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Oxfam Briefing Paper

EMBARGOED UNTIL 00:01 HRS GMT WEDNESDAY 25TH JUNE 2008

Another Inconvenient Truth

How biofuel policies are deepening poverty and accelerating climate change

The current biofuel policies of rich countries are neither a solution to the climate crisis nor the oil crisis, and instead are contributing to a third: the food crisis. In poor countries, biofuels may offer some genuine development opportunities, but the potential economic, social, and environmental costs are severe, and decision makers should proceed with caution.

Oxfam International

Summary

Biofuels are presented in rich countries as a solution to two crises: the climate crisis and the oil crisis. But they may not be a solution to either, and instead are contributing to a third: the current food crisis.

Meanwhile the danger is that they allow rich-country governments to avoid difficult but urgent decisions about how to reduce consumption of oil, while offering new avenues to continue expensive support to agriculture at the cost of taxpayers.

In the meantime, the most serious costs of these policies – deepening poverty and hunger, environmental degradation, and accelerating climate change – are being ‘dumped’ on developing countries.

Neither a solution to the climate crisis…

Rich countries’ biofuel policies currently offer neither a safe nor an effective means to tackle climate change. By increasing aggregate demand for agricultural land, they will drive the expansion of farming into critical carbon sinks such as forests, wetlands, and grasslands, triggering the release of carbon from soils and vegetation that will take decades and in some cases centuries of biofuel production to repay, at a time when emissions need to peak and fall within the next 10 to 15 years:

- Analysis published in the journal *Science* calculates that the emissions from global land-use change due to the US corn-ethanol programme will take 167 years to pay back.
- European Union (EU) biodiesel consumption is driving spiralling demand for palm oil both for use in biodiesel, but also to replace rapeseed and other edible oils diverted into the European biofuel programme. Oxfam estimates that by 2020, the emissions resulting from land-use change in the palm-oil sector may have reached between 3.1 and 4.6 billion tonnes of CO_2 – 46 to 68 times the annual saving the EU hopes to be achieving by then from biofuels.

Even ignoring land-use change, biofuels are an overly expensive way of achieving emissions reductions from transport. Improving car efficiency is far more cost effective: while the *costs* of avoiding a tonne of CO_2 through biofuels run into the hundreds of dollars, ambitious improvements in vehicle efficiency can yield *profits*, as reduced fuel costs exceed technology costs. Biomass can be used far more efficiently in static applications such as commercial boilers or combined heat and power.

…nor a solution to the oil crisis

Rich countries’ biofuel policies currently offer neither a safe nor an effective means to address fuel security. Consumption of oil in rich countries is so huge that for biofuels to be a significant alternative requires massive amounts of agricultural production. If the entire corn harvest of the USA was diverted to ethanol, it would only be able to replace about one gallon in every six sold in the USA. If the *entire world supply* of carbohydrates (starch and sugar crops) was converted to ethanol, this would only be able to replace at most 40 per cent of global petrol consumption. Global oilseed production would be unable even to reach a 10 per cent share of diesel consumption.

Moreover, the costs of using biofuels to improve fuel security are prohibitively expensive. The European Commission's own research body has estimated that the EU's proposed 10 per cent biofuel target will cost about $90bn from now until 2020, and will offer enhanced fuel security worth only $12bn. Policies to reduce *demand* for transport fuels, such as regulation to improve vehicle efficiency, are far safer and more cost effective.

Meanwhile 30 million people are dragged into poverty

Biofuel mandates and support measures in rich countries are driving up food prices as they divert more and more food crops and agricultural land into fuel production. Meanwhile sugarcane ethanol from Brazil, production of which has a far less significant impact on global food prices, is excluded through the use of tariffs.

The World Bank estimates that the price of food has increased by 83 per cent in the last three years. For the world's poor people, who may spend 50–80 per cent of their income on food, this is disastrous. Oxfam estimates that the livelihoods of at least 290 million people are immediately threatened by the food crisis, and the Bank estimates that 100 million people have *already* fallen into poverty as a result. Thirty per cent of price increases are attributable to biofuels, suggesting biofuels have endangered the livelihoods of nearly 100 million people and dragged over 30 million into poverty.

The International Food Policy Research Institute (IFPRI) notes that by forcing up food prices, rich-country support for biofuels acts as a tax on food – a regressive tax felt most by poor people for whom food purchases represent a greater share of income. Last year, it is estimated that industrialised countries spent $13–15bn 'taxing' food, equal to the amount of funding required to assist those immediately threatened by the food crisis. These amounts will continue to spiral as rich countries increase their consumption of biofuels.

Herein lies the true attraction of ethanol and biodiesel for rich-country governments – an avenue for continued support to agriculture.

Oxfam calls on rich countries urgently to dismantle support and incentives for biofuels in order to avoid further deepening poverty and accelerating climate change.

Specifically, rich countries should:

- introduce a freeze on the implementation of further biofuel mandates, and carry out an urgent revision of existing targets that deepen poverty and accelerate climate change;
- dismantle subsidies and tax exemptions for biofuels and reduce import tariffs;
- tackle climate change and fuel security through safe and cost-effective measures, prioritising regulation to enforce ambitious vehicle-efficiency improvements.

An opportunity for developing countries?

For poor countries that tend to have comparative advantages in the production of feedstocks, biofuels may offer some genuine development opportunities, but the potential economic, social, and environmental costs are severe.

Oxfam recommends that developing countries move with caution and give priority to poor people in rural areas when developing their bioenergy strategies.

Specifically, developing countries should:

- prioritise bioenergy projects that provide clean renewable energy sources to poor men and women in rural areas – these are unlikely to be ethanol or biodiesel projects;
- consider the costs as well as the benefits involved in biofuel strategies: the financial costs of support, the opportunity costs of alternative agriculture and poverty reduction strategies, and social and environmental costs.

If they decide to proceed with biofuel strategies, developing-country governments should:

- carry out their obligations under international law and conventions, including obligations to protect the right to food, to ensure decent work, and to ensure that the Free, Prior and Informed Consent of affected communities is obtained before biofuel projects commence;
- give priority to feedstocks and production models which maximise opportunities for men and women small farmers.

And companies and investors operating in developing countries should:

- ensure no biofuel project takes place without the Free, Prior and Informed Consent of local communities, and that men and women workers at all stages of production in their value chains enjoy decent work;
- treat men and women smallholder farmers fairly and transparently;
- provide smallholders in their value chains sufficient freedom of choice in their farming decisions to ensure food security for them and their families.

1 Introduction

Oil, the lifeblood on which the global economy depends, is running out. And as a result of all the oil (and coal and gas) we've sucked out of the Earth and burned, the planet is getting warmer. But melting polar ice caps should not be interpreted as an opportunity to start drilling in the arctic. Nor can we continue to turn to dirtier and heavier sources of oil as the economics presented by a soaring crude price become more favourable. To avoid global catastrophe, any solution to the oil crisis has to also be a solution to the climate crisis.

The proponents of biofuels (see Box 1) argue that they have the solution, or at least a part of it. Ethanol and biodiesel will allow us to continue our love affair with the internal combustion engine, while simultaneously reducing our greenhouse gas (GHG) emissions. Sounds too good to be true? It is.

Biofuels currently provide a solution neither to the oil nor to the climate crisis, and are now contributing to a third: the food crisis. In recent years, food prices have nearly doubled, placing poor people, who often spend over half of their income on food, in an untenable situation. The World Bank estimates that the crisis has *already* pushed over 100 million people into poverty;[1] Oxfam estimates that the crisis has endangered the livelihoods of at least 290 million of the world's rural and urban poor.[2]

The West's biofuels boom is contributing to deeper global poverty and accelerated climate change, while allowing governments to avoid difficult but urgent decisions about how to reduce spiralling demand for energy in transport.

This paper explains how a sustainable development opportunity has instead turned into an unsustainable nightmare, and examines the conditions under which some of the original promise, particularly for poor people, might still be realised.

Box 1: What are biofuels?

Biofuels are liquid fuels made from organic matter – typically crops. There are two principal kinds – ethanol, produced from carbohydrates (e.g. sugarcane, sugar beet, corn, wheat) and biodiesel, manufactured from oilseeds (e.g. rapeseed [canola], oil palm, soy, jatropha).

They can be blended in relatively small quantities with existing petroleum fuels for use in unmodified internal combustion engines, making them most relevant to transport. Ethanol can be blended with petrol (gasoline) in blends of up to 5 per cent or 10 per cent, and new 'flex-fuel' technology now allows much higher blends. Biodiesel can be blended with diesel in blends up to 20 per cent, above which relatively modest engine refinements such as replacement of rubber hoses may be required.

Source: Worldwatch Institute (2007)

2 The root of the problem

Biofuels are important because they tackle two of the most difficult challenges we face in energy policy…security of energy supply…and climate change.

Andris Piebalgs, European Energy Commissioner, keynote speech at the International Biofuels Conference, Brussels, 5 July 2007.

All over the world, governments are setting targets for biofuel production or use.[3] Many are mandatory – placing a legal obligation on fuel companies to blend a certain volume or percentage of biofuels with the petrol and diesel they sell.

The European Commission has proposed that by 2020, all member states must meet at least 10 per cent of their transport energy needs through 'renewable sources' – in practice biofuels – as part of their obligations under the Renewable Energy Sources Directive.[4] Meanwhile, in the USA, the Renewable Fuel Standard established in the Energy Policy Act of 2005 and amended with the 2007 Energy Independence and Security Act mandates the annual use of 36 billion gallons of renewable fuels, mainly ethanol, by 2022. In Canada, the Renewable Fuels Bill, now before Parliament, would require 5 per cent ethanol in gasoline by 2010 and 2 per cent biodiesel in diesel by 2012. These are all justified as measures to tackle climate change and improve fuel security.

Saving the climate?

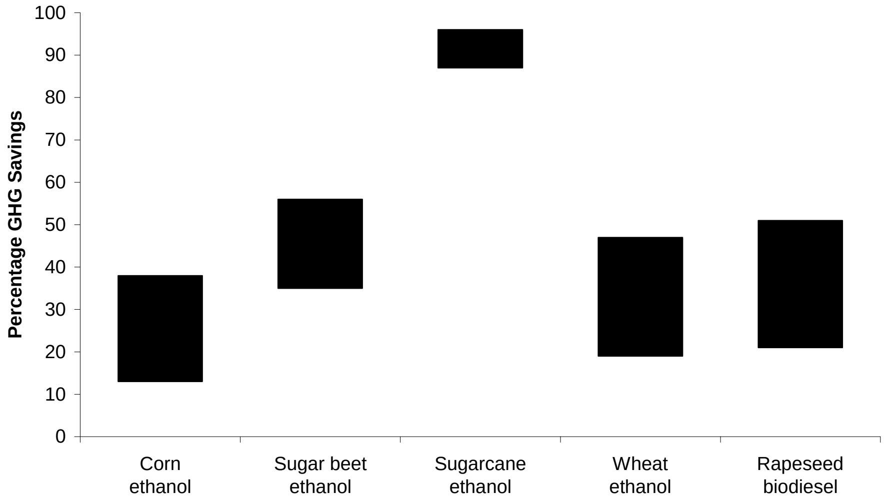
A kind of reverse Murphy's Law in effect creeps into biofuel papers: if anything can go right, it will.

Tim Searchinger, Visiting Scholar and Lecturer in Public and International Affairs, Woodrow Wilson School, Princeton University.

Much of the original attraction of biofuels lay in their perceived GHG neutrality. As crops grow, they fix carbon from the atmosphere. When they are burned (as biofuel), this carbon is simply released back, so that over the lifecycle of the fuel, the net impact on atmospheric carbon is neutral.

Of course, in reality, biofuels are not GHG neutral. There are emissions associated with all stages of their lifecycle, particularly if the crops are grown intensively, using nitrogen-based fertilisers and machinery, or if the refining process requires large inputs of (fossil) energy. Nevertheless, biofuels do not have to have zero GHG emissions to be of benefit; they only need to emit less than the fossil-fuel alternative.

Figure 1: Estimated ranges for lifecycle GHG savings compared to fossil fuels



Source: Worldwatch Institute (2007)

Estimates of the lifecycle GHG savings of biofuels when compared with fossil fuels are shown in Figure 1. The shaded area for each biofuel shows the range of savings estimated – so for example, studies for corn ethanol suggest savings in the range of 13 to 37 per cent compared with fossil fuel (differences in estimates are due to different production pathways and differing assumptions in the calculations themselves). At first glance these results suggest that biofuels provide net GHG savings when compared with their fossil-fuel counterparts. However, the science of lifecycle analyses (LCAs) continues to be refined and improved, and the results of this process are deeply disconcerting.

