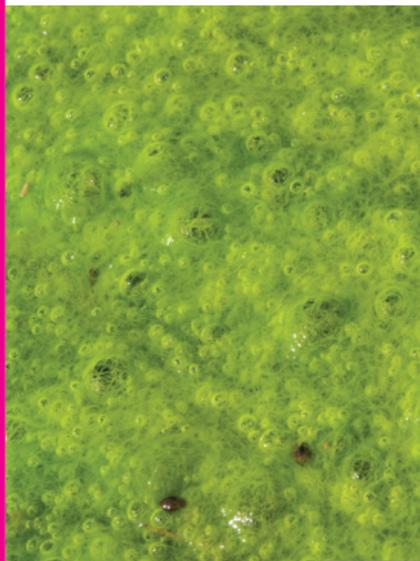


S1

Patricia Sinclair, scientist



I'm an early career microbiologist, studying algae. Until now my research has been pretty academic, but now I've got the opportunity to join an applied research team for an oil company to improve the efficiency of producing biofuels and also some important industrial chemicals from algae. There have been recent trials, deriving maritime fuel oil

from genetically modified algae to power giant cargo boats and US navy warships. From the media reports you'd think the technology was already here, but it's really expensive to harvest the algae and convert it to fuel. To make it a serious commercial proposition will need big scientific breakthroughs and then many years of development. The incentive is very inspiring for me. Even a partial switch to such oil would massively reduce air pollution. In a year, one ship can produce as much pollution as 50 million cars. But it's so far off. Can I afford to stake my career on it, or is it safer to stay an academic algae researcher?

S2

Steve Rollin, climate change campaigner

I'm developing the biofuels policy for CAN (Climate Action Now!), the environmental organisation that I work for. But I'm in a real dilemma. To prevent climate change having massively damaging effects on people and the environment means making huge and urgent reductions in our use of fossil fuels. For liquid transport fuels, responsible for about a quarter of global greenhouse gas emissions, biofuels look like the only viable alternative at the moment. CAN has campaigned against the current generation of biofuels – like ethanol from maize, or diesel from palm oil. They've caused competition for land for growing food and land grabbing from local people by unscrupulous entrepreneurs. The next generation of biofuels would solve one problem if they're not competing for food. But I'm still worried about social impacts in poor countries. Villagers in countries like Mozambique and Ghana have lost their land to biofuel companies. There's economic pressure to destroy rainforest and even reports of contemporary slavery. What should our policy be?



S3

Renata Luiz, environmental campaigner in Brazil

With so much concern about oil and climate change, I'm proud of the way that Brazil has led the way on bioethanol. Brazil is the world's second largest producer of ethanol fuel after the US and the world's largest exporter. By 2008 almost 70 per cent of all vehicles produced in Brazil were flexible fuel – they could run on ethanol as well as on ordinary petrol or a petrol/ethanol blend.

But I'm not so proud of the way that we produce bioethanol. It is made from sugar cane, and on the sugar cane plantations, wages are low and cutters have to work very hard to earn a living. In some cases, cutters have died from overwork. Working conditions are poor: some workers are effectively slaves. We are campaigning to force bioethanol companies to make sure the cane workers get decent wages and working conditions. The economic incentive to grow cane for biofuels also means a seemingly endless battle to stop companies and communities cutting down our rainforest, which is like burning the earth's lungs as well as resulting in a loss of biodiversity.



S4

Kevin Watts,
retired science teacher

I try and keep up with what's going on in my field – it keeps my brain active. But with biofuels I don't know what to think. Initially, I was really pleased when the US started producing significant amounts of bioethanol from corn in the 1990s. But I was dismayed when this bioethanol was blamed for the 'tortilla riots' in



Mexico during late 2006 and early 2007. The demand for corn to make ethanol meant that yellow corn – imported from the US to use as animal feed – increased in price. To feed their animals, Mexicans switched to white corn. This is traditionally used to make tortilla, and so the price of white corn and tortilla soared. Later it emerged that this was only one factor amongst many in food price rises. High oil prices and financial speculation were perhaps even more important. Even so, if bioethanol is only partly responsible for pushing up prices of the staple food of poor people, I'm still worried about whether this is ethical.

S5

Ian Bright, co-ordinator of an EU-funded biofuels project



I was UK co-ordinator for BEST, an EU funded biofuel project with Somerset County Council. The bioethanol we used was imported from Brazil and sold locally by Morrisons Supermarkets for use in flexi fuel vehicles. Imperial College looked at all aspects of sustainability from life

cycle carbon emissions, to the conditions of workers in the field. That was fine as part of a one-off project, but far too time-consuming and expensive to do regularly.

