

# BIOFUELS, AGRICULTURE

## AND POVERTY REDUCTION<sup>1</sup>

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### 1. Introduction

Sweeping claims have been made about the role of biofuels in development and poverty reduction (see Peskett et al, 2007 for a review). For example, it has been argued that

- energy crops are beginning a green revolution in Brazil;
- a bioproduct-based agro-revolution can offer a new development paradigm;
- biofuels can provide a solution to the twin problems of poverty and climate change; and
- countries in the tropics have comparative advantage in biofuels production which can play a role in job creation and food security.

The development of biofuels has generated vigorous debate on economic and environmental grounds. Our attention here is on its potential impacts on poverty reduction. The potential is large, whether through employment, wider growth multipliers and energy price effects. But it is also fragile: it will be reduced where feedstock production tends to be large scale, or causes pressure on land access, and its success can be undermined by many of the same policy, regulatory or investment shortcomings as impede agriculture. Whilst some of the factors facilitating, and impacts of, biofuels can be tracked at global level, its distributional impacts are complex, and point to the need for country-by-country analysis of potential poverty impacts.

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But there is also scepticism. Researchers have recently questioned whether the net energy benefits of biofuels production may be negative for many crops because their energy outputs are less than the fossil energy inputs required to produce them. Others (see Peskett et al 2007) suggest that biofuels will be a 'pandora's box' and question whether large-scale biofuel production can be environmentally, socially and economically sustainable and efficient.

This paper does not consider the broader questions about biofuels and energy policy, nor their environmental implications, but is concerned mainly with their potential contribution to agricultural sector development and to rural growth and poverty reduction.

Biofuels are defined here as organic primary and/or secondary fuels derived from biomass which can be used for the generation of thermal energy by combustion or by other technology. They comprise both purpose-grown energy crops, as well as multipurpose plantations and by-products (residues and wastes) (FAO 2000). This paper focuses on two types of liquid biofuels produced from purpose-grown crops:

- Bioethanol is an alcohol derived from sugar or starch crops (e.g. sugar beet, sugar cane or corn) by fermentation. Ethanol can be used in

either neat form in specially designed engines, or blended with petroleum fuel.

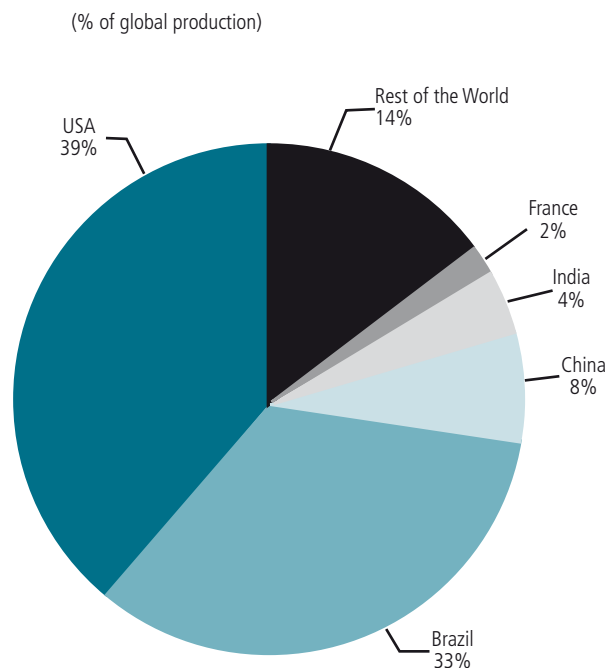
- Biodiesel is derived from vegetable oils (e.g. rapeseed oil, jatropha, soy or palm oil) by reaction of the oil with methanol. Biodiesel can either be burnt directly in diesel engines or blended with diesel derived from fossil fuels.

## 2. Trends in Production and Trade

Production of biofuels for domestic use and export is dominated by a few countries. Bioethanol, production of which began in the 1970s, is still produced in much larger volumes than biodiesel for which production started in the 1990s. The USA and Brazil are the largest producers of bioethanol by a large margin (Figure 1). The EU produces almost 95% of the world's biodiesel. Global production has increased gradually over time.

The largest increases in production volumes are expected in Brazil, the US, the EU, China, India, Indonesia and Malaysia, with annual global production of bioethanol projected to increase to 120 billion litres by 2020, and that of biodiesel to 12 billion litres (IEA 2004).

**FIGURE 1:** TOP FIVE ETHANOL PRODUCERS WORLDWIDE



Source: Based on figures from RFA 2007

By 2011 around 20% of Brazilian bioethanol production (5.2 million litres) will be exported, mainly to India and the USA. The most significant increases in biodiesel trade, from a much lower base, will probably be exports from Malaysia and Indonesia to the EU, which aims to reach a 10% blend of biofuels in transport fuel by 2020.

