Rapporter institutionen för stad och land · nr 4/2009
Sida's helpdesk for Environmental Assessment Swedish **EIA** centre

The key drivers for the rising interest in liquid biofuels differ between countries. In general, rich countries see the outlook of rising prices for fossil fuels and the need for reducing carbon emissions. Most developing countries need increased energy security and development. While the rich countries' needs require production for export, the developing countries might fulfil their needs more sustainably with production for domestic use. There is potential for win win solutions but there are also challenges to be aware of, as well as recommendations of what needs to be in place for the small holders, and the environment on which they depend, not to loose out on another mono crop system. Donors can play an important role when it comes to supporting these recommendations.

There is rising concern about the effects of rapid expansion of biofuel investment, on the environment and people in production countries. In developing countries, biofuel production is likely to have an impact within rural development, energy security, agriculture, water management, food security and ultimately; poverty reduction. Therefore, in 2008, Sida commissioned SwedBio and the Sida Helpdesk for Environmental Assessment at the Swedish University for Agricultural Sciences in Uppsala, to produce a fact sheet to summarise the main challenges and concerns that need to be addressed. The Fact Sheet would also provide recommendations on what to consider and how, to reach a positive development for people and the environment in developing countries. This summary report forms the background material produced for the Fact Sheet.

The report is part of the Report Series at the Swedish EIA Centre SLU, at the Swedish University for Agricultural Sciences. The Centre is commissioned by Sida to provide a Helpdesk to assist in integrating environmental consideration into Swedish development cooperation. The Helpdesk provides advice, training and guidance for Sida staff and support to capacity development in Sida partner countries.

ISSN: 1654-0565 · ISBN: 978-91-85735-15-0 Ansvarig utgivare: Anders Hedlund · Institutionen för stad och land SLU · Postadress: Box 7012 · 750 07 Uppsala · Besöksadress: Ulls väg 28 A-B · www.sol.slu.se
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Linda Engström Liquid Biofuels - Opportunities and Challenges in Developing Countries

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nr 4/2009

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Landsbygds**utveckling** Landskaps**arkitektur** Miljö**kommunikation** Natur**vägledning** **MKB**centrum

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Rapporten ges ut vid institutionen för stad och land SLU - Sveriges lantbruksuniversitet. I serien utges rapporter från avdelningarna för landsbygdsutveckling, landskapsarkitektur, miljökommunikation, CNV och MKB-centrum SLU, som alla är en del av institutionen.

Ansvarig utgivare: Anders Hedlund
ISSN: 1654 - 0565
ISBN: 978-91-85735-15-0

Tryck: Repro Ultuna, Uppsala

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Liquid Biofuels – Opportunities and Challenges in Developing Countries

A Summary Report from Sida's Helpdesk for Environmental Assessment

May 2009

This Summary Report is the result of a literature overview forming the background material for the fact sheet "Biofules – Opportunities and Challenges for Developing Countries" commissioned by Sida. The opinions presented do not necessarily reflect Sida's views.

A summary report from Sida´s Helpdesk for Environmental Assessment

Context

Because of the rapid expansion of biofuel producing globally, there is rising concern about the effects on the environment and people in production countries. In developing countries, biofuel production is likely to have an impact within rural development, energy security, agriculture, water management, food security and ultimately; poverty reduction. Therefore, in 2008, Sida commissioned SwedBio[1] and Helpdesk for Environmental Assessment at the Swedish University of Agricultural Sciences in Uppsala, to produce a fact sheet to summarise the main challenges and concerns that need to be addressed. The Fact Sheet would also provide recommendations on what to consider and how, to reach a positive development for people and the environment in developing countries. This summary report forms the background material produced for the Fact Sheet.

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[1] Swedish International Biodiversity Programme, http://www.swedbio.com.

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1 Introduction

The key drivers for the rising interest in biofuel differ between countries. In general, rich countries see the outlook of rising prices for fossil fuels and the need for reducing carbon emissions.[2] Most developing countries need increased energy security and development, especially in rural areas. While the rich countries' needs require production for export, the developing countries might fulfil their needs more sustainably with production for domestic use. There is potential for win win solutions but there are also potential challenges to be aware of, as well as recommendations of what needs to be in place for the small holders, and the environment on which they depend, not to loose out on another mono crop system. Donors can play an important role when it comes to supporting these recommendations.

Box 1. Short facts on Bioenergy

Bioenergy:	Energy produced from biomass = all types of organic materials, including energy crops, agricultural and forestry wastes, manure, feedstock for liquid biofuels etc.
Liquid Biofuels:	Fuel produced from renewable resources, especially plant biomass, vegetable oils, and treated municipal and industrial wastes, for use in combustion engines directly or blended. The most important first generation biofuels are ethanol and biodiesel.
	Ethanol is an alcohol derived from sugar or starch crops (e.g. sugar beet, sugar cane, sorghum, wheat, cassava or maize) by fermentation. Ethanol can be used in either neat form in specially designed engines, or blended with petroleum fuel.
	Biodiesel is derived from vegetable oils (e.g. rapeseed oil, jatropha, soy bean, pongamia, musine, castor beans or palm oil) by reaction of the oil with methanol. Biodiesel can either be used directly in diesel engines or blended with diesel derived from fossil fuels.

Sources: NCEA 2007, FAO 2008d, OECD 2007, Kuchler & Linnér 2008, Eklöf 2007

1.1 Biofuel production is expanding

Biofuel targets in the EU and the US are of major importance for the rapid expansion of biofuel production, but the demand fluctuates with the oil price. Biofuels are increasingly mentioned as a transitional solution in the conversion from fossil fuels towards more sustainable energy systems. Other alternatives such as wind power and solar energy are developing rapidly.

[2] NCEA 2007, Renewable Fuels Agency 2008.

The development of first generation liquid biofuels has become the fastest growing segment of the world agriculture market.[3] Moreover, investment in biofuels is the third largest (2, 1 billion USD) within the renewable energy sector globally in 2007, after investments in wind and solar energy.[4]

Box 2. Second and third generation biofuels

Second generation fuels are made from cellulosic or "woody" sources, such as straw, timber, woodchips or waste products from forestry, agriculture and households. Many second generation biofuels are under development, such as biohydrogen, biomethanol, dimethylester (DME) and wood diesel. However, they remain technically complex and commercially unprofitable, and are estimated to become competitive at the earliest 2020. The environmental and social impacts of cellulosic feedstock will depend on how they are grown, processed, transported and used.

