TRANSPORT 2000 trust

Wise Moves

Exploring the relationship between food, transport and CO_2

Summary and recommendations

This report focuses on food miles – what they are, whether and how it might be possible to reduce them and what the consequences of so doing might be.

'Food miles' is a phrase used to encapsulate concerns about the increasing distances our food travels, and the environmental and social consequences thereof.

In this report we consider whether measures to shorten the food supply chain and reduce food miles can help cut CO_2 emissions from transport and, in so doing, achieve an overall reduction in greenhouse gas emissions from the food system.

The Intergovernmental Panel on Climate Change states that we need to achieve a 60-80% cut in human-generated greenhouse gas emissions.[1] All sectors, including the food industry, will have to make a proportionate contribution to achieving this goal.

Food: The wider social and environmental context

Few people go hungry any more in the UK. The British food industry supplies the collective British stomach with over 40,000 different products, sourced from around the world, seven days a week, 24 hours a day. Most of us have access to an abundance of cheap food, provided by a food industry which, once the farming, manufacturing and retail sectors are combined, collectively employs around 12.5% of the workforce, contributes 8% to the economy,[2] and is delivered by a logistics system that many claim to be the most efficient in the world.[3]

Nevertheless, the food system also places very significant burdens on our society and the environment. One study estimates the food chain's contribution to greenhouse gas emissions to be at least 22% of the UK total. The Government's sustainable farming and food strategy, *Facing the Future*, puts

agriculture's contribution to UK emissions at 7.5%[4] while its 2000 Climate Change report has it even higher, at 12%.[5]

Environmental and other critics of the food industry increasingly advocate a food system based on the principles of localism. They claim that such a system would help provide consumers with seasonal food produced mainly, but not exclusively, from within a given locality, at prices which reflect the true (including socio-environmental) costs of production and which give farmers a fair return for their efforts. They also argue that such a system would help cut CO_2 emissions from food transport and that this in turn would lead to an overall reduction in emissions from food.

These claims are contested by the food industry and by many policy makers. As there is little by way of conclusive evidence on either side, we sought, in undertaking this piece of work, to shed some light on the issue.

Are things getting better or worse?

Is the food sector becoming more or less transport intensive and what are the implications for CO_2 emissions?

Perhaps the most important point to make is that food movements taking place outside the UK are not included in UK Government transport statistics, nor are the emissions they generate captured in the UK's greenhouse gas inventory. Indeed, those produced by aircraft and ships are attributed to nobody, meaning that there is little regulatory incentive to reduce them.

Emissions generated by road vehicles overseas carrying food destined for British stomachs will count towards the host country's annual greenhouse gas bill, not to the UK's. The reverse is also true; emissions produced trucking British products across the UK before they depart our shores for foreign markets will be included in the UK's balance. However, since we import much more food than we export – the UK is a net importer of food – the greenhouse gas imports/exports equation does not balance out. It is striking that, in contrast with the UK, the growth in freight transport in the European Union (EU) is outstripping growth in Gross Domestic Product (GDP).[6] This is true also of the growth in global freight transport.[7] For food journeys, this discrepancy suggests that we are driving our food on other nations' roads more than our own, and more than ever before.[8,9] As a result our food system is generating growing but, as far as the UK balance sheet is concerned, *hidden* quantities of transport-related CO_2 emissions.

The vast majority of food entering and leaving the UK will travel by ship, following a road journey in its country of origin. However, we are also seeing a rapid growth in the air-freighting of food, the vast majority of which flies in on dedicated freight aircraft rather than in the spare space or 'bellyhold' of a passenger aeroplane.

Within the UK almost all our food travels by lorry; rail accounts for less than 1% of food moved, measured in tonne-kilometres.[10] There are some indications that the growth trajectories of food transport within the UK and the CO_2 emissions this transport generates may be diverging. In absolute terms, however, food transport measured either in vehicle-kilometres or in tonne-kilometres still continues to grow.

