Scoping study into the impacts of bioenergy development on food security

Prepared for PISCES

by Practical Action Consulting

November 2008

“The availability of adequate food supplies could be threatened by biofuel production to the extent that land, water and other productive resources are diverted away from food.”

Sustainable Bioenergy: A Framework for Decision Makers

UN –Energy, 2000

“The emerging opportunities for biofuel production in the region could potentially be an avenue for mitigating chronic food security in Africa”

FAO Committee on World Food Security (Assessment of World Food Security Situation 2006, Rome, 30 October to 4 November)

Prepared by Rebecca E. Clements

Contents

1. Introduction

Depleting oil reserves, rising petroleum prices and growing international concern for reducing carbon emissions in an age of climate change have catalysed international efforts to identify alternative and renewable sources of energy capable of meeting increasing global demand.

Biofuel produced from agricultural crops first emerged in the 1970s and has today assumed a prominent position on the global energy agenda, largely due to its potential to address the pressing issue of fossil fuel substitution and as a potential solution to global warming.

In recent months, rising food prices and food supply shortages have led to unprecedented riots across the developing world. Primarily driven by the Western world, the on-going push to source and produce biofuel for transportation has been strongly linked to growing concerns for food security and has given fresh impetus and renewed vigour to the so-called ‘food vs fuel’ debate.

This paper will explore current thinking on the impacts of bioenergy on food security and investigate how this debate is framed, including underlying assumptions and limitations. In addition to scoping the international debate this study will, where possible, draw on examples from Tanzania, Kenya, India and Sri Lanka to maximise relevance to the work being undertaken by the PISCES consortium. In doing so, this study will include recommendations on areas for further study and collaboration with on-going initiatives. Finally, this paper will provide the consortium with an initial overview of approaches for integrating food security into the wider PISCES research agenda.

2. Bioenergy or biofuels?

The PISCES project conceptualises bioenergy in three ways:

1. Bioresources from natural sources including trees, bushes, grasses etc
2. Bioresidues from existing agriculture, industry or forest practices
3. Biofuels from purpose grown energy crops including sugarcane, cassava, maize, palm oil and sorghum as well as wood and forestry cultivation such as coppicing.

Traditionally used for heating and cooking, bioresources account for up to 90% of total energy consumed in some developing countries and 15% of total energy consumed worldwide (Mitchell, 2008). Given that 95% of staple foods[1] need to be cooked to be digested (World Bank, 2006), improving availability of and access to bioresources- via increased cultivation of energy crops, refined agroforestry techniques, and improved efficiency of household technology, amongst other measures- has great potential for reducing poverty.

In recent years, the term 'biofuel' has come to mean bioethanol, produced by fermenting sugar including maize, sugarcane and sweet sorghum, and biodiesel produced from transesterification of oil from jatropha, soy, and sunflower amongst others. Bioethanol and biodiesel are in high demand to meet energy needs of developed countries, most prominently the US and nations in the EU who have committed to substantial increases on current biofuel consumption and production over the next ten to fifteen years, principally to meet transport fuel requirements (US Department of Energy, 2005/EU, 2006).

The current debate linking bioenergy development to food security is framed exclusively around the rapid expansion of liquid biofuels production. Bioresidues and biofuels as defined above are incorporated within this debate, as will be shown, but bioresources are omitted entirely.

With a few exceptions, voices from the developing world are struggling to be heard in an international debate dominated by northern-based academics, research institutes, private companies and NGOS. Such underrepresentation of the energy interests and related food concerns of three quarters of the world's people is alarming and can only emphasise the need for greater north-south and south-south engagement and information exchange. Policy makers must be encouraged to make informed decisions based on a broader understanding of bioenergy in order to prevent the

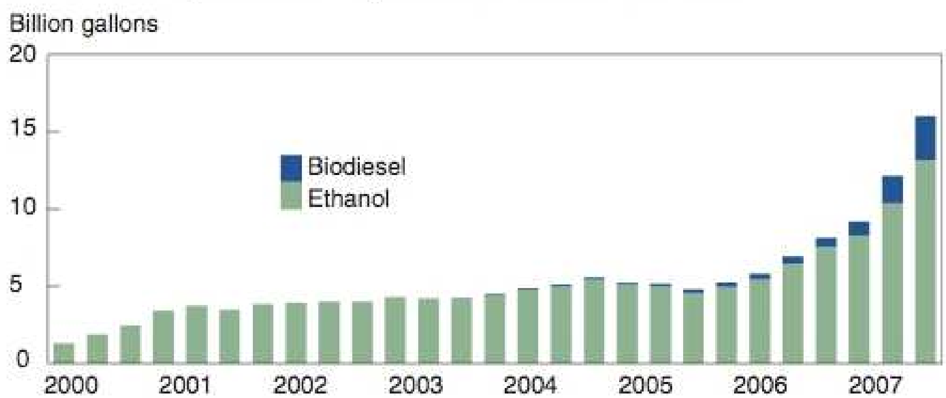
[1] The FAO defines a staple food as one that is eaten regularly and in such quantities as to constitute the dominant part of the diet and supply a major proportion of energy and nutrient needs", (Loftas et al, 1995)

biofuel for transport agenda from dominating policy choices to the detriment of energy access and livelihood considerations.

3. Food Vs Fuel: The Debate

The rising price of oil, along with concerns for climate change and a need for drastic cuts in carbon emissions, have led to a sense of urgency driven by the West for a shift away from dependency on petroleum and towards more environmentally friendly and renewable sources of energy. Biofuels have been identified as having the greatest potential to meet global demands for a substitute to fossil fuels, particularly for transport. In response to these demands, global biofuel production tripled between 2000 and 2007.

Global biofuel production tripled between 2000 and 2007



Source: International Energy Agency; FO Licht.

Biodiesel is produced from a variety of vegetable oils, including rapeseed, soy bean, sunflower, palm and jatropha. In 2007, the EU produced over 5.7 million metric tonnes of biodiesel, largely from rapeseed (FAO & OECD, 2006). Bioethanol is produced from starch-based feedstocks such as sugar cane and maize (corn). Global ethanol production is predominantly based on maize and is being driven by the US. Between 1996 and 2006 US ethanol production quadrupled to just over 20 billion litres using almost 60 million tonnes of maize (FAO & OECD, 2006). Given that biodiesel and bioethanol can and are being produced from crops traditionally grown for food, the impact bioenergy production is having, and could have, on the availability of food for human consumption, particularly in developing countries, is being called into question in the so-called Food Vs Fuel debate.

The principal argument driving the Food Vs Fuel debate is the assertion that biofuel production is impacting negatively on the availability of food.[2] This, it is argued, is occurring in several ways. Firstly, feedstocks that would otherwise be used for human consumption are being diverted for processing into biofuel for transportation i.e. there is less total food available for people to eat. Second, demand for biofuels

[2] Availability of food by FAO definitions relates to volume of supply derived from domestic agricultural output and net food imports at the national level

has increased competition for land and water resources which would otherwise be used for cultivating edible crops. Third, increased biofuel production will lead to higher food prices meaning less people are able to afford to buy food supplies.

This paper will address each of the components of the debate relating to the issues of availability of food, competition for land and water, and food prices and assess the degree to which these arguments are valid and whether alternative biofuel production options could potentially produce positive outcomes in terms of food security.

4. Food

Rice, maize and wheat provide 60 percent of the world's food energy intake alone, and are the staples of over 4,000 million people (Loftas et al, 1995). Of the most common staple foods consumed across the globe, wheat, maize (corn), millet, sorghum and cassava are currently being harvested to produce biofuels. Worldwide, 854 million people were undernourished between 2001 and 2003, one in three people in Sub-Saharan Africa does not currently have access to sufficient food and food emergencies persist in 34 countries which will require some kind of food aid assistance (FAO, 2006/FAO, May 2007). Given that global food production will have to rise by 50 percent by 2030 to meet the projected rise in demand for food[3], it is not surprising to find that grave concerns are being raised about the potential impacts of biofuel development on food security. In order to determine the validity of these concerns, it is necessary to understand the dimensions of food security and analyse potential impacts- positive and negative- of biofuel development on these dimensions.