Opportunities

- Competition with food production can be largely avoided, as they can be derived from agricultural waste and waste wood.
- A higher contribution to energy security can be achieved from using agricultural biomass since they don't need food as a feedstock, and yields are estimated to be higher.

Concerns

- Second-generation biofuel does not use food as a feedstock, but many second generation technologies may still pose similar problems because they can depend on large-scale mono-cultures that threaten biodiversity, food production, or land.
- Some feedstock for second generation biofuels require more land than current biofuel feedstock, and could have the potential to induce more indirect land-use change.
- Second generation biofuels could emit more CO_2 than for example the sugar cane ethanol production in Brazil emits today.

Third-generation fuels refer to techniques such as hydrogen fuel cells and solar cell technologies where development is at an even earlier phase.

Sources: Santi et al 2008 (cited in AidEnvironment 2008), Renewable Fuels Agency 2008, Oxfam 2008, WDR 2008, OECD 2007, Oxfam 2008, Svenska Dagbladet 17 June 2008, Mongabay News 15 July 2008.

3 UN Energy 2007.
4 UNEP 2008.

1.2 Production patterns

Ethanol production more than doubled between 2000 and 2005, and biodiesel production quadrupled. Today, biodiesel production is only one tenth of the ethanol production.[5] The US (maize) and Brazil (sugar cane) dominate the world production of ethanol, accounting for 80-90 % of the total production of 40 billion litres.[6]

The EU is the main producer of biodiesel, accounting for 75 % of the total global production of 6.5 billion litres[7]. The vegetable oil is derived mainly from rapeseed[8]. Increasingly, Southeast Asia provides the remaining share derived from oil palm.[9] Biofuel production in Africa is still marginal and large-scale export is non-existent[10] although plans for large-scale production are underway in many countries.

The two commercially most attractive crops for making biofuels – sugar cane and oil palm – are mainly produced on large scale plantations centred on a processing facility. One reason behind this is that the quality of the harvested crop deteriorates rather rapidly in terms of the energy that can be extracted, and hence there are gains from efficient infrastructure. However, Brazil out-grower schemes have succeeded in ensuring some smallholder participation.[11] For example, SDC[12], point out that 30–35 % of sugarcane in Brazil is produced by relatively small scale farmers who sell to mills.[13]

1.3 Demand and markets – status and trends

Demand for biofuel is rapidly growing, especially in the industrialized countries. In 2004, about 14 million ha of land, equal to about 1 % of the world's arable land, were used for the production of biofuel.[14] Today, liquid biofuels for transport constitute only approximately 2 % of transport fuels.[15] However, IEA and FAO project that the share of biofuel will increase to 5.9 and 5 % respectively, by 2030.[16]

In Brazil, the area of land under cultivation for soy and sugarcane is expected to triple (from 28 million ha today to 88-128 million ha by 2020). Indonesia's oil palm estate is expected to triple from 6.5 million ha today to 16.5 to 26 million ha by 2025.[17] Chinese ethanol output is expected to double to an annual 3.8 billion litres from current levels.[18]

[5] Hazell, 2007.
[6] WDR 2008, OECD 2008.
[7] WDR 2008.
[8] Earth Policy Institute, 2006, FAO 2008a, Kuchler and Linnér 2008, WWI 2007.
[9] FAO 2008a.
[10] AidEnvironment 2008, Kuchler & Linnér 2008.
[11] WDR 2008.
[12] Swiss Development Cooperation, SDC, 2007.
[13] ODI 2008 p.122.
[14] FAO 2008f, Renewable Fuels Agency 2008.
[15] FAO 2008f, IEA 2007.
[16] FAO 2008a.
[17] Rights and Resources Initiative 2008.
[18] OECD-FAO 2007.

Eklöf (2007) estimates that 500 million hectares[19] of land (more than a third of total arable land) is needed in order to produce biofuel to cover the total current need of the transport sector now being fuelled by oil and diesel.

1.4 EU target

The EU target for renewable fuels for transport is 10 % in 2020, where biofuel is regarded as part of the solution[20](Box 2).

1.5 Context specific impacts

It is important to stress that there is a huge variation of opportunities and risks associated with biofuel production, depending on for example feedstock, national legislation and degree of implementation, existing land rights, if it is produced for export or domestic use, methods and scale of production, conversion technology, transport options etc. Moreover, production costs vary considerably.

Brazilian sugar cane ethanol is often marketed as a good example, which in many ways it is. Most of all, it is the most energy efficient biofuel today, and has created nearly a million job opportunities (Box 3).

Box 3. Lessons learnt in Brazil

Positive outcomes:

• Ethanol production in Brazil has led to more than 720,000 direct jobs and more than 200,000 indirect jobs in rural areas.
• The Greenhouse gas (GHG) emission savings of using Brazilian sugar cane ethanol instead of fossil fuels is estimated to 80-90 %, due to suitable growing conditions and efficient production. However there are raising concerns about these numbers (see below).
• Brazilian ethanol is so far largely rain fed, which means little impact on e.g. ground water supply.
• Brazilian ethanol is regarded as the only biofuel production not dependent on substantial amounts of subsidies (yet it is still subsidized with 1 billion USD/yr, according to OECD).
• Brazilian ethanol production is unique regarding the share being used domestically: Only about 15 % of the production is being exported. Still, Brazil is the world's largest ethanol exporter. This has saved the country large amounts otherwise spent on fuel imports.

Continues on next page …

[19] 500 million ha is equivalent to 8-9 times the arable land area in Brazil, and 1/3 of all arable land in the world. Estimate is based on the 2007 average productivity for sugar cane ethanol in Brazil (Eklöf 2007 p.11). RRI reports that 515 million hectares of land will be needed by 2030 to meeting growing global demand for food, bioenergy, and wood products (Seeing People through the Trees, Rights Resource Initiative 08).
[20] Oxfam 2008, Peter Robertnz, pers.comm.

