



# Eating Oil

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*This paper, edited by Lawrence Woodward, is a summary version of the report “Eating Oil: Food Supply in a Changing Climate” produced by Sustain and Elm Farm Research Centre.*

*The original report was written by Dr Andy Jones.*

## **Elm Farm Research Centre**

is an international research, advisory and educational organisation based in the UK. The business of Elm Farm Research Centre is to develop and support sustainable land-use, agriculture and food systems, primarily within local economies, which build on organic principles to ensure the health and wellbeing of soil, plant, animal, man and the environment.

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## **INTRODUCTION**

“*Eating Oil*” was the title of a book published in 1978 following the first oil crisis in 1973<sup>(1)</sup>. The aim was to investigate the extent to which food supply in industrialised countries relied on fossil fuels. In the summer of 2000 the degree of dependence on oil in the UK food system was demonstrated once again when protestors blockaded oil refineries and fuel distribution depots. The ‘fuel crisis’ disrupted the distribution of food and industry leaders warned that their stores would be out of food within days. The lessons of 1973 had not been heeded.

Indeed, the food system is now even more based on cheap crude oil. Every time we eat, we are all essentially ‘eating oil’. Virtually all of the processes in the modern food system are now dependent upon this finite resource which is nearing its depletion phase.

Moreover, at a time when we should be making massive cuts in the emissions of greenhouse gases into the atmosphere in order to reduce the threat posed by climate change, the food system is lengthening its supply chains and increasing emissions to the point where it is a significant contributor to global warming.

The organic sector should be leading the development of a sustainable food system. Direct environmental and ecological impacts of agriculture ‘on the farm’ are certainly reduced in organic systems. However, global trade and distribution of organic products fritter away those benefits and undermine its leadership role.

Not only is the contemporary food system inherently unsustainable, increasingly it is damaging the environment. A different approach - focussed on localisation not globalisation - needs to be developed in order to ensure “food supply in a changing climate”.

## **GLOBAL WARMING AND FINITE OIL**

### *The threat of global warming and the need to reduce carbon emissions*

Global temperatures are rising faster than ever before recorded, and as a result weather patterns are becoming less predictable and more extreme<sup>(2)</sup>. Man made climate change is caused by emissions of greenhouse gases, particularly carbon dioxide (CO<sup>2</sup>) from burning fossil fuels<sup>(3)</sup>. During the last decade the evidence of a link between anthropogenic emissions of greenhouse gases, concentrations of these gases in the atmosphere and average global temperatures has been increasing. The Intergovernmental Panel on Climate Change (IPCC), an international advisory group consisting of 2,500 of the world's leading climate change experts, recently stated, “the balance of evidence suggests that there is a discernible human influence on global climate.”<sup>(4)</sup>

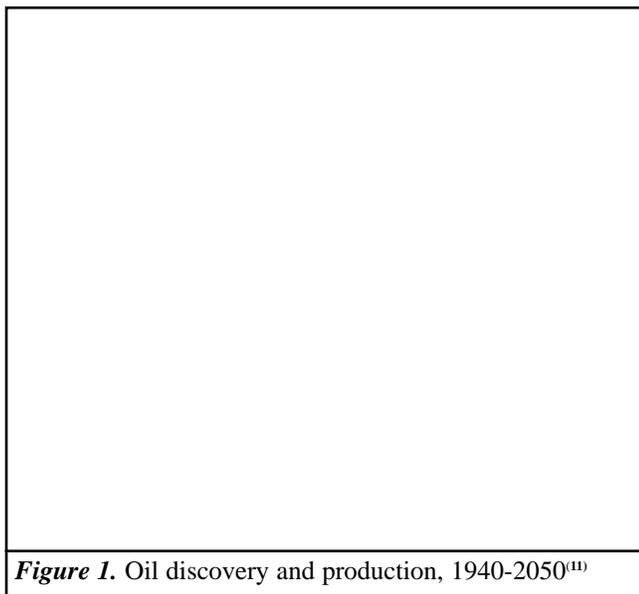


World carbon dioxide emissions from the consumption of fossil fuels increased by 21 per cent between 1980 and 1999, from 18.8 to 22.9 billion tonnes <sup>(5)</sup>. Atmospheric carbon dioxide levels are currently around 370 parts per million by volume (ppmv). Further rises are already inevitable but there is a consensus amongst scientists that the levels above 550 ppmv must be avoided. The IPCC has recommended cuts of 60-80 per cent in emissions of greenhouse gases to stabilise atmospheric levels of CO<sub>2</sub> <sup>(6)</sup>. The UK government believes that industrialised country emissions may have to be reduced by as much as 90 per cent <sup>(7)</sup>.