4.1 Food Security

The concept of food security was originally coined in the mid-1970s and emerged out of discussions on international food problems which focused primarily on the issue of food supply. Since then, the concept has evolved to incorporate new thinking surrounding the causes of famine, hunger and food crisis. The challenges of context specificity will continue to draw attention to the complexities of a universal definition of food security and impel further revision of the concept. Notwithstanding, the latest FAO-ratified definition states that "food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002). A household is considered food secure when its occupants do not live in hunger or fear of starvation. This concept of food security revolves around the following four conditions:

i. Sufficient and available food supply

The concept of food availability relates to the volume of supply and is derived from domestic agricultural output and net food imports at the national level.[4] Sufficient food indicates a diet of adequate energy and nutritional balance and potable water (FAO, 2003).

[3] Ban Ki Moon, UN Secretary General speaking at the High-level Conference on Food Security in Rome, June 2008
http://www.un.org/News/Press/docs/2008/sgsm11612.doc.htm Accessed 29 August 2008

[4] At the 1974 World Food Summit, food security was defined only in terms of volume and stability of food supplies and read: "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices", (UN, 1975/ World Food Programme, 2007)

ii. Affordable and accessible food supply

Access refers to the balance between the demand and supply side of the food security equation (FAO, 2003). The affordability of food, or a household's ability to get food (from the marketplace or other sources), depends on purchasing power which will vary according to market integration, price policies and temporal market conditions (World Food Programme, 2007).

iii. Stability of supply

Stability of food supply is related to the environmental and economic conditions that permit sustainable food production and sustainable supplies at reasonable prices. Primary environmental influences on the performance of agricultural systems are soil and water resources, biodiversity and climate. Key economic influences include access to economic resources, terms of trade, employment security, savings, price volatility and economic growth/decline (inflation/recession) (Niggli et al, 2007).

iv. Quality and safety of food

The quality and safety of food is dependent on prevailing food production, handling and distribution systems. "Food safety" implies absence or acceptable and safe levels of contaminants, adulterants, naturally occurring toxins or any other substance that may make food injurious to health on an acute or chronic basis. Food quality can be considered as a complex characteristic of food that determines its value or acceptability to consumers. Besides safety, quality attributes include: nutritional value; organoleptic properties such as appearance, colour, texture, taste; and functional properties." (FAO, 1999). The FAO is working with governments to develop food quality and safety standards based on the international recommended Codex Alimentarius Commission Standards (FAO, 2003).

4.1.1 Measuring Food Security

The FAO bases its household measurements of food security on information gathered from food balance sheets, national income distribution data and consumer expenditure figures (FAO, 2003). Combined, these sources of information present a comprehensive picture of which foodstuffs are available, which foodstuffs people are able to buy and what people actually buy.

A food balance sheet shows the pattern of a country's food supply during a specified reference period for each food item available for human consumption. The food balance sheets comprise not just staple foods but each primary commodity and a number of processed commodities potentially available for human consumption, including coffee, spices, alcoholic beverages, meat and animal fats. Available supply is calculated by adding the total quantity of foodstuffs produced in a country to the total quantity imported and adjusted to any change in stocks. Calculations are then made regarding utilisation of total available food. Distinctions are made between the quantities exported, fed to livestock and used for seed, losses during storage and transportation, and food supplies available for human consumption. The per capita supply of each food item available for human consumption is then obtained by dividing the respective quantity by the related data on human consumption.[5]

In developing countries, most people live on a diet based on cereals (FAO, 2003). Table 1 shows average per capita quantity of cereals (wheat, rice, barely, maize etc.) available in each of the four PISCES project focus countries for the year 2003.

Country	**Quantity (kg)/Capita/Year**
Kenya	125.25
Tanzania	111.73
Sri Lanka	147.74
India	158.95

Table 1: Average annual consumption in kilograms of cereal per capita
Source: FAO Food Balance Sheets

By the FAO's own admission, food production, national income distribution and consumer expenditure data is not always available and can be unreliable (FAO, 2003). Despite this, if 'bioenergy development' is an added factor in the FAO utilisation equation (for instances where feedstocks are used for bioenergy production), the food balance sheets could provide a useful tool for informing decision-makers about the potential impacts of bioenergy development on the availability of different foodstuffs primarily, and on national food security more broadly. When the calculation indicates that production of bioenergy from feedstocks is having (or could have) a detrimental impact on national food security, decision makers should defer from pursuing that particular bioenergy production pathway without first weighing up the estimated negative impacts against potential positive impacts, including social, environmental and economic benefits.

While the FAO model of food security is generally adopted by practitioners in the international development community, it is not a concept which is universally embraced since it fails to address the relationships of control which dominate food production and consumption (Windfuhr and Jonsén, 2005).

4.2 Food Sovereignty

[5] FAOSTAT

The concept of food sovereignty emerged out of the international peasant movement and was originally coined by a member of Via Campesina- an independent organisation of peasants, small- and medium-sized producers, landless, rural women, indigenous people, rural youth and agricultural workers- in 1996 (Food First, 2005). Food sovereignty is based on the human rights to food and self-determination, on indigenous rights to territory, and on the rights of rural peoples to produce food for local and national markets. It is promoted as an alternative framework to food security which, it is said, is a concept which fails to address the complex systemic causes of malnutrition. Proponents also insist that 'food security' advocates the neo-liberal free trade agenda (Via Campesina, 1996). In contrast, food sovereignty is posited as a holistic approach which characterises the conditions, or frameworks, necessary for people to be able to define their own food, agriculture, livestock and fisheries system without intervention or interference from outside. To this end, food sovereignty promotes decentralised food production and encompasses practices of sustainable agricultural production together with notions of social justice and fair economic relations.

The food sovereignty movement had gained significant impetus since its nascence and is today supported by hundreds of civil society organisations, NGOs and social movements worldwide who position the development of 'agrofuels' in direct conflict with the movement's guiding principles (Via Campesina, January 2008). The agrofuels agenda, they say, is being drafted by powerful corporations (among them oil companies, car industries, the world's food traders, biotechnology companies, and global investment firms) with the sole objective of creating a new profit-generating commodity. Furthermore agrofuels will contribute to, rather than help mitigate climate change (Via Campesina, June 2008). Although the food sovereignty framework is yet to be finalised and formally ratified, the involvement of the movement's proponents in the international debate on biofuels is important in that it calls for critical analysis of policies and frameworks which govern the relationships of food production and consumption.

The response of the food sovereignty movement to increasing global biofuel production has been focused on issues surrounding control of production and the market and has neglected thus far to explore the potential benefits bioenergy development could bring with regards energy access and livelihood considerations. Whereas data generated by food security measurements could provide useful indications of the impact of bioenergy development on the availability, affordability, accessibility and safety of food, the principles of food sovereignty could form a practical basis for guiding the *processes* of bioenergy development which would produce maximum benefits for the poor. Thus in the context of bioenergy development, food security and food sovereignty are in fact complementary in that the two concepts provide a framework with which to analyse the merits of both processes and outcomes.

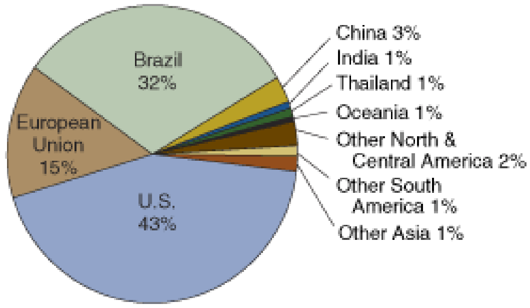
The PISCES research consortium recognises that without understanding the trade-offs and without appropriate policies in place, bioenergy development could have a devastating impact on poor communities in Africa and Asia. In response to these challenges, athe main objective of the PISCES research agenda is to identify bioenergy development processes, or pathways, which enhance energy access and livelihoods without producing negative outcomes in terms of food security.

To assess which pathways and outcomes are to be avoided and to make recommendations for further research, the following chapters will examine current thinking around, and evidence of, the impacts of bioenergy development on food security and assess whether any envisaged negative impacts are inevitable or whether they could be avoided.

5. Biofuels and the availability of food

The majority of existing biofuel production is occurring in the US, EU and Brazil.

About 90 percent of global biofuel production is concentrated in U.S., Brazil, and Europe, 2007



Source: FO Licht, includes only ethanol for fuel.