Emissions from nitrogen-based fertilisers

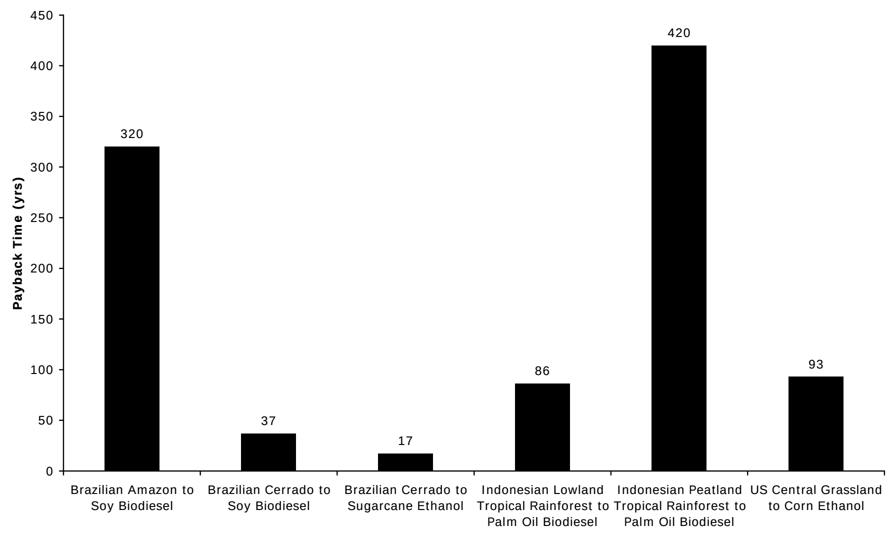
New research published this year by the Nobel Laureate Paul Crutzen has cast serious doubt on the idea that biofuels provide net GHG savings.[5] Crutzen and his co-authors investigated emissions of nitrous oxide, a GHG 296 times more potent than carbon dioxide, released through the decomposition of nitrogen-based fertilisers, commonly used in the production of corn-based ethanol in the USA and rapeseed oil-based biodiesel in the EU. They found that release rates for the gas were typically three to five times higher than had been assumed in previous LCAs. The results suggest that the use of biofuels produced from maize and rapeseed oil may actually be *increasing* emissions and worsening global warming.

Direct land-use change

There are further GHG emissions associated with the process of bringing new land into production – as we burn or let rot trees, grasses, and other vegetation, and as we plough up soil, allowing carbon previously held underground to oxidise. Together, soils and vegetation store nearly three times as much carbon as the atmosphere.[6] So clearing new land to grow biofuels results in potentially significant emissions. The LCAs in Figure 1 all ignore land-use change, implicitly assuming biofuels are only produced on existing cultivated land. But as demand for biofuels increases, new land will be cleared to grow the crops.

A recent paper in the journal *Science* estimated the emissions from direct land-use change and compared this 'carbon debt' to the annual emissions saved through using the resultant biofuel.[7] The authors then estimated the number of years of biofuel production required to 'pay back' the initial 'carbon debt'. Their results are displayed in Figure 2.

Figure 2: Pay-back times for different biofuels and land-use changes



Source: Fargione *et al.* (2008)

The results reflect the ratio between the carbon stocks of the land in question, and the GHG savings offered by the biofuel. Most disastrous is the production of palm oil-based biodiesel from the conversion of Indonesian peatland tropical forest, requiring 420 years of biofuel production to pay back the carbon debt. Corn-based ethanol from conversion of US grasslands is a net contributor to emissions for 93 years.

In order to avoid catastrophic climate change, global emissions must peak and then fall within the next 10 to 15 years.[8] All of the biofuel expansions analysed here, including Brazilian sugarcane encroaching onto the Cerrado (a biodiverse savannah-type ecosystem), will contribute to emissions over this period.

Indirect land-use change, or where standards fail

It is often argued that emissions from land-use change can be avoided by setting standards for the types of land on which biofuel feedstocks may be cultivated, and managed by including an estimate of the emissions due to land-use change in the LCA.

Both are proposed by the European Commission,[9] but this fails to account for *indirect* land-use change as global agriculture expands in response to the additional aggregate demand created by biofuels for land and/or crops. Such *indirect* effects are transmitted by the invisible hand of the market, and so ripple across borders and commodities, making them impossible to manage.

Demand for corn in the USA has skyrocketed as a result of the ethanol programme. In response, American and Canadian farmers are switching out of soy and into corn. This in turn pushes up the price of soy, which is correlated to rates of deforestation in the Amazon basin – South American soy farmers respond to higher prices by bringing new (in this case rainforested) land into production.[10] There are similar concerns that expansion of sugarcane for ethanol in Brazil is also pushing cattle and soy farmers further into the Amazon (see Box 2).

An important attempt to model indirect emissions was made by Tim Searchinger and colleagues at Princeton University.[11] He and his team modelled *global* cropland expansion and associated emissions in response to the US corn-ethanol programme. On incorporating both indirect and direct effects, they found the pay-back time for corn ethanol to be 167 years. The USA has recognised the seriousness of this, and the Energy Act requires that new domestic biofuel plants meet GHG performance standards *including indirect land-use change effects*.

Indirect effects are as much a problem for the EU, which plans to meet the vast majority of its biodiesel demand through domestically grown rapeseed oil. At first glance, this might seem safe – it is grown on existing agricultural land, thousands of miles away from the nearest rainforest. But the sheer ambition of the 10 per cent target means that the EU will have to divert a huge amount of its edible oil production into biofuel, leaving a gaping hole in the food market that will have to be plugged by imports – largely palm oil – the expansion of which is inextricably linked to the destruction of tropical peatland forest in Indonesia and Malaysia. Palm-oil imports are already surging in response to rising biofuel demand (more than doubling between 2000 and 2006) and are forecast to accelerate as the hole in the European edible-oil market grows.[12] By 2020, this hole will necessitate the annual import of 5.4 billion litres of vegetable oils.[13]

Vegetable-oil imports will also increase for direct use in biodiesel manufacture. The Commission forecasts that by 2020, 27 per cent of biodiesel will be produced from imported vegetable oils[14] – a further 5.5 billion litres per year. So by the time the EU 10 per cent target is reached, it will necessitate the import of *at least*[15] a further 10.9 billion litres of vegetable oils – more than a 100 per cent increase over current imports.[16]

Many of these imports for direct use in biodiesel manufacture are also likely to come from palm oil. Malaysia and Indonesia hope between them to directly supply 20 per cent of EU biodiesel demand through palm oil.[17] Further indirect emissions will result as production for these imports, which will be certified as sustainable for EU purposes, displaces uncertified palm oil into rainforest and peatland.

Based on the Commission's own forecasts for biofuel consumption and feedstock supply (which assume that over a quarter of biodiesel demand will be met by as yet unavailable second-generation fuels), Oxfam estimates that 3.1 billion tonnes of CO_2 could be released as a result of *unmanageable indirect land-use change within the palm-oil sector* (see Annex). This figure ignores emissions from expansion of other cropland, which will be significant. Nevertheless, it is 46 times the Commission's estimate for the annual saving from *all* biofuels in 2020[18] – meaning that it would take at least 46 years of biofuel use at 2020 levels to repay this 'carbon debt'. If second-generation biodiesel does not become commercially available in time (and many believe it will not[19]), this increases to 68 years. And of course, the Commission's estimate does not take into account Paul Crutzen's new evidence on emissions from nitrogen-based fertilisers, which suggests that in the case of rapeseed biodiesel at least, there may be no emission savings at all, meaning the carbon debt will never be repaid.

Box 2: Can Brazil produce its ethanol sustainably?

Of all biofuels currently available, Brazilian sugarcane ethanol provides the most favourable GHG balance. Mechanisation of harvesting on a growing number of plantations means that it is no longer necessary to burn the crop before cutting. Meanwhile, new ethanol plants allow the burning of waste products including bagasse and straw to provide energy for the production process, with surplus electricity being sold back to the grid. Currently, this surplus 'bioelectricity' is able to supply about 3 per cent of Brazil's overall needs, but it is hoped this will rise to 15 per cent by 2015, as the practice spreads and more efficient high-pressure boilers are installed.[20]

This highly efficient production process combined with suitable growing conditions and the natural advantages of sugarcane as an ethanol feedstock means that Brazilian ethanol is able to achieve GHG reductions in the region of 90 per cent compared with reductions of about 20 per cent for American corn-based ethanol, *before the emissions from direct and indirect land-use change are taken into account*.

But huge targets for biofuels in the USA and EU are triggering rapid expansion of sugarcane and inevitable land-use change. There are currently 7.8 million hectares of sugarcane under cultivation. This is expected to grow to around 14 million by 2020 over which time output will double from 487 million tonnes to one billion.[21] Brazil has some 90 million hectares of arable land, and although most of this cultivation takes place far away from the Amazon, particularly in São Paulo State, this expansion may push other agriculture, most notably cattle and soy, further into the Amazon, thus triggering indirect emissions.[22]

By increasing the productivity of cattle grazing, from one cow per hectare to 1.4 cows (an improvement already achieved in certain areas), potentially 50–70 million hectares (an area two to three times the size of Great Britain) of degraded pastureland could be freed up. This could easily absorb the sugarcane expansion without significant land-use change emissions. But this requires land management at a national level and enforced co-ordination between different agricultural sectors, and it is questionable whether this will be achieved. The lack of will on the part of the sugarcane sector to comply with existing rules requiring mills to keep a certain percentage of their plantations from sugarcane monoculture is disappointing.[23] New areas identified for sugarcane expansion place important carbon sinks and biodiverse areas such as the Pantanal and Cerrado under pressure and paint a somewhat different picture of sugarcane expansion from that presented by the industry.[24] Meanwhile the Amazon continues to retreat.[25]

While on *some* plantations, improvements in working conditions have been made, on other plantations, sugarcane cutters continue to work in appalling conditions.[26] Three hundred and twelve labourers are reported to have died while at work between 2002 and 2005, with 83,000 suffering injuries.[27] Amnesty International recently reported various cases of forced labour and inhumane working conditions within the sector over the course of last year.[28] For the least fortunate members of the industry, sugarcane production is far from sustainable.

The economics of biofuels as a climate mitigation strategy

Forgetting land-use change for the moment – which appears to be the approach of the European Commission – there is a further question regarding whether or not biofuels represent a cost-effective means of achieving GHG reductions. After all, governments have finite resources with which to achieve this important objective, and so should give priority to strategies that provide the greatest return (in terms of avoided emissions) on their investment.

Work by the Global Subsidies Initiative of the International Institute for Sustainable Development looks into this question. Using LCAs available at the time, which did *not* include emissions from land-use change or take account of emerging evidence on emissions from nitrogen-based fertilisers, it still found the cost of abating a tonne of CO_2-equivalent through biofuels to be extremely high due to the level of support they require in the form of subsidies. In the EU the cost ranged from €575–800 ($900–1,250) for sugar-beet ethanol, and over €600 ($930) for rapeseed biodiesel.[29]

To achieve emissions reductions, biomass can be used far more efficiently in other applications outside the transport sector. For example, replacing oil and gas in commercial boilers yields abatement costs in the region of €60 ($90) down to -€60 (-$90) per tonne of CO_2 avoided – i.e. an abatement *profit*. Similar savings are available from using biomass in combined heat and power applications. Co-firing with coal to generate electricity has costs in the range of €75–200 ($120–310) per tonne of CO_2 abated.[30]

So, even if we ignore the growing evidence regarding emissions from land-use change and fertilisers, and make the huge leap of faith that temperate biofuels will reduce GHG emissions, they are still an overly expensive way of doing so.

Emissions from transport are among the fastest growing – so it is understandable that governments may wish to focus on this sector. But there are far more cost-effective and less risky options available, such as:

- ambitious and enforced vehicle efficiency standards for new cars
- increasing support for public transport
- promotion of car-sharing schemes
- promotion of more efficient driving methods
- congestion charging
- better enforcement of speed limits

- promotion of low-rolling resistance tyres (LRRTs).

For example, a study in the UK found that emissions from transport could be reduced by 8 per cent if speed limits were enforced through Intelligent Speed Adaptation systems.[31] This compares extremely favourably with the UK's biofuel legislation which mandates the blending of 2.5 per cent biofuels, at a current annual cost of £550m ($1bn) to the Treasury. Assuming (generously) that the biofuels consumed offer GHG savings of 30 per cent, this will achieve overall emissions reductions of less than 1 per cent.