Reductions on this scale would require a significant shift away from the use of fossil fuels as an energy source, even their complete phasing out.

### *The nearness of the depletion stage of oil supplies*

Discovery of oil and gas peaked in the 1960s. Production is set to peak too, with five Middle East countries regaining control of world supply <sup>(8)</sup>. Almost two-thirds of the world's total reserves of crude oil are located in the Middle East notably Saudi Arabia, Iran and Iraq <sup>(9)</sup>. An assessment of future world oil supply and its depletion pattern shows that between 1980 and 1998 there was a 11.2 per cent increase in world crude oil production, from 59.6 to 66.9 million barrels of oil per day <sup>(9)</sup>. Current world production rates are about 25 Gb (billion barrels) per year. A simple calculation shows that if consumption levels remain constant, world crude oil reserves, at approximately 1 trillion barrels, could be exhausted around 2040 <sup>(10)</sup> (Figure 1).



**Figure 1.** Oil discovery and production, 1940-2050<sup>(11)</sup>

The oil crises of the 1970s when the Organisation of Petroleum Exporting Countries (OPEC) states reined their production have passed into folk memory. However, they were accompanied by massive disruption and global

economic recession. The same happened in 1980 and 1991<sup>(12)</sup>.

Colin J. Campbell, a pre-eminent oil industry analyst, believes that future crises will be much worse. "The oil shocks of the 1970s were short-lived because there were then plenty of new oil and gas finds to bring on stream. This time there are virtually no new prolific basins to yield a crop of giant fields sufficient to have a global impact. The growing Middle East control of the market is likely to lead to a radical and permanent increase in the price of oil, before physical shortages begin to appear within the first decade of the 21st century. The world's economy has been driven by an abundant supply of cheap oil-based energy for the best part of this century. The coming oil crisis will accordingly be an economic and political discontinuity of historic proportions, as the world adjusts to a new energy environment"<sup>(8)</sup>.

The three main purposes for which oil is used worldwide are food, transport and heating. In the near future the competition for oil for these three activities will be raw and real. An energy famine is likely to affect poorer countries first, when increases in the cost of paraffin, used for cooking, place it beyond their reach. Following the peak in production, food supplies all over the world will begin to be disrupted, not only because of price increases but because the oil will no longer be there <sup>(11)</sup>.

## **ENERGY, TRANSPORT AND THE FOOD SYSTEM**

### *Our food system is energy inefficient.....*

One indicator of the unsustainability of the contemporary food system is the ratio of energy outputs - the energy content of a food product (calories) - to the energy inputs. The latter is all the energy consumed in producing, processing, packaging and distributing that product. The energy ratio (energy out/energy in) in agriculture has decreased from being close to 100 for traditional pre-industrial societies to less than 1 in most cases in the present food system, as energy inputs, mainly in the form of fossil-fuels, have gradually increased.

In modern high input fruit and vegetable cultivation, the output/input ratio is between 2 and 0.1 (i.e. 1 calorie of food energy output requires between 0.5 and 10 calories of energy input, respectively). For intensive beef production the ratio is between 0.1 and 0.03, and may reach extreme values of 0.002 for winter greenhouse vegetables <sup>(13)</sup>. All of these ratios refer only to the energy consumed up to the farm gate and exclude processing, packaging and distribution.

However, transport energy consumption is also significant, and if included in these ratios would mean that the ratio would decrease further. For example, when iceberg lettuce is imported to the UK from the USA by plane, the energy ratio



is 0.00786. In other words 127 calories of energy (aviation fuel) are needed to transport 1 calorie of lettuce across the Atlantic. If the energy consumed during lettuce cultivation, packaging, refrigeration, distribution in the UK and shopping by car was included the energy needed would be even higher. Similarly, 97 calories of transport energy are needed to import 1 calorie of asparagus by plane from Chile, and 66 units of energy are consumed when flying 1 unit of carrot energy from South Africa.