American and European diets depend less on domestically grown staple food supplies and therefore any significant impact on availability of food as a direct result of biofuel production is not yet anticipated. Food could well become more expensive to buy, but it would take drastic events for the food security of these countries to become threatened.

With an abundance of agricultural land and an appropriate climate for sugarcane, Brazil pioneered large-scale bioethanol production in the 1970s in an attempt to meet growing domestic energy needs in the face of oil price shocks. By the 2005/06 growing season, Brazil harvested about 400 million metric tons of sugar cane on 5.5 million hectares of land and the number of bioethanol-powered cars on its roads hit the 2 million mark. Whether Brazil's biofuel industry has impacted positively or negatively on domestic food security remains a hotly contested topic. Speaking at UN Food and Agriculture Organisation (FAO) conference in April 2008, Brazil's President Luiz Inacio Lula da Silva proclaimed that biofuel production provides an opportunity for countries to attain energy security without threatening access and availability of food. Indeed, the International Food Policy Research Institute reports that farmers in Brazil have established a system of rotation between sugarcane and food crops that maintains soil fertility and a year-round balance between food and energy levels (Moreira, 2006). The Social Fuel Seal (Selo Combustivel Social), tied to Brazil's National Biodiesel Program, rewards large biofuel producers who buy feedstocks from small family farms in poor regions by charging lower federal income tax rates. The scheme provides small-scale farmers with special credit lines and social rights that empower them during price negotiation process thus increasing the direct flow of benefits from bioenergy production to producers (Ministry of Mines and Energy, 2004). At the first-ever high-level seminar on biofuels in Africa held at African Union headquarters in Ethiopia in 2007, the Brazilian biofuel model was presented as a possible model for application in Africa. Civil society groups, and in particular groups associated with the food sovereignty movement such as Comissão Pastoral da Terra, disagree with the view that the Brazilian model should be held up as a positive example and vehemently oppose biofuel production on the grounds that expansion of the sugarcane industry has dispossessed people of their land, misappropriated natural resources and aggravated national hunger levels.[6] The staples of the traditional diet in Brazil are rice and beans, neither of which can be used to produce biofuels. Therefore if biofuel production *is* having a negative impact on domestic food availability, this raises issues of competition for land and water resources. These issues will be examined in greater detail in the following chapter.

As the demand for biofuels grows, so governments in developing countries are looking to increase their share in this potentially lucrative market. Among the countries that have enacted new pro-biofuel policies in recent years are Argentina, Colombia, Ecuador, India, Indonesia, Malawi, Malaysia, Mexico, Mozambique, the Philippines, Peru, Senegal, South Africa, Thailand and Zambia. While the development of energy crops in these and other developing countries has the potential to improve food security for millions of people through the multiple benefits of enhanced rural development, a narrow focus on biofuel production for exports could pose significant risks to the availability of food domestically. In Tanzania, where in 2003 30 percent of the population was malnourished (WFP, 2003)[7], the government has been accused of putting profits before people by repossessing fertile land from small scale producers and selling it to a large German biofuel production company for the creation of large scale jatropha plantations. The Philippine Government has recently passed the Biofuels Act and is currently looking at around some 1.2 million hectares for jatropha production by the Phillipine National Oil Co.- Alternative Fuels Corp and the Department of Environment and Natural Resources is in the process of identifying 400,000 hectares of land for potential private sector investments. Only land that is at present lying idle is being considered for Jatropha production and the Department for Agriculture is supporting this new initiative with a wide-scale training programme to provide training and technical know-how to farmers. Nevertheless, recent food shortages have sparked the Food Vs Fuel debate in the country and raised concerns about the future direction of the industry (Mahabir, 2007/Abano, 2008).

There are very few available studies into the impact of biofuel production on the availability of food domestically. Several initiatives are investigating these issues, including the three-year Bioenergy and Food Security Project (BEFS) launched by the Food and Agriculture Organisation (FAO) in 2007 and funded by the Government of Germany. The aim of the project is to help policy-makers assess the potential effects of biofuel production on food security and land-use in developing countries.

[6] Full Tanks at the Cost of Empty Stomachs: The expansion of the sugarcane industry in Latin America

[7] WFP Country brief
http://www.wfp.org/country_brief/indexcountry.asp?country=834#Facts%20&%20Figures

With Tanzania as one of the project's three case study countries, the other two being Peru and Thailand, there is great potential for exchange of information between BEFS and PISCES. During phase two of the BEFS, an analytical framework was developed to understand who gains and who loses from biofuel production at the household level. Five modules on analysis constitute the BEFS analytical framework, with each module using different types of data from within the country. Once the country specific bioenergy scenario has been defined, each module is addressed in turn to examine technical biomass potential, supply curves, economic potential, macro-economic analysis and food security analysis. The food security module mainly uses household level data based on the Living Standards Measurement Study established by the World Bank. Household data collection is underway with initial results to be presented in autumn this year. Members of the PISCES consortium have already established contacts with the FAO research team and plans are underway for information sharing on data and approaches. Potential for combining resources to undertake research and testing of methodologies is also being explored.

It is expected that major agricultural producers, including Brazil, US, EU and Canada will reduce exports of basic feedstock commodities in order to meet domestic biofuel demands. For countries that import staple foods from these major producers, availability could be reduced as supplies are tightened and prices rise. However, reductions in exports are not just attributable to an increase in biofuel production. They have also been linked with weather-related shortfalls such as droughts in Australia, and poor harvests in the EU and US.

In the US, maize use for fuel production is expected to increase from one-fifth of total maize production in 2006 to almost one-third by the end of 2016 (FAO/OECD, 2006) and agricultural exports are already decreasing. Given that the US currently supplies over half of all food aid, cuts in maize exports are expected to impact hardest on those countries that receive food aid through the World Food Programme. In 2006 this totalled 40 countries in Sub-Saharan Africa, 16 in Asia, 12 in Latin America and the Caribbean, 9 in the Middle East and North Africa and 6 in Eastern Europe and the CIS. In relation to the PISCES project focus countries, Kenya could suffer the biggest impact.

Food Aid Flows (in tons)		
Recipient Country	**US**	**All Donors**
Kenya	221,601	382,839
India	74,663	153,195
Tanzania	31,158	94,954
Sri Lanka	32,387	65,420

Source: FAO 2006 Food Aid Flows, Food aid deliveries by recipient and donor

The World Food Programme has recorded that total US food aid donations have been in steady decline since 1999 with a drop in cereals for the first time in 2005 (WFP/Interfais, 2006). While many development agencies would not advocate food aid as a sustainable solution to food insecurity, it must be recognised that a sudden drop in supplies would hit the poorest first and hardest.

On the other side of the coin, food aid has long been equated with 'dumping' of excess food stocks by the West on poor countries. In Ghana, policies of food self-sufficiency meant that rice output in the 1970s could meet all local needs. These policies were revised in the 80s and 90s due to World Bank and IMF loan conditionalities and in 2002 rice imports (made up of excess food crops mostly from the US) represented 64% of domestic supply.[8] Ghanaians are now more sensitive to international rice prices which impact on prices in local markets. The country has also suffered increasing cases of shortages due to over-reliance on international supply.

Unlike Sri Lanka, Tanzania and India, Kenya is importing an increasing amount of its staple food supplies and risks, like Ghana, leaving its population highly exposed to fluctuations in world food supplies and price variability. The table below demonstrates the increased staple food imports in Kenya over a period of about 15 years.

