Overseas Development Institute

Report to the Renewable Fuels Agency

Review of the indirect effects of biofuels:

Economic benefits and food insecurity

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26 June 2008

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Acknowledgements

Thanks to John Farrington for advice and commenting on an earlier draft of this report. Martin Banse at LEI, Den Haag, Netherlands helped by sharing their database with us.

The team has also benefitted from feedback at presentations of the findings.

Abbreviations

CEPII	Centre d'Études Prospectives et d'Information Internationales
CGE	Computable Generable Equilibrium
EIA	Energy Information Administration, US
FAPRI	Food and Agricultural Policy Research Institute, Iowa State U. & U. Missouri-Columbia
GDP	Gross Domestic Product
GTAP	Global Trade Analysis Project
ha	hectare
IEA	International Energy Agency
IFPRI	International Food Policy Research Institute
IIASA	International Institute for Applied Systems Analysis
INR	Indian Rupee
IRR	Internal Rate of Return
LEI	Netherlands Institute for Agricultural Economics, Den Haag
M	million
NPV	Net Present Value
RSPO	Roundtable on Sustainable Palm Oil
USDA	United States Department of Agriculture

Summary

What are the indirect effects of expanding the production of biofuels on the poor in developing countries? Will their nutrition suffer and their poverty deepen as land and other factors of production are diverted from food to growing feedstock, and agricultural prices are driven up? Or will they gain from the opportunity to grow feedstock and otherwise find jobs in the biofuels supply chains?

This paper has been prepared at short notice. For the most part, the findings are based on reviewing the existing literature, a literature that proved to be more abundant than first imagined. But it was possible to carry out some original analysis, ranging from simple calculations to running a full-blown computable general equilibrium model modified to accommodate biofuels questions. The combination of methods provides a generally consistent story.

Economically, there is for the most part little to be said in favour of expanding production of biofuels. The poor of the developing world will be harmed, even if that harm is limited. There are, however, for some countries with abundant land the opportunity to benefit from biofuels and those are worth having. But for much of the developing world, biofuels imply net losses.

If the argument for biofuels is to be made, it will have to be on grounds other than economic.

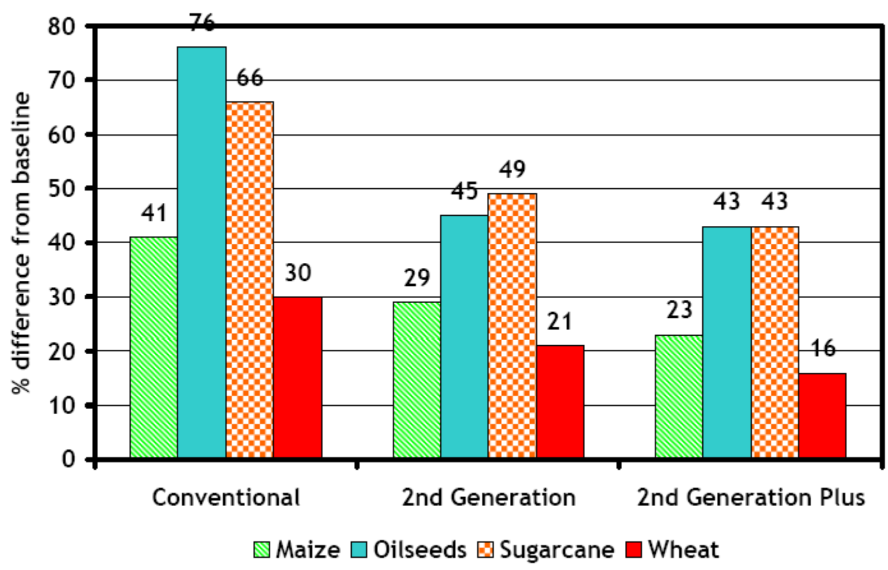
The study addresses a series of questions on impacts on world and local prices, consequences for consumers, national economies and the opportunities for local producers. Here are the main findings summarised.

How will expansion of biofuel production affect prices on the world market?

Existing studies of the effects of expanded production of biofuels on world prices of agricultural commodities can be divided into those based on partial equilibrium models, and those derived from general equilibrium.

Almost all of the former studies generate substantial price impacts for crops that are either biofuel feedstocks or close substitutes for them. Typical of these studies are the projections derived by IFPRI, see Figure S1. Even in the best of circumstances the prices of important foods could rise by between 16% and 43%.

Figure S1: Changes in commodity prices in response to biofuels expansion expected in 2020



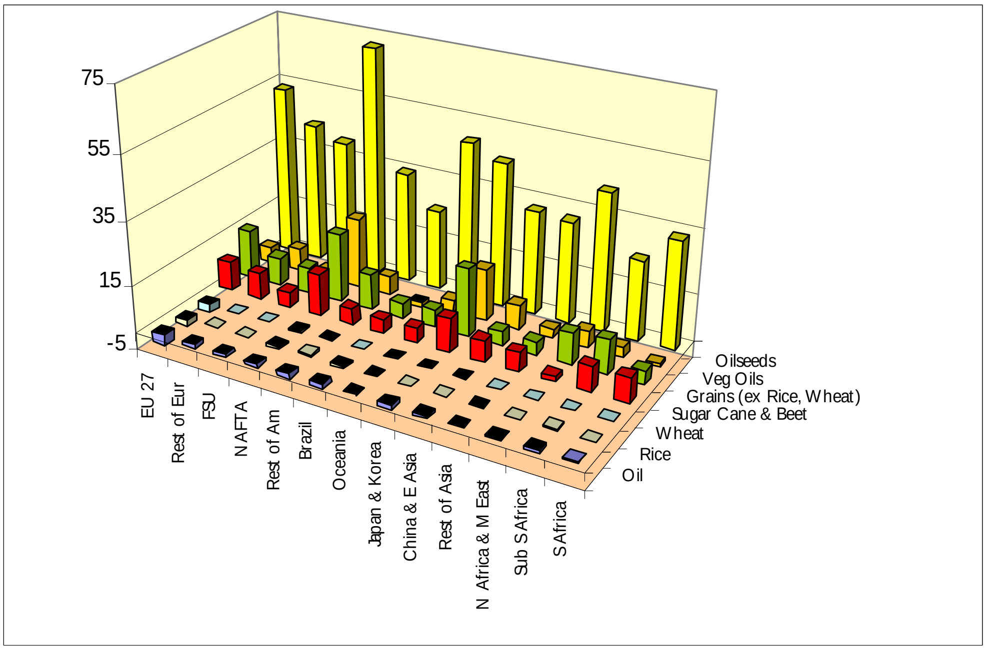
Source: IMPACT projections

Note: Conventional: rapid growth in demand for biofuels, no change in crop productivity; 2nd generation assumes that by 2015 cellulose conversion technology is economically viable; 2nd gen+ adds improvements to crop productivity.

General equilibrium gives a different picture: here the impacts on most crops, other than maize, oilseeds, vegetable oils, and sugar, are muted — with price rises rarely of more than 5%. Price rises for potential feedstock crops such as oilseeds, maize and sugar cane are much higher, up to 72% in one region, but generally lower than the IFPRI projections. Figure S2 shows the projected increases assuming that the EU and North America replace 10% of their vehicle fuels by biofuels.

The two approaches generate different degrees of price change since they assume different degrees of adjustment. The general equilibrium models allow for almost complete adjustment throughout the economy to the initial stimulus, and hence while patterns of production, consumption and trade may change substantially, price effects are often quite small. Partial equilibrium models allow less adjustment of production and consumption, especially across sectors of the economy, with the result that prices bear the weight of adjustment and thus move considerably more.

Figure S2: Changing prices from biofuel expansion, general equilibrium view



Source: modelling by McDonald & Levy using an extension of GTAP, export prices

General equilibrium results are probably a better reflection of what can happen in the medium term, and especially when markets work reasonably well. Partial equilibrium models give an indication of short run responses, and especially if imperfections and friction prevent adjustment.

Studies from both approaches agree on the direction of price movements likely if biofuels production is expanded — upwards, that the effects will be strongest on potential feedstock crops, and — that rice, one of the world's major grains — will be little affected.

From world to local prices: how do international price changes affect domestic prices?

Transmission of prices from international to domestic prices can be affected by border measures, transport costs, and the varying importance of commodity prices in the retail prices of foods. Given the number of variables, many of them specific to circumstances, it is difficult to generalise.

There will however be some muting of international price changes, especially for import parity prices — those that matter for consumers.

How will price rises induced by biofuels affect consumers in the developing world?

Consumers clearly suffer if food prices rise. From the simple and partial studies that have been carried out, the poor suffer more than the rich since they spend more of their income on food, see higher losses of real incomes to rising food prices, and may have to cut their consumption of food.

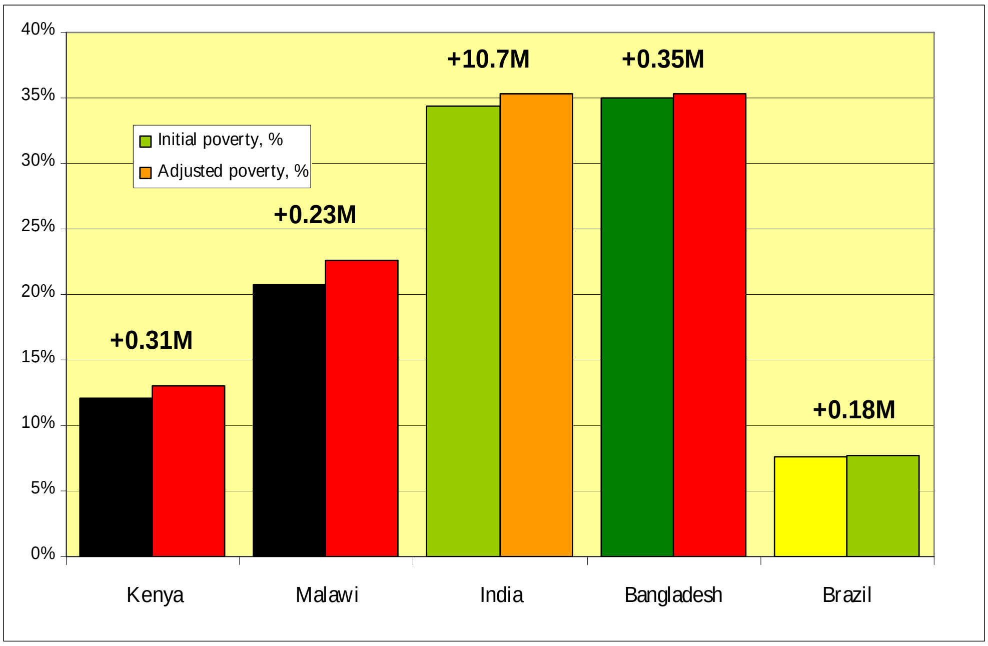
The effects, however, are not necessarily that large. Ivanic & Martin, looking at effects on households living close to the poverty line, show that a 10% rise in food prices across the main categories of food would raise poverty in a sample of nine developing countries by just 0.4 percentage points. Even in the worst affected country, Nicaragua, the increase in poverty was 2 percentage points. Urban households are more affected than rural.

Moreover, given that some of the largest countries with most malnourished persons in them, such as India, have rice as a staple and the PE models and the GE are united in predicting virtually no effect of biofuels on rice prices, then the impact on many of the world's poor will be small.

This impression was confirmed by a simple analysis of the effect of the projected price increases on the cost of food, the implied reduction of real income, and the resulting changes to poverty headcounts in five selected developing countries. Food bills increase by small amounts, at most 2%, with much lower impacts in countries where rice is the main staple.

As Figure S3 shows, poverty headcounts rise in all cases, although always by less than one percentage point. The increase in numbers in poverty as a result in most cases is a few tens of thousands. In India it is more than 10 million, a large number in absolute terms, but small relative to the population of over 1 billion.

Figure S3: Impact of projected price rises on poverty in selected developing countries



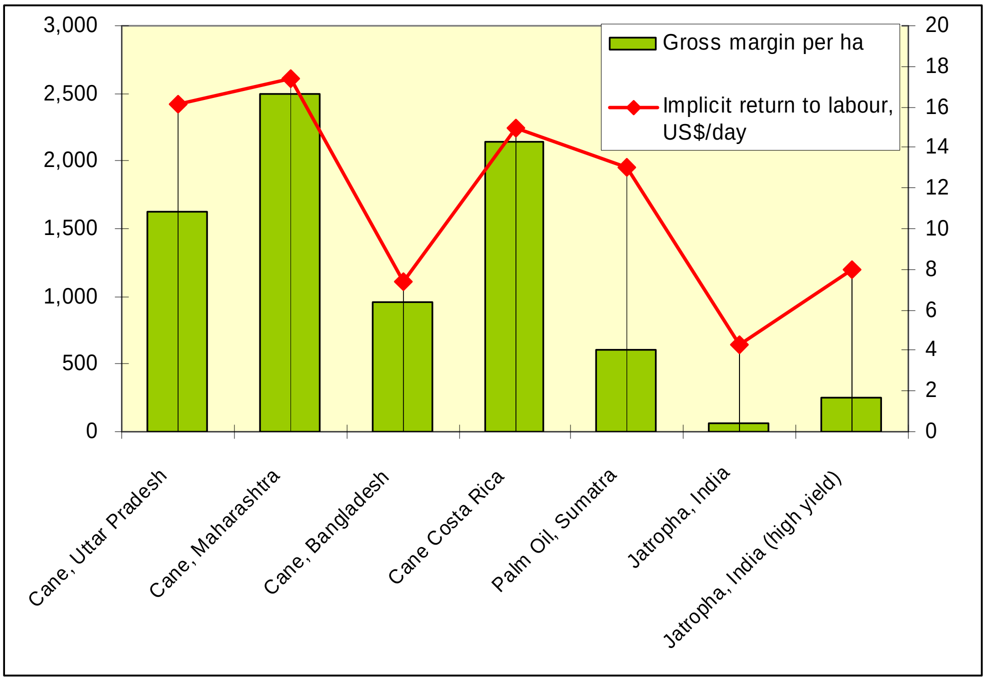
Source: own calculations with aid of FAO data on food budgets and the World Bank's PovCal

The impacts are unwelcome, but small: small enough to be countered by social protection measures.

What is the potential for the poor to earn more by producing biofuels?

Given few existing studies, the analysis is based on gross margins for smallholders growing three potential feedstocks: sugar cane for ethanol; palm oil and jatropha for biodiesel. The results are summarised in Figure S4.

Figure S4: Gross margins, returns to labour in biofuel feedstock production



Sources: Diverse — see relevant Chapter for details

Growing sugar cane for ethanol potentially gives excellent returns. In countries with spare land suitable for cane, there may be great opportunities for the poor either as small farmers, labourers on the fields or downstream in processing.

Oil palm similarly gives attractive returns, but it may be that the parity price for oil palm for biofuel is below the price offered for other uses in industry. Either way, it is no surprise that oil palm is such a boom crop. Opportunities for smallholders are limited by the fairly demanding requirement for rainfall or irrigation.

Jatropha, sometimes seen as an ideal feedstock since it can grow on marginal land and so does not compete with food crops, shows more marginal returns. Much depends on the yields obtained, and experience so far has been that yields achieved in practice have been below those expected. It is difficult to see how this crop will be of much benefit to the poor, although in some niches it may have a role — possibly in serving local energy needs.

The general equilibrium modelling provides some support to the existence of opportunities, since returns to unskilled labour rise slightly in some parts of the developing world.

In getting the poor to benefit, much depends on getting the biofuel system up and running, implying large-scale investments in processing, collection and distribution networks, and vehicle adaptations. Governments need to establish consistent and coherent policy and establish a framework of regulations

A key challenge is to link the big investors to small rural producers, with contract farming very much indicated. It is similarly important that biofuel initiatives be sensitive to conditions of local level governance: rights to land, crops and trees, especially for females; and that they take into account the views of local stakeholders. Enthusiastic promotion of biofuels can lose sight of the wider system and the views of key players within it. Above all, learning will be needed: it is very difficult to design functioning schemes as a blueprint.

What may be the social impacts of biofuels?

There are enough recorded cases of the poor being evicted from their land to make way to feedstock plantations, and of poor treatment of workers on plantations of oil palm and other feedstock, to merit concern. There is, however, nothing special about biofuels in this regard: the same ills arise in the same countries for most other crops or economic opportunities. Where the rights of the poor are neither respected nor protected, where social cohesion is low and unscrupulous behaviour tolerated, such abuses are frequent.

That does not mean to say that those promoting biofuels, in those circumstances where they make sense, can ignore the social consequences, if only on the grounds that there is nothing that they can do to prevent abuse. On the contrary, there is scope for remedial action at several levels — from working with civil society to protect the oppressed, putting pressure on indifferent governments to protect their citizens, and working with responsible private enterprise to bring in codes and standards. All these can make a difference.

How will the economies of low income countries be affected by biofuels?

The main effect will be through increased import bills for foods whose prices have risen from the expansion of biofuels. The rising cost of food imports in turn amounts to a withdrawal from the economy and will reduce gross national income. For most countries the effects would be small, less than 1% even if the overall price rise were as much as 10%: but there are some low-income food deficit countries that could see falls of more than 1%, including Armenia, Côte d'Ivoire, Egypt, Eritrea, Ghana, Guinea, Haiti, Honduras, Lesotho, Malawi, Mongolia, Senegal and Uganda.

The general equilibrium model shows that overall effects on economies in the developing world are also small: Sub-Saharan Africa would be the worst affected region in the developing world, with reductions of gross domestic absorption of up to 0.3%.

The surveys of four countries complement the answers to questions by theme, see Table S1. The potential to produce biofuels depends overwhelmingly on the existence of under-used arable land — and of good quality as well: the idea that jatropha will allow much production from marginal lands is exaggerated. Poor consumers could lose from biofuels, but much depends on how strongly international prices transmit to local markets. Impacts on economies as whole are minor for the larger economies, but can have some significance for small and poor economies, such as that of Malawi.

Table S1: Key findings from the country cases

	Bangladesh	Brazil	India	Malawi
Potential to produce biofuels	Minimal: densely settled country with most arable land already in production	High: abundant land makes possible doubling ethanol output and establishing major production of biodiesel	Modest: limited to molasses from cane, and perhaps jatropha on marginal land	Quite high: scope to produce ethanol to cover half petrol imports; possible production biodiesel from jatropha on marginal land
Impact of higher world prices for food on:				
(a) Poor consumers	Any rise in food prices a major threat to the many poor and hungry, potentially reversing the gains of the green revolution	Little evidence that biofuel industry has contributed to poverty and hunger	Large numbers of poor and hungry who could be threatened by higher food prices, but transmission from international to Indian markets is muted	Highly vulnerable to rising food prices, but limited transmission of international prices owing to land-locking
(b) Economy	Macro-economic effects significant but not that large	Limited food imports, only a slight effect on national economy	For a large economy, international food prices have little effect	10% higher food prices could depress economy by as much as 1.9%

Drawing out the principal conclusions

Summarising still further, the main findings can be reduced to four points, as follows.

1. As far as the impact that biofuel expansion will have on prices is concerned, different models can produce considerably different projections — not surprising, forecasting is an inexact science. General equilibrium (GE) models, perhaps a more reliable guide to the medium term than partial equilibrium, see quite minor impacts on the prices of most commodities other than oilseeds and maize. But no one argues that the direction of prices is anything but up. And all agree that feedstocks— maize, wheat, oilseeds, oil palm, sugar — are likely to rise in price, and that conversely crops such as rice will see little impact.

2. Price rises hurt the poor, the urban poor more than the rural, net food buyers more than those farmers who are net sellers. But even for the poor, the effects are not necessarily that strong. A 10% rise in all food prices might overall raise poverty by 0.4% percentage points — not welcome, but hardly disastrous. If we take the GE predictions, then effects will be lot less than 0.4% points — which is why the GE model shows such tiny effects on the welfare of developing countries.

3. Moreover, in rice-eating countries, there will be next to no impact on poor consumers, since no model has rice prices rising by more than a few tenths of one per cent. This matters: most of the poor in Asia, the bulk of the world's poor, eat rice more than any other staple. Similar comments would apply as well to those whose diet is centred on roots and tubers, as applies in the Andes and West Africa.

4. There is some potential for the poor to benefit from biofuels production where land is relatively abundant, and especially where oil imports are costly. This mainly means parts of Latin America, Africa, and SE Asia. By and large, not much is being done to

realise this potential. The changes needed are sufficiently complex that it will tend to be only those developing countries with some capacity to innovate and invest, and with social cohesion, that can seize the opportunities. It is easy to imagine this for Costa Rica or Thailand, less so for Malawi: but it is precisely in Malawi that the potential could be most valuable.

Final reflections:

Biofuels may just be a good thing for some developing countries and their poor, especially those that have (a) abundant land, (b) social cohesion, some sense of equity, and (c) entrepreneurship and nous. The countries that fulfil these criteria do not make a long list; but where these apply — or could apply in the near future — it makes sense to develop the possibilities.

But for most of the developing world, expanding biofuels production does not make sense. The harm to the poor of the developing world may be limited, especially where people eat crops that do not make good feedstock for biofuel, but nevertheless at the margin people will suffer. Their numbers may be sufficiently small for it to be possible for those gaining in each country to compensate them, but are there enough gaining, and would they be inclined to compensate those losing out?

In the time available for this study it was not possible to develop scenarios of the number of smallholders who might have suitable land to plant to sugar cane, oil palm and other similar feedstock that appear to offer good returns. Further work on this would be valuable.

The results of general equilibrium modelling presented here are crystal clear in one respect: the biofuels mandates for the EU and the North America make little or no economic sense — but at least the major losers are the citizens of those countries who voted in the mandate-makers.

On this evidence, there is little to be said in terms of market economics for expanding biofuel production in the EU and North America. If the promotion of biofuels is to be justified, it can only be on the longer term prospect of reducing greenhouse gas emissions.

1. Introduction

1.1 Terms of reference and scope of study

The original terms of reference for this study were:

> The DFID managed study of the economic benefits and food insecurity concerns of increasing demand for land for biofuels will:
> - Review recent changes in and drivers of food commodity prices. Consider how anticipated future changes are likely to impact upon prices to 2020.
> - Examine the drivers of food insecurity and identify vulnerable groups
> - Review the economic benefits of increased biofuel production in the South

Expanding these, the working hypotheses are that the impact of expanded production of biofuels would have the following effects on the poor and nearly poor in developing countries:

- Production of feedstock for biofuel competes for factors of production, including land, with the rest of agriculture, and thereby raises costs of production and prices of agricultural output including food;
- Increased prices of food and other agricultural output on world markets transmit to local markets in developing countries, albeit imperfectly, raising local prices;
- Households that buy in food will experience reduced real incomes and are expected to reduce their spending on food, and the composition of their remaining food budget. For the poor, this may mean cutting nutritional intake; and,
- Households with access to land may see new or enhanced opportunities to produce for the market, selling extra amounts of food, biofuel feedstock or other agricultural produce. Their incomes should rise. Through links in production — supply of inputs and processing and marketing of outputs — and consumption, additional jobs and incomes should be created.

There will also be more generalised economic impacts at national level. Higher costs of food in the world market will drive up the import bills of some low income countries that currently import food. The effect will be to raise domestic prices and deflate demand, as the cost of food rises and consumers have less to spend on other goods and services. As factors of production are switched to agriculture, other activities may be curtailed with loss of output, jobs and incomes.

Politically and socially the changes may see increased competition for resources: the poor with tenuous rights to land may be denied access to, or displaced from, land that underpins their livelihoods.

All the above effects would be expected to vary by region and country.

1.2 Approach and methods

With limited time to carry out this study, much of the work has necessarily been one of reviewing literature and bringing together the insights from existing studies.

The main exception to this has been the modelling of the likely impacts of expanded biofuels production on world market prices of key agricultural commodities.

The approach adopted has been to look at each step in the causal chain from increased production of biofuels to world market prices to local prices and to localised effects. In addition to this work, four country case studies were carried out so as to understand better what might be the implications in specific settings. These countries were chosen to reflect a range of circumstances, as follows:

- Bangladesh — With a large population with high rates of poverty and malnutrition, Bangladesh represents a good case to test the proposition that biofuels could reverse the gains of the green revolution in helping drive down food prices. With little spare land, there seems little possibility that the country could benefit from producing biofuels.
- Brazil — Brazil has had a large-scale ethanol programme in place since the 1970s, and has ambitious plans to expand production of both ethanol and biodiesel taking advantage of abundant land and know-how in both in farming and processing.

  But questions remain of the environmental impacts of biofuels in Brazil —not strictly the subject of this study — and about the benefits to the poor in Brazil.
- India — No country has more hungry persons than India: how vulnerable are they to international price rises? An energy importer, there are plans for biofuels production including by planting of jatropha on degraded and marginal lands, and using the molasses from India's very large sugar cane industry to distil ethanol.
- Malawi — A small, landlocked country with very high rates of poverty and malnutrition, food security is critical in Malawi. It is also a net energy importer. Although considered to have little spare land for biofuels, Malawi has since the 1980s been producing ethanol from molasses.

1.3 Scenarios and working assumptions

The overall study of the indirect effects of biofuels, of which this paper forms part, is based around four scenarios for the year 2020, as follows:

1. *Volume based targets* that the different regions may be likely to put in place by 2020 and how these targets might be met if there were *no second generation (2G) biofuels/feedstocks*.
2. *Volume based targets* that the different regions may put in place by 2020 and how these targets might be met if *2G biofuels/feedstocks are available*.
3. *GHG based targets* (of 10% reduction in emissions from transport fuel to come from biofuels, for *each* region) and how these targets might be met if there were *no 2G biofuels/feedstocks.*
4. *GHG based targets* (of 10% reduction in emissions from transport fuel to come from biofuels, for *each* region) and how these targets might be met if *2G biofuels/feedstocks are available*.

These scenarios have then been used to derive demands for different quantities of biofuel feedstock with associated implications for land use; on the basis of the yields of feedstock and the likely availability and suitability of land to grow feedstock in different regions.

It was not possible to follow the same scenarios in this analysis, since a key tool used is a computable generable equilibrium (CGE) model that has a slightly different regional disaggregation to that used to develop the above scenarios. Moreover, it was not prudent to use the model to reach biofuels targets of more than 10% replacement of transport fuels since the data and specification of the model only produce reliable results within modest adjustments to the current situation.

The model looks at the impacts of the EU and North America mandating that 5%, 7% and 10% of vehicle fuels come from biofuels. The 10% level is not that far from that implied by the first two scenarios, as Table 1.1 shows. That main difference is that the model does not include increased production plans in other parts of the world — although, by the nature of the model, this does not mean that other parts are unaffected, since the model allows them to produce biofuels and feedstock for export to the EU and North America.

Table 1.1: Scenarios compared

	Scenarios 1 & 2, volume targets for 2020			
Region in scenario	Policy target - bioethanol in gasoline - 2020 %	Policy target - biodiesel in diesel - 2020 %	Combined % %	CGE Model
OECD North America	15.2%	4.0%	12.6%	10%
OECD Europe	15.1%	10.8%	12.4%	10%
OECD Pacific	10.0%	5.0%	8.1%	Current
Transition economies	0.0%	0.0%	0.0%	Current
China	9.5%	3.0%	6.9%	Current
Other Asia	7.0%	9.0%	8.0%	Current
India	10.0%	8.0%	8.8%	Current
Middle East	0.0%	0.0%	0.0%	Current
Latin America	35.0%	5.0%	20.7%	Current
Africa	2.5%	1.5%	2.2%	Current

NB: Scenarios 3 and 4, based on cutting gas emissions, generate volume targets equivalent to 15% to 16% for all regions.

Hence the modelling this report examines a scenario that has less impact than the full scenarios would have, and hence understates those impacts, albeit not by much.

A key assumption made in this study is that of most other things being unchanged so as to be able to tease out the effects of biofuels from other changes likely to take place. Hence, the current soaring prices for food and other agricultural commodities on world markets have to be ignored on the grounds that they are not expected to apply in the medium term. They do however provide a window into the effects that higher food prices have on consumers.

2. How will expansion of biofuel production affect prices on the world market?

2.1 Literature review

Increasing use of agricultural products as feedstock for biofuel generation is expected to raise the prices of agricultural products on global markets. Demand for feedstock should push up directly the prices of oilseeds, grains and sugar, thereby increasing their production. Indirectly through competition for factors of production including land, this would then cause increases in the prices of other agricultural products.

Broadly speaking, studies of the impact of expanded biofuel production on prices of agricultural produce fall into two camps. One includes the analyses derived from partial equilibrium models of agricultural markets; the other set of studies use general equilibrium approaches. The two sets of studies produce different conclusions, so it is important to state why they do so.[1]

2.2 What is the difference between partial and general equilibrium analysis?

Both general equilibrium and international partial equilibrium models are simulation tools that allow the impact of a change in an economic aggregate or policy on the rest of the economy to be assessed. Both types of models aim to represent the way economic agents or markets are linked and relate to each other.

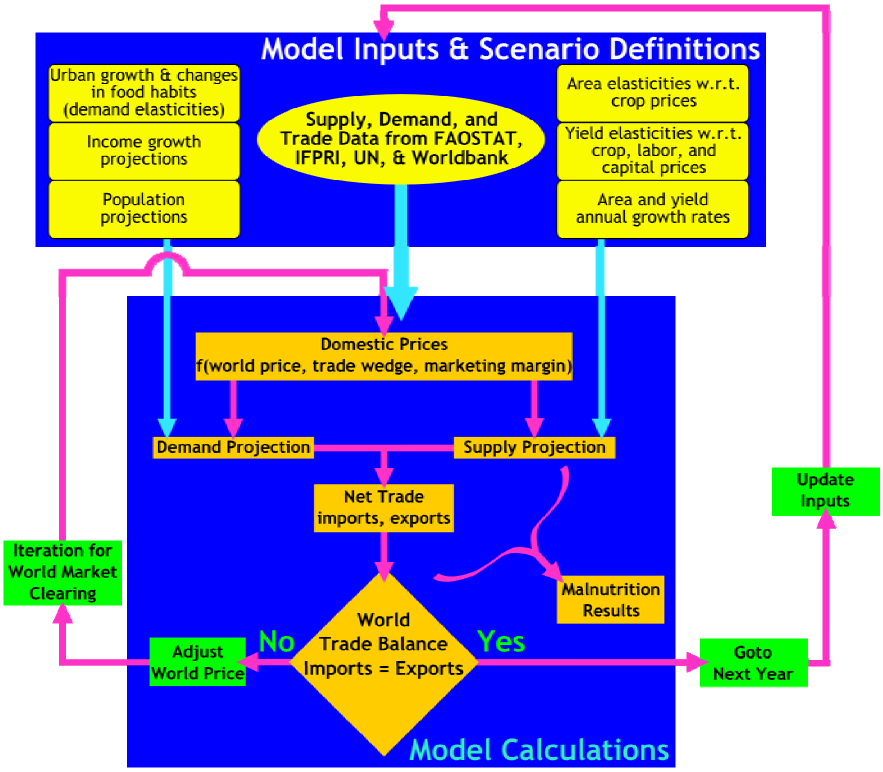
A good example of ***partial equilibrium*** is IFPRI's IMPACT model, developed to represent how 36 regions of the world produce, exchange and consume food, with agricultural products grouped into 32 commodities. The model finds equilibrium food prices that balance international commodity markets for the medium and long term. Figure 2.1 below shows how the different components of the model are linked to one another.

The model can be used to project demand and supply to assess how markets are likely to adjust and what would be the change in prices over time. However, even a model like IMPACT, which could be considered as "state of the art" in this type of analytical framework, only offers a narrow and aggregate approach to the world economy.

Partial equilibrium models (PEM) rely heavily on many assumptions about the rest of the economy, including income growth, changes in urban and rural population over time, and price elasticities of demand for food. Many economic aggregates and parameters are considered exogenous and therefore do not adjust to agricultural market changes. For example, in developing countries, changes in agricultural production typically affect labour markets and migration that in turn affect not only other production sectors, but also household incomes through feedback effects. These feedback effects are missing in PEMs and because of that, their predictions should be interpreted with caution.

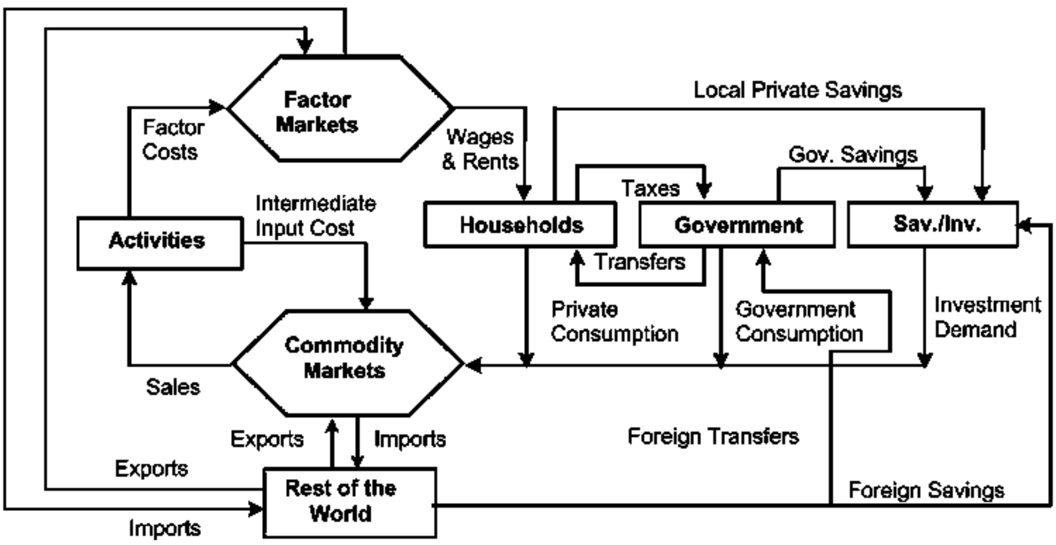
[1] Solberg et al. (2007) and Peterson and van der Werf (2007) review in more detail the structure of the existing models that have been developed, providing more technical details on the theoretical assumptions and hypotheses used. Appendix E provides a brief summary of the theoretical frameworks discussed in the review.

Figure 2.1: IMPACT, a partial equilibrium global model for agricultural markets



For this reason, a growing part of the research on the impact of biofuels is now carried out using ***general equilibrium*** models. General equilibrium models (CGEs) are designed to represent the economy of a country, region or the world. CGE models aim to give a picture of the economy at a given point of time. Based on social accounting matrices which capture all the economic and financial flows that have occurred within the economy during a given year, CGE models describe the linkages between economic agents and markets for production factors, goods and services, with equations to reflect the behaviour of these economic agents and the functioning of these different markets — see Figure 2.2. CGE models can be aggregated or very detailed for each part of the economy that they aim to study specifically. CGEs models can look at short (static) or longer (dynamic) term impacts (Dervis et al. 1982).

Figure 2.2: Links between the major building blocks of a CGE model



Source: Löfgren 2004

There are two categories of CGE models that are used to study the impact of biofuels: single country CGE model and global CGE models.

Single country CGE models allow for the analysis of the impact of biofuels on the domestic economy and trade, whether the production of bio energy is domestic or not. The impact would then be analysed on all domestic markets, on supply and demand and on trade. At the same time, the simulations allow the assessment of the effect on household's real income and their consumption. Such a model could therefore provide an in-depth impact assessment on poverty and on prospect for growth.

One country CGE models offer the advantage of allowing for a more detailed analysis of the impact of biofuels at the micro economic level, with more precision than any international equilibrium model could offer. The disadvantage of these tools is that they can not predict the impact on international supply and prices of food and oil commodities.

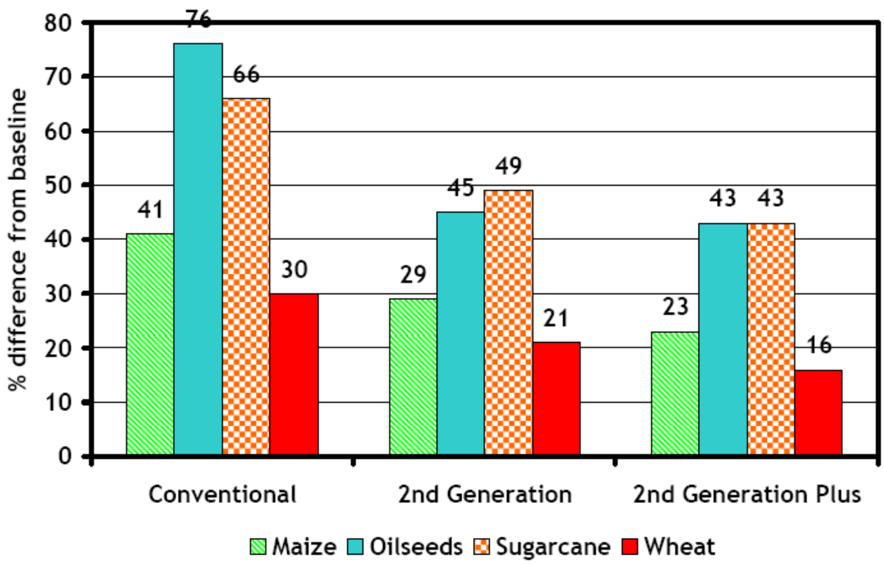
Global or international trade models divide the world economy into regions, each with its CGE model, that are linked by trade. Since such models are relatively complex to manipulate and require large amounts of data, some of which are not available for some developing countries, they cannot yet analyse outcomes in particular developing countries with much precision. But they have the advantage of being able to estimate long term supply and demand for goods, services and production factors, and therefore to predict how international prices are likely to evolve over time.

2.3 Results from partial equilibrium models

Table 2.1 summarises the predictions from existing studies of the impact of expanded biofuels on world market prices. With the exception of Banse et al. 2007, the studies are derived from partial equilibrium models.

IFPRI's IMPACT model generates large increases in crop prices in response to countries implementing the plans they have announced for biofuels by 2020, see Figure 2.3. Maize prices are up by from 23% to 72%, wheat by 8% to 30%, oilseeds by 18% to 76%, and sugar by 11.5% to 66%. Even in scenarios that see an early introduction of second generation biofuel technologies and productivity improvements in agriculture, the effects are considerable.

Figure 2.3: Changes in commodity prices in response to biofuels expansion expected in 2020



Source: IMPACT projections

Note: Conventional: rapid growth in demand for biofuels, no change in crop productivity; 2nd generation assumes that by 2015 cellulose conversion technology is economically viable; 2nd gen+ adds improvements to crop productivity.

The simulations also show that the impact on food supply and on malnutrition, especially in Africa, could be alarming if nothing is done to increase agricultural productivity in the short term.

OECD projections are for lesser price rises (von Lampe 2006): indeed in the scenario where public goals are sought while oil prices remain relatively low, the impact on the prices of most crops other than vegetable oils is less than 5%. But if oil prices of US$60 a barrel are modelled, then with more biofuel produced, the effect on agricultural prices is substantial, with rises of around 20% being seen.

USDA (2008) make projections taking into account not just the expansion of biofuels but also rising energy costs and demand from emerging economies. They see prices of maize and sorghum up by 65% and 64%, a 33% rise in wheat prices, and 19% more on soy oil.

FAPRI models generate diverse results, depending on the different scenarios for biofuels expansion. Most of the scenarios generate increases in the prices of maize, wheat, and soy oil of 16% or more[2].

The IIASA model generates a single crop price index. For a 10% replacement of transport fuels using ethanol, this rises by 37%.

2.4 Results from general equilibrium models

In the past few years, CGE models have been used to study various biofuels related issues but whether or not the scenarios assume an increase in the demand for oil by some countries or a change in the regulatory framework on the production and use of biofuels, they all conclude that food prices are likely to increase substantially.

Single country CGE models

Brazil is the largest producer of ethanol from sugarcane in the world. Two pieces of research have investigated the potential impact of an increase in the Brazilian biofuel production. Cunha et al (2007) have estimated that the Brazilian production of ethanol could be increased by 800%, inducing an 11.4% growth in the GDP and creating more than 5 million jobs.

However, Giesecke et al (2007) have investigated the impact of a rapid growth in the Brazilian ethanol industry and reached rather different conclusions. They found a contraction of the food processing industry and a decline in its exports. Although the boom in ethanol exports compensates falling food exports, the economic impact of biofuels is negative. The authors predict that Brazil is likely to contract ‘Dutch Disease’; that is, its real exchange rate is likely to increase, making non-fuel exports less competitive, reducing employment and economic growth.

[2] The FAPRI model can also look at land allocation. Fabiosa et al. (2008) use the FAPRI multi market partial equilibrium model to quantify the impact of an increase in demand for biofuels on worldwide land allocation and agricultural production. The authors measure the effect of the shock on food prices and on land use for the US and Brazil, in particular. The study shows how sensitive land allocation is to the growing demand for ethanol. The simulations also predict that the local impact would be large for countries like Brazil which could see a substantial re-allocation of its land to produce ethanol.

Global CGE models

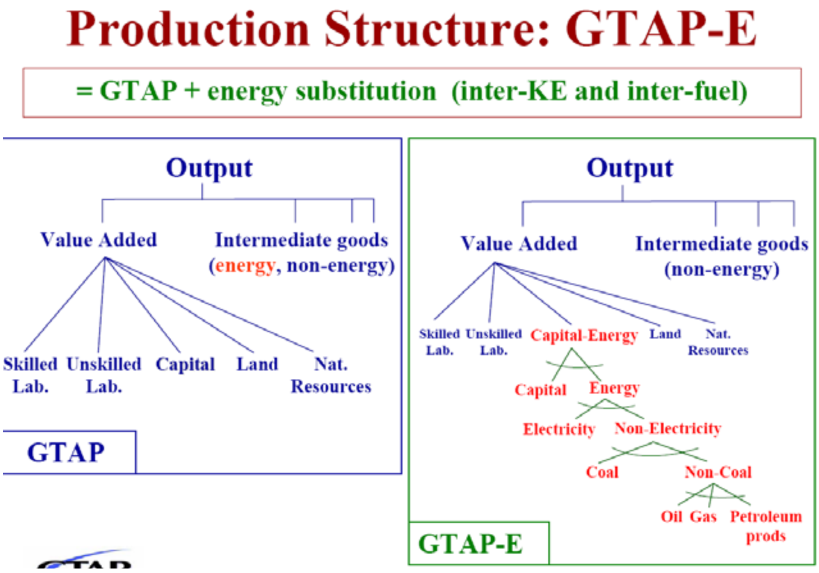
One of the main benefits of using CGE models to study biofuels is that they capture the feedback effects between the different energy markets and also between the energy sectors and the rest of the economy.

Many of the global models that have been used to study the impact of bio energy are derived from the GTAP global CGE modelling package.[3] The GTAP-E has been developed from the global GTAP model in which the energy sector has been detailed to incorporate the different elements from which energy can be produced. The energy production sector is described in the Figure 2.4 below.

Among GTAP adaptations, the USAGE model was developed by Dixon et al (2007) to study the impact of a replacement of 2% of crude oil by ethanol by 2020. They find that the world price of oil is likely to decrease as US oil consumption decreases. Biofuels would be cheaper than oil. Among their conclusions, the employment rate is likely to increase as the result of more domestic activities.

Using the GTAP dataset, McDonald, Robinson and Thierfelder (2007) develop a global model called GLOBE and reach rather different conclusions from Dixon et al. The increased world price of cereals that would result from switchgrass production in the US outweighs the benefit from domestic fuel production and causes the economic welfare to decline. In particular, developing countries suffer more from increased food prices than they benefit from a lower oil price.

Figure 2.4: Production structure in the GTAP and GTAP-E models



Banse et al. (2007) use a model similar to GTAP-E. Their results, see Table 2.1, show that even with 11.5% of EU petrol consumption being blended with biofuels, price rises are a couple of percent for cereals, 6% for sugar and 8.5% for oilseeds.

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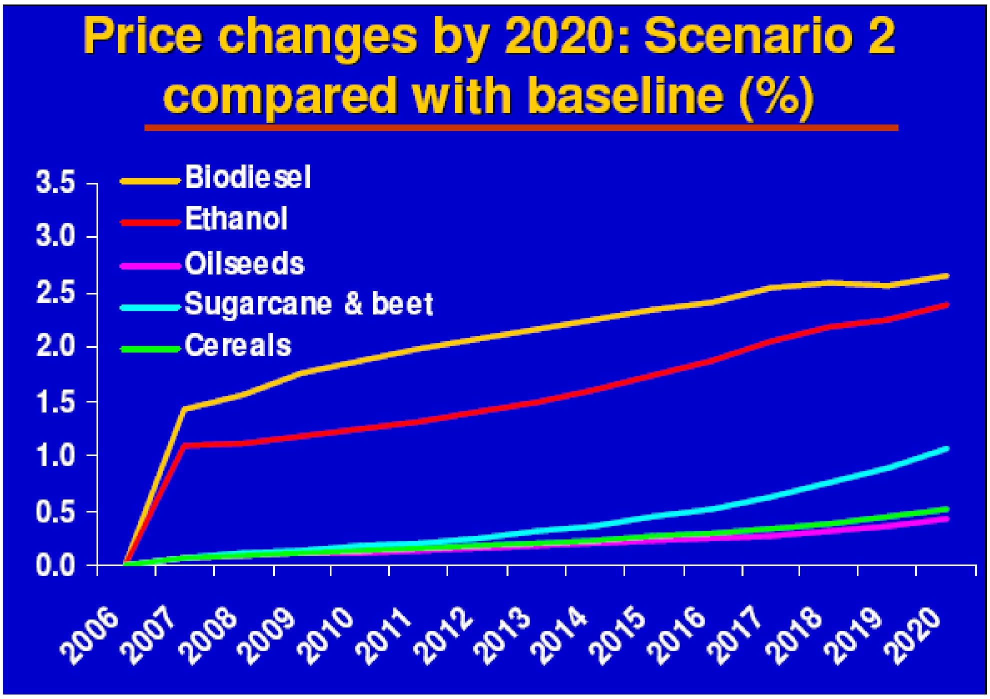
[3] This package is composed of a global dataset that provides an aggregate social accounting matrix for each region of the world and specifies the trade between them. The second component of this package is the global economy CGE model, which can be estimated on and used with different aggregations of the GTAP global dataset. The GTAP model, developed by a network of researchers across the world who use and constantly improve it, offers a unique mapping of the international trade together with the possibility to test the impact of trade shocks.