In addition to greenhouse gas emissions, the transport of food by air, sea and land is also responsible for a number of other social and environmental problems, including air, sea and land pollution, human health impacts, road injuries and deaths, land take and consequent loss of biodiversity, and a less quantifiable but nevertheless important decline in the quality of life for many people.

Will technology solve the problem?

Much policy emphasis has been placed on promoting the development and adoption of cleaner technologies, more efficient driving and management practices and the use of rail and short sea shipping for freight transport.

The adoption of these technologies and practices can help achieve very significant reductions in greenhouse gas emissions. Important savings are already being made.

The fact remains, however, that whatever the gains in efficiency, more goods are being transported

further and more frequently than ever before, leading to an absolute increase in tonne-kilometres not just in the UK but also, and very importantly, overseas, as a result of our increasingly globalised sourcing strategies. Despite the efficiencies achieved, existing technology is still a very long way off indeed from mitigating this growth.

Why are we moving things further than ever before?

Perhaps the three key influences which have fostered these globalised supply chains have been political and economic policies, the dominance and influence of food industry players with national and often global reach, and changes in consumer expectations.

The rules governing international trade, together with other economic policies (notably the low cost of transport relative to other production costs), increasing specialisation in the British and global agricultural industries, competition regulations and state aid rules have all favoured the development of international supply chains. They have also made it difficult for governments to internalise external, including transport-related, environmental costs.

Crucial too has been the growth in the power and popularity of a small number of large food retailers and manufacturers. Their appeal lies in their ability to supply consumers, wherever they are, with a very wide range of consistent products, all year round. A product on sale in Glasgow will be identical to one on offer in Slough. Large retailers and manufacturers have achieved this consistency and predictability by concentrating their manufacturing processes and sourcing from around the world, thereby overcoming seasonal or geographical variations and shortfalls.

The consumer has also had a part to play. As a society, we are busier, richer, more culturally diverse, more cosmopolitan, and more individualistic than ever before; and as a result we have come to demand ever more convenient, elaborate and exotic food – all at low cost. The food industry for its part has sought not only to fulfil, but also to anticipate where our desires might lead. This symbiotic relationship between the consumer and the food industry has fostered the development of ever longer supply chains.

Anticipating and preparing for the future

Recent years have seen the emergence of some counters to these globalising trends.

At a European level, environmentally focused measures, such as an EU-wide aviation emissions charge, are being considered and in some cases developed. Within the UK, while the broad thrust of Government policy is in favour of further liberalisation and the promotion of international trade, Government has also put in place policies to promote British agriculture. The post-Curry agricultural agenda has spurred on the efforts of the major supermarkets to source and promote UK produce. It may be that in some areas of transport policy too, there are weak incentives for developing shorter supply chains. On the other hand, these may well be cancelled by other policy influences which actively support the development of longer ones. What we may see in future years is the co-existence of separate, parallel supply chains: one for niche local and regional foods; and another, international one, for the vast majority of the goods we eat.

There are also signs that consumer demand for alternatively-sourced foods, or foods with an ethical dimension, is growing. As such, the food miles issue may well grow in importance as part of a package of concerns.

There may also be some commercial arguments in favour of building up more domestic sources of supply as a way of improving the resilience of the supply chain and preparing for the impact of climate change on existing sourcing patterns.

For the short term, the development of shorter or more locally focused supply chains may make sense to some businesses, in some areas, selling certain types of food to certain customers. On the whole, however, and for most foods, the existing globalising trends are likely to continue. It is possible though, that the situation might change more rapidly. A snowballing of concern by consumers about the climate changing actions of major food companies might be one trigger. A more rapid onset of very damaging climate change impacts is another. A terrorist or other threat to the global supply chain structure is a third.

Food, transport and life-cycle carbon emissions: Exploring the relationship

Here we set out to answer three questions.