Negative impacts:

• The production system in Brazil is based on large scale monocultures with high owner concentration, which initially has caused high demand for land previously being used for grazing, small holder production and less intensive agricultural methods. Many people have been evicted from their lands.
• The working conditions are often reported to be critical with small unhealthy living areas with little or no access to health care, low salaries and highly seasonal. Moreover, the plantations are often burned to facilitate harvesting, which results in health problems, reportedly sometimes lethal, for the plantation workers and in cities nearby.
• The number of employees in the sugar cane fields is now reported to decrease due to increasing degree of mechanization. One machine is estimated to replace 100 workers.
• The production system can cause dramatic *indirect effects*. For example, demand for land for sugar cane and soy production often replaces grazing lands, which forces herders to break new land, sometimes in rain forested areas in the Amazon, and the even more threatened tropical coast forest Mata Atlantica.
• The increasing demand also increases the value of land, which forces the poorer part of the population to look for land elsewhere, which can lead to social problems, conflicts and environmental degradation.
• Effluents from ethanol plants have been recorded to pollute nearby rivers and lakes.
• GHG emissions from indirect effects are not included in most Life Cycle Analyses, which means that the figure of 80-90 % GHG emission savings (above) might need to be revised with more developed analytical methods.
• In areas with precipitation less than 1200 mm/yr, irrigation is needed which might lead to overuse and lack of water.
• Sugar cane cultivation is the second biggest user of agricultural pesticides in Brazil, which might in addition to being a health hazard, threatens rivers, lakes and the ocean wildlife.
• The trend to grow biofuel crops on so-called marginal or idle lands, can still threaten the livelihoods of local people. Several studies show that these marginal lands can be of central importance to local livelihoods, e.g. for wood, food and construction materials, and have high conservation values.

Sources: ODI 2008, Oxfam 2008, WWF report, undated, Eklöf 2007, Mongabay News 1 July 2008.

2. Opportunities in Developing Countries

There is a clear potential that biofuels can contribute to development in developing countries. For example, the Africa Commission recognized that reduction of greenhouse gas emissions is not a primary driving factor for energy development in Africa, since the level of emissions is very low compared with other regions. However, the adoption of clean energy can lead to various "win-win" solutions.

In addition to reducing emissions, the adoption of clean energy technologies addresses supply shortages using local resources, reduces foreign exchange requirements for fuel imports, creates new industries (large, as well as small and medium enterprises) with consequent job creation and income generation, promotes rural development, and may be facilitated by access to carbon finance. Thus, clean energy contributes both to the mitigation of climate change (by reducing emissions) and to adaptation (by making populations more resilient), through its contribution to economic growth, security of supply, employment and well-being.[21]

2.1 Poverty reduction

Availability of energy is fundamental to intensifying agriculture, industrial development and pro-poor growth. Locally produced liquid biofuel, e.g. biodiesel, could lead to national and local benefits such as reduced pressure on forests, reduced dependency on oil imports and limited exposure to volatile international prices.

Picture 1. Domestically used, liquid biofuels can replace fuel wood and thereby reduce health risks associated with smoke, primarily benefitting women and children.
Photo: Gunilla Åkesson.

[21] ACTS 2008.

2.2 Energy security & reduced dependence on oil

Locally produced bioenergy can provide energy for local agricultural, industrial and household uses[22](Box 4), and reduce the dependence on oil imports. For example, by using domestically produced ethanol Brazil saved some USD 52 billion (2003) in avoided oil imports between 1975 and 2002.[23] Thus, the Brazilian success is because a large proportion of production is for domestic consumption. This scenario of energy security and oil independence is still rare, and might continue to be so, considering that the expansion taking place in many developing countries today is driven by export oriented foreign investment.

Large volumes of biofuel are needed to assist countries like the US to replace their use of fossil fuels for transport: Even if 30 % of the US maize harvest is used for ethanol, it would still account for less than 8 % of US gasoline consumption.[24] Many developing countries run their engines mainly on diesel and would therefore benefit more by producing biodiesel than ethanol. Some of the greatest gains are likely when traditional biomass practices are integrated into bioenergy schemes in ways that both support local farmers (by providing local solid biomass for cooking) and produce ethanol or biodiesel for local consumption and regional sale.

Box 4. Small scale production and local energy supply

In Mali, a community program has developed small scale jatropha plantations that provide not only liquid fuels but also electricity, heat and mechanical power for a variety of local uses.

Brazil's first biodiesel cooperative, Cooperbio, involves about 25,000 families using castor bean, jatropha, sunflower and other species produced in small scale diversified systems.

Source: Eklöf 2007.

2.3 Employment

Sugar cane production in Brazil is estimated to have led to the creation of nearly a million jobs (Box 2). In China, the liquid biofuel programme is expected to create more than nine million jobs in the next few years.[25] However, increased mechanization will lead to fewer employment opportunities.

[22] UN 2007.
[23] Eklöf 2007.
[24] WDR 2008, p 90-91.
[25] Rossi & Lambrou 2008.

2.4 Opportunities for farmers

Increasing food prices provide an opportunity for increasing benefits for farmers and intensifying production which could have positive impact on food production and food security. Biofuels are not different from other cash crops and benefits for farmers depend on how it is produced and if markets are functioning. Existing institutions such as producer companies or cooperatives have a crucial role in making biofuel production pro-poor as they can bundle the interests of the poor and create a countervailing power to larger firms.

Smallholders could increase their incomes but markets, inputs, credit and transport need to be accessible, and mechanisms in place to ensure that price increases accrue farmers. If this is taken care of both biofuels and increased food prices can stimulate rural economic growth by increased capital flows and demand for goods and services. This has been observed in Brazil, where agro-industrial activities related to sugar cane actually improved conditions for producing other crops. Substituting fuel wood and dung for biofuel could increase local energy efficiency, decrease health risks and pressure on forests – and relieve the work burden of women freeing capacity for more productive work.

Box 5. Jatropha and wasteland opportunities

- Jatropha is a tropical, perennial plant that can be grown in low to high rainfall areas and at altitudes of up to 500 meters. It grows wild in India, and has traditionally been used for fencing as cattle do not eat it.
- Jatropha has a long life cycle of 30-50 years. It takes 3-5 years before it produces yields, but after that harvesting is possible every six to twelve months with the right water and nutrient conditions.
- The jatropha seed has high oil content and can be used to produce biodiesel, it must be harvested manually, and can be stored for months after drying, which makes it an interesting smallholder crop.
- Jatropha has been marketed as a hardy and drought resistant tree/bush that can be grown on marginal lands without much investment. However, in arid and semi arid areas, fertilisers and irrigation are needed the first years. Practice shows that investments are still made primarily on fertile lands to maximize yields.
- Jatropha has also been marketed to be resistant to diseases and pests, but in humid conditions this is not always the case.
- Jatropha may not be the near perfect solution that has been widely argued, but may play an important role for example in serving local energy needs.

