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Briefing: The big biofuels debate—can we have food and fuel?

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1. INTRODUCTION

People may be feeling bewildered by the coverage in the media on biofuels, such as these in the *Sunday Times*.

> [A]re biofuels the answer to exhausted oil wells—or just another nightmare scenario?
>
> [F]uel will be grown instead of food, and small-scale farmers will be pushed off their lands.
>
> By 2030 . . . transport worldwide . . . [will] pump out 80% more carbon than it does today . . . it's biofuels or bust.[1]

Starting with the food price issue, can the world afford to feed itself, and are biofuels exacerbating the situation? Looking at wheat prices, rice prices and so on, it is clear that some commodity food prices have doubled between 2007 and 2008. Biofuels consume around 1% of the world's arable crops.[2] How can that account for a doubling in price? Crop yields fell by 15% over the same period, largely due to weather effects and possibly linked to climate change. Is this a more likely cause? In tight markets people build up large stocks in anticipation of future price rises; traders buy and sell cargoes many times over while they are in transit as a way of making money; and speculation, generally, drives prices up. The crops are shipped all over the world—but there is an acute shortage of ships because of the demand for vessels to carry steel to China and so on. Is the sharp rise in ship chartering costs a more likely cause?

Oil prices have more than doubled between 2007 and 2008, and oil prices impact on commodity food prices via fertiliser production costs, on-farm fuel costs and long-haul transportation costs. Interestingly, a recent analysis shows that biofuels keep world oil prices 15% lower than they would otherwise be.[3] The end result, though, is that prices of commodities such as maize and soybeans are rising, albeit not quite as sharply as crude oil prices.

Developing countries are switching over to a western-style diet that is high in meat. If someone wants to eat a kilogram of chicken instead of a kilogram of rice, 7 kg of chicken feed are needed to produce the chicken. Is this a more likely cause? It would appear that the science (or lack of it) behind the headlines needs to be looked at very carefully.

2. A NORTH EAST ENGLAND PERSPECTIVE

The Tees valley in north east England has seen significant levels of investment activity between 2005 and 2008 in the fields of biomass and biofuels—£450 million already invested and a further £400 million announced. This has been driven by the colocation of large-scale petrochemical industry and an extensive agricultural hinterland. The region is home to the largest biodiesel plant in the world, producing 250 000 t/year of biodiesel. If the plant were to run exclusively on rapeseed oil, and given that the north east grows 80 000 ha of oilseed rape in a typical year, it could draw its feedstocks from existing oilseed rape crops in an area stretching from the Humber to the Tweed. Note, however, that this plant on its own can satisfy a quarter of the UK's biodiesel demand against a 2010 target of 5%—and half of the UK's demand against a 2008 target of 2·5%.

Questions are often asked about whether biodiesel plants are really carbon neutral. The starting point is that the crops used to produce biofuels absorb carbon dioxide (CO_2) as they grow, and release CO_2 as they are used—with the CO_2 being absorbed by new crops to complete the cycle. It has been shown that a biodiesel plant in north east England can be 94% carbon neutral if the supply chain is optimised.[4] This figure comes from a study which looked at an idealised scenario in which fertiliser application is finely optimised, oilseed rape is crushed locally, the rapeseed oil is converted into biodiesel in a local plant, rape bran from the crusher is used as an energy feedstock for the various production plants involved, and all transportation of feedstocks, intermediates and products is minimised. The resulting carbon footprint compared with normal mineral diesel was shown to be 94% lower. In practice these idealised conditions are not realised, but the fact remains that low-carbon biodiesel can be produced in the north east using feedstocks drawn from a much smaller hinterland than the territory into which the product is being supplied. Oilseed rape not used for biodiesel production is exported.

A large bioethanol plant is under construction on the Wilton site in the Tees valley, with 1·2 Mt/year of wheat being converted into 350 000 t/year of bioethanol and about 340 000 t/year of dried distiller's grain solubles (DDGS). The region typically grows 250 000 ha of wheat and exports about 1 Mt/year of wheat beyond its borders. This plant is capable of supplying a third of the UK's bioethanol demand against a 2010 target of 5%. The carbon footprint of bioethanol is generally considered to lie somewhere between 20% and 80% of that of petrol.[5,6] Where it sits in that band depends on what the DDGS is used for and where the bioethanol plant gets its electricity and heat supplies from. The Tees valley plant is towards the greener end of the scale. Once again, there is a plant producing a low-carbon biofuel using feedstocks drawn from a much smaller hinterland than the territory into which product is being supplied.

The region has therefore demonstrated in practice that at the current low UK target levels for biofuel consumption (2·5% rising to 5%) there is no issue with food versus fuel.

