Fuelling the debate

by Geographical
Saturday, 02 February 2008

In a remarkable reversal of fortune, biofuels have gone from saviour to pariah in just a few short years. But there is still optimism that a second generation of biofuels could still come to our aid. Mark Rowe reports

The beleaguered peatlands of Indonesia, Malaysia, Brunei and Papua New Guinea have long been under threat from loggers seeking juicy returns from the high-value meranti and ramin trees that thrive in these precious habitats. Close behind the loggers came the palm oil farmers, covering thousands of hectares with the cash crop that binds Western food staples such as ice cream, margarine and biscuits.

But in the past five years, the peatlands have come to bear another burden, with palm oil production in Southeast Asia increasing by 162 per cent, according to the Netherlands Environmental Planning Agency. The catalyst, in part, is Europe’s new-fohe beleaguered peatlandsund appetite for biofuels.

As you read this, huge swathes of peatland are being logged, drained and planted with palm oil, causing not only local environmental devastation but releasing extraordinary amounts of carbon dioxide into the atmosphere. A study carried out in 2006 by Wetlands International found that, of 27 million hectares of Southeast Asian peatland, 12 million hectares (45 per cent) are deforested and mostly drained. The drainage for this crop is intense and leads to emissions of up to 100 tonnes of CO2 a year per hectare. ‘The problems with palm oil grown for food are well known, but now that it has a new market for biofuels it is going to be a catastrophe – it’s unequivocally an environmental disaster,’ says Alex Kaat, a spokesman for Wetlands International.

Changing attitudes

Somehow, biofuels have become as reviled among the environmental movement as fossil fuels. But at the start of the century, things were rather different. ‘People commenting on biofuels five years ago tended to be climate change campaigners, and their attitude tended to be that anything that could decarbonise our society had to be a good thing,’ says Ed Matthew, climate change campaigner for Friends of the Earth. ‘Biofuels were just too good to be true.

It’s only recently that people working on agricultural issues have become more involved, and that’s when the alarm bells started ringing. NGOs felt they had made a breakthrough in addressing the problem of oil palm in Indonesia, but biofuels have given the industry a whole new lease of life.’

Collectively known as agrofuels, the two main biofuels are biodiesel and bioethanol, which are generally referred to as ‘first generation’ biofuels. Liquid and gaseous in form, biodiesel is usually made from soya beans or rapeseed; bioethanol is made from corn in the USA and from sugar cane in Brazil.

Biodiesel is the best established of the fuels: it can be blended with conventional diesel fuel up to certain limits without any need for engine modification. Thanks to an investment in bioethanol in the 1970s, Brazil has now weaned itself off

imported oil, and more than half of cars there are driven on a mixture of petrol and bioethanol, known as ‘alcool’.

Most of the world’s governments, along with institutions such as the EU, see biofuels as a good thing. Unlike petrol and gas, which contain carbon that has been locked under the ground for thousands of years, biofuels contain carbon that was, until recently, in the atmosphere. Hence, releasing this CO2 back into the air doesn’t really affect the climate.

Biofuels are now grown commercially in most EU countries, ranging in scale from just 100 square kilometres in Ireland in 2006 to 6,140 square kilometres in the UK and 21,440 square kilometres in France, the largest producer in the EU. Biofuels have their own EU directive, and in January last year, a mandatory target of ten per cent agrofuel use in transport by 2020 was agreed. The USA aims to replace 15 per cent of its gasoline use with bioethanol and other fuels by 2017. A fifth of the US corn harvest is brewed into bioethanol – double the amount produced at the turn of the century. The US production of bioethanol in 2006 amounted to 18.4 billion litres, according to the US Department of the Environment.

Europe’s farming industry is being heavily subsidised to produce biofuel crops. In the UK, farmers may apply to claim support for growing energy crops under the Aid for Energy Crops Scheme. The support is usually made at a rate of £31 for each eligible hectare claimed. In the UK, the amount of land for which these grants have been applied has risen from 29,647 hectares in 2004 to 222,664 hectares in 2007.

From April this year, it will be impossible to buy petrol in the UK that doesn’t contain biofuel. The Renewable Transport Fuel Obligation (RTFO) programme will force fuel suppliers to ensure that a certain percentage of their aggregate sales is made up of biofuels. The effect of this will be to require five per cent of all fuel sold on UK forecourts to come from a renewable source by 2010.

Behind the hype

It’s easy to see why governments have fallen for the allure of biofuels. ‘If you look at it superficially, biofuels look good,’ says Richard Doornbosch, principal adviser for sustainable development for the Paris-based Organisation for Economic Co-operation and Development (OECD). ‘They could reduce greenhouse gases in some areas, they provide an alternative to fossil fuels, they could sustain rural populations and provide energy security.