On a per vehicle basis, the use of LRRTs is estimated to offer further emissions savings of the order of 3 to 6 per cent, with an additional 2.5 per cent available from electronic monitoring systems to ensure correct tyre pressures are maintained – already beyond what can realistically be achieved with a 10 per cent biofuels blend.[32]

Vehicle efficiency standards

Critically, far greater GHG savings are available from pursuing vehicle efficiency gains. For example, a recent review in the UK concluded that GHG emissions per car could be reduced by 30 per cent using technology that is already available or close to market:[33] even if biofuels offered 100 per cent GHG savings, a 10 per cent biofuel blend would only be a third as effective on a per vehicle basis.[34]

Unfortunately, nothing like enough is being done in this area. In the EU, attempts to introduce meaningful fleet efficiency standards have been delayed for years and watered down from 120g CO_2 per km to 130g as a result of concerted lobbying on the part of the European car industry (which at the same time has joyfully promoted biofuels[35]). Analysis by the European Federation for Transport and Environment shows that long-term fleet efficiency targets for European car manufacturers of 120g per km by 2012 and 80g per km by 2020 would offer an annual reduction in EU transport emissions of 95 million tonnes of CO_2 by 2020[36] – considerably more than the highly questionable 68 million tonnes the Commission believes it will be saving by then through the 10 per cent biofuel target.[37] And unsurprisingly the abatement costs of pursuing fleet efficiency gains are far lower than for biofuels – the now defunct 120g per km target offered costs of just €19 ($30) per tonne of CO_2, while separate analysis shows that improving vehicle efficiency can yield abatement *profits* as the reduced fuel costs outstrip technology costs.[38]

In the USA, new vehicle efficiency standards have been imposed as part of the same legislation mandating the consumption of 36 billion gallons of renewable fuel by 2022. This demands that car manufacturers reach fleet efficiency standards of 35 miles per gallon by 2020, improving on previous standards of 27.5 miles per gallon for cars and 22.2 for SUVs. As in the EU, previous attempts to introduce meaningful efficiency standards had been obstructed by the car industry.[39] In January 2008, Canada announced its intention to match the new US standards.

This sounds like a big improvement, and it is – estimates suggest that new US efficiency standards will save 1.2 million barrels of oil a day,[40] 40 times the oil consumption of Ethiopia.[41] But average fuel economy in Japan is already 45 miles per gallon, and even the watered-down targets of the EU should achieve average vehicle economies of about 44 miles per gallon.[42] The USA, and Canada, still have much further to go in reducing their emissions from transport.

Improving fuel security?

Here we have a serious problem: America is addicted to oil.

President George W. Bush, 2006 State of the Union Address.

Another justification for biofuel targets popular with the EU and USA is to reduce dependency on foreign oil: it's running out, the price is going up, and it's produced in geopolitical hotspots. Biofuels can be directly substituted for oil, and grown on 'safe' home soil.

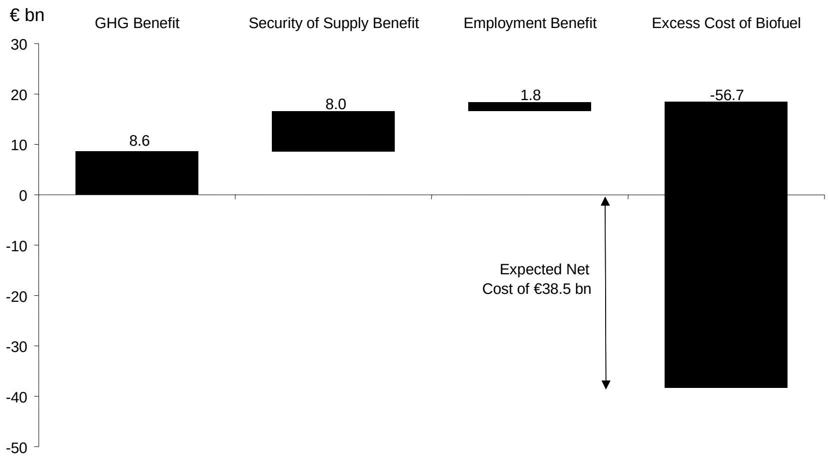
First of all, all of the alternatives to biofuels listed above reduce GHG emissions by *reducing demand for oil*. So they will also reduce dependency on foreign oil – potentially far more than biofuels, which due to the huge areas of land required, face serious limitations.

The USA currently grows enough corn to meet 16 per cent of its oil use, if it used the entire corn harvest for ethanol, and left none for feed, fuel, food, or export. In the case of the EU, the European Environment Agency's Scientific Committee, after estimating the amount of available arable land for bioenergy production, concluded 'the land required to meet the 10 per cent target exceeds this available land area even if a considerable contribution of second-generation fuels is assumed'.[43] Analysis by LMC International suggests that if *all the carbohydrates in the world* were converted to ethanol, this would still only provide enough ethanol to replace 40 per cent of global petrol consumption. Converting all global oilseeds to biodiesel would only displace 10 per cent of diesel.[44]

So the current generation of biofuels does not offer an alternative to oil for industrialised countries. But at the margin, do they offer a cost-effective way to reduce dependency on oil? The Joint Research Centre (JRC), the European Commission's research body, has analysed this question.[45] It placed a value on the security of supply provided by the

EU target, by estimating the cost of a rolling strategic fuel reserve equivalent to 10 per cent of transport fuel needs. The expected value of this benefit during the period from 2007 to 2020 was €8bn ($12bn). Unfortunately the expected *cost* of meeting the biofuel target over the same period was estimated to be nearly €60bn ($90bn) – over seven times the 'value' of the fuel security achieved. The JRC also estimated the value of GHG savings (before the effects of land-use change) and employment creation within the EU. Overall, the expected costs of achieving the target outweighed the expected benefits by nearly €40bn ($60bn) over the period in question – see Figure 3.

Figure 3: The net cost of the EU 10 per cent target



Source: JRC (2007)

Relative to other uses for biomass in energy generation and other strategies to reduce demand for transport fuel, the evidence shows that biofuels do not offer a safe or cost-effective way to reduce GHG emissions, nor a safe or cost-effective way to improve fuel security. So why are the EU, the USA, Canada, and a growing number of other industrialised countries forging ahead with targets regardless?

Digging deeper

Energy security and climate change are two of the most significant challenges confronting humanity. What we see, in response, is the familiar capture of policymaking by well-organised special interests. A superb example is the flood of subsidies for biofuels.

Martin Wolf, *Financial Times*, 31 October 2007.

Biofuel targets in rich countries are best understood as one part of a wide array of support measures provided to domestic interest groups. Last year, support provided to biofuels among Organisation for Economic Cooperation and Development (OECD) countries cost around $13–15bn, for fuels that accounted for less than 3 per cent of their transport fuel demand,[46] but accounted for nearly half of the worldwide increase in consumption of principal food crops.[47] These measures include:

- mandates that create demand for uneconomic biofuels – demand which otherwise would not exist;
- tariffs which protect domestic industries by limiting imports of cheaper biofuels from developing countries; and
- a cornucopia of subsidies and tax exemptions along the entire value chain, from feedstock production, to refining, distribution, and consumption.

The costs of these subsidies and incentives are most pronounced in the USA and EU – in 2006 coming in at just under $6bn and $5bn respectively. In Canada the cost was $0.16bn. These costs will increase as consumption climbs towards mandated levels. In the USA, total support measures for 2008 may reach $13bn,[48] and federal excise-tax credits could cost $19bn a year by 2022 (when the 36 billion gallon mandated volume would be reached).[49] In the EU, assuming current rates of subsidisation, the 2020 target will end up costing European taxpayers over $34bn (€22bn) a year (see Table 1). At projected rates of production increases, Canada's taxpayers will be paying $1bn per year in subsidies by 2010.[50]

Put another way, by the time their targets are reached, the EU, the USA, and Canada between them will likely be wasting more on support to their biofuel industries than the costs of helping developing countries adapt to climate change – an urgent responsibility that rich countries are shirking.[51]

Table 1: Estimated EU subsidies in 2020[52]

	Ethanol	Biodiesel
Subsidy rate (€/litre)	0.74	0.50
Consumption (litres)	16.4bn	20.6bn
Total subsidy	€12.1bn	€10.3bn

Source: Hebebrand and Laney (2007); Kutas *et al.* (2007); author's own calculations.

The USA, EU, and Canada implement these support measures in such a way as to favour domestic feedstocks and biofuels over imports,[53] securing as large a slice as possible of these politically created markets for their agricultural and industrial lobbies.

Ethanol tariffs

The most salient example of this in both the USA and the EU is the tariff raised on ethanol imports. The USA applies a tariff of 2.5 per cent and $0.54 per gallon added duty ($0.1427 per litre); the EU €0.192 ($0.30) per litre; Canada C$0.0492 ($0.047) per litre. While in all cases, preferential access is available to certain countries, these tend not to be significant producers of ethanol. Most notably, the tariff applies to Brazilian ethanol in each case. The net effect is to significantly reduce imports.

Although Brazilian ethanol production is far from perfect and presents various social and environmental sustainability problems discussed elsewhere in this paper, it *is* the most favourable biofuel in the world in terms of both cost and GHG balance. To argue that your policy objective is emissions reduction while simultaneously restricting imports of Brazilian ethanol is incoherent.

The costs of these distortions extend beyond the financial. The most profound example is the USA, where production of corn-based ethanol, sheltered from competition with its sugarcane cousin, continues to snowball. This is not a good thing: corn ethanol is heavily dependent on fossil fuels, often coal, endowing it with one of the worst GHG and energy balances of all (see Table 2).

Table 2: Relative performance of US and Brazilian ethanol

	US ethanol	Brazilian ethanol
Typical GHG savings*	~20 per cent	~90 per cent
Typical energy balance	1.5	8
Yield (litres per hectare)	3,100	6,500
Typical cost per litre	$0.56	$0.42

*GHG savings excludes any effects due to land-use change.

Source: Worldwatch Institute (2007).

It is also a heavy user of nitrogen-based fertilisers, the true emissions of which we may only now be starting to understand, and the run-off from which is creating a 'dead-zone' in the Gulf of Mexico.[54]

But it is perhaps the implications for worldwide food security that are most serious – while sugarcane is not a principal food crop, and its price is relatively uncorrelated with other food crops, corn is a global staple and the USA accounts for about 40 per cent of global production. Last year, about a quarter of the US corn harvest went to ethanol. This is set to grow to just under a third this year.[55] This means that the US ethanol programme will consume about 12 per cent of *global* corn production, and displace about 6 per cent of *US* transport fuel.[56]

Box 3: Second-generation biofuels, poverty, and development

The problems associated with the current generation of biofuels are often dismissed as a painful but short transition on the way to a brighter future of 'second-generation' fuels produced using new production pathways not yet commercially available. Examples include the production of ethanol from lignin and cellulose (which could allow us to use trees or grasses as feedstocks) and the production of biodiesel from algae.

It is argued that biofuel targets are necessary to provide industry with the assurances it needs to invest in second-generation, which will have fewer adverse impacts on poverty and the environment. But is this necessarily the case?

It is quite possible that using first-generation as a 'stepping stone' to second-generation may backfire – we could just as conceivably become 'locked in' to first-generation, particularly if interest groups become too dependent on it. This risk is already apparent in the USA, where legislation has positioned second-generation biofuels as a supplement to (rather than a replacement for) corn ethanol, production of which is set to hit 15 billion gallons a year by 2015. After this, so-called 'advanced biofuels' should make up the remainder necessary to reach 36 billion gallons by 2022.

Even if first-generation is *a* route to second-generation, is it the *right* route? The greatest costs – to nutrition and the environment – are irreversible. The billions of dollars currently spent in the OECD on support would therefore be better spent on research and development (R&D) into second-generation biofuels. Yet, the USA and EU only spend a tiny fraction (about 8 per cent and 2 per cent respectively) of their biofuel subsidies on R&D.[57]

So will second-generation biofuels have fewer adverse impacts on poverty and the environment? Although yields are likely to be higher, many second-generation technologies may still pose similar problems because they will depend on large-scale monocultures that threaten biodiversity, food production, or land rights. Just because a second-generation biofuel does not use food as a feedstock, it does not necessarily mean that it does not threaten food security: it may still compete with food for land, water, and other agricultural inputs. And the idea that second-generation biofuels will use less land is questionable, as higher yields will likely translate to higher targets – the European industry is already lobbying for a 25 per cent biofuel target by 2030[58] in anticipation of second-generation fuels becoming commercially available by then.