- First, what contribution do the transport stages of the food chain make to the UK's overall greenhouse gas emissions?
- Second, how do measures to shorten the supply chain affect the generation of greenhouse gases both from transport and elsewhere within the life-cycle of the product? For instance, if you cut mileage, might you increase emissions from agricultural production?
- Third, what difference does the type of retail outlet make to overall greenhouse gas emissions?

Cooking and eating are also considered, but in rather less detail; we ask whether the highly processed foods we are increasingly eating are more or less carbon-intensive than the home-cooked foods that fewer of us now prepare.

Our discussion draws upon two separate research studies that we commissioned as part of the *Wise Moves* project. The first study[11] examined various sourcing and distribution options for three products – Braeburn apples, cherries and iceberg lettuce. The second[12] looked at cheddar cheese, white sliced bread and chicken, in whole carcass form. We also base our analysis upon the findings of other relevant studies where these shed further light on the questions we raise.

The studies commissioned by Transport 2000 are not full life-cycle analyses. These require large amounts of time and money, neither of which were available. Instead, the studies focus mainly on calculating transport-generated supply chain CO_2 emissions. For non-transport impacts such as refrigeration they either use generic, publicly available data, or else limit themselves to a qualitative discussion of the likely magnitude of different impacts. Even these apparently 'simple' analyses were in fact very difficult to perform, partly because of problems accessing data, and partly because the transport stages alone are full of variabilities and uncertainties.

With all these provisos in mind, then, we turn to the first question: how much of a contribution does food transport make to the UK's total greenhouse gas emissions?

Food transport accounts for 3.5% of the UK's total CO_2 emissions, with 2.5% from road haulage and just under 1% from car-based shopping. This 3.5% represents a very significant contribution indeed to the UK's greenhouse gas balance sheet, given that this is simply one life-cycle stage of one industrial sector. Importantly, the figure does not include the unquantified emissions which are generated during the course of transporting foods from overseas. These are not only likely to be considerable, but on the increase.

This said, CO_2 emissions from other life-cycle stages will often be greater than those from transport, at least when it comes to UK produced foods. Agricultural production, food processing and refrigeration can all generate very significant impacts. We need to take action to reduce greenhouse gas emissions at all stages in the supply chain.

As regards the second question, our analysis suggests that there is a complex relationship between transport distance and other life-cycle emissions. It is not a simple question of balancing transport, on the one hand, against other life-cycle impacts on the other. Many hands will be needed: alter one life-cycle area and multiple and complex interactions will occur among all the others, some positive and others not.

Proximity is not always a good measure of carbon sustainability, for three main reasons. First, the mode of transport will affect the calculations. A long journey by sea can be preferable to a shorter trip by road (although it is important to remember that there will also be a road journey before and following the sea crossing). Second, the efficiency of the supply chain is also important and the total energy use will depend on a range of factors including vehicle size, fuel efficiency, whether the vehicle is fully or only partially loaded, the way it is maintained and operated, and the route the vehicle takes. Our study found that one retailer trucks in cheese from 470 kilometres away but in so doing clocks up fewer transport emissions than another who sources from only 300 kilometres away. It may

also be the case that it is not possible to meet demand from within the nearby area. We may be able to meet half the demand for, say, cheese, from within the locality but the rest will still have to come from further afield. This may mean two trucks, each delivering cheese, instead of one fully loaded vehicle.

When it comes to imported foods, the importance of distributional efficiency relative to distance is much less. Indeed the research we commissioned into products involving an overseas transport leg (apples, cherries and lettuce) found that the majority of transport emissions were generated before the products even reached the UK. For air-freighted foods in particular, measures to improve distributional efficiency once the food reaches the UK will have a barely discernible effect on overall transport emissions, although this is no argument for inaction.