Just how energy inefficient the food system is can be seen in the crazy case of the Swedish tomato ketchup. Researchers at the Swedish Institute for Food and Biotechnology analysed the production of tomato ketchup (14). The study considered the production of inputs to agriculture, tomato cultivation and conversion to tomato paste (in Italy), the processing and packaging of the paste and other ingredients into tomato ketchup in Sweden and the retail and storage of the final product. All this involved more than 52 transport and process stages.

The aseptic bags used to package the tomato paste were produced in the Netherlands and transported to Italy to be filled, placed in steel barrels, then moved to Sweden. The five layered, red bottles were either produced in the UK or Sweden with materials from Japan, Italy, Belgium, the USA and Denmark. The polypropylene (PP) screw-cap of the bottle and plug, made from low density polyethylene (LDPE), was produced in Denmark and transported to Sweden. Additionally, LDPE shrink-film and corrugated cardboard, were used to distribute the final product. Labels, glue and ink were not included in the analysis.

This example demonstrates the extent to which the food system is now dependent on national and international freight transport. However, there are many other steps involved in the production of this everyday product. These include the transportation associated with: the production and supply of nitrogen, phosphorous and potassium fertilisers; pesticides; processing equipment and farm machinery. It is likely that other ingredients such as sugar, vinegar, spices and salt are also imported. Most of the processes listed above will also depend on derivatives of fossil fuels. This product is also likely to be purchased in a shopping trip by car.

.....*is dependent on oil*.....

Trade-related transportation has been estimated to account for one eighth of world oil consumption and is expected to increase by 70 per cent between 1992 and 2004 from 29 to 49 trillion tonne-kilometres (15). If this occurs the carbon dioxide emissions resulting from international trade will increase from approximately 1.45 billion tonnes in 1992 to 2.45 billion tonnes in 2004. Transport associated with the food system is a significant part of this story.

One study has estimated that UK imports of food products and animal feed involved transportation by sea, air and road amounting to over 83 billion tonne-kilometres (16). This required 1.6 billion litres of fuel and, based on a conservative figure of 50 grammes of carbon dioxide per tonne-kilometre resulted in 4.1 million tonnes of carbon dioxide emissions (17). Within the UK, the amount of food transported increased by 16% and the distances travelled by 50% between 1978 and 1999 (Table 1).

	Quantity (millions of tonnes)	Average distance (kilometres)
1978	287	82
1983	264	89
1988	302	100
1993	300	119
1998	346	123
1999	333	125

**Table 1.** Tonnage and distance travelled by food 1978-98 in the UK (18)

It has been estimated that the CO<sub>2</sub> emissions attributable to producing, processing, packaging and distributing the food consumed by a family of four is about 8 tonnes a year (19)

.....*and is unnecessarily contributing to carbon emissions*

It is not that this transportation is critical or necessary. In many cases countries import and export similar quantities of the same food products (20). A recent report has highlighted the instances in which countries import and export large quantities of particular foodstuffs (20). For example, in 1997 126 million litres of liquid milk was imported into the UK and at the same time 270 million litres of milk was exported from the UK. 23,000 tonnes of milk powder was imported into the UK and 153,000 tonnes exported (21). UK milk imports have doubled over the last 20 years, but there has been a four-fold increase in UK milk exports over the last 30 years (22).

Britain imports 61,400 tonnes of poultry meat a year from the Netherlands and exports 33,100 tonnes to the Netherlands. We import 240,000 tonnes of pork and 125,000 tonnes of lamb while exporting 195,000 tonnes of pork and 102,000 tonnes of lamb (20).

This system is unsustainable, illogical, and bizarre and can only exist as long as inexpensive fossil fuels are available and we do not take significant action to reduce carbon dioxide emissions.