Commodity	1989-1991	2003
Wheat		
Import	234.7	492.4
Export	0.8	7.0
Net trade (export - imports	-233.8	-485.4
Maize		
Import	0	108.4
Export	97.1	35.2
Net trade (export - imports	97.1	-73.2
Sugar		
Import	72.9	171.3
Export	0.2	46.5
Net trade (export - imports	-72.7	-124.8

Source: FAO Food and Agriculture Indicators 2006

For Kenya, dramatic increases in the price of wheat, maize and sugar could have serious impacts. Since the signing of NAFTA in 1994, the US has sold between six and eight million tons of maize to Mexico per year. This has placed a large proportion of the nation's staple food supply firmly in the hands of American corporations and has had a devastating impact on the livelihoods of Mexico's once

[8] http://www.twnside.org.sg/title2/susagri/susagri046.htm

thriving farming community.[9] In response, Mexican maize farmers and consumers have been protesting voraciously against the flooding of their markets by cheap American GM maize. With the US retaining an increasing amount of its own maize production for bioethanol production, an opportunity could be open to the Mexican government to support it's farmers to reclaim their domestic agricultural markets and reduce dependency on the US. A potentially positive outcome of a reduction in agricultural exports from developed countries could therefore be an increase in south-south agricultural trade. A further prospective consequence of major agricultural producers diverting a larger percentage of home-grown crops to biofuel production is that these countries will increase food imports (FAO/OECD, 2007). The EU is already paying farmers an extra 45 Euros a hectare to grow crops for biofuels. Such incentives from governments in developed countries could mean an end to subsidies for over- production of food crops and could open up markets for other food producing countries to increase their competitiveness and share in global foodstock trade. Notwithstanding, wherever the price of a commodity rises the poorest consumers are at risk from losing out. While increased south-south trade and better food prices could lead to improved incomes for farmers, consumers will inevitably end up paying out a higher percentage of household income too feed their families.

[9] "The Mexican corn sector is in acute crisis because of the influx of cheap subsidised corn imports from the US. Poor Mexican farmers cannot compete against US producers, who receive $10bn per year in subsidies. […] To put this figure in context, it is some ten times higher than the total Mexican agricultural budget." (Oxfam, 2003)

6. Biofuels, land and water

Critics of biofuel production warn that rapid expansion of the industry will provoke direct competition for land, water and end-use and thus reduce availability of food (both at a national and international level). This argument is based on the assumption that there will be no increase in the total amount of land cultivated and that either i) crops currently grown for human consumption will be used instead for producing biofuel (end-use competition) or ii) land currently used to grow crops for human consumption will be turned over for growing energy crops (land-use competition). Inherent to both these is the assumption that biofuel production will increase competition for water resources.

However, there are several alternative pathways to biofuel development which could avoid these conflicts. These are differentiated in scenarios as follows:

i) No increase in total land cultivated- greater production efficiency achieved

Biofuel generates new demand for agricultural outputs thereby increasing revenue to producers (Dufey et al, 2007). Additional income could lead to improvements in efficiency and productivity of the agricultural sector and through investments in technology (including irrigation techniques) and crop diversification (Peskett et al, 2007). Amount of land dedicated to food production remains the same and outputs are increased. Extra food produced, or revenue from its sale, could increase food security of poor communities.

ii) No increase in total land cultivated- non-food crop producers start growing energy crops

Farmers growing alternative cash crops, such as tea, cotton and tobacco, could switch to producing energy crops where this generates higher income. This would have no impact on amount of food produced domestically and through increased revenues could increase food security of poor communities. Depending on the crops, water resources could be conserved by a switch to energy crops. Tea and coffee, for example, must be grown in high rain-fed areas, whereas some types on energy crop thrive in drier conditions.

iii) Increase in the total amount of land cultivated- energy crops grown on land currently unused

Some crops suitable for biofuel production can be grown successfully on unused/marginal land or land unsuitable for food crops because they require far less water to grow. Jatropha Curcas is a drought-tolerant non-edible shrub which produces fruit that can be turned into biodiesel and need not directly compete with food crops. It is suitable for intercropping and can survive on the edge of farmland in less fertile soils. In Guatemala the IDB is supporting production of vegetable oil from

Jatropha for fuel (Drosdoff, 2007). Jatropha, or piñon as it is locally known, is widely available. It is commonly used for fencing as it contains a chemical that repels cattle. The Green Africa Foundation and Vanilla Jatropha Foundation in Kenya are both promoting Jatropha production to improve incomes of local communities. The Centre for Jatropha in India is developing high-yield Jatropha along with other non-food biodiesel crops. In Tanzania the development of Jatropha is ongoing with production for export occurring in at least one case.

It is important to recognise that land which may be perceived as unusued or underutilised may in fact be extremely valuable to local communities as it can provide an important source of biomass for medicinal plants. Equally, pastoralists may depend on such land for passage and feeding of livestock. Therefore a comprehensive and participatory assessment of land-use is required to inform decisions on suitable locations for biofuel cultivation. Participatory land-use planning and design processes bring together local communities and key stakeholders (government, civil society, private investors etc.) to evaluate and agree plans for future land-use. Integral to this process is an assessment of current land-use and potential conflicts of interest, along with consensus building and conflict resolution where required (IRRI, 2007). Numerous organisations are operating throughout the world to promote poor people's land rights, including the Kenya Land Alliance, the National Land Forum in Tanzania, the Green Movement of Sri Lanka and the Environics Trust in India.

iv) Non-food crops used for biofuel development- no competition for end-use and potentially less competition for water resources

There is also the potential for expansion of biofuel production without creating competition for end-use of the crop. In the Phillipines, China and India the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is working on a sweet sorghum program for the production of biofuels. Sweet sorghum, a plant that is grown and consumed locally in dry areas, will not create a trade-off relationship between fuel and food production like corn-based ethanol production. Rural farmers can turn the grain from the plant into food products to feed themselves and their livestock, while selling the fuel-producing sugary liquid contained in the stalks to biofuel distilleries.


Jatropha


Sorghum


Kenaf

Thriving for over 400 years in Africa, Kenaf has tremendous potential in countries such as Ethiopia where it can be used for both food and fuel and contains great amounts of antioxidants. Humans and animals eat the leaves and the leftover stalks can be burned as fuel. Using a crop such as Kenaf can give subsistence farmers a way to utilize their leftovers while also making money. Using crop residues for biofuel is also a contentious issue, since bioresidue plays a crucial role in agronomic cycles, is essential for soil conservation and is often and important source of energy for rural households.

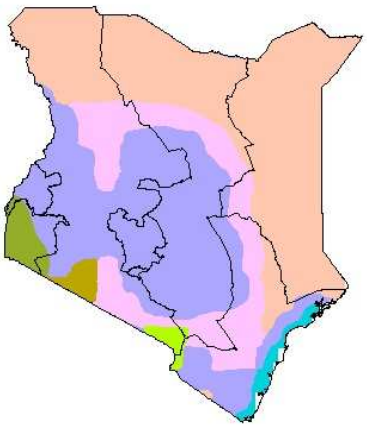
Cellulosic ethanol comes from the structural matter of the plant instead of the starch, meaning that ethanol can be produced without destroying the food source. This is very important because it means that both food and energy can be derived from a crop, instead of just one or the other. Cellulosic ethanol has a higher net energy yield than that of ethanol made from starch. Also, many of the crops used in producing cellulosic ethanol are perennials and do not have to be planted every year and they usually use fewer fertilizers and pesticides than corn (Uldrich, 2007). However, in order to extract the useful sugars within cellulosic ethanol, more advanced 'second generation' technologies are required. These technologies are still in development and may take another 10 years to reach roll-out stage. Genetic research could target traditional sources of biofuel for greater and higher quality of production. However, critics argue that the increasing emphasis on cellulosic ethanol is the accelerating promotion of fast-growing genetically engineered (or genetically modified) plants which pose a real risk to biodiversity through contamination of native plants (Smolker et al, 2008).

These bioenergy development pathways provide a range of options which can be assessed for likely impacts on a country's particular food security profile. In order to do so, linkages between food security, land-use and water resources must be fully understood. By implication, this requires an analysis of a range of environmental, social and economic factors. If this analysis leads to the conclusion that a particular pathway will have a detrimental impact on food security (either directly or indirectly at a national, regional or household level) then either that bioenergy development option must be discarded entirely or else policies must be put in place which protect and ideally seek to increase national food security. In no instance should food security be compromised in the pursuit of bioenergy development.