Finally there are other life-cycle energy impacts to consider. For processed foods the efficiency of the manufacturing plant may carry more weight than its location. It may be less carbon intensive to source fresh unseasonal produce (or produce which cannot readily be grown in our climate) from abroad. In all cases, the point beyond which other life-cycle advantages outweigh the transport disadvantages will depend on the specifics of the production process, the transport mode and other factors.

Importantly, however, we note that the 'trade-offs' work both ways. At times the growth in food transport can be a good benchmark of unsustainability in other areas. Longer supply chains can mean more time spent in refrigerated storage and more goods spoilage, both of which have implications for CO_2 emissions. Shortening the supply chain can help reduce emissions in these other areas.

We also need to consider the potential solvability of various life-cycle problems. There may be more technological scope for 'greening' UK glasshouse horticulture or refrigerated storage through the use of renewable energy than for doing the same with transport. Where this is the case, there will be synergies between reductions in production stage and transport emissions.

It is also important to emphasise that where it appears to be 'better' to source from far away, it may be preferable still not to source that product at all. Bringing winter lettuce in from Spain may use less energy than growing under glass here, but putting something else in our sandwich might be better. Many trade-offs would disappear if we ate more seasonally, suggesting that we need to look more closely at ways of encouraging a shift in consumer demand.

From our analysis, then, we conclude that there appears to be some relationship between shorter supply chains and lower transport-related CO_2 emissions although the relationship is by no means simple and will depend on the product in question, the distances involved and the mode and logistical efficiency of transport. We also suggest that there is some correlation between shorter supply chains and lower overall life-cycle CO_2 emissions. For imported foods the relative importance of transport will be much greater than for foods produced in the UK.

In addition to the food miles question, this section also examined the relative efficiency of local shops compared with supermarkets. From the supply chains of the products we examined, the evidence suggests that for a given set of equivalent foods, supermarket transport systems tend to be less carbon-intensive than those of local shops. This is not a reflection on the localness or otherwise of the food source, but rather on the question of distributional efficiency. Clearly the multiple retailers have invested large quantities of time, money and expertise in improving the effectiveness of their distribution systems. The supermarkets' logistical advantage lessens somewhat once the shopper trip is taken into account, although only in the case of one product (out of the three studied) does the advantage swing in favour of the local stores. We suggest that for perishable foods, including fresh produce, the advantages of shopping on foot at local stores (this can include multiple-owned local formats) may outweigh the disadvantages of greater logistical inefficiency.

Finally, as regards the cooking question, we highlight in our discussion a dearth of relevant research on this issue. While we explored some of the arguments for and against each mode of food preparation, our key conclusion was that much more research is needed here.

We suggest that the features of a lower carbon food system would include the following six elements:

- *Seasonal and indigenous:* Fresh produce grown during its natural growing season and well adapted to UK growing conditions will be less transport intensive and produce fewer overall CO_2 emissions than non-indigenous foods or those imported out of season.
- *Efficient manufacturing:* The processing plant needs to be efficiently operated and managed.
- *Minimal use of temperature controlled storage:* This should not, in the process, compromise safety standards or generate waste through spoilage.
- *Local clustering:* The inputs to the product in question must be situated near to the site of production. For processed foods, it is important that the constituent ingredients can be and are grown or produced near by. For livestock production a nearby source of (among other things) feed and fodder will be important. There are also downstream connections to consider – in the case of livestock this will be the location of the abattoir, the cutting rooms and so forth.
- *Journey distance:* The distance from point of production to point of retail to point of consumption should be minimised.
- *Logistical efficiency:* The fuel efficiency of a vehicle and the way it is managed and operated are very important. In addition loads must be consolidated and vehicles as full as possible while they are in use.

A lower carbon food system: Towards a way forward

The status quo is not sustainable. It is important to be very clear about this. Despite the gains in efficiencies that have been achieved, the magnitude of the problem we face dwarfs them.

We have identified the six elements, or characteristics of a lower carbon food system above. Developing a food system which contains these elements will be challenging, but not impossible. What might such a system look like in practice and what policy direction might we need to take in order to shape it?