The way in which production of biomass energy is likely to affect land use is at the centre of several other pieces of research using global CGE models.[4]

Another approach to modelling the impact of biofuels is to examine the need to replace depleting fossil fuels and consider the impact of the competition for land on food price. IFPRI has also developed a multi-region CGE model, MIRAGE (Modeling International Relationships in Applied General Equilibrium), calibrated using data from GTAP as well as from various other sources such as the CEPII trade database. The model disaggregates the world into 41 countries or regions and 18 sectors. Bouët et al (2007) have used MIRAGE to study the decrease of a fossil fuel endowment, as per the IEA 2007 predictions. They have also studied the effect of a higher substitutability between biofuels and other energy sources. Figure 2.5 shows the impact that has been predicted on food and fuel prices. Food prices rise by up to 1% by 2020.

Figure 2.5: Replacing fossil fuels by biofuels, MIRAGE simulations



Source Bouët et al. 2007

[4] Among them, the MIT-Emission Prediction and Policy Analysis (EPPA) model has been developed using the GTAP global dataset, aggregated in 16 regions and 21 production sectors. Reilly & Paltsev (2008) use it to study how the production of biomass energy could potentially affect the competition for land. They assume that the world price of oil would in 2100 be 4.5 times the 2000 level. Oil is progressively replaced by biofuels and the land requirement for that purpose becomes substantial even when they assume significant productivity improvement. For the US, the land requirement for bioenergy would be equivalent to that currently used for cropland. If trade is not restricted the US imports most of its biofuels. If US imports of biofuels are regulated, then the country becomes a substantial agricultural importer. Instead of importing oil, the US would then import its food.

The GTAP-L model focuses on land and land use across the world (Burniaux & Lee 2003, Sands & Kim 2008). This new material offers new opportunities for researchers to better understand the impact of biofuels on land use and competition for land.

From these results, it looks as though choice of model matters: the bulk of the projections from partial equilibrium generate increases in food prices of 15% or more, while those from general equilibrium have prices rising by less than 10%.

The difference derives largely from the degree of economic adjustment to changing stimuli that is modelled. GE models allow for near complete adjustment and represent what is likely to happen in the medium term providing markets work reasonably well. PE models allow for less adjustment, so that changes in demand and supply tend to prompt major changes in prices to clear markets. They may give a better picture of what happens in the short run and in circumstances where adjustment is difficult.

But on some things, the models whether PE or GE all agree: expanding biofuels will push up the prices of other agricultural commodities, especially those that can be used as feedstock. Although few of the PE models report results for rice, the one study that does shows increases of less than 1% in its price.

2.5 A new global general equilibrium model

Data and Model

This study uses a variant of the Global Trade Analysis Project (GTAP) database and a variant of the GLOBE_EN CGE model (McDonald and Thierfelder, 2007).

Augmented GTAP Transactions and Energy Data

The database used for this study is an augmented version of the GTAP database; version 6, the latest available, that has a base year of 2001. The augmentation takes two forms. The first is produced by the GTAP and involves additional data on the use of energy inputs and associated carbon emission. The second is more important in the current context. In 2001 the production of biofuels in the EU and USA and Canada was limited and hence the transactions associated with biofuel production in the database are similarly limited, whereas they have increased sharply over the last few years. To capture the change in the production of biofuels the LEI (Netherlands Agricultural Economics Research Institute) developed an updated version of the GTAP database that better represented the use of agricultural products in the production of fuels for transport (see Banse et al., 2008, for details of the LEI study). The LEI's database was made available for this study, and converted into a Social Accounting Matrix (SAM) (see McDonald and Thierfelder, 2004).

The regions and sectors covered by the database are detailed in Table 2.2. The structure of the LEI's database reflects the objective of their study, which was focused on EU agriculture. The database emphasises agricultural and energy (in italic) sectors and records the use of 'Grains', 'Oil seeds' and 'Sugar' as feedstocks to the production of 'Petroleum'. While the database provides a balanced global coverage the extent of details on developing countries is limited. However within the time scale of this project it was not possible to develop an independent database and this was the best available database.

GLOBE_EN CGE Model

The GLOBE_EN CGE model (McDonald and Thierfelder, 2008) is a development of the GLOBE model (McDonald *et al.*, 2007) where the major changes relate to the modelling of production relationships and the recording of taxes on energy use. The model is a SAM-based CGE model, wherein the SAM serves to identify the agents in the economy and provides the database with which the model is calibrated.

The modelling of energy allows for substitutability of energy feedstocks in the production of energy products and between energy products used as inputs by other productive activities. In order to model the production of biofuels the production relationships for the production of petroleum were modified (see McDonald and Levy 2008). Agricultural products were modelled as inputs to the production of a biofuel that was blended with oil based petroleum and the blended product was then treated as an input to the production of energy. The results presented assume that the blending of the biofuel and oil based petroleum was in fixed proportions where the proportions were determined exogenously, i.e., as a consequence of some directive. An alternative version was developed where a subsidy on the biofuel was increased until the desired proportions were achieved, but this makes no substantive difference to the results.

Table 2.1: Effects of biofuels expansion on prices of agricultural commodities, results from modelling

Source & model used	Scenario	Projection to what date	Cereals	Maize	Wheat	Rice	Sorghum	Oilseeds	Soy oil	Veg Oil	Palm Oil	Soy meal	Cassava	Sugar	Crop price index
Msangi et al 2007 IMPACT	Biofuel use up by US projections, Brazil targets for 2010 and 2015, China targets. Other countries assume 10% replacement by 2010, 15% by 2015, 20% by 2020	2020		41.0%	30.0%			76.0%						66.0%	
	As above + 2nd gen cellulose technology by 2015: after no inc in D feedstock from crops	2020		29.0%	21.0%			45.0%						49.0%	
	As above with agricultural productivity growth	2020		23.0%	16.0%			43.0%						43.0%	
von Braun, IFPRI 2007 IMPACT	Biofuel expansion (a) actual biofuel production plans and projections in relevant countries and regions	2020		26.3%	8.3%			18.1%					11.2%	11.5%	
	Drastic biofuel expansion (b) doubling actual biofuel production plans and projections in relevant countries and regions.	2020		71.8%	20.0%			44.4%					26.7%	26.6%	
von Lampe 2006 OECD Aglink + FAO COSIMO + OECD World Sugar Model	Constant $60 per barrel price of oil, projected to 2014. Baseline: OECD-FAO projections 2005-14, 2005	2014		19.0%	17.0%				19.0%	22.3%				20.0%	
	"Growth in line with publicly stated goals"; 28 gigaliters in the United States by 2012, projected to 2014. [Cannot be reached since rising feedstocks prices prevent]	2014		2.5%	4.4%				1.1%	12.9%				4.0%	
USDA 2008 USDA model	12 billion gallons of ethanol, 700 million gallons of biodiesel in the United States, projected to 2016.	2016		65.0%	33.0%		64.0%		19.0%					-8.0%	

J. N. Ferris and S. V. Joshi, 2006	5.7 billion gallons of ethanol, 300 million gallons of biodiesel in the United States by 2015, projected relative to baseline.	2015		6.0%					31.0%			-5.0%			
Banse et al. 2007 GTAP with an energy market, some substitution of biofuels for fossil fuels, plus land model.	Blending obligation in EU of 5.75%, compared to a reference scenario of trade liberalisation and much reduced domestic support Based on IPCC A1 SRES, with trade liberalisation, high technology change	2001 to 2010	-2.0%					2.0%						-5.0%	
	Blending obligation in EU of 11.5%, compared to a reference scenario of trade liberalisation and much reduced domestic support		2.2%					8.5%						6.0%	
FAPRI 2005 FAPRI	7 billion gallon U.S.-produced ethanol use, 7.5 billion gallon biodiesel and ethanol imports by 2012, projected from 2012 to 2015, relative to baseline.	2015		5.4%	1.7%		4.2%		-0.2%						
FAPRI 2006) FAPRI	6.6 billion gallons ethanol in Brazil, 0.8 billion gallons ethanol in EU, 8 billion gallons in United States; 4.9 mmt rapeseed oil in EU, projected to 2015–2016, relative to today.	2015/16		30.0%	11.0%				2.0%		17.0%			21.0%	
Elobeid & Tokgoz 2006 FAPRI	Long-run oil price of $60 per barrel with the United States using 30 billion gallons of ethanol, projected to 2015, relative to baseline.	2015		58.0%	20.0%				20.0%			-42.0%			
Elobeid & Hart 2007 FAPRI	Raise crude oil by US$10 a barrel (a) with limited use of ethanol for lack of FFV, effect by 2016/17	2007/08 to 2016/17		18.2%	8.3%	0.1%			84.0%		2.0%			1.0%	
	Raise crude oil by US$10 a barrel (b) no limits to ethanol use			36.5%	16.0%	0.4%			18.3%		4.0%			2.0%	

Havlik et al. 2008/IIASA GLOBIOM	Substitute 10% transport oil by biofuels, according to IIASA A2r baseline scenario 2030: (a) using ethanol from cane & maize	2030													37.0%
	Ditto, (b) using methanol from industrial plantations	2030													17.0%

Table 2.2: SAM and Model Accounts

Sectors	Sectors	Regions
Rice	*Oil*	EU 27
Wheat	*Petroleum*	Rest of Europe
Grains	*Gas & Distribution*	Former Soviet Union
Oil seeds	*Coal*	NAFTA
Sugar cane & beet	*Electricity*	Rest of America
Horticulture	Industry	Brazil
Crops	Services	Oceania
Cattle		Japan & Korea
Other Animals	**Factors**	China, HK, Taiwan, Rest of East Asia
Milk	Land & Natural Resources	Rest of Asia
Dairy	Unskilled labour	North Africa & Middle East
Sugar	Skilled labour	Sub Saharan Africa
Vegetable oils and fats	Capital	South Africa
Other food		
Other Agriculture		
Forestry		

Policy Experiments and Model Closure

Policy Experiments

The policy experiments conducted were simple. The proportions of biofuel used in the blended petroleum product in the EU and NAFTA were increased to be broadly in line with the targets set by the EU and implied for the USA; however the targets are not binding so the simulated targets are indicative. For both the EU and NAFTA the share of biofuel in blended petroleum was increased to approximately 5%, 7% and 10%; the targets were implemented for EU and NAFTA separately and together.

The model implementation is comparative static with an implied time horizon of 2 to 3 years, i.e., long enough for changes in agricultural production to take place but short enough to preclude substantive changes in the technologies used in the production of energy products. Thus the substitution possibilities between energy products are constrained, i.e., it is presumed that users cannot introduction new technologies and hence only substitute between energy inputs at the margin.

Model Closure & Sensitivity Analysis

All CGE models are sensitive to the selection of macroeconomic closure and market clearing conditions. For this model the basic closure and market clearing conditions are:

1. *Foreign Exchange Closure*: All external (trade) balances are assumed fixed in real terms and exchange rates are assumed to be flexible so that changes in the exchanges rates clear the foreign exchange market.
2. *Investment-Savings Closure*: the volumes of investment are fixed and household savings rates are variable so that the capital accounts are cleared by changes in household savings.

3. *Government Account Closure*: the government is assumed to spend a fixed share of domestic absorption and to maintain a fixed internal (government) deficit; given changes in tax revenues and the general level of economic activity the government accounts are cleared by changes in the direct tax rates levied on households.
4. *Numéraire*: the region numéraire are the region specific consumer price indices — hence changes in value variables are all real — and the global numéraire is an index of the exchange rates for the OECD regions — USA & Canada, EU and Japan.

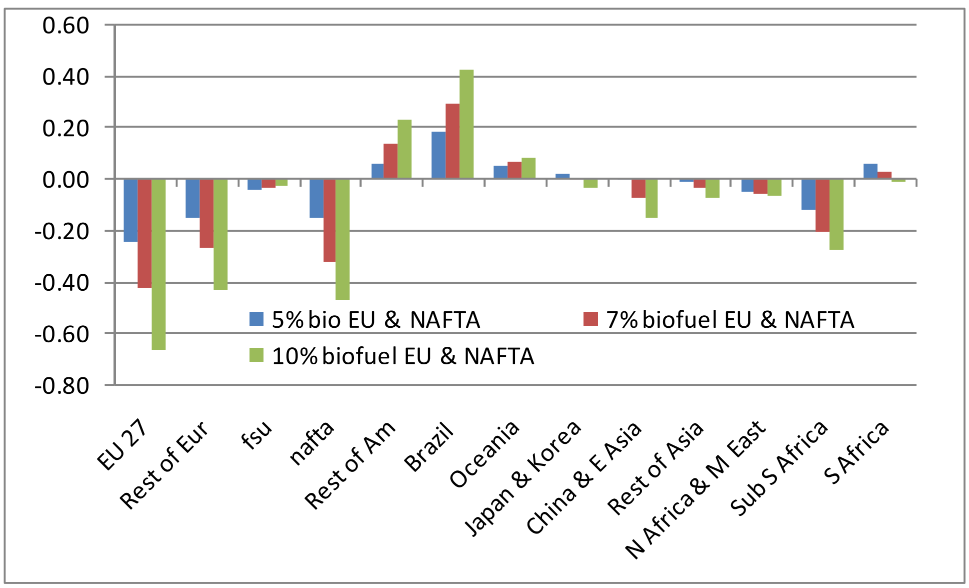
The factor market clearing presumption is that for all regions skilled labour, capital and land are fully employed and mobile between sector; the same applies to skilled labour in developed and middle income countries but for the least developed regions — Brazil, China, HK, Taiwan, Rest of East Asia, Rest of Asia, Sub Saharan Africa and South Africa — it is assumed that there is a perfectly elastic supply of labour at a fixed real wage rate. In all cases technology is assumed to the constant.

Results

The overall or macroeconomic impacts of increasing biofuels as shares of blended petroleum in the EU and NAFTA are limited. Real domestic absorption[5] in the EU falls by almost 0.7% and in North America by almost 0.5%, see Figure 2.6. The impacts across other regions are mixed with some showing small gains and others small losses, with the most notable gains accruing to Brazil.

It is unsurprising that the EU and NAFTA show losses in response to increased use of biofuels: the directives to increase biofuel use require, *ceteris paribus*, the adoption of less economically efficient technologies and hence represent a small decline in overall economic efficiency. While the implications for the EU and NAFTA are a direct consequence of their own decisions, the implications for other regions are indirect effects that derive from the biofuel 'directives'.

Figure 2.6: Real Domestic Absorption (% changes)



Source: Model simulations.

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[5] Real domestic absorption is defined as the value of domestic final demand by households, government and investment with constant (base period) prices. In the context of this type of analysis it is a better summary measure of economic performance than GDP.

These results derive from three fundamental forces that are unleashed by the directed increase in biofuel use. First, the demand for agricultural feedstock for the biofuel processes puts upward pressure on agricultural and food prices. Second, the reduced demand for (crude) oil causes oil prices to drop, thereby reducing the export price of oil. And third, the increase in the cost of petroleum[6] increases production costs elsewhere in economies and induces a relative decline in the use of petroleum that impacts upon other energy prices and hence production costs.

The impact on prices is most clear through the impact on export prices; these are defined as the average free on board (*fob*) prices received by regions on their exports to all other regions — see Table 2.3.[7] The global prices of 'grains' (mainly maize in this case) increase by between 4% and 21%, and from 24% to 72% for oilseeds. While the increases in prices are greatest for the EU and NAFTA all regions experience marked price increases because of the increased demand in both the EU and NAFTA for these commodities.

The EU increases imports of grains and oil seeds by 11% and 16% respectively while NAFTA increases import demands by 11% and 93% respectively, while all other regions reduce import demand. These are large changes in the patterns of world trade.

Noticeably the price of sugar does not increase much. This is reflection of the fact that sugar is not a substantive input into biofuel production in the EU or NAFTA and the model has not been conditioned to change the technologies used in the EU or NAFTA.

One crucial indirect effect is the reduction in the export prices for oil. For all regions oil export prices fall indicating that domestic producer prices fall but the impact on import prices is mixed. This is primarily a consequence of exchange rate effects associated with the reduced import demand from the EU and NAFTA that impact on other countries by causing changes in the real price of oil. A similar result was found in a study of the use of biomass as a biofuel feedstock in the USA (see McDonald *et al*., 2007); the underlying causal factor is the fact that the EU and NAFTA are the largest sources of energy demand and therefore even relatively small changes in demand for oil impact upon world prices and exchange rates.

Changes in prices impact upon the well being of the population in different regions according to the net effects of changes in incomes associated with changes in prices and production patterns and changes in the costs of living associated with the new prices faced by consumers. These can be summarised by the money metric welfare estimates for different regions that are reported in Figure 2.7. These indicate that in absolute terms the welfare implications are overwhelmingly concentrated in the EU and NAFTA, where the welfare losses exceed US$50bn in 2001 prices. However the indirect welfare implications are limited elsewhere and are generally positive or so small as to not be significant.

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[6] Petroleum in the model is a combination of fossil fuels and biofuels.
[7] Average import prices carriage insurance and freight (cif) paid and inclusive of trade taxes are reported in Table 2.4.

Table 2.3: Export Prices (% changes)

	EU 27	Rest of Eur	FSU	NAFTA	Rest of Am	Brazil	Oceania	Japan & Korea	China & E Asia	Rest of Asia	N Africa & M East	Sub S Africa	S Africa
Rice	-2.0	0.4	0.2	-0.6	0.6	-0.8	-0.1	0.1	0.2	-0.1	0.0	0.2	0.1
Wheat	-2.6	0.0	0.0	-0.7	-0.1	0.2	-0.2	-0.2	-0.1	0.0	0.0	0.1	0.2
Grains	14.9	8.6	8.0	21.3	11.0	4.8	5.5	21.1	4.2	4.0	9.7	10.8	4.2
Oil seeds	53.2	43.5	40.1	71.8	34.5	25.2	48.9	45.0	32.4	31.6	43.1	24.9	33.7
Sugar C&B	9.2	8.1	4.7	13.3	4.9	4.5	4.7	10.7	6.6	5.9	1.6	7.8	7.6
Horticulture	-2.6	-0.3	0.0	-1.0	-0.8	-1.7	-0.2	-0.1	-0.2	-0.1	-0.1	0.1	0.0
Crops	-2.4	0.0	0.1	-0.9	-0.9	-1.6	-0.2	-0.1	-0.2	-0.1	0.0	0.2	0.1
Cattle	-2.0	0.3	0.3	1.0	0.1	-1.3	0.6	1.0	0.7	0.3	0.5	0.4	0.3
Other Animals	-1.4	0.6	0.6	0.4	0.4	-1.2	0.4	0.8	0.9	0.5	0.7	0.7	0.6
Milk	-0.8	1.3	1.3	3.3	0.9	-0.7	1.1	1.5	1.4	1.2	1.4	1.5	1.4
Dairy	-2.2	0.2	0.2	0.8	0.4	-0.9	0.1	0.5	0.3	0.1	0.2	-0.1	0.2
Sugar	-0.7	2.0	1.8	1.6	1.5	-0.5	1.0	1.2	1.3	0.8	2.5	2.5	0.6
Veg oil & fat	5.1	7.2	2.5	22.0	5.8	-1.4	3.7	16.3	7.6	2.9	5.0	3.0	1.0
Other food	-1.7	0.3	0.4	1.2	0.3	-1.4	0.3	0.9	0.8	0.4	0.6	0.4	0.4
Other Agric	-2.3	0.0	0.1	-0.8	-0.5	-1.6	-0.2	0.1	0.1	0.0	0.3	0.1	0.1
Forestry	-2.5	-0.1	0.0	-0.7	-0.7	-1.7	-0.2	0.0	-0.1	-0.1	0.0	0.1	0.2
Oil	-3.3	-1.3	-1.2	-1.2	-1.6	-1.4	-0.4	-1.3	-0.8	-0.2	-0.6	-0.7	0.2
Petroleum	15.0	6.3	6.5	30.3	8.2	9.3	2.3	2.1	2.1	1.7	3.4	9.1	3.4
Gas	-3.0	-0.4	-0.2	-1.1	-0.4	0.6	-0.2	-0.5	-1.1	-0.2	-0.3	-0.3	0.1
Coal	-2.7	-0.9	-0.3	-0.7	-0.4	0.1	-0.1	-0.9	-0.2	-0.1	-1.5	-0.7	-0.3
Electricity	-2.3	-0.4	-0.1	0.1	-0.2	0.0	0.0	-0.1	-0.2	0.1	0.1	0.3	0.3
Industry	-2.4	-0.2	0.0	-0.9	-0.4	-1.4	-0.2	0.0	-0.2	-0.1	-0.1	0.1	0.2
Services	-2.6	-0.2	-0.2	-1.0	-0.8	-1.8	-0.3	-0.1	-0.2	-0.2	-0.1	0.1	0.1

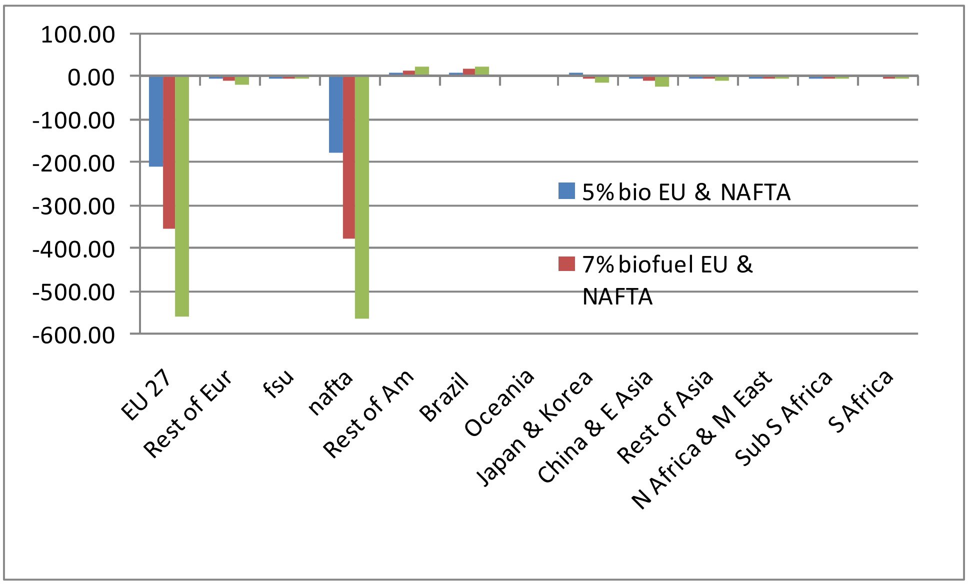
Source: Model simulations. NB: ‘Grains’ excludes rice, wheat, and consists in large part of maize

Table 2.4: Import Prices (% changes)

	EU 27	Rest of Eur	FSU	NAFTA	Rest of Am	Brazil	Oceania	Japan & Korea	China & E Asia	Rest of Asia	N Africa & M East	Sub S Africa	S Africa
Rice	-2.1	0.2	0.2	-0.9	-0.2	-0.8	-0.1	0.2	-0.1	0.0	0.1	0.3	0.4
Wheat	-2.6	0.1	0.1	-1.0	-0.6	-1.6	-0.1	0.1	-0.2	0.0	0.2	0.5	0.6
Grains	15.7	9.3	5.9	33.2	10.9	4.1	7.3	9.8	8.5	3.7	8.8	4.7	7.0
Oil seeds	40.7	16.7	21.3	88.3	27.8	14.7	40.0	37.7	28.8	27.0	23.4	10.8	6.3
Sugar C&B	6.2	4.0	1.8	11.9	6.0	2.7	3.4	3.7	1.9	2.3	3.0	3.0	3.0
Horticulture	-2.6	-0.2	0.0	-1.0	-0.6	-1.5	-0.1	0.0	-0.2	-0.1	0.0	0.1	0.2
Crops	-2.4	0.1	0.2	-0.9	-0.7	-1.7	-0.1	0.0	-0.1	-0.1	0.1	0.2	0.2
Cattle	-2.0	0.5	0.4	0.6	0.4	-1.0	0.5	1.4	0.7	0.5	0.7	0.6	0.3
Other Animals	-1.5	0.8	1.0	0.4	0.5	-0.8	0.6	1.1	0.9	0.4	1.0	0.9	0.9
Milk	-1.4	0.7	0.9	2.2	0.4	-0.6	0.7	1.0	0.8	0.7	0.9	1.0	0.9
Dairy	-2.3	0.1	0.2	0.2	0.0	-1.0	0.1	0.4	0.3	0.2	0.3	0.4	0.4
Sugar	0.1	0.1	1.4	2.6	0.5	-1.4	-0.1	0.3	0.4	0.3	1.1	0.5	0.3
Veg oil & fat	2.8	5.6	3.6	16.1	8.1	1.9	2.7	7.8	3.2	1.9	4.4	3.0	2.6
Other food	-1.8	0.5	0.5	0.7	0.7	-0.7	0.5	0.9	0.7	0.6	0.8	0.6	0.7
Other Agric	-2.3	0.1	0.2	-0.8	-0.3	-1.5	0.0	0.1	0.0	0.0	0.2	0.3	0.3
Forestry	-2.5	0.2	0.0	-0.7	-0.9	-1.6	-0.2	0.1	-0.2	-0.1	0.0	0.0	0.0
Oil	-3.8	1.2	0.2	-2.3	0.7	-1.7	-0.2	-0.2	-0.3	0.0	0.4	1.4	0.3
Petroleum	9.6	14.2	4.0	16.8	6.9	0.0	4.7	0.9	0.9	1.7	5.5	7.8	2.2
Gas	-2.8	-0.3	0.0	-1.2	-0.3	-2.0	-0.3	-0.1	-0.4	-0.2	0.0	-0.4	-0.4
Coal	-2.8	0.3	0.0	-0.8	0.2	-2.0	-0.1	0.1	-0.1	-0.1	0.2	0.3	0.5
Electricity	-2.5	0.1	0.1	0.0	-0.2	-1.5	0.3	0.3	-0.2	0.1	0.2	0.3	0.2
Industry	-2.4	0.0	0.0	-0.9	-0.6	-1.9	-0.2	0.0	-0.2	-0.1	0.0	0.2	0.2
Services	-2.6	-0.2	0.0	-1.0	-0.7	-1.8	-0.2	0.0	-0.2	-0.2	-0.1	0.1	0.1

Source: Model simulations.

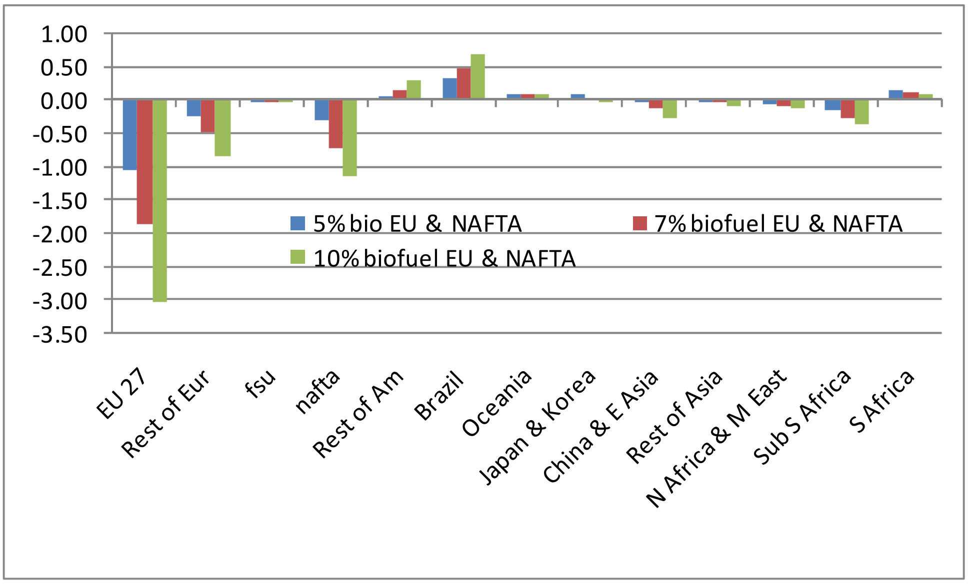
Figure 2.7: Welfare Impacts ($'00m Equivalent variation — 2001 prices)



Source: Model simulations.

One possible disadvantage of welfare measures is that they include income effects and therefore while the overall impact might be negligible for the average household there may be appreciable distributional effects. An alternative measure is the real level of household consumption expenditure, and estimates for this measure are reported in Figure 2.8.[8] These results indicate that households in the EU, Rest of Europe and NAFTA are the main losers, while a group of middle income countries gains — primarily because the decline in oil prices reduces the cost of living — and Sub-Saharan Africa stands to lose up to 0.4% of real disposable income.

Figure 2.8: Real Household Expenditure (% change)



Source: Model simulations.

[8] Household consumption expenditure is defined after tax and savings. This is relevant since savings are allowed to adjust to maintain real investment while tax rates are free to vary to maintain a constant level of government borrowing/saving.

Distributional impacts are also made transparent by the impacts on factor prices, see Table 2.5. Unsurprisingly returns to land increase sharply in the EU and NAFTA, which explains in part why many commentators have expressed a view that biofuel 'directives' will operate as *de facto* agricultural support mechanisms; support mechanisms that have long been claimed to adversely impact on less developed economies. However at least the biofuel 'directives' increase demand for agricultural products and hence land prices rise in all regions.

Furthermore, outside of the EU and NAFTA, the price of unskilled labour rises marginally in some parts of the developing world relative to skilled labour and capital. This suggests that there is a slight redistribution towards the less well-off members of the workforce which implies some, albeit minor, redistribution. However the changes are small and are likely to be dominated by the changes in the returns to land, which implies that landowners will gain substantially relative to landless workers.

Table 2.5: Factor Prices (% changes)

	Land	Unskilled labour	Skilled labour	Capital
EU 27	51.47	-2.97	-2.99	-3.76
Rest of Eur	11.60	-0.22	-0.25	-1.27
FSU	1.85	0.03	0.02	0.00
NAFTA	110.13	-1.24	-1.19	-1.77
Rest of Am	12.25	-0.23	-0.07	-0.05
Brazil	7.57	0.13	0.03	0.89
Oceania	12.17	-0.09	-0.03	-0.06
Japan & Korea	13.01	-0.02	-0.02	0.03
China & E Asia	2.87	-0.08	-0.30	-0.15
Rest of Asia	0.65	0.02	-0.19	-0.08
N Africa & M East	5.60	-0.15	-0.17	-0.14
Sub S Africa	0.35	0.34	-0.32	-0.84
S Africa	3.37	0.22	0.11	0.39

Source: Model simulations.

2.6 Concluding Comments

The results from these analyses are broadly consistent with those found elsewhere, e.g., Banse *et al*., (2008). Biofuel 'directives' appear likely to generate increases in world prices of agricultural products: these price increases will be concentrated in the products used as biofuel feedstock, which will see price rises of the order of 5% to 20% — except for oilseeds where the results are much higher — depending on the product, and there will be some, albeit limited, implications for other agricultural prices.

How do these results compare to those produced by other studies, and in particular the partial equilibrium models? Table 2.6 compares the results between the CGE and the projections from the IFPRI IMPACT model. Bear in mind that the IFPRI scenario considers broadly twice the replacement levels of transport fuels by biofuels that the CGE contemplates. Assuming that roughly doubling the replacement might lead to results twice as large, then the oilseeds prices are comparable. Otherwise, the results from the IFPRI model are far higher for the other three commodities that can be compared, and considerably so for wheat and sugar. It is, unfortunately, not clear exactly what features of the two models lead to such divergent results in these cases.

Table 2.6: Comparing results from partial and general equilibrium models

		Maize	Wheat	Rice	Oilseeds	Sugar
IFPRI IMPACT						
Biofuel use up by US projections, Brazil targets for 2010 & 2015, China targets. Other countries assume 10% replacement by 2010, 15% by 2015, 20% by 2020		41.0	30.0		76.0	66.0
As above + 2nd gen cellulose technology by 2015		29.0	21.0		45.0	49.0
As above + agricultural productivity growth		23.0	16.0		43.0	43.0
CGE						
10% replacement of transport fuels by biofuels in EU & North America	Max	21.3	0.2	0.6	53.2	13.3
	Min	4	-2.6	-2	24.9	1.6
	Median	8.6	0.0	0.1	40.1	6.6

Note: CGE results are maximum, minimum and median for 13 regions, export prices. The CGE results for ‘sugar’ are for cane and beet prices, rather than processed sugar.

On balance the welfare losses will be concentrated in the countries that push to increase biofuel use; due primarily to an introduction of production inefficiencies. However, there are likely to be winners; typically these will be countries that benefit from the reduction in world oil prices and/or increased trade with the EU and NAFTA. However there are likely to be small negative implications for some countries; typically those for which the net costs of increased food prices are not compensated for by reduced oil prices and/or increased agricultural exports.

Analyses at this level of aggregation provide limited insights into the detailed distributional consequences within regions. They do however confirm the expectation that net food seller/exporters may gain through biofuel ‘directives’ while net food purchasers/importers lose and that, given the predicted price changes, the implications may be substantial for some families.

There are reasons to be cautious with these results. The modeling of biofuel production in this study is arguably less than ideal and was determined by the availability of data within the short time span for the study. It is arguable that biofuel could be better modeled using a framework that provides a more comprehensive and flexible specification of the technology used to produce biofuel: the current specification is the best available without a substantial investment in data collection. The study also does not encompass issues of land use; modeling of these considerations is beginning, see Hertel *et al*., (2008), but clearly the increased prices for oil seeds are likely to have implications for the demand for land in areas capable of producing these crops, which suggests that fragile lands in tropical regions may come under even greater pressure.

Overall it would appear that biofuel ‘directives’ will have limited direct welfare implications, although these may well be negative for the lesser developed regions and the less well off in those regions. However these results do indicate the potential for concern about the implied patterns of price incentives. It would appear likely that the biofuel ‘directives’ will distort agricultural prices away from those driven by demand for food and contribute to greater distortions in global agricultural markets at a time when there was hope, albeit fading, that the Doha round might reduce distortions in agricultural markets.

3. From world to local prices: how do international price changes affect domestic prices?

The impact of a biofuel-induced rise in the international prices of food and agricultural commodities on the poor in developing countries depends on the transmission of prices between international and domestic markets.

An understanding of the speed and magnitude of transmission is important for two reasons. Firstly, the welfare of the poor is affected by the domestic prices that they face and not by world prices. Secondly, the supply response of producers and adjustment in consumption by consumers will also depend on the domestic prices faced by producers and consumers in different countries. The magnitude of production and consumption adjustments and their contribution to stabilisation of world prices will depend on the extent to which international prices are transmitted to domestic prices. This transmission is affected by a range of factors including transport and transaction costs, substitutability between food products and relative price movements, trends in exchange rates and border and domestic policies followed by governments. The speed and extent of transmission is, therefore, likely to vary substantially depending on country characteristics.

At the macro level, the importance of international prices[9] in determining domestic prices is likely to be much greater for developing countries that import a substantial part of their food grain requirement. The transmission effects of international prices will depend on the food import dependency of developing countries. At the level of consumers, a number of factors affect how much of an increase in world prices passes through to consumers' budgets. These include the percentage of income spent on food, the percentage of retail food expenditures spent on staple foods, government trade and domestic food policies.

A simple example taken from Trostle (2008) illustrates the differential impact of higher food commodity prices on consumers in developed and low income food deficit developing countries, see Table 3.1. The illustration shows that in a high-income country, a 50% increase in staple food prices causes retail food expenditures to rise by 6% leading to a marginal increase in the share of income spent on food from 10% to 10.6%. For a consumer in a typical low-income food-deficit country food expenditures increase by 21%, increasing the percentage share of income spent on food to more than 60%. In developing countries the impact of higher international food commodity prices is magnified by the higher food budget shares and the higher share of the cost of staples in food expenditures.

An FAO survey (FAO: 2008a) also shows whenever developing countries with large populations of poor consumers and small farmers are faced with significant increases in the international prices of food staples, they take measures that restrict transmission in the short run but allow transmission to take place slowly so that domestic prices adjust to international prices over a period of time. Such an approach gives them the time to take measures to offset the effects of the price increases in domestic markets. In the face of such responses, the transmission of international prices depends upon the fiscal sustainability of the support measures and the duration for which they are maintained.

The transmission of international prices to domestic producer prices has also important welfare consequences. The impact on producer prices not only affects the income gains

[9] In a situation where major exporters ban exports to moderate domestic prices, volumes in international trade may become very thin and international reference prices may not be very relevant for domestic price determination (e.g., current international rice prices are reported to be almost $1000 a ton the volume of deals struck at that price are perhaps very low). In the case of sugar where the bulk of world trade takes place under various bilateral and multilateral arrangements, the international price reflects only the price of the "residual" sugar in the market.

accruing to producers but also influences the supply response that can be expected. Many of the measures that developing countries take to insulate consumers from price increases may have the effect of depressing or controlling producer prices. This may delay the stabilisation of prices by attenuating the supply response.

Table 3.1: Impact of Higher Food Commodity Prices on Consumers' Food Budgets*

Food Budgets*	High-income countries	Low-income food-deficit countries
I. Base scenario		
Income	$40,000	$800
Food expenditure	$4,000	$400
Food costs as % of income	10.0%	50%
Disaggregated retail food spending (staples vs. non-staples)		
Staples as % of total food spending	20%	70%
Expenditures on staples	$800	$280
Expenditures on non-staples	$3,200	$120
II. Scenario: 50% price increase in staples, partial pass through on staples		
Assumed % pass through	60%	60%
Increase in cost of staples	$240	$84
New cost of staples	$1040	$364
New total food costs	$4,240	$484
Food costs as % of income	10.6%	60.5%

*These are illustrative food budgets that characterize the situations for consumers in high- and low-income countries.

Source: ERS-USDA (Trostle: 2008)

The extent of transmission of world prices to producer prices depends on the whether the commodity in question is an exportable good or an import substitute. In general we can expect that the impact of an increase in world prices will have a bigger impact on export parity prices compared to import parity prices. A few illustrative calculations using data from selected countries in different years show that between 58% and 99% of international price movements may be transmitted to farmers whose crops replace imports, while for export producers transmission can be far larger, from 1.5 to 3.8 times the movement in international prices, see Table 3.2.

Table 3.2: Transmission of International Prices to Domestic Producer Prices

Impact on farm gates prices: 10% rise in price international		Increase in Import Parity Prices	Increase in Export Parity Prices
Burkina Faso	Millet, 1986	5.8%	37.9%
Ethiopia	Maize, 1988/89	6.7%	18.2%
Kenya	Maize, 1984/85	9.2%	25.1%
Zimbabwe	Maize, 1981	7.2%	16.1%
India	Wheat, 1987	9.9%	19.8%
Pakistan	Wheat, 1989	7.6%	14.8%

Bangladesh	Wheat, 1993	7.0%	
Bangladesh	Rice, 1993	6.9%	18.3%

Sources: Based on Bangladesh data from Morris, Chaudhury and Meisner (1993) and data for other countries from Byerlee and Morris (1993)

The transmission of international prices during the last peak in agricultural commodity prices has been analysed in a number of studies using econometric time series studies (Sharma 1996, 2002; Conforti 2004, Rapsomanikis et al. 2003). While these studies find wide variation in speed and magnitude of transmission effects across countries, they do find some common patterns across products and countries, which are summarised below:

- African countries show lower degree of price transmission than other countries. Transmission is relatively complete in Asian countries with a more mixed picture in Latin America. The slower degree of transmission in African countries is generally attributed to the relatively much poorer transport infrastructure that hinders the spatial integration of markets;
- In Asian countries high and fast transmission is relatively more frequent for cereals, followed by oilseeds and is the slowest for livestock products. Among cereals transmission is strongest for maize, followed by wheat, with the lowest for rice. This appears to be related to the special status of rice in food security in Asian countries, whereas maize is largely used as a feed grain;
- Vertical transmission between the producer, the wholesale and the retail level within countries is generally higher than the transmission of changes in world reference prices. That is, in many countries, transmission between domestic and border prices are fairly incomplete even when domestic markets appear to be fairly integrated; and,
- Price transmission does take place for products and countries that are known to have considerable public intervention (Egypt, India, Pakistan). An interventionist policy environment does not insulate domestic prices from world prices and signals over the long term.

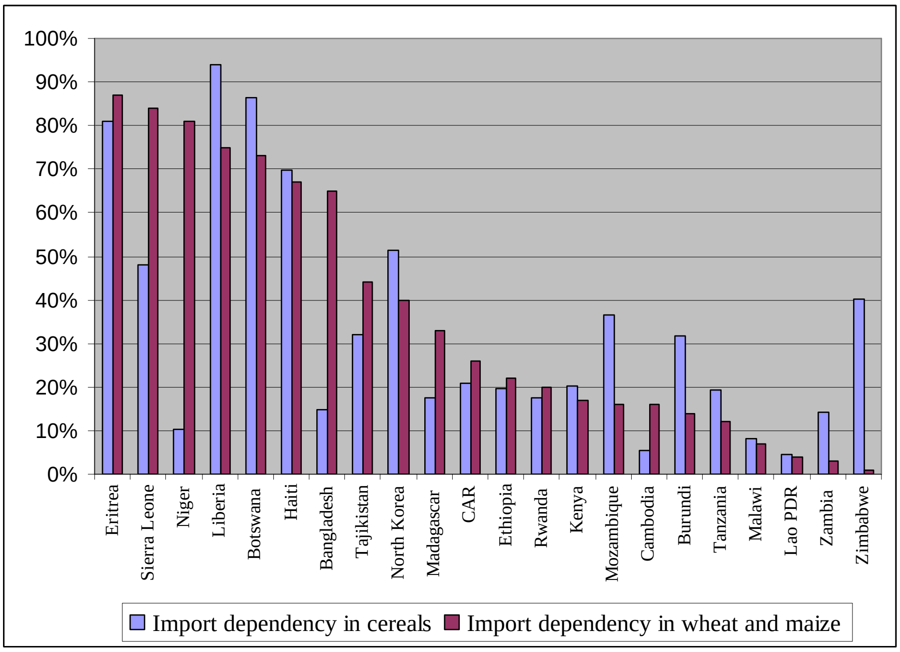
The period since 1995–96 has seen significant changes in the international trade regime for agricultural commodities. An important question to consider is whether factors affecting the transmission of international prices and the ability of developing country governments to insulate domestic markets have changed significantly since the mid-1990s. Some of the key developments influencing price transmission are discussed below:

(a) One consequence of global trade liberalisation is that economies are much more open now as evidenced by the increase in import to consumption ratios. This has been facilitated by the large foreign exchange reserves held by major importing countries, which has enabled them to contract for their import needs regardless of how high the world price rose.[10] More liberal import regimes, lower tariffs, lower transaction costs and Regional Trade Agreements have all facilitated the growth of international trade in

[10] According to the USDA “there have been very large accumulations of foreign exchange reserves held by oil-exporting countries (OPEC, Russia, and Ukraine) and by countries with large non-oil trade surpluses (China, Japan, and other Asian countries). Countries holding these large foreign exchange reserves are able to import large volumes of food commodities in order to meet their consumption needs and allay their domestic food price inflation. In essence, they can bid supplies away from other traditional importers that do not hold significant foreign exchange reserves.” (Trostle: 2008; p.22)

agricultural commodities. Import dependency in many developing countries has increased significantly. The import dependency ratios for Low-Income Food-Deficit Countries that have more than 30% of their population undernourished may be seen in Figure 3.1.

