PART ONE

Peak oil and food security
FUELLING A FOOD CRISIS

Our current industrial agriculture, food production and trade systems are increasingly dependent on fossil fuels, including artificial fertilisers, packaging, transport and processing methods. With peak oil imminent, food and agricultural policy will have to change. **CAROLINE LUCAS** (member of the European Parliament), **ANDY JONES** and **COLIN HINES**, investigate the consequences of the decline of cheap oil on food security in the UK and elsewhere and call for a Royal Commission on Food Security to give the matter urgent consideration.

> When the price of oil climbed above $50/barrel in late 2004, public attention began to focus on the adequacy of world oil supplies – and specifically on when production would peak and begin to decline. Analysts are far from a consensus on this issue, but several prominent ones now believe the oil peak is imminent.[1]
>
> – U.S. Department of Energy, 2005

Petroleum has become the lifeblood of both industrialised and developing economies. It's difficult to find a single product available in the UK that has not consumed crude oil derivatives (and natural gas or coal) during its production, distribution and retail. Yet there's increasing evidence, easy access to cheap oil is fast running out. Many expect it to occur well before 2020. Some believe we may already have passed the point of maximum production. Some consequences of our addiction to fossil fuels have been well documented, particularly its impact on our transport systems. Less analysed, is the impact of higher oil prices on our increasingly industrialised food system.

The geological reality of ever-dwindling fossil-fuel supplies is non-negotiable. While it has taken 145 years to consume half the 2–2.5 trillion barrels of conventional oil supplies generally regarded as the total available, it's likely the other half will be largely consumed within the next 40 years, particularly given China and India's huge increase in demand. Some 98% of global crude oil comes from 45 nations, over half of which may already have peaked in oil production, including seven of the 11 OPEC nations. Major oil field discoveries fell to zero for the first time in 2003, while excess capacity held by OPEC nations has dwindled, from an average of 30% to about 1% of global demand today.[2] World oil and gas production is declining at an average of 4–6% a year, while demand is growing at 2–3% a year. The implications for every aspect of our lives today, are overwhelming.

As food undergoes more processing and travels further, the food system consumes ever more energy each year

The industrialisation of farming accelerated dramatically in industrialised countries after World War Two, and began in many poorer countries as a result of the Green Revolution of the 1950s and 1960s. These trends transformed food production around the globe, with world grain harvests increasing by 250%. Yet this reliance on fossil fuels for fertilisers, accounting for around a third of agricultural energy consumption, pesticides, and hydrocarbon-fuelled farm machinery and irrigation systems, means industrialised farming consumes 50 times the energy input of traditional agriculture. In extreme cases, agriculture's energy consumption has increased 100-fold or more. It's been estimated that 95% of all our food products require oil use.[3] Just to farm a single cow and deliver it to market requires six barrels of oil, enough to drive a car from New York to Los Angeles.[4]

Much of our food system is staggeringly inefficient. Overall, including energy costs for farm machinery, transport, processing and feedstocks for agricultural chemicals, the modern food system consumes roughly ten calories of fossil-fuel energy for every calorie of food energy produced.[5] Processing is particularly energy-dependent. Next time you reach for a typical 450 gram box of breakfast cereal, you might pause to consider that it may have required over 7,000 kilocalories of energy for processing, while the cereal itself provides only 1,100 kilocalories of food energy.[6]

Oil and food – our addiction

> From farm to plate, the modern food system relies heavily on cheap oil. Threats to our oil supply are also threats to our food supply. As food undergoes more processing and travels further, the food system consumes ever more energy each year.
>
> – Danielle Murray, *Oil and Food: A Rising Security Challenge*, 2005

There have been dramatic changes in how food is produced, processed and distributed over the last fifty years. The most significant changes include:

- The mechanisation of agriculture and increased reliance on external supplements, such as synthetic fertiliser, pesticide, feed, plastics, energy and fuel
- A major shift to highly processed and packaged food
- The globalisation of the food industry, characterized by an increase in food trade (imports and exports) and wider sourcing of food within the UK and overseas. Of particular note is the rise in imports of fresh fruit and vegetables, with more produce sourced from further a field, such as Africa, Asia and the Far East
- Supermarkets emerging as sales leaders, accompanied by loss of small shops, markets and wholesalers. Parallel to this trend is the concentration of the supply base into the hands of fewer, larger suppliers, partly to meet supermarket preferences for bulk year-round supply of uniform produce
- Major changes in delivery patterns, with most goods now routed through supermarket regional distribution centres, a trend towards use of larger Heavy Goods Vehicles (HGVs) and just-in-time delivery, sometimes referred to as 'warehouses on wheels'
- A switch from frequent food shopping on foot at small local shops, to shopping by car at large out-of-town supermarkets.

