abattoirs in the rural economy*, DEFRA unpublished paper.
- ⁵⁷ DEFRA, 2001, *Economic costs of the foot and mouth disease outbreak in the UK in 2001*.
- ⁵⁸ See the Compassion in World Farming report which compares the welfare implications of different assurance schemes and concludes that organic farming standards offer much higher welfare than minimum UK standards. <http://www.ciwf.org.uk/littleredtractor/index.htm> for a summary, and full report at <http://www.ciwf.org.uk/littleredtractor/Images/Farm%20Assurance%20Report.pdf>
- ⁵⁹ Tweddle G, Nellthorp J, Sansom T, Link H, Stewart L and Bickel P (2002). *Pilot Accounts-Results for the United Kingdom*. Annex to Deliverable D8 Pilot Accounts – Results for Tranche B Countries, **UNITE** Project (Unification of accounts and marginal costs for Transport Efficiency). Funded by the European Commission 5th Framework RTD Programme. ITS, University of Leeds.
- ⁶⁰ MAFF Agricultural and horticultural census, June 2001

- ⁶¹ IGD (2002), *Small food producers in the UK*, IGD Fact Sheet, www.igd.com.
- ⁶² Countryside Agency, *Market Towns and Local Food*, National Market Towns Advisory Forum, www.countryside.gov.uk/market-towns.
- ⁶³ Institute of Grocery Distribution (2002) '*Retail Logistics 2003*' Letchmore Heath.
- ⁶⁴ Institute of Grocery Distribution (2002), *Retail Logistics 2003*, Letchmore Heath.
- ⁶⁵ DEFRA, *EU Tariff Equivalents on Major Commodities*, figures supplied in e-mail from Brendan Bayley (HM Treasury), 10/2/05.
- ⁶⁶ National Farmers Union, www.nfu.org.uk
- ⁶⁷ DEFRA, 2002, *Agriculture in the UK*, Chapter 2, <http://statistics.defra.gov.uk/esg/publications/auk/2002/chapter2.pdf>
- ⁶⁸ The Countryside Agency (2003), *The state of the countryside 2003*.
- ⁶⁹ Countryside Agency (1999), *State of the Countryside*
- ⁷⁰ Mind, *Suicide and occupation*, Suicide fact sheet, www.mind.org.uk.
- ⁷¹ Matt Lobley, Gillian Johnson and Matt Reed, with Michael Winter and Jo Little, Exeter University centre for Rural Research, on behalf of DEFRA Rural Stress Information Network, , *Rural Stress Review*, Research Report No: 7, ISBN: 1 870558 79 0, <http://www.ex.ac.uk/crr/pdf1/reports1/StressReviewFinalReport.pdf>
- ⁷² Andrew Stuart and Dr Carol Burgoyne, School of Psychology, University of Exeter, *Farming Under Pressure: Culture, Concerns and Coping strategies*, <http://www.ex.ac.uk/~arcstuar/lafab.htm>
- ⁷³ Norberg, H. & S. Gorelick (2002) "Bringing the Food Economy Home" International Society for Ecology and Culture. <http://www.isec.org.uk/articles/bringing.html>
- ⁷⁴ FLAIR, 2002, *The Local Food Sector: Its Size and Potential*, Foundation for Local Food Initiatives, www.localfood.org.uk
- ⁷⁵ DEFRA, 2004, *Policy Paper on Local Food*, www.defra.gov.uk.
- ⁷⁶ FLAIR, 2003, *FLAIR report 2003: The development of the local food sector 2000 to 2003 and its contribution to sustainable development*. Foundation for Local Food Initiatives, www.localfood.org.uk
- ⁷⁷ DEFRA, 2002, *Agriculture in the UK*, Chapter 4, <http://statistics.defra.gov.uk/esg/publications/auk/2002/chapter4.pdf>
- ⁷⁸ NFU, 2002, *NFU exposes shopping basket discrepancy*; <http://www.farm-link.com/n519.html>
- ⁷⁹ DEFRA, *Agriculture in the UK 2003*, <http://statistics.defra.gov.uk>.
- ⁸⁰ London Economics, July 2004, *Investigation of the Determinants of Farm-Retail Price Spreads*, report for DEFRA, <http://statistics.defra.gov.uk/esg/reports/pricespreads/default.asp>