‘All of these things are possible, but what has been overlooked is the scale required. Biofuels may work on a low or local level, but meeting the demands of the transport sector is of a different order of magnitude. The benefits these biofuels might offer on a small scale are simply no longer there on a large scale. We need to look very carefully at the subsidy schemes that stimulate biofuels and scale them down and avoid fixed, mandatory production targets.’

Environmental groups are also looking more closely at biofuels and are unhappy with what they see. The major concerns centre on the large amounts of fossil fuel energy required to produce biofuels and their impact on biodiversity, food prices and food availability.

In September, Birdlife International sent an open letter to members of the European Parliament entitled The EU Biofuel Target, Great Risks for Little Gain. The letter called on the parliament to abandon its biofuel targets, highlighting numerous recent warnings that are ‘all suggesting that the implementation of the mandatory biofuel target is much more likely to cause environmental and social harm than to help the fight against global warming’.

At the same time, the Transnational Institute, a think-tank on sustainability issues, published a report that was highly critical of the EU’s approach to biofuels. The report, entitled Paving the Way for Agrofuels, concluded that ‘the rush to agrofuels and bio-energy looks set to fuel a massive expansion in monoculture plantations, a process that is being accelerated by EU agrofuel targets and subsidies’.

‘The trouble is that the EU’s plans aren’t what would be considered small scale,’ says Tamra Gilbertson, co-author of the report. ‘I doubt that even if biofuels were ten per cent of our future fuel mix that they could be sustainable. There is strong and growing evidence that, far from reducing global emissions, their use will significantly accelerate climate change.’

It isn’t just the direct impact that biofuels have on biodiversity and their immediate environment that is causing concern. Many scientists now believe that the fuels aren’t as ‘green’ as many people think. ‘The trouble is that biofuel infrastructure is fossil fuel-based,’ says Dr Andrew Boswell, director of the campaign group Biofuelwatch. ‘A lot of biofuel crops suffer from poor greenhouse gas balances. Governments are trying to prove that they are doing something about climate change. There is such a momentum that you feel governments are backing biofuels even though they know they aren’t the solution.’

And to make matters worse, growing and burning many biofuel crops may actually raise, rather than lower, greenhouse gas emissions, according to Professor Paul Crutzen, who was awarded the Nobel Prize in chemistry in 1995 for his studies of the effects of man-made activity on the ozone layer. He and his colleagues have calculated that microbes convert much more of the nitrogen in the fertiliser that is used to grow many biofuels into nitrous oxide (N2O) than previously thought: three to five per cent, which is greater than the generally accepted figure of two per cent used by the International Panel on Climate Change (IPCC). His findings, which are currently being peer-reviewed, suggest that the impact of N2O, which is up to 300 times more potent as a greenhouse gas than CO2, has been underplayed in the production of biofuel crops. According to Crutzen’s findings, the levels of N2O produced could wipe out any benefits accrued through the reduction in fossil fuel use.

Supply and demand

Even if first-generation biofuels had no negative impact on the environment and were truly ‘green’, the consensus is that it would be impossible for them to ever meet the world’s current energy demands, much less keep up with the projected increases.

According to Professor Roland Clift, founding director of the Centre for Environmental Strategy at the University of Surrey, some estimates suggest that an EU target of 15 per cent biofuels for transport would require more than two thirds of the land under cultivation in Europe to be dedicated to growing biofuels. According to the International Energy Agency (IEA), in 2005, about 14 million hectares of land were used for the production of biofuels – about one per cent of the world’s available arable land. Under scenarios drawn up by the IEA, this share rises to more than 2.5 per cent in 2030 – an area larger than France and Spain combined.

Four years ago, researchers at the University of Strathclyde calculated that, even if the UK’s entire set-aside farmland – all 644,000 hectares of it – were given over to biofuels, it would replace just four per cent of conventional diesel. They calculated that the UK could produce 851 million litres of biodiesel a year: to put this into context, in 2002, the UK released almost 20 billion litres of diesel for consumption.

Calculations by the UK’s Department for the Environment, Food and Rural Affairs (DEFRA) conclude that if biofuels were to make up five per cent of the UK’s fuel mix, it would save around 700,000–800,000 tonnes of carbon, representing a saving of around 0.4 per cent of the UK’s forecast emissions for 2010. DEFRA also reports that, if the EU target of ten per cent biofuels by energy content for 2020 is met, carbon savings could be around seven or eight per cent of emissions from road transport, and about 1.3 to 1.5 per cent of total emissions.

According to the OECD, these potential, and seemingly slight, gains are outweighed by other consequences. The OECD’s recent report on the roundtable discussion for biofuel performance, entitled Biofuels: is the Cure Worse than the Disease?, questioned the benefits of first-generation biofuels and concluded that governments should scrap mandatory targets.