Technologies that do not require extensive monocultures, and therefore do not put food production or vulnerable people's land rights at risk, will present the least risks to poor people. Therefore biofuels produced from municipal waste, crop residues (as long as sufficient residues are left to enrich the soil), or non-arable feedstocks such as algae, may present the most promising avenues for development.

3 Impacts on poverty

The fashion for biofuels could be a catastrophe.

Louis Michel, European Commissioner for Development, addressing the Belgian Senate, 15 April 2008.

The big losers from the rich countries' biofuel boom are poor people, at risk from spiralling food prices, and a 'scramble to supply' that places their land rights, labour rights, and human rights under threat.

Food security

After decades of subsidised agricultural dumping by rich countries, resulting in stagnant commodity markets and a pervasive agricultural malaise in the developing world, suddenly, food prices have shot up, by an estimated 83 per cent in the last three years.[59] For poor households, which may spend in the region of 75 per cent of their income on food,[60] the implications are devastating. Within these households, all too often women will suffer the most, as men's consumption takes precedence.

Of course, biofuels are not responsible for all of this price rise, nor even most of it. A number of factors have combined together to create a 'perfect storm', including:

- shifting consumption patterns – as incomes increase in emerging markets, people are eating more meat and dairy products;[61]
- rising oil prices, which push up the costs of inputs such as fertilisers as well as transport and storage costs;
- climatic events such as the drought in Australia, which lost 60 per cent of its wheat crop last year and almost 98 per cent of its rice crop; and
- speculation in commodities markets.[62]

But biofuels are also playing a significant role in the food crisis and have been identified as a major culprit by the UN, World Bank, and International Monetary Fund (IMF). The IMF estimates that last year they accounted for almost half of the increase in demand for major food crops.[63] The OECD has estimated that between 2005 and 2007, almost 60 per cent of the increase in consumption of cereals and vegetable oils was due to biofuels.[64] And biofuels do not just consume food directly, they compete with it for land, water, and other inputs, pushing up prices further. The International Food Policy Research Institute (IFPRI) has commented that support for biofuels, which incentivises the diversion of crops and agricultural land away from food production and into fuel production, acts as a tax on food – a tax that is felt most by poor people.[65] Commentary by the Food and Agriculture Organization (FAO) suggests biofuels may explain 10 per cent of recent food price rises. IFPRI estimates that biofuels explain 30 per cent of food price rises, an estimate corroborated by the IMF.[66] Research from the World Bank puts the contribution of biofuels even higher, at 65 per cent.[67]

Perhaps even more worryingly, this is only the tip of the iceberg: the International Energy Agency predicts that total biofuel consumption is set to increase tenfold between 2004 and 2030.[68]

30 million and counting?

It is a gross-oversimplification to suggest, as for example the European Commission has done,[69] that higher prices are 'bad' for poor people in urban areas, but 'good' for poor people in rural areas. While it is certainly true that small farmers in poor countries have suffered as a result of decades of stagnation in commodity markets – in large part due to protectionist agricultural policies in the industrialised world and chronic underinvestment in agriculture – current food price rises do not so much represent a reversal of this trend (to which they might respond) as an economic shock. In fact, price rises may be even more acute in rural areas due to poor infrastructure and low competition among retailers. And poor farmers may be without access to the necessary resources (land, credit, infrastructure, and inputs) to take advantage of the opportunity.

Most poor rural households are actually net consumers, not producers, of food[70] – so, just like urban households, they are worse off when prices rise. This is captured in World Bank analysis which estimates that recent price rises have led to an increase in global poverty of 105 million people.[71] Oxfam estimates that the livelihoods of at least 290 million people worldwide are now endangered, necessitating $14.5bn in immediate assistance – the same as rich countries are estimated to have spent on support to biofuels last year.[72]

If recent food price inflation – of which IFPRI estimates 30 per cent is attributable to biofuels – is responsible for an increase in the poverty headcount of 100 million and endangering the livelihoods of nearly 300 million, then biofuels may already be responsible for dragging over 30 million people into poverty and similarly endangering the livelihoods of nearly 100 million.[73]

By some estimates, the current biofuels rush, if it continues as forecast, could result in an extra 600 million hungry people by 2025[74] – 16 million extra for each percentage point increase in food prices until then. Biofuel targets and subsidies are therefore completely undermining the first Millennium Development Goal of eradicating poverty and hunger.

Land rights

Access to land is a fundamental precondition in realising the potential role of agriculture in reducing poverty. Unfortunately, one of the side effects of biofuel targets – particularly those set in the absence of any requirements for companies to behave responsibly – is a 'scramble to supply', in which companies or rich and powerful investors rush to buy up new land, potentially displacing vulnerable communities whose rights to the land are poorly protected. This can sometimes be a violent process.[75] Frequently, though by no means always, these may be indigenous people (the UN has identified 60 million at risk of displacement by biofuels).[76] More often than not, they will be women, who are more vulnerable than men to displacement as a result of systematic and pervasive discrimination within land tenure systems throughout the developing world.[77]

Marginal land

A trend is now emerging among governments and companies to target 'marginal', 'idle', or 'degraded' lands, the idea being that these areas are unsuitable for food production and poor in biodiversity. But there is no accepted definition of marginal land. The Indian government, for example, has identified 400,000 hectares of wastelands for jatropha – an oilseed-yielding tree that can grow in relatively dry conditions.[78] However, these lands, largely classified as Common Property Resources (CPRs), are integral to the livelihood strategies of poor people who use them for food, fuel, and building materials. Separate studies have shown CPRs can contribute up to a quarter of poor household incomes – with the poorest households being most dependent on them.[79] In any case, 'marginal' lands are often likely to be worth far more to poor people than their market values reflect.

Once again, it is women who stand to lose the most, as it is they who tend to be allocated the most marginal lands for growing subsistence crops or medicinal herbs.[80] As well as being most at risk (due to less secure access to land), and with more to lose (due to greater reliance on marginal lands), women may also have less to gain from biofuels, as production of cash crops is usually dominated by men.

Tanzania

Nearly half Tanzania's land area has been identified as suitable for biofuel production.[81] Already this is causing tensions as investors' land requirements come into conflict with those of communities. For example, 1000 farmers in the Wami Basin – a rice-growing area – currently face clearance to make way for a Swedish investor looking to develop 400,000 hectares of sugarcane plantations.[82]

Box 4: Case study – 'Jatropha comes to Kisarawe'

Mtamba, in the coastal district of Kisarawe, is one of 11 villages forming a circle within which Sun Biofuels Tanzania Ltd, a subsidiary of British company Sun Biofuels plc, is about to invest $20m in 8,200 hectares for jatropha, of which Mtamba owns the majority. Together, the villages are home to about 11,000 people, 850 of whom live in Mtamba.

Although uncultivated, the land is used by the villagers of Mtamba, principally for charcoal-making, firewood, and collecting fruits, nuts, and herbs. Mtamba was invited to a meeting of all 11 villages with Sun Biofuels to discuss the investment, but their invitation did not arrive until after the meeting had taken place. They were soon visited by the District Land Officer who urged them to make a quick decision, sparking a hastily convened meeting at which the investment was agreed in principle.

However, the first many of the villagers knew about the scale of the investment was when they saw men laying beacons marking out the area for development. They still do not know how much land they have conceded, but many of the villagers are convinced that this is a big opportunity. 'They're giving us seeds and a market, so this is good for the villagers', says Mussa Mrisho, a local farmer.

Despite the investment being in its final stages, confusion still reigns. According to local press reports, the 11 villages were entitled to total compensation of 800m Tanzanian Shillings (about $630,000) – equating to about $77 per hectare. However, Sun Biofuels has confirmed compensation of $220,000 to be shared between 152 people with trees on their land, and a further $10 per hectare – suggesting total compensation of less than half that reported in the press.

In Mtamba, most do not know whether they will receive any compensation. The Village Council received a letter from the District Land Officer requesting villagers to apply for compensation. But the village committee was unsure what to do. As a result, they say only six people have returned it. The deadline has now passed. The District Land Office says that everyone who is receiving compensation has been informed.

Although they do not know how much land they are actually conceding to Sun Biofuels, the villagers do know it includes a waterhole which is the only place that they can collect water when it is dry. They also collect clay there to build houses. They say they have had assurances from Sun Biofuels that they will retain access to the waterhole and clay once the development is under way. However, they have nothing agreed in writing and when asked about this, Sun Biofuels was unaware of the waterhole.

What the people of Mtamba really want are jobs. During a meeting with Sun Biofuels, they were told that 4,000 of the 11,000 villagers in the area would be employed. Two hundred people from Mtamba have applied for jobs as drivers, guards and farmers, but none have heard anything back. Sun Biofuels estimate that there will initially be about 1,500 jobs to clear the land and in the longer term expects to create one job for each hectare. The villagers have been told that they will be given priority, but they remain uncertain, and wish they had something in writing to confirm this.

Source: Oxfam research, including interviews, field visits, and desk research

The Tanzanian government has yet to finalise its biofuels policy, but hopes to create rural employment and new opportunities for small farmers, to increase access to energy in marginalised areas, and to reduce the need for increasingly expensive oil imports. These are important objectives. Although oil only provides about 6.5 per cent of the country's energy, 26 per cent of foreign currency earnings are used to buy petroleum products.[83] Agricultural areas are home to about three-quarters of the population, but are grindingly poor with average per capita income of about $160 per year.[84] Only one rural household in 100 has access to electricity.[85]

However, as yet, there is no discernible strategy regarding this flood of investment or how to regulate it: the emerging picture is one of investment for export with seemingly no requirements on companies to maximise value-addition within country, supply national markets, form links with local companies, adopt production models likely to maximise opportunities for poor people, or work with local communities to increase access to energy.

In this regard, the proliferation of Bilateral Investment Treaties and free trade agreements restricting the ability of developing countries to regulate investment is a serious problem. For example, if Tanzania negotiates a 'full' Economic Partnership Agreement with the EU, its ability to regulate European biofuel companies in order to achieve many of these kinds of policy objective may be seriously undermined.[86]

In addition, the lack of transparency with which much of the investment is taking place, particularly regarding the allocation of land, is equally worrying (see Box 4).

Indonesia

In Indonesia, the palm-oil sector is inextricably linked to land conflict as the interests of politicians, plantation companies, indigenous peoples, and resettled communities collide. The explosion of biofuel targets is a huge driver of palm-oil expansion. The government has stipulated that 40 per cent of palm-oil production should be set aside for biofuel. Along with Malaysia, Indonesia hopes to supply a fifth of

EU biodiesel demand.[87] Twenty million hectares (an area nearly six times the size of the Netherlands) has been identified for expansion by 2020 – more than three times the area currently under cultivation.[88]

This places literally millions of people at risk. The UN has identified 5 million indigenous people in West Kalimantan alone who may lose their land because of biofuels.[89] Under the Indonesian constitution, indigenous peoples' 'customary' rights are subordinate to the 'national interest', which in practice is interpreted as the interests of the palm-oil industry.

When an area is identified for oil-palm development, the law requires that the indigenous people and local communities should be consulted about the development and the level of compensation. But the reality is a litany of deception, corruption, and broken promises in which the communities involved may find themselves in a struggle against the palm-oil industry, local politicians, and the judiciary. The result is conflict, poverty, and the destruction of entire communities.[90]

Labour rights

The labour conditions of agricultural workers across the world are a continued cause for concern. Many of the problems associated with the exploitation of labour in biofuel production are discussed in the Oxfam Briefing Note 'Bio-fuelling Poverty'[91] (also see Box 5). They include:

- the persistence of forced and bonded labour, often perpetuated through the use of gangmasters and subcontractors;
- denial (*de jure* and *de facto*) of the right to organise and bargain collectively;
- inhumane conditions including exhausting work over long hours, lack of access to clean water and sanitation facilities, and cramped and unclean living quarters;
- lack of adequate health and safety training, particularly regarding the use of dangerous equipment and pesticides;
- use of piece-rate systems that systematically discriminate against women and may result in the exhaustion of workers and the use of child labour.

Box 5: 'Investing in Poverty'

Investments are flooding into the Brazilian sugarcane industry – from 2008 to 2012 they are expected to total $33bn, over which time the share of plants under foreign control is expected almost to double. Investors are coming from everywhere, including India and China, as well as the more familiar international agribusiness firms – Cargill, Bunge, ADM, and Louis Dreyfus. Financial investors are also apparent – Goldman Sachs, Merrill Lynch, George Soros, and Carlyle Riverstone.

