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Learning experiences for sustainable biofuel strategies in Mozambique

Marc Schut, Sandra Bos, Lara Machuama and Maja Slingerland

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The Netherlands' Directorate-General for International Cooperation and Wageningen UR are implementing the Partnership Programme 'Globalisation and Sustainable Rural Development'. In the context of conflicting local, national and global interests and drivers of change processes, the programme aims, among other things, to generate options for the sustainable use of natural resources, pro-poor agro-supply chains and agro-biodiversity. These options need to result in improved rural livelihoods, poverty alleviation and economic development in the south. Farmers and other small-scale entrepreneurs in the agricultural sector form the primary target group. The program has a strong -but not exclusive- focus on countries in Sub-Sahara Africa.

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Abstract

Climate change, rising oil prices and a concern for future energy supplies, have led to a growing interest in the use of biomass for energy purposes. Several studies have shown the potential for liquid biofuel production on the African continent. According to analysts, Mozambique has favourable growing conditions, and the availability of land, water and labour that may contribute considerably to the continent's biofuel production potential. Moreover, biofuel production in African countries could be a driver for technological, economic and rural development. However, the production of biomass energy crops can also result in negative environmental and socio-economic impacts, such as changing land-use patterns and competition with food production. In order to deal with these impacts, some countries (UK, Netherlands), multi-stakeholder platforms (Roundtable for Sustainable Biofuels) and supra-national institutions (European Commission) have developed sustainability guidelines for biofuel production. The implementation of such biofuel sustainability criteria will have clear consequences for African countries, and in response, the Mozambican government has requested to explore such criteria, and to think about how they could be operationalized to fit the Mozambican reality.

As a response, the Mozambican government defined the necessary steps to develop their own national biofuel sustainability framework to guide biofuel investments and production in the country. To elaborate on this, a National Biofuels Taskforce was formed, which includes a subgroup on 'Sustainability Criteria and Development Models'. One of the objectives of this subgroup is to develop a national strategy for sustainable biofuel production that reflects the Mozambican reality and long-term market-requirements for developing a sustainable biofuel sector.

This study seeks to support the work of this subgroup by providing learning experiences in three distinct ways. Firstly, we provide experiences from biofuel production in Brazil. Secondly, we looked at other commodities produced in Mozambican, which apply sustainability criteria and/or certification systems such as FSC, GlobalGAP and fair-trade. Thirdly, we provide an overview of biofuel developments in Mozambique and analyze to what extend reality fits to the suggested potential in the country, and the (sustainability) objectives of the Mozambican government and international institutes. Data was gathered through analysis of literature, by doing field visits and by conducting semi-structured interviews with investors, farmers, extension-workers, researchers, NGO-representatives and policy-makers.

We found that the biofuel sector is characterized by high uncertainty and heterogeneity. When analyzing our case study experiences from a sustainability point of view, our major concern was not so much whether or not the Mozambican biofuel system is or could be sustainable, but more if and how multi-stakeholder objectives can become compatible. To accommodate the debate we distinguished between operational (short-term) and strategic (long-term) sustainability at different scale-levels. It is important that operational sustainability objectives contribute towards developing a strategic sustainable biofuel sector in Mozambique, but also that long-term sustainability does not restrict the development of the sector on the shorter term.

The Mozambican national biofuel policy and strategy (Resolution 22/2009), formally approved in March 2009, covers some of the concerns raised in this study. It stimulates the development of the domestic market, focuses on certain feedstock, adopts national blending targets, promotes local processing capacity to add value, biofuel tax to the build up of the sector and land approval in designated agro-ecological zones. A major challenge will remain how to deal with heterogeneity in the sector and specifically how a sustainability framework could responsibly stimulate the integration of smallholder farming and rural development in general while remaining economically competitive. One of our recommendations is the establishment of Community-Private-Public partnership as a platform to facilitate learning within the sector.

Keywords: Mozambique, sustainability, biofuels, potential, policy, reality, certification, Brazil

Resumo

Mudanças climáticas, subida dos preços de combustíveis e preocupações relativamente ao futuro do fornecimento de energia, têm criado um interesse crescente no que diz respeito ao potencial do uso de biomassas para propósitos energéticos. Vários estudos mostram o potencial biofísico da produção de biocombustíveis no continente Africano. Analistas vêem Moçambique como um dos países Africanos que pode contribuir de forma considerável para uma larga e potencial de produção de biocombustíveis no continente. Condições de produção favoráveis, existência de terra, água e mão-de-obra são mencionados como os maiores condutores no suporte deste potencial. Além disso, a produção de biocombustíveis em países Africanos é vista como uma forma de criar espaço para desenvolvimento tecnológico, económico e rural. Contudo, a produção de plantas energéticas para biomassa poderá também resultar em impactos ecológicos negativos, mudando padrões de uso de terra, criando impactos socioeconómicos, e, com impacto nas emissões de gases de estufa (i.e., para transporte e contra uso alternativo no local). Para lidar com as dinâmicas e os processos legais, sociais e ambientais esperados, alguns países líderes (Reino Unido, Países Baixos/Holanda) e estruturas internacionais (UE, RSB) desenvolveram modelos de sustentabilidade. A implementação desses tipos de critérios de sustentabilidade poderá ter consequências claras em países Africanos com Moçambique. Como resposta, o governo Moçambicano definiu medidas necessárias para desenvolver o seu sistema nacional de princípios de sustentabilidade para servir de modelo para o investimento e produção de biocombustíveis no País. Para este fim, foi constituído um Grupo Interministerial para Biocombustíveis. Este, também inclui um subgrupo: 'Critérios de Sustentabilidade e Modelos de Desenvolvimento'. Um dos objectivos deste subgrupo é, desenvolver uma estratégia nacional de sustentabilidade para produção de biocombustíveis que reflicta a realidade Moçambicana, e, os requisitos do principal mercado a longo prazo.

Este estudo visa apoiar o trabalho deste subgrupo trazendo experiências de aprendizagem de três maneiras distintas. Primeiro, oferecemos experiências da produção de biocombustíveis no Brasil, em seguida, olhamos para produção de outros bens em Moçambique que usam critérios de sustentabilidade e/ou sistemas de certificação tais como o FSC, GlobalGap e fair-trade. Por último, dedicamo-nos ao desenvolvimento do sector biocombustíveis em Moçambique, e, analisamos até que ponto a realidade iguala o sugerido potencial no País, e os objectivos de sustentabilidade do governo Moçambicano e instituições internacionais. Os dados foram recolhidos através de pesquisa bibliográfica, visitas de campo e através de entrevistas semi-estruturadas com investidores, produtores, extensionistas, pesquisadores, representantes de ONGs e legisladores.

Descobrimos que o sector de biocombustíveis é caracterizado por incertezas e heterogeneidade. Ao analisarmos as experiências dos estudos de caso sob o ponto de vista de sustentabilidade, a nossa maior preocupação, não foi só se o sistema de biocombustíveis Moçambicano é ou poderá ser sustentável, mas sim se os objectivos relacionados com os biocombustíveis, nos vários níveis e interpretação de tempo, poderão ser facilitados para que possam ser compatíveis. Para acomodar o debate é necessário distinguir, entre sustentabilidade operacional (a curto prazo) e estratégica (a longo prazo) nos diferentes níveis de escala. É importante que os objectivos operacionais de sustentabilidade contribuam no desenvolvimento de sustentabilidade estratégica no sector de biocombustíveis em Moçambique, mas também que a sustentabilidade a longo prazo não restrinja o desenvolvimento do sector a curto prazo.

A Estratégia Moçambicana Nacional de Biocombustíveis aborda alguns aspectos levantados neste estudo. Ele estimula o desenvolvimento do mercado interno, realça certos *feedstock*, adopta alvos nacionais para misturas de biocombustível e combustíveis fósseis, promove a capacitação de processamento local para acréscimo de valores, taxas de biocombustíveis para promover o sector e aprovação de terras em zonas agroecológicas designadas. Um dos maiores desafios será como lidar com a heterogenia no sector e

especificamente, como os princípios de sustentabilidade poderão estimular a integração da produção de pequenos agricultores bem como o desenvolvimento rural em geral, e, ao mesmo tempo, permanecendo competitivos economicamente. Uma das nossas recomendações é a criação duma parceria entre os sectores Comunidade-Privado-Público como uma plataforma para facilitar aprendizagem dentro do sector.