Sources: AidEnvironment 2008, Renewable Fuels Agency2008, Eklöf 2007.

Picture 2. Small scale jatropha plantations have proved to be a potential boost for e.g. local energy security, heat and electricity. However, despite drought resistance, commercial plantations need fertile lands and irrigation for high yield production. Picture from Mozambique. Photo: Gunilla Åkesson.

2.5 Reduced greenhouse gas emissions

Bioenergy is seen by many as a "clean" form of energy, with the assumption that the amount of CO_2 released when it is burned is generally equivalent to the amount of CO_2 captured during the growth of the crop that produced it.[26] Brazilian sugar-cane ethanol is estimated to save up to 90 % of the GHG emissions compared to that of fossil fuels, however the gains depend on e.g. the crop, production system and previous land use, and whether the analysis includes indirect emissions from land use change. Hence, net carbon and energy savings are not assured (Table 1 and Box 7).

[26] OECD 2007.

3. Challenges

3.1 Food security and the role of biofuels

The FAO Summit in Rome (2008) states; "The role of biofuel for increase in food prices varies across countries and may not be quantifiable with certainty". Moreover, depending on methods and data used, and assumptions made, figures vary between studies. However, major actors such as International Monetary Fund (IMF), World Bank, United Nations (UN) and Organisation for Economic Co-operation and Development (OECD) are concerned about the effects on food prices of the rapid expansion of feedstock production for biofuels. It is also clear that the crops of major importance are maize[27] and oil seeds[28], crops for which the prices have doubled during 2008.[29]

As for sugarcane, the International Food Policy Research Institute (IFPRI) warns that the price of sugar is very closely connected to the price of ethanol which in turn increases the risk that high energy-price fluctuations are increasingly translated into high food-price fluctuations.[30] However, Oxfam states that biofuel derived from sugarcane has not had such a dramatic impact.[31]

Below is a selection of the estimates of major actors.

Table 1. *Estimated influence of biofuels on food prices hikes*

Institution	**Estimated influence on food price hikes (%)**	**Published**
World Bank	65	2008 (July)
IMF	50	2008 (April)
OECD-FAO	60	2008
Renewable Fuels Agency	5-72	2008 (July)
IFPRI	30	n.a.
Oxfam	up to 30	2008 (April)

Sources: D. Mitchell, 'A Note on Rising Food Prices', World Bank (cited in FAO 2008c), IMF 2008, OECD/FAO 2008, ActionAid 2008, Oxfam 2008, Renewable Fuels Agency 2008.

The most alarming estimate comes from the World Bank in July 2008: the author Donald Mitchell estimates the role of biofuels for rising food prices to 65 % higher than any other previous estimate. The report also states that "the EU and US drive for biofuels has had by far the biggest impact on food supply and prices". The World Bank also states in its World Development Report (2008) that "biofuel production has pushed up feedstock prices".

[27] Action Aid 2008, WDR 2008.
[28] OECD/FAO 2007, FAO 2008c, Renewable Fuels Agency 2008.
[29] FAO 2008f.
[30] von Braun 2007.
[31] Oxfam 2008.

The observed price increases in the Gallagher analysis vary widely between feedstock. For most crops, price rises are rarely more than 5 %. However, price rises for potential feedstock crops like oilseeds, maize and sugar cane are much higher, up to 72 %. The Mitchell study mentions three mechanisms that connect biofuel production with rising food prices:

- Biofuel production has diverted grain away from food, with over a third of US corn now used to produce ethanol and about half of vegetable oils in the EU going to the production of biodiesel.
- Farmers have been encouraged to set aside land for biofuel production.
- It has sparked financial speculation in grains, driving prices up higher.

Other factors influencing the food prices are the expansion in livestock consumption and production in non-OECD countries, lower grain stocks, rising oil prices, which push up the costs of inputs such as fertilisers[32] as well as transport and storage costs, weather-related production shortfalls such as the drought in Australia, which lost 60 % of its wheat crop last year and almost 98 % of its rice crop.[33]

3.2 Possible impacts on small-holders

3.2.1 Land tenure

Long-term, large-scale production of biofuels for export to meet energy demands in transportation of industrialized countries could lead to major land-use changes, deforestation and land clearing, displacement of people, contamination of water, and eventually food scarcity, if careful planning does not take place. Domination of only few agro-industries in a domestic market could leave small farmers without many market/production options and without substantial benefits.[34]

Large scale biofuel production often competes with other land and water uses. Power imbalances make it difficult for local communities to negotiate a fair deal or sufficient compensation (Box 6). It can be difficult for local land users, especially if they hold no formally recognized tenure rights, to negotiate sufficient compensation for losing land to ensure a sustainable livelihood. Indigenous communities are particularly vulnerable because many governments do not recognize the legitimacy of their land and territorial rights.[35] Women may have less to gain from biofuel production, as production of cash crops is usually dominated by men.[36]

[32] Oxfam 2008.
[33] Oxfam 2008; FAO 2008c; OECD/FAO 2007.
[34] Kuchler & Linnér 2008.
[35] FAO 2008b.
[36] Oxfam 2008.

Box 6. Need for awareness in Tanzania

A feasibility study of large scale biofuel production in Tanzania shows that villages in for example Kilwa and Kisarawe districts, targeted by foreign investment, have little or no knowledge about their legal rights to land and other resources, neither about the size of their village lands. Thus, they have no chance of knowing how large areas they can sell/give away to investors, without jeopardizing their long term needs for land, food and fodder for the village. The study recommends that land use plans and awareness raising in villages on relevant jurisdiction, such as the Village Act, and other issues concerning the investments, are put in place before investments are approved in these areas. Sida commissioned the study performed by 16 researchers from three Tanzanian universities.

Source: Mwamila et al. 2008.

3.2.2 Marginal lands

The trend is emerging among governments and companies to target 'marginal', 'idle', or 'degraded' lands, because these areas are considered unsuitable for food production and poor in biodiversity.[37] However, such lands are often habited and utilized by rural poor who are dependent on ecosystem services for their subsistence.[38] For local farmers and pastoralists, access to this land may be their most valuable asset.[39] For example, wild edible plant species that grow on these lands, and the knowledge and skills associated with the collection and the utilization of such species, particularly among women, can be threatened.[40]

There is great chance that the so-called 'idle' land can be in fallow, used for grazing or saved for future expansion.[41] Some studies have shown that such Common Property Resources can contribute up to a quarter of poor household incomes.[42] In India, 20 % of the rural households depend on common lands for grazing.[43] In Africa, livestock production forms the backbone of rural economy in the agriculturally marginal areas.