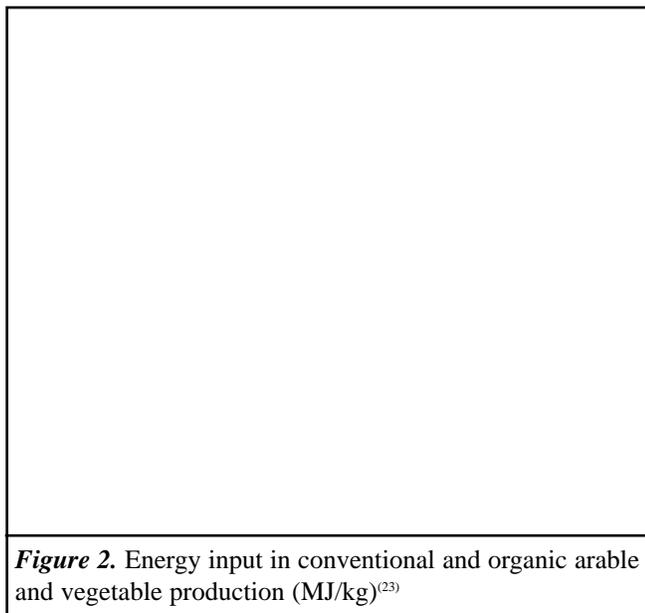
**IS ORGANIC ANY DIFFERENT?**

*The organic system is more energy efficient to the farm gate.....*

One of the benefits of organic production is that energy consumption and, therefore, fossil fuel consumption and greenhouse gas emissions, are less than that in conventional systems.

The energy used in food production is separated into direct and indirect inputs. Indirect inputs include the manufacture and supply of pesticides, feedstuffs and fertilisers while direct energy inputs are those on the farm, such as machinery. One measure of the energy efficiency of food production that allows a comparison between different farming practices is the energy consumed per unit output, often expressed as the energy consumed per tonne of food produced (MJ/tonne) or the energy consumed per kilogram of food (MJ/kg).

A study comparing organic and conventional livestock, dairy, vegetable and arable systems in the UK found that with average yields, the energy saving with organic production ranged from 0.14 MJ/kg to 1.79 MJ/kg, with the average being 0.68 MJ/kg or 42 per cent <sup>(23)</sup>. The results for arable and vegetable production are shown in (Figure 2).



**Figure 2.** Energy input in conventional and organic arable and vegetable production (MJ/kg)<sup>(23)</sup>

The improved energy efficiency in organic systems is largely due to lower (or zero) fertiliser and pesticide inputs, which account for half of the energy input in conventional potato and winter wheat production and up to 80 per cent of the energy consumed in some vegetable crops.

In conventional upland livestock production, the largest energy input is again indirect in the form of concentrated and cereal feeds. When reared organically, a greater proportion of the feed for dairy cattle, suckler beef and hill

sheep is derived from grass. In the case of milk production it has been found that organic systems are almost five times more energy efficient on a per animal basis and three and a half times more energy efficient in terms of unit output (the energy required to produce a litre of milk) <sup>(23)</sup>.

*.....but not when it goes global.*

So far so good but once passed the farm-gate things begin to go wrong. Britain imports over three-quarters of its organic produce, and despite consumer demand, only two per cent of its land is organically farmed <sup>(24)</sup>. As the market has grown it has been met by imports (Table 2).

	1997/1998		1998/1999		1999/2000	
	UK sales (£m)	Imports (%)	UK sales (£m)	Imports (%)	UK sales (£m)	Imports (%)
Eggs	5	N/s	9	0	31	0
Meat	13	0	14	5	24	30
Dairy	18	10	54	40	106	40
Babyfoods	8	N/s	12	70	24	65
Cereals and baked products	36	50	50	70	67	75
Multi-ingredient	18	20	58	80	97	80
Fruit, vegetables and herbs	140	80	175	82	230	85
Beverages	16	N/s	18	90	24	85

**Table 2.** UK retail sales and imports of the main organic food product categories <sup>(25)</sup>

A study looking at the energy consumption and carbon dioxide emissions when importing organic food products to the UK by plane <sup>(26)</sup> found that carbon dioxide emissions range from 1.6 kilograms to 10.7 kilograms. Air transport of food is the worst environmental option but road transport, especially unnecessary journeys, is also bad. For example 5kg of Sicilian potatoes travelling 2448 miles emits 771 grammes of carbon dioxide.