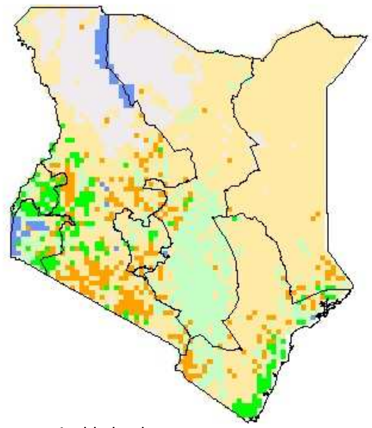
The following constitutes a basic assessment of the bioenergy development pathways set out above in the context of Kenya, Sri Lanka, India and Tanzania. The maps show the major farming systems and permanent crops (left), and arable land (right) in each of the countries.[10]

[10] FAO Online Country Profile and Mapping System, 2008

Kenya



Major farming systems and permanent crops



Arable land

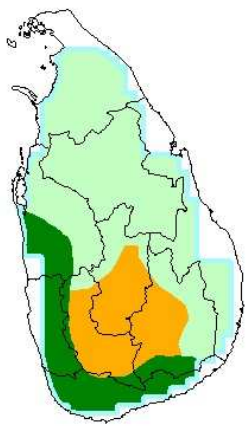
Kenya is classed by the Food and Agriculture as a Low Income Food Deficit Country (LIFDC).[11] Between 2001 and 2003, a third of Kenya's population was undernourished (FAO, March 2006). As discussed in the previous chapter, Kenya is importing increasing quantities of staple food supplies. If bionenergy development were to be pursued in Kenya, it should not be to the detriment of existing staple crop production. Other crops, such as tea, coffee and flowers could feasibly be replaced with energy crops but unless energy crops generate higher revenues it is unlikely that the large corporations running the tea, coffee and flower industries will abandon these already highly profitable enterprises.

In Kenya, ninety percent of the rural population derives its livelihood from land. Of the total area of 582, 646km² only 17% is suitable for rain-fed agriculture (tea, coffee, horticulture and floriculture and food crops such as maize, wheat, potatoes and pulses). Arid and semi-arid land represents 82% of total land, with the remaining 2.2% covered by forest reserves (Kenya Land Alliance, 2004). Of the semi-arid and arid land, just over half is used for extensive livestock production under nomadic systems. The country harbours significant potential for irrigation which as yet has remained significantly underdeveloped (IFAD, 2007). A key objective for Kenya's

[11] A country is classed as LIFDC based on three factors. First, if the average per capita GNP is $1, 575 or less. The second factor is based on the net (i.e. gross imports less gross exports) food trade position averaged over the preceding three years. The third factor pertains to "persistence of position", that is a country can only leave the list if it does not meet the first two LIFDC criterion for three years running.

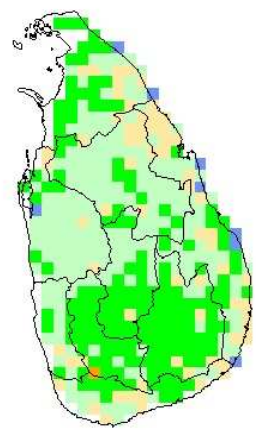
development must be to harness the potential of these semi-arid areas to improve the food security of it population. An innovative way of doing so could be to cultivate energy crops for biofuel. Jatropha would be particularly suitable for cultivation in the vast areas of Kenya with minimal rainfall as it can grow with little water and would not require huge investments in irrigation (not a viable option for most Kenyans). A participatory assessment of land-use by nomadic tribes would be integral to selecting this pathway.

Sri Lanka



Major farming systems and permanent crops

Legend:
- Rice
- Coastal artisanal fishing
- Highland mixed
- Rainfed mixed



Arable land

Legend (% intensity)
- Sparsely Vegetated
- Undetermined (0 - 30)
- 30 - 40
- 40 – 60
- > 60
- Water
- No Data

Sri Lanka is also classed as an LIFDC by the FAO. Between 2001 and 2003, 22% of the country's population (4.1 million people) was undernourished (FAO, March 2006). About 80 per cent of Sri Lanka's population lives in its rural areas[12] and farming rice is the most important economic activity for the majority of the rural population.[13] Of total land, the FAO classed 63% as non-arable in 2000 (FAO, 2005).[14] The Government's Ten Year Horizon Development Framework 2006-2016 (Government of Sri Lanka, 2006) discussion paper states that "the agriculture and

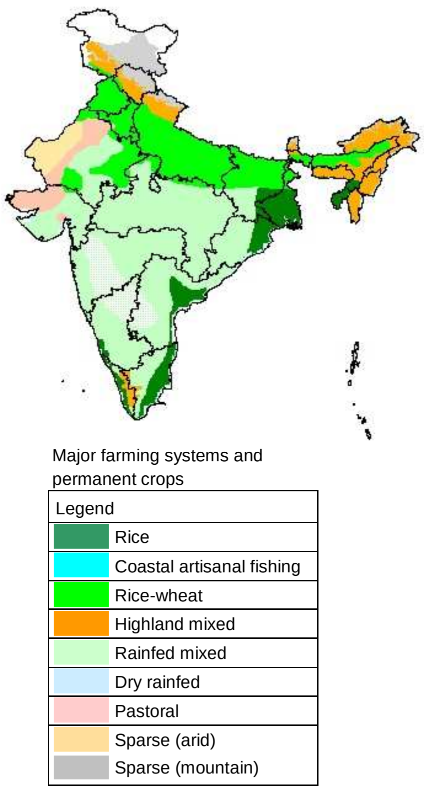
[12] Http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/SOUTHASIAEXT/EXTSAREGTOPAGRI/0,,contentMDK:20273817~menuPK:548217~pagePK:34004173~piPK:34003707~theSitePK:452766,00.html

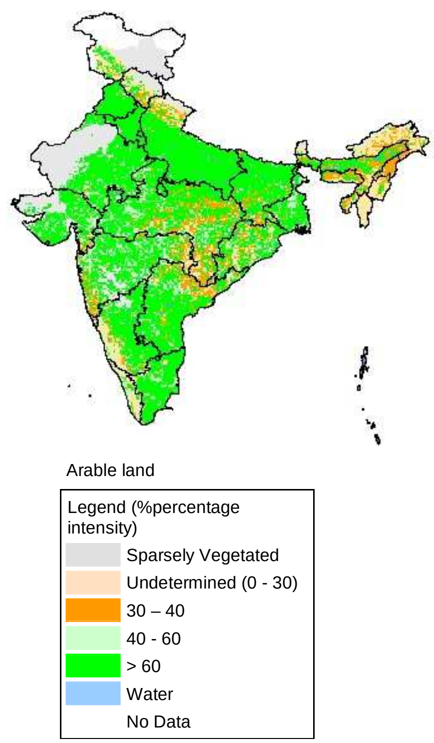
[13] http://www.nationsencyclopedia.com/economies/Asia-and-the-Pacific/Sri-Lanka-AGRICULTURE.html

[14] FAO Statistical Yearbook, Sri Lanka Country Profile, FAO 2005

food security policy will focus on rational allocation of land, improvement of productivity and non-conversion of non-marginal land to other uses." This would indicate that the Government is already initiating policies to protect the country's food production levels. As in Kenya, growing Jatropha for bioenergy could provide an important source of income to finance improved agricultural efficiency in areas where marginal land would otherwise remain un-used. Sorghum production could provide benefits to both food and energy security without increasing land-use demand.