3. A UK PERSPECTIVE

The UK (in common with most of the EU) has spent the last 20 years throttling back on agriculture—incentivising farmers not to grow crops because of various 'food mountains'. Since the 1990s, 45 Mha of crop land has been taken out of production around the world—including 7 Mha in Europe under the 'set-aside' scheme. Now that the surpluses are almost gone the funding regime is changing, with the effect that the UK has about 500 000 ha of former 'set-aside' land which can be used for additional crops. Even without that, the UK is a net exporter of both soft wheat (ideal for bioethanol) and hard wheat (suitable for bread-making)—amounting to 4–5 Mt/year. It is also a small exporter of rape oil. With 18 Mha of land in the UK, of which just over one third is suitable for growing arable crops, it is generally considered that there is sufficient land capacity without impacting on UK food production to support biofuel displacement of petrol and diesel up to around the 10–15% level based on current biofuels technology.[7]

Effort is being deployed at Newcastle University[8] and elsewhere to develop more advanced biofuels production processes that utilise the whole crop. Roughly speaking, if the whole of a crop (especially the lignocellulosic components in the stalk) can be used instead of just the edible components, then twice as much biofuel can be obtained from a fixed area of land. This takes the UK limit on displacing petrol and diesel up to 20–30%.

Turning to the food supply side, it has recently been estimated by the Waste and Resources Action Programme that the UK throws away 20 Mt/y of food derived from arable crops. Linking that to the observation that the cost of the cereals going into a loaf of bread is less than 5% of the selling price[9] (with the remaining 95%+ comprising other ingredients, production costs, packaging, marketing, distribution, profit margins and so on), there is clearly scope for constraining UK food prices without necessarily restricting the growth of biofuels.

4. A EUROPEAN PERSPECTIVE

The EU imports significant volumes of animal feed protein from other parts of the world. This is due in a large part to the high meat content in the European diet. The imported feed complements indigenous supplies derived from arable farming, including materials like DDGS (a by-product of bioethanol manufacture) and rape cake (a by-product from oilseed rape crushing). Much of the imported animal feed protein comes in the form of soya. Much of the world's soya is grown in a perfectly sustainable manner—but some of it impacts on Brazilian rainforests, and thereby threatens one of the planet's main defences against climate change. Consequently—and contrary to popular belief—the production of biofuels in Europe (if by-products are used in the right way) can actually take the pressure off land in developing countries. It has been estimated, for example, that if Europe replaced 10% of its petrol with bioethanol, and if all the DDGS was used as an animal feed, this would reduce the Brazilian land demand by 4 Mha. Once again, the food versus fuels debate is more complex that it first appears.

5. A WORLDWIDE PERSPECTIVE

World population is expected to grow from just over 6·6 billion people today to 9 billion by the middle of the century. With most of the growth happening in developing countries, and with people there aspiring to a developed-world lifestyle, shortages of both food and fuel are projected. Those who champion the concept of 'single planet living' would argue that if the world's population were to consume resources in the way that Europe does, society would need three planets to provide those resources—or seven planets if everyone adopted a US lifestyle. If China were to use the same amount of oil per person as Europeans it would require an additional 36 million barrels per day: about the same as the oil production of four Saudi Arabias.[10]

So there is clearly an issue looming with respect to population growth and a desire to imitate a lifestyle that is very demanding—and wasteful—in respect of fuel resources and food resources. This is happening against a background where fossil fuel resources are finite, land resources are finite and water resources are finite. The answer has to lie in making better use of all of our resources and reducing waste in all of its forms. This line of thinking has led to (among a great many other things) a programme of work to develop high-yielding varieties of the *Jatropha Curcas* plant for countries lying within 30° latitude of the equator. If this inedible plant can be grown economically on low-grade land without excessive irrigation, then tropical countries can use their land to produce both food and fuel by growing the right crops on the right land.

6. FUTURE DEVELOPMENTS

There is a longer-term challenge to develop new varieties of crops—maximising the protein content of crops for food, maximising the carbohydrate content of crops for energy and maximising the productive use of by-products. There is a challenge to develop crops that can grow on lower-grade land and in areas where rainfall patterns are difficult. There is a further challenge to find ways of converting carbon-containing waste streams into fuels. For all of this to work given that many of today's vehicles will still be on the road in 15 years' time, it is important to start the process of manufacturing car engines that are capable of running efficiently and interchangeably on biofuels and fossil fuels (so-called 'flex-fuel' vehicles). To some extent, all of the above is already underway based on the availability of the oft-maligned first generation biofuels of today which are creating the market conditions and infrastructure to support further investment. Society is already on a path of fuel development and engine development that will allow it to have both food and fuel provided it also manages the demand for both.

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