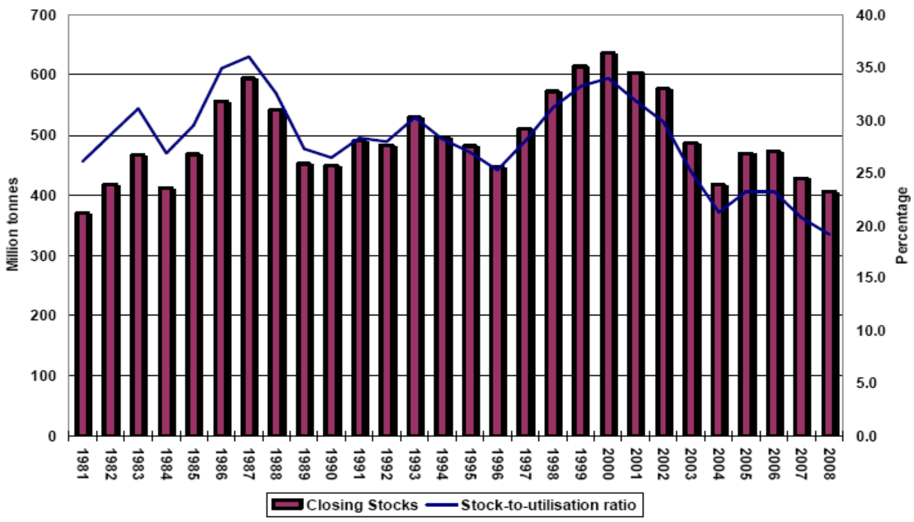
Figure 3.1: Import Dependency in Countries with Significant Levels of Undernourishment



Source: FAOSTAT

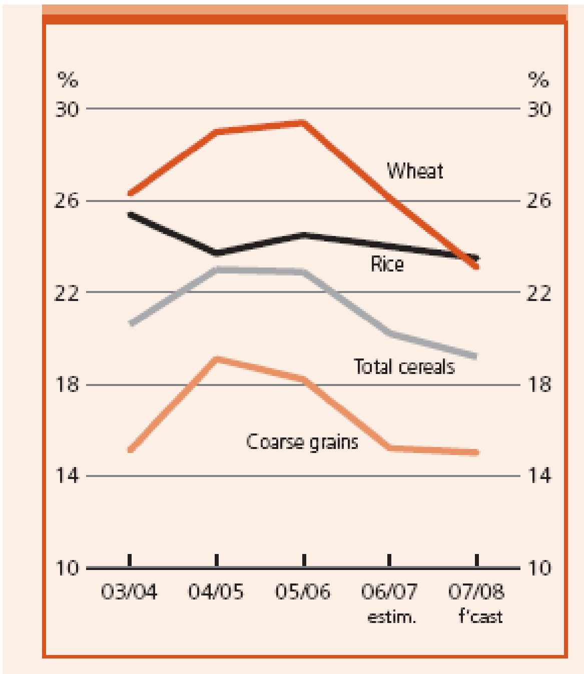
(b) The level of (domestic and international) stocks has an important bearing on the transmission of international prices to domestic markets. A developing country with a large domestic buffer stock of cereals may be able to use these stocks to prevent or mitigate food price inflation on account of spikes in international prices. Developing countries also frequently use imports to mitigate domestic food shortages and food price inflation. But the ability to import significant quantities may be linked to the availability of global stocks. The post-1995 (see Figure 3.2) period has witnessed a gradual decline in the stocks of food commodities particularly of cereals. The FAO (2008a) reports that global cereal stocks have declined at an average of 3.4% per annum in the post 1995 period. This has had a knock-on effect on other food commodities like oils and fats in recent years. The reduction in stocks has been a feature of both major exporting countries as well as that of low-income food-deficit countries.

Figure 3.2: Global Cereal Stocks and Stock-to-Utilisation Ratio



Source: FAO (2008a)

Figure 3.3: Ratio of Stocks to Utilisation for Major Cereal Crops



Source: FAO 2008b

Several factors have contributed to the declining stock levels. Figure 3.3 shows the trends in the stock to utilisation ratio for major cereal crops. The decline in the ratio over the last few years reflects the fact that the world consumption has exceeded production leading to a draw down of stocks. This reflects trends of slower growth in production in the face of rapid demand growth led by population and income growth in developing countries. Other factors contributing to lower stock levels include pressures to reduce the cost of maintaining large reserves by public institutions, increasing participation of private sector in the agricultural commodities trade, increase in the number of countries able to export, larger foreign currency reserves with many developing countries giving them the confidence that shortages can be met through imports and improvements in transportation and information. Increasing openness to international trade meant that it was possible to meet increasing consumption requirements through trade and it was no longer necessary to pursue self-sufficiency objectives. But lower stocks imply sharper price responses when unexpected events occur.

(c) The advent of biofuels has created a stronger relationship between agricultural commodity markets and energy markets. Given the much larger size of the energy market compared to the market for agricultural commodities, it has been argued that the expansion of biofuels will lead to increasingly tighter integration between two markets, with the prices in energy markets effectively setting a floor and ceiling for the price feedstock crops (Schmidhuber 2006). This tighter integration may signal a structural change in agricultural commodity markets heralding the end of the long time decline in agricultural commodity prices. The link with energy prices may mean that higher international food prices may persist for several years compelling developing countries to allow a more complete pass through of international prices.

(d) As was the case during the previous boom in agricultural commodities in the mid-1990s, developing country governments are responding with a range of measures to insulate their consumers from the impact of increasing international prices. Annex 3.1 provides a summary of measures by leading exporters and importers of foodgrains. These measures include reduction in tariffs or import restrictions in the case of importers and increased export levies or an outright ban on exports in the case of exporters. If the prices of agricultural commodities remains high owing to the strong inter-relationships between the agricultural and energy markets (and if what we are witnessing is a reversal of the long term decline in agricultural commodity prices), then the sustainability of many of these interventions will be doubtful. For instance, India's food subsidy bill has increased from US$1.2 billion in 1990–91 to over US$12 billion in 2007–08 constituting more than 1% of its GDP. If agricultural commodity prices remain high, then subsidies to consumers to insulate them from the effects of international price changes will balloon and will be fiscally unsustainable over long periods. Developing country governments will, therefore, be forced to allow international prices to be transmitted through to domestic markets.

The FAO has attempted a quick assessment of the extent of the pass-through of international prices in seven large Asian countries during the current spike in cereal prices (Dawe 2008). A simple method is used which compares the cumulative change in the (inflation adjusted) real domestic prices of wheat, rice and maize and their international prices adjusted for exchange rate appreciation in seven major Asian countries over the period Q4 2003 to Q4 2007. The study finds that world market prices have increased substantially in real US dollar terms over this period: rice 56%, wheat 91%, maize 40% and urea, the main fertiliser used by Asian farmers, 107%. However, during this period the US dollar has depreciated substantially against many currencies (this is perhaps one of the causes of high commodity prices) and this has dampened the increase in prices in domestic currency terms. The depreciation of the dollar has been a widespread phenomenon with an average depreciation of around 15% even with respect to low income and lower-middle income countries. The pass through of rice prices in seven Asian countries after taking into account the depreciation of the US Dollar are summarised in Table 3.3.

Table 3.3: Cumulative Percentage Changes in Real Rice Prices, Q4 2003 to Q4 2007.

Country	(1) World price (nominal US$)	(2) World price in domestic currency (exchange rate adjusted)	(3) Domestic price (Inflation adjusted)	(4) Pass through (%) = (3)/(1)
Bangladesh	56	55	24	43
China	48	34	30	64
India	56	25	5	9
Indonesia	56	36	23	41
Philippines	56	10	3	6
Thailand	56	30	30	53
Viet Nam	39	25	3	11

Source: Dawe: 2008

There is considerable variation across countries in terms of pass through of rice prices. India, Philippines, Bangladesh and Vietnam are stabilisers, using a variety of policy instruments and interventions — storage, public distribution systems, export restrictions, changes in tariffs — so that changes in real domestic prices are less than half of changes in exchange rate adjusted international prices. Thailand and China appear to allow more complete transmission of international rice prices, even though China does not allow the private sector to trade. In Indonesia, domestic prices have been more volatile than international prices. On average increases in real domestic prices have been one-third of the increases in exchange rate adjusted US dollar prices.

For wheat, the study finds Asian countries stabilising wheat prices less than rice prices, but stabilisation of wheat prices is still substantial in many cases. Bangladesh is found to be not stabilizing domestic wheat prices whereas India is stabilizing domestic wheat prices, but less than in the case of rice. In the case of Indonesia, domestic rice and wheat prices have increased by approximately the same amount. The greater stabilisation efforts directed at rice may be related to its greater importance in terms of cropped area and consumption of the poor in these economies.

The study also finds that the pass through of urea prices appears to have been largely neutralised by the depreciation of the US Dollar.

Changes in producer (farm prices) and consumer (retail prices) appear to be closely in step indicating that the markets are well integrated in Asian countries, Table 3.4.

Table 3.4: Percentage change in real domestic producer and consumer prices Q4 2003 to Q4 2007

Country	Commodity	Producer Prices	Consumer Prices
Bangladesh	Rice	8	2
Bangladesh	Wheat	42	39
China	Rice	28	30
Indonesia	Rice	28	32
Philippines	Maize	9	5
Philippines	Rice	7	3

(Dawe: 2008)

The above discussion suggests that there is considerable heterogeneity of individual country effects, even within a group of seven Asian countries. The nature and speed of transmission effects could be considerably different in sub-Saharan African countries where import dependency may be greater, transport infrastructure may be poorer and the capacity of governments to stabilise markets may be more limited. Notwithstanding the heterogeneity of country effects, it appears that international prices shocks are being transmitted fairly rapidly to domestic markets in developing countries although the magnitude of transmission has been substantially offset by the depreciation of the dollar and governmental interventions to insulate domestic consumers against food price inflation.

Liberalisation of agricultural trade, greater import dependency and import to consumption ratios and lower stock levels are all factors that may contribute to quicker transmission of international prices in the future. The main effect of biofuel expansion on the transmission process may arise from the tighter integration of agricultural commodity markets and the reversal of the long time decline in agricultural commodity prices.

There is no universal measure of price transmission. Variations between countries and for different products outweigh general tendencies, other than to say that there will in most cases be some muting of changes in international price movements on domestic prices.

Annex 3.1: Measures Taken by Developing Countries to Fight Food Price Inflation

Countries	Reduce or eliminate tariffs	Reduce or eliminate consumer taxes	Increase export levies	Quotas	Reduce export licences or ban exports	Fix consumer prices
Argentina			Corn levies increased to 25%; Wheat levies to 28%		Stopped maize export permits	
Azerbaijan		Eliminated VAT on grains				
Bangladesh	Reduced tariffs of rice and wheat imports by 5%					
Bolivia	Eliminated import duties on wheat, wheat flour, rice and maize				Banned wheat exports	
Brazil	Considering removal of tariffs on wheat					
Cameroon		Eliminated VAT on rice				Fixed prices of rice
China			Introduced export levies on wheat, buckwheat, barley and oats by 10 % Increased those on wheat flour and starch, maize, sorghum, millet and soybeans	Introduced export quotas on flour made of wheat, maize and rice		
Ecuador	Eliminated tariff on wheat and wheat flour					Fixed bread prices Raised food subsidies
Egypt						Raised food subsidies
EU	Suspended import duties on cereals (excluding buckwheat, oats and millets					
Honduras					Introduced export ban on maize	
India	Eliminated					

	tariffs on wheat and wheat flour						
Indonesia	Eliminated tariffs on wheat and soybeans						
Morocco	Reduced tariffs on cereals						
Mexico	Remove tariffs on maize, pulses, milk and sugar				Remove quotas on maize, pulses, milk and sugar		
Pakistan					Imposed levies on exports of wheat and wheat flour	Banned private exports wheat to Afghanistan	
Peru							Considering subsidising bread prices
Republic of Korea	Reducing tariffs on wheat and maize; eliminating those on soybeans and feed maize						
Turkey	Reduced tariffs on wheat and maize; eliminated that on barley						

Source: FAO: 2008a)

4. How will price rises induced by biofuels affect consumers in the developing world?

4.1 Introduction

In this section we examine the poverty and food security impacts of rising food prices induced by the expansion of biofuel production. In most developing countries, the poor spend a very high proportion of their income on food. This proportion can be as high as 70% in many countries and generally increases as we go down the income quintiles. A sustained rise in food prices can have substantial negative impact on the real incomes of the poor with detrimental effects on nutrition and health. At the household level, analysis of impacts has to take into account livelihood characteristics as they are the key drivers of welfare impacts. Importantly, the analysis must distinguish between the urban and the rural poor and between net buyers and net sellers of food. Short-term effects also need to be distinguished from long-term effects.

Poorer households in urban areas are predominantly net buyers of food as they mainly rely on wage income. Transmission of international prices to urban areas tends to be quicker as these areas are better connected to ports and international trade. These households are invariably likely to suffer negative welfare consequences on account of higher food prices unless these are offset by government intervention. While most agriculture producers are in rural areas, not all rural households are net sellers of food. A large proportion of the rural poor, particularly the landless and those with very small holdings, are net buyers of food. The proportion of rural households that are net buyers of food is an important determinant of the poverty impact of food price increases.

The benefits from higher food prices accruing to food producers who are net sellers will depend on a number of factors. The extent of transmission of higher food prices to the farm-gate level, the structure of markets and the quantum of marketable surplus will be important determinants of welfare gains. If the spatial transmission of prices is hindered by poor infrastructure, or if the structure of markets allows farmers to appropriate only a small share of the price increases, then the gains to net sellers will be limited. The gains to producers will also depend on their access to land and complementary inputs, which will determine their ability to respond to higher prices with increased production. The production response generated by higher prices has an important effect on poverty as food production in developing countries uses unskilled labour intensively. As food production expands in response to higher prices, input prices including wages are likely to be bid up. If the increase in wages is of a magnitude that offsets the increase in food prices, then wage earners in agriculture will also stand to gain. Given that landless agricultural workers and other agricultural wage earners are amongst the poorest in rural areas, the wage effects have important implications for poverty and access to food for the poor.

In a developing country, where a majority of the poor are net buyers of food, and where agriculture is not a major component of GDP, the overall impact of a sustained rise in food prices on poverty is likely to be strongly negative in the short term. The overall impact will be driven by the adverse impacts on food consumption of poor households with high food budget shares. These negative impacts for the poor will be worsened if food price increases contribute to inflationary pressures in the economy.

The nutritional implications for the poor will depend on relative price changes of different foods, which will determine substitution possibilities. Substitution of cheaper foods can mitigate the adverse nutritional impacts of higher food prices. Substitution possibilities may be limited if prices of different foods increase uniformly.

In the longer term, as a supply response is generated, increasing agricultural production and productivity could have important poverty reducing impacts through wage effects and multiplier effects on the non-farm and other sectors of the economy.

Given the complexity of factors and the nature of inter-relationships to be considered, a precise empirical assessment of the poverty and food security impacts food price increases is difficult. A reliable empirical assessment requires detailed data at the household level on consumption patterns, substitution possibilities, market participation (net buyer or seller position), factor endowments and wage effects. High quality household level data is required as aggregate consumption and production data are not useful for the purpose. We review below a few recent empirical studies on the impact of rising food prices on poverty using large household data sets. The welfare impacts are estimated by assessing the magnitude of the price effects and income effects of an increase in prices.

4.2 Existing studies

Elobeid and Hart (2007) use the projections from the FAPRI models[11] to see how world agricultural prices are affected by US plans to expand biofuels production, with scenarios based on a US$10 rise in the price of a barrel of crude oil. Using data from FAO food balance sheets, they then show how the increase in world commodity prices would affect the costs of food baskets around the world and how higher food costs will impact food security, particularly in developing countries. In general, they find that countries where maize (corn) is the major food grain experience larger increases in food basket cost while countries where rice is the major food grain have smaller food basket cost increases. Countries where wheat and/or sorghum are the major food grains fall in between.

Consequently, the highest percentage increases are seen in Sub-Saharan Africa and Latin America where food basket costs are estimated to increase by at least 10%. The lowest percentage increases are seen in Southeast Asia, with cost increases of less than 2.5%. The results from this study illustrate how differences in the composition of food baskets influence the impact of price increases on consumers. However, the analysis which is done at the level of country-specific aggregates masks the differences in effects on consumption patterns across socio-economic groups within a country. It also does not allow for substitution effects.

FAO (2008) reports the results of a study by Karfakis et al. (2008) that estimates the short-run impact on real household income of a 10% increase in the price of main staples for Bangladesh and Malawi. The methodology uses information on net buyers and net sellers of food derived from the RIGA[12] data base of household surveys. Results for the two countries are summarised in Table 4.1.

- In Bangladesh, rural households in all income quintiles have greater welfare losses than urban households. The biggest losers in the poorest rural quintile are characterised by a high level of dependence wage income with a vast majority being net food buyers. The lower welfare losses of urban households are on account of their lower dependence on wage income. Small landholders and the landless face the most adverse consequences in terms of welfare.
- In Malawi, welfare losses are greater for urban households than for rural households, but the welfare losses are highest in the poorest income quintiles. Only households in the highest income rural income quintiles gain in the short run and these households are associated with a high proportion of income earned from crop production (in spite of market participation being limited in these households).

[11] A series of international agricultural commodity models by FAPRI, Iowa State University. See http://www.fapri.iastate.edu/models/

[12] FAO's Rural Income Generating Activities Database which brings together household surveys from 14 developing countries.

Table 4.1: Effect on Real Household Income of a 10% Increase in the Price of the Main Staple Food (% change)

Country		Per Capita Expenditure Quintiles (1 = poorest					
		1	2	3	4	5	All
Bangladesh	Rural	-3.2	-2.6	-1.9	-1.6	-1.1	-1.8
	Urban	-2.4	-1.9	-1.5	-1.1	-0.7	-1.3
	Total	**-3.0**	**-2.3**	**-1.8**	**-1.4**	**-0.9**	**-1.6**
Malawi	Rural	-1.2	-0.6	-0.2	-0.0	0.5	-0.2
	Urban	-2.6	-2.0	-1.4	-1.2	-0.2	-1.1
	Total	**-1.3**	**-0.6**	**-0.4**	**-0.2**	**-0.1**	**-0.4**

Source: FAO: 2008

These results suggest that short term welfare losses and gains depend on household characteristics and are country-specific. The welfare losses are driven by the net buying position of households in both urban and rural areas. Greater reliance on wage income and landlessness are associated with greater welfare loss. Unless strong substitution effects towards cheaper food items are present, in the short term the majority of households will see their welfare deteriorating. Only a small proportion of wealthier rural households are net sellers of food and this implies that poverty rates can be initially expected to rise (FAO: 2008).

Data from the World Bank's World Development Report for 2008 (World Bank 2007) for seven developing countries (Table 4.2) illustrate the fact that the majority of the poor are not net sellers of (tradable) food staples. In all cases, net sellers constitute less than a third of the poor with the percentage being as low as 6–8% in some countries. This implies that the aggregate welfare effect on the poor of an increase in the price of food staples will be dominated by its effect on net buyers.

The adverse welfare impact will be greater in cases where a large percentage of the expenditure of net buyers is spent on staples. This is the case in Bangladesh, where net buyers spend 27% of their expenditure on the purchase of the main staple (rice) making them particularly vulnerable to increases in the price of rice. The gains to net sellers from a rise in prices are likely to exceed the losses to net buyers only when a significant proportion of the poor are net sellers and income from crop sales represents a large proportion of their income as is the case in Madagascar and Vietnam.

The World Bank has estimated that nearly 100 million people could be pushed into poverty as a result of the recent increases in food prices nullifying seven years of poverty reduction efforts. This much-quoted assessment of short-term poverty impacts is based on a quick assessment of the poverty impacts (Ivanic & Martin: 2008) of food price inflation in selected developing countries with good availability of household level data and extrapolation of the results to all low income countries. The analysis is based on a model that takes into account the both price and wage effects on poor households using large household data sets (from the Bank's Living Standards Measurement Surveys) in nine countries.

The authors consider two scenarios. The first scenario involves a 10% price increase for major food products separately for each product and for all products together. The second scenario is based on the actual observed price changes from 2005 to 2007 for major food products. They first simulate the effects of a 10% price increase for (1) each product separately and (2) for all products together on households close to the poverty line, estimating changes to their incomes as consumers paying more for food, as net sellers of produce earning more and as labourers in unskilled markets earning higher wages in activities producing goods with higher prices. Country CGE models (national versions of GTAP) are used to estimate the impact of higher commodity prices on wages. Their results show considerable differences for countries and for products, but overall poverty rises and rises more for urban than rural households. Only in a few cases do price rises confer sufficient additional income to the poor to offset their rising costs as consumers. The authors also present poverty impacts with and without wage effects: as may be expected find that increases in poverty rates are greater when wage effects are ignored.

Table 4.2: Net buyers and Net Sellers of Tradable Food Staples among the Poor

	Bolivia 2002	Ethiopia 2000	Banglades h 2001	Zambia 1998	Cambodia 1999	Madagasc ar 2001	Vietnam 1998
Share of internationally traded staples in food consumption of the poor (%)	25.5	24.1	41.2	40.4	56.3	62.7	64.4
Distribution of poor (%)							
Urban (buyers)	50.9	22.3	14.9	30.0	8.4	17.9	6.1
Rural landless (buyers)	7.2	—	53.3	7.4	11.5	14.8	5.8
Smallholders net buyers	29.1	30.1	18.8	28.8	25.8	18.9	35.1
Smallholders self-sufficient	7.1	39.5	4.6	20.8	18.0	27.3	19.4
Smallholders net sellers	5.6	8.0	8.4	13.0	36.3	21.1	33.6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Share of net purchase/sale of staples by specific groups of the poor (% of the total expenditures of the specific groups)							
Purchase per net urban buyer	12.0	9.4	22.7	11.5	5.9	4.8	13.1
Purchase per net rural buyer	12.9	28.4	27.3	18.9	20.8	10.7	19.9
Sales per net seller	37.6	35.1	39.7	21.0	39.0	70.3	37.4
Share of net purchase/sale of staple aggregated across all the poor (% of the total expenditure of all poor)							
Purchase by all poor net buyers	11.3	10.2	22.0	10.3	8.1	3.6	8.8
Sales by all poor net sellers	1.4	2.8	4.0	2.3	14.4	18.4	12.5

Source: World Bank 2007

They then estimate the changes in poverty and poverty gaps resulting from the price increases assuming full pass-through of international prices to domestic prices making no adjustment for the depreciation of the US Dollar. In the second scenario they simulate the observed price changes from 2005 to 2007, but with adjustments for the decline in the dollar relative to the currencies of the sample countries and for inflationary effects. They also make adjustments for barriers to the transmission of international prices, assuming an average transmission percentage of 66%. With these assumptions they estimate the increase in poverty in each sample country taking into account the effect of increased commodity prices as well as the increase in wages relative to other prices. They find that for the nine countries in the sample, there is an average 4.5% increase in the national poverty ratio reckoned at the US$1 a day poverty line. The application of this average percentage to all low income countries yields a figure of 105 million people who are likely to be pushed into poverty — out of a total population of low income countries of 2.3 billion — offsetting the gains in poverty reduction achieved over a period of seven years.

These are quick estimates that are mainly intended to illustrate the magnitude of the potential increase in poverty as a result of continuing rises in world food prices. An important limitation is that they do not make allowances for substitution effects which may be very significant as the diets of the poor change quickly in response to food price inflation. The use of an average percentage figure to assess the poverty impact in all low income countries implies that the differences in distribution of poverty are not taken into account.

The wages effects are contingent upon a vigorous supply response in agricultural production. In the present context, supply responses could be muted if farmers are deterred from expanding production on account of high input prices or lack of access to complementary inputs.

Notwithstanding these limitations, this approach provides a useful framework for assessing the poverty impacts of a sustained increase in food prices induced by biofuel production.

4.3 Nutrition Impacts

The IFPRI IMPACT model generates likely changes in nutrition. It is estimated that every percentage point increase in real international prices for staple foods would make 16 million more people food insecure — leaving 1.2 billion chronically hungry by 2025 — 600 million more than previously imagined.

In their projections of the impacts of biofuels, calorie consumption decreases in all regions in all the scenarios considered compared to baseline levels. The biggest decreases are in sub-Saharan Africa where the expected decrease in 8%. Under the ‘conventional scenario’ with aggressive demand for biofuel feedstock from traditional food and sugar crops, the number of malnourished children increases by 11 million children, with the largest absolute increase in Sub-Saharan Africa, followed by South Asia. In percentage terms, on the other hand, the increase is largest in Latin America.

4.4 The consequences of predicted price rises on poverty in the developing world: a simple illustration

How might the price rises modelled in Chapter 2 affect poverty in the developing world? A simple illustration can be made as follows, selecting a few countries to illustrate — in this case the four case country countries plus Kenya:

- Take the price increases in imports projected for the region in which the country lies — see Table 2.4, assume full transmission through to domestic prices;
- Compare to the average food budget (FAO data) for households in the country, calculate the increased cost of the food budget assuming no change in diets in response to price changes (zero elasticity of demand); and,
- Use the implied change in real income to shift the poverty line upwards, and thereby see the change in the poverty headcount. The World Bank’s PovCal tool was used to do this.

Table 4.3 shows the results. Food bills increase by small amounts, at most 2%. Differences between countries reflect the different composition of diets, with Malawi having the largest increase since maize dominates the diet and this is a feedstock for biofuel; in marked contrast to Bangladesh that has rice as its main staple, the price of which is little affected by biofuels.

Poverty headcounts rise in all cases, although always by less than one percentage point. The absolute numbers in poverty as a result in most cases is a few tens of thousands, although in India the number of 1.8M.

The impacts are small, even if unwelcome. But small enough to be countered by social protection measures.

Table 4.3: Impact of projected price rises on poverty in selected developing countries

Country	Population, M	Initial poverty, %	Increase in average food bill, %	Final poverty, %	Increased number of poor, M
Kenya	34	12.1%	12.1%	13.0%	0.31
Malawi	13	20.8%	20.8%	22.6%	0.23
India	1,079	34.3%	34.3%	35.3%	10.67
Bangladesh	139	35.0%	35.0%	35.3%	0.35
Brazil	184	7.6%	7.6%	7.7%	0.18

Source: own calculations with aid of FAO data on food budgets and the World Bank's PovCal

5. What is the potential for the poor to earn more by producing biofuels?

There appear to be surprisingly few assessments of the potential of the poor to benefit from biofuels that go much beyond advocacy or statements derived from principles. Just a few studies report on experiences to date (ECDO 2007, Euler & Gorriz 2006), generally telling of greater problems than expected.

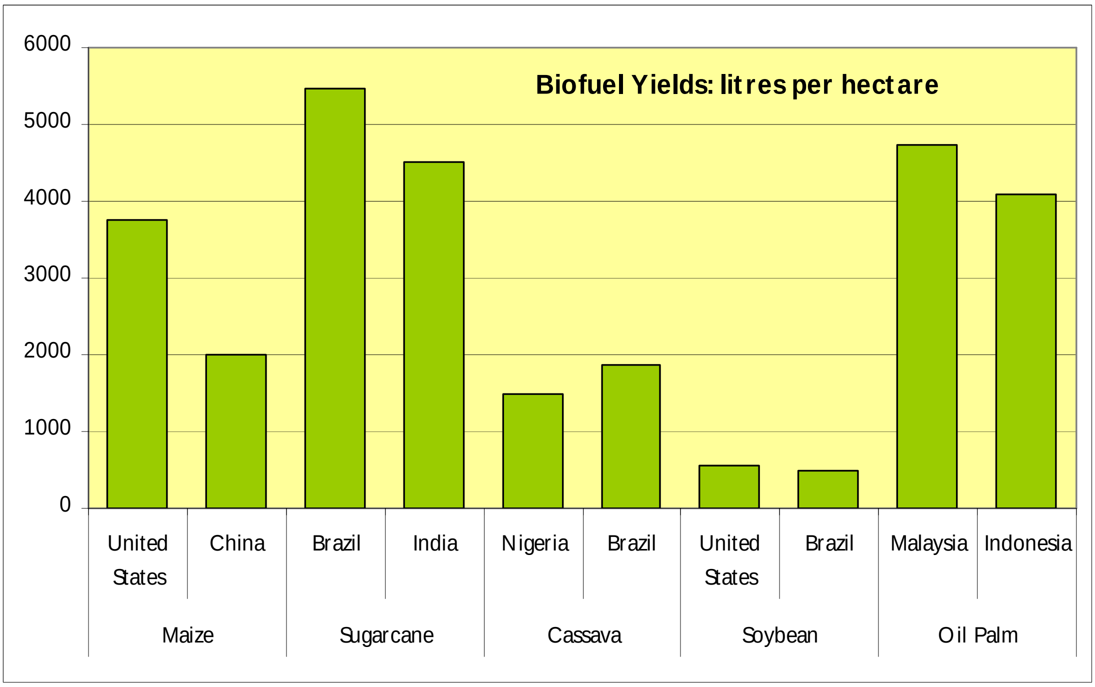
This section looks at the issues in two ways. First, some simple analyses of the potential gross margins of growing biofuel feedstock have been made to explore just how attractive biofuel might be to a small farmer. Second follows some consideration of whether small farmers could become involved in such production.

5.1 Analysis of gross margins possible from biofuels

To understand the potential for smallholder production of biofuels, it is useful to examine the gross margins that might be earned by farmers for producing feedstock. To simplify matters, just three crops are considered here: sugar cane for ethanol; and oil palm and jatropha for biodiesel. Several other crops, including maize, sorghum, cassava, soy bean, and castor, could also be grown.

The three selected have been picked out since at first sight they are all promising candidates. Sugar cane and oil palm are distinguished by the very high yields per hectare that they potentially offer — see Figure 5.1. And it is not just their physical productivity: several sources state that ethanol produced from sugar cane in southern Brazil is the lowest cost biofuel on offer at present — see, for example Schmidhuber 2006. Jatropha has been added on the grounds that it is has excited much interest as being a feedstock that can be grown on marginal lands and thus does not compete with food crops for land.

Figure 5.1: Biofuel yields of different feedstock, litres per hectare



Source: Data taken from Naylor et al. 2007

Deriving farm-gate prices for feedstock

A key issue in preparing a gross margin for these crops is to estimate what the farmers may receive at the farm-gate for their feedstock. Since the feedstock is to be used to prepare a fuel, then the price of interest is that for the alternative fossil fuel, either petrol in the case of ethanol, or diesel in the case of biodiesel. For the purposes of imagining the future value of biofuels, the price of crude oil taken is that projected by USDA for 2016/17, 13% higher than in 2006 in constant terms (USDA 2008, Table 1). In 2006 crude oil prices to US refiners were US$59 a barrel (EIA data), so the projected price for 2017 would be **US$66.5** a barrel in 2006 prices.

Turning a crude oil price into petrol and diesel prices is difficult to do if one proceeds by looking at the costs of refining and distribution, largely since oil refining produces more than a dozen different products, so that attributing a refining cost to any given product is difficult. Hence the approach taken here has been to observe pump prices reported for oil prices within two dollars of the US$66.5 benchmark in recent times. The rise in oil prices over the last five years fortunately provides an observatory of the relation of fuel prices to those of crude oil. EIA data show 16 weeks in recent years when the West Texas oil price lay in the range US$64.5 to US$68.5 a barrel. For those weeks there are observations from US markets and from five European markets, for both petrol and diesel. The average over the 16 weeks for the six markets for each product was computed, and the lowest observed price across the six markets was taken.[13] This turned out to be France for petrol, the US for diesel, and in both cases the price was equivalent to **US$0.59 a litre** — prices excluding taxes.

That price becomes the point from which to estimate the farm-gate value of ethanol and biodiesel. The main elements to be deducted from pump prices are then, working back from pump to farm:

- Transport, distribution and retail margin of fuel;
- Processing and refining costs of the biofuel;
- Transport of feedstock from farm gate to processing plant; plus,
- Value of by-products.

The calculations are summarised in Table 5.1. Significant variations in farm-gate values can be generated by differences in processing costs, transport and the value of by-products.

As Kukrika (2008) describes in detail for the case of jatropha in India, there are trade-offs between the transport costs of hauling bulky feedstock to large-scale processing plants with economies of scale, versus making shorter trips to smaller-scale plants with higher unit operating costs.

Setting a value on by-products is tricky: much depends on the scale of the industry and the development of the economy that allows the by-products to be put to best use. Glycerin, for example, is a relatively high-value by-product of biodiesel processing, but only so long as the biodiesel industry is relatively small. Once it grows, the glycerine market can quickly be swamped and prices fall. Bagasse illustrates the second point: virtually a waste product in simple cane mills, it becomes valuable when the mill can use the bagasse for power and even more so when it can generate a surplus of electricity for sale to a grid — as has recently been achieved in Mauritius.

Given these farm-gate values, what then are the economics of growing feedstock?

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[13] The six markets reported prices that were quite close to one another. The difference between the cheapest and most expensive fuel was around 18–19%.

Table 5.2: Farm-gate prices for feedstocks

Biofuel:	Unit	Biodiesel			Ethanol	
Data concerns:		Jatropha, India	Palm oil, Panama	Palm oil, Indonesia	Sugar cane, Brazil	
Pump price	US$/litre	0.59	0.59		0.59	
Transport, distribution and retail margin of fuel	US$/litre	-0.07	-0.11		-0.11	
Processing and refining costs	US$/litre				-0.075	-1.03
• Transesterification	US$/litre	-0.14	-0.07			
• Oil extraction	US$/litre	-0.08	-0.07	-0.09		
Transport feedstock from farm gate to processing plant.	US$/litre	-0.03	-0.03		-0.03	
Sub-total		***0.27***	***0.31***		***0.37***	
Conversion: litre biofuel to tonne feedstock		293.25	232.68	211.00	75	
Value of feedstock	**US$/tonne**	**79.37**	**71.18**		**27.73**	
By-products						
Product	By-product	Glycerin	Glycerin		Vinasses	
	kg per tonne processed	100	25		115.7	
	US$/tonne	150	200		93.75	
	Value	15	5.00		10.85	
	By-product		Palm Kernel Oil			
	kg per tonne processed		15.2			
	US$/tonne		770			
	Value		11.70			
	By-product		Palm Kernel Pulp		Cane pulp/Bagasse	
	kg per tonne processed		21.6		310.7	
	US$/tonne		130		4	
	Value		2.81		1.24	
Total, by-products		15.00	19.51		12.09	
Total farm-gate value	**US$/tonne**	**94.37**	**90.69**		**39.82**	
Data source		Kukrika 2008	Bhattacharya 2007		CEPAL 2006	Refuel 2007

Value bagasse at Maurice R100/t = US$4/t
Deepchanda

Gross margins for feedstock

Sugar cane

Table 6.3 presents the gross margins, and returns to labour where computable, for four sugar cane operations in Bangladesh, Costa Rica and India. It is clear that sugar cane grown for ethanol can offer very high returns: from just under US$1,000 a hectare to over US$2,000 a hectare per cut[14] that typically varies from 12 to 18 months. Given the length of time to harvest, and the time to establish the cane, these data overstate the case a little, but even so the returns are very attractive. Expressed in terms of returns to days worked on the cane fields — a measure of great interest to the smallholding household that generally provides the bulk of the labour, the results are even more striking: in the Indian cases, the implicit return is US$16 and US$17 a day, and over US$7 a day in Bangladesh.

Table 5.3: Returns to sugar cane as an ethanol feedstock

Cost Items		Uttar Pradesh	Maharashtra	Bangladesh	Costa Rica
Seed	US$/ha	44.1	87.2	193.3	
Fertilizer	US$/ha	40.6	114.0	114.6	192.1
Manure	US$/ha	13.0	12.8	5.1	
Pesticides	US$/ha	0.8	0.0	27.7	42.2
Irrigation	US$/ha	28.9	91.5	24.0	111.4
Machine rental	US$/ha	14.4	67.7	75.3	
Animal labour	US$/ha	8.9	28.2	25.6	
Human labour	US$/ha	178.5	252.8	185.7	
Other operations	US$/ha				895.8
Total cost	US$/ha	329	654	651	1,242
Yield (t/ha)	tonnes/ha	49	79	41	85
Unit Cost ($/ton)	US$/tonne	**6.71**	**8.27**	**16.06**	**14.61**
Value as feedstock	US$/tonne	39.8	39.8	39.8	39.8
Total value	US$/ha	1,954	3,150	1,614	3,384
Gross margin	US$/ha	1,625	2,496	963	2,143
Return to labour	US$/day	16.17	17.40	7.42	
Lab days		111.5	158.0	154.7	
Wage rate	US$/day	1.6	1.6	1.2	

Sources: Hossain & Deb 2003, CEPAL 2007. Data for Costa Rica are for second and subsequent cuts

How well does ethanol pay compared to the producer prices reported in these cases? For South Asia, Hossain & Deb register prices of under US$18 a tonne for India, but as much as US$30 a tonne in Bangladesh. For Central America, prices paid varied between US$13 and

14 Sugar cane is a perennial. Once planted it takes 12–22 months to the first cut, after which the subsequent ratoon crops, of which usually two are taken, can be harvested in 12–18 months.

US$19 a tonne. The farm-gate price used here for ethanol of almost US$40 a tonne makes producing feedstock far more attractive than growing for sugar.

Can smallholders achieve these results? It is believed that the data for the South Asian cases refer to small farms producing for a centralised sugar mill. Inspection of the inputs and yields shows that the four systems reported span a range from low-input, low-yield as seen in U.P., to high input-high yield as seen for Costa Rica. This suggests that small farmers could get similar returns, so long as they have a nearby sugar mill and distillery.

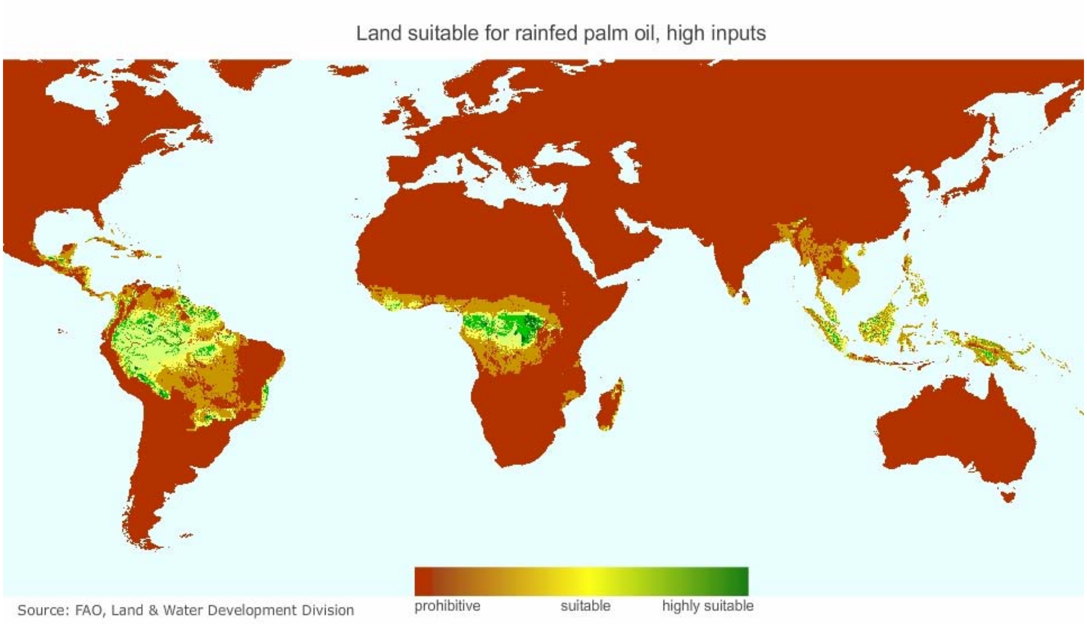
Oil palm

Table 6.4 shows the potential returns to a smallholder growing oil palm in Sumatra, Indonesia, under supervision. In this case of a long cycle perennial crop, it is necessary to compare returns through time: a Net Present Value (NPV) has been calculated based on a 5% rate of discount.

The returns are highly attractive: an NPV of more than US$9,000 a hectare. Seen in terms of implicit returns to labour, in this case the NPV would run to zero if labour were rewarded at US$13 a day. Returns are, not surprisingly, sensitive to the discount rate — if it were set at 10%, these returns would be roughly halved. The Internal Rate of Return (IRR) if labour is rewarded at US$5 a day comes to 21% — a figure that should satisfy most people's preferences for consumption today over that in the future.

How does the farm-gate price deduced compare to actual prices paid? In 2004 it was reported that in Indonesia growers were getting around US$60 a tonne, but that was when the international price for palm oil was far below the 2007 price — if the 2004 figure were inflated to 2007 values at the same rate as the increase in the international price over that time, 65%, it would be almost US$100 a tonne. In a more recent study Bhattacharya (2007) reports a fruit price of over US$100 a tonne in Panama. At these levels, two things are clear: first, it seems to make little sense to turn the palm oil into biodiesel; second, oil palm is extremely attractive crop to any grower who has the capital to establish the plantation and wait three years for the plants to bear fruit.[15]

Figure 6.2: Areas suitable for rain-fed oil palm



[15] If these estimated returns are anything like realistic, the incentives to clear tropical forest for oil palm are alarmingly strong.

Table 5.4: Gross margin for oil palm smallholding, Sumatra, Indonesia

Year			**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Material inputs, 2006 values	US$, 06		614	135	112	46	46	46	46	46	46	46	46	46	46	46	46	46
Labour	Day		185	100	39	39	48	56	59	58	68	68	68	68	68	68	68	63
Labour cost	US$		925	500	195	195	240	280	295	290	340	340	340	340	340	340	340	315
Sub-total, costs			1,539	635	307	241	286	326	341	336	386	386	386	386	386	386	386	361
Yield, fruit	t		0	0	0	4	7	11	12	14	18	18	18	18	18	18	18	16
Price paid per tonne fruit	US$/t	90.69																
Total returns	US$/ha		0	0	0	363	635	998	1,088	1,270	1,632	1,632	1,632	1,632	1,632	1,632	1,632	1,451
Net returns	US$/ha		-1,539	-635	-307	121	348	671	747	933	1,246	1,246	1,246	1,246	1,246	1,246	1,246	1,090
Discount rate		0.05																
Discount factor			1.000	0.952	0.907	0.864	0.823	0.784	0.746	0.711	0.677	0.645	0.614	0.585	0.557	0.530	0.505	0.481
PV			-1,539	-605	-279	105	287	526	557	663	843	803	765	729	694	661	629	524
NPV		9,056.2																
Labour cost	US$/day	5																

Year	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Material inputs	46	46	46	46	46	46	46	46	46	46
Labour	63	63	63	63	62	62	62	62	62	62
Labour cost	315	315	315	315	310	310	310	310	310	310
Sub-total, costs	361	361	361	361	356	356	356	356	356	356
Yield, fruit	16	16	16	16	14	14	14	14	14	14
Price paid per tonne fruit										
Total returns	1,451	1,451	1,451	1,451	1,270	1,270	1,270	1,270	1,270	1,270
Net returns	1,090	1,090	1,090	1,090	913	913	913	913	913	913
Discount rate										
Discount factor	0.458	0.436	0.416	0.396	0.377	0.359	0.342	0.326	0.310	0.295
PV	499	475	453	431	344	328	312	297	283	270

Source: Input-output data from Ruthenberg 1980, for smallholding observed in 1972

Can smallholders benefit from this? Yes, provided that (a) they are close enough to an oil extraction plant — not a very demanding criterion since fairly small-scale plants can be set up; and (b) the physical conditions are apt — a more demanding criterion and one that effectively limits oil palm to the humid zones where more than 1,500 mm and preferably 2,000 mm of rain can be expected, as illustrated in Figure 6.2.

Jatropha

Table 5.5 shows gross margins and returns from jatropha in India. There are two variants presented. Most of the inputs are for a relatively low material input system, with modest yields that reach 5 tonnes per hectare of seed. The last part of the table looks at what might be achieved at much higher yields of 10 tonnes per hectare.

The first variant offers moderate returns: an NPV of US$574 a hectare with labour paid at US$3 a day, and an IRR of around 12%. In situations where jatropha can be grown on lands with little alternative use, where labour is cheap, and people are prepared to plant and wait three years before seeing a pay-back, the enterprise may be attractive.

The picture changes if the higher yields could be achieved: depending in large part on fertilisation and irrigating when necessary. Now the NPV rises to more than US$2,000 a hectare, the IRR to more than 24%, and — at 5% discount rate — the implicit return to labour could be as much as US$8 a day.

But the major question here concerns the yields. In promotional pieces, jatropha is commended as a crop that offers high yields, but equally praised for its ability to grow on marginal lands. But the two cannot apply at the same time: jatropha grown on marginal lands with poor fertility and moisture stress will probably yield equally marginally — two tonnes of seed per hectare or less. A review of previous experiences of jatropha repeatedly mentions how meagre yields have been unless the plant has been fertilised or grown on good soils, and in areas with reasonable rainfall or with irrigation (Euler & Gorriz 2006).[16]

How attractive is jatropha to smallholders? On these yields, the hopes in Malawi that it could substitute for tobacco fields look exaggerated. It is easy to imagine as well that small farmers might cavil at being asked to plant a perennial that they have not planted as a field crop before, to wait several years before seeing the returns, and finally produce an oil that is not edible and for which a good return depends on the biodiesel plant operator. As a mainstay of people’s livelihoods it looks distinctly marginal.

But there is another scenario: jatropha is in some countries already a familiar plant, as a hedge and producer of medicinal products and soaps. Presumably increasing the planting of hedges, perhaps tending them a little more, would then allow poor people to gain some income from the somewhat laborious task of collecting the seeds that could then be sold to biodiesel processors, as well as used traditionally. For those poor who lack other opportunities it may then be a useful additional option to their livelihoods. In such cases, however, would a biodiesel operator ever set up a plant close enough to the collectors of seeds?

If not, then it might be that the oils could be used to power local generators, either as biodiesel or straight vegetable oil. But the feasibility of local level schemes does not seem to have been proven, as explained in the next section.

[16] Indeed the dismal experience collected by these authors suggests that in four different States of India, there was next to no evidence that jatropha had ever become an attractive crop to farmers. As a hedgerow or conservation crop for degraded land there had been some success, but not as a commercial enterprise. Of course, higher oil prices may change this.