Many would agree that importing bioethanol shouldn't be allowed to cause harm to poor people in poor countries and we should make sure that it really does reduce carbon emissions from road transport. The BEST project recommended an accreditation scheme, to ensure that the potential environmental and social benefits of bioethanol are realised.

Such a scheme would take a little work and could add to the price of bioethanol but how else will we be able to tell whether our bioethanol is produced fairly and ethically?

S7

John Graham, farmer

I am an arable farmer in Southern Scotland. In our colder climate, we grow mostly malting barley and wheat for whisky and wheat biscuits, but it's too far north to grow bread wheat. In a good year, we usually manage OK. But if the weather is too wet or too cold, I have to sell my grain for animal feed, at a much lower price per tonne. It's getting so hard to compete, at today's global food prices. Some of my neighbours are borrowing just to keep going. I'm thinking I might move out of food and go into biofuels. There's talk of a market for wheat for making bioethanol. Or I could grow willow or a hardy grass like miscanthus, which can both be used as biomass for fuel. With so much talk about food security and global pressure on land I'm reluctant to switch to growing for fuels, but if I can't be sure to sell my crops for food, then what else can I do?



A1

What is biomass?



Biomass is a catch-all word for any living biological material like plants and algae; residues from recently harvested plants like straw and wood; and many biological wastes from agriculture, industry or municipal waste.

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A2

Different criteria for evaluating biofuels



- What is technically possible?
- What is economically viable?
- What is socially acceptable?
- What is environmentally responsible?

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A3

How much can biofuel crops contribute?



This depends on:

- Having enough land available suitable to grow the crops
- How efficiently the crops can be grown and converted to fuel
- What else you might use this land for
- Other uses for either the crop or its residues

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A4

Bioenergy old and new



Traditional uses of biomass, including wood, straw and charcoal, make up 8 % of global energy supply. Modern technological forms of bioenergy provide another 2 % (and rising), supplying heat, electricity and transport fuels.

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A5

Plant residues: lignocellulose



Lignocellulose is the ‘woody’ structural material of plants. At present it can be burnt to generate energy; however this is not energy efficient. Research is going on to look at ways of generating energy more efficiently from lignocellulose.

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A6

Alternative Fuels from Plant Residues



Producing biofuels from crops that can be used as food can cause a conflict of use. But the woody residues from food crops could be used as a valuable biofuel source, if converting cellulose to fuel can be made more efficient.

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A7

Future biofuels 1



Research is ongoing to make biofuels from woody parts of plants (lignocellulose). Using these residues means that food crops could produce both food and fuel. And non-edible plants (e.g. grasses, trees like willow) could be grown just for biofuels.

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A8

Future biofuels 2



Plant matter that is high in cellulose requires more sophisticated and expensive processing than current biofuels. Future scientific advances, that may include genetic modification, are expected to lower costs significantly, but that may not happen for a while.

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A9

Using straw for biofuels



In the UK, around 3 million tonnes of straw a year is available to make biofuel. This needs no additional land, although there may be some loss of soil nutrients from straw that is no longer ploughed in.

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A10 Using unused land for future biofuels



An important goal for dedicated biomass crops like willow and poplar, or special grasses, is to be able to use land that is not used for growing food or is part of a crop rotation programme.

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A11 Biofuels from algae



Algae are simple organisms which are very efficient at photosynthesis. Grown in large ponds and the right circumstances they could be much more productive than biofuels grown on land. But major technological advances would be needed to make this commercially viable.

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A12 Fuels from plant residues using synthetic biology



Synthetic biology is a new area of science which aims to design new biological parts or redesign existing ones for new purposes. Making biofuels from plant wastes would need a lot of genes and enzymes to work together. Synthetic biology could help crack the problem.

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A13 The cost of new biofuels



If managed correctly biofuels from wood or grass will have less environmental impact than current biofuels. But they involve breaking down cellulose, which at the moment makes them too expensive to compete with biofuels made from sugar or oils from plants.

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A14 What land is available for energy crops?



Up to 20% of global energy demand could be met by bioenergy even if demand for food is high and without expanding agriculture into areas of forest, grassland or marginal land.

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A15 How biogas is made



Biogas is a substitute for natural gas (methane) usually made from wet biological materials such as grass, food waste, animal dung, and sewage. A process called anaerobic digestion converts it into carbon dioxide and methane.