But new producers are coming on stream in Latin America, and Caribbean countries, where the EU sugar import reforms could reduce revenues by 40%, are seizing opportunities derived from biofuels trade to diversify their sugar industry. South East Asian countries such as the Philippines and Thailand have introduced aggressive policies for biofuels and begun production.

Predictions are particularly hazardous, given the rapid development of production and processing technology and effects of environment pricing, which may alter the commercial feasibility of transporting biofuels around the world. Together with rising oil prices, technological improvements may increase global demand for biofuel crops and for farmland, putting upward pressure on world prices for biofuels, food and feed. Broadly speaking, the effect of this would be to increase the incomes of producers (and countries that are in net surplus) and reduce those of consumers (and countries that are net importers).

- Between countries, therefore, there would tend to be a shift, for example, in favour of Argentina and Brazil and against much of Sub-Saharan Africa.
- Within countries there would tend to be a shift in favour of agricultural producers (largely in rural areas) and against consumers (including those in urban areas but also those living in rural areas but with limited ability to participate in agriculture as farmers or labourers) – even in countries that are net importers.

There would be parallel shifts in the cost of energy. These would be less visible: oil prices may simply rise more slowly than they would otherwise have done. Nonetheless, this will tend to benefit countries that are net energy importers and disfavour those net exporters and who do not participate in the biofuel trade (Peskett et al 2007, UN-Energy 2007).

If there are no artificial restrictions on trade the international distribution of production will be determined very broadly by the relative cost of production (including transport to market). This is because, in practice, markets are never perfect and commercial considerations are likely to favour one source of supply over another.

One effect will be that the supply of biofuels increases most in the countries with the lowest constraints on raising their total level of arable production. Few, if any, countries are likely to have limitless capacity (especially in the short to medium term) but the trade-offs between using factors of production either for biofuels or for food / feed will be smaller in some countries than in others. The cost of producing biofuels in the countries where the trade-offs are small will tend to be lower than in countries where they are high.

An increase in biofuel production in the EU, USA or other OECD states is particularly likely to result in substitution for food/feed production and so is likely to drive up global food/feed prices and, hence, increase the potential shock for developing country producers and consumers.

### 3. Poverty Impacts

It is difficult to generalise about the impacts of biofuels on poor people because of the differing effects of: different feedstocks/production systems; varying downstream (transportation) costs; existing (non-biofuel) crop production and processing patterns; and patterns of land holding.

Will biofuels expansion impede or improve poor people's access to land under different biofuels scenarios? With sugarcane, biofuel yields can be very high, reducing the pressure on land, but the economies of scale sought by producers and subsequent land concentration may reduce access by the poor to land. This is likely to be the case also with palm oil and, to a lesser degree, jatropha.

Notwithstanding the differences between different production systems, feedstocks, or historical patterns of agricultural production and poverty levels, the economics of biofuels production show us that in general:

- Economies of scale are important in biofuels production (though relatively less important in the production of feedstock than in the processing);
- In all current biofuels production systems, feedstock is the largest cost of production;
- Biofuels production can be complementary to other types of agricultural production and create linkages and multipliers; and
- Biofuels production requires a significant labour force.

## 4. Prospects for Expansion

The challenges related to on-farm and off-farm technical processes and policies are reviewed in Box 1. Those linked to international policies are reviewed in Box 2, which gives an example of the prospects for support under Kyoto.

In terms of adaptation challenges on-farm, economies of scale, especially in ethanol production, are likely to favour large-scale production systems. Adaptation on small farms will depend on outgrower schemes, or on the successful engagement of co-operatives and other producer organisations. In the case of off-farm, how far existing agro-industry will be able to transform to biofuels production, and what roles public and private investment may have, will be context-specific.

The arguments above illustrate how many different dimensions there are to analyse when seeking to understand the impact of biofuels expansion on agricultural growth and poverty. The net implications are difficult to identify, and meaningless unless contextualised – which we attempt to do on the basis of three typical cases in the concluding section. It is clear though that many of the problems that emerge from biofuels are not unique to biofuels but are challenges that have faced agricultural development policy for many decades. However, given the potential rate of increase of biofuels production, it is possible that the sub-sector may provide a new impetus and urgency to efforts to solve some old problems.