- ⁸¹ Sustainability Institute, April 2003, *Commodity System Challenges*, Sustainability Institute, Vermont.
- ⁸² OFT 2004, *OFT publishes supermarkets code review: OFT to conduct compliance audit with supermarkets*, press release 20 February 2004, <http://www.of.gov.uk/news/press+releases/2004/28-04.htm>.
- ⁸³ Competition Commission, 2000, *Supermarkets: A report on the supply of groceries from multiple stores in the United Kingdom*, http://www.competition-commission.org.uk/rep_pub/reports/2000/446super.htm#summary
- ⁸⁴ Study by the National Retail Planning Forum for Boots the Chemist, cited in *Ghost town Britain*, New Economics Foundation (2003), www.nef.org.uk.
- ⁸⁵ Tim Boyde, 2001, *Cusgarne Organics Local Money Flows*, New Economics Foundation.
- ⁸⁶ Wrigley, N., Warm, D. and B. Margetts, 2000, *Deprivation, Diet and Food Retail Access: Findings from the Leeds 'Food Deserts' Study*, paper as reported in *Regeneration and Renewal* 27th Sept 2002 (to be published in *Environment and Planning A* 2002 V34). <http://www.geog.soton.ac.uk/school/staff/profiles/nw/DDFRA.pdf>
- ⁸⁷ East Anglia Food Link, 2003,
- ⁸⁸ New Economics Foundation (2003), *Ghost town Britain*, www.nef.org.uk.
- ⁸⁹ DEFRA (2000), *Rural White Paper, Our Countryside: The Future - A Fair Deal for Rural England*, www.defra.gov.uk
- ⁹⁰ See Chapter 5, "Trade in low income countries", HM Treasury and DTi, May 2004, *Trade and the Global Economy: the role of international trade in productivity, economic reform and growth*. www.hm-treasury.gov.uk.
- ⁹¹ United Nations Environment Programme, 2004, *Agri-food and the environment*, <http://www.unepie.org/pc/agri-food/issues.htm>
- ⁹² Sustainability Institute, 2003, *Commodity Systems Challenges*, www.sustainabilityinstitute.org
- ⁹³ Kym Anderson, September 2004, *Agricultural trade reform and poverty reduction in developing countries*, World Bank Policy Research Working Paper 3396.
- ⁹⁴ The British Tomato Growers Association, www.britishtomatoes.co.uk
- ⁹⁵ Chris Plackett (2002), *Energy Efficiency in UK Horticulture*, FEC (Farm Energy Centre), www.hortips.co.uk/plenaries/Chris%20Plackett.pdf
- ⁹⁶ Action Energy (2002), *Energy saving guide for agriculture and horticulture*, Good Practice Guide 323, www.actionenergy.org.uk
- ⁹⁷ Soil Association (April 2004), *Soil Association Supermarket survey*, Soil Association Information Sheet, www.soil-association.org.uk.

⁹⁸ Govan, Fiona (2003), *Farmers turn their backs on organic crops*, The Telegraph, 24/8/03

Also icScotland, 9 Aug 2003, *Farmers 'shunning organic produce'*, www.icScotland.co.uk

⁹⁹ ADAS Consulting Ltd., *Energy Use in Organic Farming Systems*, use of figures with permission. Full document at:

http://www.defra.gov.uk/science/project_data/DocumentLibrary/OF0182/of0182.pdf

¹⁰⁰ DEFRA (2001), *Guidelines for Company Reporting of Greenhouse Gas Emissions*, Annex 6. www.defra.gov.uk/environment/envrp/gas/10.htm.

¹⁰¹ Pretty et al. (2000) *An assessment of the total external costs of UK Agriculture*, Agricultural Systems, Volume 65, pp 113-136.

¹⁰² Audsley, Eric et al *Harmonisation of Environmental Life Cycle Assessment for Agriculture*, Final report of concerted action AIR3-CT94-2028, European Commission DG VI Agriculture.

also Leake, Alastair R., *Performance of Arable Organic Farming: a UK Experience*, Teagasc, www.teagasc.ie/publications/2001/tillageconference/

also Huxham, S et al, *selection of appropriate conversion strategies for stockless organic systems*, www.nottingham.ac.uk/biosciences/ah/organic/webbyields.html

and Institute of Science in Society, *Organic agriculture fights back*, www.i-sis.org.uk/organicagriculture.php

¹⁰³ Elm Farm Research Centre, *Organic Cereal Mixtures Trials, 1999-2000*, <http://www.efrc.com/research/cereals.htm>.

¹⁰⁴ Liam Connelly, Teagasc, Irish Agriculture and Food Development, *Costs and Margins in Organic Production in Comparison with Conventional Production*,

www.teagasc.ie/publications/2002/ruraldev2002/paper12.htm.

also Duchy Originals website, www.duchyoriginals.com/wheatandoats.asp

¹⁰⁵ Boge, S (1995), *The well-travelled yoghurt pot*, World Transport Policy and Practice Vol 1 No. 1 pp7-11.

¹⁰⁶ DEFRA (2003), *Final Report into the Development of a Market Transformation Policy Brief for the Food Sector* and BNF07: ENERGY MODEL ASSUMPTIONS AND SCENARIOS.