We suggest that a more regionally focused approach to sourcing and distribution can help foster a lower carbon food system. Such an approach would rely upon the development of an invigorated farming sector which works with its regional manufacturing base to supply a regional population with much of the food it needs. Where supplies are not available from within the region, producers from elsewhere within the UK would largely be able to satisfy demand.

We would of course continue to import some foods, because they have come to be seen as essential and a part of our food culture, or because there are benefits, in terms of carbon reduction, from so doing. A sustainable (as opposed to simply low carbon) food system will also have to balance carbon reduction objectives against other wider social and environmental issues, such as support for developing countries through fair terms of trade. These considerations are, however, beyond the remit of this report.

In our view, a regional approach offers more CO_2-reducing potential than either globalised systems or very local ones. We highlight in the report some of the problems of globalised systems. As regards local systems, it will not always be possible to grow and produce a sufficient variety of foods locally in sufficient quantities to meet local needs. As a result, transport journeys from a number of different sources will be needed to meet demand, possibly leading to more transport mileage overall. It is also the case that for some manufacturing

processes there are energy efficiency gains to be had from scaling up operations. In addition, we would argue that from a transport perspective at least a reduction in overseas imports is perhaps the most significant challenge we have to address and as such we should concentrate on this rather than on the final thirty miles or so. This said, there are some particularly fertile and agriculturally varied parts of the UK where a fairly local approach may well be both achievable and environmentally preferable.

Supporting the agricultural supply base would be an efficient and co-ordinated distribution system, involving co-operation among suppliers and retailers throughout the supply chain. Supporting it too would be a technological infrastructure specifically geared towards reducing carbon emissions and based on renewable or cleaner energy sources. This would enable goods to be grown, manufactured and produced in ways that do not create the potential trade-offs that we highlight elsewhere in the report. Information and Communication Technologies as well as intelligent transport systems would also provide decision makers with the information and other tools they need both to maximise distributional efficiencies and to make sourcing decisions based upon carbon life-cycle analyses of the goods in question.

We also envisage a more diverse retail structure, fostering different patterns of shopping and more seasonal approaches to eating.

This is a somewhat simplistic account of what would undoubtedly be a far more complex picture. It does however highlight the fact that a lower carbon food system is likely to look significantly different from the way things are right now.

To achieve a full 60-80% cut in food-related greenhouse gas emissions, we will need to make very substantial changes in our way of life. However some reductions are better than none at all – we can work towards this goal by making many small shifts in the right direction. Hence the measures we suggest are not intended to be absolutist.

Some indeed build upon policies that are already in place. None of them will work in isolation; a combination of policies is needed. All should of course be placed in the wider context of a sustainable food agenda.

In short, then, action to foster a lower carbon food system requires movement in the following direction:

1. A recognition that the food system needs to reduce the quantities of CO_2 it emits very considerably.
2. Policies and measures to reduce carbon emissions throughout the life cycle of food so that trade-offs become synergies.
3. A stronger national and regional food base.
4. Measures to shift businesses away from long distance food transport and towards more nationally and regionally based sourcing.
5. Co-ordinated and co-operative methods of distributing goods both for the multiples and for local independent stores.
6. Information and Communication Technology which assists the development of less carbon intensive systems.
7. Different retail structures.
8. Changes in the way we consume.
9. Ongoing research.

Finally, industry, government and consumers alike have a choice. We can seek to salvage elements of sustainability from the current system, in order to keep the system going as it is for a little longer. Or we can take a risk, look further into the future, and start to think and do differently. We believe the second route to be the only survivable option.

Recommendations

These recommendations summarise the policy proposals we outlined in section seven, grouped in accordance with the nine key areas identified.