Palavras-chaves: Moçambique, sustentabilidade, biocombustíveis, política, realidade, certificação, Brasil

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ACP-countries	African, Caribbean and Pacific countries
AGOA	African Growth and Opportunity Act
ANP	*Agencia Nacional de Petroleo, Gas Natural e Biocombustiveis*
BGJ	Billion Giga Joules
BNDES	*Banco Nacional de Desenvolvimento Economico e Social* Brazilian Development Bank
CDM	Clean Development Mechanism
CEPAGRI	*Centro de Promoção da Agricultura* Agriculture Promotion Centre
CEPEIA	Centro de Pesquisa e Investimento Agrario
COC	Chain of Custody Certification
CONDES	*Conselho Nacional de Desenvolvimento Sustentável* National Counsel for Sustainable Development
CPI	*Centro de Promoção de Investimentos* Investment Promotion Centre
DGIS	Dutch Ministry of Foreign Affairs and Development Cooperation
DNTF	*Direcção Nacional de Terras e Florestas* National Directorate for Land and Forestry
DUAT	*Direito de Uso e Aproveitamento das Terras* Land Use and Exploitation Rights
EU	European Union
EPFL	*Energy Center Ecole Politeque*
FAO	Food and Agriculture Organization
FLO	Fair-trade Labelling Organizations
FLO-CERT	FLO-certification
FM	Forest Management
FOB	Free on Board
FSC	Forest Stewardship Council
GDP	Gross Domestic Product
GHG	Green House Gas
GlobalGAP	Global Partnership for Good Agricultural Practices
GMO	Genetically Modified Organism
GSP	Generalized System of Preferences
GTBC	*Grupo Interministerial de Trabalho dos Bio-combustíveis* Inter-Ministerial Working Group on Biofuels
GTE-FBOMS	Grupo de Trabalho Energetico – Forum Brasileiro de Organizações e Movimentos de Socieidade Civil
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
GTZ-PROBEC	Deutsche Gesellschaft für Technische Zusammenarbeit - The Programme for Basic Energy and Conservation (PROBEC)

HDI	Human Development Index
IATP	Institute of Agriculture and Trade Policies
IEA	International Energy Agency
IIAM	*Instituto de Investigação Agrária de Moçambique* National Institute of Agronomic Research
INCAJU	*Instituto de Fomento do Caju* Institute for the promotion of Cashew
INOQQ	*Instituto Nacional de Normalização e Qualidade* National institute for Normalization and Quality
IPEX	*Instututo para a Promoção de Exportações* Institute for Export Promotion
ISO	International Organization for Standardization
MICOA	*Ministério de Coordenação e Acção Ambiental* Ministry for Coordination of Environmental Affairs
NER	Net (School) Enrolment Rates
NGO	Non Governmental Organization
OECD	Organisation for Economic Co-operation and Development
PARPA	*Plano de Acção para a Redução da Pobreza Absoluta* National Poverty Alleviation Strategy
PJ	PetaJoule
PNPB	*Plano Nacional para uso e Produção de Biodiesel*
PPO	Pure Plant Oil
PROINFA	*Programa de Incentivo a Fontes Alternativas de Energia Elétrica*
PRONAF	*Programa Nacional de Agricultura Familiar* National Programme for Family Farming
PRSP	Poverty Reduction Strategy Paper
R&D	Research and Development
RSB	Roundtable for Sustainable Biofuels
RTFO	Renewable Transport Fuel Obligation Programme (UK)
SADC	Southern African Development Community
SGS	*Société Générale de Surveillance*
SLIMF	Small and Low Intensity Managed Forests
SPS	Sanitary and Phytosanitary Measures
TBT	Technical Barriers to Trade
UK	United Kingdom
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNICA	*União Industrial de Cana de Açúcar* Industrial union of sugarcane producers
US	United States
WTO	World Trade Organization
WUR	Wageningen University & Research Centre
WWF	World Wildlife Fund

1. Introduction

Why learning from existing experiences if our goal is to give recommendations on future developments regarding sustainable biofuels? One answer can be found in philosopher George Santayana's famous proclamation: "Those who cannot remember the past are condemned to repeat it" (Santanaya, 1953 384). This quotation is widely used to argue that exploring the past helps us understand who we are today and where we are going (Wyche et al., 2006 36).

Increasing fossil fuel prices and growing concerns regarding their finiteness, use and impacts (including climate change) have driven the demand for biomass for energy purposes worldwide (Commission of the European Communities, 2006; Braun, 2007; van Dam et al., 2008 750). In Mozambique, there is a growing interest in the production of biomass for biofuels. Currently, big investments are made by mostly foreign private investors. In different parts of the country plantations of sugarcane, Jatropha, sweet sorghum and cassava have emerged; of which some have the intention of growing up to 150,000 ha. Biofuel production is perceived as a good alternative for fossil fuels, and framed as a pathway out of poverty for development countries by creating local labour opportunities, and stimulating local, regional and national economies. However, there is little known about the direct and indirect ecological, social and economic side-effects of biofuel production for countries like Mozambique. The food-fuel-feed discussion provides a good example of how biofuel production could compete for land, water, labour, and other resources.

As a response to deal with the possible environmental, social and economic impacts, multi-stakeholder platforms, the European Commission and governments of the Netherlands and the UK (amongst others) have formulated sustainability criteria for biofuel production. In response, the Mozambican government has requested to explore such criteria, and to think about how they could be operationalized to fit the Mozambican reality. To facilitate this process, the government has recently formed a subgroup sustainable biofuel production, which is under the supervision of the National Counsel for Sustainable Development *(Conselho Nacional de Desenvolvimento Sustentável – CONDES)*, part of the Ministry for Coordination of Environmental Affairs *(Ministério de coordenação e acção ambiental – MICOA)*.

This research project seeks to contribute to the subgroup sustainable biofuel production in three distinct ways. Firstly, we provide an overview of biofuel policies and experiences with sustainable biofuel production from Brazil. Secondly, we have studied the development and implementation of existing certification systems like FSC, GlobalGAP and fair-trade in Mozambique which provided insight on the challenges and opportunities accompanying certification in the Mozambican context. Thirdly, we have made an inventory of existing biofuel initiatives in Mozambique, linking them to policy objectives and providing hands-on case study experiences that were gathered during fieldwork.

2. Background Mozambique

This chapter provides general information on Mozambique, its economy, development and agricultural situation. Subsequently we describe trade-agreements which are relevant for Mozambique's position in the global biofuel market. Thirdly, biofuel-related laws, policies and legislation are described. This includes the land-law, investment law, National Poverty Alleviation Strategy (PARPA), the national biofuel policy and strategy and agro-ecological zoning.

2.1 General information on Mozambique

The Independent People's Republic of Mozambique was formed in 1975, with Samora Machel as its first President. In the years that followed, Mozambique was wracked with flooding, drought and political instability. An armed conflict between Frelimo (*Frente de Libertação de Moçambique*) and Renamo (*Resistencia Nacional Moçambicana*) uprooted social networks and destroyed most of Mozambique's commercial and transport infrastructure, educational and health systems. In 1986, Samora Machel died in a plane crash, and was succeeded by the more moderate Joaquim Chissano. A peace agreement was signed between Frelimo and Renamo in 1992. In 1994, Mozambique held its first democratic election, with Frelimo narrowly winning. Since then, Frelimo has been the ruling party in Mozambique, with Renamo and MDM (Mozambique Democratic Movement) as main opposition parties.