Food supply in the UK now accounts for 21% of total UK energy use. As table 1, below, shows, agriculture and food processing are significantly responsible for this food-related energy consumption, with food transportation contributing almost a fifth (18.5%) of the total. Despite the energy intensity of UK agriculture, self-sufficiency in food has fallen to around two-thirds.[8]

The energy on average, used in each UK household currently requires the equivalent of almost 10 barrels (1860 litres) of crude oil each year. The energy used to produce, package, process, distribute, store and cook food comes from several sources, not just from oil. Food distribution is totally dependent on petroleum products, whereas food processing consumes coal, natural gas and electricity as well as crude oil. Through every stage of the food chain, the use of renewable energy is currently at very low levels.

About half the energy used to transport food is consumed in the UK. The other half comes from transport in countries that export foodstuffs to the UK and international transport by road, sea and plane for these UK food imports. About a third of energy used to produce food on farms and in market gardens, and for food processing and packaging will be in countries that export food products to the UK, as UK self-sufficiency in food has fallen to around two-thirds.

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Fertiliser

The manufacture of synthetic fertilizers is particularly energy intensive, accounting for around one third of the UK's agricultural energy consumption. It's been estimated 40% of world food protein production now relies on synthetic nitrogen fertilizers. Although synthetic fertilisers have only been used on a large

Table 1: Annual energy use associated with UK food supplies, in terms of energy use and barrels of oil equivalent

		Energy (Gigajoules)		Barrels of oil equivalent	
	%	Total	per person	Total	per person
Retailing	6.4	98 M	1.65	16.0 M	0.27
Packaging	7.6	115 M	1.93	18.8 M	0.32
Catering	9.9	151 M	2.54	24.7 M	0.41
Transport & distribution centres	18.5	282 M	4.74	46.1 M	0.78
Home preparation	23	350 M	5.89	57.2 M	0.96
Agriculture & food processing	34.5	525 M	8.83	85.8 M	1.44
Total	100	1,521 M	25.58	248.6 M	4.18
Total Energy use		7,4214 M	121.31	1,180 M	19.8

Table adapted for *Pacific Ecologist*[9,10] scale since the 1950s, consumption in that period increased dramatically. World fertiliser consumption increased from 70 million tonnes in 1970 to 138 million tonnes in 2000 and is expected to rise to 200 million tonnes by 2030. China now consumes the most fertiliser, at 40 million tonnes in 2004. The fertiliser industry accounts for around 2% of world energy consumption, with a large proportion of this used to produce nitrogen fertilizer.

Table 2 below shows that producing a kilogram of synthetic nitrogen fertiliser requires the energy equivalent of 2 litres of diesel, and phosphate fertiliser, almost half a litre of diesel.

Food processing is extremely energy intensive, while the packaging, which is often difficult to separate and recycle, also requires large amounts of energy and raw materials to produce

Energy consumed during fertiliser manufacture was equivalent to 191 billion litres of diesel in 2000, which is projected to rise to 277 billion litres in 2030 (Table 3).

Higher energy and fuel prices will be a triple blow for the synthetic fertiliser industry, and farmers dependent on this quick fix and unwilling to consider alternatives. Firstly, because of the large amount of energy required to extract ores and consumed during the manufacturing processes; secondly, natural gas use as a feedstock, and thirdly, costs of the fuel required to transport these bulk commodities. The export of fertilisers and their raw materials are a significant part of sea-borne bulk trade: the fourth most traded bulk commodity in world shipping trade after iron ore, coal and cereals. Trade in fertilisers has increased because the fertiliser industry has gradually relocated plants to countries with low electricity prices and the required natural gas feedstock. These include the former Soviet Union, Eastern Europe, the Middle East and Venezuela.