Table 5.5: Returns to jatropha, India

Year		0	1	2	3	4	5	6	7	8	9	10
Labour costs												
Site preparation i.e. cleaning and leveling of field		10										
Alignment and staking		5										
Digging of pits (2500) @ 30 pits per Day		50										
Manuring. inc mixing with insecticide, fertiliser, refilling pits		45										
Fertiliser application		2	2	2	2	2	2	2	2	2	2	2
Planting		25										
Re-planting			5									
Irrigation		5	2	2	2	2	2	2	2	2	2	2
Weeding, working soil		20	20	5	5	5	5	5	5	5	5	5
Plant protection		1										
Harvesting, days per tonne	7.5	0	0	0	18.75	18.75	37.5	37.5	37.5	37.5	37.5	37.5
Sub-total		153	29	9	27.75	27.75	46.5	46.5	46.5	46.5	46.5	46.5
Labour rate, US$/day	3											
Labour costs		459	87	27	83.25	83.25	139.5	139.5	139.5	139.5	139.5	139.5
Material costs												
Manure, 2kg/pit 1st year, 1kg/pit 2nd year; @Rs 400 tonne		46.19	23.09									
Fertiliser, 50 gr/plant 1st yr, 25 gm subsequent years, Rs6/kg		17.32	8.66	4.33	2.17	1.08	0.54	0.27	0.14	0.07	0.03	0.02
Plants: 2500 1st yr, then 500 replanting in 2nd yr, Rs4/plant		230.95	46.19									
Irrigation, 3 in 1st yr, 1 in 2nd yr, Rs500		34.64	11.55	11.55	11.55	11.55	11.55	11.55	11.55	11.55	11.55	11.55
Plant protection		5										
Sub-total		334.10	89.49	15.88	13.71	12.63	12.09	11.82	11.68	11.62	11.58	11.56
Total costs		**793.10**	**176.49**	**42.88**	**96.96**	**95.88**	**151.59**	**151.32**	**151.18**	**151.12**	**151.08**	**151.06**
Yield												
kg/plant	2	0	0	0	2500	2500	5000	5000	5000	5000	5000	5000
US$/tonne	94.37											
Value output		0.00	0.00	0.00	235.93	235.93	471.86	471.86	471.86	471.86	471.86	471.86
Cash-flow		**-793.10**	**-176.49**	**-42.88**	**138.97**	**140.05**	**320.27**	**320.54**	**320.68**	**320.74**	**320.78**	**320.79**

Discount rate	0.05											
Discount factor		1.000	0.952	0.907	0.864	0.823	0.784	0.746	0.711	0.677	0.645	0.614
PV		-793	-168	-39	120	115	251	239	228	217	207	197
NPV	574.0											
High yield variant					1,112	4,446	7,225	8,337	8,893	10,004	10,004	10,004
Value output					105	420	682	787	839	944	944	944
Cash flow		-793	-176	-43	8	324	530	635	688	793	793	793
Discount rate	0.05											
Discount factor		1.000	0.952	0.907	0.864	0.823	0.784	0.746	0.711	0.677	0.645	0.614
PV		-793	-168	-39	7	266	415	474	489	537	511	487
NPV	2,186.5											

Sources: Kukrika 2008, UN DESA 2006

5.2 Conditions necessary for widespread smallholder production of biofuels

Small-scale biofuels initiatives to date may be divided into two groups. One set look to biofuels to provide energy for local needs, typically by producing biodiesel to power generators for electricity for lighting and running machinery, such as flour mills. Examples from Brazil and Mali appear in Box 5.1. Reports of these ventures seem only to be of plans and pilots: it does not seem to be known if there are examples of success, especially of efforts that can be sustained by local communities once the support of a sponsoring agency has been largely withdrawn.[17]

Box 5.1: Biofuels for local energy needs

Mali: jatropha is already known as a hedge and the seeds are used to make soap. The aim is to plant more, make biodiesel for local electricity generation:

> 'The aim of the 15-year project is to reduce poverty of the village population and setup Jatropha-fuelled electricity generators for 10,000 people in the Commune de Garalo. The expected results are:
>
> - 10,000 people benefit from clean electricity services supplied by a local electricity company with 300 kVA generating capacity; 400 connections; and an extension plan developed for the next 5 years;
> - 1,000 ha plantations of Jatropha (and other oil-producing plants) implemented to cover the electricity; this includes training of people at different levels and a guaranteed quality of the processed oil;
> - Environmental benefits (CO2 emission savings) of 9,000 tons per year over the project life; as well as protection of soil against erosion to combat deforestation and desertification.'

Brazil: PROVENAT aims to produce palm oil locally and then power diesel generators on straight vegetable oil, with suitable adaptation.

> 'In a pilot phase, the project is working with the Igarapé Açú community, Moju Municipality, Pará. The project will implement 500 hectares of oil palm trees distributed in 10 ha plots to each one of the 50 selected families. It is expected that the project will allow for six hours of electricity per day, and some of the main positive foreseen impacts include:
>
> - Better income. Production of cassava flour is the main source of income for the Igarapé-Açu community, and this will be boosted thanks to increased availability of electricity;
> - The possibility to hold adult literacy classes in the evening; and
> - Health improvement through the reduced use of kerosene lamps. The financial viability of the project would be achieved through the increased sales of cassava flour, with a proportion being earmarked to cover some running costs of the project (e.g. engine maintenance), and the sale of electricity to local residents.'

Source: Dubois 2008

These pilots are intriguing. Given the relatively high cost of bringing fossil fuels into remote rural areas, on economic grounds there may be potential. But equally they face some stiff challenges in co-ordinating local activities and in keeping generators and machinery in running order.[18] It is not surprising then to read in reviews of what little experience there is to

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[17] UN DESA (2007) reports pilot schemes of jatropha biodiesel in two areas of Ghana, in Mozambique, Tanzania and Zambia.

[18] In this respect, Kukrika's (2008) warnings on the art and craft of biodiesel are pertinent: biodiesel processing is a craft that has to be learned so that quality fuels

date, that the problems have proved significant — see for example, the cases of attempts to develop jatropha growing for local fuels, stoves and light in Tanzania (ECDO 2007).

The other set of initiatives involve schemes to link smallholder production of biofuel to large-scale processors, the biofuel being intended mainly to feed into national energy supplies. Examples of this include the scheme established between an international biofuels company and a smallholder association in Malawi — see the Malawi country case study, and Jain Irrigation's plans for contract farmers growing jatropha in Maharashtra (Kukrika 2008).

The challenges in these schemes are the familiar ones of contract farming, including gaining enough mutual assurance between smallholder growers and large-scale processors that each will play its part. Contract farming can potentially overcome two major constraints that smallholders face: working capital and access to technology.

Fromm (2007) outlines the prospects and problems for small-scale oil palm farmers in northern Honduras. It seems that whether Honduras's ambitious plans to expand biodiesel production — by adding another 200,000 ha of oil palm to the current 84,000 ha — are met by small farmers or by large-scale plantations will be a close-run decision. It is perhaps not surprising that in Brazil where the same choice applies for processors seeking to source castor, palm and soy oil, the government has created the Social Fuel Stamp policy to give the processors incentives to work with small and family producers — see Brazil case study.

In other cases, trying to establish a new feedstock for biofuel processing has proved problematic. Proyecto Tempate from Nicaragua provides some lessons. Started in 1991, it aimed to provide biodiesel to national diesel supplies by growing jatropha on farms. Despite three years initial research on jatropha varieties, too little attention was paid the agronomy of the plant within the farming systems in which it would be grown, or to the social and economic circumstances of the project participants. In the event yields proved disappointing and farmers were soon discouraged. It is not clear that the processing plant ever functioned at scale. By 1999 the project was closed. (ECDO 2007, Euler & Gorriz 206)

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are produced that do not damage engines. Indeed, on such grounds he is sceptical of micro-processing and argues that the necessary expertise may only be available when running larger plants serving districts and provinces, rather than villages.

6. What may be the social impacts of biofuels?

Are there grounds to fear that producing biofuel will lead to the poor losing access to land and otherwise being marginalised? The evidence for this is necessarily difficult to piece together since abuses tend to take place in remote areas and those harmed often have little power to seek redress or publicise their plight. Box 6.1 chronicles some reports of evictions and protests, plus a contrasting case of satisfaction with biofuels plantations.

Box 6.1: Evictions, protest and satisfaction
Evictions: **Colombia**: The Colombian government is embarking on a massive expansion of oil palms, sugar cane and other monocultures at the expense of rainforests, biodiverse grasslands and local communities to feed automobiles. Palm oil expansion is linked to large-scale rainforest destruction and to serious violence and human rights abuses. Colombian international NGOs have documented 113 killings in the river basin of Curvaradó and Jiguamiandó, in Chocó region, at the hands of paramilitaries who are working with plantation companies to acquire land which legally belongs to Afro-Colombian communities. (www.biofuelwatch.org.uk) Armed groups in Colombia are driving peasants off their land to make way for plantations of palm oil, a biofuel that is being promoted as an environmentally friendly source of energy. Surging demand for "green" fuel has prompted rightwing paramilitaries to seize swaths of territory, according to activists and farmers. Thousands of families are believed to have fled a campaign of killing and intimidation, swelling Colombia's population of 3 million displaced people and adding to one of the world's worst refugee crises after Darfur and Congo. (**www.guardian.co.uk)**
Indonesia, Kalimantan: Barto's village of Aruk is on the Indonesian side of the border with Malaysia, in West Kalimantan. It is a key region earmarked for palm oil expansion, as Indonesia hopes to reap the benefits of a growing demand for palm oil products in China, India and Europe. "I went to my land one morning, and found it had been cleared. All my rubber trees, my plants had been destroyed," he says, fighting back the tears. "Now I have to work as a builder in Malaysia, so I can feed my three children." (www. news.bbc.co.uk) Indigenous people are being pushed off their lands to make way for an expansion of biofuel crops around the world, threatening to destroy their cultures by forcing them into big cities, the head of a U.N. panel said Monday. (www.checkbiotech.org) A coalition of environmental groups in Indonesia has called on the United Nations to intervene in a palm oil project being planned in Borneo. Existing oil palm plantations in other parts of the country show there is little regard for indigenous people's rights, and that the extensive land clearing necessary for plantations destroys traditional eco-systems.
Tanzania Use of bioenergy in rural economies could help, especially women, but 11,200 people to be evicted by Sun Biofuels Jatropha plantation in Tanzania.
Paraguay In Paraguay, an estimated 90,000 rural families have been pushed off their land by soya expansion. The demand for biofuels, which is already pushing up soya prices, is accelerating soya expansion at the expense of small farmers as well as ecosystems,

not just in Paraguay but also in other countries including Argentina, Brazil and Bolivia. The European Commission's Consultation paper, however, completely ignores human rights abuses, including evictions, and land conflicts.(http://ec.europa.eu)

Protests

Uganda

In the face of intense opposition within the country, the Ugandan government was forced in late May 2007 to cancel plans to convert thousands of hectares of rainforest on an island in Lake Victoria into an oil-palm plantation. A few days earlier, President Museveni had also suspended negotiations to give a large chunk of one of the country's last protected mainland forests to a sugar-cane company owned by Ugandan Asians. This decision followed massive demonstrations against the proposal in April 2007 in the Ugandan capital, Kampala, which degenerated into an ugly race riot. Several Asian shops were ransacked. Two protesters were killed and an Asian was stoned to death. (www.grain.org)

Support cases

Indonesia:

The arrival of the plantation may have changed the landscape, but Mangat says it has also changed the lives of the people who live here.

"After the plantation took over, more people came and suddenly we had roads and schools. We've also opened a small shop, so it's improved our income significantly." (www news.bbc.co.uk)

There is nothing unusual about biofuel feedstock in these accounts. For many agricultural and forestry products, when there is profit to be made unscrupulous operators will ride roughshod over the rights to land of less powerful claimants as and when they can get away with it. In societies with high inequality, with few legally established or socially accepted rights for the underprivileged, such abuses take place.

Similar concerns arise over labour conditions. Allegations that workers in plantations of sugar cane or oil palm receive inadequate wages for seasonal and insecure jobs are heard. For example in Indonesia:

> Plantation labour is generally poorly paid, highly dependent on the employer in all aspects of life and regularly exposed to danger and unhealthy working practices. Inequities between various types of labour (day labour vs. permanent workers, men vs. women) are widely reported. Pesticide use poses a real health risk to (predominantly female) plantation workers all over the region. (WRM 2006)

The same source notes the lack of protection offered to migrant workers on oil palm plantations in neighbouring Malaysia and the hard lives of plantation workers in Colombia.

Again, disturbing as these accounts may be, they are not restricted to biofuel feedstock: similar complaints arise for all manner of estate and plantation cultivation in similar countries. The causes appear to lie in a combination of labour markets where many seek the few jobs on offer, plus political unwillingness to implement labour codes.

Economic opportunity does not inevitably result in exploitation and dispossession. There are cases where commercial gain in farming strengthens the rights of small farmers to their land — as applies, for example, to the small farmers growing coffee and tea on the slopes of Mount Kenya. Better returns to working the land can result in higher wages for farm workers. The cane estates of southern Brazil that produce large quantities of ethanol claim that they pay three times the minimum wage to their workers — see the Brazil case study.

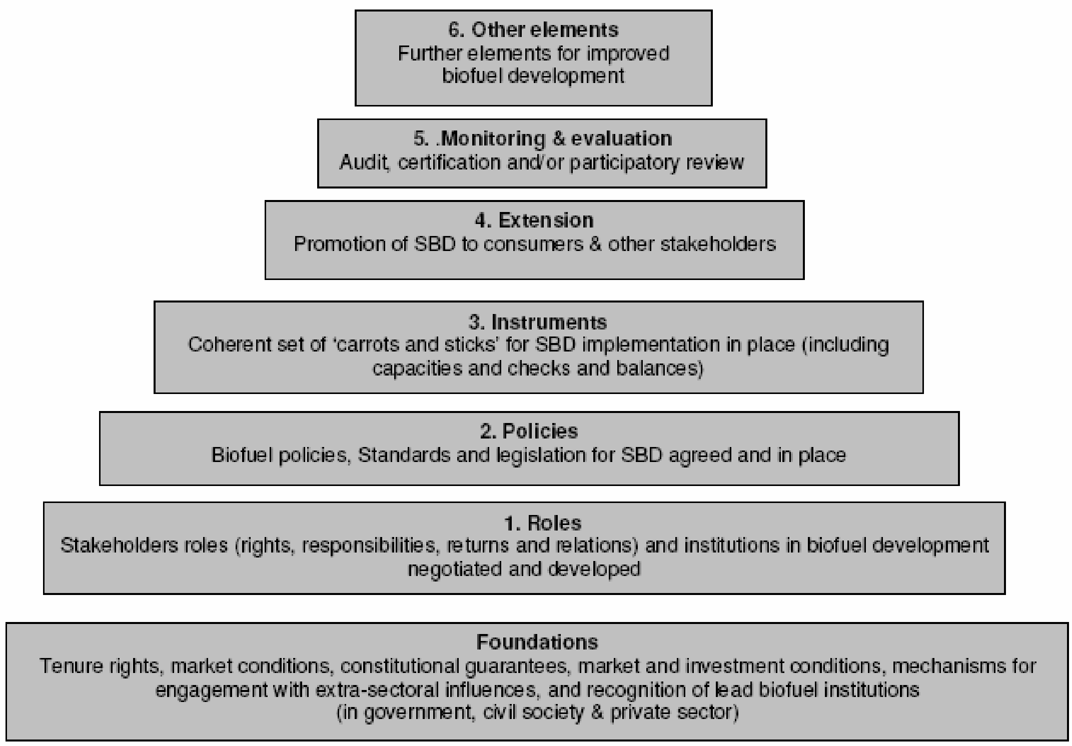
That might suggest that there is little to done on social problems by those engaged in promoting biofuels, but that would exaggerate. Governments clearly have roles to play and they should be active in establishing rights, mediating disputes and protecting their citizens from abuse. In practice, too many are unwilling or incapable of doing so. But they are not the only actors. Civil society can be instrumental in publicising abuses, pressing for government to act, and organising the weak to defend their rights. Private enterprise itself, or at least those enterprises with a social conscience or a public image to protect, can play a role.

Setting up (voluntary) codes of practice can encourage employers to respect the rights of the less powerful and indeed to take a pride in their social responsibility. The Roundtable on Sustainable Palm Oil (RSPO), for example, is a membership body that brings together representatives from all parts of the palm oil supply chain to promote good practice and fairness in the industry. (Dubois 2008)

Getting biofuel chains to work technically, economically and socially probably requires actions at various levels by different actors. Mayers et al. (2005, quoted in Dubois 2008) present a hierarchy of measures, see Figure 6.1. Clearly actions are needed at all levels, although the lower levels of the hierarchy are fundamental to allow higher level measures to operate.

Dubois (2008) comments, however, that getting the elements in place and working effectively is not something that can be designed, but rather is likely to be highly specific to circumstances and require iteration and learning. As he comments, in the language of Grindle, the search is not so much for ideal governance, but for 'good-enough' governance.

Figure 6.1: A hierarchy of governance for sustainable biofuels development



Source: Adapted from Mayers et al, 2005

7. How will the economies of low income countries be affected by biofuels?

In low-income food-deficit countries (LIFDCs), the main impact of rising international food prices at the national level will be on the food import bills of these countries. The adverse balance of trade effects in turn can retard economic growth through multiplier effects on GDP. The multipliers will vary according to the characteristics of the economy, but have been estimated to be fairly high in some developing countries (e.g., Malawi where the multipliers have been estimated to be as high as 2.94 — see case study on Malawi).

In the short-term an important concern for LIFDCs is their ability to secure food imports and finance them when conditions in international markets are tight. LIFDCs are not the largest importers of food. It is the developed countries that acquire a large proportion of food imports: the top ten developed country importers account for over 72% of world food imports. These countries (and also the OPEC countries) with large foreign exchange reserves have been contracting for food imports at almost any price (Trostle: 2008). For LIFDCs, the implication may that they are effectively priced out of the international markets and unable to procure supplies. Many of these countries also have relatively low foreign exchange reserves, which restricts their ability to sustain current import quantities, as FAO (2008a) observes.

A quick assessment of national level impacts is presented in Table 7.1 for selected LIFDCs for which data were readily available. The table shows the current average ratio of food imports to merchandise imports (2002-2006) and the average food import of these countries over the same period. The impact of a 10% increase in food prices is calculated and this is related to the current levels of foreign exchange reserves in these countries. The impact on GDP from rising food import bills is calculated using a simple multiplier derived from the average savings rate and propensity to import.

The total increase in the food import bill of the 49 LIFDCs in Table 7.1 as a result of 10% price increase is US$3.68 billion. In many LIFDCs in Asia and Africa, the foreign exchange burden resulting from increased international food prices could be significant. The most extreme example is Eritrea where the increased food bill would consume 140% of the current foreign exchange reserves. For Zimbabwe, the figure is as high as 93%. Other African countries where the higher food import bill would be more than 10% of the average foreign exchange reserves over the last few years include Cote d'Ivoire, the Gambia, Niger, Malawi, Sudan and Swaziland. In Asia the largest impact is in Bangladesh where the incremental food import bill would be 12% of the foreign exchange reserves. Countries like India and Indonesia have large reserves and the impact of higher food import bills may be partially offset by improved export earnings on their food exports. In the Central American region Haiti and Honduras will face a substantial foreign exchange constraint as a result of higher food import expenditure.

Table 7.1: Foreign Exchange and GDP Impacts on Low Income Food Deficit Countries

Country	Average food imports 2002-2006 (Current US $ million)	Average food imports to merchandise imports (2002-2006) - (%)	Impact of 10% food price increase on food import bill (Current US $ millions)	Average GDP 2002-2006 (Current US $ million)	Multiplier	Impact on GDP (%) -	Average foreign currency reserves 2002-2007 (US $ Million)	Increase in food import bill to foreign currency reserves
Albania	420.37	19.11	42.04	6,994	1.10	-0.66%	604.24	7%
Armenia	263.23	19.92	26.32	4,014	2.05	-1.34%	351.18	7%
Bangladesh	1740.75	17.07	174.07	55,602	2.78	-0.87%	1,433.73	12%
Benin	218.78	25.56	21.88	3,895	n/a	n/a	351.73	6%
Burundi	17.28	10.56	1.73	698	1.84	-0.46%	43.97	4%
Cambodia	167.68	8.18	16.77	5,506	1.20	-0.36%	478.39	4%
Cameroon	435.45	18.37	43.54	15,095	3.20	-0.92%	562.16	8%
Central African Republic	23.96	20.92	2.40	1,281	3.97	-0.74%	56.04	4%
Cote d'Ivoire	806.07	22.17	80.61	14,846	2.20	-1.19%	782.87	10%
Ecuador	698.79	8.73	69.88	32,692	1.88	-0.40%	617.35	11%
Egypt	3291.81	24.93	329.18	89,358	2.73	-1.01%	8,591.36	4%
Eritrea	181.72	n/a	18.17	781	1.78	-4.14%	13.02	140%
Ethiopia	317.60	16.39	31.76	9,926	2.14	-0.69%	474.25	7%
Gambia	75.93	38.59	7.59	422	n/a	n/a	44.57	17%
Ghana	673.33	19.00	67.33	9,256	1.44	-1.05%	656.21	10%
Guinea	153.82	23.58	15.38	3,506	2.61	-1.15%	58.28	26%
Haiti	346.96	..	34.70	3,960	2.33	-2.04%	77.52	45%
Honduras	637.50	17.31	63.75	7,672	1.22	-1.01%	919.35	7%
India	4213.16	4.82	421.32	703,521	2.68	-0.16%	63,226.27	1%
Indonesia	4403.23	10.26	440.32	267,738	2.76	-0.45%	17,022.26	3%
Kenya	441.30	11.60	44.13	16,815	2.24	-0.59%	852.16	5%
Kyrgyz Republic	141.57	13.61	14.16	2,178	1.32	-0.86%	261.16	5%
Lesotho	184.93	n/a	18.49	1,196	0.85	-1.31%	228.38	8%
Madagascar	159.45	14.99	15.95	4,955	2.17	-0.70%	236.66	7%
Malawi	175.29	19.11	17.53	1,982	2.96	-2.62%	67.14	26%
Mongolia	151.88	14.32	15.19	1,766	1.24	-1.06%	248.96	6%
Morocco	1907.94	11.67	190.79	47,773	2.02	-0.81%	6,860.65	3%
Mozambique	267.86	12.51	26.79	5,843	1.93	-0.89%	485.39	6%
Nepal	311.20	17.28	31.12	6,709	1.96	-0.91%	589.51	5%
Nepal	311.20	17.28	31.12	6,709	1.96	-0.91%	589.51	5%
Nicaragua	326.78	14.75	32.68	4,581	1.36	-0.97%	324.11	10%
Niger	202.56	35.76	20.26	2,957	n/a	n/a	131.25	15%
Nigeria	2298.71	17.54	229.87	77,796	2.52	-0.74%	11,276.98	2%
Pakistan	2062.64	10.84	206.26	98,389	3.02	-0.63%	4,715.28	4%
Philippines	3019.56	7.04	301.96	91,690	1.67	-0.55%	7,830.47	4%
Rwanda	35.79	14.01	3.58	1,976	2.92	-0.53%	136.30	3%
Senegal	755.66	28.03	75.57	7,239	1.91	-2.00%	539.00	14%
Sri Lanka	981.82	13.16	98.18	21,068	1.88	-0.88%	1,012.36	10%
Sudan	589.83	15.26	58.98	23,981	2.59	-0.64%	520.36	11%
Swaziland	163.09	18.24	16.31	2,148	1.08	-0.82%	160.52	10%
Syrian Arab Republic	1070.56	17.32	107.06	26,324	2.27	-0.92%	n/a	n/a
Tanzania	354.55	13.48	35.45	11,352	2.84	-0.89%	963.92	4%

Note: Multipliers were computed using savings ratios and import to GDP ratios from the World Bank's World Development Indicators and the Penn Word Tables.

Uganda	256.49	15.52	25.65	7,390	3.08	-1.07%	585.84	4%
Yemen	1021.39	27.08	102.14	14,117	n/a	n/a	n/a	n/a
Zambia	167.06	9.87	16.71	6,325	2.13	-0.56%	249.22	7%
Zimbabwe	377.04	14.93	37.70	8,487	n/a	n/a	40.65	93%
Total			3682.37					

The impact on GDP shows a fair amount of variation because of the differences in multiplier values. But for 13 countries out of the 46 listed in Table 7.1, which are mostly in Africa, the increase in food prices lead to a reduction in GDP in excess of 1%. These countries are quite vulnerable to an increase in international food prices. In other countries the impacts are less significant.

The above results are based on a 10% across the board increase in international food prices. However, the vector of import price increases derived from our CGE model for biofuel expansion in EU and NAFTA is smaller than the 10% assumed here. It can, therefore, be argued that impact of biofuel expansion on economic growth in LIFDCs will be fairly modest.

8. Country cases

8.1 Introduction

Four countries were selected to show a range of circumstances. In each case, the impacts of expanded biofuel production were assessed in terms of the opportunities this might present for producers, and threats to consumers — and national economies — from higher food prices.

8.2 Bangladesh

The steady increases in global food prices since 2005, reaching a marked high this year, have led to real fears of a ‘silent famine’ in Bangladesh. As a low-income food deficit country (LIFDC), these price increases in food grains have meant that the poor in Bangladesh — almost half the population — face real difficulties in meeting their daily food needs. If increased biofuels production push up world prices, the poor of Bangladesh may be at risk.

In spite of progress made since the 1980s in increasing food production, Bangladesh is still unable to feed her increasing population and has to rely on imports. Moreover, Bangladesh is and will remain a natural calamity-prone country in the foreseeable future so a short-fall in domestic crop loss is to be expected.

For Bangladesh, the critical issue is whether somehow it can respond to high prices today by effecting a transformation in agriculture so that it is less reliant on world food markets in the future, particularly those of its Asian neighbours.

The key problem in food security is that people cannot afford to buy food. There is enough food available but the issue is one of access. In Bangladesh, 46% of families live at or just below the poverty line of US$1 a day and spend up to 70% of income on food. At the poverty line of US$2 a day the figure jumps to 82%. The World Food Programme reports that more than 50,000 households are getting emergency food.

Rising food prices threaten the poor, since even in rural areas, most are net buyers of food rather than sellers. Opportunities to switch consumption towards cheaper foods are limited by generalised increases in food production, and by the lack of alternative staples to rice available in any quantity.

High prices are associated with reduced consumption (early evidence indicates the poor are cutting back on the number of meals per day) and a less diverse diet. It is not only the poor who are affected. The non-poor, especially those on fixed wages based in urban areas, are now finding it very difficult to make ends meet.

Food imports represent 19% of total imports to Bangladesh. Poor world growth and a weak US dollar may have the effect of cutting Bangladesh’s export revenues and capital inflows as well as reduce the value of dollar investments abroad. Higher food prices could strain government coffers and generate increased inflationary pressures given widespread food subsidies. Moreover, further increases in energy prices remain a risk for Bangladesh, which is highly dependent on oil imports.

The current food crisis may be seen as an opportunity to transform the agricultural sector. There seems to be a growing understanding that only Bangladesh can resolve its food crisis. IRRI estimate that with good seeds, good plants, balanced growth of crops and efficient irrigation at the right time Bangladesh is capable of producing six to seven metric tonnes of food grains per hectare which would dramatically ease supply constraints. Without this action, global markets will push up food prices within Bangladesh and may well undo some of the gains of the Green Revolution.

8.3 Brazil

Brazil has a longstanding policy on biofuels development, beginning in the early 1930’s, but which took off with *Proalcool* (National Alcohol) programme in 1974. Producing more than one third of all the sugar in the world, more than half the sugar cane crop is distilled to ethanol that replaces up to 40% of petrol. Ethanol production is estimated to have led to the creation of more than 720,000 direct jobs and more than 200,000 indirect jobs in rural areas. Salaries and benefits for employees are estimated to be 3.5 times the national minimum salary.

But has the creation of a large-scale biofuel industry harmed the poor or reduced their food security? Food **availability** in Brazil is more than sufficient for its entire population — estimated at the equivalent of 340 kg per capita per year — about one third more than per capita nutritional requirements. Yet 7% of the population, or 13 million individuals, are reckoned to be under-nourished at present.

The problem in Brazil is **access** to food rather than lack of. Poverty is pervasive: by the national poverty line, 22% are poor, and by the World Bank measures, 33% live on less than US$1 a day. In a middle income country, incomes are distributed highly unequally. There is little evidence that the expansion of ethanol production during the last ten years or more has prevented increased domestic production of food. This is reflected in food prices that, until the recent world rise in food prices, had been falling in real terms. Given that Brazil imports some food staples, most notably rice, wheat and cereals, world price rises consequent on increased biofuel production may transmit into domestic food price rises, harming the poor.

Brazil has ambitious plans to expand biofuel production, doubling output by 2016. Another 3M ha of land may be needed to achieve this: not that much given that Brazil already has 61M ha under cultivation and another 80M ha are considered apt for cultivation. Given the employment intensity of sugar cane cultivation this is likely to increase employment.

Biodiesel will be produced on a much large scale, making use of soy, castor and oil palm. To encourage processors to source feedstock from small and family farmers of these crops and so to spread the benefits more equitably across social groups and regions, a ‘social fuel stamp’ has been introduced that offers tax rewards to processors who do so.

8.4 India

Biofuels strategy in India has been mainly driven by energy security considerations, although environmental benefits, greening of wastelands, potential for increased rural employment and income, improved energy access to the poor are cited as supporting objectives.

Food security is an important consideration in a country with the largest number of the world’s poor — so biofuels strategy carefully tries to avoid competition between food and fuel crops by focusing on the use of wastelands and degraded lands for growing feedstock crops. A National Policy for Biofuels is still in the works. India has followed a two-pronged strategy for biofuels development (1) promoting the use of ethanol derived from sugar molasses for blending with gasoline and (2) promoting the use of non-edible plant based oils for blending with diesel.

Ethanol

India is the second largest producer of sugarcane and now the largest producer of sugar, but plans for development of ethanol as biofuel are hamstrung by limited potential for area expansion under sugarcane, regulatory and policy constraints and competing demands for ethanol from different sectors. Ethanol policy has largely become a balancing exercise in meeting the demands from competing users. Government policy has mainly been a response to cyclical variations in sugarcane/sugar production and appears to lacks a long term perspective. This is reflected in the way in which the blending mandate, a key instrument for promoting biofuel use of ethanol, has been handled. A stop-go approach and the dilution of the mandate when faced with feedstock shortage and making them voluntary/contingent on the commercial viability for oil companies suggest a somewhat half-hearted approach to the promotion of ethanol as a biofuel. An extraordinarily complex regulatory and taxation regime has created a range of market distortions leading to large idle unutilised capacities for ethanol production and uncertainties for future investments. The enforcement of ethanol blending mandates is also complicated by the pricing arrangements for petroleum products that appear to create an incentive for state-owned oil companies to drive down the price of ethanol even below economic levels and, somewhat paradoxically, consider large-scale ethanol imports from Brazil to comply with the mandates — even in the face of substantial idle domestic capacity.

In India, therefore, the promotion of ethanol as a biofuel appears to be constrained by intense competition from other ethanol users and a policy regime that appears to relegate biofuel use of ethanol as a “residuary” activity. It is doubtful that the targeted 10% blending mandate will be achieved over the course of the next few years. Regulatory reform in the sugar and petroleum sectors appears to be the key challenge facing India in its efforts to promote the use of ethanol as a biofuel.

Biodiesel

India has an ambitious programme for the development of biodiesel based on feedstock crops like Jatropha and Pongamia. The National Mission on Biodiesel envisages rapid expansion of area under these crops (to an eventual 11.2 million hectares) by using so-called wastelands or degraded lands. A blending target of 20% in envisaged by 2012 with substantial environmental benefits and expansion of rural income and employment opportunities.

No mandates for blending are yet in place. However, the road map envisaged by the National Mission has led to flurry of activity and a number of public and private sector initiatives for the cultivation of jatropha and production of SVOs and biodiesel have emerged. It is still too early to assess the commercial success and sustainability of these ventures. The profitability of jatropha cultivation on degraded lands is yet to be fully established and the economics of biodiesel production appear to be very sensitive to yield assumptions. Many private sector ventures now appear to be scaling down the rather optimistic assumptions originally made.

Progress to date has been modest — with only about 400,000 hectares of jatropha plantations. The biodiesel programme is ambitious in scope, but a clear policy framework is yet to emerge. The policy needs to address several critical issues confronting a programme for creating a new value chain for a liquid biofuel. The Indian experience suggests that potential for cultivation of feedstock crops, availability of processing technology and incentives provided by high crude oil prices are necessary but not sufficient conditions for development of biofuels. The policy framework must facilitate the range of investments required at different levels of a complex new value chain.

The food versus fuel debate has been side-stepped in the Indian biofuel development plans but could re-emerge if jatropha cultivation becomes profitable for small farmers displacing food crops on arable lands. Jatropha cultivation could also intensify the competition for water between cash crops and food crops.

The expansion of biofuel production can have important direct and indirect impacts on poverty alleviation through a variety of channels. Given the rather slow development of biofuel production in India, it is too early to assess the direct income and employment benefits and improved energy access for the poor. The indirect impact resulting from global biofuel expansion and resultant increases in international food prices is likely to be much more serious as they could threaten to push more than 40 million people into poverty in a country which already has the highest number of undernourished people.

8.5 Malawi

For Malawi, a relatively small land-locked country with high rates of poverty and food insecurity, an expansion of biofuels production could be a threat or an opportunity. With many living on the breadline, anything that pushes up food prices imperils their welfare and nutrition. But for a largely agrarian society it represents the chance to add the growing of feedstock to livelihood options, while substituting biofuels for oil imports made all the more costly by land-locking.

Malawi has since 1982 been distilling ethanol from cane molasses to blend with petrol. The two distilleries have a combined capacity of more than 30M litres a year, sufficient if able to operate fully to substitute for as much as one third of current petrol imports. But they operate at between half and two-thirds of capacity, impeded amongst other things by a shortage of molasses.

More recently an international oils firm put in place a deal to buy jatropha seed from small-scale farmers for crushing and refining to make biodiesel. Although a few years ago the plans were to plant 13,000 or more hectares of marginal lands to jatropha, it seems that progress to that target has been slow so far, and it is not clear whether any biodiesel has been refined on a commercial scale. There is also a smaller initiative to produce ethanol gel for cooking stoves.

So far, biofuels produced within Malawi have not competed with food production: molasses is a by-product from sugar cane refining, and the plans for jatropha target marginal land. Indeed, there seems, at first sight, to be the potential to increase biofuels production without detracting from food production. To produce enough ethanol to replace half the current imports of petrol could require as little as 9,000 ha of sugar cane: this in a country where the arable area currently used is around 3M ha and the potential arable area is estimated at over 6M ha. Given Malawi's very low costs of sugar cane production — amongst the lowest anywhere in the world — and the high cost of oil imports, inflated by the expense of delivering overland, the economic potential surely exists. In a poor country the additional jobs created would be valuable. The obstacles to realising this potential probably lie in additional investment in flex-fuel vehicles, ethanol distribution systems, and additional distilleries.

But biofuels could threaten the 52% of Malawians who are poor, and the 35% who are under-nourished, if rises in international food prices were transmitted to the national market. By one analysis, a 10% rise in food prices in Malawi would push another 68,000 persons into extreme poverty.

Transmission of international prices is incomplete, however. The same land-locking that raises the cost of imported fuels also gives the country a degree of insulation from international prices, driving up import parity prices to the point where it makes more sense for Malawi to produce most of its food rather than import. This is reflected in current agriculture: staple foods are planted sufficiently to meet domestic demand, a target that is usually achieved so long as reasonable rains fall, and farmers can get the inputs to fulfil their plans — conditions that have applied for the last three years of bumper harvests.

Hence the threat posed by production of biofuels in other countries is limited to the impact of these on prices of foods that Malawi does import regularly. For a small economy, a 10% rise in the general cost of these imports could — assuming that there is no ability to substitute for these foods — mean higher import bills that would deflate the overall economy by 1.5% to 1.9% of gross domestic product: a strong although not unmanageable impact.

8.6 Commentary

Table 8.1 summarises the analyses of the four countries. The potential to gain from biofuels ranges from very little to high, depending largely on the extent to which the country has unused potentially arable land.

The impact on poor consumers of food prices being raised by biofuels depends in part on the degree of transmission to national markets, and perhaps in larger degree on extent of poverty and its causes. It is not surprising that when there are substantial numbers living in poverty, with many undernourished and living on the breadline, that any rise in food prices will harm them.

Effects on economies as a whole are muted, since in two cases the volume of food imports compared to the size of the overall economy is slight. But low income countries with under-developed economies are vulnerable.

Table 8.1: The four country cases summarised

	Bangladesh	Brazil	India	Malawi
Potential to produce biofuels	Minimal: densely settled country with most arable land already in production	High: abundant land makes possible doubling ethanol output and establishing major production of biodiesel	Modest: limited to molasses from cane, and perhaps jatropha on marginal land	Quite high: scope to produce ethanol to cover half petrol imports; possible production biodiesel from jatropha on marginal land
Impact of higher world prices for food on:				
(a) Poor consumers	Any rise in food prices a major threat to the many poor and hungry, potentially reversing the gains of the green revolution	Little evidence that biofuel industry has contributed to poverty and hunger	Large numbers of poor and hungry who could be threatened by higher food prices, but transmission from international to Indian is muted	Highly vulnerable to rising food prices, but limited transmission of international prices owing to land-locking
(b) Economy	Macro-economic effects significant but not that large	Limited food imports, only a slight effect on national economy	For a large economy, international food prices have little effect	10% higher food prices could depress economy by as much as 1.9%

9. Conclusion and discussion

9.1 What are the main points that arise from this review?

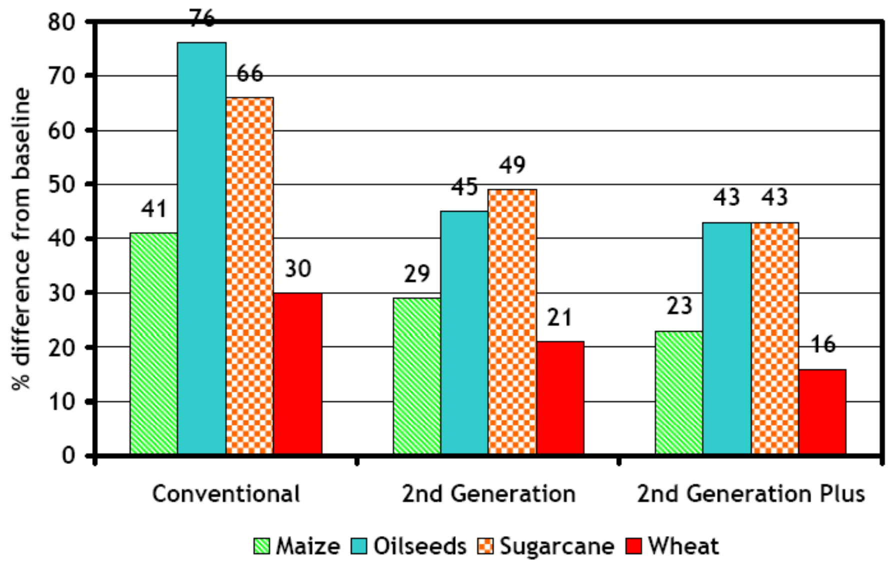
Following the sequence of questions that the study set out to answer, here are the key points.

How will expansion of biofuel production affect prices on the world market?

Existing studies of the effects of expanded production of biofuels on world prices of agricultural commodities can be divided into those based on partial equilibrium models, and those derived from general equilibrium.

Almost all of the former studies generate substantial price impacts for crops that are either biofuel feedstocks or close substitutes for them. Typical of these studies are the projections derived by IFPRI, see Figure 9.1. Even in the best of circumstances the prices of important foods could rise by between 16% and 43%.

Figure 9.1: Changes in commodity prices in response to biofuels expansion expected in 2020



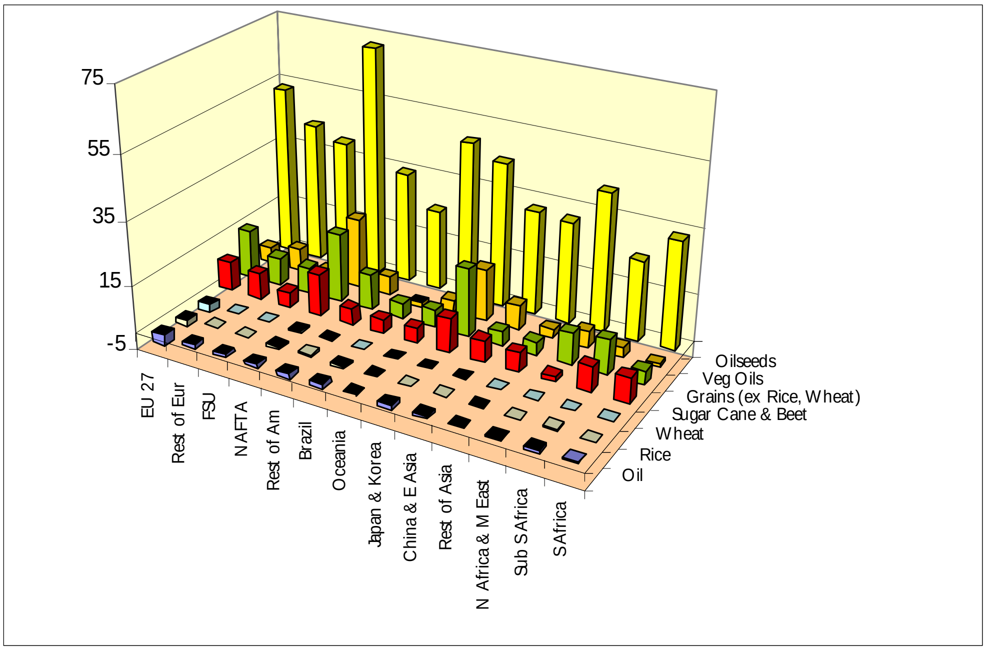
Source: IMPACT projections

Note: Conventional: rapid growth in demand for biofuels, no change in crop productivity; 2nd generation assumes that by 2015 cellulose conversion technology is economically viable; 2nd gen+ adds improvements to crop productivity.

General equilibrium gives a different picture: here the impacts on most crops, other than maize, oilseeds, vegetable oils, and sugar, are muted — with price rises rarely of more than 5%. Price rises for potential feedstock crops such as oilseeds, maize and sugar cane are much higher, up to 72% in one region, but generally lower than the IFPRI projections. Figure 9.2 shows the projected increases assuming that the EU and North America replace 10% of their vehicle fuels by biofuels.

The two approaches generate different degrees of price change since they assume different degrees of adjustment. The general equilibrium models allow for almost complete adjustment throughout the economy to the initial stimulus, and hence while patterns of production, consumption and trade may change substantially, price effects are often quite small. Partial equilibrium models allow less adjustment of production and consumption, especially across sectors of the economy, with the result that prices bear the weight of adjustment and thus move considerably more.

Figure 9.2: Changing prices from biofuel expansion, general equilibrium view



Source: modelling by McDonald & Levy using an extension of GTAP, export prices

General equilibrium results are probably a better reflection of what can happen in the medium term, and especially when markets work reasonably well. Partial equilibrium models give an indication of short run responses, and especially if imperfections and friction prevent adjustment.

Studies from both approaches agree on the direction of price movements likely if biofuels production is expanded — upwards, that the effects will be strongest on potential feedstock crops, and — that rice, one of the world's major grains — will be little affected.

From world to local prices: how do international price changes affect domestic prices?

Transmission of prices from international to domestic prices can be affected by border measures, transport costs, and the varying importance of commodity prices in the retail prices of foods. Given the number of variables, many of them specific to circumstances, it is difficult to generalise.

There will however be some muting of international price changes, especially for import parity prices — those that matter for consumers.

How will price rises induced by biofuels affect consumers in the developing world?

Consumers clearly suffer if food prices rise. From the simple and partial studies that have been carried out, the poor suffer more than the rich since they spend more of their income on food, see higher losses of real incomes to rising food prices, and may have to cut their consumption of food.

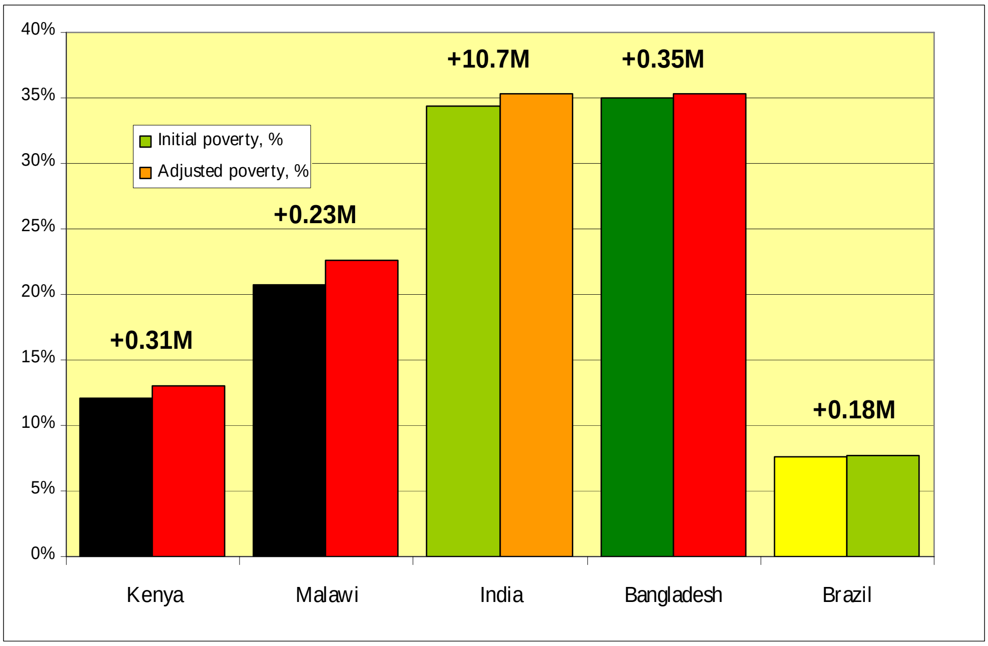
The effects, however, are not necessarily that large. Ivanic & Martin, looking at effects on households living close to the poverty line, show that a 10% rise in food prices across the main categories of food would raise poverty in a sample of nine developing countries by just 0.4 percentage points. Even in the worst affected country, Nicaragua, the increase in poverty was 2 percentage points. Urban households are more affected than rural.