Mozambique is one of the fastest growing economies in sub-Saharan Africa, with a growth of around 7% per annum, since the early 1990s (World Bank, 2008b). Although poverty rates had dropped from 69% in 1997 to 54% in 2003 (Arndt et al., 2008 1), Mozambique is still among the world's poorest countries. On the August 2007 Human Development Index (HDI) it ranked 172 out of 182 countries, the lowest among the 14 Southern African Development Community (SADC) (UNDP, 2009). Mozambique has an extremely low level of national development, with a GPD per capita US$364 in 2007[1] (World Bank, 2008b). The country has approximately 21.4 million inhabitants with an average life expectancy of 42 years at birth (World Bank, 2008b) Between 2002 and 2004, there was a prevalence of undernourishment of 44% in the total population (FAO, 2008 17). Of the current population, approximately 85% are rural subsistence farmers with little or no education. The country is vulnerable to natural disasters and food insecurity, as around 30% of the population is food deprived (FAO, 2007a).

Mozambique has an average population density of 20.1 people per square kilometer (WFP, 2009). In 2000 population rates per km^2 were highest for Nampula, Maputo and Zambézia provinces. Lowest population density was found in Niassa and Tete provinces reflecting potential labor force (table 1). According to the Mozambican Household Survey 2002-2003, adult literacy rates are around 50% (HDI for 2007 indicated average literacy rates 44.4%). There is evidence of large differences in illiteracy rates between rural households (73%) and urban households (34%) (Castanheira Bilale, 2007 78). Manica, Maputo, and Maputo City province scored much higher than average literacy. In most other provinces, adult literacy rates were below the average; with Cabo Delgado and Nampula at the lower end. In rural areas, on average 80.7% of adult residents did not have any formal education (Castanheira Bilale, 2007 82). In Nampula (82%), Zambézia (79%), Cabo Delgado (76%) and Tete (70%) between 70-82% of the population had no formal education, and between 10 and 20% had only achieved primary education. Looking at current school enrolment figures (NER) we found that nowadays around 80% of children between 6 and 18 years are enrolled at school. The difference between provinces was still present, with Maputo, Maputo City, Gaza, Inhambane and Manica province amongst the highest, and Nampula, Tete, Sofala, Cabo Delgado, Niassa and Zambézia provinces at the lower end (table 1).

[1] GDP per capita was calculated by dividing total GDP (US$ 7.8 billion) by estimated population in 2007 (21.4 million)

Province	*Population density (population per km²)*	*Literacy rates*	*NER*
Maputo City	Not included	77%	93%
Nampula	37.8	32%	69%
Maputo	35.6	67%	94%
Zambézia	28.1	40%	77%
Sofala	19.1	47%	71%
Cabo Delgado	16.4	28%	72%
Inhambane	16.4	52%	86%
Manica	15.6	60%	84%
Gaza	14.0	53%	90%
Tete	11.3	45%	70%
Niassa	6.2	49%	74%
Average for Mozambique	20.1	50%	80%

Table 1: Population density, literacy rates and Net Enrolment Rates (NER) per province after data from CAP 1999-2000 (quoted in Coughlin, 2006 6) and Castanheira Bilale (2007)

Portuguese colonization and the war that lasted until 1992 destructed and uprooted most of Mozambique's social and physical infrastructure (Newitt, 1995 570; Arndt et al., 2000). Cooperatives and unions were systematically destroyed and service provision, such as access to agricultural inputs and extension, disappeared. In 2002 the highest percentage of communities with access to improved seeds, fertilizers and pesticides were found in Manica, Sofala and Inhambane provinces. For Tete this was the lowest (TIA 2002 in Coughlin, 2006 13). Access to extension services was low in every province with an average of 1.3 extension workers per 10,000 inhabitants (MADER, 2004 cited in Coughlin, 2006 32).

Despite recent investments in roads, the density of the road network is the lowest in southern Africa, only 32 kilometers per square kilometer (World Bank, 2006a xvi). "Under the Portuguese colonial government, roads and railways were mainly laid to facilitate the exportation of agricultural produce from Malawi, Zambia and Zimbabwe" (Coughlin, 2006 6). The deep-sea ports of Maputo, Beira and Nacala are still used by Mozambique's neighboring countries to export and import a substantial part of their commodities (Meeuws, 2004 5). These ports have (fuel) storage and processing facilities and are well accessible by road. Poor north-south infrastructure makes transport by road inside the country more costly than exporting from the nearest port (cf. World Bank, 2005 60; Coughlin, 2006 6).

Efforts to provide electricity to rural Mozambique are mainly concentrated around urban centers, such as the Beira and Maputo corridors, and along the coast (OCIN, 2006). There are plans for building of a 1,000 kilometers north-south power line, linking hydroelectric, coal- and gas-fired power stations in central and northern Mozambique with the main consuming areas in the south. At present, Mozambique imports most of its power from neighboring South Africa (EarthTimes, 2009).

Mozambique's expenditures exceed revenues, and the country is still highly dependent on external aid and imports. As Mozambique is fully dependent on fuel imports (FAO, 2008 17), a considerable and increasing amount is being spent on fuel and energy; 10% of total import in 1997, 15% in 2006 and 17% in 2007 (World Bank, 2008b). The total import in 2007 amounted to US$3,093 million and exceeded exports which amounted to US$2,412 million (World Bank, 2008b). The country's main export commodities include aluminium, cashews, prawns, cotton, sugar, tobacco, bulk electricity from hydropower, and natural gas. The main export markets are EU (61% of total exports in 2002), South Africa (18%), Zimbabwe (6%), followed by UK, Switzerland and China. Imports mainly come from South Africa (30% of total imports in 2002), the EU (12%), and the USA (5%). In the first three months of 2009 export decreased with 36% compared to the same period in 2008 (Noticias, August 21, 2009a). Over the last years, foreign direct investments in Mozambique have

increased substantially (Econergy, 2008 ES1). According to the World Bank (2009a), sustaining the performance of the country's economy requires further investments and reforms to improve the business environment, make the legal and judicial sector more effective, strengthen the overall governance framework, and further decentralize and encourage the delivery of key services, especially in rural areas.

Mozambique stretches 2,500 km along the coast of southeast sub-Saharan Africa and has a land area of 799.390 km² of which 45% is suitable for agriculture (PARPA II, 2006). The country has a large diversity of biophysical, geological and climatic conditions. Except for some humid tropical mountains in Zambézia and Manica province, the majority is low-lying coastal and semi-arid plains with a number of rivers flowing through into the Indian Ocean. The northern and central parts of the country consist of semi-arid, wet and sub-humid zones knowing well-defined rainy seasons. The South is characterized by arid and semi-arid zones with erratic rainfall (Bias and Donovan, 2003 23). The rainy summer season from December to March starts earlier in the South and gradually spreads to the North, and is followed by the dry winter season from April to November. Agriculture in Mozambique is mainly rain-fed, with average precipitation varying from 400 mm/year in the southwest to 2,600 mm/year in the humid mountains.

Smallholders dominate agriculture in Mozambique. The 3.2 million small farmers contribute to 95% of the agricultural GDP, and 24% of the total GDP. Table 2 shows that commercial farmers (around 400 in 2006) contribute to 5% of the agricultural GDP and 1.3% to the total GDP (Coughlin, 2006 25). Average cultivated area per agricultural household is 1.4 hectares (Coughlin, 2006 4). Productivity of the agricultural sector is relatively low as it presents 25% of the GDP (FAO, 2007b; World Bank, 2008b). This is mainly due to limited use of irrigation, low availability, adoption and use of agricultural technologies, and poor rural infrastructure (Coughlin, 2006 26). Agriculture employs about 80% of the estimated 8.8 million labour force (African Development Bank, 2008 3; Econergy, 2008 ES4). The remaining 20% is involved in the industrial, transport, communication and service sectors (World Bank, 2009a).