3.2.3 Reduced resilience to climate change

The replacement of local crops with large-scale mono-cropping for the production of biofuels might lead to a reduction in the level of variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food, fodder, fibre, fuels and pharmaceuticals.[44] For example, intact forest and wetland ecosystems provide services such as clean water, protection against extreme weather events, carbon storages, erosion protection, pollination etc. Therefore, large scale

[37] Oxfam 2008.
[38] Gilbertson et al. 2008.
[39] FAO 2008b.
[40] Rossi & Lambrou 2008.
[41] Kjell Havnevik, NAI, 2008.
[42] Oxfam 2008.
[43] Eklöf 2007.
[44] Rossi & Lambrou 2008.

mono-cropping can lower the resilience of rural communities and individuals to exogenous shocks, and potentially also reduce their ability to cope with the impacts of climate change.[45]

3.2.4 Reduced domestic energy supply

There is a risk that countries in the South become exporters of feedstock for biofuel production, at the expense of fulfilling domestic energy demands. However, biomass for clean cooking fuels offers huge opportunities to address the effects of poverty among women.[46]

3.2.5 Weather changes and market uncertainties

The future availability and success of biofuel production also depends on a number of variables that are difficult to predict. These include droughts, fluctuating oil price, other events that reduce feedstock production and market mechanisms that can make other uses of the feedstock more attractive for producers.[47]

Picture 3. Young woman raising her voice during a stakeholder meeting on land rights issues in Niassa Province, Mozambique. Photo: Gunilla Åkesson.

[45] Rossi & Lambrou 2008.

[46] Oxfam 2008, Kuchler & Linnér 2008.

[47] Eklöf 2007.

3.3 Genetically modified crops

The use of genetically modified (GM) crops for producing biofuel up to date seems to be an issue primarily in soybeans and maize. In 2007, 80 % of the US soybean crop and 10 % of the Brazilian was genetically modified. Many countries in North and South America, Africa, and Asia grow GM maize.[48] In the US, over half of the maize produced is genetically modified. Genetically modified sugarcane has not been commercialised yet, but research and field testing of several varieties is taking place and some are close to commercialisation.[49]

The risks with GM crops have been raised by various institutions. Among others, FAO warns that agricultural biodiversity could be affected by large-scale mono cropping practices and the introduction of genetically modified materials.[50]

3.4 Greenhouse gas emissions

The impact of renewable fuels on greenhouse gas (GHG) emissions varies significantly depending on various factors such as;

- earlier land use.
- location and production system.
- the extent of use of fertilisers.
- if the biofuel is for domestic use or for export.

Therefore, Life-Cycle Analyses (LCA) for various crops and their GHG emissions show different results. There is consensus that Brazilian sugarcane ethanol provides the most favourable GHG balance of all biofuels currently available, followed by biodiesel from vegetable oils and ethanol from corn. Some estimates show that use of corn ethanol results in an actual increase of GHG, particularly if coal is used to fuel the conversion process. It is important to keep in mind that the result of the LCA is directly dependant on the scope of the analysis. To gain correct results, the total use of fossil fuels as well as indirect impacts on e.g. land use, need to be included, which is a time consuming and costly analysis.

Table 2. *Estimated ranges for lifecycle GHG savings compared to fossil fuels.*

Corn ethanol:	10-40 %
Sugar beet ethanol:	35-55 %
Sugarcane ethanol:	85-95 %
Wheat ethanol:	20-45 %
Rapeseed biodiesel:	20-50 %

Source: World Watch Institute 2007. Differences in estimates are due to different production pathways and differing assumptions in the calculations themselves.

[48] GMO Compass.
[49] Friends of the Earth Europe 2008.
[50] FAO 2008f.

In the case of maize for ethanol, fuel-efficiency measures in the transport sector are likely to be a much more cost effective way to decrease GHG emissions.[51]

A recent research study states that "while expansion of biofuels into productive tropical ecosystems will always lead to net carbon emissions for decades to centuries, expansion into degraded or already cultivated land will provide almost immediate carbon savings"[52].

Other concerns regarding GHG emissions and biofuels include:

• all stages of the biofuel production chain (e.g. planting, fertilizing and harvesting) requires energy input, often in the form of fossil energy and minerals, particularly if the crops are grown intensively, using nitrogen-based fertilisers[53] and machinery, or if the refining process requires large inputs of fossil energy.[54]

• if land with high carbon content, such as forest or peat land, is converted to grow biofuels, it will give negative carbon balance, creating "carbon debts" that could take decades or even centuries to "repay"[55](Box 7). Moreover, oil palm plantations store considerably less carbon than the primary forests that they often replace.[56]

• many current LCA methods fail to take account of indirect land use change/ displacements effects, implicitly assuming biofuels are only produced on existing cultivated land[57] and have no spill over effects on use of other land.

The *Global Bioenergy Partnership (GBEP)* is establishing a Task Force on Sustainability to complement its ongoing work on the harmonization of methodologies to measure GHG emission reductions.[58]

3.5 Water supply and quality

The FAO Summit in Rome (2008) concludes that many feedstock – including sugar, palm oil and maize – are highly water intensive, meaning that their expansion is likely to make water less readily available for household use, threatening the health status and food security status of affected individuals.[59]

However, sugar production in Brazil and maize production in the US are predominantly rain fed.[60] Sugar cane needs about 1500-2000 mm of water per year, making irrigation necessary in regions where the annual rainfall is lower.[61] Crops like cassava, sweet sorghum, maize and jatropha can grow on drier soils, but may require irrigation to become commercially attractive.[62]

[51] WDR 2008.
[52] Gibbs et al. 2008.
[53] Nitrous oxide is a GHG 296 times more potent than carbon dioxide.
[54] Oxfam 2008.
[55] FAO 2008f, Kuchler & Linnér 2008, WDR 08.
[56] Mongabay newsletter 11 July 2008.
[57] WDR 2008, Oxfam 2008; Renewable Fuels Agency 08, Gilbertsson et al. 2008.
[58] FAO 2008f.
[59] FAO 2008f.
[60] FAO 2008f.
[61] Eklöf 2007.
[62] AidEnvironment 2008.