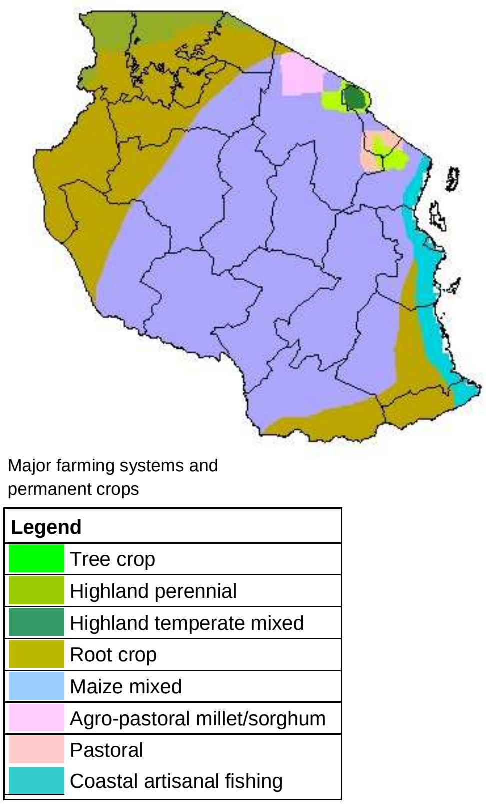
<u>India</u>



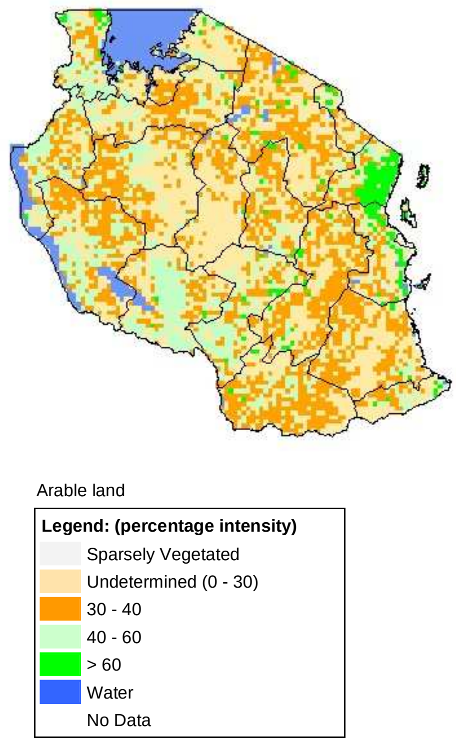


Agriculture is a key sector in India, providing both employment and livelihood opportunities to more than 70 percent of the country's population who live in rural areas. In 2004, India produced 128 million tonnes of rice and 72 million tonnes of wheat (FAO, November 2006). The Government accredits much of this success to small-scale farmers, the 'backbone of Indian agriculture and economy' (IARI, 2007). Yet India is classed as LIFDC and 212 million of its population went undernourished between 2001 and 2003 (FAO, March 2006). It is clear that while production levels are high, and import of staple foods is minimal, the poorest people in India are still not able to access sufficient food. While the dimensions of food insecurity in India require more detailed investigation than the parameters of this paper permit, it can be stated that bioenergy development should not be pursued where it could restrict access to food yet further by inducing price increases and negatively affecting the purchasing power of the poor. In addition, water availability is projected to decline. With agriculture accounting for about 80% of water withdrawals, drop of yields in irrigated crops is expected over the coming years. (IPCC, 2007). With a high proportion of India's total land already under cultivation, potential for agricultural expansion is limited. Increases in production will essentially be achieved through improvements in efficiency. Bioenergy development could help generate the income required to finance these improvements.

<u>Tanzania</u>



Major farming systems and permanent crops



Arable land

The FAO also classes Tanzania as LIFDC. With almost half of the population undernourished in 2004, food security is a very serious concern for Tanzania (FAO, March 2006). Agriculture in Tanzania provides employment opportunities to about 80% of the population. A major constraint facing the agriculture sector is the falling labour and land productivity due to application of poor technology, dependence on unreliable and irregular weather conditions. Both crops and livestock are adversely affected by periodic droughts.[15] With 96% of arable land not currently irrigated, water resources will be the key to stabilising agricultural production and making important advances to national food security levels. Major staples currently

[15] http://www.tanzania.go.tz/agriculture.html

cultivated in Tanzania include maize, sorghum, millet, rice and wheat. The benefits of sorghum production could be maximised by using the crop for both energy and food supplies. Income to farmers could be increased without adverse impacts to food security. Jatropha could be grown in arid areas and the revenues generated from its sale invested in irrigation for food crops.

While the above analyses demonstrate the types of initial questions that need to be answered about a country's profile before selection (or not) of bioenergy development pathways can start to be made, they do not attempt address issues of ownership and responsibility. Making decisions about the appropriate scale and model of bioenergy development (e.g. centralised vs decentralised, large scale vs community-led) and stakeholder roles and responsibilities (e.g. policy and institutional set-ups, finance, capacity building) relies on analysis of a different but interlinked set of pathways which must be given equal consideration but which are beyond the scope of this paper.

The Common Fund for Commodities has developed a framework to guide governments in commodity dependent countries in making strategic choices about bioenergy development. The framework is conceptualised as a decision tree which maps out a chain of inter-linkages between policy goal choices, analyses of challenges, opportunities, risks and trade-offs of biofuel development and options for market and policy decisions. Policy goals may include export development, growth and diversification of the economy but development pathways should be focussed towards maximising benefits for rural development (CFC, 2007). By examining the food security profile, land-use and water resource, we can see how these pathways could be initially assessed in practice.

New knowledge generated by the PISCES research consortium on access and delivery models, value chains, trade-offs and impacts, amongst others, will provide important guidance to decision makers on appropriate options for bioenergy development in a range of contexts which not only sustain but improve people's access to food.

In addition to supply, the affordability of food is also a key determinant to access (Sharma, 1992). The following chapter explores the relationship between food and energy prices.

7. Biofuels and the price of food

Unprecedented rises in oil prices coupled with ongoing world food shortages have catalysed assertions from critics that increased biofuel production is inducing higher food prices and leaving millions facing starvation. It is generally acknowledged that food prices have been propelled by a number of temporary and longer-term factors including increased oil prices, weather-related shortfalls and poor harvests, global population growth and economic growth in emerging economies. Yet in recent times no other factor seems to be cited as frequently or as vociferously as the impact of increased production of biofuels. This is a challenging perception since the causal link between increased biofuel production and rising food prices remains unclear given the extremely low relative production volumes of biofuel versus food at the present time. Due to the range of contributing factors to food price increases, it remains extremely difficult to disaggregate the impact of biofuel production from these other factors. What can be said for certain is that biofuel production is a 'new' factor impact on world food prices.

7.1 Fuel Prices

A rise in global demand for oil together with low levels of available surplus production and instability in producer regions has led to dramatic increases in prices over recent years. Whereas the price of a barrel of oil was generally under $25 dollars in 2005, this has spiralled over the past five years reaching $135 a barrel in May 2008.[16] With world oil prices set to remain high (IEA, 2006), the US and EU are pushing ahead with biofuel production targets. In 2005, the US government initiated the Energy Policy Act which established a mandate — called the Renewable Fuel Standard—to require 4-billion gallons for national biofuel consumption in 2006, with an increase to 7.5 billion gallons by 2012. Similarly, the EU has established a biofuel mandate for member states, from a voluntary target of 2 percent of fuel consumption in 2005, up to 6 percent 2010 and 20% by 2020. Although at present the bulk of biofuel production is consumed domestically, increasing international demand is expected to expand the international trade market rapidly over the coming years with an increasing number of developing countries set to capitalise.

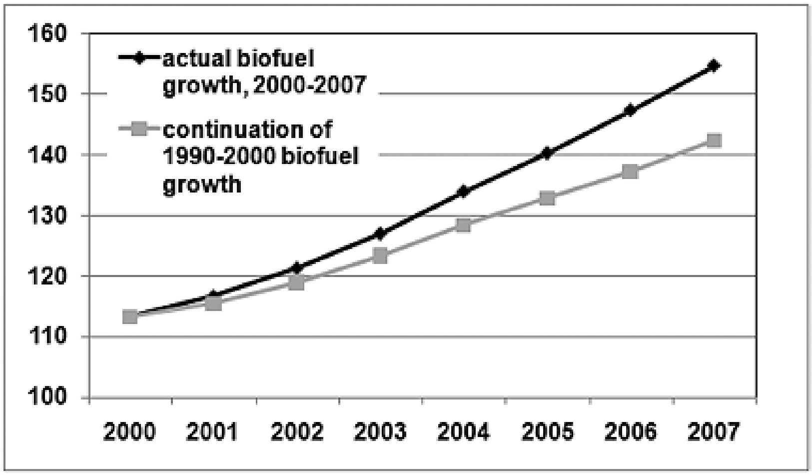
7.2 Food and Energy

In his article, *Starving People to Feed the Cars*, Lester Brown, President of the Earth Policy Institute, argues that runaway oil prices would drive up the fuel value of food crops and food crop production for human consumption would be diverted away from the mouths of the poor and into the petrol tanks of the rich (Brown, 2006). Brown also warns that a return of the "wheat oil exchange rate", a long-running relationship between oil and wheat prices, will further exacerbate food prices. As the world's

[16] Oil soars to new record over $135, BBC News, 22 May 2008, Accessed 22 May 2008

economy continues to grow and the demand for energy responds in kind, the price of food could continue to rise for the foreseeable future. The OECD and FAO warn in the Agricultural Outlook 2007-2016 that a shift to reliance on biofuels for energy will induce a systemic change in commodity markets which in turn will maintain higher food prices over the next 10 years and that the susceptibility of food prices to increased uncertainty and price variability of energy may lead to higher dependence on energy markets and the policies that affect them (FAO/OECD, 2007). Furthermore, energy costs of production could also be set to rise. However, there are opposing views on the potential impacts of this relationship between food and fuel prices, that tighter coupling of food and energy prices could lead to more stable prices long term and even prevent a collapse in national food security (Schmidhuber, 2007, OCD).