The Brazilian Renewable Energy Company's (BRENCO's) investors include former President of the USA Bill Clinton, former President of the World Bank James Wolfensohn, former CEO of AOL Steve Case, and former CEO of Sun Microsystems and current biofuel mega-investor Vinod Khosla. BRENCO is managed by the former President of Petrobras, Henri Philippe Reichstul.

Despite this high level of involvement, following an inspection of its operations in the State of Goias by the Ministry of Labour, in 2008, BRENCO was found to be employing workers in degrading conditions.

Problems reported by the inspection team included use of the exploitative 'gato' sub-contracting system, inadequate access to food, lack of sanitation facilities, and cramped and squalid living conditions. In one case seven people shared a room of 11 square metres; others had to sleep on wet mattresses and in rat-, cockroach-, and garbage-infested quarters.

BRENCO has apologised and has said it is fixing the problems. But for the labour prosecutor allocated the case, this is not enough – he intends to prosecute the company in order to compensate the workers.

Source: Reporter Brasil and other media[92]

4 A pro-poor role for biofuels?

Energy consumption differs drastically between rich and poor countries (per capita oil consumption in the USA for example is more than 100 times that of Tanzania[93]), prompting many to wonder whether biofuels, which can be produced more efficiently in the South, offer an opportunity to redress this imbalance.

The current era of high oil prices places a huge strain on the balance of payments of many of the poorest countries in the world, with direct implications for poverty. Some poor net oil-importing countries spend up to six times as much importing oil as they do on essential services such as health.[94] For countries such as these, the opportunity to offset some of their oil imports (by no means large, at least by industrialised country standards) with biofuels is understandably of interest.

Other developing countries, aware of their comparative advantages in feedstock cultivation, are hoping to earn foreign exchange from exporting feedstocks, or better still finished biofuels, to the burgeoning markets in the North.

Of all countries, industrialised and developing, none has more experience with biofuels than Brazil – since the mid 1970s it has been using ethanol as a substitute for oil, and is now pursuing an export strategy. It is also embarking on an ambitious biodiesel programme targeting smallholder farmers in some of its poorest regions.

Easing the balance of payments

Import substitution of oil

The Brazilan ethanol programme (ProAlcool) was launched in 1975 in response to the oil crisis. Over time, the programme has ebbed and flowed depending on the level of governmental support and relative prices of oil and sugar. It was liberalised in 2002 and is currently enjoying a renaissance due to a combination of factors including the high oil price, the advent of flex-fuel cars (which can run on blends of ethanol up to 100 per cent), and emerging demand in the USA and EU.

In the last eight years, ethanol is estimated to have saved Brazil $61bn in avoided oil imports – the total amount of the Brazilian external public debt.[95]

But it has not always been plain sailing. Now largely free of subsidy, the programme in the past required heavy support. Over its first decade, it barely turned a profit – from 1975 to 1987 saving $10.4bn but costing $9bn,[96] at which point it collapsed when falling oil prices, rising sugar prices, and a national economic crisis meant that the cost of subsidies became too great to bear.

The experience of Brazil illustrates that biofuel programmes are an expensive business. Not only is considerable capital investment required, but biofuels require financial support in order to remain viable. In Tanzania for example, estimated production costs for jatropha-based biodiesel are about five times the cost of fossil diesel, suggesting that a 10 per cent biofuel blend could easily consume 10 per cent of total tax revenues.[97]

Over the last 15 years, prices for soy, coconut, rapeseed, and palm oil have generally been higher than diesel prices, meaning that countries producing biodiesel from these feedstocks would be better off selling the oils into the commodities markets and buying diesel instead.[98] This is likely to persist: the OECD and FAO predict biodiesel prices will remain well above fossil diesel prices for the next decade.[99] This should provide food for thought to developing countries hoping to make significant savings on their oil-import bills by producing biofuels – it is easier said than done (see Box 8).

Brazil has got round this problem by developing plants that can switch between sugar and ethanol production according to their relative prices, and reducing ethanol blending during periods of high prices. But even then, analysis suggests that it may not always have got the balance quite right.[100]

Biofuels for export

Brazil consumes about 85 per cent of its ethanol and exports the remainder, but is still the world's largest exporter. The cost, energy, and GHG characteristics of Brazilian ethanol make it a very promising export. Brazil is now working frantically to turn ethanol into a global commodity with internationally accepted specifications. Promoting an internationally diversified production base is key, so that potential importers will not worry too much about having all their eggs in one basket. To this end, Brazil is actively exporting its ethanol technology to other developing countries, particularly in Africa.[101] However, while this may certainly provide an attractive opportunity for countries seeking to 'leapfrog' up the learning curve, they should also be aware that the Brazilian ethanol model is premised on extensive monoculture, concentration of land, and a now rapidly decreasing employment level.

Estimates for the number of people employed in the ethanol industry are typically around 700,000 to 1 million, but many of these are migrant sugarcane cutters – often working in desperately poor conditions.[102] Moreover, these numbers are set to drop dramatically as mechanised harvesting sweeps through the industry. One machine reportedly replaces 100 workers and pays for itself in two years. In the main sugarcane-producing state of São Paulo, mechanisation already accounts for 40 per cent of the harvest, and it is hoped that this will reach 70 per cent by 2010, with mechanisation becoming obligatory in 2017. This process therefore has huge implications for the livelihoods of up to half a million unskilled, often migrant, labourers, and presents an urgent challenge to the government and the industry.

Sugarcane expansion in Brazil has not been inclusive, and in its early years was associated with the displacement of rural communities.[103] Although in certain areas co-operatives do operate,[104] production remains dominated by large-scale plantations, resulting in the concentration of land and resources.

Various other countries also see significant trade opportunities, including Malaysia, Indonesia, and a number in Africa. As we have seen, Tanzania is currently attracting considerable export-oriented foreign direct investment, but without a clear strategy as to how to manage this to achieve national objectives. There is a similar lack of clarity in Mexico (see Box 6).

Box 6: Trade and food security – the case of Mexico

The road to national biofuel legislation in Mexico has been fraught with controversy and confusion. In April 2007 the senate passed the Law for Promotion and Development of Bioenergy, only for the president to freeze the legislative process a few months later. The presidential veto was employed in response to criticism regarding the use of corn as a feedstock. Concerns were raised not only around its poor GHG performance, but also regarding its importance as a national staple of huge cultural significance.

Nevertheless, in February 2008, the law eventually came into effect with stated objectives of reducing dependency on petroleum imports (Mexico currently exports crude and imports petrol and diesel), reducing GHG emissions, and stimulating agricultural development. The immediate goal for urban areas is to blend 5.7 per cent ethanol into petrol by 2012, which will largely be produced from sugarcane and corn. But Mexico has its work cut out. Ethanol is corrosive, necessitating substantial investment in transport and storage infrastructure that will compete for funding with existing initiatives to improve fuel quality and build domestic refining capacity. Nor does the state oil company, PEMEX, appear willing to invest in an ethanol infrastructure itself. This suggests that a more likely destination for Mexican ethanol is the USA, to which Mexico can export ethanol tariff-free under the North American Free Trade Agreement (NAFTA).

The Mexican government has an even bigger task ahead in ensuring its population's food security. During the 'Tortilla Crisis', the price of tortillas rose by 30 per cent in three months, underpinned by surging demand from the US ethanol programme.[105] For the poorest families in Mexico, who spend 65 per cent of their incomes on food, this was untenable, and riots erupted.

Currently, the law states that only surplus corn (i.e. beyond that required for food consumption) may be used for ethanol – but Mexico is not self-sufficient in corn, currently importing about 30 per cent of its consumption. Despite this, of the ten companies currently investing in ethanol production in Mexico, half are developing capacity to process corn, bringing into question if and how this will be enforced in practice. If Mexican ethanol production grows rapidly in response to spiralling US demand, this could have serious implications for food security.

Source: Hugo García (2008)

While in some cases an export strategy may make sense, as it certainly does for Brazil, which is able to produce a significant exportable surplus, it is not without its risks. In particular, developing countries should be aware that:

- biofuel export markets are politically created, and therefore at risk of being revised, particularly in light of emerging evidence regarding their negative consequences;
- the impact of second-generation technologies, when they become available, remains uncertain, but if their application and use is restricted to industrialised countries, they could dramatically curtail demand for tropical biofuels;[106]
- export markets in biodiesel and ethanol (feedstocks) are likely to be dominated by a handful of major exporters such as Brazil, Malaysia, and Indonesia, meaning that prices will be set by these countries, rendering smaller exporters 'price takers';
- the international biofuel value chain demonstrates high downstream concentration, particularly in distribution, which is typically controlled by a select number of fuel companies; and in feedstock trading, which is controlled by an even smaller number of agribusiness companies such as Cargill and ADM – experience shows that such structures are associated with lower returns for producers; and
- the cost efficiencies demanded by export markets will make it harder to pursue social objectives such as maximising rural employment.[107]

Putting poor people first

Models of production which maximise employment opportunities for rural populations may not be the most efficient from an export perspective, but may offer greater benefits for rural communities. Developing countries that favour smallholder over large-scale production can expect higher returns on their public spending due to greater economic multiplier effects and reduced demand for social welfare expenditure.[108] Biodiesel (which also has lower transport and infrastructure costs[109]) in particular lends itself to small-scale agriculture, providing a happy coincidence with the predominance in developing countries of diesel in both transport and electricity generation. The economic viability of smallholder agriculture in oilseed production is underlined by the performance of smallholdings in the Malaysian palm-oil industry[110] and the promotion of outgrower schemes among biodiesel companies such as D1 Oils.

Brazil and biodiesel

In 2003, the National Biodiesel Production Programme (PNPB) was created by decree, proposing mandatory blending of 2 per cent biodiesel by 2008, rising to 5 per cent by 2013. A fundamental objective of the PNPB is the inclusion of smallholder farmers, initially in oilseed production, and ultimately in processing and refining. The programme ensures their participation through the use of the 'social seal' awarded to biodiesel companies that purchase a certain minimum percentage of their feedstock from family farmers, and enter into contractual arrangements to establish a minimum price and provide technical assistance. Companies awarded the social seal are eligible for tax incentives and allowed to participate in national auctions to supply the state fuel company, Petrobras.

Box 7: Case study – 'Biodiesel comes to Coopaf'

The north-east region of Brazil is one of the poorest in the country. Family agriculture is widespread, but the farmers struggle with semi-arid conditions and lack of infrastructure. The biodiesel programme is bringing new opportunities, which the Coopaf co-operative hopes to grasp with both hands. Now they grow castor for biodiesel, intercropped with corn, and sometimes beans. Many of them keep a plot aside for vegetables and livestock.

Many of Coopaf's 5,000 members are descendents of escaped slaves who have farmed the land for generations. But they're noticing some changes of late. 'I think the prospects from the biodiesel programme are good', says Jose Brito Lima, 'but we are worried about the rain. In the last 12 years, we've been having less rain'. The increase of drought in the region has meant that there have only been two good bean harvests in the last decade. But castor is more drought-resistant, requiring only one month of rain instead of the three required for beans. Jose joined the co-operative last year, and started to sell castor for biodiesel when he saw other farmers benefiting from the technical assistance and fixed price provided through the programme. 'In the past, we could only get 12 Reals (about $7) for a 60 kilo bag of castor beans. With the biodiesel programme, this has increased to 36 Reals.' For next season, Coopaf has agreed a price of 45 Reals with the biodiesel company. 'The programme is creating a better life for us because of the guaranteed price', Jose adds.

The co-operative's president, Érico Sampaio da Souza, is optimistic. 'People are seeing that the programme has credibility – that the prices are guaranteed and that there is technical assistance. The farmers are planting with more confidence that they will see results.' But he also recognises that there are many challenges ahead. 'The main ones are to consolidate family agriculture not just in the production of a crop, but the production of the fuel, to innovate with seed varieties, and to improve access to credit. But the main challenge is to organise farmers as a whole.'

Source: Oxfam research

The minimum percentages of feedstock that companies must purchase from family farmers are set by region according to the scale and productivity of family farming. Acceptable oilseeds are also defined on a regional basis, depending on climatic conditions.

In 2007 the Brazilian government reported about 200,000 farmers involved in the programme, forecast to rise to nearly 350,000 as blending of biodiesel increases to 5 per cent.[111] For many of these farmers, the PNPB has provided an important opportunity to diversify or raise income streams and benefit from technical assistance and a guaranteed price (see Box 7). However, the programme faces a number of challenges.