Water pollution is a widespread problem both in oil palm and sugar cane producing areas, as well as in the mills that produce biodiesel and ethanol. Both palmoil and cane mill effluents tend to be rich in organic matter. The decomposition of the nutrient loads that result from these effluents reduces oxygen levels in the water, affecting natural biochemical processes and the species that inhabit those freshwater ecosystems.[63] Oil palm plantations have been criticised for their use of herbicides. The most commonly used in Southeast Asia's plantations is paraquat, and many employed pesticide sprayers have shown acute paraquat poisoning symptoms.[64]

Picture 4. Women and girls in many developing countries spend a lot of time fetching water. Sugar cane and other water demanding biofuel crops could threaten the access to water, thereby increasing the work burden for women and girls to find and fetch water to the household. Photo: Gunilla Åkesson.

[63] Eklöf 2007.

[64] Wakker 2005 (cited in Eklöf, 2007).

3.6 Biodiversity

The threat to biodiversity from biofuel production is associated primarily with land-use change. When areas such as savannas or forests are converted for feedstock production, the loss of biodiversity may be significant. This is also a major threat to local communities and indigenous groups depending on biodiversity for their livelihoods if they are not adequately compensated. As stated by the UN Declaration from High Level World Food conference 2008: Maintaining biodiversity is a key to future sustainable food production performance. Land use changes for the production of palm oil and soy represents some of the main issues of biofuels and biodiversity:

Oil palm plantations are a significant driver of deforestation, mainly in South East Asia, but also increasingly in South America. A study by Lian Pin Koh and David Wilcove[65] found a 77 % decline in forest bird species and an 83 % loss of butterfly species upon the conversion of old-growth forest to oil palm plantations. By comparison, secondary forest 30 years after logging retained roughly 80 % of the original forest species.

Box 7. Oil palm expansion - biodiversity and climate change

- Oil palm is mainly produced in Indonesia and Malaysia, with approximately 85 % of the world production. The plantations are considered to be one of the largest threats to tropical forests and peat lands in the region. Production is also expanding rapidly in South America, for example in Colombia.
- The area planted in Indonesia has increased from 600 000 to 6,4 million hectares between 1985 and 2006, with conversion plans for another 20 million hectares of oil palm in the next 20 years (2008).
- Much of today's expansion is occurring on peat lands, an ecosystem that stores 30 % of all terrestrial carbon. The loss of these lands is a major cause for concern for climate change. Draining and burning peat lands for plantations have placed Indonesia as the third largest CO_2 emitter in the world (previously number 21). Estimates suggest it would take 420 years of biodiesel production to pay back the carbon debt incurred by clearing and draining the land to grow the palm oil.

Sources: Wetlands International 2008, Eklöf 2007, Oxfam 2008.

The expansion of soy is a major driver of deforestation and habitat loss in South America. Many of the habitats threatened by soy expansion are biologically diverse and have high levels of endemism, including the Chaco bush savannah of Argentina, Bolivia and Paraguay, the Bolivian Atlantic forest, and the Cerrado savannah and Amazon rainforest in Brazil.

[65] Cited in Mongabay News 15 April 2008.

3.7 Indirect effects of land use change

The most obvious example of indirect effects of land use change associated with biofuel production is when current land use is shifted to supply biofuel markets and the existing production for other markets will move to new areas, for example forests or areas of small scale agricultural systems.[66] Other mechanisms are, for example:

• Corn – soy

Demand for corn in the US has skyrocketed as a result of the ethanol programme. In response, American and Canadian farmers are switching out of soy and into corn. This in turn pushes up the price of soy, and South American soy farmers respond to higher prices by bringing new (in this case rain forested) land into production.[67]

• Sugarcane - biodiversity and ecosystem services

There are similar concerns that expansion of sugarcane for ethanol in Brazil is pushing cattle and soy farmers further into the Amazon, thereby indirectly causing deforestation.[68] For example, in Brazil, companies planting sugar cane for ethanol production have been fined for illegal logging in the shrinking Mata Atlantica forests along the coast. Moreover, cattle ranch owners that are pushed towards the Amazonian regions due to expanding soy and sugar plantations, have been fined for illegal logging to make new grazing lands.[69] Similarly, Oxfam states that new ethanol investments are underway in states surrounding the Amazon and also states covered by the Cerrado – a high biodiversity savannah system, and into the Pantanal – the world's largest wetland and a massive carbon sink.[70]

• Rape seed - oil palm - biodiversity and ecosystem services

The ambition to increase the use of biodiesel means that the EU have to divert a huge amount of its edible oil (mainly rape seed) into biofuel, leaving a hole in the food market that will have to be filled by imports – largely palm oil[71]. A 2006 FAO report shows that the increased use of European rapeseed oil for biodiesel is one of the main factors for the rise in palm oil prices, which in turn promotes palm oil expansion[72]. Malaysian companies are also expanding into other regions with rich biodiversity. For example, in 2008, Malaysia's Land Development Authority announced plans to establish 100,000 hectares (250,000) of oil palm plantations in the Brazilian Amazon.[73]

These issues are not included in LCA, EU sustainability criteria or in most GHG emission calculations, despite the fact that they play a major role for the social, environmental and economic impacts of biofuel production.

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[66] Gilbertsson et al. 2008, Oxfam 2008.
[67] Oxfam 2008.
[68] Oxfam 2008; Mongabay News 21 August 2007; Friends of the Earth Europe 2008; Eklöf 2007.
[69] Lennart Kjörling 2008.
[70] Oxfam 2008, p. 46.
[71] Oxfam 2008.
[72] Gilbertsson et al. 2008.
[73] Mongabay News 9 July 2008.

3.8 Subsidies

The costs of converting and distributing biofuels are often reduced through capital grants, loan guarantees, subsidised loans, income tax concessions and excise and value-added tax exemptions. At the moment, Brazil is the only major country producing biofuel from crops on an economically viable basis. Still, there is government support in Brazil: biofuel are exempted from the oil fuel excise tax and biofuel producers are exempted from a social tax on revenues. Biofuel production in OECD countries (mainly EU and US) is currently supported by USD 13 to 15 billion/yr[74], estimated to add up to USD 29 billion in 2020[75].

[74] Oxfam 2008, FAO 2008c, p. 9.

[75] Oxfam 2008, 22 billion Euros converted into USD May 2009.