From February 2007 to February 2008 food prices (led by wheat, soybeans, corn and edible oils) increased by 39 percent (IEA, 2008). The price of maize alone has increased by about 60% over the last two years (World Bank, 2007). While an increase in demand for cereals, sugar, oilseeds and vegetable oil to supplement maize, wheat and rapeseed as traditional sources of biofuel will increase income for producers of these crops, a general rise in crop prices will result in higher feed costs for animals as well as human beings and an impact will also be felt in the livestock sector. (FAO/OECD, 2007). According to the International Monetary Fund the price of food has increased dramatically over the past two years; this is attributable to several factors, an important one being the use of grain for ethanol production in the USA (IMF, 2007). The IFPRI estimates that biofuel demand accounted for 39% increase in the real prices of grain between 2000 and 2007.



Simulated Real Grain Prices, 2000-2007 (US$/metric ton)
Source: IFPRI IMPACT

Understanding the impacts of expanding biofuel production on commodity markets and trade flows is extremely complex and at present provokes more questions than answers. Notwithstanding, it is essential that we recognise the dimensions of the interactions between these two markets and distinguish the drivers behind market changes. At a time when the world is producing enough food to feed its people, speculation regarding future fuel and food markets and supplies has also played a part in pushing up prices (Jordans, 2008).

7.3 Energy prices and access to food

Proponents of current and future links between food and energy prices maintain that biofuel production will reduce access to food as crops become unaffordable at a local level. According to others, domestic food prices have not historically been tightly linked to international food prices. This is due to complex price transmission mechanisms bound within historical and political relationships between food price policy and reforms (Hazell et al, 2005). The research team of the FAO BEFS will be investigating the impact of global food prices at a local level in the three case study countries, with results expected over the coming year.

Families in developing countries typically spend around 50% of household income on food and the majority are net buyers of food (Mitchell, 2008). A rise in the cost of staple foods is expected to impact on buying power and could lead to a reduced variety in diet if families are forced to spend a larger proportion on staples. For net producers of food (particularly sugar producers from Brazil and India, as well as some countries in Africa) increased prices for agricultural crops could lead to overall gains and could induce a shift in favour of those producers located in largely rural areas. Consumers in rural and urban areas, and net importer countries will be worse affected. Calorific intake of families (particularly those that do not grow their own food or are net buyers of food) could be cut in half as dependence on lower quality food increases. In the face of higher food prices, families are expected to opt for a smaller amount of calories and fewer meals. An evaluation by the International Food Policy Research Institute of the impact of increased biofuel production on food security concluded that meeting current EU and US targets would lead to an overall reduction in daily calorie consumption (IFPRC, 2006). However, the analysis did not take into account the potential multiplier effects of biofuel development which could include lower energy costs, increased rural employment opportunities and income. Increased income could provide the economic incentives for farmers to invest in more efficient agricultural production methods. Irrigation could vastly improve yields for both food and biofuels crops, thus increasing farm incomes and food security. This has been the case in sugarcane producing regions in Brazil where biofuel production is said to have stimulated rather than competed with food crops. By generating additional income, agriculture has become 'capitalised' and resulted in improved conditions for all agricultural crops thus improving access to and availability of food (Zarrilli, 2006). The International Institute for Applied Systems Analysis has conducted a quantative analysis into the impact of biofuel production on food security in Sub-Saharan Africa where one in three people are undernourished

(FAO, 2006). The analysis calculated that where first generation biofuel technology was used to meet ten percent of the 2020 projected transport fuel consumption, the prevalence of undernourishment in Sub-Saharan Africa would increase by 4%. Where second generation technologies are used the effect on nutrition levels would be neutral. However, when the *agricultural revenue effect*[17] is added to the equation, second generation biofuels development has the potential to reduce undernourishment to 15% of the total population. Such models have obvious limitations since it is difficult (if not impossible) for static data to adequately represent the diverse and changing contexts in which biofuel might be developed.

A study of biofuels, poverty and food security run by Stanford University in the US in collaboration with the IFPRI and funded by the Gates Foundation is attempting to understand and quantify the effects of expanding biofuel production. By collecting detailed data from China, Indonesia, the United States, India, Brazil, Senegal and Mozambique the research team will create an analytical framework which will be applied to account for "interactions among energy, food and other commodities; interactions among food commodities; interactions between consumers and producers; interactions between exporting nations and importing nations; interactions among actors within economies and interactions between the economy and land use." (Stanford University, 2007) The program team are currently in the initial stages of data collection and developing a modelling methodology and it will be instructive to follow progress of the work and get access to the results. Currently, the program is actively recruiting scholars initially from the seven target countries and then from other parts of the world to join a network to ensure sustainability and ability to scale up. It is recommended that the PISCES consortium link into this network in order to share data and research approaches with participants from around the world.

[17] Increased purchasing power of farmer households as a result of biofuel producing generated income

8. Conclusions and Recommendations

Reflecting back on the three definitions of bioenergy discussed at the beginning of this paper, it can be said that biofuel is the only one of the three whose development is argued to have potentially negative impacts on food security. Bioresources and bioresidues are, as yet, outside the current debate. This is due to three main arguments discussed in this paper and summarised here:

1. Biofuels are currently being produced from staple food crops and the amount of total food available for people to eat is being reduced
2. Biofuels increase demand for land and water resources which would otherwise be used for cultivating edible crops. Amount of total food available for people to eat is being reduced
3. Increased biofuel production is inducing higher food prices meaning less people are able to afford to buy food supplies

In exploring the underlying assumptions of these arguments, this paper has demonstrated that insufficient evidence is as yet available to substantiate or disprove any one of the three conclusively. Furthermore, this paper has shown that bioenergy development generally, and a range of development pathways more specifically, could in fact reinvigorate the agricultural sector in some countries and provide a range of livelihood benefits to poor communities, including increased food security.

While the focus of this paper has been on the impacts of bioenergy development on food security, the concept of food sovereignty has been shown to provide a useful framework for assessing the processes of bioenergy development and the impacts of these processes on poor communities. It is recommended that the PISCES consortium refer to the central tenets of the food sovereignty movement when investigating the potential for a range of bioenergy development access and delivery models and institutional arrangements to bring broader livelihood benefits to the poor.

A basic assessment of potential bioenergy development pathways in relation to country food security, land-use, trade and water resource profiles was set out in Chapter 2. Although biofuel production is occurring in India, Tanzania, Kenya and Sri Lanka, limited information is available on the impacts these developments are having on food security. It is recommended that the PISCES consortium undertake further study into individual bioenergy projects. This will be valuable for identifying which pathways are being taken up, for understanding what initial impacts on food security are being recorded and how this experience can guide future developments. Despite the need for further research and analysis, the following broad recommendations can be set out for biofuel development:

- Do not use staple food crops (edible part)
- Do not clear significant vegetation (negative impacts on water resources, land fertility and biodiversity)
- Do not displace existing food production which is destined for domestic consumption
- Do not draw water resources away from existing uses (additional water resource requirements should be comfortably accommodated within existing and future water resource availability

While at the time of writing this report many uncertainties around the actual impacts of biofuel production on food security remain, increasing case study evidence is being documented from around the globe and a number of institutions are now devoting resources to explore these linkages. This will allow for the testing of theories and assertions which until now have been largely speculative. The development of new research tools will also be required if detailed analysis of impacts on food security at local and national levels are to be understood. It is recommended that PISCES continue to build linkages with existing and new research initiatives and networks in order to share information on data and research approaches. Potential areas for collaboration could include testing analytical frameworks and participating in consultations and events. At present, the FAO BEFS Project shows particular potential for synergies with the PISCES research agenda which should be further explored. While it might never be possible to predict conclusively what the impact of biofuel development will be on the availability of and access to food, research can guide governments in decision making processes.

Based on the findings of this paper, the following additional research questions are recommended:

- What are the impacts of bioenergy development for local consumption on food security?
- What is the impact of international food price rises at a national, regional and household level?