‘I was surprised by the extent of the drawbacks,’ says Doornbosch, the report’s author. ‘There are a lot of indirect consequences, and some of them are quite damning. We have major concerns about the impact of first-generation biofuels on the agricultural market, food prices, and the effect on land use.’

Doornbosch points out that some of the indirect impacts of biofuels may have serious environmental consequences. ‘Sugar cane [for bioethanol] grown in Brazil on the cerrado is not a problem in itself, but is causing soybean growth to be displaced and grown further north in more vulnerable regions,’ he says.

Food or fuel?

The OECD report highlighted another area that is causing great alarm – the impact that biofuel farming has on food prices. ‘Land use will be driven by the net private benefit owners can derive from their land,’ the report concluded. ‘Any diversion of land from food or feed production to production of energy biomass will influence food prices from the start, as both compete for the same inputs. The rapid growth of the biofuels industry is likely to keep these prices high and rising throughout

at least the next decade.’

The UN waded into this debate last autumn, when Jean Ziegler, the organisation’s special rapporteur on the right to food, called for a five-year international ban on producing biofuels in order to combat soaring food prices. Ziegler said that the conversion of arable land for plants used for green fuel had led to an explosion of agricultural prices that was punishing poor countries forced to import their food at a greater cost. Pointing to what he described as the ‘potentially grave negative impact of biofuels (or agrofuels) on the right to food’, Ziegler added that ‘232 kilograms of corn is needed to make 50 litres of bioethanol – a child could live on that amount of corn for a year’.

Corn prices rose in the middle of 2006 as the USA began to divert the crop to the production of bioethanol. This has had a dramatic effect in countries that imported corn from the USA. In Mexico, there were food riots in January. ‘The sudden, ill-conceived rush to convert food – such as maize, wheat, sugar and palm oil – into fuels is a recipe for disaster,’ said Ziegler. ‘There are serious risks of creating a battle between food and fuel that will leave the poor and hungry in developing countries at the mercy of rapidly rising prices for food, land and water. Instead of using food crops, biofuels should be made from non-food plants and agricultural wastes, reducing competition for food, land and water.’

Agricultural wastes fall under another category of biofuels, known as second-generation biofuels. These ligno-cellulosic

or ‘woody’ solid biofuels are made from paper pulp, stalks, leaves, husks of corn plants, wood chips, sawdust, tree bark, municipal solid waste, grasses or non-agricultural plants, such as jatropha, a wild bush that grows naturally in arid areas and whose seeds yield an oil that can run in diesel engines.

The UK’s Royal Commission on Environmental Protection feels second-generation biofuels are the way forward. It calculates that, of England’s 11.5 million hectares of land, a ‘significant amount’ of all but the highest grades of agricultural land could be used for biomass production of ‘crops’ such as willow. In a special report, Biomass as a Renewable Energy Source, published in May 2004, the commission declared that the failure to realise the potential of these resources was down to a lack of effective, co-ordinated government policy that had failed to establish investor and farmer security and to develop the supply chain.

The larger energy companies – driven perhaps by shareholder concern and an eye for a new market rather than altruism – are investigating both first- and second-generation biofuels. ‘Biofuels will give the world energy security,’ says BP spokesman David Nicholls. ‘You can grow them anywhere – most countries aren’t fortunate enough to have the geological location to benefit from what happened thousands of years ago when our coal was laid down.’

Next year, BP, in association with DuPont and Associated British Foods, will open a plant near Hull to produce ethanol from wheat grown in the East Midlands and Lincolnshire. And in its pursuit of second-generation biofuels, the company is also investing £32million in a plant in India that will produce biodiesel from jatropha.

‘The key with jatropha is that it grows on scrubland – it’s seen as a weed in most parts of the world – and so you would not be displacing any food crops,’ says Nicholls. ‘We think first-generation biofuels can be highly efficient, but there are other aspects to consider – you can’t grow them in places where they would displace other crops that are valuable to people. Just because something is derived from biological matter doesn’t necessarily mean that it’s better for the environment. We’re at the beginning of this journey, and we feel that the technology isn’t at the end of the journey either.’

Generation game

The EU has started to take on board the emerging criticisms of biofuels. At a summit in March last year, EU heads of state added two important conditions to the mandatory biofuels targets: that agrofuels should be produced sustainably, and that second-generation agrofuels should become commercially available.

In November, the government of the Netherlands abolished all subsidies for biofuels produced from palm oil. Meanwhile, the UK government, while aware of the huge swing against first-generation biofuels, feels that the technology is still worth pursuing. DEFRA says that the RTFO will require companies to report against sustainability standards. From 2011, the government plans mandatory minimum sustainability standards for UK biofuels, both domestic and imported. These will include measures of lifecycle greenhouse gas emissions, biodiversity loss, land-use change, impact on water resources and labour standards.