	%	*US$*	*Source:*
Mozambique's GDP in 2007	100	7,800,000,000	(World Bank, 2008b)
Average agricultural contribution to GDP in 2007	25.3	1,973,400,000	(FAO, 2007b; World Bank, 2008b)
Subsistence farmers' contribution to agricultural GDP	95	1,874,730,000	(Coughlin, 2006)
Subsistence farmers' contribution to total GDP	24	1,874,730,000	
Commercial farmers' contribution to agricultural GDP	5	98,670,000	(Coughlin, 2006)
Commercial farmers' contribution to total GDP	1.3	98,670,000	

Table 2: Overview of subsistence and commercial farmers' contribution to agricultural and total GDP

Agriculture mainly takes place in the fertile central and northern regions with higher and more reliable rainfall, accounting for the country's food crop production; maize, sorghum and cassava, and the main cash crops; sugar, cashew nuts, cotton, tea and tobacco (World Bank, 2006b). Mozambique has 36 million ha of arable land, of which approximately 10% is under cultivation (FAO, 2007b). Average maize yields are below 1 t ha^{-1}, based on neither mechanization nor use of inputs (FAOSTAT 1980-2003 in: ODI, 2004 9). According to FAO: "Agro-ecologically attainable yields in a high-input agricultural production system of the three most important cereals range from 8 to 12 t ha^{-1}" (cited in: Batidzirai et al., 2006 59). Moreover: "Cultivated land is expected to increase by 26% to say 8 million hectares by 2015" (Batidzirai et al., 2006 56-57). Integration in international markets is limited: agriculture provides only 16% of exports and the agribusiness sector is small, with larger-scale plantations accounting for under 1% of total surface area, or 3% of currently cultivated land (Econergy, 2008 4).

2.2 PARPA

According to Mozambique's Minister of Energy: "The government decided to embark upon the promotion of biofuels production and use, with the aim of responding to our National Poverty Alleviation Agenda, especially in rural areas" (Namburete, 2009). The government of Mozambican intends to further reduce poverty from 54% in 2003 to 45% in 2009 through their Poverty Reduction Strategy Paper (PRSP), also called the Action Plan for the Reduction of Absolute Poverty (PARPA). The PARPA is developed in cooperation with the World Bank and other donors and stresses that economic growth must be both rapid and broad-based to benefit the poor. It describes the country's macroeconomic, structural and social policies and programs to promote growth and reduce poverty, as well as associated external financing needs (World Bank, 2009b). The strategy is based on an average growth rate of 8% for the period 2001-2010, taking regional differences into account. The PARPA involves spending about two thirds of public expenditure on priority sectors; of which 30% on education, 20% on health, 29% on infrastructure, 6% on agriculture, and 12% on good governance. It emphasizes reduction of rural poverty, as the majority of Mozambique's population live in rural areas. Moreover, in relation to biofuel production, the PARPA contains efforts to provide more reliable energy sources to the rural areas, and to contribute to general energy security and climate protection, as part of international efforts (PARPA II, 2006). The PARPA highlights the connections between energy and poverty reduction in that increased access to affordable energy sources for domestic and industrial use would function as a catalyst for stimulating economic development (Jumbe et al., 2009 3). Like other southern African countries such as Madagascar and Malawi, Mozambique has explored the potential for decentralized and renewable energy options for meeting future energy needs (Jumbe et al., 2009 3).

The World Bank's Country Partnership Strategy for 2007-11 sets forth priorities and activities to support Mozambique's efforts to reduce poverty and promote sustainable economic growth. The strategy is designed to be aligned with the Government's PARPA II, and is guided by three overarching principles:

- Increased accountability and public voice
- Equitable access to key services
- Sustainable and broad-based growth

The strategy also seeks to address cross-cutting issues such as HIV/AIDS, private sector development, and capacity and institutional strengthening (World Bank, 2009a).

In relation Mozambique's PARPA three major biofuel-related areas can be distinguished:

1. Alleviation of food insecurity and increased agricultural productivity: Even though about 80% of the country's population is engaged in agriculture, about 54% lived below the poverty line in 2003 (De Matteis et al., 2006; PARPA II, 2006; USAID, 2009b). According to De Matteis et al. (2006 7) 35% of the population is highly vulnerable to food insecurity, due to low purchasing power and poor infrastructure limiting access to food. Surprisingly vulnerability to chronic food insecurity is highest in the Northern provinces, whereas the southern ones are more prone to natural disasters such as floods and droughts decreasing food production. Many claim that food insecurity in Mozambique is therefore not only the result of food availability within the country, but a consequence of the ineffective accessibility, storage and distribution of food (cf. Batidzirai et al., 2006 55; USAID, 2009a). It is expected that biofuel production changes this situation to the better by facilitating and encouraging new production methods to increase output and efficiency; improving infrastructure; promoting dual production models (food/economic commodities and biomass production); and attracting large-scale investments into the sector, which will facilitate agricultural research, development and production. This, according to policy-makers, should eliminate any questions that may relate biofuel production to food insecurity. The biofuel production program has been developed to balance space for the population, biofuel and food production (Noticias, February 13, 2009). Competition between food and biofuel production will be avoided as food production has priority in designated areas.

2. Reduce dependency and oil imports: Mozambique is fully dependent on oil imports (FAO, 2008 17). The government decided to promote biofuel production to provide a response to high, unpredictable and volatile oil prices on the world markets (Namburete, 2009). Oil imports are determined by international oil prices, and by the exchange rate dependent on the value of the Mozambican Metical to the US Dollar. It is expected that biofuels could contribute to 15% of Mozambique's fuel consumption in the coming five years (2009-2014) (Noticias, February 13, 2009), which could reduce Mozambique's dependency on oil imports. The current energy consumption consists for 90% of charcoal and firewood, only 7-8% of petroleum products and 1-2% of electricity.

3. Generate employment and income: "Mozambique is strategically positioned to exploit its potential to produce biomass energy for export to the international market as well as meet some of its own internal energy needs" (Batidzirai et al., 2006 78). This could generate income both at the macro-, as well as the micro-economic scale. In line with the Mozambican government's agricultural and economic development policies, sustainable cultivation of energy crops should contribute to open up rural areas, creating employment, improving degraded land and infrastructure while generating foreign currency from exports (Batidzirai et al., 2006 78).

2.3 Trade agreements

Mozambique is a signatory to several trade agreements that establish the terms and conditions for access of Mozambique's potential biofuel production to regional and international markets, with the EU, the US and as member of the SADC (cf. Rebello Da Silva and L. Da Silva Garrilho, 2003 84-85).

Access to the EU market for biofuels is granted under two key agreements:

1. The Cotonou Protocol between the EU and African, Caribbean and Pacific countries, which is in the process of being transformed into a regional economic partnership agreement (EPA) between the EU and SADC.
2. The 'Everything But Arms' arrangement which grants duty-free access to the EU market for all goods (except arms) for least developed countries.

As a result, duty-free access is provided for ethanol, biodiesel, and vegetable oil exports from Mozambique to the EU. However, only ethanol and biodiesel deemed to have been produced according to the EC's recently published sustainability criteria will be eligible for the market incentives for biofuels sold on the EU market.

Mozambique also has duty-free access to the US market under the Generalized System of Preferences (GSP) which grants reduced duty or duty-free access to developing countries. This was extended by the African Growth and Opportunity Act (AGOA) in 2000. This US Trade Act significantly enhances US market access for 39 sub-Saharan African countries, including Mozambique.

The SADC Trade Protocol is an agreement between eleven SADC members[2] aimed at promoting regional trade. Under this agreement, tariffs on intra-regional trade of certain goods have been eliminated or reduced. Tariffs on so-called 'sensitive goods' are to be eliminated by 2012, although final details remain under discussion, and Mozambique has until 2015 to comply. When fully implemented, the protocol will give Mozambican products duty-free access to a market of over 200 million people with a GDP of US$275 billion, with reciprocal treatment for the goods from the other members (Embassy of the United States, 2006). However, in the case of biofuels, the final size of the regional market and Mozambique's access to it will depend on the establishment of harmonized fuel standards and blending mandates or authorization in the other member countries.

[2] Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe

2.4 Biofuel related laws, regulation and policies

2.4.1 Land law

According to the Constitution, all natural resources in Mozambique, including land, belong to the state. Land acquisition procedures are governed by the Land Law[3] and its Regulation[4] and culminate in the attribution of a 50-year renewable lease in the form of a land title or DUAT (*Direito de Uso e Aproveitamento dos Terras*). The Land Law states clearly that: "Land is the property of the State and cannot be sold or otherwise alienated, mortgaged or encumbered"[5], and establishes three means of acquiring land:

1. Through existing occupation established by customary norms and practices,[6] including used and unused (fallow and common) lands that a rural household needs to have access to and control over for a certain period of time.
2. Through existing occupation 'in good faith',[7] when people have occupied the land for at least ten years without challenge, which aims to protect the rights of displaced persons that settled in lands during the war that were formerly owned by colonial powers.
3. Through a formal request to the State.[8] Formal requests to the State must be accompanied by a community consultation[9], which seeks to ensure that community rights are taken into account and provides an opportunity for communities to negotiate some element of compensation or benefit with investors.