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A16 New infrastructure



Scaling up biofuels will require some new infrastructure. This includes biofuel production facilities, blending terminals, pipelines, and terminals, ethanol retail facilities and flex fuel vehicles.

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A17 Does bioethanol require dedicated vehicles?



Not if bioethanol is only 10-15 % of the total. Where the proportion is higher (up to 85 % in Brazil), the differences between fossil fuels and bioethanol require changes to the vehicle engine and a dedicated fuelling system.

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A18 The resource context for biofuels



It is predicted that by 2030 the world will need to produce around 50 per cent more food and energy, together with 30 per cent more fresh water, while also dealing with climate change.

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A19 Obstacles to the use of bioethanol in transport



However desirable bioethanol is in theory, in practice there are the usual problems in getting new ideas taken up. In Madrid, bioethanol was initially subject to a high beverage alcohol tax.

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A20 The Somerset Biofuel Project



This successfully deployed 41 new flexi fuel vehicles (petrol and ethanol), supplied by five ethanol fuel pumps on Morrisons Supermarkets forecourts in Somerset in 2006. The bioethanol was imported from Brazil.

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A21 Biofuels in the past



When first demonstrating the engine bearing his name, Rudolf Diesel ran it on peanut oil at the World's Fair in Paris in 1900. In an interview in 1925, Henry Ford envisaged the processing of fruit and other plant material into fuel for cars.

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A22 Biofuels and economic development



A powerful incentive for biofuels in the US was significant agricultural overproduction of maize, which led to enthusiasm to use food crops for biofuels, supported by the powerful farming lobby.

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A23 Support for biofuels manufacturers in the UK



A 20 pence per litre duty differential in favour of biodiesel was introduced in 2002 and for bioethanol in 2005. These duty differentials were abolished in April 2010 for all biofuels except biodiesel produced from used cooking oil.

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A24 Production of bioethanol in 2008



The US produced the most: 9 billion gallons. Second was Brazil with 6. The EU was third at less than one billion gallons.

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A25 Energy security



This means: “The uninterrupted physical availability of energy products on the market, at a price which is affordable for all consumers (private and industrial).” (The European Commission)

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A26 Policies for biofuels



The EU Renewable Energy Directive (RED) requires that by 2020, 10% of transport energy in EU Member States comes from renewable sources.

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A27 Biofuels and biodiversity



When forests are converted into agricultural land this can significantly reduce biodiversity, for example, by decreasing the species richness of forest birds and butterflies.

Images:

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A28 Biofuels and UK greenhouse gas (GHG) emissions



Biofuels supplied in the UK during 2009 - 2010 generated GHG emissions savings equivalent to taking half a million vehicles off the road, or making Edinburgh, Cardiff and Belfast car free.

Images:

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A29 Replacing fossil fuels



Replacing fossil fuels requires many technologies, depending on the different uses. Biofuels could be particularly useful for transport. For electricity, there may be alternatives like wind, solar or hydro power.

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A30 No free lunch – biofuels still have a climate impact



Biofuels are ‘carbon neutral’ in returning to the air the CO₂ which the plants had absorbed in growing. But if fertilisers are used in growing crops, they and processing and transport of the crops may release additional greenhouse gases.

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A31 Usefulness of biofuels in specific situations



Biofuels are particularly useful where there are no other alternatives to fossil fuels, such as kerosene for aviation and diesel for road freight, fuel oil and shipping. They can also provide back-up for a mainly wind-based electricity system.

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A32 When biofuels increase greenhouse gas emissions



Growing transporting and processing bioenergy crops all produce carbon emissions so development of biofuels will require careful management to ensure that their production and use does not cause an overall increase in greenhouse gas emissions compared with fossil fuels.

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A33 Biofuels and land use in Britain 1



The area of Britain is 22m hectares, of which 6m is arable. Growing biomass on 1m of these would supply 11 % of our predicted 2030 demand for heating.

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A34 Biofuels and land use in Britain 2



A recent Rural Economy and Land Use project has shown there is sufficient land to meet the UK biomass strategy objective of 350,000 hectares for electricity without significantly affecting domestic food production.

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A35 Benefits for biofuels in developing countries



- the creation of employment and income
- diversification of energy supply
- diversification of agricultural output
- increased national exports and/or decreased national imports

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A36 Replacing products based on fossil fuels



Researchers at the Plymouth Marine Laboratory have found a way to produce specific compounds from microalgae. These could provide alternatives to petroleum-based materials in healthcare products as well as in the development of biofuels and bioplastics.