1 Recognise that the status quo is not sustainable

Government should:

- Set a target for the food industry to reduce field-to-store CO_2 emissions by 20% over ten years.
- Make lower carbon food a clear cross-departmental policy objective.
- Incorporate food emissions reduction into the aims and work plans of all Government departments and agencies, and in particular DEFRA, the DfT, Department for Education and Skills (DfES), Department of Health (DoH), Department for Trade and Industry (DTI) and the Food Standards Agency.
- In the follow-on work from the Energy White Paper, implement a cross-departmental and organisational work programme to research, promote and help achieve lower carbon food chains.

The main food industry players should:

- Measure their CO_2 emissions from all sources (including those generated overseas) and develop policies and targets for reducing them in line with the government target above. They should report on their progress in corporate social responsibility and annual reports.

2 Aim for a low carbon food chain

Government should:

- Focus attention and funding on the research, development and application of greener technologies across the food chain, including in agriculture, horticulture, food processing, refrigeration (both in situ and in transit), storage and waste disposal.
- Encourage greater transparency and consistency of company greenhouse gas reporting to enable comparisons between companies and over time to be made.
- Ensure carbon reduction is a clear criterion of sustainable procurement contracts.
- Provide more support to enable smaller businesses to reduce their carbon emissions.

3 Develop measures to promote regional sourcing patterns

Government should:

- Promote and develop, through grants and regulation, the infrastructure and other aids to the development of more regional sourcing patterns. This will, among other things, include support for the development of:
  - More and smaller abattoirs, cutting rooms and so forth.
  - More (and more diverse) horticultural and agricultural enterprises.
  - More consolidation centres and other logistics related infrastructure.
- Expand Food from Britain's remit to focus on supporting mainstream and not just 'value-added' foods.
- Set reduced maximum journey limits for the transport of live animals.
- Campaign for changes to EU public procurement requirements, to enable procurers to purchase goods on the basis of environmental and social as well as economic considerations.

Regional Development Agencies should:

- Carry out detailed food maps. These maps should identify what is eaten, where the food comes from and what the environmental implications are. They should also identify where nearer sources of such foods exist and where there could be scope for developing enterprises to fill gaps in regional availability.

Non-food elements, such as packaging, also need to be included:

- Provide support for infrastructure (including that detailed here), for the development of enterprises to fill gaps in availability, and for the marketing of regional foods.

The Food Chain Centre should:

- Broaden its remit to include environmental sustainability, part of which will entail fostering lower carbon food chains.

4 Put in place measures to curb energy intensive transport

Government should:

Recognise that we need absolute, and progressively declining limits on food freight transport emissions both in the UK and from UK-owned traffic overseas. To help achieve this reduction Government should:

- Monitor the impact of the lorry charge on CO_2 emissions and consider ways of altering the charging structure, so as to help achieve an absolute decline in emissions from freight transport.
- Review the criteria and scale of the road-building programme.
- Review those proposals for airport expansion which are based on a projected increase in freight movements.
- Reduce non-UK food transport emissions through the development of economic instruments, including a European or internationally applied aviation emissions charge. Work within the EU and International Civil Aviation Organisation respectively for their implementation at the earliest opportunity.
- The DTI and Department for International Development (DfID) should examine the scope for UK businesses to invest overseas in products which produce lower carbon emissions both at the production and at the transport stages and which provide viable alternatives to air-freighted horticulture.
- Continue and strengthen measures to promote rail and short sea shipping.

5 Develop better distribution and collaborative working

National and regional government should:

- Develop frameworks to promote collaboration for CO_2 reduction among retailers of all sizes. This might include incentives such as removing restrictions on deliveries made by lower-emission vehicles at certain times of the day.
- Examine ways of promoting collaboration and the use of shared infrastructure among different elements of the food industry.
- Focus attention on improving the distributional efficiency of smaller players and consider measures to encourage improvements.
- Consider the potential role of urban distribution centres and develop trials to test their use and effectiveness.
- Examine the distribution systems of public bodies (such as the NHS) and examine ways of improving their efficiency.