DUATs can also be transferred from one titleholder to another, without State intervention, most commonly through the acquisition of an existing titleholder's assets, such as buildings and infrastructure. However, formal titles are linked to an approved production plan, such that investors have to receive authorization from the government if land acquired in this way is intended for other use.

Land requests submitted to the government are initially evaluated by the relevant government departments that oversee the activity[10] at provincial level. When the area requested is greater than 1,000 ha, and therefore no longer the remit of the Provincial governor alone, evaluations are requested from the relevant government departments at national level, and requests have to be authorized by the Minister of Agriculture.[11] Requests for over 10,000 ha of land are submitted for consideration and decision to the Council of Ministers.[12] Provisional DUATs are attributed for two years to foreigners and five years to nationals, after which definitive DUATs are allocated, subject to review by the government that production plans have been fulfilled.

2.4.2 Investment law

The basic legal framework for investment in Mozambique is established by the Investment Law (Law No. 3/93). The Regulation of the Investment Law, approved by Decree No. 14/93 and subsequently altered by Decree No. 36/95, defines the procedures for project evaluation. The government's Investment Promotion Centre (CPI) is responsible for implementing the legislation. Government approval of an investment project is necessary to gain access to certain fiscal benefits provided under the Code of Fiscal Benefits[13] and expressed

[3] Law No. 19/97 of October 1
[4] Decree No. 66/98 of December 8
[5] Article 3 of the Land Law.
[6] Article 12 of the Land Law and Article 9 of the Regulation of the Land Law.
[7] Article 12 of the Land Law and Article 10 of the Regulation of the Land Law.
[8] Article 12 of the Land Law and Article 11 of the Regulation of the Land Law.
[9] Article 13 of the Land Law and Article 27 of the Regulation of the Land Law.
[10] Article 24 (2) of the Regulation of the Land Law, Article 26 (1) of the Regulation of the Land Law.
[11] Article 26 (3) of the Regulation of the Land Law.
[12] Article 22 (3) of the Land Law.
[13] Law no. 4/2009 of 12 January, which altered Decree no. 16/2002 of 27 June, subsequent to the original Code of Fiscal Benefits approved by Decree no. 12/93 of 21 July.

in a legal agreement between the government and the investor. In addition, the Land Law requires that foreigners have an approved investment project in order to apply for a DUAT.[14]

The Code of Fiscal Benefits establishes incentives for investors to locate production in certain provinces that are deemed to be less developed than others. Two location-specific incentives are granted:

1. Investment tax credits for five years are provided, equal to 5% of total realized investment in Maputo City province and 10% for other provinces. A greater distinction is made in relation to designated "rapid development zones"[15], which are privy to a tax credit equivalent to 20% of total realized investment.
2. Deduction of expenditure on infrastructure undertaken by the investor, equal to 110% of expenditure for projects located in Maputo City province and 120% of expenditure for projects in other provinces. No additional benefit is granted for the rapid development zones.

In September 2009, the government of Mozambique announced its plans to create three special industrial free zones in the city of Nacala-Porto, Nampula province. The objective is to promote social and economic development of some provinces in the centre and north of the country, namely Zambézia, Tete, Niassa and Cabo Delgado (Macauhub, 2009d). This would be most relevant for (biofuel-related) processing activities, which heavily depend on imported goods and machinery.

All investment proposals have to be signed off by the Minister for Planning and Development, which oversees CPI. Where proposals involve areas of more than 10,000 ha or investment values greater than US$100 million, they have to be submitted to the Council of Ministers for approval.[16] Prior to going to the Council of Ministers, projects are normally reviewed by the Economic Council which comprises the key Ministries involved in the social and economic sectors, chaired by the Prime Minister.

2.4.3 Linking land and investment

Until recently, the process for evaluating land title requests and the evaluation of investment proposals linked to these requests were quite separate. The land title process concentrated mainly on the administrative steps laid down by the Land Law and its Regulation, while investment proposals were evaluated by CPI.

Related to the increase in expressions of interest for large tracts of land, the government made two changes to the project review procedure. Firstly, it tightened the link between the processes for awarding land titles and approving investment proposals. Whereas previously a proposal for a large-scale investment project could be approved by the Council of Ministers independently of the land process, from 2007, investment and land requests had to be submitted together to the Council of Ministers, with the two processes being launched simultaneously.[17] In addition, the Provincial Governor had to submit an evaluation of both the land request and investment project. Secondly, at the end of 2008, the Council of Ministers approved the introduction of Investment Guidelines (Resolution 70/2008). These guidelines are applied to large-scale projects, defined as more than 10,000 ha, establishing the type of information required for the presentation of projects to the Council of Ministers for their analysis. This now represents the legal basis for the evaluation of large-scale agrarian projects, including many of the biofuels projects submitted to the government.

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[14] Article 11 of the Land Law and Article 18 of its Regulation.

[15] These are geographical areas which have "great natural resource potential but which are lacking in infrastructure and have a weak level of economic activity" (Code of Fiscal Benefits). These include the Zambeze river valley, which covers all districts in Tete province, most districts in Zambézia and Sofala provinces and four districts in Manica province, Niassa province and Nacala district.

[16] Article 15 of the Regulation of the Investment Law. This article states that agricultural projects of over 5,000 has and forestry and livestock projects of over 10,000 has should be submitted to the Council of Ministers. However, Article 22 (3) of the Land Law, which stipulates that requests for over 10,000 should go to the Council of Ministers seems to have taken precedence.

[17] Circular no. 009/DNTF/07 of October 16, 2007, on the basis of the "necessity and urgency to impose common procedures in relation to some subjects relating to the processing (*tramitação*) of steps to obtain DUATs, with the objective of greater institutional efficiency and due synchronization with the Law and Regulation (*of the Land Law*)".

2.4.4 National biofuel policy and strategy and agro-ecological zoning

On May 21, 2009 the Mozambican government published a national biofuels policy and strategy (Resolution 22/2009) based on a study on the technical, economic, social and environmental feasibility of biofuel production in Mozambique (Econergy, 2008). The Resolution, approved by the Council of Ministers on the 24th of March 2009, should contribute to energy security and socio-economic sustainable development by exploring agro-energetic resources through stimulating the diversification of the energy mix, contributing to the well-being of the population and create socio-economic development, particularly in rural areas (Government of Mozambique, 2009 15). Some of the important political and strategic pillars are: the quick establishment of a national biofuel market; promote feedstock according to the agro-ecological zoning exercise; increase export to create tax-revenues and foreign currency; avoid the use of basic food crops and monocultures, and favour biofuel development that enhances biodiversity; adopt national blending targets; promote local processing capacity to add value; significantly higher biofuel tax than the present 20-40% to support the build up of the sector; and limitation in land approval (referring to the agro-ecological land zoning exercise) (Government of Mozambique, 2009).

Based on sustainability of feedstocks as well as evaluating their potential for income generation, cost of production, socio-economic and environmental impacts the selected crops for biofuel production in Mozambique are sugarcane and sweet sorghum for ethanol, and Jatropha and coconut for biodiesel production. Even with modest expectations of biofuel expansion (450,000 ha), combined with mandatory blending of E10 (10% of ethanol, 90% of gasoline) and B5 (5% of biodiesel with 95% of fossil diesel) the biofuel industry is expected to generate substantial macroeconomic benefits amongst which approximately 150,000 new jobs including the ones created through new self-employing businesses. Two-third expected to work in the biodiesel sector (100,000 jobs), the rest in the production of ethanol (50,000 jobs) (Government of Mozambique, 2009 17-18).