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The sustainability of biofuels is a real concern,’ says a spokeswoman for DEFRA. ‘Calculating the precise carbon savings from biofuels is an emerging area of work. We have revised downward our expectations of the carbon savings from biofuels to take into account the latest developments in this field. As advanced biofuels come onto the market, the carbon savings have the potential to go up and the costs to come down. You can’t get to tomorrow’s biofuels without first creating a market for today’s biofuels.’

Yet most observers agree that commercial second-generation biofuels are perhaps two decades away. ‘The result is that first-generation biofuels are going to grow and grow,’ says Biofuelwatch’s Boswell. ‘What we need is energy reduction above all. It’s non-negotiable. The longer we put it off, the deeper the cuts we’re eventually going to have to make. It’s going to need a social change from people to realise that the way we do energy and transport has a big impact. Once we’ve reduced the carbon we use, we then need to move on to removing it from our society.’

The OECD agrees that a low-carbon economy is the way forward. ‘We don’t know the technology that will provide a way out for us,’ says Doornbosch. ‘We need to increase taxation on carbon and encourage low carbon use. There may be room for developments in technology that we haven’t yet seen. But for now, we need to assume that the answer just isn’t there, so we need to reduce our consumption and increase energy efficiency.’

Setting the problem aside

Set-aside, whereby EU countries must leave up to ten per cent of their agricultural land unused, was originally designed as an economic tool for farmers. But this unused land has, over the past 20 years, developed into a vital haven for wildlife. Last autumn, the EU moved to fast-track proposals into law to effectively abolish set-aside. This is to release up to 2.9 million of the 3.8 million hectares now under obligatory set-aside for growing more biofuels, including rapeseed.

In the UK, woodlarks, skylarks, yellowhammers and tree sparrows use set-aside for winter food and nesting sites; 80 per cent of linnets spend the winter on set-aside in East Anglia, preferring it to winter cereals. In France, the little bustard now lives almost entirely on set-aside land.

Out of Africa

The inexorable rise in the price of fossil fuels is driving many African governments to search for alternatives and, inevitably, attention is turning to biofuels. At a pan-African ministerial meeting held in March last year in Maputo, Uganda, ministers responsible for energy development in their countries announced a declaration committing to increased research in the development of renewable energy – notably biofuels. And last October, Brazilian president Luiz Inácio Lula da Silva toured the continent to promote bioethanol and biodiesel production.

At present, Africa only produces a fraction of the world’s biofuels, but according to industry analysts, the continent has great potential for production thanks to its vast areas of arable land and large workforce.

Several African countries already have biofuel research and production projects underway. In Malawi, for example, gasoline is being blended with ten per cent locally made sugar cane ethanol. A similar system is in place in Nigeria, although in this case, the ethanol is derived from cassava – Nigeria is the world’s largest producer of the starchy tuber. The Nigerian government has plans to turn cassava ethanol production into an industry worth more than US$150million a year and Brazil is providing assistance with the construction of 15 bioethanol plants. And in May, the government announced plans to establish a US$100 million ‘biofuel town’ near Lagos. The 600-hectare settlement will house 1,000 bioenergy experts, who will work on novel technologies to improve bioenergy production.

Meanwhile, Mozambique is being talked about as a potential ‘biofuel superpower’. The country has already

developed an effective biofuel sector based on sorghum and sugar cane, and the government recently set aside more than US$700million for research, production and promotion. While the primary aim is to achieve energy independence, Mozambique has such a small economy that domestic energy needs could be quickly met, raising the prospect of turning biofuels into an export commodity.

Turning to termites

With the debate over the use of food crops for bioethanol production hotting up, one alternative feedstock being discussed is wood. In New Zealand, for example, there have been suggestions that bioethanol produced using plantation pine could make the country self-sufficient in sustainable fuel, heat and power by 2050.

However, there’s one major problem – it’s considerably more difficult to turn tough, woody material into a viable fuel. But, as many a homeowner has discovered, there’s one creature that’s extremely good at turning wood into fuel: the humble termite.

Like cows, termites have a series of ‘stomachs’, each of which contains a distinct bacterial community that plays a specific role in the conversion of wood into sugar. The termites use these sugars for food, but they could also be fermented to create ethanol.

With this aim in mind, scientists at the US Department of Energy’s Joint Genome Institute in Walnut Creek have mapped the DNA of the bacteria that live inside the guts of a species of termite found in Costa Rica. In one ‘stomach’ alone, they discovered more than 500 genes related to the deconstruction of cellulose and hemicellulose, which, along with lignin, are the basic building blocks of wood. They hope to synthesise the enzymes that these genes code for in order to use them in engineering schemes that can convert wood into biofuels.

February 2008

source:
www.geographical.co.uk