The need to access raw materials for other fertilizers has seen the industry also move into areas with extensive natural reserves, including Africa, China, the U.S., and Morocco. Worldwide demand for fertiliser has caused significant levels of international trade. Shipping costs are relatively high for these low-value bulk commodities: the lower the value of the shipped material, the greater the incidence of transport in the landed cost. But the fertiliser industry does not see peak oil and natural gas as being a problem for fertiliser producers. According to the International Fertiliser Industry Association "…processes for ammonia production can use a wide range of energy sources. Thus, even when oil and gas supplies eventually dwindle, very large reserves of coal are likely to remain. Coal reserves are sufficient for well over 200 years at current production levels, and their location is geographically diverse: 60% of China's nitrogen fertiliser production is currently based on coal."[11] But the climate change consequences, would be catastrophic. Also, production of ammonia from coal is 70% more energy intensive than production from natural gas. Given the high energy input required to produce nitrogen fertiliser, it's inevitable manufacturing costs have risen as oil and gas prices worldwide have increased. Since 2003, ammonium nitrate costs, have risen from £90 per tonne to over £170 per tonne in early 2006.

Table 2: Energy requirements for synthetic nitrogen, phosphate, potash (MJ/kg)

Nutrient	Production	Packaging	Transportation	Application	**Total**	Litres diesel equivalent/kg
Nitrogen (N)	69.5	2.6	4.5	1.6	**78.2**	2.03
Phosphate (P_2O_5)	7.7	2.6	5.7	1.5	**17.5**	0.45
K_2O	6.4	1.8	4.6	1.0	**13.8**	0.36

Table 3: Global consumption and energy requirements for nitrogen, phosphate, and potash fertilisers in 2000 and 2030

	2000		2030	
Nutrient	Consumption (millions of tonnes)	Energy use (millions of litres of diesel equivalent)	Consumption (millions of tonnes)	Energy use (millions of litres of diesel equivalent)
Nitrogen (N)	83	168,490	120	244,188
Phosphate (P_2O_5)	33	14,850	48	21,522
K_2O	22	7,920	32	11,478
Total	138	191,260	200	277,188

Plastics

The global food packaging industry is now worth $100bn-a-year and expanding by 10–15% annually. Consumption of polymers for plastics applications in Western Europe amounted to 39,706,000 tonnes in 2003, about 100 kilograms per person yearly. Half of all goods consumed in Europe are now packed in plastic, with food and non-food packaging representing the largest end-use, accounting for 37.2% of all plastics consumed. Packaging represents the largest single use of plastic, more than is used in the building and construction, automotive, electrical and electronics industries combined. Plastics have replaced more traditional food packaging materials because they are lightweight, flexible, durable and until recently, prices have been low.

In the UK, food and drink packaging now accounts for two-thirds of packaged consumer goods, a total of 130kg per household per year. Food packaging consumes 4.6 GJ of energy per household yearly. Increased food packaging, particularly plastic, is linked inextricably with the rise in processed food, which now accounts for three-quarters of total world food sales. Food processing is extremely energy intensive, while the packaging, which is often difficult to separate and recycle, also requires large amounts of energy and raw materials to produce.

Use of plastic in the food system demonstrates how complicated food supply chains have become. Most visible to the consumer are the plastic bags and the over-wrapped groceries, symbols of the profligate use of resources that characterises current food production. Closer examination of the entire food chain reveals widespread use of plastics, and shows just how dependent the food system has become on finite fossil fuels. For example, in Europe in 2003, three-quarters of a million tonnes of agricultural plastics were consumed for fertiliser and feed bags, to cover silage and for irrigation and drainage systems. The distribution of food involves plastic crates, shrink-wrap and secondary packaging. Plastic is also used for parts for tractors and other farm machinery and equipment.

Food miles

Transport, because of its almost complete dependence on fuels from crude oil, is very vulnerable to decline in availability of cheap oil. Food transportation has increased significantly in recent decades with food distribution now accounting for at least 30% of all road freight within the UK. One in every three lorries on motorways and in town and city centres contains food and drink. Vehicles and vessels travelled a cumulative distance of 30 billion kilometres moving food products to and within the UK in 2002.

Shopping trips for food by car have also increased, in length and frequency, local shops being replaced by out-of-town supermarkets. As fuel prices rises, so do transport costs. In the UK, the retail price of diesel increased from 42p a litre in 1990, to 65p in 1998, and 87p in 2005. In 2006, both diesel and petrol prices reached just below the milestone of £1 a litre in the summer. In the year to mid-March 2006, petrol and diesel increased in price by 8.1 pence (10%) and 7.8 pence (9%) per litre respectively. The prices have since dropped somewhat but are expected to stay higher than has been the case since the early 1980s.