4. Sustainability criteria and certification

The Gallagher review concludes that it should be possible to establish a genuinely sustainable industry provided that robust, comprehensive and mandatory sustainability standards are developed and implemented, but that significant challenges remain in the detailed design, implementation and enforcement. These challenges are complex and will take time to overcome.

The EU target for renewable fuels for transport is 10 % in 2020, where biofuel is regarded as one part of the solution. Growing concern is expressed regarding the implementation of the directive[76] target, due to its potential social, environmental and financial impacts. The directive therefore includes sustainability criteria since December 2008 (Box 8), to be put into force in 2010[77] together with the results from ongoing studies on Indirect Land Use Change (ILUC)[78]. Today, approximately 1 % of the fuels for transport in EU are biofuels.

Box 8. EU Proposed Sustainability critera (in brief)

- A minimum 35 % GHG savings relative to fossil fuel.
- No raw material to be taken from lands with high biodiversity value in 2008 (including grassland).
- No conversion of land with high carbon stock, such as pristine peatlands and other wetlands.
- No conversion of nature protected areas.
- No conversion of undisturbed forests.

Read the complete criteria in the Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources, January 2008.

Concerns about the EU criteria lacking social issues and inclusion of displacement effects have been raised by various organisations and research papers.[79] Important measures when creating certification systems in general, include local/national interests and taking needs of the impacted stakeholders of the producer country into consideration, and setting up functioning monitoring systems and relevant measures for those not applying to the criteria.

[76] Directive on the promotion of the use of energy from renewable sources (In Swedish: Förnybarhets-direktivet).
[77] http://www.euractiv.com/en/energy/eu-states-handed-ambitious-renewable-energy-targets/article-169799.
[78] Wijkman, personal communication, 2009.
[79] Peter Roberntz, Oxfam 2008, Friends of the Earth Europe 2008, Gilbertsson *et al* 2008, Renewable Fuels Agency 2008 etc.

4.1 Initiatives on certification

Many organisations and governments are currently developing sustainability standards and criteria for Biofuels[80], for example The Global Bioenergy Partnership (GBEP)[81], and since April 2007, there is a Round Table on Sustainable Biofuels.[82]

Box 9. Successful certification of ethanol in Sao Paolo, Brazil

Cana Verde in Sao Paolo, Brazil is one of the world's largest organic projects, and one major example to prove that it can be viable to produce ethanol from certified organic sugar cane. In total, the factory is supplied by 13,500 hectares of certified cane and produces both sugar and ethanol. The sugar cane is grown without chemical fertilizers and pesticides. The organic effluents from industrial procedures are recycled in agronomic applications, so that nutrients and organic matter can be returned to the soil. A crop rotation with green fertilisers is used before new sugar cane is planted. Harvesting is done without burning, and residues are left in the field as mulch. Pest control is based on monitoring and the use of the pests' natural enemies. In addition, the factory is self-sufficient in energy through the production of heat, mechanical energy and electricity from bagasse.

Source: Eklöf 2007.

[80] Gilbertsson et al. 2008.
[81] UN Energy 2007.
[82] http://cgse.epfl.ch/page65660.html.

5. Recommendations

The points below are a summary of recommendations from OECD, the British Renewable Fuels Agency (RFA), FAO, Oxfam, Overseas Development Institute (ODI) and World Watch Institute (WWI).

• Reduce energy demand

The overall aim with any energy policy should be to reduce overall energy demand. An OECD report suggests focusing efforts on policies to reduce energy *demand* and GHG emissions, such as regulation to improve vehicle efficiency, which would be more cost efficient than replacing fossil fuels with biofuels.[83]

• Perform context specific assessments

The impacts and potential of biofuel production for poverty reduction is complex. There is need for in-depth studies, country-by-country and local analysis to ensure that biofuel production is sustainable.[84]

• Assess GHG emissions

The impacts and potential of biofuel production for poverty reduction is complex. There is need for in-depth studies, country-by-country and local analysis to ensure that biofuel production is sustainable.

• Secure local energy security

Assess what type of energy dependency could be possible to reduce by introducing a biofuel strategy in a given country, as well as what scale of production would be needed to meet the related energy demand.

• Safeguard profits for small holders

- There is a need to implement and enforce national legislation to secure vulnerable people's access to land an regulate the private sector's access to land, particularly to avoid displacement and concentration of land resources. Free, Prior and Informed Consent should be obtained before the commencement of any biofuel project[85] in addition care must be taken in ensuring that consultations/negotiations are conducted in a way that ensures local participation of all affected socio-economic groups and that power imbalances in the process are counteracted.[86]
- Ensure consensus on the definition of "marginal lands" and the extent to which it is being used by local communities for fodder, grazing, wood and vegetable collections etc.
- Perform assessment of the gender-differentiated effects of liquid biofuels production, to ensure that women and female-headed households have the same opportunity as

[83] OECD/ITF 2007.

[84] ODI 2007, FAO 2008e.

[85] Oxfam 2008.

[86] Åkesson et al 2008.