First, during 2007, more attractive international prices meant that biodiesel companies sold feedstocks into commodity markets rather than honouring their contracts with Petrobras – although 800 million litres of biodiesel had been agreed at auction, only half of this was delivered. Farmers also were unprepared to swallow the opportunity costs and failed to honour their contracts: as a result of its members selling instead to middlemen, the Coopaf co-operative discussed in Box 8 was only able to deliver 6,500 tonnes of castor beans to its buyer, despite having agreed 15,000 tonnes. For the future, Coopaf has agreed a scheme in which it will buy half its members' castor for biodiesel, leaving them the remaining half to sell into alternative markets. From now on, biodiesel companies that fail to honour their contracts with Petrobras will be fined heavily.

Second, the primary feedstock for biodiesel is soy oil, meeting about 90 per cent of demand last year. Soy oil tends to be produced by agribusiness rather than family agriculture, and although some family farms are involved in soy production, being relatively large and well-off, they do not represent the intended beneficiaries of the PNPB.

Third, biodiesel-blending mandates are increasing too rapidly. The obligatory use of 3 per cent biodiesel will commence from July 2008, and a new decree has brought forward the 5 per cent target three years to 2010. The accelerated timetable is understood to be the result of lobbying by biodiesel companies that over-invested at the beginning of the PNPB, and now have considerable excess capacity. However, it is unclear whether family farmers, particularly in the poorest regions, will be able to keep pace with the increase in demand; if not, they risk losing even more ground to soy.

Finally, but perhaps not unsurprisingly, the programme has struggled to really penetrate family agriculture in the poorest regions – the relative success of Coopaf is the exception, rather than the rule. Instead, family farmers in the south and south-east regions, who enjoy better conditions, infrastructure, and organisation, have been the main beneficiaries of the programme so far.[112]

Indonesia

In 2006, the Indonesian government passed Presidential Decree 5/2006, setting a target for biofuel consumption in the total national energy mix of 5 per cent by 2025. This was followed shortly by a further decree establishing a national biofuel authority (Timnas BBN) to develop and manage the country's biofuel strategy.

Through biofuels, the government wishes to:

- reduce its dependency on oil (Indonesia became a net importer in 2004);
- earn foreign exchange from exports, particularly to the EU; and
- reduce poverty in rural areas through the creation of income opportunities and the development of schemes to increase access to energy.

Timnas BBN estimates that industry development will require Rp100 trillion (about $10.8bn) over five years,[113] although other estimates have put the figure higher – at as much as Rp250 trillion[114] (about $27bn) – nearly five times the 2007 budget for the national poverty reduction programme.[115]

A critical objective for Indonesia is substitution for oil, which it not only imports, but also subsidises heavily. Oil subsidies are expected to total Rp126 trillion ($13.8bn) this year[116] – 12 per cent of the national budget, and twice the national education spend. For its part, the government hopes that the effect of reducing oil imports will save it $5–6bn a year, which it can spend on poverty reduction.[117] But this is not happening, because the soaring palm-oil price makes biodiesel uncompetitive with (heavily subsidised) petroleum products (see Box 8).

Box 8: Case study – 'Indonesia and palm oil'

Indonesia is one of the world's biggest consumers of palm oil, partly for the manufacturing industry (detergents, etc.) but also because palm-based cooking oil is a staple in the Indonesian diet. In 2007 the consumer price of cooking oil went up 40 per cent, against an overall inflation rate of 6.6 per cent, and continues to rise in 2008.[118] The poorest households feel the strain most, especially in rural areas where incomes are lower and prices of cooking oil are higher – ironically even in areas growing oil palms.

Some areas have seen outright shortages and queues, while food vendors and home industries have been forced out of business. 'With the new prices we can't sell', says Sanuri, a small-scale manufacturer of Indonesia's ubiquitous krupuk crackers, 'but if we make our krupuk smaller, customers will complain'.[119]

Food and fuel prices have provoked a massive public outcry, with demonstrations in Jakarta and other centres. The government has been quick to take action. Export tax on crude palm oil was tripled last year and import taxes on soy scrapped. Direct market intervention programmes are providing cooking oil and soybeans to the poorest families – a programme that will cost the government Rp500bn ($54m) between March and September 2008.

Biofuels may be one of the drivers of the palm-oil price internationally, but not within Indonesia itself. Following Indonesia's co-commitment with Malaysia in 2006 to devote 40 per cent of palm-oil production to biodiesel and to build a world-leading industry in the two countries, investment in processing facilities was rapid and production capacity topped 2 million tonnes in 2007.[120] The Indonesian government agreed a target of 5 per cent of renewables in the transport fuel mix by 2025. But by January 2008 only five biofuel companies remained in operation, at around 15 per cent of their combined production capacity, while at least 17 others had suspended operations.[121] The problem is simple: domestic biodiesel manufacturers cannot afford the international price of crude palm oil, and the government's fuel-subsidy bill is high enough without further subsidisation of biofuel production. For the time being at least, biodiesel in Indonesia just cannot compete with fossil fuels.

Source: Oxfam research

Higher palm-oil prices though are good news for farmers, and the benefits are being felt by even the smallest of small-scale producers. But price transmission is not perfect. Farm-gate prices are calculated according to a government-set formula of the global crude palm-oil price minus the costs of transport and processing in the mill. However, the mills, owned mainly by big companies with local processing monopolies, refuse to divulge how mill costs add up. Independent smallholders can gain better prices by selling to smaller independent mills, but these are largely confined to the more established production areas such as Sumatra, and are under threat of closure by the government, which is concerned about rising palm-oil smuggling – a result of high prices and export taxes.

The right to food and the right to choose

A risk for many developing countries is that a rapid shift in domestic agriculture away from food production to fuel production may increase food insecurity at both the household and national levels.

At the household level

Small-scale biofuel production in particular should be compatible with food production. A number of oilseed crops suitable for biodiesel production can benefit from intercropping with nitrogen-fixing leguminous vegetables such as beans, or can form part of a more diversified farming strategy (see Box 7). However, in some instances, rather than promoting diversification and food security when dealing with smallholders, companies have discouraged or prevented it. Whereas palm-oil smallholders in the north of Brazil are encouraged to keep aside a proportion of their land for food production,[122] in Indonesia and Papua New Guinea, households have not been allowed by companies managing the schemes to produce as much food as they would like.[123] Smallholders must be allowed a set-aside area in which they have free choice in their farming decisions, and with which companies should not interfere. Governments should regulate to ensure such set-aside areas in smallholder schemes are respected, and should not create policies that favour monoculture over diversified production.

At the national level

As well as promoting diversification and set-aside land for food production, governments may also need to take national-level decisions regarding for example to what extent staple crops may be used for biofuel production,[124] or where energy feedstocks may be grown. There are likely to be winners and losers from such decisions, so considerations of equity will be key – in particular, it will be important to ensure that the most vulnerable people are consulted and heard.

It is important to move very cautiously with biofuel developments, to avoid precipitating a rush from food to fuel production. Biofuel strategies must be fully integrated with other relevant policies on food security and poverty reduction, and in particular, must be consistent with governments' obligations under international law to ensure the right to food.[125]

Addressing energy poverty

It is rural areas where energy poverty is highest and where feedstocks are grown. A model of decentralised production and consumption is an obvious opportunity, and has the added advantage of locating the entire value chain in the local economy, so maximising incomes and economic spillovers.[126] One such example is the Cuiabá Biofuels Cooperative in Brazil which has established a biodiesel plant in Mato Grosso. The objective is not to supply the national market; it is to reduce the fuel costs of the co-operative's members by avoiding the need to buy at the pump, which the co-operative estimates generates savings of up to 40 per cent.[127]

Generally speaking though, biodiesel and ethanol are of little use for poor people, who tend not to own cars. Other forms of bioenergy are more appropriate and able to address poverty more effectively. In particular, biomass for clean cooking fuels offers huge opportunities to address the effects of poverty among women. Gathering fuel wood

- supplying a certain percentage of biofuel to local or national markets
- developing access to energy projects.

- Strengthen South–South collaboration on research and production models that foster sustainability and social inclusion.

For companies and investors

- Ensure no biofuel project takes place without the Free, Prior and Informed Consent of local communities.
- Ensure that men and women workers at all stages of production in the value chain enjoy decent work as defined by the International Labour Organization.
- Where applicable, promote smallholder organisation, and work with men and women farmers on a fair and transparent basis including:
  - clear, freely negotiated and respected contracts
  - transparent pricing and credit arrangements
  - timely payment with procedures for regular review and procedures for objections and recourse.
- Where applicable, promote diversification strategies for smallholder farmers and allow them sufficient freedom of choice in their planting decisions to ensure food security for them and their families.
- Promote access to energy projects in remote areas.

Annex: Estimation of indirect emissions through palm-oil expansion as a result of the EU 10 per cent biofuel target

Calculation basis

This calculation seeks to provide a conservative estimate of the emissions from indirect land-use change which will result from palm-oil expansion into rainforest and peatlands. There will of course be other indirect land-use change emissions generated as a result of the EU target, but it is beyond the scope of this calculation.

The indirect emissions arise from:

- Palm-oil expansion as a result of increased demand for direct use in biodiesel – although the Commission's proposed certification scheme will block the use of palm oil grown at direct expense of rainforest or peatland, the net effect of increasing aggregate demand will simply be to displace uncertified palm oil, frequently into rainforest and peatland – it is this indirect expansion we are seeking to capture here.
- Palm-oil expansion as a result of increased demand in order to substitute for European edible oils displaced into biodiesel production, predominantly rapeseed.

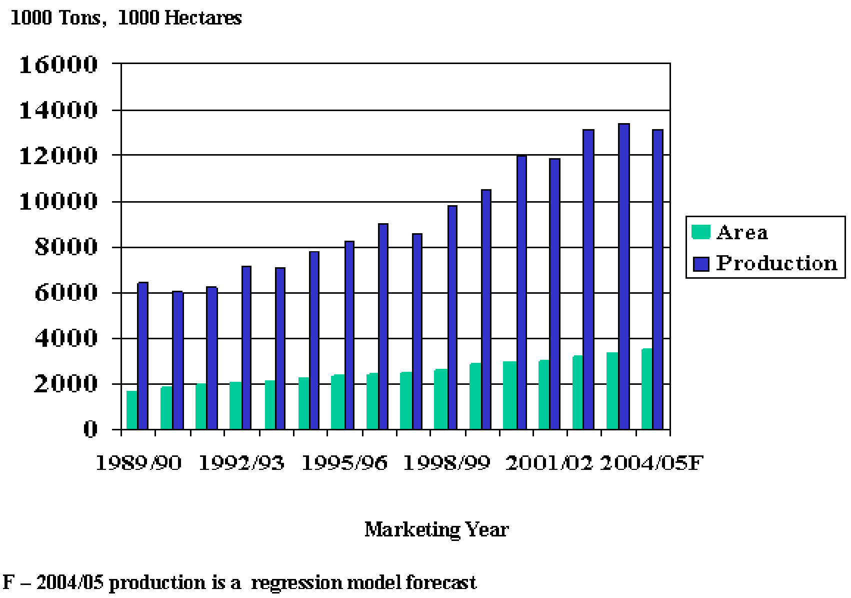
We focus the calculation on Indonesia and Malaysia, which between them intend to supply 20 per cent of the EU's biodiesel demands through palm oil directly (Tauli-Corpuz and Tamang 2007). As the two largest producers of palm oil in the world (between them accounting for about 90 per cent of global production and trade[130]), it is also Malaysia and Indonesia that will meet most of the additional demand to replace diverted rapeseed oil.

A note on yields

It is commonly argued by the Commission that higher demand for feedstocks will predominantly be met through increases in yield rather than expansion. This will not be the case for palm oil, the yields for which, as the FAO shows, have been stagnant for the last 20 years.[131] This means that increases in demand are met through expansion – illustrated quite clearly in the chart below from the

Malaysian Palm Oil Board, which shows that as production has doubled, so has the total area under cultivation.

Malaysian palm-oil production and cultivated area



Source: Malaysian Palm Oil Board

The reason for this is most probably hard economics – it is more lucrative to log rainforest and sell the timber than to invest in increasing yields.

Methodology

Expected 2020 biofuel consumption volumes are taken from Hebebrand and Laney (2007). DG-AGRI analysis of where feedstocks in 2020 are expected to come from is taken from JRC (2007).