In the national biofuel policy and strategy, the agro-ecological zoning exercise plays an important role. The zoning was coordinated by an inter-ministerial working group in which the National Institute of Agronomic Research (*Instituto de Investigação Agrária de Moçambique* – IIAM) was responsible for the agro-climatic analysis, and the National Directorate for Land and Forestry (*Direcção Nacional de Terras e Florestas* – DNTF) did the land availability analysis. The first phase of this study was finalized in 2008; identifying 6,966,030 ha (19.4% of total arable land) as available[18] for large-scale agricultural activities. The study was conducted at a scale of 1:1,000,000, which subsequently provided a generalized image of land-availability in the country (capturing contiguous areas of more than 1,000 ha). Subsequently, 3,780,933 ha (54%) was found suitable for large-scale agriculture (including biofuel developments), the other 3,185,097 ha (46%) was identified for other purposes such as: forestry and grazing (Government of Mozambique, 2008). An overview of land-availability is provided in figure 1. Table 3 shows the allocation of available land per province.

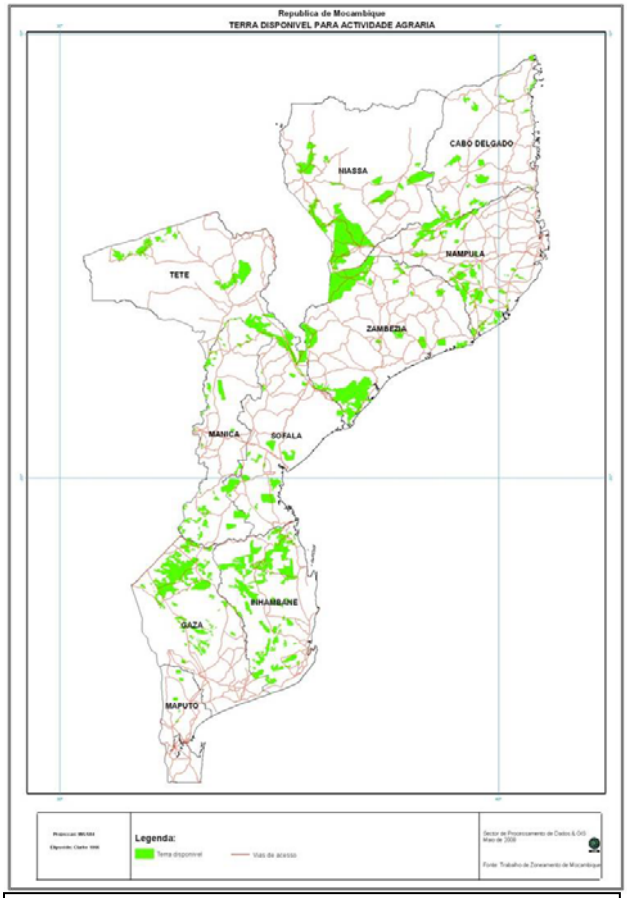


Figure 1: Identified available land for large-scale agricultural activities (scale 1:1,000,000) (IIAM & DNTF, 2008)

Province	*Available land (ha)*	*% of total*
Zambézia	1,365,300	19.6%
Niassa	1,220,400	17.5%
Inhambane	1,071,660	15.4%
Gaza	866,780	12.4%
Nampula	709,160	10.2%
Tete	661,730	9.5%
Sofala	408,650	5.9%
Manica	381,950	5.5%
Cabo Delgado	269,400	3.9%
Maputo	11,000	0.2%
Total:	6,966,030	100%

Table 3: Allocation of land per province according to the agro-ecological zoning exercise (IIAM & DNTF, 2008)

There was quite some critique on the first zoning exercise. The scale was too large, soil-suitability data were supposed to be out-dated and only rainfall-data from the 1980s were available. The zoning did only consider water availability from rainfall, which reduced the opportunities for irrigated agriculture near rivers. Moreover, the accuracy of zoning was questionable. "A random locality in Mozambique identified as available and suitable based on the interrogation of 1km^2 satellite databases, turned out to be extensively utilized and inhabited when viewed at the finer resolution provided by Google Earth" (Watson, 2008 13).

Currently, a second phase of zoning is being carried out at a scale of 1:250,000. The primary focus will be on provinces with high interest of investors such as Manica, Sofala and Zambézia provinces.

[18] Note by the authors: Availability does not equal suitability

3. Biofuels, sustainability criteria and the Mozambican response

3.1 The need for biofuels

Over the past years biofuels have become a global issue, largely due to rising concerns about global energy security, increasing energy prices and concerns about climate change (Braun, 2007 1). The Kyoto Protocol, which was approved in February 2005, was an important push for the emerging biofuel industry and related investments, especially in developing countries (FACT Foundation, 2008). Currently, discussion on biofuels range from very positive and promising; biofuels can be used as a way to reduce carbon emissions and the reliance on fossil fuels, to very negative and concerning mostly related to food insecurity, displacement of local communities, negative environmental impact and loss of biodiversity.

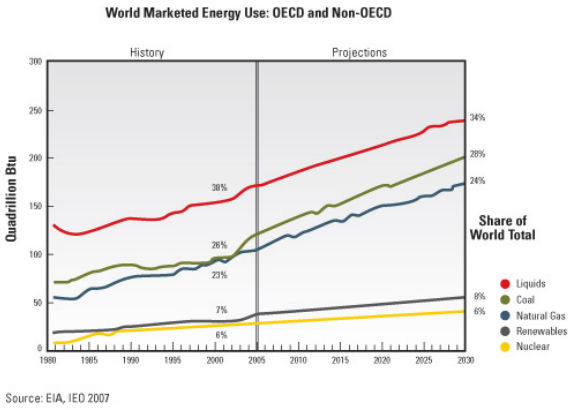


Figure 2: World marketed energy use (EIA, 2007)

As the figure 2 shows, all forms of energy consumption has increased since the 1980s, with liquid fossil fuels as most consumed, and coal and renewable energy as the fastest growing energy sources (EIA, 2009). Despite its growth, the consumption of biofuels only represents a small percentage of the global energy consumption. In 2005, out of the total 116.8 billion giga joules (BGJ) of energy generated and consumed in the world, 115.7 BGJ came from fossil sources (gasoline 48.1 BGJ, diesel 53.8 BGJ, LPG 11.9 BGJ, kerosene 3.9 BGJ). Only 1.1 BGJ (less than 1% of the total) came from biofuels such as ethanol and biodiesel.

The limited availability of fossil fuels puts pressure on the whole debate, especially when fuel prices are high. There are many different opinions on when fossil fuels will run out. Current estimations suggest within 50 years. Research over the last decades reflects a consensus among oil experts that oil reserves are within the range of 1,800 to 2,200 billion barrels. By the end of 1999, the world had consumed approximately 857 billion barrels of these reserves (MacKenzie, 2000). This shows that the rate of consumption is a great concern, especially when the worldwide energy consumption is ever increasing (EIA, 2009).

Although the global consumption of liquid biofuels is limited, and production costs are still higher than fossil fuels, there is a growing interest in the production of biomass as a renewable energy source. “International trade in biofuels and related feedstock may provide win–win opportunities to all countries: for several importing countries it is a necessary precondition for meeting self-imposed targets.[19] For potentially producing countries, especially small and medium developing countries, these export markets are necessary to initiate their industries” (van Dam et al., 2008 750), and could generate economic and environmental benefit, create additional employment, reduce energy import bills and open up potential export markets (Commission of the European Communities, 2006 4).

3.2 History of biofuels

Using biomass for energy purposes is as old as since man discovered using fire for heating, cooking and later for transport. Wood was the first large-scale application of biomass used until the mid 18th century. At the end of the 18th century, man started using coal. In many industrialized countries, wood and coal remained the

[19] For example the European Commission’s Energy Policy target for biofuels of 10% of vehicle fuel by 2020

primary energy source until replaced by natural gas and electricity in the 1950s. In development countries like Mozambique the current energy consumption still consists for 90% of charcoal and firewood, only 7-8% of petroleum products and 1-2% of electricity.