Moreover, given that some of the largest countries with most malnourished persons in them, such as India, have rice as a staple and the PE models and the GE are united in predicting virtually no effect of biofuels on rice prices, then the impact on many of the world's poor will be small.

This impression was confirmed by a simple analysis of the effect of the projected price increases on the cost of food, the implied reduction of real income, and the resulting changes to poverty headcounts in five selected developing countries. Food bills increase by small amounts, at most 2%, with much lower impacts in countries where rice is the main staple.

As Figure 9.3 shows, poverty headcounts rise in all cases, although always by less than one percentage point. The increase in numbers in poverty as a result in most cases is a few tens of thousands. In India it is more than 10 million, a large number in absolute terms, but small relative to the population of over 1 billion.

Figure 9.3: Impact of projected price rises on poverty in selected developing countries



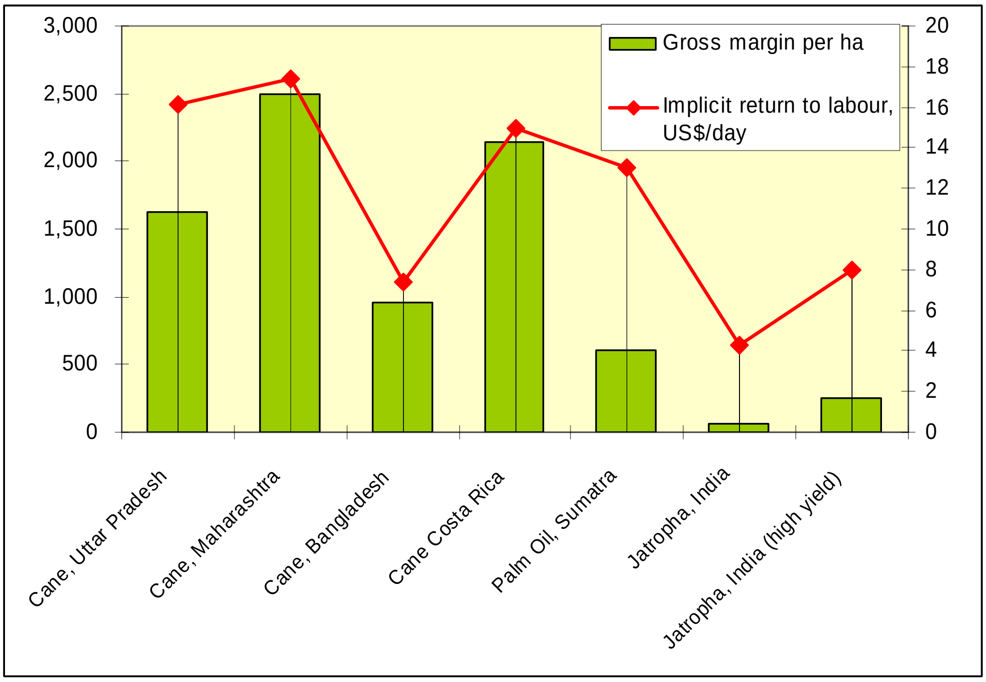
Source: own calculations with aid of FAO data on food budgets and the World Bank's PovCal

The impacts are unwelcome, but small: small enough to be countered by social protection measures.

What is the potential for the poor to earn more by producing biofuels?

Given few existing studies, the analysis is based on gross margins for smallholders growing three potential feedstocks: sugar cane for ethanol; palm oil and jatropha for biodiesel. The results are summarised in Figure 9.4.

Figure 9.4: Gross margins, returns to labour in biofuel feedstock production



Sources: Diverse — see relevant Chapter for details

Growing sugar cane for ethanol potentially gives excellent returns. In countries with spare land suitable for cane, there may be great opportunities for the poor either as small farmers, labourers on the fields or downstream in processing.

Oil palm similarly gives attractive returns, but it may be that the parity price for oil palm for biofuel is below the price offered for other uses in industry. Either way, it is no surprise that oil palm is such a boom crop. Opportunities for smallholders are limited by the fairly demanding requirement for rainfall or irrigation.

Jatropha, sometimes seen as an ideal feedstock since it can grow on marginal land and so does not compete with food crops, shows more marginal returns. Much depends on the yields obtained, and experience so far has been that yields achieved in practice have been below those expected. It is difficult to see how this crop will be of much benefit to the poor, although in some niches it may have a role — possibly in serving local energy needs.

The general equilibrium modelling provides some support to the existence of opportunities, since returns to unskilled labour rise slightly in some parts of the developing world.

In getting the poor to benefit, much depends on getting the biofuel system up and running, implying large-scale investments in processing, collection and distribution networks, and vehicle adaptations. Governments need to establish consistent and coherent policy and establish a framework of regulations

A key challenge is to link the big investors to small rural producers, with contract farming very much indicated. It is similarly important that biofuel initiatives be sensitive to conditions of local level governance: rights to land, crops and trees, especially for females; and that they take into account the views of local stakeholders. Enthusiastic promotion of biofuels can lose sight of the wider system and the views of key players within it. Above all, learning will be needed: it is very difficult to design functioning schemes as a blueprint.

What may be the social impacts of biofuels?

There are enough recorded cases of the poor being evicted from their land to make way to feedstock plantations, and of poor treatment of workers on plantations of oil palm and other feedstock, to merit concern. There is, however, nothing special about biofuels in this regard: the same ills arise in the same countries for most other crops or economic opportunities. Where the rights of the poor are neither respected nor protected, where social cohesion is low and unscrupulous behaviour tolerated, such abuses are frequent.

That does not mean to say that those promoting biofuels, in those circumstances where they make sense, can ignore the social consequences, if only on the grounds that there is nothing that they can do to prevent abuse. On the contrary, there is scope for remedial action at several levels — from working with civil society to protect the oppressed, putting pressure on indifferent governments to protect their citizens, and working with responsible private enterprise to bring in codes and standards. All these can make a difference.

How will the economies of low income countries be affected by biofuels?

The main effect will be through increased import bills for foods whose prices have risen from the expansion of biofuels. The rising cost of food imports in turn amounts to a withdrawal from the economy and will reduce gross national income. For most countries the effects would be small, less than 1% even if the overall price rise were as much as 10%: but there are some low-income food deficit countries that could see falls of more than 1%, including Armenia, Côte d'Ivoire, Egypt, Eritrea, Ghana, Guinea, Haiti, Honduras, Lesotho, Malawi, Mongolia, Senegal and Uganda.

The general equilibrium model shows that overall effects on economies in the developing world are also small: Sub-Saharan Africa would be the worst affected region in the developing world, with reductions of gross domestic absorption of up to 0.3%.

The surveys of four countries complement the answers to questions by theme, see Table 9.1. The potential to produce biofuels depends overwhelmingly on the existence of under-used arable land — and of good quality as well: the idea that jatropha will allow much production from marginal lands is exaggerated. Poor consumers could lose from biofuels, but much depends on how strongly international prices transmit to local markets. Impacts on economies as whole are minor for the larger economies, but can have some significance for small and poor economies, such as that of Malawi.

Table 9.1: Key findings from the country cases

	Bangladesh	Brazil	India	Malawi
Potential to produce biofuels	Minimal: densely settled country with most arable land already in production	High: abundant land makes possible doubling ethanol output and establishing major production of biodiesel	Modest: limited to molasses from cane, and perhaps jatropha on marginal land	Quite high: scope to produce ethanol to cover half petrol imports; possible production biodiesel from jatropha on marginal land
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(a) Poor consumers	Any rise in food prices a major threat to the many poor and hungry, potentially reversing the gains of the green revolution	Little evidence that biofuel industry has contributed to poverty and hunger	Large numbers of poor and hungry who could be threatened by higher food prices, but transmission from international to Indian markets is muted	Highly vulnerable to rising food prices, but limited transmission of international prices owing to land-locking
(b) Economy	Macro-economic effects significant but not that large	Limited food imports, only a slight effect on national economy	For a large economy, international food prices have little effect	10% higher food prices could depress economy by as much as 1.9%

9.2 Drawing out the principal conclusions

Summarising still further, the main findings can be reduced to four points, as follows.

5. As far as the impact that biofuel expansion will have on prices is concerned, different models can produce considerably different projections — not surprising, forecasting is an inexact science. General equilibrium (GE) models, perhaps a more reliable guide to the medium term than partial equilibrium, see quite minor impacts on the prices of most commodities other than oilseeds and maize. But no one argues that the direction of prices is anything but up. And all agree that feedstocks— maize, wheat, oilseeds, oil palm, sugar — are likely to rise in price, and that conversely crops such as rice will see little impact.

6. Price rises hurt the poor, the urban poor more than the rural, net food buyers more than those farmers who are net sellers. But even for the poor, the effects are not necessarily that strong. A 10% rise in all food prices might overall raise poverty by 0.4% percentage points — not welcome, but hardly disastrous. If we take the GE predictions, then effects will be lot less than 0.4% points — which is why the GE model shows such tiny effects on the welfare of developing countries.

7. Moreover, in rice-eating countries, there will be next to no impact on poor consumers, since no model has rice prices rising by more than a few tenths of one per cent. This matters: most of the poor in Asia, the bulk of the world's poor, eat rice more than any other staple. Similar comments would apply as well to those whose diet is centred on roots and tubers, as applies in the Andes and West Africa.

8. There is some potential for the poor to benefit from biofuels production where land is relatively abundant, and especially where oil imports are costly. This mainly means parts of Latin America, Africa, and SE Asia. By and large, not much is being done to

realise this potential. The changes needed are sufficiently complex that it will tend to be only those developing countries with some capacity to innovate and invest, and with social cohesion, that can seize the opportunities. It is easy to imagine this for Costa Rica or Thailand, less so for Malawi: but it is precisely in Malawi that the potential could be most valuable.

Final reflections:

Biofuels may just be a good thing for some developing countries and their poor, especially those that have (a) abundant land, (b) social cohesion, some sense of equity, and (c) entrepreneurship and nous. The countries that fulfil these criteria do not make a long list; but where these apply — or could apply in the near future — it makes sense to develop the possibilities.

But for most of the developing world, expanding biofuels production does not make sense. The harm to the poor of the developing world may be limited, especially where people eat crops that do not make good feedstock for biofuel, but nevertheless at the margin people will suffer. Their numbers may be sufficiently small for it to be possible for those gaining in each country to compensate them, but are there enough gaining, and would they be inclined to compensate those losing out?

In the time available for this study it was not possible to develop scenarios of the number of smallholders who might have suitable land to plant to sugar cane, oil palm and other similar feedstock that appear to offer good returns. Further work on this would be valuable.

The results of general equilibrium modelling presented here are crystal clear in one respect: the biofuels mandates for the EU and the North America make little or no economic sense — but at least the major losers are the citizens of those countries who voted in the mandate-makers.

On this evidence, there is little to be said in terms of market economics for expanding biofuel production in the EU and North America. If the promotion of biofuels is to be justified, it can only be on the longer term prospect of reducing greenhouse gas emissions.

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Appendices

A. Case Study: Bangladesh.

1. *Introduction*

The last time a serious famine occurred in Bangladesh was in 1974. Since then, investment in the Green Revolution has brought real food prices down dramatically and Bangladesh has not seen the devastating effects of serious food insecurity. The steady increases in global food prices since 2005, reaching a marked high this year, have led to real fears of a “silent famine”. As a low-income food-deficit country (LIFDC), these price increases in food grains have meant that the poor in Bangladesh — almost half the population — face real difficulties in meeting their daily food needs. The current food price increases result from a combination of factors although one factor that has caused enormous cause for concern is the growing demand for biofuels. This has raised the very important question of how low-income food deficit countries will manage to feed themselves adequately if developed countries maintain their commitment to increasing their use of biofuels.

Bangladesh is and will remain a natural calamity-prone country in the foreseeable future so a short-fall in domestic crop loss is to be expected. It is expected that food prices on international markets over the next few years are likely to remain high (although not as high as in recent months). When the internal food crop fails, Bangladesh relies on imports. The cost of imports is going up. The changing food scenario on a global scale does necessitate a rethink about previous policies on food provision if chronic and persistent food insecurity is to be avoided.

It is, at present, difficult to segregate the effects of biofuels demand on food prices from other factors. However, by examining the effects of current high prices we can gain some insights into the effects that continued high food prices may have on the food security of poor countries. If increased demand for biofuels places increasing upward pressure on food prices, then the effects we see today are likely to persist in the long term, all things being equal. For Bangladesh, the critical issue is whether somehow it can respond to high prices today by effecting a transformation in agriculture so that it is less reliant on world food markets in the future, particularly those of its Asian neighbours. The problem now for Bangladesh is that people cannot afford to buy food. There is enough food available but the issue is one of access. If wealthy nations continue to demand greener fuels and switch their food production to fuel production, then we may well see food imports in these nations rising significantly. This will impact on food prices with adverse consequences for poor nations.

2. *The current food crisis*

According to the Food and Agriculture Organization (FAO) overall food prices have increased by 75% in dollar terms since 2000. A complex mix of factors explain these rising prices ranging from frequent droughts, downpours, floods and various other kinds of natural calamities as well as the shift in the use of food grains for feedstock and biofuels along with increasing energy prices. There is also evidence of speculative dealings, in wheat and maize especially, exacerbating prices further. Stocks, which were already low at the start of this year’s season, are likely to remain so because global cereal production may only be sufficient to meet expected world utilization. Although world cereal production in 2007–08 is estimated to have gone up by 5%, most of it is attributed to a sharp increase in maize, the main food grain used for biofuels. The observed increase in food prices is not a temporary phenomenon, but likely to persist in the medium term. Food crop prices are expected to remain high in 2008 and 2009 and then begin to decline as global supply and demand respond to high prices. However, they are likely to remain well above the 2004 levels through 2015 for most food crops. Forecasts by FAO, OECD and USDA who regularly monitor and project commodity prices are broadly consistent with this projection (see table below). Predictions of high food price in the medium run are further strengthened when we factor in the impact of policies aimed at achieving energy security and reduced carbon dioxide emissions, which may present strong trade-offs with food security objectives.

Table A.1: Index of projected real food crop prices, 2004=100

	2007	2008	2009	2010	2015
Real Prices					
Maize	141	179	186	176	155
Wheat	157	219	211	204	157
Rice	132	201	207	213	192
Soybeans	121	156	150	144	127
Soybean oil	138	170	162	153	119
Sugar	135	169	180	190	185

Source: Development Economics Prospect Group (DECPG), World Bank.

As a net importer of food, Bangladesh has suffered severe terms of trade shocks of approximately 1% of GDP (World Bank, 2008). Foreign exchange earnings and international purchasing power has also decreased. Rice is the staple food of poor Bangladeshis. Rice prices have almost doubled in just a year in Bangladesh. Last December's Sidr Cyclone in Bangladesh destroyed US$600 million worth of the country's rice crop. A kilo of rice now costs 30p (US$0.60) or 25 Taka (the local currency). The government has tried to import rice stocks, but now the major exporting countries, such as neighbouring India, have severely restricted their exports.

The ‘boro’ rice harvest, which accounts for about 60 % of the country's yield, is expected to be a bumper one (10% higher than last year) but this will only provide temporary relief. It is unlikely to offset the severe crop losses of 2007. In addition Bacterial Leaf Blight (BLB), a serious rice disease, also poses a threat to stocks, although this is not going to affect this year’s ‘boro’ production (Roundtable, Bangladesh Agricultural University, Mymensing, April 2008). Even if the `boro’ harvest remains favourable over the next few seasons, the food crisis is likely to continue over the next two to three years and prices will remain high.

According to the World Food Programme (WFP), Bangladesh is a low-income, food-deficit country with annual average food grain imports of two million metric tonnes (mt). With world oil prices also predicted to remain high along with food cereal prices, the costs of imports will increase. High fuel prices have not only raised the costs of producing agricultural commodities, but also of transporting them. The increase in energy prices have been very rapid and steep, with the Reuters-CRB energy price index more than doubling over a period of three years since the middle of 2004. Freight rates have also doubled, mainly within a one-year period beginning February 2006 (FAO Food Outlook, No. 2, 2007). At present, Bangladesh cannot feed its population without rice imports. National stocks of food are very low.

About half of the population (63 million people) live below the food poverty line, spending 70% of their household income on food. Among these, 28 million people, representing 20% of the total population, are considered “ultra poor” (WFP, 2007). The average daily food requirement for humans is between 2000–2200 calories. For those that live on or below the poverty line, average daily consumption in Bangladesh is 1600 calories (FAOSTAT). Continued rising prices would reduce total energy intake. Moreover, as prices of staples increase, the quality of diets of the poor diminishes as increasingly less income is available for other foods.

According to the Bangladesh Food Ministry's Food Situation Report 2007, the total food grain import requirement for the current fiscal year (July 2007–June 2008) is projected at 4.03 million metric tonnes, while in the last fiscal year 2.42 million metric tonnes were imported. This amounts to approximately 26 kg per capita of food imports this year. On 6th April 2008 a government food adviser, A.M.M. Shawkat Ali, told a conference of district administrators in Dhaka that the present food situation would probably continue for some time.

Events in the international market are pushing Bangladesh into a tight corner. The state exchequer clearly cannot sustain paying high prices for imports while also subsidising the price of rice in local markets. The recent rice price hikes are likely to be partially offset by the 'boro' harvest and by increased supply on global markets following the harvests of the southern hemisphere. According to FAO global rice production is expected to increase by 1.8% — or 12 million metric tonnes — this year, easing a tight supply situation in key cultivating countries. Assuming normal weather conditions, sizeable production increases were expected in all the major Asian rice-producing countries, including Bangladesh. In this sense the current price rises may not be sustained although they are unlikely to fall down to the levels of 2003.[19]

Bangladesh could turn into a food surplus country, provided the government ensures supplies of quality seeds, fertiliser, diesel, and electricity to farmers in time. The government has not been very good at disseminating validated agricultural information to farmers and in making sure that farmers are updated with the latest technologies in order to get the best harvest and protect crops from any diseases.

In addition, the quantity of arable land is diminishing for a number of reasons. Unplanned construction of residential and commercial areas, shopping malls, educational institutions, industries, roads and highways have risen. The legal structures to prevent the illegal appropriation of land are largely absent. Agricultural productivity is also hampered by increased salinity which affects soil fertility. On more than 25,000 hectares of land in the south, agricultural production has dropped significantly in recent years. Most of the affected area is less than 1.5m above sea level. With every rising tide, sea water deposits salt on the land. Cultivation of rice has suffered most, while the production of wheat, pulses, rape seed and coconut has also been affected. Another factor is the sharp rise in shrimp cultivation, which has created permanent saline water-logging in the region. Undoing saline damage is very costly requiring massive investment in irrigation.

With the prospect of securing food grains from international sources dwindling faster than ever before, Bangladesh has to face some critical questions over its long-term food security. The gains in agriculture stemming from the Green Revolution adopted in the 1980s have helped keep real food prices low for over 20 years. A critical question seems to be whether the global demand for biofuels could reverse the gains of the Green Revolution. If so, the consequences for Bangladesh could be devastating.

3. Biofuels and Bangladesh

Biofuels have two economic effects. On the one hand they may stimulate supply and have a positive effect on farm incomes. On the other hand low income food deficit countries (LIFDCs) stand to lose as they struggle to feed their populations. The Earth Policy Institute in Washington has reported that land turned to biofuels in the US alone in the last two years would have fed nearly 250 million people with average grain needs. In 2008, 18% of all US grain production will go to biofuels. In the last two years the US has diverted 80m metric tonnes of food to fuel (ODI, Briefing Paper 37, 2008).

[19] In 2003, global price for Indian rice was US$163 per mt. (Note: Bangladesh relies on imports of Indian rice especially)

3.1 Bio-fuels and farm incomes: is there an opportunity for farmers?

The answer is no. Bangladesh is not a country that can take advantage of the incentives generated by biofuels demand by switching production to food crops that serve as inputs to biofuels production. The government has no policy on biofuels development.

Agriculture in Bangladesh struggles to feed its own people. 63% of the labour force in Bangladesh is employed in agriculture but this contributes only 19% to GDP (World Bank, 2007). Rice is the major food crop accounting for 76% of total agricultural cropped area and contributing 95% of cereal food for the nation. Any failure in the harvest means that the country has to rely on imports. There are a number of problems in agriculture which need to be overcome if progress towards rice self-sufficiency is to be made.

Although Bangladesh was able to increase food grain production to 40 million tonnes from less than half that in the early 1980s because of better farming practices and high-yielding varieties of rice, Bangladesh has reached a saturation point in producing grains. Food production is being outpaced by population growth at nearly 2 % annually. According to the World Bank Bangladesh needs to change cultivation practices to boost food security, plant large areas of forest in flood-prone areas along rivers and the coast and build embankments(see UNEP, 2008).

Only a handful of rich farmers have surplus saleable rice and are able to get the benefit of soaring rice prices. Out of thirty million farmers in the country, only 15% have surplus rice to sell after harvest. The vast majority of farmers are compelled to sell most of their rice just after harvest to repay debts and depend on the market to buy their food.

Whilst there is no defined policy on biofuels there seems to be the potential for some farmers to develop biofuels, albeit for domestic consumption, through rice production. The rice plant produces a significant amount of by-product which is used as energy. Rice husk production in Bangladesh has been steadily rising, playing a significant role in the country's energy use. The main consumer of rice husk energy is the rice milling sector. Biomass is the dominant energy source in Bangladesh, accounting for approximately 67% of the country total energy consumption (RWEDP 2000). The per capita energy consumption in Bangladesh is one tenth of the world average i.e. 6.27 GJ/year (Ellery et al. 2000).

There are three main biomass by-products from rice: rice straw, rice husk and rice bran. Rice straw and rice bran are used as feed for cattle, poultry, fish etc. and rice husk is used as energy. A significant amount of total national energy comes from rice biomass. Fung and Jenkins (2003) reported that rice husk is an abundant biomass resource in the Philippines, offering the potential for energy generation. Biomass-to energy projects could create sustainable enterprises, protect the environment, and reduce poverty and improve the quality of life for the rural poor. The same study also reports that biomass energy projects could create employment for rural people. The total employment generated was estimated as 14,048 employees for a whole year in Bangladesh.

However, serious constraints prevent the dissemination of rice husk energy technologies for the benefit of the rural economy. These range from policy and regulations, official recognition of the opportunities of rice husk development and the difficulty in raising loans. Given this, it is unlikely that the demand for bio-mass energy would generate significant changes in rural non-farm employment to offset the rise in food prices in the short to medium term. Moreover, bio-mass energy is used domestically and would not command world prices although it may contribute to a reduction in the national bill for other types of energy. Bangladesh annually imports 3.8 million tonnes of oil including 2.1 million tonnes of diesel. The cost of Bangladesh's fuel imports rose 19 % to US$2.5 billion for the fiscal year to June 2007 due to higher oil prices in international markets and the annual import cost of oil is expected to reach US$3.0 billion in the fiscal year 2007–08 (Bangladesh Petroleum Corporation, BPC, 2008).

There is some hope possibly for farmers. At the present time, public procurement is paying US$400 per mt for rice which should serve as a very powerful incentive for farmers to mobilise themselves and secure their livelihoods long-term. Along with targeted government support of agriculture, Bangladesh could become much more food secure than ever.

3.2 Impact on the poor

Normally, if the price of one food staple rises, consumers switch to other staples. The problem now is that the prices of all staples have gone up. For Bangladesh, rice, the main food staple, has seen prices explode on the global market. Rice prices have risen 74% in the last year alone (Asian Development Bank, 2008).

World rice stocks have shrunk from a peak of 130 million tonnes in 2000–2001 to 72 million tonnes in 2007–2008, the lowest level since 1983–84 (USDA, 2008). This amount is estimated to meet only 17% of global consumption. Nearly half of the world's 6.6 billion people are dependent on rice and are already eating more than is harvested yearly. The situation in the Asian rice market has particular consequences for Bangladesh. Bangladesh relies on the exports from its close neighbours to meet domestic shortfalls in rice. Thai rice was selling at US$780–$800 a tonne on April 4, up from US$100 not long ago. Thai exporters are no longer offering supplies because they may fail to meet their commitments. The world's largest producer, China, needs its 123 million tonnes for its own population. Vietnam, the world's second largest producer of rice, has stopped selling abroad in order to secure domestic food supplies. Recently, India, which normally exports 4 million tons annually, imposed a ban on non-basmati rice exports to ensure the country has enough rice to feed its more than 1 billion people and to ease pressure on domestic prices, which have pushed wholesale inflation to a 14-month high. Cambodia, which is experiencing a rice surplus, also announced this week to ban rice exports for two months. Indonesia, another major rice producer, is also planning a ban on rice exports. The pressure on rice prices is affecting all rice qualities and origins.

In Bangladesh, 46% of families live at or just below the poverty line of US$1 a day and spend up to 70% of income on food. At the poverty line of US$2 a day the figure jumps to 82%[20]. The World Food Program reports that more than 50,000 households are getting emergency food. Bangladesh is currently importing rice from its immediate neighbours, India and Myanmar, to meet the shortage. This has already created a problem because, several times in the past few months, India has imposed a ban on rice exports or has increased the minimum export price, and each time, the price of rice in Dhaka spiked.[21] The price of the low quality subsidised rice sold to the poor has risen dramatically over recent months, almost double what is was a year ago at 25 Taka (30 cents) per kilo. Low income workers are spending most of their pay on rice and eating only twice a day. More recently there is evidence that many are just eating once a day. Wages are not rising in line with inflation. Inflation is currently 11%. Food inflation is around 14%, down slightly from December 2007 when it peaked at over 15% (Bangladesh Bureau of Statistics).

3.2.1 Global prices and domestic prices

Domestic prices affect food consumption much more than world prices. It is changes in the level of domestic prices that determine the adjustment made by consumers and producers. Therefore, it is important to consider the degree to which world cereal prices have been transmitted to national economies. If an economy is largely buffered from the global economy then these adjustments are not necessary. If there is full price transmission then low income food deficit countries like Bangladesh confront very real problems in feeding its people adequately as consumption adjustments could be very pronounced.

[20] Figures from the World Bank Database

[21] India has agreed to sell rice to Bangladesh for US$540 per tonne, US$200 more than the Government wishes to pay.

A very recent study by FAO presents evidence on price transmission for rice, wheat and maize in Bangladesh (see Dawe, 2008). World market prices in real dollar terms have gone up 56% for rice, 40% for maize and 90% for wheat. At the same time the dollar has depreciated against many currencies. This can serve to buffer the effects of rising global prices at the domestic level through a real exchange rate (RER) appreciation. The FAO study shows that unlike other Asian countries, notably the Philippines and India, Bangladesh has not benefited from a real exchange rate appreciation.

Table A.2: Cumulative percentage changes in real rice prices in Bangladesh, last quarter 2003 to last quarter 2007

World Price US$	World Price (Domestic Currency-Taka)	Domestic price (Domestic Currency-Taka)	Pass through %
56	55	24	43

Source: FAO, ESA Working Paper no.08-03

The difference between columns (1) and (2) shows the extent to which exchange rate appreciation has muted the effects of rising US dollar world rice prices. We can see for Bangladesh it is not very much at all. Comparison of columns 3 and 4 show the extent to which changes in world prices in domestic currency terms have been passed through to consumers and farmers. Column 3 shows the cumulative increase in domestic wholesale or retail prices from the fourth quarter of 2003 to the fourth quarter of 2007 in real domestic currency terms. A comparison of columns 2 and 3 illustrates how Bangladesh has dealt with rising food prices after controlling for exchange rate movements. Column 3 is less than half of column 2 reflecting the use of commodity based policies (i.e. excluding exchange rate policies) to insulate the domestic economy from price increases on international markets. Bangladesh has used changes in rice tariffs to stabilize domestic prices.[22]

Wheat ranks second in importance, after rice, as a source of energy and protein in Bangladesh. Wheat consumption averages 19.9 kg/year per person. Rice consumption, by contrast, averages 155kg per day (FAO). Wheat provides an estimated daily contribution of 170 calories, 5 grams of protein and 0.8 grams of fat to the average daily diet. It also provides about 8% of the energy and 11% of the protein in the national diet. Wheat is consumed primarily in flat breads known as *chapatis* and *parathas*, although raised breads and pastries are also consumed in urban areas. The flat breads are made with high-extraction flour known as *atta*, whereas breads and pastries are made with various grades of white flour, known as *maida*. Wheat consumption is more important in urban areas than in rural areas. A recent survey of food consumption patterns in Bangladesh indicates that while overall consumption averages 54 gm/day per person, the averages for the urban and rural sectors were 66.6 and 46.5 gm/day per person, respectively. The same study reports separately for families classified as poor and non-poor. These families had an average consumption of 38.1 and 65.5 gm/day per person, respectively. With no action taken on wheat prices, poor consumers do not have the option of adjusting consumption to wheat. The non-poor may revert to increased rice consumption.

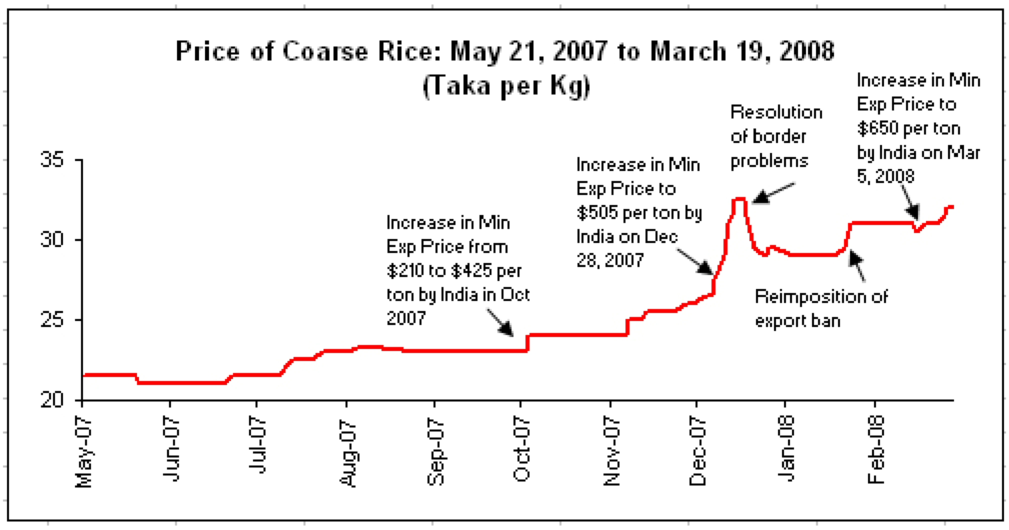
While rice price increases within Bangladesh do not reflect world prices fully, the impact of domestic price increases for the poor are substantial and have serious effects on household nutritional status. With an increasing proportion of income just going on staples, there is little left to spend on other food groups, vegetables, pulses, meat and cooking oils. Household purchasing power of these foods is further reduced also because of high prices.

[22] The analysis by David Dawe considers only short-run effects. In the long-run, the issue will be whether the government of Bangladesh can continue using financial reserves to keep rice prices low.

4. *Response to the current food situation*

In Dhaka, government open market sales (OMS) centres have been set up which are usually established whenever there is a food crisis. The authorities have opened over 2,500 outlets nationwide, with an additional 3,800 set to open shortly. Rice and other commodities in these outlets are almost 30% cheaper than the market rate. One kilo of coarse rice now sells at US$0.30 a kilo through the OMS, while the same rice elsewhere sells for US$0.51 a kilo (April 2008 prices). The Bangladesh Institute of Development Studies (BIDS) estimates that the price of coarse rice has gone up by close to 70% over the past 12 months (see graph below).

Figure A.1: Rice price, Bangladesh, 2007 to 2008



Source: World Bank 2008

OMS dealers sell rice on Saturdays, Mondays and Wednesdays. Each day they are given 1,020 kg of rice. With 5 kg per person allowed, this is only enough for 204 people a day. The Bangladeshi press report that queues are often more than a thousand long. The problem is compounded by price rises in other food essentials, such as pulses, flour, oil, onions and sugar that have increased by nearly 50 % in the last six months. The price of chickens, eggs and fish has also gone up. The OMS is primarily aimed at the poor but now the lower middle classes find that they too have to queue for food, their salaries insufficient to cover food bills. Their nutritional status is also affected as they buy more rice than before. Purchasing power has declined by around 4% due to higher inflation in 2007, propelled by the 16% food inflation in December alone (BIDS).

In early April 2008, the government announced it would import 400,000 metric tonnes (mt) of rice from India by the end of May to lessen the blow. Monthly economic indicators of the Bangladesh Bank (BB), the country’s central bank, reveal food stocks stood at 715,000 mt in January 2008, while currently the country had around 550,000 mt, (including 350,000 mt of rice and 200,000 mt of wheat).

The Government has committed itself to buying imported rice. Rice import expenditure increased by 761% in the first six months of the current fiscal year (July 2007-June 2008) compared to the expenditure in the same period of the last fiscal year creating pressures on the Balance of Payments[23]. Bangladesh Bank data also show that rice imports during the fist six months of the current fiscal increased by 470% compared to imports during the same period

[23] Source Bangladesh Bank

of the last fiscal year. Importers also opened letters of credit (LC) for importing both rice and wheat. The table below shows the increase in expenditures on food imports.

Table A.3: Food imports, Bangladesh

	July 2007-December 2007 (first six months of current fiscal year)	July 2006-December 2006
Expenditure on rice imports	US$310m	US$36m
Quantity of imports. mt	998,000	175,000
Letters of credit for rice imports	US$538m	US$47.4m
Quantity of rice imports under LCs, mt	1,600,000	232,000
Letters of credit for wheat imports	US$456m	US$238m
Quantity of rice imports under LCs, mt	1,262,000	1,119,000

Bangladesh's trade deficit has soared by more than 150% in the first four months of the current fiscal year, dragging the current account balance to a negative US$229 billion (Bangladesh Bank figures). The overall trade deficit rose to US$1.739 billion in the July-October period, (156% more than the corresponding period last year), owing largely to the high oil and food import bill. The central bank is, at present, not too concerned about the deficit and has been encouraging more food grain imports to ensure food security in the country. In addition, it is encouraging the commercial banks to disburse more agricultural loans in rural areas to ensure smoother production of food grains. The governor of the Bangladesh Bank, Salehuddin Ahmed, agrees with many analysts that it would be better for the country to have a safe food reserve rather than a high foreign exchange reserve.

Bangladesh also has very well run social assistance programs that worked well during the floods and cyclone of 2007. These included food aid and food-based transfers. The latter involve in-kind transfers of food such as rice and wheat. The government has also encouraged people to consume more potatoes in an effort to ease pressure at OMS outlets. Whilst potatoes may be a potentially promising way forward to ease future food pressures, at present it is difficult to persuade people to change food habits unless they are forced to. Rice remains the preferred food staple.

5. The long-term effects of high cereal prices on Bangladesh.

Assuming there are no changes in fundamentals that would bring world prices down or increase current levels of food stocks, then sustained global food inflation will affect national food security. This section will consider the key issues for food security, the national economy and the impacts on the livelihoods of the poor.

5.1 Effects on food security

Bangladesh is one of the world's poorest countries. The population is predominantly rural, with about 85% of its 150 million people living in rural areas. Estimates of rural poverty rates now stand between 53% and 43.6 %. Urban poverty is on the increase in Bangladesh. The current food crisis has identified a new group of urban poor — industrial workers and low-paid government employees with fixed incomes. They have been the hardest hit by rising food prices. The headcount poverty rate in Bangladesh declined from 59% in 1991–92 to 50% in 2000. Progress in reducing poverty incidence was equal across urban and rural areas, with rural areas performing better in lowering the depth and severity of poverty. Income inequality in Bangladesh has risen considerably since then. Net rural-urban migration in the last 15 years has contributed to lower rates of poverty reduction in urban areas.

The next two sections briefly identify the poor and food insecure.

5.1a The rural poor

Rural people depend mainly on the land, which, although fertile, is very vulnerable. Most of the country is made up of flood plain. The alluvial soil provides good arable land but large areas are at risk because of frequent floods and cyclones damaging crops, livestock and property as well as taking human life.

20% of rural households live in extreme poverty. Chronically poor people suffer persistent food insecurity, own no cultivable land or assets, are often illiterate and may also suffer serious illnesses or disabilities. Another 29% of the rural population is considered moderately poor. They may own a small plot of land and some livestock, but while they generally have enough to eat, their diets lack protein and other nutritional elements. This segment of the rural population is at risk of sliding deeper into poverty as severe weather conditions frequently ruin their livelihoods. Small-scale farmers may subsist at either of these levels of poverty- extreme or chronic. Their livelihoods are precarious because of the seasonal nature of farm income and because of natural disasters such as floods and drought.

Women are among the poorest of the rural poor, especially when they are the sole heads of their households. Among extremely poor people, there are a disproportionate number of households headed by women. When food crises occur their nutritional status is often the first to decline rapidly. This also has implications for the health status of pregnant women and newborns.

5.1b The urban poor

The urban poor are increasingly made up of poor migrants from rural areas. They are mostly the landless, households without assets who cannot earn a living and farmers whose dwellings are regularly threatened by the floods. Rural migrants have difficulties finding employment in new urban environments which contributes to the increase in urban extreme poverty.

There has been inadequate redistribution of the benefits of urban growth to the poor, partly because of the lack of job opportunities and partly because of insufficient coverage of the existing social safety nets.

5.1.1 Quantifying the effects of price rises on food insecurity

World Bank data on food consumption patterns confirm the fall in poverty during the last decade and into 2004. Anthropometric data suggest good progress in reducing child malnutrition, significant improvements in infant and child mortality, and increases in various measures of life expectancy. The reduction in fertility has been substantial, though in the last few years the total fertility rate seems to have reached a plateau. Progress in increasing literacy and school enrolments has not been as successful. Considerable progress has been made to reduce household vulnerability particularly towards improvements in food security and the strengthening of disaster coping mechanisms.

However, weather and natural disaster continue to make the population vulnerable as was seen in 2007. The rise in global food prices exacerbates the effects making recovery more difficult. If prices continue to be high households suffer a fall in real incomes, which affect all nutritional indicators.

In February 2008, FAO prepared a report examining the effects of high food prices. They find that with increases in rice prices of 10%, household welfare (as measured by reductions in purchasing power) declines. They measure the short-term impact of a 10 % increase in the price of rice on the net income of households by expenditure quintile. Their results suggest that both urban and rural households face welfare losses. The losses are higher in the lower quintiles (see Table A.4 below).

Table A.4: Bangladesh: effect of a 10% increase in the price of rice on welfare (percentages)

Per capita expenditure quintiles						
	1	2	3	4	5	All
Rural	-3.19	-2.60	-1.88	-1.64	-1.10	-1.83
Urban	-2.37	-1.90	-1.45	-1.09	-0.71	-1.26
Total	-3.02	-2.33	-1.83	-1.36	-0.94	-1.64

Source: FAO 2008

We can see from the table above that for households in the lowest expenditure quintile, purchasing power declines by 3.19% after taking into account the impact of both the increase in the revenue on the production side and the increase in the expenditure on the consumption side of an increase in the price of rice. For urban households in the lowest quintile, purchasing power falls by 2.37%.

The same study also finds that rural households exhibit higher welfare losses than urban households from the increase in rice prices. Households in the poorest rural quintile in Bangladesh earn on average 63 % of their income from on and off farm wages. Furthermore the vast majority of them are net food buyers; only 12 % are net food sellers. These characteristics identify households that are highly vulnerable to increases in food prices, and as expected, experience high welfare losses when confronted with increases in rice prices. See table below.

Table A.5: Rural Bangladesh: effect of a 10% increase in the price of rice on welfare (percentages)

	Rural per capita expenditure quintiles					
Land Quintiles	**1**	**2**	**3**	**4**	**5**	**All**
Landless	-3.26	-2.81	-2.28	-2.02	-1.41	-2.33
1	-3.72	-2.59	-2.19	-2.14	-1.66	-2.31
2	-3.10	-2.88	-2.34	-1.66	-1.23	-1.76
3	-1.77	-2.55	-1.61	-1.45	-0.86	-1.44
4	-2.49	-1.33	-1.06	-0.85	-0.74	-0.99
5	-5.09	-2.45	-0.23	-1.09	-0.79	-0.98

Source: FAO 2008

What can we say overall about the effects on food security? It is difficult to be precise because we need to look more closely at household characteristics as producers and consumers of staple foods. However, what is clear is that unless strong substitution effects towards cheaper food items are present, in the short-term, the majority of the households will see their welfare deteriorating. The net food seller position characterizes only a small proportion of relatively wealthier (non poor) and market-oriented rural households and thus, we would expect to see poverty rates rise. The evidence for Bangladesh is that all food prices are rising, which suggests that poor households who are net buyers of food do not have the option of adjusting consumption to alternative staples. High prices are likely to be associated with reduced consumption (early evidence indicates the poor are cutting back on the number of meals per day) and a less diverse diet.

It has been too early to quantify the effects on nutrition after the floods and cyclone of last year. However, floods in 2004 saw a 30% jump in child malnutrition. We may reasonably expect a rise in 2008–2009, the effects of flood, displacement and high prices impacting on nutritional status.

What this analysis does tell us is the direction and the magnitude of expenditure adjustment across different groups of the population? We see clearly (from the tables above) that the rural poor suffer the most. If global biofuel demand results in higher food prices we could see even greater deterioration in food security.

5.2 Effects at national level

The World Bank has projected Bangladesh's economic growth at 5.5% in 2008, lower than domestic estimates, due to political tensions, severe flooding and cyclone Sidr. Rising inflation, potential threat to exports, increases in food and energy prices and pressure on external balance would have an adverse impact on the economy, according to the World Bank's Global Economic Prospects 2008.

The sharp gains in international food prices present a growing threat to Bangladesh, where food imports represent 19% of its total imports. Poor world growth and a weak US dollar may have the effect of cutting Bangladesh's export revenues and capital inflows as well as reduce the value of dollar-investments abroad. Apart from putting increased pressure on external positions, the World Bank report said higher international food prices carry potentially serious implications for the poorest members of society. The higher food prices could strain government coffers and generate increased inflationary pressures given widespread food subsidies. Moreover, further increases in energy prices remain a risk for Bangladesh, which is highly dependent on oil imports.

The Food Ministry of Bangladesh estimate an import requirement of 4.03m mt for 2008. With the price of rice between US$522 and US$567 (FAOSTAT data), the import bill for Bangladesh will rise. Even if the harvest is good in the next few seasons Bangladesh will probably have an annual import requirement of 2M mt per year (WFP). However, with domestic stocks still very low after last year's floods and cyclone, the import requirement may need to be higher.

We have calculated the effect of price increases of between 10% and 40% on import expenditure (in absolute terms and as a percentage of GDP) over a range of import elasticities. If the import elasticity for rice remains unchanged (i.e. zero) the import bill would rise by US$870m for a 40% increase in price. However, as consumption and production adjustments are made we would expect some elasticity in imports. Were the elasticity 0.2, the import bill (for a 40% price increase) would be US$696. See Tables 1 and 2 in the appendix.

With rising imports the effects on national income can be calculated using a simple multiplier. We calculate both the absolute decline in GDP and the percentage decline in GDP. What is striking about our results is that the impact on income, GDP, is relatively modest. For a 10% increase in rice price, the fall in income is 0.08% or US$564m assuming no change in import elasticity. However, for a 40% increase in rice prices the effect is more marked. National income falls by 0.32% or US$2,255 million, again assuming an import elasticity of zero. Tables 3 and 4 in the appendix show the absolute decline in GDP and the percentage decline in GDP as import prices increase for a range of import elasticities.

These calculations are based on an import requirement of 4.04 mt in 2008. This is not necessarily the norm. The average import requirement for Bangladesh is around 2m metric tons. Using this lower import level, we calculate, in Tables 5–8, the effects of rising prices on both the import bill and national income. The effects are roughly halved.

5.3 Effects on livelihoods

Severe floods and Cyclone Sidr in 2007 affected 10 million people and resulted in the loss of a large area of the *aus* paddy crop (20 % of the annual production) being harvested, and prevented the *aman* crop being planted. Overall, 13 % of the total area with paddy was compromised by the floods.

Most of the population affected by the cyclone was critically dependent on agriculture for its living and many are vulnerable to food insecurity. Indeed, Dhaka has seen an influx of rural migrants. In general, damage to agriculture has a negative impact on livelihoods and, although still too early to quantify fully last year's total loss, it is likely to result in a deterioration of the food security situation. Rising food prices could harm the food security of the poor as they struggle to pay for food. In the absence of assistance directed at restoring livelihoods, many of the poor may well suffer a drastic decline in welfare. If the global demand for biofuels continues to place pressures on food prices, which is quite likely, then Bangladesh will find it increasingly difficult to support even current nutritional intakes.