It is assumed that Malaysian and Indonesian palm oil supplies 20 per cent of overall EU biodiesel:[132]

Total biodiesel consumption in 2020	20.6bn litres
Of which palm oil	4.1bn litres
Of which diverted domestic edible oils	5.3bn litres
Of which second-generation	5.7bn litres
Of which diverted exports of edible oils	0.5bn litres
Of which increased domestic production	3.6bn litres

European edible oils diverted into biodiesel will have to be replaced by imports of 'vegetable oil and oilseeds, especially palm oil' (JRC 2007). Other candidates include sunflower oil and soy oil, though neither of these is expected to make significant contributions to the deficit – the former is of limited supply, and GM soy is widely rejected for food use in the EU.[133] The FAO predicts that palm oil will account for 68 per cent of global trade in vegetable oils in 2015/16[134] – it is therefore assumed that palm oil will replace 68 per cent of the diverted edible oils. Assuming that Malaysia and Indonesia continue between them to supply 90 per cent of traded palm oil, this means that about 61 per cent of the diverted edible oils will be replaced with Malaysian and Indonesian palm oil.

It is assumed conservatively that 1 litre of vegetable oil yields 1 litre of biodiesel:[135]

Increase in demand for palm oil	7.3bn litres
For biodiesel	4.1bn litres
To replace diverted domestic edible oils	3.2bn litres

It is assumed that actual expansion occurs within Indonesia – Malaysia is already reaching its limits for oil-palm expansion.[136] Meanwhile Indonesia has identified a further 20 million hectares of land for palm-oil expansion.[137]

Yields in Indonesia are below those in Malaysia, with reported averages in the range of 2.8–3.5 tonnes per hectare[138] – 3.3 tonnes per hectare is assumed here. These increases in demand will therefore require the following expansion:[139]

Total additional area required	2.1m ha
For biodiesel	1.2m ha
To replace diverted domestic edible oils	0.9m ha

Over 50 per cent of new plantations in Indonesia are planned on tropical peatlands.[140] Although the proportion planned on forested land is unclear, historically, about half of plantations have been on deforested land.[141] It is therefore assumed that 50 per cent of this expansion occurs into peatland, and 50 per cent into rainforest (note that these are not mutually exclusive – there is likely to be significant overlap between both as tropical forest grows on peatland). This expansion will therefore lead to the destruction of the following areas:

	Rainforest	Peatland
For biodiesel	0.6m ha	0.6m ha
To replace diverted domestic edible oils	0.5m ha	0.5m ha
Total	1.1m ha	1.1m ha

Estimates for the resultant carbon debts are based on Fargione *et al.* (2008). These are 702 tonnes of CO_2 per hectare for rainforest, and 2,750 tonnes of CO_2 per hectare for peatlands (reflecting the continued annual emissions from peat oxidation). The total carbon debt arising is therefore:

Total carbon debt	3.6bn tonnes CO_2
For biodiesel	2.0bn tonnes CO_2
To replace diverted domestic edible oils	1.6bn tonnes CO_2

As per Fargione *et al.* (2008), this is allocated among the co-products of the oil palm with weightings based on 2007 average market values, resulting in an allocation of 87 per cent to palm oil.

The final carbon debt allocated to the palm oil is therefore 3.1bn tonnes of CO_2.

This assumes that 28 per cent of biodiesel demand is met through second-generation. However, the Joint Research Centre argues that second-generation biofuels 'will not make a significant contribution to supply by 2020'.[142]

Assuming that second-generation is not commercially available in time, and as under the same set of assumptions above, 61 per cent of the shortfall in diverted edible oils is met by Malaysian and Indonesian palm oil, the associated indirect land-use change effects increase the carbon debt to 4.6bn tonnes of CO_2.

Notes

[1] M. Ivanic and W. Martin (2008) 'Implications of Higher Global Food Prices for Poverty in Low-Income Countries', Policy Research Working Paper 4594, Washington DC: World Bank.

[2] A. Fraser and F. Mousseau (2008) 'The Time is Now: How World Leaders Should Respond to the Food Price Crisis', Oxfam Briefing Note.

[3] See for example Worldwatch Institute (2007) 'Biofuels for Transport'. Countries that have set or are setting mandates include Australia, Argentina, Brazil, Canada, China, Colombia, the EU, India, Japan, Malaysia, Indonesia, Philippines, Thailand, and the USA.

[4] Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources, 2008/0016 (COD), European Commission, Brussels, 23 January 2008.

[5] P.J. Crutzen, A.R. Mosier, K.A. Smith, and W. Winiwarter (2008) 'N2O release from agro-biofuel production negates global warming reduction by replacing fossil fuels', *Atmospheric Chemistry and Physics* 8(2): 389–95.

[6] W. Schlesinger (1997) *Biogeochemistry: An Analysis of Global Change*, San Diego: Academic Press, second edition, cited in J. Fargione *et al.* (2008).

[7] J. Fargione *et al.* (2008).

[8] To avoid average serious global warming of over 2°C above pre-industrial temperatures, a threshold at which some of the most extreme impacts of climate change are expected to begin, the Intergovernmental Panel on Climate Change (IPCC) has shown that global emissions must peak by 2015 and then fall by 50–85 per cent below 2000 levels.

[9] Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources, *op.cit*.

[10] D. Morton, R. S. DeFries, Y. E. Shimabukuro, L. O. Anderson, E. Arai, F. del Bon Espirito-Santo, R. Freitas, and J. Morisette (2006) 'Cropland expansion changes deforestation dynamics in the Southern Brazilian Amazon', *Proceedings of the National Academy of Sciences of the United States of America*, 103(39): 14637–41.

[11] T. Searchinger, R. Heimlich, R. A. Houghton, F. Dong, A.Elobeid, J. Fabiosa, S. Tokgoz, D. Hayes, and T.-H. Yu (2008) 'Use of US Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change', *Science* 319(5867): 1238–40.

[12] EU imports of palm oil more than doubled from 2000–2006, mostly to substitute for rapeseed oil diverted into fuel. See P. Thoenes (2006) 'Biofuels and Commodity Markets – Palm Oil Focus', FAO. The Commission's research body, the Joint Research Centre, identified palm oil as the principal replacement for diverted rapeseed oil. See JRC (2007). M. Jank *et al.* (2007) 'EU and US Policies on Biofuels: Potential Impacts on

Developing Countries', The German Marshall Fund of the United States, predicts imports of palm oil to more than double again by 2012 in order to substitute for diverted edible oils.

[13] The Joint Research Centre identifies about 26 per cent of EU biodiesel demand in 2020 coming from domestically produced edible oils diverted into biodiesel, and notes that these will have to be replaced by imports. Assuming total biodiesel consumption in 2020 of 20.6 billion litres, this suggests a 'hole' of 5.4 billion litres.

[14] JRC (2007).

[15] The actual figure is likely to be higher, as the Commission's estimates assume that nearly 28 per cent of biodiesel demand will be met by as yet commercially unavailable second-generation technologies. See Note 19. JRC (2007) estimates that without second-generation, EU biodiesel demand will account for nearly a fifth of global vegetable-oil production in 2020.

[16] Estimated 2007 imports of vegetable oils for the EU-27 were 9.1 million tonnes – equivalent to about 9.8 billion litres. See W. Schulz-Greve, 'EU potentials for biomass – will the targets be achieved?', presentation at Krafstoffe der Zukunft, Berlin, 26–27 November, 2007.

[17] V. Tauli-Corpuz and P. Tamang (2007).

[18] The European Commission predicts an annual emissions saving in 2020 of 68 million tonnes of CO_2. See 'Biofuels – relevant data and analysis', extracted from the annex to the impact assessment for the climate and energy package, European Commission, 2008.

[19] The Joint Research Centre of the European Commission concludes that '[second-generation biofuels] are still at the pilot plant stage and will not make a significant contribution to supply by 2020'. See JRC (2007). The OECD and FAO do not expect second-generation biofuels to be commercially available at any time before 2018. See 'OECD-FAO Agricultural Outlook 2008–2017', OECD and FAO, 2008.

[20] C. Costa (2007) 'Brazilian Perspectives on Biofuels', UNICA.

[21] 'Frequently Asked Questions About the Brazilian Sugarcane Industry', UNICA.

[22] Gonçalves (2007) cited in Wilkinson and Herrera (forthcoming). See also Friends of the Earth (2008) 'Sustainability as a Smokescreen', for a discussion of cattle and soy displacement in Brazil, and for further information on the damage sugarcane expansion has caused to the Cerrado and Atlantic Forest. 'Brazil disputes cost of sugar in the tank', the *Guardian*, 10 June 2008, reports that as a result of sugarcane expansion in São Paulo State, the price of land has soared so that one hectare of land there is the same price as 800 hectares in the Amazon, encouraging displacement of other agriculture northwards.

[23] Of the 12 principal areas in which sugarcane investments are taking place, Cardoso da Silva finds that seven have already been developed more than their legal limits allow, and only one has what is described as a reasonable state of formal conservation. More than a third of the area

identified for sugarcane was key to biodiversity. See Cardoso da Silva (2007) cited in Wilkinson and Herrera (forthcoming). This is not only a problem for sugarcane. For example, in São Paulo, if the law was adhered to, 3.7 million hectares planted with sugarcane, oranges, coffee, corn, etc. out of 18.9 million would return to natural reserves. See J.S. Gonçalves and E.P. Castanho Filho (2006) 'Obrigatoriedade da reserva legal e impactos na agropecuária paulista', *Informaçoes Econômicas*, SP, 36(9): 71–84.

[24] The Brazilian government and sugarcane industry have identified ethanol production with the Centre-South and North-West regions, arguing that there is no sugarcane produced in the Amazon, and that it is not appropriate to grow sugarcane there. But this is contested by many of the state governments in the north of the country, encircling the Amazon, which are seeking to attract ethanol investments. For example the state of Pará, to the east of Amazonas, is campaigning for investment. The state of Acre, to the south-west of Amazonas, has a mill producing 3 million tonnes of sugarcane. Roraima, to the north of Amazonas has two projects under consideration. Even in the state of Amazonas itself, the Governor defends ethanol investments to the extent that they are limited to 'degraded lands'. And in Figueiredo, 100 kilometres from Manaus in the heart of the Amazon, a sugarcane plantation operated by Coca Cola is testimony to the viability of sugarcane production in the Amazon. Meanwhile, new ethanol investment programmes are extending into the Centre-West region's Cerrado – a highly biodiverse savannah system to the north-west of São Paulo State; and into Mato Grosso do Sul, home to the Pantanal – the world's largest wetland and a massive carbon sink – although official policy is to prevent investments in the Pantanal itself. Taken from Wilkinson and Herrera (forthcoming). Also see 'Brazil disputes cost of sugar in the tank, the *Guardian*, 10 June 2008, in which it is claimed that 250,000 hectares of the Amazon are already being used for sugarcane.

[25] In the last five months of 2007, 3,235 square kilometres of rainforest disappeared. See BBC (2008) 'Brazil Amazon deforestation soars', 24 January, http://news.bbc.co.uk/1/hi/world/americas/7206165.stm

[26] R. Bailey (2007) 'Bio-fuelling Poverty: Why the EU Renewable-Fuel Target May be Disastrous for Poor People', Oxfam International Briefing Note.

[27] Figures from the social security administration reported in 'Brazil disputes cost of sugar in the tank', the *Guardian*, 10 June 2008.

[28] Amnesty reports that last year, 288 workers were rescued by the Ministry of Labour from six plantations in São Paulo State; 409 (including 150 indigenous) workers were rescued from a distillery in Mato Grosso do Sul; and a further 831 indigenous cutters were lodged in appalling conditions at another plantation in the same state. A further 1000 workers were released from conditions 'analogous to slavery' from a plantation in Pará State. See 'Amnesty International Report 2008: The State of the World's Human Rights', 2008.

[29] Kutas *et al.* 2007.

[30] See ‘UK Biomass Strategy 2007 Working Paper 1’, Department for Trade and Industry, 2007 for a comparison of the carbon abatement costs for different biomass energy applications.

[31] University of Leeds and the UK Motor Industry Research Association (2000) ‘External Vehicle Speed Control’, cited in European Federation for Transport and Environment (2005) ‘Road transport speed and climate change’.

[32] European Federation for Transport and Environment (2007) ‘Reducing car CO_2 emissions through the use of low rolling resistance tyres’.

[33] HM Treasury (2008) ‘The King Review of Low Carbon Cars’.

[34] If biofuels offered 100 per cent GHG savings, then a 10 per cent biofuel blend would provide a 10 per cent reduction in emissions on a per vehicle basis – one third of that available from improvements in vehicle efficiency.

[35] The role of the car industry, particularly of German manufacturers, in lobbying to have proposed fleet efficiency standards delayed and then watered down from 120g/km to 130g/km is well known. See for example European Federation for Transport and Environment (2008) ‘CO_2 Emissions from New Cars: position paper in response to the European Commission proposal’. In the context of attempts to force *them* to cut emissions from transport, car manufacturers promoted biofuels as an alternative requiring no action on their part – the motor industry was the best represented sector on the Commission’s Biofuels Research Advisory Council, the vision of which was an EU in which as much as 25 per cent of transport fuel needs are met by biofuels in 2030. See for example BIOFRAC (2007) ‘Biofuels in the European Union. A Vision for 2030 and Beyond’.