### MAJOR ADAPTATION CHALLENGES

#### On-farm

- Institutional structures: adapting to fit production models that allow economies of scale. Large-scale systems are often economically favoured, so smallholder farmers might need to organise into cooperatives and/or outgrower schemes to allow access to markets.
- Environmental impacts: increased/decreased soil fertility; water pollution; downstream effects such as the draining of wetlands.
- Technology: access to farm technology which helps increase yields (e.g. the Brazilian experience suggests that this can be achieved through the selection of better varieties and irrigation).
- Changes in land use affecting: access to land; effects of biofuels on cost of land which are currently poorly understood.
- Need for flexibility to changes in the prices of feedstocks and to changes in the prices of inputs.

#### Off-farm

- Employment patterns: employment patterns are expected to change as biofuel sectors grow. Much work in the biofuels sector is non-skilled, but requirements for skilled labour are likely to increase.
- Investment: biofuel processing and distribution infrastructure can require substan-

tial up front investment.

- Need for flexibility: converting current production systems into biofuels production systems (e.g. existing legacy of sugar processing plants in Caribbean countries could be a constraint); flexibility within processing plants is also a constraint (e.g. many Brazilian plants are designed to switch between sugar and ethanol production which allows adaptation to price changes).
- Adapting regulations: changing regulation to suit efficient production processes will be needed in some cases. (e.g. in some countries efficiency gains through co-generation is not an option because producers are not allowed to sell into the grid).

**Source:** Adapted from Peskett et al 2007

### IMPLICATIONS OF THE KYOTO PROTOCOL FOR BIOFUELS ADAPTATION

Because biofuels have the potential to reduce greenhouse gas emissions, the Kyoto Protocol's Clean Development Mechanism (CDM) offers potential for funding biofuels projects in developing countries. However, because of the complex rules, processes and politics of the CDM, access to the CDM by the Least Developed Countries is restricted, and smaller producers are bypassed in those countries. For example:

- Biomass projects (a common type of CDM project) are generally large in scale and related to grid-based power systems. Their geographical spread is also limited, with most projects in larger developing countries and few in Africa.
- Rules for land-use related projects in the CDM are restricted to include only afforestation, reforestation and certain biomass related processes (such as methane capture from biodegradation) while the EU Emissions Trading System (EU ETS), the largest functioning carbon market, does not currently accept land-use projects.
- Small farmers are less able to access the carbon market because they lack expertise in implementing complex methodologies, ex-post payment systems mean there is a lack of up front funding for projects and investors are less interested in smaller projects with high risks and long timescales. Small-scale methodologies with simpler requirements and processes for bundling projects have been developed to address some of these issues, but there is currently no small scale methodology for liquid biofuels, and only one large scale methodology based on use of waste cooking oil for biodiesel (CD4CDM 2007).
- Despite their potential for bringing sustainable development benefits (a core aim of the CDM) biofuel projects are less attractive to investors because of high abatement costs, difficulties in proving additionality for projects and difficulties in calculating reduced greenhouse gas emissions of projects (Bakker 2006).

Negotiations over the next phase of the Kyoto Protocol (post-2012) are considering options for programmatic approaches to the CDM, meaning that developing countries could benefit from finance from developed countries for putting in place biofuels policies. However, perverse incentives could arise, discouraging developing countries from putting in place legislation on biofuels because of rules over 'additionality' under the CDM.

There are alternative carbon markets outside of the Kyoto Protocol that show potential for supporting moves towards biofuels production in developing countries. These voluntary markets are smaller, but tend to focus on smaller projects aimed at reducing greenhouse gases and alleviating poverty. However, the quality of projects, in both environmental and social terms, can also be very variable, implying a need for more universal standards, an issue currently under consideration by the UK Department for Environment and Rural Affairs (Defra).

## 5. Starving the People to Feed Cars? Debates about Food Security and Biofuels

Whilst de Keyser and Hongo (2005) argue that biofuels production presents a win-win situation for developing countries by creating rural jobs, increasing incomes and thereby improving food security, there are also claims that biofuels will result in increased hunger as maize is diverted away from household food utilisation in developing countries to feed the cars of households in the developed world. In this regard, three critical questions must be explored:

### Will biofuels take land from food production?

Monbiot (2004) uses examples of the significant land requirements in the UK of a switch to biofuels. However, examples from parts of the developing world, where there are large areas of suitable land, and conditions for biomass production are up to five times as good as the UK (Johnson et al 2006) are more useful. Thus, de Keyser and Hongo (2005) estimate that in Tanzania around 300,000 ha out of a total of 4.6 million ha currently under crop, would be required to match current fuel imports. Koonin (2006) estimates that biofuels could supply 20-30 per cent of global fuel demand in an environmentally responsible manner without affecting food production. In many developing countries, efforts to increase land and labour productivity will be crucial if biofuels are to avoid competing with the use of land for food staples.