Airfreight

While food exports from the UK have increased significantly since 1961, from 2 million tonnes to 15 million tonnes in 2000, the value of these exports is declining. And the UK still imports almost twice the amount of food it exports, with imports growing significantly in value and weight. In 1980 the UK trade gap in food, feed and drink was £3.5 billion. This increased to £5.9 billion in 1990, £8.3 billion in 1999, £10 billion in 2002 and £12.2 billion in 2004. More recently the trade gap widened by 11% in just 12 months.[12]

Although airfreight currently accounts for only a small fraction of food imports, it has a much greater impact when energy use and greenhouse gases are considered. A recent report for the Department for Environment, Food and Rural Affairs (DEFRA) concluded, "Transport of food by air has the highest CO_2 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 CO_2 equivalent emissions."

Currently imports by plane consist mainly of perishable goods like seafood, fruit and vegetables. The largest category is vegetables from Africa (green beans, baby corn, mangetout), mainly from Kenya, Gambia, Egypt and South Africa. Vegetable imports account for 40% of food airfreight in or out of the UK, fruit imports for 21% and fish imports for 7%. Until recently aviation fuel has been very cheap, compared to petrol and diesel for road vehicles. In 2000 aviation fuel was a sixth the price of diesel. Yet in the last three years, the cost of jet fuel has risen significantly in line with increased cost of crude oil. This has resulted in increased costs for airlines of $22 billion in the first half of 2006. Airfreight is likely to be one of the first aspects of current food sourcing and distribution systems to be hit if oil prices continue to rise overall.

Half of vegetables and 95% of all fruit consumed in the UK now come from overseas

Importing produce by air is less likely to be viable particularly for food products that could be sourced in the UK or transported by sea. For farm owners and farm workers from poorer nations in Asia, Africa and Latin America who have become dependent upon production for export by air, this is likely to result in economic difficulties. Since aviation cost is likely to increase (e.g. via the European Commission's proposals to include aviation in its Emissions Trading System), support should urgently be given to enable poorer countries to diversify away from such dependence.

Energy security versus food security

Food security in a fossil-fuel constrained world will take on increasing significance, particularly for countries heavily dependent on food imports, like the UK. We currently rely on imports to provide almost one third of food consumed in the UK, and have one of the lowest self-sufficiency ratios in the EU.[13] UK food imports are currently growing with DEFRA figures showing imports in tonnes increasing by 38% between 1988 and 2002. For some types of food, the increase has been even more dramatic. Imports of fruit have doubled, and imports of vegetables have tripled. Half of vegetables and 95% of all fruit consumed in the UK now come from overseas.[14] Half of food imported in 2002 was indigenous produce, that is, it could have been grown in the UK's temperate climate.

Energy-wise, there are some cases where it's currently more efficient to import non-indigenous produce or out of season produce than to grow it in the UK. A recent study suggests the energy used for growing tomatoes in heated greenhouses in the UK outweighs the energy used in importing tomatoes grown outdoors in Spain. But with rising oil and gas prices, neither option is likely to be an economic option for many. For some developing countries, import dependence consequences are even more serious, since we already face a world of potential grain shortages. In China, for example, the grain harvest fell by 34 million tons, or 9%, between 1998 and 2005. There's a real risk, China's increasing reliance on world markets for major imports, together with a growing diversion of farm commodities to biofuels, will cause grain prices to be driven so high, many low-income developing countries will be unable to import enough grain.[15] This in turn could lead to escalating food prices and political instability on a global scale.

Food security must not be further jeopardised by committing vast areas of land for the production of fuel rather than food

It would be complacent to imagine Europe would be unaffected by these trends. Food supplies on global export markets could be so tight, the UK, may be unable to source sufficient imports to meet its needs. World grain stocks are now at their lowest levels in 34 years and, according to Lester Brown, world trade in food may now be moving into a period dominated not by food surpluses but by shortages.[16] The emphasis of global food policy is therefore likely to shift from exporters' access to markets, to importers' access to supplies.