[36] European Federation for Transport and Environment (2008), *op.cit.*

[37] ‘Biofuels – relevant data and analysis’, extracted from the annex to the impact assessment for the climate and energy package, European Commission, 2008.

[38] For a discussion, see European Federation for Transport and Environment (2007) ‘Regulating CO2 emissions of new cars: response to the EU “Public consultation on the implementation of the renewed strategy to reduce CO2 emissions from passenger cars and light-commercial vehicles”’.

[39] See for example: www.washingtonpost.com/wp-dyn/content/article/2007/06/21/AR2007062101026_pf.html

[40] This is more than the USA currently imports from Iraq. See: www.35mpgby2020.com/the-facts.html

[41] Based on daily oil consumption for Ethiopia of 29,000 barrels, from the CIA World Factbook: https://www.cia.gov/library/publications/the-world-factbook/

[42] www.washingtonpost.com/wp-dyn/content/article/2007/06/21/AR2007062101026_pf.html

[43] Opinion of the EEA Scientific Committee on the environmental impacts of biofuel utilisation in the EU, 10 April 2008, www.eea.europa.eu/highlights/suspend-10-percent-biofuels-target-says-eeas-scientific-advisory-body

[44] LMC International (2006) 'A Strategic Assessment of the Impact of Biofuel Demand for Agricultural Commodities', cited in M. Kojima, D. Mitchell, and W. Ward (2007) 'Considering Trade Policies for Liquid Biofuels', Energy Sector Management and Assistance Program, World Bank.

[45] JRC (2007).

[46] R. Steenblik (2007) 'Biofuels – at what cost? Government support for ethanol and biodiesel in selected OECD countries', Geneva: Global Subsidies Initiative of the International Institute for Sustainable Development.

[47] IMF (2008) 'World Economic Outlook', April.

[48] D. Koplow (2007) 'Biofuels – at what cost? Government support for ethanol and biodiesel in the United States: 2007 update', Geneva: Global Subsidies Initiative of the International Institute for Sustainable Development, and Steenblik (2007).

[49] R. Steenblik (2007), *op.cit.*

[50] *Ibid.*

[51] The annual costs of adapting to climate change are estimated to be at least $50bn a year. See K. Raworth (2007) 'Financing Adaptation: Why the UN's Bali Climate Conference Must Mandate the Search for New Funds', Oxfam International.

[52] The Commission has recently indicated that it intends to eliminate the Energy Crop Scheme, which pays €45 per hectare subsidy to farmers for growing biofuels. However the Energy Crop Scheme currently makes up a tiny amount of total support for biofuels – less than 2 per cent of support for biodiesel and less than 1 per cent of support for ethanol. This will therefore have a negligible impact on support rates. See Kutas *et al*.

[53] C. Hebebrand and K. Laney (2007).

[54] Fertiliser run-off from the US corn-belt eventually finds its way via the Mississippi to the Gulf of Mexico, causing an oxygen-free 'dead zone' each summer in recent years, reaching 20,000 square kilometres in area. Recent analysis in *the Proceedings of the National Journal of Sciences* suggests new US targets will make it almost impossible to solve. See for example www.publicaffairs.ubc.ca/media/releases/2008/mr-08-025.html

[55] USDA Long-Term Projections to 2017, United States Department of Agriculture, February 2008.

[56] Similarly, conversion of Canada's corn crop to ethanol is expected to rise from 4 per cent of the total in 2006, to more than 13 per cent in 2008. According to government research, Canada would have to use 36 per cent of its farmland to produce enough biofuels to replace just 10 per cent of the fuel currently used for transport. Half of Canada's total corn-seeded area

and 11–12 per cent of the wheat-seeded area would have to be grown for ethanol for Canada to reach its domestic biofuel target of 5 per cent of national fuel consumption by 2010. See F. Forge (2007) 'Biofuels: an Energy, Environmental or Agriculutral Policy?', Library of Parliament, Science and Technology Division.

[57] In 2006, the USA is estimated to have spent $465m on federal grants, demonstration projects, and R&D for ethanol, out of a total support package of $5.1–6.8bn. See D. Koplow (2007), *op.cit.* In 2006, the EU spent €91m on biofuels R&D, out of total support of €3.7bn. See Kutas *et al.*

[58] The European Biofuel Technology Platform, heavily dominated by energy, car, and biotech companies, has proposed a biofuel target of 25 per cent by 2030.

[59] World Bank (2008) 'Rising Food Prices: Policy Options and World Bank Response'.

[60] M. Ivanic and W. Martin (2008), *op.cit.*

[61] Although consumption of meat and dairy products is increasing in emerging economies, there is still a long way to go before it reaches the level in rich countries. US Department of Agriculture statistics suggest for example that total foodgrain consumption of the average American is more than five times that of the average Indian and three times that of the average Chinese, and is increasing. See http://timesofindia.indiatimes.com/US_eats_5_times_more_than_India_per_capita/articleshow/3008449.cms

[62] The extent of the role of speculation in the food crisis remains contested. See for example: www.ft.com/cms/s/0/e299bd06-1fbc-11dd-9216-000077b07658.html

[63] IMF World Economic Outlook, April 2008.

[64] 'Rising Food Prices: Causes and Consequences', OECD, paper prepared for the DAC High Level Meeting, 20–21 May 2008.

[65] 'The World Food Situation: New Driving Forces and Required Actions', IFPRI, 2007.

[66] For IFPRI commentary, see www.guardian.co.uk/environment/2008/feb/26/food.unitednations. Also see IFPRI (2008) 'Biofuels and Grain Prices: Impacts and Policy Responses'. Simon Johnson, Chief Economist of the IMF, estimated that biofuels account for '20–30 per cent' of price rises on *The Today Programme*, BBC Radio 4, 14 April 2008. For FAO commentary, see: www.ft.com/cms/s/0/a503b8ce-131a-11dd-8d91-0000779fd2ac.html

[67] D. Mitchell (2008) 'A Note on Rising Food Prices', World Bank, cited in 'Soaring Food Prices: Facts, Perspectives, Impacts and Actions Required', FAO, 2008.

[68] IEA (2007) 'Renewables in Global Energy Supply, An IEA Fact Sheet'.

[69] For example, the Commission argues that 'the rise in prices of agricultural products should benefit farmers and rural communities, notably in

developing countries'. See 'Biofuels – relevant data and analysis', extracted from the annex to the impact assessment for the climate and energy package, European Commission, 2008.

[70] See for example M. Ivanic and W. Martin (2008), *op.cit.*

[71] *Ibid.*

[72] A. Fraser and F. Mousseau (2008), *op.cit.*

[73] Calculated as 30 per cent of the increase in poverty headcount and endangered livelihoods.

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[92] See for example: www.reporterbrasil.org.br/exibe.php?id=1310; www.community-hug.org/brazilnetdev/index.php?option=com_content&task=view&id=142&Itemid=793; http://earth2tech.com/2008/04/01/brencos-big-uh-oh-ethanol-workers-terrible-conditions/; http://www.thealarmclock.com/mt/archives/2008/04/brencos_brazil.html

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[101] Brazil is entering into numerous agreements with African nations on ethanol production, and its ethanol industry is investing heavily in the continent. Countries entering into agreements with Brazil or accepting foreign direct investment from Brazilian ethanol companies include Nigeria, Senegal, Ghana, Mozambique, and Angola. See for example: www.ecoworld.com/home/articles2.cfm?tid=389; www.scidev.net/en/news/brazil-and-india-join-senegal-for-biofuel-producti.html; www.thelocal.se/11536/20080504/; www.macauhub.com.mo/en/news.php?ID=4004; www.sarwatch.org/page.php?84

[102] R. Bailey (2007), *op.cit*.

[103] J. Goldemberg, T. Johansson, A. Reddy, and R. Williams (1998) *Energy for a Sustainable World*, Chichester: John Wiley and Sons.

[104] In the South of Brazil, a number of co-operatives involved in ethanol production challenge the dominant large-scale model. One of these is Cooperbio, which counts 20,000 farmers among its members and produces

ethanol through ten decentralised micro-distilleries for sale to the state oil company Petrobras. The co-operative has diversified production, also producing oilseeds for the national biodiesel programme, alongside food crops and livestock. See Wilkinson and Herrera (forthcoming).

[105] A. Keleman and H. García (2007) 'La Crisis de Maíz y la Tortilla en México: ¿Modelo o Coyuntura?', Oxfam GB, ANEC, and Procientec.

[106] On the basis of patent applications filed, the vast majority of R&D into second-generation biofuels is taking place in the industrialised world, most notably the USA. If and when these become available, many first-generation biofuels may be rendered less competitive, possibly reducing developing countries to exporters of feedstock such as wood chip. See JRC (2007).

[107] 'Sustainable Bioenergy: A Framework for Decision Makers', *ibid*.

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[112] *Ibid.*

[113] See for example: http://en.ce.cn/World/Asia-Pacific/200608/13/t20060813_8117046.shtml

[114] See 'Profil Bahan Bakar Nabati' in http://tkpkri.org/content/view/180/229/lang,id

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[116] Ministry of Finance Budget 2008. Also see Reuters 'Indonesia sees 2008 fuel subsidy bill rising', http://in.reuters.com/article/asiaCompanyAndMarkets/idINJKB00054020080218

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[120] See: http://renewenergy.wordpress.com/2008/01/17/indonesia-biodiesel-output-seen-doubling/

[121] See R. Mahabir (2008) 'Failed policies knock biodiesel production by 85 per cent', *Jakarta Post*, 24 January.

[122] Smallholder oil-palm farmers in the Agropalma outgrower scheme in Pará, North Brazil keep 2 hectares of their plots aside for other crops. See Wilkinson and Herrera (forthcoming), *op.cit.*

[123] S. Vermeulen and N. Goad (2006), *op.cit.*

[124] For example, South Africa and China have both placed a limit on the amount of corn that may be used in ethanol production.

[125] Article 11 of the 1966 International Covenant on Economic, Social and Cultural Rights.

[126] A. Dufey *et al.* (2007), *op.cit.*

[127] J. Wilkinson and S. Herrera (forthcoming), *op.cit*.

[128] E. Larson and S. Kartha (2000) 'Bioenergy Primer: Modernised Biomass Energy for Sustainable Development', United Nations Development Programme.

[129] *Ibid.*

[130] P. Thoenes, *op.cit.*

[131] P. Thoenes, *op.cit.*

[132] It is sometimes asserted that palm oil is unlikely to make up a significant part of European biodiesel, due to the fact that at cooler European temperatures palm-based biodiesel can solidify. However, the Malaysian Palm Oil Board has reportedly already licensed technology for making EU and US winter-specification-compliant palm-based biodiesel – see for example Kojima *et al.* (2007), *op.cit.* Greenpeace recently analysed biodiesel being sold in London on 3 April 2008 (a week during which London experienced snowfall) and found that it was based on 30 per cent palm oil. See: www.timesonline.co.uk/tol/news/environment/article3740163.ece

[133] P. Thoenes, *op.cit.*

[134] P. Thoenes, *op.cit.*

[135] This conservatively assumes perfect conversion ratios, which are not achieved in practice. See for example: www.biodieselexpertsintl.com/AboutBiodiesel/tabid/71/Default.aspx

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[137] 'How Unilever Palm Oil Suppliers are Burning up Borneo', Greenpeace, 2008.

[138] See for example M. Chandran (2006) 'Country Perspectives: Indonesia/Malaysia', presentation at the 75th IASC World Congress, San Francisco, 13–16 June – reports 3.3 tonnes per hectare; J. W. van Gelder (2004) 'Greasy Palms: European Buyers of Indonesian Palm Oil', Friends of the Earth – reports 3.2 tonnes per hectare; GAPKI (the Indonesian Palm Oil Association) reports 3.5 tonnes per hectare – cited in *Down To Earth* No. 63, 'Sustainable palm oil: mission impossible?', 2004; separate industry

correspondence reports average yields of 2.8 tonnes per hectare for Indonesia.

[139] Based on a density for palm oil of 0.93 kg per litre.

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This paper was written by Robert Bailey. Oxfam acknowledges the assistance of Sonja Vermeulen, Sophia Murphy, John Wilkinson, and Selena Herrera in its production. It is part of a series of papers written to inform public debate on development and humanitarian policy issues.

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