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A37 What is bioethanol?



Ethanol is ethyl alcohol, the “alcohol” in alcoholic drinks. It’s produced when many plant sugars ferment, which we’ve harnessed as part of the processes which make wine from grapes, rum from sugarcane, etc. But we can instead distil out pure 100% ethanol to make biofuel for road vehicles - bioethanol.

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A38 How much biofuel are we using in the UK?



In 2009/10:

- 3 percent of the UK's road transport fuel came from biofuels
- 76 percent of the UK's biofuel was imported from countries such as Argentina, Brazil, Malaysia, Indonesia and Germany

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A39 The potential for biogas in the UK



Currently, biogas generated from waste such as landfill and sewage plants is used to produce electricity. If all waste was used to produce biogas, it is estimated that biogas could meet up to half of the predicted UK residential gas demand for 2020.

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B1

Does bioethanol production cause deforestation?



Irresponsible logging, increasing pressure for land from the landless poor and growing crops for animal feed and vegetable oil is what destroys forests. The new market for bioethanol may add to these pressures, but it is not the only pressure on land.

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B2

What does a country need to make biofuels work?



- Security and stability
- The development of infrastructure
- A decent level of regulation, including enforcement
- A reasonable livelihood for the producer

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B3

Biomass and the environment



Policy incentives that stimulate the greatest uptake of bioenergy may not provide the best environmental protection, globally or locally.

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B4

How tough should biofuel regulation be?



Some fear that tough biofuels regulation in Europe could result in large-scale producers concentrating on countries where regulation is lax. But shouldn't we stick to our principles and try to spread regulation and certification more widely?

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B5

Policies for current and future biofuels



There is a big discrepancy between the powerful targets and penalties in place for current biofuels and the very few incentives for new biofuels that would stand a better chance of complying with ethical principles.

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B6

Biofuels and economic development



Biofuels production might be a very attractive prospect in poorer countries in which a large proportion of the population engages in agriculture, provided this is not at the expense of growing food.

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B7

George Bush on bioethanol



“The best way and the fastest way to replace oil is to expand the use of ethanol. Ethanol is good for economic development for rural America. New bio-refinery construction creates jobs and local tax revenues.” *The Washington Post* April 2006

Images:

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B8

Biofuels and hunger



Biofuels have been blamed for a rise in world food prices in 2007/08, leading to riots in India, Indonesia and Mexico etc. But some studies suggest that they were responsible for only a third of the rise or less, with high oil prices and financial speculation among other causes.

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B9

Biofuels can be produced anywhere



Unlike fossil fuels, biofuels can in principle be developed in most countries, so they are not restricted to certain countries that can control supply or dominate the market.

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B10 Biofuels and aviation etc.



If biofuels can be produced that closely resemble kerosene and diesel, they are likely to be a significant source of liquid fuel for sectors such as aviation and heavy long-distance haulage over the next twenty years.

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B11

We can't rely on oil for ever: what then?



As fossil based extractable oil begins to run out, prices for what's left will go sky high. Some say the signs are already there. The only real alternatives for petrol and diesel are biofuels, maybe hydrogen/electric cars, or cutting most people's mobility.

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B12 Comparing biofuels and fossil fuels



Biofuels might present fewer risks than offshore drilling for fossil fuels e.g. the BP oil spill in the Gulf of Mexico. In addition, spills of biofuels are less toxic.

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B13 Biofuels can suit more local production



Many biofuels can be produced in a more decentralised way than traditional fossil fuel production, with many advantages for local production. And using wastes as biomass only really works locally.

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B14 Habitat loss in Malaysia



Where land clearance to grow cash crops involves deforestation, this can lead to further pressure on endangered species. There are fears for the orang-utan of Borneo through deforestation to grow palm oil for biodiesel and other products.

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B15 New biofuels and soil fertility



New biofuels that do not compete so directly with food crops as current biofuels may still do harm if, for example, inappropriate quantities of agricultural waste is used to produce fuel rather than being ploughed back to maintain soil fertility.

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B16 Water use for biofuels



Agriculture already uses some 70% of fresh water globally. Expansion of crop production for biofuels would be adding to this. In particular in water scarce regions, this may lead to another form of competition with food.