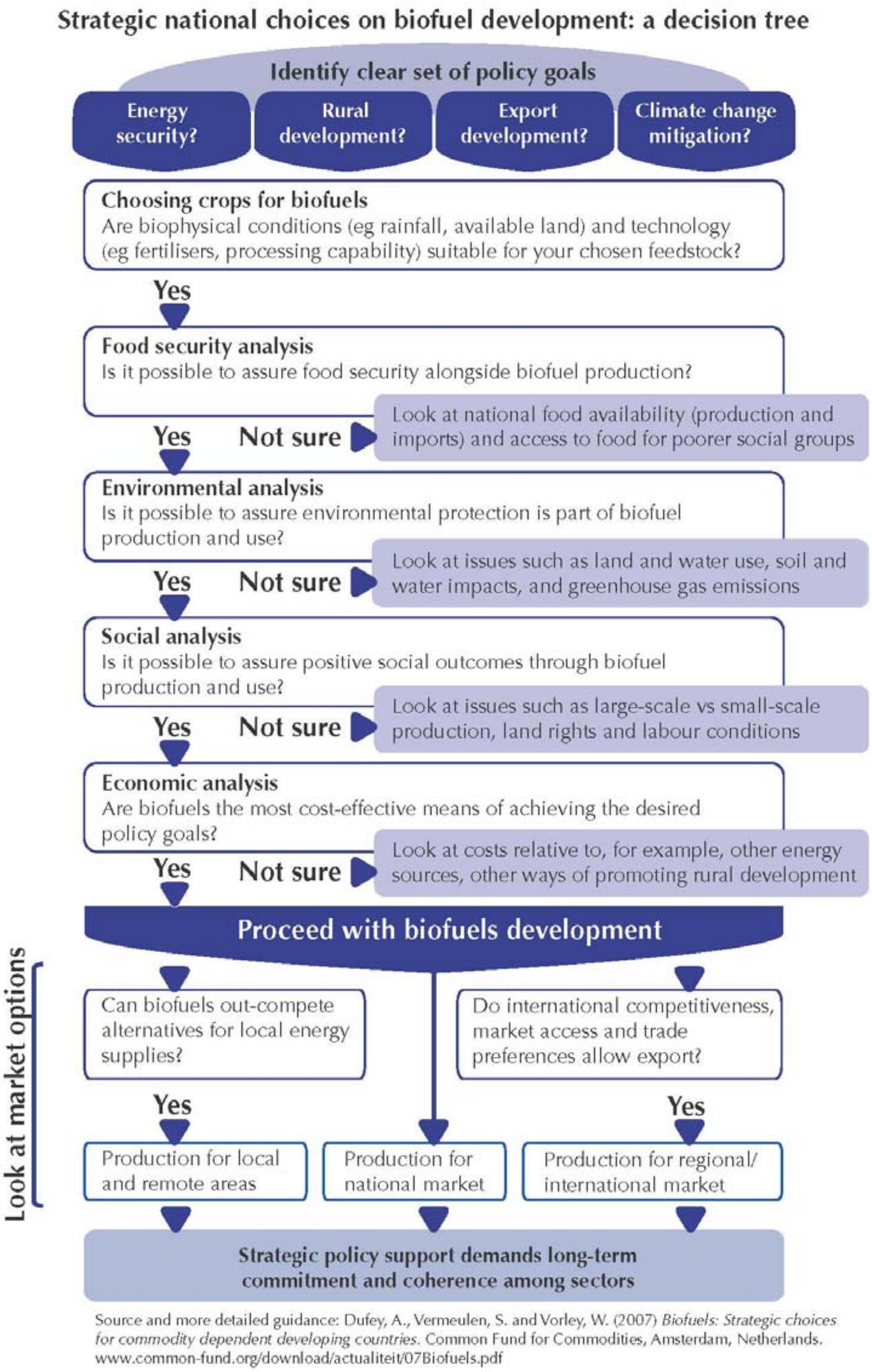

Figure 1. Strategic National Choices on Biofuel Development: A Decision Tree, courtesy of IIED (International Institute for Environment and Development).

men and male-headed households to engage in an benefit from the sustainable production of liquied biofules.[87]

- Safeguard Food Security

  For long term sustainability, biofuel strategies can be integrated with other relevant policies including food security strategies and poverty-reduction strategies, promote diversified farming strategies and ensure that men and women are allowed to grow the food that they require.[88]

- Safeguard intact ecosystems

  Assessments must be made on the impact on ecosystems and biodiversity before any land use change takes place, including possible indirect effects. Deforestation, draining of wetlands and encroaching on species rich savannas or grass lands must be avoided.

- Investment in research and technology (R&T)

  Encourage investment in R&T to accelerate the introduction of second or third generation biofuels and biorefineries that are able to produce a range of products, including but not restricted to biofuels.[89] Strengthen South–South collaboration on research and production models that foster sustainability and social inclusion.

- Develop Sustainability criteria that:

  - include social aspects such as land rights, food security, livelihoods and survival strategies for men and women.
  - ensure that all biofuels consumed offer real GHG savings based on LCAs that properly account for the emissions from direct and indirect land-use change, and use of nitrogen-based fertilisers.[90]
  - ensure that the energy output from biofuel production is greater than the amount of energy used in the process.[91]
  - include indirect changes in land value and land use patterns.
  - require participation from all major producers and buyers as well as strong monitoring systems.[92]

- Secure healthy working conditions and fair employment agreements

  Implement and enforce national legislation to ensure that all biofuel workers, men and women, enjoy decent work as defined by CSR and the International Labour Organization. On plantations and in processing mills, identification of additional non-seasonal sources of work, can avoid highly seasonal employment.

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[87] Rossi & Lambrou 2008.

[88] Oxham 2008.

[89] OECD 2007.

[90] Oxfam 2008.

[91] von Braun 2007.

[92] WDR 2008.

• Strengthen policy and institutions

The successful promotion and sustainable production of biofuel requires strong policy and institutional support, often cited as primary constraints to the effective implementation of sustainable development.

• Adjust production to future climate changes

Climate change uncertainties and weather related risks in the form of droughts, fires and floods, as well as various crop diseases have to be seriously taken into consideration in bio-energy strategy implementation, particularly in developing countries that are most vulnerable to global warming impacts.[93]

[93] Kuchler & Linnér 2008.

6. Assessment Tools

Many organisations and governments, including EU, are currently developing sustainability standards and criteria for biofuel production. One example is the Roundtable for Sustainable Biofuels, RSB.

SEA, Strategic Environmental Assessment, can be described as a family of approaches which use a variety of tools adapted to the specific context in which it is applied. SEA is a process linked to or integrated in planning to help ensure that environment is integrated into strategic decisions and policies, plans and programs. It can help promote informed, strategic decision making, elaboration of alternatives, win-win strategies and measures to enhance positive impacts and minimise negative ones, and provides a means of involving relevant stakeholders prior to decisions. Implementation of SEA for biofuel strategies, legislation or plans can help provide better insight into the trade-offs between environmental, economic and social issues related to biofuels. It can help identify cumulative effects of several isolated biofuel production plans going on simultaneously in a country/region, on e.g. land and water resources, food production and social movements.[94]

Poverty and Social Impact Analyses, PSIA, which may also form part of an SEA, can be used to highlight social consequences and systematically strengthen the different stakeholders' involvement in the assessment of the anticipated social changes and impact.

[94] Applying Strategic Environmental Assessment: OECD Good Practice Guidance for Development Cooperation: (http://www.oecd.org/dataoecd/4/21/37353858.pdf)

7. About Sida's Helpdesk for Environmental Assessments

The Swedish EIA Centre SLU is commissioned by Sida to provide a Helpdesk to assist in integrating environmental consideration into Swedish development co-operation. Sida's Helpdesk for Environmental Assessment provides advice, training and guidance material for all Sida staff and support to capacity development in Sida partner countries.

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