**ALTERNATIVES, CONCLUSIONS AND RECOMMENDATIONS**

*Proximity and localisation of food system would be beneficial*

The contemporary food system is inherently unsustainable. Indicators of social, environmental and economic performance, such as food security, greenhouse gas emissions, food miles, farm income and biodiversity highlight this fact.

This process could be reversed by re-establishing local and regional food supply systems and substituting ‘near for far’ in production and distribution systems. This would reduce both the demand for and the environmental burdens associated with transportation.

The proximity principle is a straightforward concept in



which production processes are located as near to the consumer as possible. When applied to food supply, local food systems in the form of home-delivery box schemes, farmers' markets and shops selling local produce would replace imported and centrally distributed foodstuffs.

Taking UK food supply and trade at present, there is great potential to apply the proximity principle, in the form of import substitution. Apart from products such as bananas, coffee and tea, many of the foodstuffs that are imported at present could be produced in Britain. Many meat products, cereals, dairy products and cooking oils are or could be available here throughout the year. So could fruit and vegetables, perhaps the most seasonal of food groups, through a combination of cultivating different varieties and traditional and modern storage and preservation techniques.

The land currently used to produce food that is exported could be used to increase our self-sufficiency.

Table 3 shows foodstuffs for which the quantity produced in the UK is very close to the amount consumed here. Despite this, there are significant levels of imports and exports in these products at present.

	Production	Imports	Exports	Domestic Use
Wheat	15470	1844	4663	13551
Pulses (such as peas and beans)	701	167	186	682
Meat	3733	1408	649	4492
Dairy Products	464	350	252	587
Milk	14635	3029	2266	15451

**Table 3.** UK food production and trade for five food categories, 1998 (1000 tonnes) <sup>(22)</sup>

There is growing evidence of environmental benefits of local sourcing of food in terms of reduced transport related environmental impact. In the case of organic produce, a survey of retailers compared local and global sourcing of produce marketed in different outlets between June and August 2001. Products were chosen that were available in the UK during these months but are at present imported by the multiple retailers. These included spring onions imported by plane from Mexico, potatoes imported by road from Sicily, onions imported by ship from New Zealand. It was found that local sourcing through a farmers market, for example, would therefore reduce the greenhouse gas emissions associated with distribution by a factor of 650 in the case of a farmers' market and more for box schemes and farm shop sales <sup>(27)</sup>.

The value of UK food, feed and drink imports in 1999 was over £17 billion. It is clear that a reduction in food imports through import substitution would not only be of benefit to the UK economy as a whole but could also be a major driver in rural regeneration as farm incomes would increase substantially. Local food systems also have great potential to reduce the damaging environmental effects of the current food supply system.

**There are essentially three mechanisms through which the food system could relocalise.**

**These are:**

**a) Voluntary approaches by the agriculture and food industries and consumers**

Although many multiple retailers now have a local sourcing policy and targets for the percentage of food products sourced within the locality or region, the targets that have been set are low. Asda, for example, aims to source two per cent of food products locally. Even when supermarkets promote produce as being local or regional, the food will probably have been transported a considerable distance due to regional distribution centres and centralised processing. The economies of scale and centralised distribution systems of the multiple retailers are not easily suited to dealing with small-scale producers and direct deliveries to stores by local farmers and processors. However more could be done especially if the economic framework changes and there is more pressure from consumers.

Many concerned consumers do not have the information with which they could make an informed choice. Information could be improved through some form of label that indicates the distance accumulated and the transport-related environmental impact. Colour coding could also be applied. The organic certifier Bio-Swiss already distinguishes between imported and national produce on their labels.

Farm assurance schemes and organic certification bodies, could introduce the proximity principle into certification. The options for reducing the damaging effects of post-farm gate transport by providing incentives to market produce locally, for example, through reduced certification costs or an added premium or market advantage should now be considered.

Many restaurants, hotels and public houses now source ingredients locally. This is often seen as a direct way to support local farmers and also indicates the freshness and seasonality of the food on the menu. The National Trust now has a policy to supply its restaurants and cafeterias with local food. This is a welcome move that could become more widespread.

**b) Increases in environmental taxes**

Another way to reduce the damaging effects of food miles is to increase the costs of transportation so that the environmental damage (such as air pollution and greenhouse gas emissions) are accounted for. In Switzerland, a Heavy Vehicle Fee (HVF) was introduced in January 2001 <sup>(28)</sup>. The HVF charges heavy goods vehicles (over 3.5 tonnes) based on their gross weight, kilometres driven and emissions.