6. Ways forward

On 20th March, the World Food Programme issued an emergency appeal for more funding to keep aid moving to the world's poorest countries. Of the US$500 million it sought for global food aid, US$15 million was required just for Bangladesh. On the United Nations' list of countries most vulnerable to food shocks (according to their demand for imported food) Indonesia, the Philippines and Bangladesh rank first, second and fourth, respectively. The very poor suffer not because there is not enough food but because they cannot afford it.

The present circumstance of high food prices affects Bangladesh in two key ways. First, rice exporters are holding back supplies which put prices up on the global market. Second, the cost of oil affects food prices on the global market by making it more costly to produce and transport and also affects the total import bill for Bangladesh. Bangladesh is both a net food importer and a net oil importer.

For Bangladesh a dependence on the global market for food may affect its development prospects as much needed reserves are, more and more, channelled into buying food imports which are then sold at subsidised prices. However, our results suggest that the impact on GDP of rising rice prices is relatively modest. The problem today in Bangladesh is really one of how food production can match population growth which has outpaced the dramatic yield growth produced by the Green Revolution. If food production does not keep up, then Bangladesh will have to rely on imports increasingly. At present food imports are 19% of total imports. This could go up. It seems that for Bangladesh the priority needs to ensure stable rice supplies in quantities that support the increasing population. Bangladesh has to rely on itself..

According to the International Rice Research Institute (IRRI), Bangladesh needs to increase rice production by 0.35 million tons yearly to feed an extra 2 million people per annum. IRRI consider that hybrid rice, produced commercially by crossing different varieties to attain higher yields, could hold the key to increasing production. Hybrids, pioneered by China, are bred by crossing three genetically different rice varieties to produce a plant that grows faster and produces yields of up to 20% higher. The downside is that farmers need to buy new seeds to plant every year, which raises costs, because seeds saved from the previous hybrid crop have inconsistent yields and grain quality can also be a problem. Traditional rice varieties are self-pollinating, so the seeds from every harvest can be used again in the next planting season.

A further problem stems from the widespread use of insecticides which not only represent an environmental threat, but are a significant expenditure to poor rice farmers. The Bangladesh Rice Research Institute is working with various NGOs and international organizations to reduce insecticide use in rice.

Bangladesh has thousands of hectares of land, approximately 1.8 million hectares, in unfavourable areas that potentially could be used for rice paddy cultivation using hybrid seeds according to the government. What these lands are and where they are is not clear. Many households have access to common lands which provide an important resource in terms of pastures for animals. Moreover, some unfavourable lands are lands that have been prone to long-term flooding. Making these lands productive would require two key inputs: first, more irrigation to manage water provision and reduce soil salinity and second, create lending opportunities for small and marginal farmers to access new technologies. Without proper management of agriculture and its modernisation Bangladesh would be unable to ensure adequate food for its more than 150 million people, of whom 40% live on less than US$1 a day.

To date the government's role in supporting hybrid rice has been limited to assuring a conducive regulatory environment, participating in the occasional promotional programme and carrying out some breeding work. The Asian Development Bank, IRRI, and NGOs like Bangladesh Rural Advancement Committee (BRAC) collaborate with multinational seed companies and have been the main conduit for hybrid rice in Bangladesh. Despite heavy promotion at the local level—in the form of leaflets, posters, publicity banners, village meetings, broadcasts through megaphones and advertisements on radio and TV—sales of hybrid rice seeds remain low. In 2003, less than 50,000 hectares were planted to hybrid rice in the country.

Farmers growing both hybrid rice and high-yielding varieties on their farms found that, while the hybrids were higher yielding, the costs of inputs were 23% higher compared to non-hybrids. Farmers complained of high seed costs, the need for more crop care and management time, low yield gains, high pest and disease attack, low profits and lack of suitability for home consumption. The price of inputs is very high and beyond the purchasing power of small farmers.

The Government announced in 2007 that it will expand urea deep placement (UDP) (a technology that doubles the efficiency of urea fertilizer use) to almost 1 million hectares (ha) of rice land, reaching about 1.6 million farm households. UDP is the insertion of large urea briquettes into the rice root zone after transplanting. UDP cuts nitrogen losses significantly. Farmers who use UDP can increase yields by 25% while using less than 50% as much urea as before, helping to reduce production costs. UDP technology improves nitrogen use efficiency by keeping most of the urea nitrogen in the soil close to the rice roots and out of floodwater. The technology not only improves farmer incomes, but creates employment because of the need for the briquettes. Ten Bangladeshi manufacturers have produced and sold more than 2,000 briquette-making machines. The new UDP program will include the manufacture and establishment of some 300 briquetting machines to manufacture 2.7-gram briquettes. UDP technology was introduced in Bangladesh in the late 1990s. By 2006 more than half a million farmers had adopted UDP. Average paddy yields increased by 20% to 25%, and income from paddy sales increased by 10%, while urea expenditures decreased 32%. Farmers who use UDP can reduce urea use by 78 to 150 kg/ha and increase paddy yields by 900 to 1,100 kg/ha (Bangladesh Department of Agricultural Extension).

The current food crisis may be seen as an opportunity to transform the agricultural sector. There seems to be a growing understanding that only Bangladesh can resolve its food crisis. Agricultural advisors in government have called upon more public-private partnerships to modernise agriculture. The IRRI estimate that with good seeds, good plants, balanced growth of crops and efficient irrigation at the right time Bangladesh is capable of producing six to seven metric tonnes of food grains per hectare which would dramatically ease supply constraints. Without this action, global markets will impact on food prices within Bangladesh and may well undo some of the gains of the Green Revolution.

7. Conclusions

The current food crisis in Bangladesh is affecting the food security of the poor and also the low-income non-poor. Increased demand for biofuels on a global level could have serious impacts for food security in Bangladesh in a number of ways. First, the total production of food may decline as more land is diverted to biofuels production. Second, the food import requirement of rich nations may rise markedly as they switch domestic production away from food. The result would be high prices for all foods with particularly negative effects for low income food deficit countries like Bangladesh. The current crisis provides an important lens on the effects of rising prices in poor countries. This is not something that is feasible in the long-term. However, at present poor governments can use reserves to buy food imports. Food aid has also taken the pressure off national governments to some extent although last year the

WFP did not reach its required target in terms of its global aid requirement. High prices affect aid provision too. For Bangladesh increasing food stocks are seen as more important than increasing the foreign exchange reserve. This will require a redirection of efforts towards agriculture in order to increase output. If such efforts are not forthcoming, the food situation in Bangladesh may become increasingly worse.

Table A.5: Absolute increase in import expenditure (million US$)

(based on current rice import requirement of 4.03m metric tonnes and a current rice price of US$540 per mt)

		elasticity of imports				
		0	0.05	0.1	0.15	0.2
percentage	0.1	218	207	196	185	174
increase in	0.2	435	413	392	370	348
price	0.3	653	620	588	555	522
	0.4	870	827	783	740	696

Table A.6: Increase in import expenditure as a percentage of GDP

(based on GDP US$70600 million)

		elasticity of imports				
		0	0.05	0.1	0.15	0.2
percentage	0.1	0.31	0.29	0.28	0.26	0.25
increase in	0.2	0.62	0.59	0.55	0.52	0.49
price	0.3	0.92	0.88	0.83	0.79	0.74
	0.4	1.23	1.17	1.11	1.05	0.99

Table A.7: Absolute decline in income (in million US$)

(based on a saving rate of 0.136 and an average import rate of 0.25.)

		elasticity of imports				
		0	0.05	0.1	0.15	0.2
percentage	0.1	-564	-536	-507	-479	-451
increase in	0.2	-1128	-1071	-1015	-958	-902
price	0.3	-1691	-1607	-1522	-1438	-1353
	0.4	-2255	-2142	-2030	-1917	-1804

Table A.8: Percentage decline in income

(based on GDP US$70600 million)

		elasticity of imports				
		0	0.05	0.1	0.15	0.2
percentage	0.1	-0.08	-0.08	-0.07	-0.07	-0.06
increase in	0.2	-0.16	-0.15	-0.14	-0.14	-0.13
price	0.3	-0.24	-0.23	-0.22	-0.20	-0.19
	0.4	-0.32	-0.30	-0.29	-0.27	-0.26

Table A.9: Absolute increase in import expenditure (million US$)

(based on current rice import requirement of **2.0 m** metric tonnes (average yearly import requirement) and a current rice price of US$540)

		elasticity of imports				
		0	0.05	0.1	0.15	0.2
percentage	0.1	108	102.6	97.2	91.8	86.4
increase in	0.2	216	205.2	194.4	183.6	172.8
price	0.3	324	307.8	291.6	275.4	259.2
	0.4	432	410.4	388.8	367.2	345.6

Table A.10: Increase in import expenditure as a percentage of GDP

(based on GDP US$70600 million)

		elasticity of imports				
		0	0.05	0.1	0.15	0.2
percentage	0.1	0.15	0.15	0.14	0.13	0.12
increase in	0.2	0.31	0.29	0.28	0.26	0.24
price	0.3	0.46	0.44	0.41	0.39	0.37
	0.4	0.61	0.58	0.55	0.52	0.49

Table A.11: Absolute decline in income (in million US$)

(based on a saving rate of 0.136 and an average import rate of 0.25.)

percentage	0.1	-280	-266	-252	-238	-224
increase in	0.2	-560	-532	-504	-476	-448
price	0.3	-839	-797	-755	-713	-672
	0.4	-1119	-1063	-1007	-951	-895

Table A.12: Percentage decline in income

		elasticity of imports				
		0	0.05	0.1	0.15	0.2
percentage	0.1	-0.04	-0.04	-0.04	-0.03	-0.03
increase in	0.2	-0.08	-0.08	-0.07	-0.07	-0.06
price	0.3	-0.12	-0.11	-0.11	-0.10	-0.10
	0.4	-0.16	-0.15	-0.14	-0.13	-0.13

(Based on data from World Bank, Bangladesh Ministry of Food and FAO)

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B. Brazil

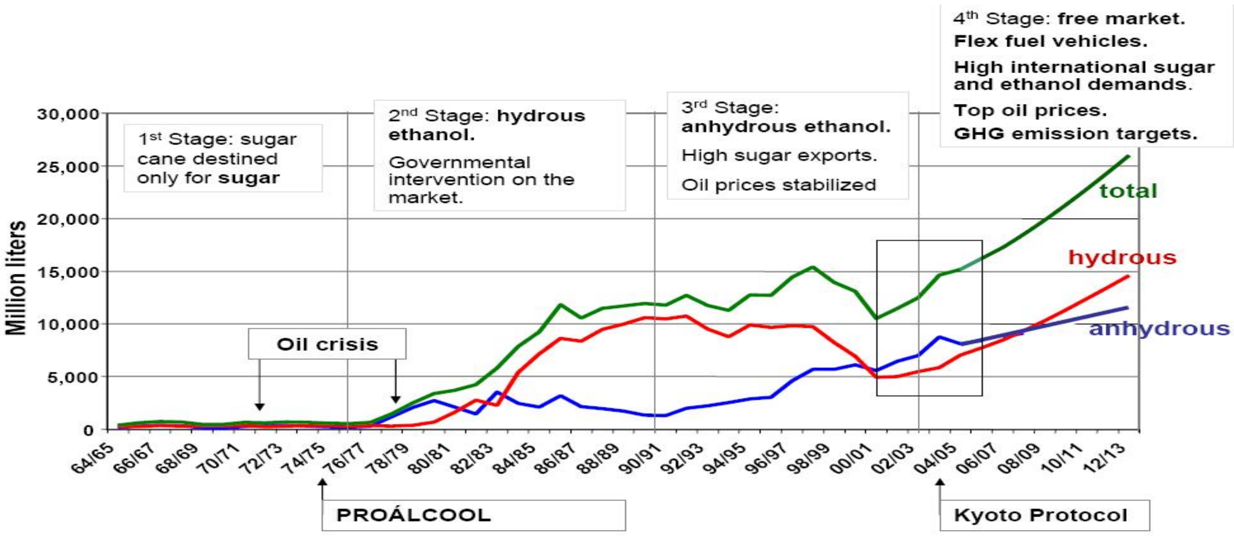
Policy on Biofuels

Brazil has a longstanding policy on biofuels development, beginning in the early 1930's with bioethanol. The Proalcool programme[24] (1974) was designed so as to reduce dependency on foreign oil and used subsidies and tax breaks in order to get farmers to plant more sugar cane, incentivise investment in distilleries and get car manufacturers to design their vehicles based on bioethanol fuel production.

Brazil has made the most of its natural resources - subsidising bioethanol production throughout the 1970's means the industry is self-sustaining and the world leader in GHG efficient bioethanol. Strong government support and a tropical/subtropical climate to which sugarcane is well adapted make Brazil's the world's most technologically sophisticated, energy-efficient, and market-integrated biofuels industry (WDR 2008).

Brazilian bioethanol is the most price competitive in the world.[25] Historically Brazilian biodiesel production has lagged behind that of bioethanol production, but there are now national targets in place and active programs which vary by region as does the source material (Nass et al. 2007).

Figure 1: Timeline of Bioethanol Production and Development in Brazil



Source: Ministry of Agriculture, Livestock and Food Supply (2006)

As illustrated by Figure 1, during Phase One of the *Proalcool* policy (1970–1990) production of hydrous ethanol jumped from low to negligible levels of production in 1978/79 to over

[24] National Alcohol Program (Proalcool) Decree no 76.593,1974.

25 Production costs of ethanol average around US$0.18-0.25 a litre, with an average export price of US$0.23 a litre (see Lima (2007). This compares to the US cost of bioethanol production of 1.14 (US$/gallon). In the EU, the cost of producing bioethanol from sugar beet costs more than twice as much as producing it from sugarcane in Brazil and nearly 40% more than from corn in the US. Bioethanol production within the EU is said to become competitive when the price of oil reaches US$70 a barrel, in the US cheaper foodstocks mean bioethanol production is competitive at around half of that.

10,000 million litres of production by 1988/89.[26] Although production of anhydrous ethanol (also know as 'neat' or ethyl-alcohol) initially developed quicker than hydrous ethanol (which is cheaper to make being 95% ethanol and 5% water) production levels of hydrous ethanol continue to outpace anhydrous production.

The period 1990 to date is known as Phase two of the Proalcool policy and is more flexible in terms of catering to market demands[27] but still meeting policy objectives. There is no ethanol-free gasoline on sale in the Brazilian fuel market. All gasoline is marketed with varying shares of bioethanol (for example, a 25% share of bioethanol is E25, also called gasohol, pure bioethanol is E100). 'Fuel flex' systems built into Brazilian automobiles means drivers are able to switch their fuel source according to price, should they wish to do so. The volume of bioethanol sold on the Brazilian market therefore varies yearly in response to the market situation, but it is the highest in the world second only to the US.

Given the strong fundamentals of bioethanol production in Brazil, the policy emphasis has now shifted to biodiesel production. There is strong government support for this sector – in order to generate rural employment and enable Brazil to be self-sufficient in energy. President Lula has recently inaugurated *Barralcool*, the first integrated biofuels plant that will produce sugarcane-based ethanol and biodiesel from oilseeds.[28]

The Brazilian energy policy[29] intends to meet the following objectives: to increase the share of biofuels in the national energy matrix; to protect the environment; to promote energy security; to protect the consumer; and to promote free competition. Brazil's current bioenergy programme intends to consolidate leadership on 1st generation biofuels and develop 2nd generation biofuels (Dornelles 2007). The following sub-sections will discuss 1st generation bioethanol and biodiesel production in Brazil in more detail.

Bioethanol

Brazil accounts for one third of global sugarcane production; bioethanol production consumes around 54% of the sugarcane crop (the rest being converted to sugar).[30] Although Brazilian bioethanol producers face considerable tariffs in the EC and US, their world market share of bioethanol exports is estimated to be significant. Nevertheless obtaining quantitative data on Brazil's world market share of export bioethanol is difficult and compounded by the fact that it may enter countries in different tariff lines (and therefore SITC and ISIC codes).[31]

It is fair to say that Brazil's world market share in bioethanol exports would be higher if it were not subject to high tariffs from the EU and US, keen to protect their own nascent

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26 Phase One of the Proalcool programme meant: a guaranteed volume of ethanol purchased; a guaranteed price; prefential interest rates to facilitate investment; and subsidies for the purchase of vehicles running on pure ethanol. Although once oil prices decreased in the mid-1980's and sugar prices increased this made ethanol production less attractive to both producers and consumers, Phase Two of the Proalcool programme introduced market forces, ending fixed price guarantees but using a mixture of tax breaks and targets, which has ensured the competitiveness of the industry to date through appropriate incentive mechanisms and flexibility.

27 In terms of the price incentives for consumers to use either oil or ethanol.

28 See Mae-Wan Ho (2006).

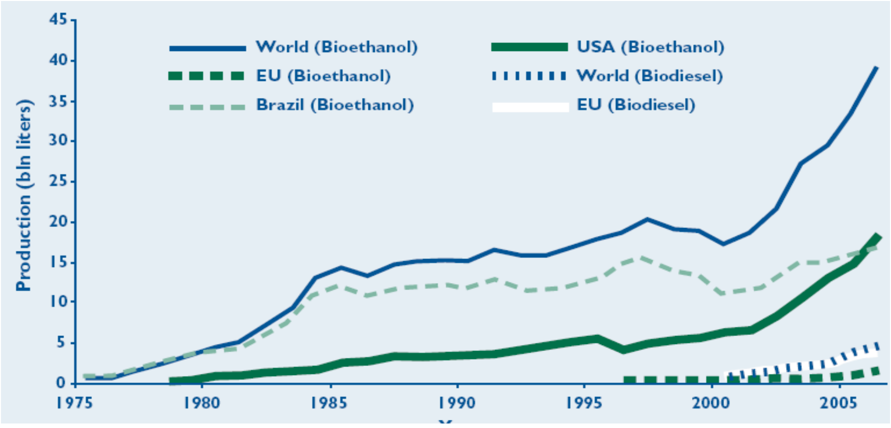
29 Brazil's energy policy is set out in law no.9.478/1997.

30 See World Development Report (2008) for a good overview of Brazilian production and competitiveness.

31 And sometimes in an underhand way such as in 'splash and dash' trade routing in order to take advantage of US and EU subsidies including those available 'at the pump', for example.

bioethanol industries.[32] The Brazilians are currently engaged in talks at the WTO to get bioethanol classified as an 'environmental good.'[33] Nevertheless as of 2006 Brazil had a 21.4% world export market share in 'sugars' with a year on year growth in value of 30%. However, year on year growth in volume remains low at 2%.[34]

Figure 2: World Bioethanol Production



Source: Henniges et al (2006)

As shown by Figure 2 above global production of bioethanol in 2006 was around 40 billion litres, of which 42% or 17 billion litres was produced in Brazil. Presently about 14 billion litres of bioethanol is sold on the domestic market.[35] Around 3 billion litres of Brazilian produced bioethanol is making its way onto world markets.

Domestically the programme is estimated to have led to the creation of more than 720,000 direct jobs and more than 200,000 indirect jobs in rural areas.[36] GTZ (2005:87) estimate the direct employment of the sugar-cane industry to influence around 60,000 rural producers (small and medium sized enterprises supply around 17% of total Brazilian production) in more than 960 municipalities. Salaries and benefits for employees are estimated to be 3.5 times the national minimum salary (Ibid).[37] Bioethanol employment will be further discussed in the sub-section on biofuels potential and smallholder production.

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32 When expressed as a percentage of the 'before tax price', the 2006 tariff on imports from Brazil of denatured ethanol was equivalent to 27%. The net effect is to restrict imports of ethanol (ODI 2008).
33 See Dufey (2007) who notes that the lack of a clear classification of biofuels within the multilateral trading system constrains effective trade: there is no agreement on whether biofuels are industrial or agricultural goods which means that biofuels are not compartmentalised as a 'green box' good which means that subsidies are currently non-actionable, or otherwise.
34 Data taken from ITC for 2006, value of 'sugars and sugar confectionary' exports were equal to US$6,347,522, 000. See Table 2 on Brazil's agricultural exports.
35 See Schmitz (2005)
36 Boyle (2005) makes reference to a study by Navarro (1992), figures are therefore likely to be considerably underestimated, given that the industry has had a further sixteen years worth of growth. It also fails to include indirect jobs created as a result of increased export earnings and domestic investment in gross capital formation, for example.
37 Most producers are remunerated according to the total sugar content of the raw material and the price of sugar and alcohol in internal and external markets.

Biodiesel

Brazil launched the Probiodiesel Programme in 2002 with the intention of reducing dependence on diesel imports; to replicate the success of bioethanol substituting petroleum. Expansion of biodiesel production is considered to be a program of social inclusion and job creation.[38] This view is echoed by Dornelle (2007:15) who states the reason for the Brazilian push into biodiesel production as including the need to secure rural jobs.

Mandatory targets for blending biodiesel have been passed[39] initially at 2% inclusion from 2005, increasing to 5% from 2013 and 20% by 2020.[40] Soybeans account for most biodiesel in Brazil and use the most technologically advanced production methods.[41] Although not competitive in terms of world market prices — castor oil production is part of a rural poverty reduction program which will be subsidised by the government and will meet local energy demands as opposed to world energy demands.[42]

The ‘social fuel stamp’ policy is part of the Lula administrations drive to encourage and reward biodiesel production by smallholders. The social fuel stamp will be granted to producers who purchase, sign contracts and train family growers and smallholders. The benefits of the policy include: tax exemption from federal taxes according to the amount purchased; low rate loans; overseas trade facilities.[43] In terms of sourcing strategies Romeiro (2007) points out that the Brazilian government expects the following shares of biodiesel produced to be purchased from smallholders/ family growers:

- 100% palm oil purchased from the North;
- 100% castor oil purchased from the Northeast;
- 30% of sunflower or peanut oil purchased from the Southeast;
- 5% of soy oil purchased from the Centre West; and
- 51% of soy oil purchased in the South.

In terms of the geographic dispersal of bioethanol and biodiesel production, the following points may be noted: sugar cane is produced mostly in the Centre South region of Brazil (85% of total sugar cane production); and the Northern East region (15% of national sugar cane production); any expansion of sugar cane will be within the South and North Eastern coast;[44] the semi-arid North East is focusing efforts on castor seed production; the Amazon region is likely to adopt palm oil; soy-bean production is concentration in the South and South Central regions; sunflower and or peanut oil are to be located in the South East. These aspects will be further discussed in the following sub-section on biofuel potential and smallholder production in more detail.

National Economy

The aggregate picture tells us that things are looking up for Brazil. The economy is maintaining growth, GDP per capita is increasing, the current account has moved from deficit to surplus and inflation has been tamed and steadily reduced. Gross domestic product is

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38 See USDA (2004)

39 Law 11.097/2005 establishes mandatory targets for blending biodiesel.

40 This equates to around 840million litres a year from 2005, around 1 billion litres a year 2008-2012 and 2.4billion litres from 2013 onwards. See Dornelle (2007:16) and GTZ (2005:74).

41 USDA (2004) notes that the processing sector is well developed and soybean research is advanced.

42 In terms of comparative price costs, castor oil produced in Brazil is US$110/ton more expensive than USA soybean oil, and China Soybean oil.

43 See Romeiro et al (2007)

44 See Strapasson (2006)

racing ahead, similarly industrial production. Brazil is currently managing to control inflation whilst other Latin American countries are not: in Venezuela inflation is up 29% compared to April 2007, Chile and Argentina are similarly experiencing year on year aggregate price level rises of around 8–9%. [45]

Table 1: National Economy indicators

Indicators	2000	2001	2002	2003	2004	2005	2006
GDP (billions, constant prices)	1,024.03	1,037.45	1,065.02	1,077.24	1,138.81	1,174.78	1,218.89
GDP (% change at constant prices)	4.308	1.31	2.658	1.147	5.716	3.158	3.754
GDP per capita (PPP)	7,186.67	7,346.47	7,561.67	7,697.90	8,231.33	8,603.36	9,080.64
Population (millions)	171.28	173.822	176.391	178.985	181.586	184.184	186.771
Current account balance (%GDP)	-3.76	-4.187	-1.51	0.756	1.76	1.61	1.27
Inflation (average annual consumer price change %)	7.056	6.835	8.425	14.784	6.597	6.884	4.196

Source: Word Development Indicators and IMF

This year is posited to be testing in terms of the Brazilian resolve to control food prices. Nevertheless as this section will discuss, given Brazil's long history of biofuel production any food price rises are more likely to be a result of world price transmission than as a result of domestic pressures.

In terms of trade, the agricultural sector makes up approximately 20% of Brazil's GDP, income should reach US$84.2 billion in 2008.[46] The recent take-off of agricultural exports since mid–2002 can be seen by Figure A1 (Appendix). Agricultural exports were around 15 million tons in 2002 and increased by around 1 0million tons by 2005 — an increase of two thirds in three years.

Understandably so, Brazil's trade surplus has shifted considerably in its favour with a surplus of approximately US$41 billion in 2007.[47] Brazil's main agricultural exports consist of meat, sugar, oil seed and wood, as shown by Table A1 (Appendix). Brazil's main trading partners for meat include Russia and Japan and Hong Kong all of which have increased demand by one third in one year.[48] Sugar exports increased by 70% year on year to Malaysia who imported around US$300million worth of sugar.[49] Brazil exported US$2.4billion worth of oil seed to China in 2006, a 30% increase on the previous year. Italy similarly imported 25% more than in 2005.[50]

Although Brazil is substantially increasing its exports of food stuffs and natural resources, it is still dependent on some food imports most notably cereals, as shown by Table A2 (Appendix), but the level of imports has been decreasing over time as shown by Table 2 below.

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45 See Economist April (2008) country data estimates.
46 Pagel (2008) puts this as the highest estimate in Brazil's history. In 2006, net trade value was £46.5billion.
47 See Brazilian Finance Ministry (2007)
48 Based on figures from the ITC, HS code 02 Meat, edible meat and offal. Russia imported US$1.6billion, Japan US$500million, and Hong Kong US$454million.
49 Russia ($1.3billion) and the UAE ($400million) also increased their year on year demand by 30% each respectively, using HS code 17.
50 Around US$243million, HS code 12.

Table 2: Food Imports into Brazil

Indicators	2000	2001	2002	2003	2004	2005	2006
Food imports (% of merchandise imports)	6.57	5.69	6.7	7.01	4.82	4.36	4.48

Source: World Development Indicators

Transmission of world prices

There is considerable variation in the culinary habits of the Brazilian people, but it is fair to say that the following may be considered as staple consumption goods of Brazilian diet and therefore part of the typical ‘consumption basket’: manioc (cassava flour); rice; sugar; potato; banana; meat; coffee; wheat; beans; and milk.[51] In terms of estimating transmission effects of world market prices on domestic prices, it is necessary to firstly establish imported food staples. Table 3 below presents Brazil’s trade balance for some key food staples of which rice, wheat and cereals had a considerable trade deficit in 2004.

Table 3: Brazil’s Trade Balance in Key Food Staples (US$ ‘000)

Barley	Maize	Rice	Wheat	Cereals
-34,404	561,409	-245,047	-630,969	-361,672
Ground nuts	**Cocoa beans**	**Coffee ground**	**Cotton lint**	**Sugar**
25,981	-61,230	1,757.409	238,073	2,640,099
Meat	**Milk**	**Tea**	**Tobacco**	**Wine & Vermouth**
5,444,902	7,442	4,303	1,405,112	-90,774
Soy-beans	**Sun-flower seed**	**Sunflower seed cake**	**Soy-bean oil**	**Cotton seed**
5,321,123	-2,369	-163	1,365,162	12,846
Pulses	**Potatoes**	**Apples**	**Bananas**	**Pineapples**
-38,304	-3,983	52,657	26,947	6,058

Source: FAO Stat

World prices of wheat, maize and rice have soared recently as shown by Figure 3 below. ODI (2008a) notes that rice and wheat prices as of March 2008 were up 60% and 80% on 2007 levels. But have world price rises transmitted into domestic price rises in Brazil? And what is their impact on the Brazilian poor?

Figure 3: World Prices of Rice, Maize and Wheat

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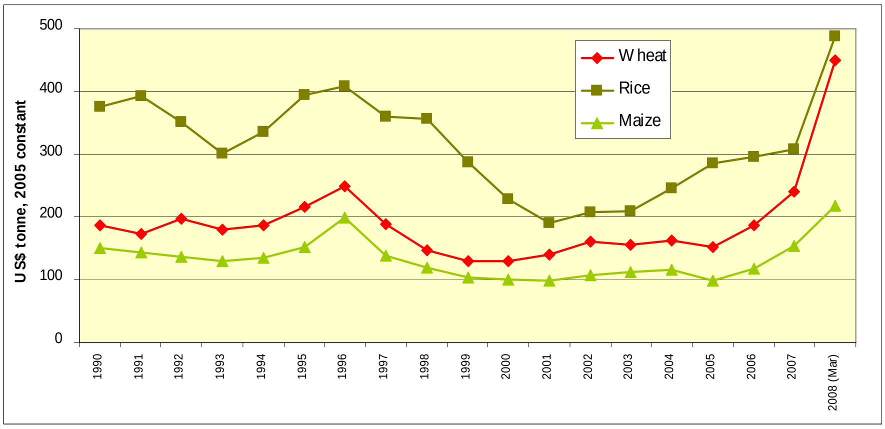
51 See Azzoni et al (2004). Drawing on household expenditure surveys produced by the Brazilian official statistics office (IBGE). They consist of surveys covering expenditure of 14,000 families in 1987/88 and 16,000 families in 1995/96, for the most important metropolitan areas in Brazil: Belém (North), Fortaleza, Recife and Salvador (Northeast), Belo Horizonte, Rio de Janeiro and São Paulo (Southeast), Curitiba and Porto Alegre (South), and Brasília (Center-West). For food expenditure, income was allocated to the following products: sugar, rice, banana, potato, coffee, onion, wheat flour, manioc flour, beans, chicken, orange, milk, pasta, margarine, vegetable oils, bread, cheese, and tomato.

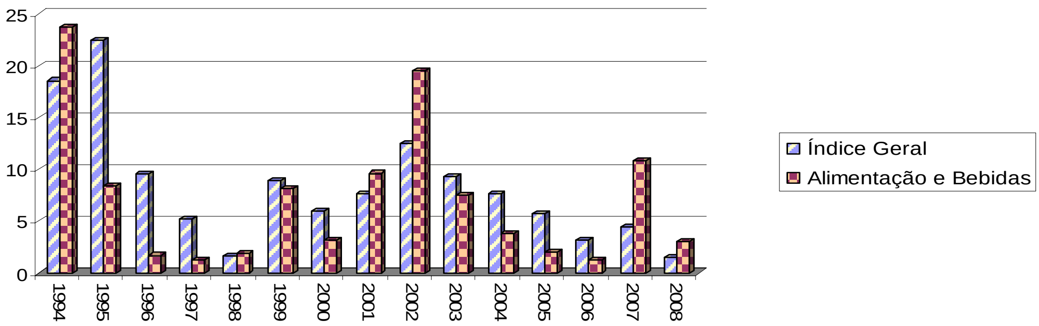


Source: ODI (2008a), IMF commodity prices

Domestic prices

Given Brazil's history of biofuel production it is important to point out that over the medium term food prices have been decreasing shown by Figure 4 overleaf. We know that Brazil's production of biofuels has largely been beneficial in that bioethanol production has provided much needed employment, foreign exchange through substituting oil and being exported; volumes produced have substantially increased since the 1970s, providing employment to many and inflation and food prices have in the medium term fallen.

Figure 4: Brazil Consumer Prices and General Price Index[52]

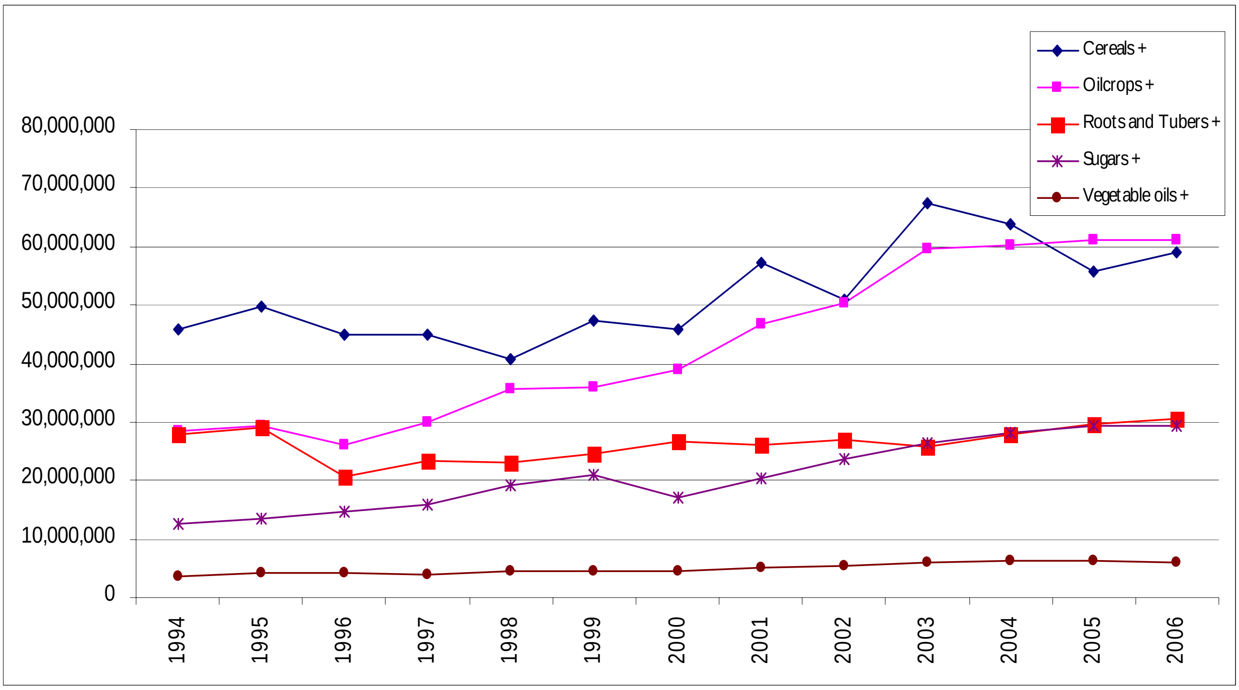


Source: Indice Nacional de Precos ao Consumidor Amplo (IPCA)

It is perhaps important to point out that the 'spike' of food and drink prices in 2002 corresponds to the year in which President Lula da Silva was elected with pro-poor policies at the top of the agenda setting up the ambitious Zero Hunger (*Fome Zero*) campaign to provide basic food supplies to millions of families.[53] As can be seen by Figure 5 below overall crop production has been increasing since 1994.

Figure 5: Brazilian Crop Production (ha) 1994 - 2006

52 General Index (Indice geral) and Food and Drinks (Alimentacao e bebidas)
53 See the new Agriculturalist, http://www.new-agri.co.uk/07/06/countryp.php



Source: FAOSTAT

If we correlate Brazil food prices since 1994 with crop production in quantity (kg) it gives us a small negative correlation of -0.3, which indicates that as crop production quantity increase food prices decrease.

Given that Brazil imports some food staples, most notably rice, wheat and cereals, world price rises may have transmitted into domestic food price rises. In the short-term the price of some agricultural goods in the typical Brazilian consumption basket has increased, if comparing prices of 2006 with 2007 as presented in Table A3 (Appendix).

Food Security

Brazil is facing rising international criticism as a contributor to rising food prices. This is not to discount food *security* as an issue for Brazil, but to elucidate that food security for the poorest sections of Brazilian society has arguably always been a problem due to the unequal distribution of wealth in the country. On a national level, food *availability* in Brazil is more than sufficient for its entire population. Meade et al (2004) point out that domestic production of food, plus imports, minus exports result in per capita food availability (in grain equivalent) of more than 340 kg per capita per year — about one third more than per capita nutritional requirements.

Despite Brazil's biofuel take-off in both bioethanol and biodiesel production — Brazil's average per capita calorie availability has grown steadily and according to most recent estimates is around 3,100 Kcal a day per person.[54] This is around one third more than the level needed to maintain adequate nutritional standards. However, due to the highly unequal nature of Brazilian society, low income groups in Brazil are still consuming below adequate levels; this has been the case long before world food prices rocketed.

Who are the poor and food insecure?

Although Brazil is a middle income country, many Brazilians are poor and undernourished. The proportion of the total population currently under nourished is around 7% — this equates

[54] See FAO stat, data is for 2004.

to approximately 13 million individuals.[55] At the national poverty line, Brazil has a poverty headcount ratio (poverty rate) of around 22%.[56] This means that approximately 34.9 million, or one fifth of Brazilians live in households with a per-capita income *below* the poverty line;[57] and of which 13 million or just over one third are undernourished. According to the World Banks *global poverty* measure around 33% of the Brazilian population are living on less than a dollar a day, this equates to approximately US$33.74 a month: compared to the average monthly per capita income/consumption expenditure of US$279.6 a month.[58] The minimum wage in Brazil is around US$71 a month (240R).[59]

The Rural/Urban Divide

Although per capita GDP in Brazil has increased year on year[60] the proportion of agricultural GDP accruing to the rural population is around half the aggregate level of per capita GDP.[61] There is a strong urban/rural divide in Brazil. Although the rural population make up just 15% of the total population of Brazil over half of those living in rural areas are poor and live below the national poverty line.[62] This compares to around 10% of the urban population classified as poor, 17.5 million out of a total population of 160 million.

However, one could argue that the poor in rural areas may have better recourse to substitute their low incomes and low consumption of ‘goods’ through their use of natural resources. Thus making the distinction between the urban and rural poor in Brazil is pivotal when discussing the impact of biofuels on food security. Those who are food insecure broadly speaking can be categorised as those with both a lack of *access* to resources in order to buy food (income) and/or lack of *resources* to grow food (land).

Table 4: Spatial Dimensions of Poverty in Brazil

Share of total poverty	Northeast	Centerwest	North	Southeast	South	Total
Metropolitan Core	3.6%	0.2%	0.4%	1.3%	0.3%	5.8%
Metropolitan Periphery	2.4%	0.0%	0.1%	2.4%	0.5%	5.4%
Large Urban	4.8%	0.7%	1.1%	1.3%	0.6%	8.5%
Medium Urban	6.6%	0.7%	1.7%	1.9%	1.3%	12.2%
Small Urban	12.5%	1.2%	2.4%	3.1%	1.2%	20.5%
Rural	32.7%	2.1%	0.7%	7.7%	4.3%	47.5%
Total	62.7%	5.0%	6.4%	17.7%	8.1%	100.0%

“Poor Areas” (per capita earnings less than R$160 per month) shaded in gray.

Source: Carneiro (2003)

As Table 4 above shows, most of the rural poor are located mostly in the North Eastern corner of Brazil (63%) and to a lesser extent the South East (8%). Most of the urban poor are located in ‘small urban’ areas in both the North and South of Brazil.

55 Ibid.
56 According to National poverty measures, a poor person is defined as living in a household with per capita income less than the equivalent of R$65 per month at São Paulo Metropolitan Area prices. The poverty line of R$65 is determined by the cost of a basic food basket at the extreme poverty line (see Carneiro, 2003).
57 See Carneiro (2003:2-3).
58 See Brazilian profile on World Bank PovcalNet.
59 As of December 2006, see http://news.bbc.co.uk/2/hi/business/2905511.stm
60 As shown by Table 1.
61 FAOSTAT puts per capita GDP as of 2004 at 3,636USD. This is compared to agricultural GDP/divided by agricultural population of 1,589USD. Data is for 2004.
62 See World Development Indicators for population profile and Carneiro (2003) for more information on poverty profiles.

Inequality

In terms of inequality as measured by the Gini coefficient, in 2004 the result of 0.57 for Brazil tells us that income is highly unequally distributed.[63] In terms of land ownership the Gini coefficient for Brazil in 2004 was 0.85. This tells us that incomes are highly unequal, *but land ownership is much more unequal.*

Although the average monthly per capita income expenditure is estimated to be approximately US$300 a month, one third of the Brazilian population consume around ten times *less* than the average monthly expenditure. In terms of income/consumption distribution, the top income deciles account for almost half of total consumption. The top five income deciles account for 86% of total consumption/expenditure.[64]

Consumption

The following products account for most calories consumed: sugar (533); wheat (368); rice (364); soybean oil (255); milk (195); maize (190); poultry meat (134); bovine meat (131); cassava (101); pigmeat (98). Azzoni et al (2004) estimate income elasticies of demand for 19 food products based on household expenditure surveys produced by the IBGE.[65] Some of the results are noted below in Table 5.

Table 5: Income Elasticities of Demand

Sugar	Rice	Banana	Potato	Meat	Manioc Flour	Wheat Flour	Beans	Chicken	Milk	Pasta	Oil	Bread
0.19	0.16	0.62	0.59	0.65	-0.06	0.42	0.0	0.30	0.56	0.32	0.42	0.16

Source: Azzoni et al (2004)

As shown by Table 5 beans are income demand inelastic, that is, they will be purchased even if their price rises. Manioc flour is also inelastic but slightly more of an inferior good: if incomes increase people are less likely to purchase, but if incomes decrease they are more likely to purchase. Rice, bread, sugar and chicken are still relatively income inelastic goods. If the prices of these goods rise — those less well off are most likely to be hardest hit or most likely to adapt their consumption in response to price increases.

Concluding remarks

The problem in Brazil is access to food rather than lack of; this is related to both poverty and inequality. Increasing biofuel production in Brazil may offer more opportunities than challenges for those able to participate in production, but any discussion of the impact of biofuels on the poor and food insecure in Brazil needs to consider the following points:

- the actual share of total consumption by the poor is currently low to negligible thus although the 'poor' are likely to be negatively impacted by domestic price rises which result from world food price rises, many have unable to maintain adequate food security despite domestic food price falls in Brazil over the medium term;
- one third of 'poor' people are also undernourished, this was the case prior to world food price increases in the last two years and despite the average Brazilian daily intake of calories being around one third more than the minimum necessary to sustain adequate nutrition.

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63 See World Bank, PovcalNet http://iresearch.worldbank.org/PovcalNet/jsp/index.jsp. Brazil is one of the most unequal societies in the world.

64 As at 2004, see World Bank PovcalNet

65 Data from the 1987/88 and 1995/96 POF (Pesquira de Orcamentos Familiares) household expenditure survey produced by the IBGE which consists of 14,000 and 16,000 families respectively.

Potential for Biofuels in Brazil

Brazil occupies 1.6% of the terrestrial globe and 66% of the South American territorial area. Table 6 below presents current land use. Brazil produces around 17 billion litres of bioethanol per annum and is the second largest producer in the world (the US produces around 18 billion litres[66]) but sugar cane for ethanol takes up just 0.9% of total arable land use, compared to 60% used for pasture land (and cattle ranches), 18% for crop land (food crops) and 7% for soybeans. In terms of available land for biofuels expansion, as shown by Table 6 Brazil currently has around 80 million hectares of available land. This excludes forestry.

Table 6: Bioethanol production, land use (million ha) and potential

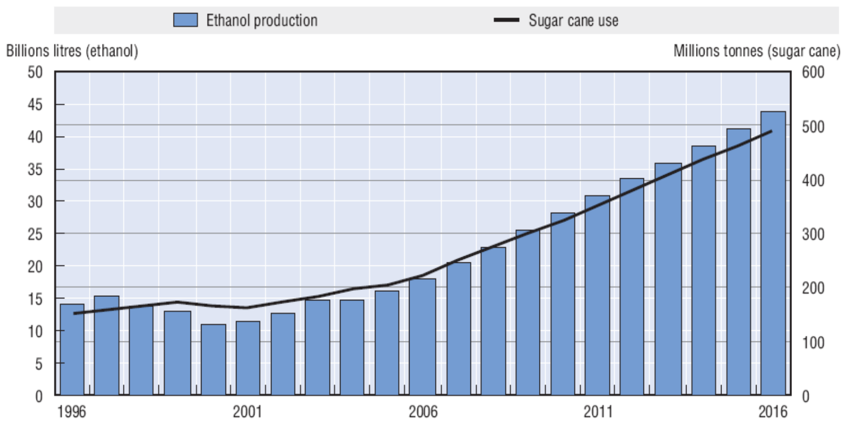
Total land area (million ha)	**850**	**% total land**	**% arable land**
Total arable land (million ha)	**340**	**40**	**-**
Cultivated land (all crops)	**61**	**7.2**	**17.9**
Soybeans	23	2.7	6.8
Corn	11	1.3	3.2
Sugar cane	6	0.7	1.8
Sugar cane for ethanol	**3**	**0.4**	**0.9**
Oranges	1	0.1	0.3
Pastures	200	23.5	58.8
Available land (million ha)	**80**	**9.4**	**23.5**

Source: ICONE (2007)

Bioethanol production potential

Current levels of bioethanol are around 17 billion litres, but Brazil is expected to increase production by around double by 2016 (OECD 2007) as shown by Figure 8 below. Taking a conservative estimate this would require an additional 3 million hectares. With rapidly growing internal and export markets for ethanol, there are now plans to expand production from the current level of 355 plants to 412 plants.[67] Most new bioethanol plants are planned for the Southern region of Brazil, due to climatic constraints on sugar cane production.

Figure 8: Bioethanol production in Brazil – Projections



Source: OECD (2007)

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[66] And uses 31.6million ha of land for maize production compared to just 3million has for sugar cane production in Brazil.
[67] See Brazil Institute (2007).