The food industry should:

- Build upon the improvements they are already making and examine ways of collaborating along their supply chains.

Other agencies should:

- The English Food & Farming Partnership should, as part of its work to promote co-operation and collaboration among farmers and food manufacturers, consider the scope for improving the distributional efficiency of these enterprises.

6 Utilise Information and Communication Technology for carbon reduction

Government and the food industry should:

- Examine the potential for developing integrated Information and Communication Technologies to help the food industry make lower carbon sourcing and distribution decisions. Such a system would provide information about CO_2 emissions throughout

a product's life-cycle, enabling decisions to be made about source (based on embodied energy, distance, mode and conditions of delivery), route and vehicle type.

Government should:

- Provide financial support for the development and application of such technology in a commercial environment.
- Work to ensure that such technology is available to, affordable for and adopted by retailers of all sizes.

7 Establish different retail structures

Government should:

- Introduce a strengthened Code of Practice for supermarkets and appoint an independent watchdog to ensure compliance with the code.
- Continue to tighten planning legislation to curb out-of-town food shopping.
- Develop other policies to discourage car use and encourage non-car based food shopping.

8 Encourage different ways of shopping and eating

Government should:

Require the DoH to ensure that the policies it puts in place to promote better nutritional health are compatible with the goals of environmental sustainability, and require health development agencies and other health promotion bodies to do likewise. As part of this the DoH should:

- Work with the Department for Transport to consider the logistical implications of the five-a-day fruit and vegetables message.
- Place a clear focus on carbon emission reduction in its work on sustainable procurement.
- Explore ways of raising awareness among consumers of the hidden social and environmental costs in our existing food system, and persuading people of the need for food pricing which better reflects those hidden costs.

9 Further research goals

Government should:

Prioritise lower carbon food research. It should provide sufficient funds and support for such research. In the first instance we need to undertake more work to:

- Refine life-cycle analysis methodology and expand the database on which LCA calculations are made. Importantly, we also need to develop ways of applying life-cycle data to commercial contexts so that food buyers can easily access and use such information when making decisions.
- Develop ways of undertaking life-cycle analyses for whole sectors of the food industry, as opposed to specific products. This will help in the early stages of assessing food's carbon impacts as individual life-cycle analyses for all products will present a considerable challenge.
- Undertake research into the relative energy efficiency of small and large-scale manufacturing enterprises for commonly eaten goods such as cheese, bakery products, fruit juice and so forth.
- Examine and quantify the contribution that UK consumption patterns make to food production and transport emissions generated overseas.
- Develop appropriate methods of conducting energy life-cycle comparisons between processed ready-meals and home-cooked meals.
- Examine the logistical effectiveness of alternative distribution systems highlighted in the Cardiff study,[13] as well as UK box or community-supported agriculture schemes. We need to consider whether these models have carbon reducing potential and if so whether there is scope for refining, building upon and applying such systems to a more mainstream context.
- Identify where new infrastructure, such as pack-houses, consolidation centres, processing plants, abattoirs and so forth may be needed in order to help the development of *shorter-plus* supply chains.

- Examine the merits of developing different, lower carbon retail structures based on maximising opportunities for non-car based shopping.
- Consider the impact of Protected Status (Appellation Controllée) foods on food transport emissions.
- Look more closely at the impact of the food service sector on freight emissions as well as on other life-cycle impacts such as food processing and preparation, refrigeration and storage.
- Assess further the strengths and weaknesses of regional and national sourcing patterns, in keeping with the DfT's recent work on supply chain vulnerabilities. Consider in particular how to ensure that *shorter-plus* supply chains of the kind described are as resilient as possible.
- Examine ways of increasing people's understanding of the environmental implications of their food choices.
- Undertake more research into ways of sustainably extending the growing season of UK produce.
- Carry out further work into the potential impact of the growth in light goods vehicles and the contribution that food movements make to this growth. Examine the scope for improving both their technological and logistical efficiency.

Footnotes

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