In 1994, in the UK, The Royal Commission on Environmental Pollution recommended that fuel duty be



increased every year so as to double the price of fuel, relative to the prices of other goods, by 2005, which would require a 9 per cent annual increase in fuel duty <sup>(29)</sup>. Successive UK governments adopted increases in fuel duty until the fuel protests in 2000, following which the fuel duty escalator was dropped.

It is assumed that increases in the costs of road transport will encourage a shift to more environmentally benign modes of transport such as rail freight, and public transport and home delivery in the case of shopping trips that are currently done by car. In theory, if transport costs continue to increase there will be a point at which existing distribution systems become uneconomic and alternative distribution systems that are more localised become a viable alternative. The most obvious gap in the economic framework is the failure to tax aviation fuel.

At present most of these taxation measures are seen as being politically unacceptable. Yet the introduction of some kind of fiscal or taxation policy is likely to be required if sustainable food supply is to become a reality. However, local food schemes will need to be developed at the same time and preferably beforehand, in order to provide an attractive and viable alternative to transport-intensive food supply chains.

### **c) Targets and direct policy and fiscal support for local food systems**

Developing a sustainable food system should be a key policy objective for central government, local government and regional development agencies, based on targets for sustainable food production, import substitution, fair trade and local sourcing of food. For instance, the initiative recently announced to provide 'one piece of fruit per school child' offers an ideal opportunity for the government to show its commitment to the development of a sustainable food system. Ambitious targets could be set to meet this increased demand in fresh fruit locally.

Funds available at local, regional, national and European (Rural Development Regulation) level should be directed to support the development of sustainable local and regional food distribution systems. Specifically, there should be an increase in siphoning off CAP production subsidies into support for sustainable farming and regional food economies. Regional Development Agencies could also play an important role in developing regional food systems through grant allocation, technical support and marketing advice. All regional development plans should include local food economy targets.

Direct support for the expansion of local food systems could come in the form of targets set for the procurement of local food by schools, hospitals and publicly run catering facilities. The targets could be modest to begin with, which would allow local food producers to adapt to the new

circumstances. Another mechanism that could be used is inducement through the tax system, so that the rates paid by businesses such as hotels, restaurants and caterers would be reduced if a certain percentage of their food is supplied locally or regionally.

The introduction of practical and classroom based education on food, farming and sustainable development in the National Curriculum would also help to raise awareness and understanding.

## **CONCLUSIONS**

A sustainable food system cannot rely, almost completely, on one finite energy source; an energy source which causes enormous levels of pollution during its production, distribution and use. Although food supplies in wealthy countries such as the UK appear to be secure and choice, in terms of thousands of food products being available at supermarkets, seems limitless, this is an illusion.

The vulnerability of our food system to sudden changes was demonstrated during the fuel crisis in 2001. A sharp increase in the price of oil or a reduction in oil supplies could present a far more serious threat to food security and is likely to as oil enters its depletion phase. Food production and distribution, as they are organised today, would not be able to function. Moreover, the alternatives, in the form of sustainable agriculture and local food supplies, which minimise the use of crude oil, are currently unable to respond to increased demand due to low investment and capacity.

The food system is now a significant contributor to climate change. Reducing the carbon dioxide emissions from food production, processing and distribution by minimising the distance between producer and consumer should be a critical part of any strategy to mitigate global warming.

There are many benefits to organic farming, including reduced fossil fuel energy consumption and greenhouse gas emissions. However, these are often overshadowed by the environmental damage of long distance transport. Organic products that are transported long distances, particularly when distribution is by plane, are almost as damaging as their conventional air freighted counterparts. Highly processed and packaged organic foodstuffs have an added adverse environmental impact.

The priority must be the development of local and regional food systems, preferably organically based, in which a large percentage of demand is met within the locality or region. This approach, combined with fair trade, will ensure secure food supplies, minimise fossil fuel consumption and reduce the vulnerability associated with a dependency on food exports (as well as imports). Localising the food system will require significant diversification, research, investment and support that have, so far, not been forthcoming. But it is achievable and we have little choice.



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