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B17 Biofuels, carbon emissions and deforestation



The aim of biofuels to reduce carbon emissions only works if we grow them sensibly. The world's forests store carbon dioxide. If we clear them to produce biofuels, it could undo all the gains.

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B18 The climate impact of transport biofuels



Some people fear that emissions from the growing and processing, and land use changes will offset most or all of the reduction in greenhouse gases. Others disagree, especially for new biofuels from plant wastes, non-food crops and algae.

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B19 Developing appropriate biofuel crops



If each region utilized a specific biofuel crop, the need to use fossil fuels to transport the fuel to other places for processing and consumption would be diminished.

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B20 Biofuels and human rights



“No one speaks of banning tobacco, cotton or other non-food crops in order to free up more land for food, because these provide crucial income-earning opportunities for farmers. Biofuels do the same.” (Respondent to a Nuffield consultation)

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B21 Growing biofuels on unused land



In some countries, biofuels could be grown on land unsuitable or uneconomic for growing food. This could create opportunities for rural employment and produce biofuel feedstock close to sources of demand in mining and agriculture.

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B22 Biofuels in developing countries



“In many regions of the world, many smallholder communities do not have any access to any type of energy. Bioenergy crops could be produced and transformed into biofuels that can be used to generate bio-electricity.” (Nuffield consultation)

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B23 Danger of land grab



Poor people in developing countries could lose their land if biofuels made it more valuable, especially as they often do not have formal titles to the land they use.

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B24 Biofuels and local communities



Small-scale biofuel plants can provide fuel and livelihoods to local communities, meaning they become less reliant on outside sources to support their lives.

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B25 Workers rights in Brazil



Young people under the age of 17 make up 3% of the workforce producing sugar cane bioethanol, according to a report by the Nuffield Council on Bioethics. Some sugar cane cutters are reported to be effectively slaves.

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B26 The need for participation



Those directly affected by biofuels production should be heard regarding their concerns about local impacts and potential negative side effects.

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B27 Who has a duty to develop biofuels?



The duty is mainly on:

1. Those with the greatest ability to pay
2. Those who have used up a greater share of fossil fuels and emitted the most greenhouse gases.

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B28 The principle of just reward 1



New mass products often impact on the small scale farmer and worker negatively unless they are protected in participatory schemes (shares, minimum prices regulations, etc.)

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B29 The principle of just reward 2



Biofuel distilleries generally must be large to be economically efficient which leads to concentration of profits in the hands of a few; however farmer alliances and multiple-option crops can significantly empower farmers in their relationships with distillers.

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B30 Biofuels and fair trade



Fairtrade offers producers a better deal, so could help make sure that the benefits of biofuels are spread. But there are no internationally agreed biofuels fair trade principles yet, only national principles, such as Brazil's 'Social Fuel Seal'.

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B31 Biofuels aren't enough: we have to drive and fly less too



Biofuels could really reduce transport emissions of greenhouse gases, but not prevent them altogether. The pressing issue is greatly to reduce our use of cars, lorries, flying, if we are ever to bring climate change under control.

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B32 We need biofuels!



Given that 22% of greenhouse gases come from burning transport fuels, oil supplies will dwindle and we need more security on where our fuels come from, then surely biofuels are a 'no-brainer'.

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B33

Should we have a moratorium on industrial biofuel production?



Yes, until the UN assesses the full global impact, and there is legislation to combat abuses – to implement sustainable land use, put priority on local food production, and protect local land rights and workers.

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B34 Biofuels and land conversion



The first generation biofuels increase demand for grains, oilseeds and sugars. This could mean that more tropical forests are turned into agricultural land, losing rich biodiversity and releasing carbon dioxide stored in trees and soil.

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B35 Using Water vs Saving Carbon?



A study estimates that for first generation biofuels, over twice as much water is used in converting maize to ethanol as in refining petrol. It's a typical environmental trade-off: how much extra water used versus carbon emissions saved?

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B36 Will the new biofuel technologies be viable?



Some are sceptical, arguing that they are still largely in the demonstration phase, and it's uncertain whether they will become economically viable on a reasonable timescale. But the same is true of many emerging technologies.

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B37 Diet and the land available for energy crops



Diet can play a big role in this. Some say that if global red meat consumption were reduced, large amounts of land would be released from feeding animals. Some of that land could be used for bioenergy.

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Blank Card

- to write whatever you want

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Cluster Card

Name of cluster _____

What is the meaning of this cluster?

What cards did you use in this cluster

(e.g. S3, A7, A29)?