Finally, the PISCES consortium should endeavour to broaden the current debate on biofuel and food security to incorporate a fuller understanding of bioenergy in order to influence policy makers to select development pathways which promote the interests of and maximise benefits to the poor.

Bibliography

Abano Imelda, Food versus Fuel in the Philippines, Panos London, March 2008

African Biodiversity Network, Agrofuels in Africa- Impacts on Land, Food and Forests, ABN, 2007

Brazilian Ministry of Mines and Energy, Brazilian Biofuel Policy Documents, Legislation relating to the social fuel seal, Decree No 5.297, December 2004

Brown, L. Starving the People to Feed the Cars, Washington Post, September 2006

Commission of the European Communities, An EU Startegy for Biofuels, EU, 2006

De La Hamaide, Sybille, 'Biofuel impact on farm prices overplayed', Reuters, January 2008

Drosdoff, D. IDB in Guatemala, IDB, April 2007

Dufey, A., Vermeulen, S., andVorley, B., Biofuels: Strategic Choices for Commodity Dependent Developing Countries, Common Fund for Commodities, 2007

Food and Agriculture Organisation, The Importance of Food Quaility and Safety for Developing Countries, FAO Committee on World Food Security, 1999

Food and Agriculture Organisation, The State of Food Insecurity in the World 2001, FAO, 2002

Food and Agriculture Organisation, Trade Reforms and Food Security: Conceptualizing the Linkages, Commodities and Trade Division, FAO, 2003

Food and Agriculture Organisation, The State of Food Insecurity in the World 2006: Eradicating world hunger- taking stock ten years after the world food summit, FAO, 2006

Food and Agriculture Organisation, Food Security Statistics- India, March 2006

Food and Agriculture Organisation, Food Security Statistics- Kenya, March 2006

Food and Agriculture Organisation, Food Security Statistics- Sri Lanka, March 2006

Food and Agriculture Organisation, Food Security Statistics- Tanzania, March 2006

Food and Agriculture Organisation, Food and Agriculture Indicators: India, November 2006

Food and Agriculture Organisation, Food and Agriculture Indicators: Sri Lanka, November 2006

Food and Agriculture Organisation, Food and Agriculture Indicators: Kenya, November 2006

Food and Agriculture Organisation, Food and Agriculture Indicators: Tanzania, November 2006

Food and Agriculture Organisation, Assessment of the World Food Security Situation, Committee on World Food Security, Rome, May 2007

Food and Agriculture Organisation, 'Food Security and Bioenergy Concept Note', FAO, 2007

Food and Agriculture Organisation & Organisation for Economic Co-operation and Development, Agricultural Outlook 2007-2012, 2006

Food First, Global Small-Scale Farmers' Movement Developing New Trade Regimes", *News & Views*, Volume 28, Number 97 Spring/Summer 2005, p.2.

Gidley, R. As Biofuels Boom, Will More Go Hungry?, Reuters, March 2007

Government of Sri Lanka, 'Mahinda Chintana: Vision for a new Sri Lanka: the 10 Year Horizon Development Framwork 2006-2016', Government of Sri Lanka, 2006

Hazell, P., Shields, G., and Sheidls, D. "The nature and extent of domestic sources of food price instability and risk", Paper presented at the World Bank workshop on "Food Price Risk Management in Low Income Countries", Washington DC., February. 2005

IFPRI, What Goes Down Must Come Up: Global Food Prices Reach New Heights, IFPRI Forum, March 2008

Indian Agricultural Research Institute, 'Perspective Plan: Vision 2025', Indian Council of Agricultural Research, August 2007

Intergovernmental Panel on Climate Change, Fourth Assessment Report, 2007

International Energy Agency, World Energy Outlook, 2006

International Energy Agency, World Energy Outlook, 2008

International Fund for Agricultural Development, International Fund for Agricultural Development's Strategy in Kenya for 2007-2012, 2006

International Institute of Rural Reconstruction, Sustainable Agriculture Extension Manual, International Institute of Rural Reconstruction, 2000

International Monetary Fund, World Economic Outlook, 2007

Jordans, F. Food price jump blamed on speculation, AP, 2008 http://www.globalresearch.ca/index.php?context=va&aid=8844

Loftas, T. et al, Staple Foods: what do people eat? Dimensions of need- An atlas of food and agriculture, FAO, 1995

Kenya Land Alliance, Land Reform Volume 3: Land use in Kenya- the case for a national land-use policy, 2004

Mahabir, R., Philippines (Bicol) Embarks on Jatropha Production, August 24, 2007, http://asiacleantech.wordpress.com/2007/08/24/philippines-bicol-embarks-on-jatropha-production/

Mitchell, D., A note on Rising Food Crisis, World Bank, July 2008

Moreira, J-R., Bioenergy and Agriculture: Promises and Challenges. Brazil's experience with bioenergy, Focus 14, Brief 8 of 12, December 2006

Niggli, U., Earley, J. and Ogorzalek, K. Issue Paper: Organic Agriculture and Stability of Food Supply, FAO, May 2007

Oxfam, *Dumping Without Borders: Oxfam Briefing Paper* , Oxfam, 2003 http://www.oxfam.org.uk/resources/policy/trade/downloads/bp50_corn.pdf, Accessed 28 August 2008

Peskett, L., Slater, R., Stevens, C., and Dufey, A., Biofuels Agriculture and Poverty Reduction, ODI, March 2007

Regional Hunger Vulnerability Programme, Biofuel production and the threat to South Africa's food security, Wahenga Brief Number 11, April 2007

Regional Hunger Vulnerability Programme, Biofuels and Food Aid: The Impact on Southern Africa, May 2007

Roberto, J., Bioenergy and Agriculture: Promises and Challenges. Brazil's experience with bioenergy, IFPRI, December 2006

Sharma, R. P., Monitoring access to food and household food security (article adapted from *Approaches to monitoring access to food and household food security,* FAO Committee on World Food Security, 17th Session, Rome, 23-27 March 1992)

Smolker, R., Tokar, B., Petermann, A., Hernandez, E. and Thomas, T., The Real Costs of Agrofuels: Impacts on food, forests, people and the climate, Global Forest Coalition, Global Justice Ecology Project and Institute for Social Ecology, 2008

Stanford University, Concept Note for a Program for the Study of Biofuels, Poverty and Food Security, 2007

Uldrich, Jack. "New Kid on the Farm: Cellulosic Ethanol." The Motley Fool. 29 Mar. 2007. 26 Sept. 2007 http://www.fool.com/investing/general/2007/03/29/new-kid-on-the-farm-cellulosicethanol. aspx

United Nations, Report of the World Food Conference, Rome 5-16 November 1974, 1975

United Nations, Sustainable Bioenergy: A Framework for Decision Makers, April 2007

U.S. Department of Energy, Energy Policy Act of 2005, Public Law 109-58, August 8, 2005

Via Campesina, Right to grow, right to feed, right to eat. Via Campesina Position Paper presented to the media on in Jakarta during the International Conference on Peasant Rights, 24th June 2008

Via Campesina, Tlaxcala Declaration of the Via Campesina, April 1996

Via Campesina, Food Sovereignty for Africa: A Challenge at Fingertips, January 2008

Von Braun, J., Rising Food Prices, What Should Be Done?, IFPRI, April 2008

Windfuhr, M. and Jonsén, J. Food Sovereignty: towards democracy in localized food systems, ITDG Publishing - working paper, 2005

World Bank Group, Improving Lives: World Bank Group Progress on Renewable Energy & Energy Efficiency in Fiscal Year 2006, World Bank, 2006

World Bank, World Development Report 2008: Agriculture for Development, World Bank, 2007

World Food Programme, Country Brief http://www.wfp.org/country_brief/indexcountry.asp?country=834#Facts%20&%20Figures

World Food Programme/Interfais, Food Aid Flows, WFP, 2006

World Food Programme, Food Assistance Programming in the Context of HIV/AIDS, Food and Nutrition Technical Assistance Project and World Food Programme, September 2007

Zarrilli, S. 'Trade and Sustainable Development Implications of the Emerging Biofuels Market' in International Centre for Trade and Sustainable Development *Linking Trade, Climate Change and Energy: Selected Issue Briefs*, ICTSD, 2006