### What impact on food prices are likely?

In many developing countries, most poor people are net consumers of food – even on farms in rural areas. So, food prices are as important as food availability. At present, evidence that biofuels are leading to food price increases is only circumstantial. On the positive side, analysis of variation in world grain prices suggests that they have continued to decline in real terms (World Bank 2006), and, of the three main staples – rice, wheat and maize – only maize is currently used for ethanol production. More worrying but somewhat unrelated, global stocks of staples have declined as the major stockholders (USA, EU and China) have reduced their stocks, thereby making global prices more vulnerable to price shocks.

### How might biofuels production affect food aid from the USA?

The USA's cheap energy policy is coming under pressure from increased demand for fossil fuels from rapidly-growing economies (China, India).

One policy response has been to provide financial incentives for supplying 25% of United States' energy use from renewable resources by 2025. At the same time, US foreign aid is heavily dependent on US agricultural surplus production. Aid is used to manage surpluses and stocks and the farm bill continues to reflect these priorities. The result is a foreign aid programme in which food (either distributed or monetised) plays a major role. It is impossible to predict whether the use of maize for biofuels will result in a switch to monetary aid, and, if it does, whether this will result in more innovative and flexible approaches to aid programming – or simply in a decrease in overall levels of aid.

## 6. Environmental Impacts of Biofuels

In terms of effects on the agricultural frontier, if the cultivation of energy crops replaces intensive agriculture, impacts can range from neutral to positive; if it replaces natural ecosystems or displaces other crops into protected areas, the effects will be mostly negative.

In terms of energy balances, emissions and air quality, the evidence suggests wide variation in greenhouse gas (GHG) savings from biofuel use depending on feedstock, cultivation methods, conversion technologies, and energy efficiency assumptions. The greatest GHG reductions can be derived from sugarcane-based bioethanol and the forthcoming 'second generation' of biofuels such as lignocellulosic bioethanol and Fischer-Tropsch biodiesel. Maize-derived bioethanol, on the other hand, shows the worst GHG emission performance and, in some cases, the GHG emissions can be even higher than those related to fossil fuels. The use of fire to clear new land, in some cases for biofuels, is problematic in China, Indonesia and Brazil resulting in reduced air quality, and fossil fuels are often used to generate process heat in the production of biofuels.

Regarding soil and water management, the production of some biofuels (e.g. sugarcane) requires large volumes of water, which is problematic in semi-arid areas. In addition, processing of some feedstocks requires large volumes of water and tends to generate effluent. Perennials such as palmoil and jatropha are likely to have more benign impacts on soil quality (and lower levels of agrochemical requirement) than annuals such as maize.

The introduction and enforcement of appropriate technologies, regulations and standards can help to mitigate most of these problems, but will be slow to materialise where policy environments are weak.

## 7. Drawing together the arguments

This analysis of the impacts of biofuels expansion on agricultural growth and poverty reduction has highlighted many uncertainties about what will happen to global markets and prices, and the opportunities that this may offer for poverty reduction. Overall, it is very difficult to distil net recommendations from biofuels research that will be appropriate for different countries. We agree with Kojima and Johnson’s (2005) assessment that:

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**Biofuels should be integrated within a broader context of investment in rural infrastructure and human capital formation. Low-income countries should assess whether the underlying conditions for a successful biofuel programme exist or could be developed in the near-term, including infrastructure and essential public services (2005: 3)**

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The three scenarios presented below generate lessons and more specific country level policy recommendations.

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### **Scenario 1: Biofuels production in a net energy-importing country - Malawi**

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Whilst maize production accounts for a massive proportion of total agricultural production in Malawi, prospects for ethanol production from maize for export are limited. Transportation costs would be particularly high. At present, options for smallholder farmers to engage in jatropha production appear very limited. There has been some expansion of biodiesel production but mainly among former tobacco growers through outgrower schemes.

In policy terms, making biofuels work for poor people in Malawi would require:

- improved market coordination;
- investments in transport infrastructure;
- decentralised processing capabilities;
- improved storage to reduced the seasonality of employment in biofuels.

None of these challenges are unique to biofuels but are ones which donors and the Government of Malawi have been grappling with for some time. Whether opportunities in biofuels will enable further progress to be made is not clear. A focus on non-staple food feedstocks will lessen the impact on staple food prices in Malawi. Other small, poor and landlocked countries that are currently heavily dependent on a poorly-performing smallholder agriculture sector are likely to require similar policies.