The use of ethanol for transport dates from the beginning of the 18th century. The first automobiles ran on pure ethanol. When the automobile became increasingly popular as means of transport, the American oil industry 'pushed' the use of gasoline. Gasoline could be offered for a cheaper price, but people like Fort already indicated that ethanol could help farmers and keep nations independent of political oil pressure. Until the 1930s, many countries were using ethanol fuels. Scientists and engineers were enthusiastic about the clean burning and high compression characteristics of ethanol fuel. Nevertheless, the US oil industry claimed it was technically inferior to the use of fossil fuels. After a strong lobby, the oil industry became leading as energy supplier. There are certain moments in history (first and second World Wars, fuel crisis in the 1970s) that show an increased demand for biofuel due to shortage of fossil fuel. From the 20th century, attention for biofuels increased again. Besides economic concerns based on high fuel prices and increasing dependency on fossil fuels, the climate change debate gave birth to renewed attention for renewable energy such as biofuels.

Biofuels can be categorised as alternative energy sources. Besides biofuel, some other alternatives to the conventional fuels are solar, wind and hydropower, which are also called renewable energy sources. These form by far the most environmentally friendly forms of producing energy. The main reason why biofuels receive much attention is because its appropriateness for the transport sector. So far, it is the only renewable energy source that can be added to fossil fuel without major adaptations in car engines, infrastructure and logistics.

The main sources of biofuels are plant and plant-derived materials, called biomass. It can be in solid, liquid or gas state. From biomass, four different types of biofuels can be produced: bioethanol, biodiesel, vegetal oil and biogas. Some of the agricultural products that are specially grown for the production of bioethanol are sugarcane, sweet sorghum, cassava, maize, and switch grass. Recent biofuel developments manly focus on:

- Bioethanol: Can be blended with gasoline up to 10% for use in normal gasoline engines, or higher in adapted engines. The world market leader in ethanol is Brazil, who have been producing sugarcane for ethanol to reduce dependence on fossil fuel imports. In Brazil, ethanol is highly competitive with gasoline. More recently, ethanol is produced from corn in the US. In 2006 ethanol accounted for 90% of the global biofuel production; the remainder (10%) was oil-based (FACT Foundation, 2008).
- Biodiesel: Can be produced from for example Jatropha, soybean, coco, groundnut, canola, palm, cottonseed, sunflower, castor and industrial waste. Biodiesel is an oil-based biofuel and can be used as Pure Plant Oil (PPO), or as biodiesel which is the result of the esterification of the PPO. Biodiesel can be blended with petroleum-based diesel for use in conventional vehicles. Cars that use 100% biodiesel or run on PPO need technical modifications.

In general, biofuels can be distinguished in several generations (Biopact, 2007a; Lerner, 2009). The first generation biofuels are made of food crops, grains, vegetable oil or animal fat by using fermentation and trans-esterification as bioconversion technique. This first generation encountered problems as for the negative impact on food prices (when made from grains) and biodiversity (especially in the case of palm oil). A second generation of biofuels tries to dispose this negative image by using techniques that allow the use of different types of biomass. Besides the use of first generation crops, also grass species, non-edible crops, trees, agricultural and industrial residues are used. The World Energy Council recently estimated that second generation biofuels could replace approximately 40% of all petroleum based transport fuels by 2050 (Biopact, 2007b). The latest, third generation developments in biofuels explore the use of low-input but high-yield

organisms such as algae. Some sources claim that: “Micro-algae are capable of producing more than 30 times the amount of oil (per year per unit area of land) as compared to regular oil seed crops”.[20]

Developments in the field of biofuels go rapidly. The fourth, carbon-negative generation of biofuels is under study supposed ‘to clean up the past’. Test flights are being carried out to explore the use of biofuels in the airline industry. Airlines including Virgin Atlantic, Continental, Air New Zealand and Japan Airlines have already flown routes with one engine partly powered by a range of biofuels including algae and Jatropha based biodiesel (Jacobson, 2009). For the test flight of Air New Zealand, Jatropha oil was used that came, among others, from Mozambique (The Bioenergy Site, 2008). Countries like Brazil and China, have identified sub-Saharan Africa as a region with high biofuel production potential (affordable labour and supposedly abundant land resources), necessary to become a large-scale biofuel feedstock provider over the next decade (Oxford Analytica, 2009).

3.3 Biofuel sustainability criteria

By embracing international agreements on sustainable development, many national governments have committed themselves to environmentally sustainable development. One of the outcomes of the Earth Submit (United Nations Conference on Environment and Development), in Rio de Janeiro in June 1992 was the Kyoto Protocol. The treaty was negotiated in December 1997 at the city of Kyoto, Japan and came into force February 2005. The Kyoto Protocol is a legally binding agreement under which industrialized countries should reduce their collective emissions of greenhouse gases by 5.2% in 2012 compared to the emissions produced in the year 1990 (http://www.kyotoprotocol.com/).

Biofuels are high on the global political agenda. In December 2005, the European Commission (EC) adopted an Action Plan designed to increase the use of energy from forestry, agriculture and waste materials. The EC’s main focus is on the transport sector, which is responsible for around 21% of the EU's harmful GHG-emissions. A wide range of actions is already being taken. Vehicle manufacturers are developing new models that are cleaner and more fuel-efficient. As part of its Energy Policy for Europe, the EC is committed to encouraging the production and use of biofuels by proposing to set a binding minimum target for biofuels of 5.75% by 2010 and 10% of vehicle fuel by 2020” (Commission of the European Communities, 2006 8; Europe Press Release, 2007).

Protocols like Kyoto created opportunities for the promotion of renewable energy. The biofuel debate has intensified since the beginning of the new millennium. Research and media attention led to an increased awareness about global warming, its effects and subsequently attention for sustainable use of energy resources. This created, supported by the high fossil-oil prices, a ‘window of opportunity’ for investments in biofuel production, but also increased concerns about the potential negative impact on environment and local social and economic processes. Some of these concerns were summarized in the Econergy report (box 1) which assessed the potential competitiveness of Mozambique’s biofuels production in the domestic, regional and international biofuels markets (Econergy, 2008 ES1).

[20] http://www.svlele.com/algae.htm

Box 1: Some concerns quoted from the Econergy report (2008 250)

"There are, however, a number of potential risks associated with the biofuels industry, critics argue. This viewpoint cites the experience in Southeast Asia, for instance, and argues that to be competitive with traditional fossil fuels, the biofuels industry requires a large, constant, reliable flow of feedstock. This will keep the unit costs of production per liter of biofuels as low as possible. These large-scale requirements could result in a move toward large-scale commercial farming, which in turn could push small-scale rural farmers off the land and exclude them from the potential opportunities and benefits associated with biofuels. Large-scale production of biofuels could also result in the replacement of food crop cultivation with biofuel crops. This would, in turn, trigger an increase in food prices, increasing poverty and hunger."

"The cultivation of energy crops for the production of biofuels may also trigger – or exacerbate – several of the environmental problems typically associated with large-scale, agricultural commodity production such as deforestation, monocropping, water usage, land degradation and water pollution (IIED, 2007 2). Of these, the increased land take associated with biofuels production is a key concern, especially the impacts this may have on tropical forests, savannahs and biodiversity. It is not only the growing of biofuel crops that creates potential impacts. Processes put in place to produce biofuels also generate waste products that can affect the environment."

At different levels stakeholders are developing strategies on how to optimize potential and deal with the negative impacts. Several governments, supra-national institutes and multi-stakeholder groups have designed sustainability criteria to deal with these concerns. This has resulted in over 25 biomass certification initiatives which are either in place or under development. In order to deal with the expected legal, social, economic and environmental dynamics and processes, some leading individual countries (Netherlands and UK), the EC (supra-national level), and multi-stakeholder platforms such as the Roundtable for Sustainable Biofuels have developed sustainability guidelines.