Smallholder production and political economy considerations

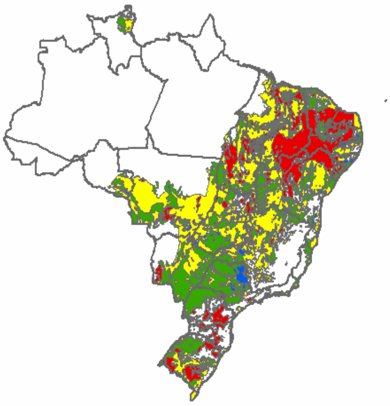
Most bioethanol production takes place in Southern Brazil and on large estates (85%) with the rest taking place in the North Eastern region (15%). Although rural and urban poverty exists in Southern Brazil, there are more urban and rural poor located in the North Eastern corner of Brazil. It has been noted that a major cause of poverty in Brazil's North East and Central region is that of land tenure and that the rise of agribusiness has seen tenants evicted as smaller farms merge into larger commercial operations.[68] Most of the farmers in the North Eastern corner are either smallholders or landless farmers renting from landowners.

Most of the sugar cane farmers in the South are large-scale and concentrated around the region of Piracicaba — the densest sugar cane area of the world.[69] Production of sugar cane is labour intensive; thus expansion presents both opportunities and challenges for smallholders and landless labourers. WDR (2008) notes that ethanol production requires fairly large economies of scale and vertical integration because of the complexity of the production process in distilleries. Likewise sugarcane production is generally large scale, although in Brazil out-grower schemes have succeeded in ensuring *some* smallholder participation. For example, Smeets et al, (2006) point out that 30–35% of sugarcane is produced by relatively small scale farmers who sell to mills.

Smeets et al. (2006) also note that landowners expect higher revenues from their production of sugar cane. For example, in 2006 the annual net income per ha were R$1000 (U$487) for forestry, R$700 (U$350) for sugar cane, R$350 (U$170) for crops (bean, corn, soybean), and R$120 (U$58) for cattle farming.[70] Even though land in São Paulo is more expensive, it is expected that half of additional cane to be produced by 2015 will be produced in São Paulo (*Ibid*). An expansion of the sugar cane area in the South could therefore result in a shift of land use functions to the border areas of agricultural expansion, but a doubling of land area for bioethanol production still amounts to only 0.4% of total land or 2.4% of *available* land.

Figure 9: Sugar cane culture in Brazil Figure 10: Potential for Sugar Cane

68 See http://www.new-agri.co.uk/07/06/countryp.php
69 See http://www.bioenergytrade.org/downloads/sustainabilityofbrazilianbioethanol.pdf
70 See Smeets et al (2006:37).



Source: Smeets et al (2006) Blue = high land suitability, green = average suitability, yellow=low suitability, red=inadequate. Source: Smeets et al (2006)

Sugar cane production is seven times more labour intensive than pasture production: thus although expansion in the South is likely to displace some crops and pastures from the local vicinity of São Paulo, given the high unemployment rate of 11% (as of 2006) and given the higher ability of sugar cane production to absorb labour, the overall welfare gain is likely to be positive: as income equals the ability buy some food, rather than none. Indeed most findings suggest net employment gains due to bioethanol production being an *additional* activity that does not displace other agricultural activities given the large amount of *available* agricultural land in Brazil — *it just moves them.*[71]

Biodiesel production potential

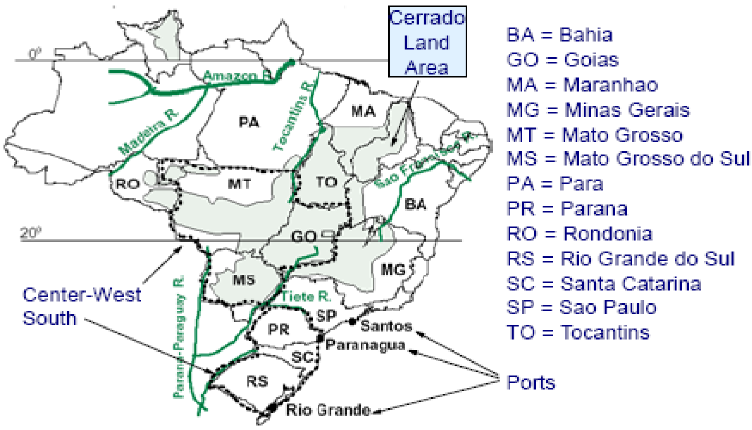
Soybean is currently the largest biodiesel crop produced in Brazil, accounting for 94% of oil producing crops (ICONE 2006), 2.7% of total land use and 6.8% of arable land (23 million ha). The South has been the historical centre of Brazil's soybean production including the states: Parana; Santa Catarina; and Rio Grande do Sul. Development of the Centre West region began in the 1960s and includes the states of: Matto Grasso do Sul; Goias; and the Federal District surrounding Brasilia. The Centre West region is increasing its soybean production to a greater extent than in South.[72] Soybean is the most produced biodiesel crop in

71 See Smeet et al (2006: 56)

72 For a good overview see Flaskerud, G. (2003) Brazil's Soybean Production and Impact, North Dakota State University, Fargo, http://www.ag.ndsu.edu/pubs/plantsci/rowcrops/eb79.pdf. and UNEP (2008) report on fossil and biofuels http://www.worldmun.org/MUNBase/files/downloads/guides/UNEPGuideA.pdf

Brazil, but it is not the most productive. In terms of average land productivity (kg/ha) palm oil is more than seven times as productive, followed by sunflower production and castor oil.[73]

Figure 10: Soybean Growing Areas



Source: Flaskerud (2003)

Although results vary according to temperature and type of diesel, 1 metric ton is equivalent to 1176.5 litres. As shown by Table 7 below, Brazil is producing around 101 million litres of biodiesel a year. Pure biodiesel is known as B100, B20 is a blend of fossil fuel diesel with 20% biodiesel, B5 is a blend of diesel with 5% biodiesel, and so on and so forth. GTZ (2005:63) break down what the national targets mean for suppliers of biodiesel in Brazil. Putting the initial target of biodiesel as a share of fuel supply at 2% per annum as of 2006 (B2) converts into 800 million litres of biodiesel *per year*. This target is extremely ambitious. Nonetheless the Brazilian government's goal of purchasing 70 million litres of biodiesel was met by four producers with an estimated 65,500 family farms benefiting through their participation in the Social Fuel Stamp policy (GTZ 2005:63).[74]

Table 7: Current Production of Biodiesel Crops and Costs of Production (2004)[75]

Crop	Area (ha '000's)	Production ('000 tons)	Approx. cost of production (US$/ton)	Average market price (US$/ton)
Soybean	21,275.7	49,770.1	220	450
Corn	12,822	37,441.9	-	-
Cottonseed	1,100	2,099.2	-	-
Castor oil	164.9	106.1	600	1000
Groundnut	98.2	217.3	-	-
Palm tree/ oil	59.3	132.0	225	410
Sunflower	52.8	82	-	-
Total	**47,352.7**	**119,152.2**	**-**	**-**
Share of total crop land	**72%**			
Share of total arable land	**13%**			

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73 Romeiro (2007) presents palm oil as having an average land productivity of 4,500kg/ha, sunflower 1,300kg/ha, castor oil 1000kg/ha and soy 600kg/ha.

74 The opening price was R$1.920/litre (around US$US0.83) – higher than market prices.

75 Crop areas vary slightly compared with Table 6, ICONE (2007) most likely due to the time lag in data collection.

Source: GTZ (2006), crop production data is 2003/4, price data is 2004

Brazil is price competitive vis-a-vis the US for all of the biodiesel crops noted in Table 7 for which data is available.[76] Romeiro et al (2007) point out that one litre of soybean biodiesel can be produced at around US$0.17 in Brazil (or R$1.16) compared to the world market price of approximately US$0.40 a litre. Prices do vary however, in terms of the crop and region produced.

Palm produced in the North is the cheapest at RS$0.51 a litre (pre tax), followed by sunflower in the South East at RS$0.69 (pre tax), and caster oil in the North East at RS$0.81 a litre. These crops remain the most price competitive due to their higher relative productivity as compared to soy produced in the Centre West and South, even with included distribution, resale margins and freight costs and tax.[77] Nevertheless, although Brazil is *price competitive* in the production of biodiesel, the key question is whether or not it is able to match demand of biodiesel and fulfil national targets with supply — whilst reducing poverty and increasing food security for poor.

Small holder and political economy considerations

Brazil's Biofuel programmes presents an opportunity for smallholders through the social fuel stamp scheme (FAO, 2008), generating employment and higher incomes.[78] Biodiesel producers that acquire raw material from family farmers under the social fuel stamp scheme are eligible to reduction of up to 68% in federal taxes. If these purchases are made from family-based producers of palm oil in the North Region, or of castor oil in the Northeast and in the Semi-Arid Region, the reduction may reach 100%. If the raw material and the regions are the same, but if producers are not family farmers, the maximum reduction is of 31%. In order to qualify for these tax benefits, biodiesel producers have to hold a certificate.[79] Several major biodiesel producers in Brazil have joined the programme, since the costs of purchasing from smallholders are offset by tax breaks.

The ICONE (2006) warns that overly ambitious targets may result in Brazil being unable to fulfil its biodiesel target in the most pro-poor way. In the short-term the only feasible solution may be to produce more biodiesel from soybeans given that soybean production is more technologically advanced.[80] In terms of potential crops for scaling up biodiesel production, GTZ (2005) make a series of projections both in terms of land use and employment (see Table A4 appendix).[81] Castor oil is the most labour intensive, followed by palm and lastly soy. Meeting the 2% biodiesel target is estimated to result in an additional 2.2 million hectare land-use, but will provide an additional 380,000 direct jobs. Extrapolating up to the 5% diesel/biodiesel substitution will require an estimated 5 million hectares, but almost 1 million

[76] EU produced biodiesel breaks even at around 60Euro a barrel of oil.
77 Although of course, tax rebates are offered depending on whether or not the purchase was made under the Social Fuel Stamp and certification system.
78 The FAO (2008) points out that smallholder and farmer families could receive higher and more stable incomes.
79The Social Fuel Stamp is issued by the Ministry of Agrarian Development (MDA) to biodiesel producers (processors) that not only purchase minimum amounts of produce from smallholders but also enter into contract with smallholders – with all the benefits that may result from having a guaranteed buyer, and technical assistance. Qualifying farmers typically own around 1-4 ha of land. See http://www.biodiesel.gov.br/docs/Folder_biodiesel_ingles_paginado
80 See ICONE (2006) http://www.iconebrasil.org.br/en/?actA=7&areaID=8&secaoID=64&artigoID=1202
81 Based on data from EMBRAPA (linked to the Ministry of Agriculture Livestock and Supply) which assumes direct employment generation of 0.2 employees per ha for palm oil, 0.3 employees per ha for castor oil, and 0.07 employees per ha for soy.

new jobs created. Meeting the 20% target by 2020 could result in additional 3.8 million jobs, and require additional 20 million hectares of land, around 25% of current available land, depending on suitability.

The Biopact (2008) note that farmers the Northeast are likely to be the main beneficiaries of the programme: since it is in this region that biodiesel crops like castor thrive well and require relatively low inputs.[82] But current crop production levels are low and investment is required in increasing volumes produced.

Although ultimately the climatic regions in Brazil determine biofuel crop production and potential, small-scale producers are also likely to consider the potential trade offs in producing according to the social fuel stamp scheme as opposed to producing for other non-certified buyers. Smeets et al (2006) present evidence to suggest that on average wages paid to those producing soybean are double those paid to sugar cane workers, indeed any other crop for which data is available. Soybeans are in demand from countries such as China for animal feedstock.[83] China currently purchases almost 50% of Brazil's exported soybeans — year on year growth in demand increased by 30% in 2006.[84]

Thus although Brazil has the available land to accommodate the ambitious biodiesel targets set and arguably an ideological and workable framework to ensure more pro-poor production takes place, increasing world demand for some of its biodiesel food stuffs may mean that buyers are not always those that chose to be certified according to best practice.

There are justifiable concerns as to Amazon deforestation — given that palm oil is the most productive biodiesel crop and the *cheapest* to make and most suited to the North of Brazil — one of the poorest regions of the country. Indeed, the Brazilian government is projecting 100% of palm oil to be produced in the North, with generous tax rebates offered for purchases from this region.

One could argue that the ambitious biodiesel targets set by the Brazilian government may result in increased deforestation unless adequate measures are taken: which go beyond the social fuel stamp scheme with its more social than environmental focus. Given the persistent pressing domestic difficulty of poverty and food insecurity in Brazil, one could argue that social concerns should trump environmental concerns: but this is a very contentious point since even if Brazil were to fulfil all domestic biofuel targets the total numbers of rural poor employed would still be marginal to those in need of well paid employment, and still does not solve the problem of inequality within the country.

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82 Biopact (2008) also point out that win-win synergies appear when intercropping schemes are used and biodiesel producer extension services focus on such integrated systems.

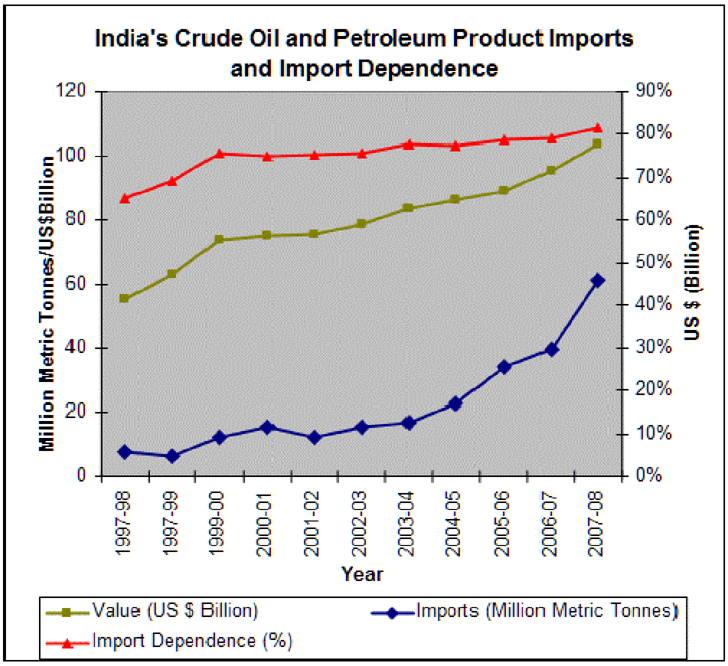
83 Naylor et al (2007) note that as additional crop land is used for soybean production, the price of beef is also increasing domestically , resulting in additional incentives for cattle ranchers to encroach on cerrado land. It is noted by (Naylor et al 2007) that the cerrado is experiencing dramatic loss of 2.2–3 million hectares of native habitat per year.

84 The Netherlands accounts for 15%, Spain accounts for 7.5% of exports, Germany and Spain just over 4%, based on ITC trade data (value as of 2006).

C. India

Biofuel development perspectives and plans in India have been largely shaped by burgeoning energy demand and increasing import dependency. It is the sixth largest consumer of energy in the world accounting for 3% of world energy demand. A rapidly growing economy (projected to grow at 9% per annum in the XI Plan period 2007-2012), rising population and an increasing number of middle class consumers have made India one of the fastest growing energy consumers in the world. With only limited domestic crude reserves (0.5% of world reserves) and stagnant domestic production in recent years, India now imports 77% of its crude oil and petroleum products requirements (Figure C.1). This import dependency is expected to grow to 85% by 2012 and to 94% by 2030. (IEA: 2002). India has been particularly vulnerable to increasing oil prices, with its oil import bill nearly doubling over the last three years to US$61 billion. Energy security is an important priority for the government as any disruptions in the supply of petroleum fuels or sustained increase in petroleum price can have significant adverse effects on the growth of the Indian economy. The International Monetary Fund estimates that a sustained $10 increase in price of crude oil would lead to a 1% fall in GDP and 1.2% deterioration in its current trade balance (expressed as a share of GDP) one year after the price increase (IEA:2004). It is in this context that indigenously produced biofuels are being seen as an attractive renewable energy option to partially substitute for petroleum fuels and reduce reliance on imports.

Figure C.1: Dependence on imports of crude oil and petroleum products, India



(Source: Data accessed from Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, India at http://ppac.org.in/)

Biomass contributes nearly 30% of India' energy needs (especially for cooking and heating in rural areas). However, oil provides 95% of the energy for transportation and demand for transport fuel has been rising rapidly (Planning Commission: 2003). Over 80% of passengers and nearly 60% of freight are transported by road. Rising incomes are leading to increased reliance on personal modes of transport like cars and two wheelers. Between 1991 and 2004, the total number of vehicles more than trebled, increasing from 21.3 million to 72.7 million. Rapid growth of motor vehicle population, estimated at 12–15% over the next few years is expected to fuel a 5–8% growth in demand for petroleum based energy in India. The projections of the Planning Commission for growth in demand for fuels for transportation are presented in Table C.1. A notable feature is that India's diesel consumption is more than five times its petrol consumption. By the end of the 12th five year plan, domestic supply will provide less than 10% of the total requirement. Thus, it is in the area of transportation that biofuels offer substantial potential for substituting conventional fuel. The current growth in transport is also a significant environmental concern given that India's carbon emissions are growing at the rate of 3.2% per annum. The Government of India has brought in increasingly stringent fuel emission norms for vehicles in urban areas. Adoption of "cleaner" biofuels can help achieve adherence to these norms.

Table C.1: Demand and Domestic Production Of Transport Fuel

Item	Demand Projections in Thousand MT				Annual Growth %			Domestic supply %		
	2001-2002	2006-2007	2011-2012	2016-2017	10th Plan (2002-2007)	11th Plan (2007-2012)	10th Plan (2012-2017)	10th Plan (2002-2007)	11th Plan (2007-2012)	12th Plan (2012-2017)
Petrol	7,070	10,067	12,848	16,398	7.3	5.0	5.0	22.2	Lower than 10%	
Aviation Fuel	2,299	2,691	3,150	3,687	3.2	3.2	3.2	22.2		
Diesel	39,815	52,324	66,905	83,575	5.6	5.0	4.5	22.2		
Natural* Gas	81.33	179	313					47.9		

* in million std cubic meters per day

Source: Planning Commission: 2003

Energy security considerations may provide the dominant thrust for the development of biofuels, but their promotion is being supported by a number of other objectives.

- Creation of substantial new employment opportunities in raising, reaping and processing of biofuel crops.
- Addition of renewable energy options for decentralised distributed generation of electricity and for motive power applications. This can improve energy access for India's rural poor. 57% of India's rural households do not have access to electricity and even households with access are faced with inconsistent or unreliable supply.
- Utilisation of wastelands and degraded forest lands helping in eco-restoration and preventing further land degradation.
- Environmental improvement through reduced Green House Gas emissions.

With a population of over a billion and 260 million below the poverty line, food security is a key issue in India. Food grain production in India has been relatively stagnant in the last decade forcing India to import food grains in some recent years after having been an exporter for several years. India is also a major importer of edible oil in the world as demand exceeds production by a considerable margin. India, therefore, cannot afford to use cereals for ethanol production or edible oils for the production of biodiesel, as that may aggravate the food supply situation. Consequently, India has opted to follow a two pronged approach to the development of biofuels:

- Use of ethanol derived from sugar cane molasses for blending with petrol.

- Use of non-edible oils for blending with diesel.

Ethanol

Sugarcane Production

With 5 million hectares of land under cultivation, India is the largest producer of sugarcane and the second largest producer of sugar in the world. From around 2.53 million hectares in 1970, sugarcane cultivation expanded rapidly in the 1970s and 1980s, but growth has tapered off in the last decade. Nearly 50 million sugarcane farmers and a large number of agricultural workers are involved in sugarcane cultivation and ancillary activities, constituting nearly 7.5% of the rural population. Besides, the industry provides employment to about 2 million skilled/semi-skilled workers mostly from rural areas. Sugar cane presently accounts for 2% of total cropped area and 3% of irrigated area. (Ministry of Agriculture: 2007).

Unlike Brazil where up to 55% of sugarcane is used for ethanol production, in India sugarcane is only produced from molasses. The production of molasses and ethanol and use of ethanol in different sectors is summarised in Table C.2. A striking feature of ethanol usage is that the potable alcohol and chemical industries account for a third each of ethanol consumption. The use of ethanol for biofuel, therefore, has to compete with strong and growing demand for ethanol from other sectors.

Table C. 2: Ethanol Production and Use in India

Alcohols year	Molasses Production	Production of Alcohol	Industrial use	Potable use	Other uses	Surplus availability of alcohol
	Million metric tons	(Million litres)	(Million litres)	(Million litres)	(Million litres)	(Million litres)
1998–99	7.00	1411.8	534.4	5840	55.2	238.2
1999–00	8.02	1654.0	518.9	622.7	576	455.8
2000–01	8.33	1685.9	529.3	635.1	588	462.7
2001–02	877	1775.2	5398	647.8	59.9	527.7
2002–03	9.23	1869.7	550.5	660.7	61.0	597.5
2003–04	9.73	1969.2	578.0	693.7	70.0	627.5
2004–05	10.24	2074.5	606.9	728.3	73.5	665.8
2005–06	10.79	2187.0	619.0	746.5	77.2	742.3
2006–07	11.36	2300.4	631.4	765.2	81.0	822.8

Source: Planning Commission: 2003

Regulatory Framework

As in many other countries the sugar industry in India is one of the most highly regulated and remains so even after the post-1991 economic liberalisation and industrial deregulation. Despite some limited liberalisation measures in 1997, an incredibly complex system of regulations, levies and taxes governs every aspect of the industry — from procurement of sugarcane, to production and distribution of sugar to the utilisation and disposal of by-products. Historically these control stem from the designation of sugar as an “essential” commodity for the consumption of the poor. They were also intended to sustain production and protect farmers against characteristic cyclical fluctuations in sugarcane prices. Excise duties and other levies on the industry have become significant sources of revenue for the central and state Governments. Fears regarding the potential diminution of these revenue streams have tended to perpetuate the complex regulatory regime.

The regulatory framework allows the central government to specify the minimum price to be paid by the mills to sugarcane growers (currently INR 695 per ton linked to an 8.5% recovery rate). Installation of new production capacity and expansion of existing capacity are subject to licensing arrangements. The government also demarcates a catchment area for each sugar mill to support the utilisation of existing capacities. The distribution of sugar is regulated through a system of levy sugar (pre-emptive procurement of sugar produced by the mills at a specified price to be channelled through the public distribution system) and by specifying the quantities to be released by sugar mills for open market sales in each month. The central government levies excise duties on sugar and molasses, while state governments levy sales tax (VAT) and a host of other levies (e.g., entry fees on ethanol). State government levies vary substantially across states with states that do not produce ethanol having higher levies.

Almost a third of the ethanol produced from molasses is used by the potable alcohol industry, which is protected with import duties of 190%. Levies on potable alcohol are a major source of revenue for state governments. Extensive movement restrictions on molasses and ethanol are in place in all states to enforce state levies and to prevent the unauthorised diversion of ethanol to other uses. The substantial revenue from ethanol use for potable alcohol production has important implications for the willingness of states to participate in programmes for ethanol use as biofuels. The complex regulatory system is not only beset with a number of inefficiencies, it also has a number of important implications for the development of ethanol as a biofuel. The widely different levies in different states imply major differences in the cost of molasses and the economics of ethanol production.

Ethanol Policy

The commercial production and blending of ethanol blended gasoline started in January 2003 when the Government of India issued a notification on the ethanol blending programme making 5% ethanol blending with petrol mandatory in nine states and four Union Territories. Under the provisions of the notification it was the responsibility of the state owned oil companies to procure ethanol and blend it with petrol. The oil PSUs were also offered certain excise duty concessions as incentive for blending ethanol. The programme could be implemented only partially as ethanol was not consistently made available by the sugar industry to the oil companies mainly on account of drought conditions which restricted the supply of molasses. In 2003-04, it is estimated that the oil companies could procure only 196 million litres as against a requirement of 363 million litres (GTZ: 2005). Ethanol supplies to oil companies came to virtual halt by September 2004. In October 2004 the Government diluted the mandate with a new notification which stipulated that oil companies were obliged to blend 5% ethanol in designated states only if ethanol could be procured at prices that made blending commercially viable for the companies. These conditions were intended to shield the oil companies from any large increases in the price of ethanol. As this criterion was not met in a number of states, the ethanol blending programme virtually came to a halt.

The recovery of sugarcane production in 2005–06 revived the interest in the ethanol programme. In August 2005 the Government facilitated an agreement between the sugar industry and the oil companies to enable the purchase of ethanol by the latter and programme restarted in a limited number of states and Union Territories. With a strong resurgence in sugar production in 2006-07, the Government announced the next phase of the ethanol blending programme (EBP) with effect from November 2006, mandating 5% blending of ethanol with petrol subject to commercial viability in twenty states and eight Union

Territories. The requirement of ethanol for meeting this mandate was estimated at 550 million litres. Although the Government had announced an indicative price for the purchase of ethanol (currently INR 21.50 per litre), the oil companies have floated tenders to obtain cheaper prices. After finalising bids the ethanol programme has resumed in about ten states. In the other states, the programme remains unimplemented as state taxes, excise duties and levies make ethanol blending commercially unviable. The Government has announced that in the next phase of the programme, it will raise the ethanol blending ratio to 10% by October 2008 in the designated states.

Efforts to produce ethanol from other feedstock crops like sweet sorghum, sugar beet and sweet potatoes are at an experimental stage. Efforts are being made to identify sweet sorghum cultivars suitable for cultivation in semi-arid wastelands. Some research organisations have initiated research for utilisation of crop residues/wastes for the production of ethanol. Some concessional finance is also being offered to sugar mills to set up ethanol production units.

Prospects for ethanol

It is generally accepted that the potential for area expansion under sugarcane is limited. Sugarcane not only competes with food crops, it is also a highly water intensive crop. During 2003–04 and 2004–05 the area under sugarcane declined to 3.9 million hectares (MoA: 2007) on account of drought and pest attacks. With over 70% of the country's districts categorised as overexploited in terms of ground water use (GTZ: 2005), the judicious use of water resources is important from the food security perspective. There have been strong criticisms that the disproportionate use of water for a cash crop like sugarcane has had a negative impact on agriculture as a whole. As case in point is the state of Maharashtra, one of the leading producers of sugarcane. The mill licensing policy has led to extensive expansion of sugarcane in drought prone areas, necessitating artificial irrigation projects. It is estimated that 60% of water from these irrigation projects goes to irrigating 0.5 million hectares of sugarcane (3% of cropped areas of the state). This has a negative impact on other crops and on the availability of water for consumption needs.

The operation of the minimum price mechanism also has an important impact on sugarcane area. Although the minimum price for cane is meant to protect farmers against cyclical fluctuations in the price of cane, in practice the system has often created serious difficulties for farmers. When sugar mills run into difficulty on account of uneconomic cane prices, inefficiency or mismanagement, they are unable to pay farmers on time and large arrears of cane price arrears get built up, which can persist for years[85]. Payment of "cane arrears" is often a sensitive political issue and often calls for ad-hoc financial assistance from state governments to sugar mills. Farmers' incentives for sugarcane cultivation are not determined so much by the minimum price set for cane as by the current state/promptness of payments. When these arrears mount, farmers may simply have no option than to move to other crops (or to sell their cane to the "gur" and "khandsari" sector).

With limited scope for area expansion in sugarcane, ethanol policy becomes an exercise in allocating the available supplies between competing uses, biofuel use being only one of them. The Planning Commission's assessment of ethanol demand and supply, including bioethanol requirement for 5% blending are presented in Table C.3

Table C.3: Ethanol Supply and Demand for Blending in Gasoline

Year	Gasoline demand	Ethanol demand	Molasses	Ethanol production			Utilisation of ethanol		
			Production	Molasses	Cane	Total	Potable	Industry	Balance
	MMT	Million	MMT	Million	Million	Million	Million	Million	Million

85 The demarcation of areas for mills also means that farmers do not have the option of transporting their cane to other mills.

		litres		litres	litres	litres	litres	litres	litres
2001–02	7.07	416.14	8.77	1775	0	1775	648	600	527
2006–07	10.07	592.72	11.36	2300	1485	3785	765	711	2309
2011–12	12.85	756.35	11.36	2300	1485	3785	887	844	2054
2016–17	16.4	965.30	11.36	2300	1485	3785	1028	1003	1754

Assumptions:

1. Area under cane cultivation is expected to increase from 4.36 million hectares in 2001-02 to 4.96 in 2006-07 which would add additional cane production of around 50 MMT.

2. About 30% of cane goes for making gur and khandsari. If there is no additional increase in khandsari demand, sugar and molasses production would increase.

3. The present distiller capacity is for 2900 million litres of ethanol looks to be sufficient for 5% blend till 12th plan

4. A growth of 3% in potable use and a 3.5% in chemical and other use has been assumed

Source: Reproduced from Planning Commission; 2003

The above projections of ethanol production assumed a substantial contribution from conversion of sugarcane juice directly into ethanol. Although this has been recently allowed by the Government, it is too early for the measure to affect ethanol supply. Further, the projections take into account only the potable alcohol and industrial uses in computing the “available balance” of ethanol for blending. With a petrol consumption of 11.6 million tons estimated for 2006-07, the ethanol required for 5% blending would be 682 million litres, which could be met from the “surplus” projected in Table C.2. The figures regarding the availability of surplus ethanol for blending deserve to be treated with considerable caution as there are widely varying assessments of surplus availability and installed capacities by competing ethanol users. The chemical industry facing higher ethanol prices as a result of the blending programme generally argues that supplies are much tighter and that there is no “surplus”. The sugar industry anxious to deal with the current sugar glut generally inflates the surplus.

Largely based on sugar industry sources and information from distillers, the USDA (2007) estimates that there are about 300 ethanol distilleries in India with a capacity of about 3.2 billion litres. One bottleneck facing the ethanol blending programme is that many sugar mills do not have production capacity for ethanol production. After the announcement of the Government’s blending programme, nearly 110 mills are reported have modified their plants to produce ethanol with a total production capacity of 1.3 billion litres. There are also reported to be nearly 51 standalone ethanol units, which would be entirely dependent on external molasses supply. The total capacity utilisation of ethanol units is estimated only at 40–50%. On the whole, it appears that current ethanol capacity is sufficient for meeting the requirements of the 5% blending mandate. But the move a 10% mandate may call for additional capacities particularly in sugarcane juice based ethanol production units. However, availability of molasses may be the binding constraint on expansion of the ethanol blending programme.

The economics of ethanol production for biofuel use depends on the processing route chosen (molasses to ethanol or sugarcane juice to ethanol), feedstock costs and the pricing of ethanol for use as biofuel. Several studies have shown that ethanol can be produced at INR 18–20 per litre which is competitive with the import parity price of petrol when international oil prices are in the range of US $ 50–60 per barrel (GTZ: 2005, Gonsalves: 2006). With oil prices currently at over US$100 a barrel, ethanol would perhaps become still more competitive.

However, the economics of ethanol production depends greatly on the cost of molasses as feedstock costs represent more than 50% of production costs. Molasses prices are subject to wild fluctuations ranging from 50 per MT to 5000 per MT (GTZ: 2005). The variations in molasses prices over space and time are exacerbated by the highly fragmented markets for molasses that exist on account of differential state levies and movement restrictions. While the central government is making efforts to have a uniform system of taxes and levies across states, an integrated market for molasses is a long way off. There are also substantial differences in the revenues that accrue to states from the use of ethanol in the potable alcohol industry versus its use as a biofuel. An important implication is that states have no incentive to divert ethanol to biofuel use. The uneven economics of ethanol production for biofuel use is reflected in the fact that even in the restarted EBP, oil companies have not found it viable to procure ethanol in several states. The pricing of ethanol by the Government has been influenced by a number of factors including the need to retain supplies to the chemical industry and the commercial interests of the oil companies. The prices fixed for biofuel use of ethanol appear to be below current import parity levels for petrol. The inflexibility of the pricing regime and large variations in feedstock costs imply that the long term viability of ethanol production for biofuel remains uncertain.

The enforcement of the EBP mandate has been complicated by the commercial interests of the oil companies and their current economic difficulties which largely stem from the pricing mechanism for petroleum products. After several decades of administered pricing, in April 2002 the Government abolished the Administered Pricing Mechanism (APM) for petroleum products, making petrol and diesel prices market determined based on the import parity principle. However, as global crude oil prices started rising, the Government retreated from this principle to protect the Indian consumer from sharp rises in the prices of petroleum products. Consequently, retail price increases have been kept below increases in international price. Under the present regime, oil companies are faced with large “under-recoveries” (losses), severely straining their profitability. In this situation, oil companies have a strong incentive to push down the price at which they buy ethanol for blending. They have successfully lobbied to make the ethanol mandate contingent on commercial viability criteria being met. They have floated tenders for ethanol in an effort to secure supplies at prices even below those indicated by the Government. Finally, the oil companies are also contemplating the import of ethanol from Brazil to comply with the blending mandate and are seeking reduction in import tariffs on ethanol. The Indian Oil Corporation is reported to be considering a joint venture with a Brazilian firm to source ethanol on a long term basis from Brazil. This is somewhat paradoxical in the light of the large unutilised capacities for ethanol production within the country — although this may be commercially sensible for the oil companies.

Progress in the promotion of ethanol as a biofuel has been hampered by the short-term perspective of government policy which appears to respond primarily to cyclical fluctuations in sugarcane production and molasses availability. The virtual abandonment of the first phase of the EBP when faced with the scarcity of molasses illustrates the stop-go approach to the use of ethanol. On occasion other users of ethanol have (e.g., the chemical industry) have successfully opposed concessions intended to support the biofuel mandate. Faced with a large increase in sugar production, mounting stocks and depressed international sugar markets, the government has now allowed sugar mills to go for direct conversion of sugarcane juice to ethanol. It is difficult to assess whether this measure will be continued, if sugar markets tighten considerably in the next phase of the cycle.

Biodiesel

We have already noted that food security considerations preclude the use of edible oils in India for biodiesel production. India, therefore, has to look for non-edible plant based oils for its biodiesel programme. Another important consideration is that large plantations of biofuel crops must not compete for land with food crops. India has over 300 species of trees producing oil bearing seeds. The promising sources of non-edible oilseeds are Jatropha curcas, Pongamia pinnata, Melia azadirachta and Shorea robusta. Traditionally the collection and selling of these oilseeds is done by poor people for use as fuel or for lighting and these oils are also extensively used in chemical and cosmetic industries. However, the current utilisation of these oilseeds is very low. Jatropha and Pongamia have been identified as species most suitable for a large scale biodiesel programme as both species grown in rainfed semi-arid areas and are not browsed by livestock (Planning Commission: 2003). In April 2003, the Government of India launched a National Mission on Biodiesel that identified Jatropha as the most suitable tree-borne oil seed for the production of biodiesel and focused on promoting plantations on wastelands.

National Biodiesel Mission

The National Biodiesel Mission envisaged an ambitious target of 11.2 million hectares to be planted to Jatropha by 2012, sufficient to produce enough biodiesel for a 20% blend with conventional petro-diesel. The area required to be brought under Jatropha, and the production of biodiesel required under different blending scenarios, were as in Table C.4.

Table C.4: Diesel & Biodiesel Demand, Area Required under Jatropha for Different Blending Rates

Year	Diesel Demand MMT	Bio-Diesel @ 5% MMT	Area for 5% Million hectares	Bio-Diesel @ 10% MMT	Area for 10% Million hectares	Bio-Diesel @20% MMT	Area for 20% Million hectares
2001–02	39.81	1.99	N.A.	3.98	N.A.	7.96	N.A
2006–07	52.33	2.62	2.19	5.23	4.38	10.47	8.76
2011–12	66.90	3.35	2.79	6.69	5.58	13.38	11.19

The programme originally envisaged a blending target of 5% by 2006–07 that would call for 2.19 million hectares to be planted with Jatropha to produce 2.62 MT of biodiesel. It also envisaged a demonstration phase of bringing 400,000 hectares under Jatropha over a five-year period. The demonstration would involve identifying suitable Jatropha cultivars, developing nurseries and providing subsidised planting material to farmers in different agro-climatic zones. This was to be followed by a self-sustaining expansion of Jatropha on 11.2 million hectares to produce 10.38 MT of biodiesel by 2012 to meet the proposed 20% blending targets.

A major benefit envisaged from the programme was the generation of rural employment. It was estimated that one hectare of plantation would create employment of 311 man-days in the plantation phase (first three years) and 40 days per hectare thereafter on a long term basis. Thus, the demonstration project covering 400,000 hectares was itself expected to generate employment of 127.6 million man-days in the plantation phase, 36.8 million man-days on a sustained basis in seed collection and 3,680 person years for running seed collection centres and oil extraction units. Very positive impact on farm incomes was also expected with a net income of INR 15,000 per hectare of Jatropha plantation. The demonstration project was expected to provide an output of 1.5 million tons of seed generation an income of INR 7.5 billion.

Biodiesel Policy

The Ministry of Rural Development was designated as the nodal Ministry for implementation of the National Mission on Biodiesel, given the thrust on plantations on wastelands. However, several Ministries and other agencies are involved in policy making, regulation, promotion and development of the biofuel sector in India. The state governments have a key role to play in the development of plantations and in putting in place the collection, processing and marketing infrastructure.

No blending mandates have been announced so far but in October 2005, the Ministry of Petroleum and Natural Gas announced biodiesel purchase policy effective January 2006. Under the terms of this policy, public sector oil companies were mandated to purchase biodiesel and blend it with diesel at a 5% rate. Biodiesel was to be procured at a pre-determined price (currently INR 26.5 per litre, to be reviewed every six months). The purchase of biodiesel was to be carried out through 20 purchase centres spread across major producing areas in the country. The central government also exempted biodiesel from excise tax, but state governments do not provide any excise or sales tax exemptions for biodiesel or for biodiesel blended diesel. The use of Jatropha oil for fuel as a straight vegetable oil (SVO) attracts no excise duties as vegetable oils are exempted from excise duties.

Performance

Although the Government has not announced a blending mandate for biodiesel, the road map laid out by the Planning Commission and the National Mission have sparked a flurry of activity for the development of biofuel plantations and biodiesel processing capacity all over the country from both public and private sector agencies. There is a considerable amount of activity in research and development, extension of plantations and development of new technologies and capacity. Several state governments have also initiated programmes for large scale biofuel plantations. A snapshot of current activities in different areas in summarised in Annex C.1.

Production of biodiesel in significant quantities is yet to commence in India. This is mainly because the progress of Jatropha plantations has been rather slow. It is difficult to get precise estimates of the area planted to Jatropha. While the Planning Commission envisaged an area of 2.19 million hectares by 2006–07, it is estimated that the total Jatropha plantation in India is currently only around 400,000 hectares, of which about 70–80% are new plantations of 1–3 years that have not yet started to yield (USDA: 2007).The production from 400,000 hectares of mature Jatropha plantations would only meet 0.5% of the diesel demand in 2012. Biodiesel units do not have adequate supply of seeds to crush and produce oil for sale to oil marketing companies. Biodiesel processing capacity does not currently appear to be a constraint. Estimated currently at 100,000 MT per annum, most biodiesel units are closed during most parts of the year. The fulfilment of a 10% blending target would require 4.9 million tons of biodiesel from 6 million hectares of Jatropha plantations. This does not appear to be feasible at this stage.

Issues

A key issue facing the biodiesel programme is the availability of wastelands and degraded lands for large area coverage under Jatropha. The Planning Commission's assessment of land for biofuel crops was essentially a macro-level exercise based on assumptions about the proportions of different categories of land that could be brought under Jatropha (Table C.5). While these assumptions do not appear to be unreasonable, the approach and mechanism for micro-level identification of suitable lands has not been spelt out.

Table C.5: Planning Commission's Assessment of Potential Area for Jatropha (Million hectares)

Land Type	Area	Potential for Jatropha plantation	Key Assumptions
Under stocked forests	31.0	3.0	14 Million hectares of forests are under the scheme of Joint Forest Management out of which 20% would be easily available for Jatropha plantation
Protective hedge around agricultural fields	142.0	3.0	It is assumed that farmers will like to put a hedge around 30 million hectares for protection of their crops
Agro-forestry		2.0	Considerable land is held by absentee

			landlords who will be attracted to Jatropha plantation as it does not require looking after.
Fallow Lands	24.0	2.4	10% of the total area is expected to come under Jatropha plantation.
Land related programmes of Ministry of Rural Development		2.0	
Public lands -railway tracks, roads, canals etc.		1.0	
TOTAL	197.0	13.4	

Source: Planning Commission: 2003

There are widely varying estimates of wastelands in India by different Government agencies probably because of the use of different definitions (GTZ: 2005). The most recent remote-sensing estimates appear to suggest that the extent of wastelands may be in the region of 63.5 million hectares. However, no data is available on regarding how these lands are presently being used, who owns them and how many people live on them. In the context of the biodiesel programme, an important distinction needs to be made between (1) lands in some kind of productive use and lands not in productive use and (2) lands under communal or government ownership (forestry lands, government owned wastelands) and lands under private ownership (which may include wastelands allotted to poor families under different government programmes over the last several decades).

It may not be correct to assume that bringing communal wastelands under biofuel crops will not involve any opportunity costs. These costs could be substantial if poor families that use these lands for grazing, fuel wood, etc. lose access to these livelihood support services. It is also generally accepted that in forest lands and government owned lands, it is difficult to involve local communities unless some form of ownership or clear tenurial/usufructuary rights are given to them. (These arrangements may need to be different in different states depending upon current practice and institutional arrangements). A clear delineation of these rights is a pre-requisite for the large scale use of government owned waste lands for biofuel crop cultivation. On privately owned lands, Jatropha cultivation cannot be mandated; farmers will take up cultivation only if they are offered assured returns or are convinced of the financial viability of raising plantations. Thus, institutional arrangements that allow local communities to utilise government-owned lands for biofuel cultivation and a system of incentivising farmers to take up cultivation on private lands are both critical if the ambitious area targets are to be met.

Given that Jatropha is proposed to be planted mainly on wastelands and degraded land, that yields start only 3–4 years after planting and further given the uncertainties of yield, farmers are likely to take up plantations only if they receive financial support towards initial planting and maintenance costs. Some state governments are already offering generous subsidies towards these costs. If Jatropha is grown in highly fragmented and dispersed holdings, then organising the collection of seeds will be a major challenge. Farmers may not be able to market their produce unless institutional arrangements for collection of seeds and payment of a remunerative price to farmers are put in place. There is no price support mechanism for Jatropha seeds at present.

There is some anecdotal evidence that some farmers in Andhra Pradesh may have uprooted Jatropha plantations on account of poor yields and unremunerative prices (GTZ: 2005). Several states have built up a network of oilseed producer cooperatives in the 1980s and

1990s and related seed collection and oil extraction infrastructure under the National Mission on Oilseeds. This infrastructure has large unutilised capacity that could be used for non-edible oilseeds as well. Several other mechanisms for linking feedstock producers/supplies to oil processors are possible such as contract farming arrangements and large-scale captive plantations for processors on leased or owned lands. These mechanisms differ in their economics and the distribution of risks between processors and farmers. Contract farming arrangements involve coordination with a large number of growers, may put a large portion of the risk on farmers and may be unenforceable in many situations in rural India. Development of large scale plantations on leased or owned land by producers may give them greater control over feedstock supply, but may call for special exemptions under agricultural land ceiling laws in most states.

The growth in the market for biodiesel will be largely determined by the cost competitiveness with conventional diesel. Studies have shown that biodiesel and SVOs can be produced competitively with diesel, offering cost advantages of 12–25% over the cost of diesel (Kukrika: 2008). Some of these studies were made when international oil prices were in the range of US$50–60 per barrel. The current prices of above US$100 a barrel would increase the cost competitiveness of biofuels. However, assessments of the cost competitiveness of Jatropha are contingent on Jatropha yields of 3–5 tons per hectare. The Planning Commission (2003) observed that there could be wide variations in Jatropha yields from 0.4 tons per hectare to 12 tons per hectare. Several private companies, which had started out with fairly high yield expectations, now appear to be scaling down their projections to more realistic levels of 1.8–2.0 tons per hectare (Kukrika: 2008) and even these are yet to be achieved. A reduction in yields would quickly erode the cost advantages of biofuels. A decline in oil prices from the current high levels would also affect the commercial viability of biofuel production. The Government of India has exempted biodiesel from excise duties and SVOs are not taxed at all as they are treated like any other vegetable (edible) oil. However, considerable uncertainty exists about the continuation of these policies. Removal of current exemptions would considerably alter the economics of biofuel use. In the longer term, the cost competitiveness of Jatropha based biodiesel would be affected by the development of second generation technologies that are able to utilise feedstocks cheaper than Jatropha like crop residues, grasses etc. These second generation technologies may also render some of the current investments in biodiesel processing uneconomic or redundant.

The marketing of biofuels lends itself to both centralised and decentralised distribution systems. The centralised system involves upstream blending within the existing diesel distribution chains operated by the state owned oil companies, that presently distribute more than 90% of all diesel in India. Upstream blending by oil companies is advantageous to large scale producers as it obviates the need for them to set up separate distribution channels. To support such an approach the Government of India has come up with a biodiesel purchase policy described earlier. However, as the mandated price is below the cost of production for most producers, no biodiesel producers are selling biodiesel to these centres. The government purchase policy is, therefore, hindering the growth of the biodiesel market. If the uptake of biodiesel by oil companies is hamstrung by the purchase policy, it is possible that biodiesel may be exported to EU and the US, where a strong demand for feedstock oils appears to be emerging. Several companies (e.g., D1 Oils) already have arrangements to export part of their production to the EU. Exports would, however, hinder the growth of the domestic market. Decentralised distribution of biofuels through existing agricultural input marketing networks is also a possible option. This would suit decentralised small and medium producers who could supply markets in their close vicinity. As these distribution networks extend to the village level, this could provide improved energy access to the poor who may be able to afford only small quantities of fuel at a time. Maintenance of quality is an important issue in decentralised production and distribution systems.