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### **Scenario 2: Biodiesel production in Indonesia for EU consumption**

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Increasing openness in oil palm fruit markets in recent years has allowed direct sales to mills by smallholders and stimulated growth in the smallholder sector. However, different types of smallholders are likely to win or lose in different ways. Some independent growers, mainly former plantation staff or wealthier local entrepreneurs, have increased market share through high yielding varieties but others still struggle to access markets. Palm oil price increases in the short term are likely to benefit smallholders, but this may not be sustained given increased competition with prices of soy oil and palm oil grown in other areas (e.g. West Africa, South America). Countries likely to have similar experiences include Malaysia, Philippines and Nigeria. Biodiesel production is raising the risk of conflict between those having commercial and customary land rights.

In policy terms, making biofuels work for poor people in Indonesia would require:

- a continued focus on biodiesel which requires fewer economies of scale, can draw on existing transportation systems and uses familiar crops;
- decentralised milling to reduce producer transportation costs in remote areas;
- improved land tenure for smallholders to avoid potential conflicts;
- support to small farmers – for example quotas for mills that encourage them to buy from smallholders.

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### **Scenario 3: Domestic and export ethanol production in Brazil**

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Ethanol production from sugarcane has created many jobs in Brazil, and had wider agricultural sector multipliers. However, predominantly migrant labour is employed and low skilled jobs dominate the industry. Increasing economies of scale and land concentration have limited the benefits of ethanol production for small land owners. Countries likely to have similar experiences include South Africa and parts of Latin America.

In policy terms, improving the benefits of biofuels for small farmers would require:

- continued investment in biodiesel which, on the whole, is more pro-poor than ethanol production, does not depend so much on economies of scale, has lower transportation costs and is already a small-holder activity;
- continued pro-smallholder policies – for example quotas for procurement of feedstock from family farms.

## 8. Knowledge Gaps and Conclusions

The development of biofuels has potentially important roles to play in poverty reduction – through employment effects, wider growth multipliers and energy price effects. There are risks that some of this potential may be lost as economies of large scale operation kick in, especially with bioethanol, and as pressure is increased on land access in some settings.

Global environmental incentives to small scale producers remain slight. The distributional effects of biofuel development are crucial – between producers and consumers, and between food/feed/energy deficit and surplus countries. The impacts of biofuels on aid flows from OECD countries – whether financial or as food – remain difficult to predict. There are some important global level knowledge gaps – for example biofuel and food staples prices and stocks need to be tracked, and this data fed into early warning systems for food security; mechanisms need to be identified by which climate change mitigation funds might be used to support ‘clean’ biofuels production processing; and how WTO negotiations might affect biofuels markets and developing countries needs to be identified. On the whole, however, the types of question outlined in this paper concerning poverty impacts can only be addressed at country level. Without this it will not be possible to identify patterns of appropriate feedstocks, production systems, processing and marketing opportunities, and government roles that will maximise the impacts that biofuel production could have on rural livelihoods and poverty. Donors have significant roles to play at both global and national level with technical and policy support.

### POLICY CONCLUSIONS

Of high importance, but unlikely to be achieved in the short term:

- OECD countries need to reduce agricultural support regimes for biofuels to avoid penalising developing countries who already have restricted access to OECD markets.
- Developing countries need to address the same critical policy, regulatory and public investment constraints as affect agricultural production.
- Efforts are needed to make staples markets work better to enable switching between the main staples (maize, rice and wheat) as more maize is used for biofuels production.

Much of the requirement for policy improvement is at country level, and whilst highly context-specific, each context is likely to include several of the following:

- Investment in improved land administration systems to deal with conflicting claims emerging under biofuels expansion.
- Improved market coordination.
- Priority investment for biodiesel which, in many contexts, generates more labour, has lower transportation costs and simpler technology.
- On plantations and in processing mills, identification of additional non-seasonal sources of work to avoid highly seasonal employment in biofuels.
- Improving storage infrastructure (especially in ethanol feedstocks) to lengthen the processing season.
- Investing in feedstocks compatible with existing domestic production patterns to keep down costs of processing.
- Striking a balance in processing capabilities between large, centralised units capturing economies of scale and smaller, decentralised units, impacts strongly on rural employment, incomes and economic diversification.
- In food insecure countries/regions, focus biofuels investment on non-staple food crops.
- Provide support for small farmers to increase productivity to cope with downward pressure on biofuels producer prices – for example through improved varieties – and set quotas for procurement from them.
- Depending on context, invest in biofuels feedstocks with higher yields that result in less competition over land; in those that can be cultivated on marginal lands and have net benefits for soil rehabilitation; and/or in those that generate the best multipliers with the wider agricultural and rural economy.
- Ensure enforcement of regulations, standards and appropriate technologies to improve the contribution of biofuels production to climate change mitigation.

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