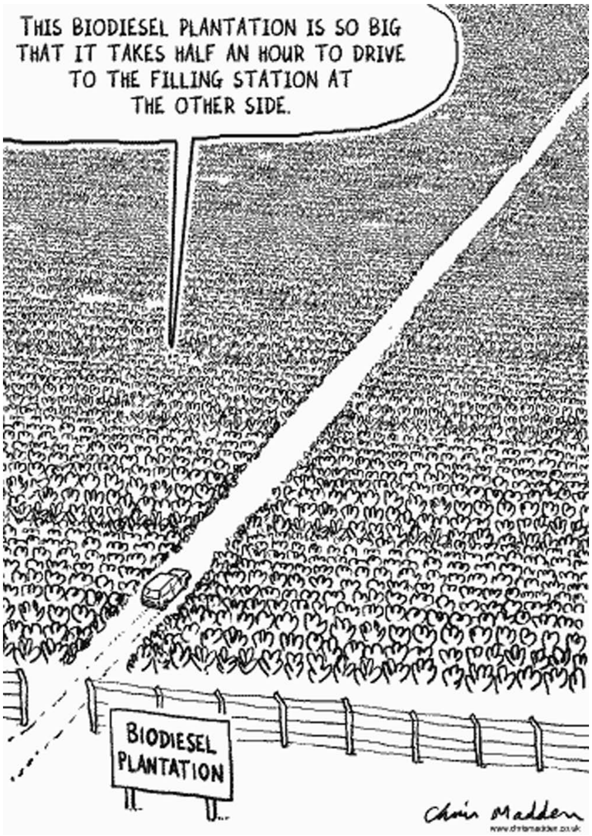
The rise of biofuels

> Road transport in the UK consumes 37.5m tonnes of petroleum products a year. The most productive oil crop that can be grown in this country is rape. The average yield is 3–3.5 tonnes per hectare. One tonne of rapeseed produces 415kg of biodiesel. So every hectare of arable land could provide 1.45 tonnes of transport fuel. To run our cars and buses and lorries on biodiesel, in other words, would require 25.9m hectares. There are 5.7m in the UK. Even the EU's more modest target of 20% by 2020 would consume almost all our cropland.[17]
>
> – George Monbiot, *The Guardian*, 2004

This trend will be exacerbated by climate change, with its potential to significantly reduce harvests and, by some responses to it, including mass development of biofuels. A large-scale switch from growing crops for food to growing crops for fuel is beginning to occur. Bioethanol and biodiesel can be produced from crops like corn and soya. Biofuels are also made from plant oils, crop wastes or wood, and can be used to run cars, buses and lorries.

Switching from fossil fuels to biodiesel and bioalcohol is currently being promoted as one of the major solutions to climate change. As Lester Brown observes, cars, not people, will already claim most of the increase in world grain consumption this year.[18] The U.S. Department of Agriculture projects world grain use will grow by 20 million tonnes in 2006 with 14 million tonnes being used to produce fuel for cars in the U.S., leaving only 6 million tonnes to satisfy the world's growing food needs. Brown points out the world's appetite for automotive fuel is insatiable: the grain required to fill a 25 gallon SUV gas tank with ethanol could feed one person for a year. The amount of corn used in U.S. ethanol distilleries has tripled in five years, jumping from 18 million tonnes in 2001 to an estimated 55 million tonnes from the 2006 crop. In South Dakota, a top-ten corn-growing state, ethanol distilleries are already claiming over half the corn harvest. With so many ethanol distilleries being built, livestock and poultry producers fear there may not be enough corn to produce meat, milk, and eggs. According to Brown, since the U.S. supplies 70% of world corn exports, corn-importing countries are understandably worried about their supply. And where the U.S. goes, the EU is trying to follow, with ambitious plans not only for a 2010 target of 5.75% market share of biofuels in the overall transport fuel supply, but much greater growth afterwards.

Last year, the EU produced 1.6 billion gallons of biofuels; 858 million gallons were biodiesel, produced from vegetable oil, mostly in Germany and France, and 718 million gallons were ethanol, most of it distilled from grain in France, Spain and Germany. Already margarine manufacturers, struggling to compete with subsidized biodiesel refineries, have been asking for help as a result.[19] It's been calculated that to meet the EU's target of 20% of transport fuel from biodiesel by 2020 would consume almost all of Britain's cropland. Environmentalist George Monbiot concludes if this were attempted worldwide, most of the arable surface of the planet will be deployed to produce food for cars, not people. Clearly, food security – already at risk as a result of peak oil – must not be further jeopardised by committing vast areas of land for the production of fuel rather than food.



In 2004, the UK's vulnerability to disruptions in energy imports became very clear, when Russia tweaked the spigot on gas supplies to Europe and catapulted energy security to top of the agenda. The arrival of large importers like China on the world food market, together with the growing effects of higher energy costs and climate change on global food production, means a similar vulnerability to sufficient supplies of food imports to the UK and Europe is a possibility. As a matter of urgency this report calls for a Royal Commission on Food Security to give serious consideration to these issues. **PE**

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