Impacts on the Poor

In analysing the impact of biofuel development on the poor, one can distinguish between direct and indirect impacts. Direct impacts of biofuel expansion can be assessed along several dimensions such as (1) employment and income generation (2) access to energy (3) food security and (4) health related effects. The indirect impacts arise from the increase in international food prices resulting from the global expansion of biofuel production and their transmission to domestic markets. The indirect effects can have significant poverty and nutrition effects and may arise even if biofuel development in India is limited or takes place without competition for land or other inputs with food crops.

Direct Impacts

The Government of India's road map for biodiesel development envisages a substantial potential for employment generation through plantation, seed harvesting, processing and distribution activities. Based on the Planning Commission's estimates for employment generation, every 1000 hectares of Jatropha plantation should generate 313,000 man-days of employment in the plantation phase and 48,000 man-days per annum on an ongoing basis thereafter. The employment potential from 11.2 million hectares of Jatropha plantation is, therefore, truly impressive. Nevertheless, with only about 400,000 hectares of plantations achieved so far (with most plantations being in early stages) only a small proportion of employment effects have been realised. The sustainability of employment generated will depend on yields and economic viability of these plantations.

There have been several estimates of the income per hectare that can be generated from Jatropha plantations. The estimates of the National Bank for Agriculture and Rural Development (NABARD) prepared for its financing scheme are in Table C.6.

Table-6: Estimates of Yield and Income from Jatropha by NABARD

Year	Seeds/ tree in kg	No of trees/ha	Quantity of seeds (in kg)	Cost INR/kg	Total income INR
3	0.5	2000	1000	5	5000
4	1.0	2000	2000	5	10000
5	1.5	2000	3000	5	15000
6	2.0	2000	4000	5	20000
7	2.0	2000	4000	5	20000
8th year onwards	2.5	2000	5000	5	25000

It must be noted that the above estimates are for gross income per hectare and make no provision for the use of inputs, seed collection costs and transport costs. They indicate a potential for gross income up to INR 5,000 per hectare in Year 3 (the first year of yield) rising to INR 25,000 per hectare in the eighth year and thereafter.

Many private sector firms have made much higher projections of net income per hectare (GTZ: 2005; Kukrika: 2008) of INR 30,000 in the first year (Year 3) rising to INR 100,000 per hectare in the fifth year. These estimates are presumably for block plantations. Estimates of income per hectare are highly sensitive to anticipated yields. The NABARD estimates assume an eventual yield of 5 tons per hectare. As previously noted many private companies that had predicted very high yields of 12 tons per hectare and average yields of 3–5 tons per hectare are now scaling down their estimates to more realistic levels of 1.8–2.0 tons per hectare. The estimates of income also generally assume seed prices of INR 5–8 per kilogram. In the absence of a minimum support price, farmers may realise these prices only if they are supported through effective contract farming or cooperative marketing arrangements. Given the uncertainties relating to yield and prices, the income projections made by different actors appear to be overly optimistic. Farm incomes from Jatropha are likely to exhibit considerable variability depending on agro-climatic conditions.

Biofuels have the potential to improve energy access to the poor, especially if a decentralised production and distribution system is adopted. Rural transport and agriculture (irrigation) are two potentially large user segments. Biofuels can improve the reliability of the fuel supply chain in rural areas. The extent of penetration in rural areas will depend on cost savings associated with their use. Cost savings through reduced fuel costs for irrigation can translate into increased production through larger area coverage under irrigation and higher farm incomes. But these benefits are likely to accrue mainly to those who already use conventional diesel or other forms of commercial energy. In spite of their cost advantages, biofuels are likely to remain unaffordable to those poor families that rely on fuel wood or biomass for energy. Biofuel use also presupposes ownership of relevant equipment (e.g., diesel pump sets) that a vast majority of the rural poor cannot afford. The benefits in terms of improved energy access to the poor are likely to be confined to rural users of commercial energy. This is also likely to be true of health benefits (through reduced incidence of respiratory illness) on account of the use of cleaner burning biofuels. As substantial quantities of commercial biofuels are yet to be used in rural areas it is too early to assess health and energy access benefits.

Any conflict with food crops has been avoided in the Indian programme by stipulating that Jatropha be grown only on wastelands and degraded lands. However, the food versus fuel conflict could re-emerge under certain conditions — if realisation of economic yields in jatropha requires substantial water use[86] or if Jatropha cultivation is found to be feasible only on arable lands. Provision of water in wastelands may be challenging in itself, but any diversion from food crops could be a potential source of conflict. It must, however, be noted that such a conflict arises with the cultivation of any cash crop which is not consumed by subsistence farmers. Crops like sugarcane are quite water intensive and have a far greater impact on water availability than Jatropha would. So the situation would be no different than what prevails in Maharashtra where large areas have been brought under sugarcane in drought prone areas. But large scale Jatropha cultivation could add another element to the intense competition for water and potentially impact food production.

The cultivation of Jatropha on arable lands would of course create a direct conflict with food crops. This is not envisaged in the India plans, but the government has no mechanism to prohibit the conversion of arable land to Jatropha or to effectively enforce such a prohibition. If Jatropha cultivation on arable lands proves to be profitable for small farmers, large scale conversions could happen under the umbrella of contract farming arrangements. Such conversions may be economically rational for farmers, but may impact food production, reviving the politically sensitive food versus fuel debate.

Indirect Impacts

Even if the development of biofuels is slow in India, the global expansion of biofuel production could have important consequences for India through the impact of a sustained rise in international food prices and their transmission to domestic markets. Elsewhere in this study we have reviewed the likely increase in international food prices under various biofuel expansion scenarios. While these projections vary a great deal, a 10% sustained increase in the international prices of major crops is a fairly reasonable assumption. We have also seen that increases in international prices are getting transmitted to domestic markets even in economies like India which undertake considerable public intervention to insulate domestic consumers from price increases.

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[86] Kukrika (2008) quotes an estimate of water requirement of 9000 litres of water per hectare.

With a population of over one billion, India is home to the largest number of poor people in the world. Over 240 million people are estimated to be below the national poverty line (Planning Commission: 2007). Over the last three decades significant strides have been made in poverty alleviation. Poverty rates have fallen to 27.5% in 2004-05 down from 36% in 1993-94 and 51% in 1977-78. Some of the key parameters of India's food security situation are summarised below.

Table C.7: Key Parameters of Poverty and Food Insecurity in India

	1980–81	1990–91	2000–01	2001–02	2003–04	2004–05	2006–07
Agricultural Production (in million tons)	129.6	176.4	212.9	174.8	213.2	208.6	209.2
	1980–81	1990–91	2000–01	2001–02	2002–03	2003–04	2004–05
Per capita of food grain availability (grams per day)	454.8	510.1	416.2	494.1	437.6	462.7	422.4
	1969–71	1979–81	1990–92		1995–97	2001–03	2002–04
Per capita calorie consumption (kcal per capita per day)	2040	2080	2370		2440	2440	2470
	1969–71	1979–81	1990–92		1995–97	2001–03	2002–04
Number of undernourished in total population (millions)	218.3	261.3	214.8		201.8	212.0	209.5
	1969–71	1979–81	1990–92		1995–97	2001–03	2002–04
Proportion of undernourished in total population (%)	39	38	25		21	20	20

Source: Ministry of Agriculture (2007); FAO (2007)

An important aspect of India's food security is that in recent years, food grain production has tended to stagnate. While the Green Revolution period saw rapid growth in agricultural production from the mid-1960s to the mid-1980s, the rate of growth has slowed down considerably since then. Food grain production has stagnated in the range of 200–210 million tons for the last several years. With a burgeoning population, this has implied a decline in per capita availability of food grains and stagnant per capita calorie consumption. The decline in consumption coupled with increased consumption of India's expanding middle class of 300–350 million, means that consumption inequalities have worsened. Persistent inequalities have kept 209 million people food insecure, although the proportion of the undernourished in the population has declined. Child malnutrition rates have barely budged from around 45% in spite of economic growth of 8–9% in the last few years.

The impact on poverty arising from sustained increases in the price of food can be assessed in terms of the erosion in real incomes as result of food price increases. Table C.8 presents the erosion of real income at different income quintiles in urban and rural areas resulting from a 10% increase in food prices. The calculations are made using data on the food budget shares in different expenditure quintiles.

Table C.8: Real Income Effects of a Sustained Increase in Food Prices of 10%

India – Rural – 2003			India-Urban-2003		
Expenditure category (Average monthly household expenditure) INR	Average monthly expenditure INR	Real income effect of a 10% increase in all food prices (%)	Expenditure category (Average monthly household expenditure) INR	Average monthly expenditure INR	Real income effect of a 10% increase in all food prices (%)
Total	554	-5.39	Total	1022	-4.20
< 225	195	-6.36	< 300	250	-6.14
226 - 255	241	-6.27	301 - 350	326	-5.82
256 - 300	278	-6.24	351 - 425	392	-5.77
301 - 340	321	-6.15	426 - 500	465	-5.61
341 - 380	360	-6.02	501 - 575	536	-5.50
381 - 420	400	-5.98	576 - 665	621	-5.31
421 - 470	443	-5.89	666 - 775	720	-5.01
471 - 525	497	-5.84	776 - 915	846	-4.76
526 - 615	567	-5.63	916 - 1120	1009	-4.61
616 - 775	685	-5.42	1121 - 1500	1286	-4.22
776 - 950	852	-5.13	1501 - 1925	1673	-3.77
950 <	1440	-4.16	1925 >	3116	-2.83

(Source: LABORSTAT, ILO)

The erosion of real incomes in the different income quintiles ranges from 2.83% to 6.14% in urban areas and from 4.16% to 6.36% ranges in urban areas. The expected, but striking feature of these results is that it is the poorest income quintiles that will be hurt the most on account of the increases in prices. Based on approximate calculations using the methodology of Martin and Ivanic (2008), a 10% increase in the price of all food commodities in India will push 42 million people below the poverty line. Such an indirect poverty impact of biofuel expansion is extremely significant as it could wipe out the gains in poverty reduction achieved over the last decade. The potential income and employment gains from biofuel expansion in India will be insufficient to offset the large welfare losses arising from increasing food prices.

Trade Balance Effects

Development of ethanol may not have a significant trade impact effect – as it may lead to increasing import of ethanol for other industrial use (or even for biofuel use). India consumes five times the amount of diesel as it does of petrol — therefore, the trade balance impact of 20% blending with diesel could be significant — a potential saving of US$5–6 billion on its import bill at current price and consumption levels.

Environmental Impacts

Energy security considerations rather than beneficial environmental impacts have driven biofuel development plans so far. Explosive growth in passenger and commercial vehicles have led to serious pollution problems in urban areas (especially in the large metros) and increased incidence of respiratory illness. Concerns about vehicular pollution in urban areas are growing and vehicular emission norms are being gradually introduced for the whole country, with more stringent norms being applied in metros and urban areas. Adoption of environmentally friendly fuels is a must for conforming to these norms. On several occasions, serious pollution problems in cities have invited judicial intervention for securing implementation of control measures.

India is the 5th largest emitter of carbon dioxide and its emissions are expected to grow from 1,147 million in 2005 tons to 2,254 million tons by 2030 (IEA: 2007). Per capita emissions are projected to increase from 1.0 to 1.6 tons by 2030. However, India contributes only 4% of the world's Green House Gas (GHG) emissions and its carbon emissions are less than 80% of Japan's and less than 1/6th of the United States.

India accords high priority to economic growth and would not like its development efforts to be hampered by emission control regimes. Given its low per capita consumption of energy, India has been arguing that developed countries should do much more to curb emissions before any kind of quantitative targets for emission reductions are imposed on developing countries. India is not a signatory to the Kyoto Protocol. However, G-8 countries have recently designated Brazil, China, Mexico, South Africa and India as "outreach countries" to be "integrated into global responsibility". As and when India gets drawn into international arrangements for GHG emission reductions, the use of biofuels on environmental grounds will get an impetus.

The "Clean Development Mechanism" (CDM) can also play a role in promoting biofuel development in India. Industrialised countries with targets to meet under the Kyoto Protocol can use the CDM to get certified emission reductions by creating projects in countries without targets. Biodiesel projects qualify as CDM projects and India is reported to be the recipient of the largest number of CDM projects (around 600). Use of biodiesel can lead to substantial reductions in emissions. Kukrika (2008) reports that replacement of 20% of the nation's conventional diesel consumption with biodiesel would lead to a reduction in carbon dioxide emissions by 16.%, sulphur dioxide by 20% and particulate matter by 22%

Conclusions

India's biofuels strategy is mainly driven by energy security considerations, although environmental benefits, greening of wastelands, potential for increased rural employment and income, improved energy access to the poor are cited as important supporting objectives. Food security is an important consideration in a country with the largest number of the world's poor — so the biofuels strategy carefully tries to avoid competition between food and fuel crops by focusing on the use of wastelands and degraded lands for growing feedstock crops. A National Policy for Biofuels is still in the works, but India has followed a two-pronged strategy for biofuels development (1) promoting the use of ethanol derived from sugar molasses for blending with gasoline and (2) promoting the use of non-edible plant based oils for blending with diesel.

India is the second largest producer of sugarcane and now the largest producer of sugar, but plans for development of ethanol as biofuel are hamstrung by limited potential for area expansion under sugarcane, regulatory and policy constraints and competing demands for ethanol from different sectors. Ethanol policy has largely become a balancing exercise in meeting the demands from competing users. Government policy has mainly been a response to cyclical variations in sugarcane/sugar production and appears to lacks a long term perspective. This is reflected in the way in which the blending mandate, a key instrument for promoting biofuel use of ethanol, has been handled. A stop-go approach and the dilution of the mandate when faced with feedstock shortage and making them voluntary/contingent on the commercial viability for oil companies suggest a somewhat half-hearted approach to the promotion of ethanol as a biofuel. An extraordinarily complex regulatory and taxation regime has created a range of market distortions leading to large idle unutilised capacities for ethanol production and uncertainties for future investments. The enforcement of ethanol blending mandates is also complicated by the pricing arrangements for petroleum products that appear to create an incentive for state-owned oil companies to drive down the price of ethanol even below economic levels and, somewhat paradoxically, consider large-scale ethanol imports from Brazil to comply with the mandates.

In India, therefore, the promotion of ethanol as a biofuel appears to be constrained by intense competition from other ethanol users and a policy regime that appears to relegate biofuel use of ethanol as a "residuary" activity. It is doubtful that the targeted 10% blending mandate will be achieved over the course of the next few years. Regulatory reform in the sugar and petroleum sectors appears to be the key challenge facing India in its efforts to promote the use of ethanol as a biofuel.

India has an ambitious programme for the development of biodiesel based on feedstock crops like Jatropha and Pongamia. The National Mission on Biodiesel envisages rapid expansion of area under these crops (to an eventual 11.2 million hectares) by using so-called wastelands or degraded lands. A blending target of 20% is envisaged by 2012 with substantial environmental benefits and expansion of rural income and employment opportunities. No mandates for blending are yet in place — however, the road map envisaged by the National Mission has led to flurry of activity and a number of public and private sector initiatives for the cultivation of jatropha and production of SVOs and biodiesel have emerged. However, it is too early to assess the commercial success and sustainability of these ventures. The profitability of jatropha cultivation on degraded lands is yet to be fully established and the economics of biodiesel production appear to be very sensitive to yield assumptions. Many private sector ventures now appear to be scaling down the rather optimistic assumptions originally made. The progress to date has been modest — with only about 400,000 hectares of jatropha plantations achieved. The biodiesel programme is ambitious in scope, but a clear policy framework is yet to emerge. The policy needs to address several critical issues confronting a programme for creating a new value chain for a liquid biofuel.

The expansion of biofuel production can have important direct and indirect impacts on poverty alleviation through a variety of channels. Given the rather slow development of biofuel production in India, it is too early to assess the direct income and employment benefits and improved energy access for the poor. The indirect impact resulting from global biofuel expansion and resultant increases in international food prices are likely to be much more serious as they could threaten to push more than 40 million people into poverty in a country which has the highest number of undernourished people.

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Annex C.1: Biodiesel Development Activities in India

The road map for biodiesel development laid out by the Government in the National Mission on Biodiesel has led to a flurry of development activity in areas of biofuel plantations, processing and research and development by governments and other public and private sector agencies. A snap shot of these activities is provided below:

- Development of high-yielding varieties is being undertaken by a range of agencies like the Department of Biotechnology, the Bhabha Atomic Research Centre, State Agriculture Universities, Indian Council of Agricultural Research institutes and a few private research centres. Germplasm is also being imported by the National Bureau of Plant Genetic Resources from Egypt, Ghana, Nepal, Nicaragua and Brazil.
- Plantation of Jatropha and Pongamia is being undertaken under the auspices of a range of public sector agencies:
    - The National Afforestation and Eco-Development Board under the Ministry of Environment and Forests. The Ministry of Environment and Forests has plans to take up 20,000 hectares of plantations under "Clean Development Mechanism" Projects.
    - The National Oilseed and Vegetable Oil Development Board. The Board has a range of schemes for the development of non-edible oilseeds. It is estimated that there are approximately 8,300 hectares of model plantations that are currently being grown in collaboration with 20 state governments. These initiatives involve 200-300 hectare plots with the intention of identifying, superior germplasm for certain sets of agro-climatic conditions.
    - The Indian Railways have a programme to bring large areas of railway land under Jatropha. A pilot project for Jatropha planting on railway land has already been initiated by the Indian Oil Corporation.
    - The Department of Biotechnology is raising 500,000 plants to plant an area of 200 hectares.
- Many states have been pro-active in taking up Jatropha plantations:
    - The Government of Andhra Pradesh has set up a separate department to encourage the plantation of up to 728,000 hectares of biofuel plantations. It is also offering generous subsidies covering 100% of the initial planting of Jatropha on plots up to 5 acres.
    - The Government of Chattisgarh has initiated a plan to produce 80 million saplings in 350 nurseries operated by local NGOs. The Government had expected to plant 20,000 hectares by 2007-08 and has a long term target of 1 million hectares state wide.
    - The Government of Uttaranchal is focusing on Jatropha plantations on community lands/wastelands and degraded forests by giving management of 2 hectares of land for raising Jatropha to each "below-poverty-line" (BPL) family. The Government estimates that since 2004, Jatropha plantations have been taken up in 10,500 hectares benefitting 500 poor families.
    - Other states include Rajasthan which has a target of 2.2 million hectares and Haryana (50,000 hectares) and Tamil Nadu (40,000 hectares).
- Pilot plants on transesterification have been set up by the oil major Indian Oil Corporation (Faridabad), Indian Institute of Technology (Delhi), Punjab Agricultural University (Ludhiana), Indian Institute of Chemical Technology (Hyderabad), Indian Institute of Petroleum (Dehra Dun), Indian Institute of Science (Bangalore) and Southern Railways (Chennai).
- A number of trials have been made on a variety of transport modes using 5% biodiesel blends, including on the locomotives of the Indian Railways.
- A number of private sector initiatives have been reported in the press. Some of the major players include the UK based D1 Oils, Reliance, BP etc. The activities of some of these players is summarised in the table below:

D1 Oils India	Joint venture – D1 Mohan Bio Oils – Contract farming operations in Tamil Nadu (40,000 hectares)

	Joint venture with Williamson Magor to develop plantations in North East India. Joint venture with BP – D1 BP Fuel Crops – For planting operations. Total target of 350,000 hectares in the next four years. Agreements and oil supply arrangements with Indian partners.
Labland Biotech	Agreement to supply 10,000 MT a year to D1 Oils UK. Plans for 130,000 hectares under cultivation by 2010.
Nandan Biomatrix	Planted 20,000 hectares. Targeting another 80,000 hectares and plans to roll out biodiesel processing capacity as plantations mature, in collaboration with UK based Green Fuel.
Jain Irrigation	Testing 150,000 seedlings in a variety of soil conditions Large scale plant envisaged in Maharashtra and plans to expand into Chattisgarh.
Naturol Bioenergy	90,000 tons per year plant in Kakinada, Andhra Pradesh – Joint venture with Energea GmbH (Austria) and Fe Clean Energy (US) Has been allocated 120,000 hectares for Jatropha cultivation. Meanwhile obliged to procure seeds from other sources
Southern Online Biotechnologies	9,000 tons per year plant in Andhra Pradesh. Feedstock on 1000 hectares of wasteland. Seeking CDM approval – anticipated CDM revenue of $108,000 and reduction in carbon dioxide emissions of 26,792 tons.
Godrej Agrovet	Rs 5 billion for Jatropha plantations in Gujarat and Mizoram
Emami	Joint venture being explored with a leading European company for biodiesel production
Reliance	Talks with Maharastra, Gujarat, Andhra Pradesh and Rajasthan Governments to get access to land for contract farming
BP	Invested $0.4 million in Andhra Pradesh with the Energy and Resources Institute to develop 8000 hectares of wasteland with Jatropha and production capacity of 9 million litres per year.
Mint BioFuels	Plans for plant at Chipun with a capacity of producing 5000 tons of biofuel a day.
Nova Bio-Fuels	Biodiesel plant with 30 tons per day capacity.
Kochi Refineries	Pilot plant with US firm for extracting oil from rubber seed.
Clean Cities Biodiesel India	25,000 tons per annum biodiesel plant in Vizag special economic zone. Will initially procure feedstock from abroad with plans for backward integration into energy plantations
Coastal Energy	100,000 tons per annum biodiesel plant in Falta (Kolkata) special economic zone.

Sources (GTZ: 2005, Kukrika: 2008, Gonsalves: 2005 and websites of biodiesel producer bodies in India)

D. Malawi

Malawi is a relatively small land-locked country in south-eastern Africa, with high rates of poverty and food insecurity. The majority of the population live in rural areas and most are engaged in agriculture, usually as small-scale farmers, for the significant part of their livelihoods.

For Malawi an expansion of biofuels production could be a menace: with so many living on the breadline, anything that pushes up food prices imperils their welfare and threatens malnutrition. But it could also be an opportunity for a largely agrarian society to add the growing of feedstocks to their livelihood options. Being both landlocked and importing most of its vehicle fuel there could be considerable scope for substituting biofuels for oil imports.

This paper explores these issues.

Experiences and policies

As long ago as 1982 Malawi began production of ethanol distilled from cane molasses to be blended with petrol:

> … two private companies namely, Ethanol Company of Malawi and Press Cane in the Central and Southern Regions of Malawi are involved in ethanol production. The Ethanol Company of Malawi received government support for developing an ethanol plant in 1980s. In both companies, large sugar plantations owned by the Illovo Group provide the raw materials (molasses) which is further processed into ethanol. However, some of the molasses is provided by smallholder farmers who grow sugarcane under out-grower schemes. (Jumbe et al 2007)

It seems the Ethanol Company has been distilling ethanol at its cane mill in Dwangwa, on the shores of Lake Malawi in Nkhotakota District, since 1982. This apparently has a capacity of 18M litres a year, although its working capacity is more like 15M litres and production may be lower. The second plant, built in the Shire Valley south of Blantyre in 2004, came on-stream in 2005 and has a capacity of 16M litres.

Reports state that originally the ethanol was blended into all leaded petrol at 20%. According to Jumbe et al. (2007) the country was in recent years importing 80–90M litres of petrol a year. If the higher figure were complemented at a ratio of 20%, then the quantity of ethanol so used would be 22.5M litres — more than the reported combined output of both plants in recent years. Press Corp, which has large stakes in both ethanol plants, sources mention a lack of molasses as being constraint to production.

Apparently in February 2006 the blending requirement was reduced to 10%, for reasons not stated in the literature and sources seen. Sources from Press Corp mention that the new plant is exporting some of its ethanol, but no further details are given.

A quite different initiative is also under way, although progress is difficult to ascertain. For several years there have been repeated reports that the Climate Change Corporation (3C) has been arranging to buy jatropha seed from small farmers organised in the Biodiesel Agricultural Association. Jatropha already grows in Malawi, apparently mainly as a hedge. The Association aims to encourage farmers to plant up abandoned and degraded marginal lands, and to harvest the seed. UNCTAD (2006) reports and comments:

> However, much of the recent activity in feedstocks for biodiesel cultivation is the result of a private company's initiative which gives farmers free Jatropha trees to plant along with an engagement to later buy the Jatropha oil harvested for biofuel processing. The farmers, not the private company, retain ownership of both the land and the trees. The Biodiesel Agricultural

> Association serves as liaison between the private company and the Malawian farming community. The association has embarked on a nationwide campaign to discuss the crop's potential in stakeholder communities and encourages farmers to utilize land not suitable for other crops in order to maximize their economic potential.
>
> However, a chicken and egg situation is hampering Malawi's feedstock market from expanding more rapidly, namely farmers do not want to shift their production to Jatropha in the absence of processing facilities, and investors are hesitant to build processing facilities before feedstocks become available.

It is not known how much progress has been made with this initiative. Reports from 2005 talk of 13,000 ha, even 20,000 ha in some accounts, being planted to Jatropha with possible returns of US$2,000 a ha to farmers; making this a possible replacement for tobacco. The leader of the BDAA was speaking of the possibility of planting as many as 200,000 ha to the crop. An NGO had installed a crushing plant at Kanengo (SADC 2005).

But by early 2008 reports were more measured: C3 reported that 1.5M seedlings had been planted in Salima,[87] but at the recommended rate of 2,500 per hectare, that would make at most 680 ha planted, well short of the original plans.

One other initiative reported (SADC 2005) is an NGO that had started producing ethanol gels for use in stoves at a workshop in Lilongwe, but tellingly the report noted that production had stopped when ethanol prices rose.

National policies recognise the potential of ethanol, yet the policy of blending has apparently not yet been made law, although a draft bill to this effect is contemplated. (Jumbe et al. 2007)

Food insecurity and biofuels in Malawi

The majority of the population are poor: 52% in 2004/05, with 22% classified as ultra poor — see Table D.1. Poverty tends to be worse amongst the rural population, where the equivalent statistics were 56% and 24%. By region, the Southern part of the country has the highest rates of poverty.

The situation may be improving, especially in urban areas. In rural areas, however, the apparent pace of poverty reduction — 9 percentage points reduction in seven years — is slow: at this rate and given the high levels of poverty, it would take more than 20 years to halve rural poverty.

Table D.1: Malawi poverty headcount, 1997/98 and 2004/05

	Poor			Ultra Poor		
	National	Urban	Rural	National	Urban	Rural
1997/98	64%	57%	65%	36%	31%	37%
2004/05	52%	22.5%	56%	22%	7.5%	24%

Sources: Cromwell & Kyegombe, 2005, Table 5; and Devereux et al. 2007, Table 3

The main source of livelihoods is farming, 90% of households are involved. Fully 81% of the rural population engage in subsistence farming on rain-fed plots. (DFID 2007)

Income poverty is accompanied by high rates of mortality amongst children aged under five at 120 per 1000 in 2006 and low life expectancy of 47 years at birth.[88]

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[87] BF Fuels web site: C3 is a subsidiary of the BF Fuels.

Many of the population are under-nourished. FAO estimate the fraction of the population that consumes less than the Kcal 1,790 necessary, as 35% in 2002/04, a modest improvement on the 40% estimated for 1995/97. Direct observation of the nutrition of young children confirms the high rates of malnutrition with one quarter of children underweight in 2000, and almost half of them stunted. There is, however, some evidence of modest improvements during the 1990s, see Table D.2.

Table D.2: Malnutrition rates for children under five years, Malawi, 1981 to 2000

years of age

Year	Source	Stunting (height for age <-2 z score) %	Underweight (weight for age <-2 z score) %	Wasting (weight for height < -2 z score) %
1981	NSSA[3]			
	Pre-harvest	56.5	34.6	4.0
	Post-harvest	56.3	27.4	3.5
1994	NSSA[4]			
	Pre-harvest	57.7	32.4	3.9
	Post-harvest	56.7	28.7	3.7
	Overall	57.3	30.6	3.8
1992	MDHS			
	National	48.7	27.2	5.4
	Urban	35.0	15.4	2.6
	Rural	50.3	28.6	5.8
2000	MDHS			
	National	49.0	25.4	5.5
	Urban	34.2	12.8	4.9
	Rural	51.2	27.3	5.6

Source: NSSA (1991, 1994), DHS (1992, 2000) cited in GOM (2004)

Given the levels of poverty and malnutrition, it is not surprising that to find that more than three-quarters of households interviewed in the 2004/05 Integrated Household Survey reported having been affected by large rises in the price of food during the previous five years — see Table D.3. Food prices rises were the most commonly recorded shock, more frequent than harvest losses or illnesses and accidents.

Table D.3: Frequency of shocks at the household level, Malawi

[88] Statistics from World Development Indicators, April 2007, World Bank website.

Type of shock	Yes	No
Large rise in price of food	77.0	23.0
Lower crop yields due to drought or floods	62.7	37.3
Illness or accident of household member	45.7	54.3
Death of other family member	40.6	59.4
Large fall in sales price for crops	38.0	62.0
Livestock died or were stolen	33.3	66.7
Crop disease or crop pests	23.8	76.2
Household business failure	21.9	78.1
Theft	19.3	80.7
Birth in the household	11.0	89.0
Dwelling damaged or destroyed	10.2	89.8
Break-up of the household	10.1	90.0
Loss of salaried employment or non-payment of salary	8.9	91.1
Death of working member of household	8.7	91.3
End of regular assistance, aid, or remittance	7.2	92.8
Death of household head	4.8	95.3
Other	1.4	98.6
Total	**23.8**	**76.2**

Source: IHS2, Module AB

On average, Malawian households spend 53% of incomes on food, with more than 40% of spending going on staples of bread and cereals. (USDA data, in Seale et al. 2004).

How severe are food price rises to Malawian households? Ivanic & Martin (2008) have used household survey data to estimate the impact on the budgets of those living close to the poverty line. They model the impacts of 10% rise in food prices, with and without effects on wages, but with the restrictive assumption of no adjustment to consumption or supply in response to the price rises —as might be expected in the short-term. In the longer run, the impacts may be mitigated by supply response and adjustments to consumption patterns, so that these results represent an upper bound on impacts.

Table D.4: Changes in poverty headcount in response to a 10% increase in food prices

		Rural	Urban	Total
Initial	With or without wage effects	23.3	3.7	20.8
Beef	NW	0	0	0
	WW	0	0	0
Dairy	NW	0	0	0
	WW	0	0	0
Maize	NW	0.5	0.3	0.5
	WW	0.5	0.2	0.4
Poultry	NW	0	0	0
	WW	0	0	0
Rice	NW	0	0	0
	WW	0	0	0
Sugar	NW	0.1	0	0.1
	WW	0.1	0	0.1
Wheat	NW	0	0	0
	WW	0	0	0

All	NW	0.6	0.4	0.5
	WW	0.5	0.3	0.5

Source: Ivanic & Martin 2008

The overall effect of a 10% rise in food prices is to increase the numbers of ultra poor by 0.5 percentage points. In a nation of 13.6 million, this would represent around 68,000 persons pushed into ultra poverty. The price effect comes overwhelmingly through the price of the main staple, maize. For the poor, other foods are much less important.

Effects of food price rises on the national economy

A rise in world food prices of, say, 10% would lead to an increased import bill for foodstuffs with knock-on effects for the economy as a whole. On average between 2002 and 2006, Malawi imported US$175M of food (WTO data).[89] Assuming that a 10% price increase did not affect import levels, the additional cost of a 10% rise in food prices would be US$17.5M.

Multipliers for Malawi have been estimated at 2.94 for the whole economy (Giles & Jennings 1982, cited in Davies & Davey 2008), and between 2.3 and 2.79 for the Traditional Authority (TA) Chakhaza in northern Dowa District, in central Malawi (Davies & Davey 2008).

Applying the smallest and largest of three estimates suggests that the increased import bill would depress the gross domestic product by between US$40.M and US$51.5M, equivalent to 1.5% and 1.9% respectively of the average GDP for 2002 to 2006.

On this basis, it looks as though Malawi is highly vulnerable to changes in world market prices.

Transmission of world prices to Malawi

The caveat to these considerations is that Malawi is to some extent insulated from changes in world market prices by the high costs of transporting bulky foodstuffs to and from the closest Indian Ocean ports, Beira and Nacala. Shipping maize from the port of Beira, for example, cost US$50–60 a tonne a few years ago and may cost more as oil prices have arisen.

This introduces a large price wedge between world prices for maize and those within Malawi. In effect, the difference between import and export parity prices for maize would be at least US$100 to US$120 a tonne. If the international price of maize were US$140 a tonne, import parity prices would be at least US$190 a tonne, and export parity prices at most US$90 a tonne. With local production costs of around US$125 a tonne, it would take a large change in world market prices to affect the price in Malawi. Not surprisingly then, the general pattern over the last twenty years or more has been for Malawi to produce maize sufficient to meet domestic requirements: with the notable exceptions of those years where poor weather has led to harvest failures.

Figure D.1 shows changes in the food price index for Malawi since January 2001, compared to non-food price index for Malawi and the international food price index. Food prices clearly cycle every year, with high prices in the hungry months leading up to the main maize harvest, and sharp declines in prices from March to August in the months during and following the harvest. Otherwise the trend in food prices follows the non-food price index upwards at relatively rapid rates of inflation. There appears to be little correspondence between Malawian and international food prices.

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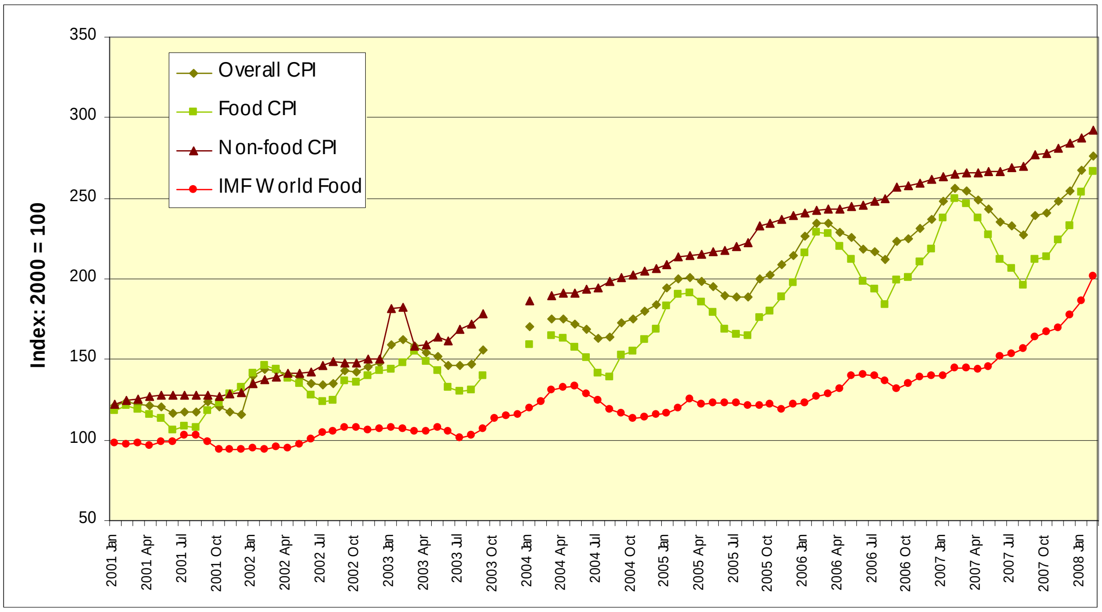
89 What makes up the bulk of these imports by value? Prominent in 2005 were staples that could not be grown in Malawi such as wheat, dairy produce, vegetable oils, maize — this was the year before the recent bumper harvests began, and luxury items such as chocolate, cigarettes, wine, and breakfast cereal.

Figure D.1: Changes in food and other price indices in Malawi compared to international food prices, 2001 to 2008



Sources: Reserve Bank of Malawi Consumer Price Indices; IMF Commodity Food Index, rebased to Jan 2000

The price wedges created by high transport costs to Malawi will tend to mitigate the effect on import parity prices, but increase the effect on export parity prices. Hence producers of export crops are likely to be much more sensitive to changes in world market prices than those producing import-substituting crops for the domestic market.

Social and political dimensions of biofuels in Malawi

Little has been recorded on these. Rights to land in Malawi are understandably sensitive, and that may explain why the initiative to plant jatropha is couched in terms of using marginal and waste lands.

Sensitivities over land may also limit the ability of the sugar estates to expand production, although further enrolment of smallholders under contract might be a response.

Potential for biofuels

At first sight, Malawi would appear to have considerable potential to substitute biofuels for vehicle fuel imports. On average between 2002 and 2006 fuel imports cost Malawi almost US$120M a year, equivalent to more than 4% of the GDP.

The Malawian sugar industry produces very high yields of cane on the estates and on smallholder grower schemes, with lower yields for out-growers. Costs of production are reckoned to be amongst the lowest in the world, at US$0.07 a pound at the factory gate (ODI/DESTIN 2005). Production of sugar from the two main mills exceeds national needs and much is exported, making sugar one of the country's main earners of foreign currency. At present, ethanol is distilled from molasses, a by-product of cane crushing.

If the country were to pursue a goal of replacing, say, half its petrol imports by ethanol, does it have the land to do so? With petrol imports running at 80–90M litres a year, and with potential biofuel yields in excess of 5,000 litres per hectare of cane, just 9,000 ha of cane could produce all the ethanol needed.

Does Malawi have the land? At first sight, yes. The area under crops in 2006 has been estimated at just over 3M ha — of which about half was sown to maize; with just 22,000 ha under sugar cane. In 1994 the potential crop land in the country was reckoned to be 6.7M ha, out of a total area of 1,100M ha (FAO Terrastat data). Finding another 9,000 ha for sugar cane thus sounds very possible.

The limitations, however, include that not all the land potentially cultivable may be suitable for cane — the estates on which most the cane is currently grown are irrigated. Additional land for cane would need to be within a convenient radius of a mill, since sucrose content rapidly declines if the harvested cane cannot be promptly delivered to the mill and crushed.

More immediate concerns may be inertia and lack of capital. Blending small fractions of ethanol into petrol creates few challenges for fuel supply, distribution, and use. Moving to higher fractions of ethanol would require modifications to vehicles to run on flex fuels, and some changes to storage and distribution systems to accommodate ethanol where contamination with water can be a problem, one that does not apply with petrol. There would also be capital costs in setting up additional sugar mills and ethanol distilleries.

Equally fundamental issues concern the economics of ethanol. While it should be possible to produce ethanol at a cost that undercuts imported petrol, above all when world prices of crude are higher than US$60 a barrel — let alone the US$100 plus currently being paid — there are questions as how well ethanol pays in comparison to sugar production. The sugar estates and the mills are operated by one company that effectively has a monopoly position in the domestic market that may allow it to charge over the odds and get a far better price for sugar than the world market price would imply. Moreover, of the sugar that is exported, much goes to the EU under preferential schemes that again boost returns.

The scope for producing biodiesel may be almost as compelling as that for ethanol in terms of replacing expensive imports. There may also be scope for local level electricity generation running engines on either biodiesel or straight vegetable oil.

But in this case, unlike that of ethanol, there appears to be no experience of growing a feedstock for biodiesel at anything other than a very small scale. The jatropha initiative described earlier seems to remain at a pilot scale for the time being, and indeed there are no reports of any substantial amounts of biodiesel having been produced to date. Questions arise with jatropha of just how good the yields may prove to be, especially when grown on marginal plots, and how willing farmers are to plant and tend the crop for the three or four years before it begins to yield.

With other oilseeds it may well be that the local prices for cooking oil are more attractive than those for biodiesel. Moreover, there may well be sensitivities to using oil that is edible for fuel in a country with high rates of poverty and malnutrition.

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E. Frameworks used for modelling

Reference	Year	Authors	Institution	Aim	Country	Model	Scenario	Results
Modeling the Competitionfor land: Methods and Application to Climate Policy	2008	Ronald D Sands Man-Keun Kim	Pacific Northwest National Laboratory University of Nevada	Improve AgLU model:	US	AgLU (Agriculture and Land Use model	(1) geographical disaggregation of UD (2) Improvement in forestry dynamics (3) the response of biofuels to a carbon incentive	Optimal tree rotation age Increases along with a carbon incentives paid to owner of managed forests. The amount of land used for biofuels becomes quite large at higher carbon prices, with decreases in land use for pasture and unmanaged forests
Land allocation Effects of the Global Ethanol Surge: Predictions from the international FAPRI model	2008	Fabiosa Beghin Dong Elobeid Tokgoz Yu	IOWA state University	Quantification of the emergence of biofuel markets and its impact on US and world agriculture	US Brazil China EU India	Multi-market multi-commodity international FAPRI model	Exogeneous Changes in ethanol demand: (1) in US (2) then in Brazil, China EU and India and compute shock multipliers for land allocation decisions for crop and countries of interest	The multiplierse show ar the margin how sensitive land allocation is to the growing demand for ethanol. In US higher coarse grains prices transmit worldwide. Also affects US wheat and oilseeds prices. In brazil it affects land used for sugarcane productionand other sugar producing countries (but small impact on other land use)
Modeling Land Use Changes in GTAP	2003	Jean-Marc Burniaux Huey-Lin Lee	OECD Purdue University	Consider Land-use Changes in integrated assessment of climate changeissues. Impact on prices of GHG emissions reductions	US EU	GTAPE -L model (CES substitution elasticities + RIVM IMAGE 2.2 for the land transition matrix estimation + alternative version with obscured sources of land supply	2 countries: US and EU and 2 scenario: with or without counting in changes in emission due to land changes (or transitions)	The results show that land use transitions do help reduce the marginal costs (3% for US 30 % for UE). The alternative version leads to mis-measurement of economics costs Impact on output are negative. Impacts on prices depends on the scenario
Biomass Energy and Competition for Land	2008	John Reilly Segey Paltsev	GTAP. Joint program on the Science and Policy of Global	Approach for incorporating biomass energy production and	USA World	MIT Emission Prediction and Policy Analysis model	Multiple scenarios where greenhouse gas emissions are	The general conclusion is that a biofuel industry that was supplying a substancial share of liquid fuel

			Change, MIT, Cambridge, USA	competition for land into the MIT EPPA madol (CGE model of the world economy)		(EPPA)	abated or not by 2100	demand would have very significant effects on land use and conventional agricultural markets
Energy Scenarios for East Asia:2005-2025	2007	John Reilly Segey Paltsev	Global Science Policy Change, MIT	Different scenarios considering the increase of energy demand in East Asia	East Asia	MIT Emission Prediction and Policy Analysis model (EPPA)	Different scenarios to consider: (1) How fast might energy affect demand grow and how does it depends on key uncertainties? (2)Do rising prices for energiy affect growth? (3) Would growth have a substantial effect on world energy markets? (4) Would development of regional gas market have substantial effects on energy use and on gas markets in other regiosn	It is found that with more rapid economic growth, demand in East Asia could reach 430 EJ by 2025 almost twice the level in the baseline; rising energy prices place a drag on growth of countries in the region of 0.2 to 0.6% per year; world crude oil market (price effect being as much as $25 per barrel in 2025; development of regional gas market could expand gas use in east asia while leading to higher prices in Europe
Bioethanol as basis for regional development in brazil: an Input-output model with mixed technologies	?	Marcelo P. Cunha Jose A. Scaramucci	Interdisciplinary Center for Energy Planning, State University of Campinas	Considering Bioethanol as a development opportunity. What impact?	Brazil	Input-Output Model with mixed technologies (sugarcane collected Manually or via harvesting machines; plants appended to a sugar mill or autonomous distilleries) Linear-technology and Leontief prod func.CGE model	Impacts of a large scale expansion of bioethanol production in Brazil so as to replace 5% of the estimated global demand for gasoline in 2025.	Production is augmented in nearly 800%, GDP would increase by a factor of 11.4% and more than 5 million jobs would be created
The downside of Domestic Substitutiion of Oil and Biofuels: Will brazil catch the Dutch Disease?	2007	James A Giesecke J Mark Horridge	Centre of Policy Studies Monash University	Investigate the regional and industrial economic consequences of rapid growth in brazilian ethanol consumption and export	Brazil	Multi regional CGE with energy industry detail	Substantial expansion in ethanol production	Contractions in output by food processing sectorsw. Different effects on food processing supply: many are trade-exposed via significant export sales; Growth in HH demand for private transport services must come at the expense of private consumption of other commodities. The ammount of land must shift from other

		Jose A Scaramucci	Interdisciplinary Center for Energy Planning, State University of Campinas				agriculture to mechanical harvesting is small relative to the amount of land presently used in other agriculuture
Effects of climate change on global food production under SRES emissions ans socio-economics scenarios	2004	Parry	UK meteorological office	Analyses the global consequences to crop yields and risk of hunger of linked socio-economic and climate scenarios	HadCM3 global climate Model + Basic Linked system (BLS)	Intergovernmental Panel on Climate Change Special Report on Emission Scenarios (SRES)	Details for every scenario… Globally, the use of the SRES scenarios highlights several non-linearities in the world food supply system, both in the biophysical sense, where the levels of atmospheric CO2 tested reach new levels and the socio-economic sense where changes in population dynamics and economics and political structures complicate the climate change impacts into social indices (risk hunger)