In 2006, the Netherlands established a project group *Sustainable Production of Biomass* in 2006 (van Dam et al., 2008 752). The objective was to develop a framework principles that should be universal and in line with international initiatives. Moreover, it should be practical and verifiable, avoiding unnecessary administrative burden. In February 2007, the project group provided advice to the Dutch government and a testing framework which was published. The testing framework is intended for biomass that is applied in the Netherlands or is subsidized in the Netherlands (Cramer et al., 2007 3-4). The Cramer Criteria (as the framework got known) were benchmarked against existing certification systems such as Sustainable Agriculture Network / Rainforest Alliance (SAN/RA), the Round Table on Responsible Soy (RTRS), Integrated Farm Assurance for Combinable Crops (EurepGAP – changed in 2007 to GlobalGAP) and the Forest Stewardship Council (FSC). The benchmark exercise showed there was some overlap in the field of biodiversity, environment and social well-being, and little or no overlap in the field of GHG-emissions, competition with other biomass applications (food production) and prosperity (Cramer et al., 2007 55-56).

The UK implemented the Renewable Transport Fuels Obligation (RTFO) in April 2008, which requires companies to sell a minimum of 2.5% renewable transport fuels in the UK in 2008/2009, and 5% in 2010/2011 (Dehue et al., 2008 1). The RTFO programme includes sustainability criteria and indicators; categorized either as 'minimum requirements' or 'recommended'. The UK adopted a meta-standard approach to optimize the use of existing standards for sustainable agriculture (e.g. SAN/RA and EurepGAP), forestry (FSC) and multi-stakeholder roundtables for sustainable biofuel feedstock production (e.g. Roundtable on Sustainable Palm Oil – RSPO and RTRS).

On supra-national level: "The Brussels European Council of March 2007 reaffirmed the Community's commitment to the Community-wide development of renewable energies beyond 2010. It endorsed a

mandatory target of a 20% share of renewable energies in overall Community energy consumption by 2020 and a mandatory 10% minimum target to be achieved by all Member States for the share of biofuels in transport petrol and diesel consumption by 2020" (Council of the European Union, 2008 5). Following the initiatives of individual countries, the EC developed a policy framework to guarantee sustainable biomass production. Under Resolution 17086/08, Article 15, a set of legal, social and environmental sustainability criteria for biofuels and other bioliquids is presented, accompanied by guidelines on verification of compliance (17086/08, Article 16), calculation of GHG-impact (17086/08, Article 17), and monitoring and reporting (17086/08, Articles 19-20) (Council of the European Union, 2008).

Following roundtables on Palm Oil and Soy, the Ecole Polytechnique Federale de Lausanne (EPFL) initiated the establishment of the Roundtable on Sustainable Biofuels (RSB) in 2007 (van Dam et al., 2008 763). This multi-stakeholder platform brought together farmers, companies, NGOs, researchers, governments, and intergovernmental agencies concerned with the sustainability of biofuels production and processing. After considerable stakeholder consultation, *Version Zero* of the principles and criteria for sustainable biofuels was released in August 2008 for a further six-month period of public consultation. A number of draft revisions were released throughout 2009, culminating in a meeting of the Steering Board in November 2009 in Lausanne, Switzerland to discuss approving the first full version of the standard (Roundtable on Sustainable Biofuels, 2009). Both *version zero* and *version one* contain a set of principles, criteria and minimum requirements. In our analysis we used available data from *version zero*.

Table 4 provides an overview of their main principles and indicators of these guidelines. Every guideline is accompanied by a source and we have also numbered the different principles and criteria (e.g. #5a).

Framework/ criteria	European Commission[21]		Roundtable Sustainable Biofuels[22]			Cramer criteria (NL)[23]	RTFO (UK)[24]
Legalities							
Legal frameworks	Biofuels and other bio-liquids shall be obtained in accordance with the **requirements and standards** under the provisions referred to under the heading EU's "**Environment**" and in accordance with the minimum requirements for **good agricultural and environmental condition** (#5) as well as whether the country has ratified and implemented **Carthagena protocol** on bio-safety and the **Convention on International Trade in Endangered Species of Wild Fauna and Flora** (#5a)[25]	Energy from biofuels and other bio-liquids shall be taken into account for the purposes listed under points (a), (b) and (c) only if they fulfil the sustainability criteria #2 to #5. (a) measuring compliance with the requirements of this Directive concerning national targets, (b) measuring compliance with renewable energy obligations, and (c) eligibility for financial support for the consumption of biofuels and other bio-liquids. Biofuels and bio-liquids produced from waste and residues, other than agricultural, aquaculture, fisheries and forestry residues, need only fulfil the sustainability criterion #2	Respect country's existing **legal framework** (#1)		Biofuels shall be produced in the most cost-efficient way. The use of technology must improve production efficiency and social and environmental performance in all stages of the biofuel value chain (#11)	No **violation of national laws and regulation** applicable to biomass production and the production area (**land and land-use** rights), **soil management**, **water management** (water-use) and **emissions and air quality** (air emissions and waste management) (specified under #4, 5, 6 and 7)	**Compliance with national laws and regulations** relevant to biomass production and the **area** where biomass production takes place, **soil degradation and soil contamination and depletion of water** sources. **air emissions** and **burning** practices (#2, 3, 4 and 5)
Water rights			Not violate existing formal and customary **water rights** (#9)				
Land rights	[5]Respect of **land use rights** (#5a)		Not violate formal and customary **land rights** (#12)				Biomass production does not adversely affect existing **land rights** (#7)
Social				Contribute to economic and social development of local rural and indigenous peoples/ communities (#5)			
Stakeholder participation			**Participatory process** with all relevant stakeholders (#2)				No new plantings are established on local peoples' land without their **free, prior and informed consent** (#7.1)
Human and labour rights, and social well-being	[5]Whether the country has ratified and implemented **International Labour Organisation Conventions** 29, 87, 98, 100, 105, 111, 138 and 182 (#5a)		Not violate **Human and Labour Rights**, ensure decent work and well-being of workers (#4)			No negative effects on **Human Rights** and working conditions of employees (specified under #9)	Biomass production does not adversely effect **workers rights** and **working relationships** (#6) and **community relations** (#7)
Food security and other biomass-applications	[5]Social sustainability related to **availability of foodstuffs at affordable prices** and wider development issues (#5a)		Biofuel production shall not impair **food security** (#6)			Production of biomass must not endanger **food supply** and local **biomass applications** (#3)	
Economic							
Micro economy						Contribute towards **local prosperity** (#8)	
Environmental							
GHG-emission	The **GHG-emission** saving from the use of biofuels and other bio-liquids taken into account shall be 35% (#2)		Contribute significant to **GHG-emission reduction** taking direct and indirect land-use change into account (#3)			**Positive GHG-balance** of the production chain and application of the biomass (#1)	
Biodiversity	Biofuels shall not be made from raw material obtained from land with **high biodiversity value**, unless evidence is provided that the production of that raw material did not interfere with those nature protection purpose (#3)		Avoid negative impacts on **biodiversity, ecosystems and High Conservation Value Areas** (#7)			Biomass production must not affect protected or vulnerable **biodiversity** and will – where possible – have to strengthen biodiversity (#4)	Biomass production will not lead to the destruction or damage of high **biodiversity** areas (#2)
Soil – *Soil carbon stocks*	Biofuels and other bio-liquids shall not be made from raw material obtained from land with high **carbon stock** (#4)					Biomass production must not be at the expense of **carbon sinks** in vegetation or soil (#2)	Preservation of above and below ground **carbon stocks** (#1)
Soil – *Soil quality*	[5]National measures taken to respect the sustainability criteria set out in #2 to #4 and for **soil, water and air protection** (#5a)		Promote practices that seek to improve **soil health and minimize degradation** (#8)			Soil and **soil quality** are retained or improved (#5)	Biomass production does not lead to **soil degradation** (GAP[26]) (#3)
Water			Optimize **surface and groundwater** use, **minimize contamination** or depletion (#9)			**Ground and surface water** must not be depleted and **quality** must be **maintained or improved** (#6)	Biomass production does not lead to the **contamination or depletion of water sources** (GAP) (#4)
Air			Minimizing **air pollution** along the supply chain (#10)			**Air quality** must be **maintained or improved** (#7)	Biomass production does not lead to **air pollution** (#5)

Table 4: Overview of leading frameworks and criteria for sustainable biofuel production

[21] (Council of the European Union, 2008); Final version. Under article 15, 7 principles related to production of biofuels and other bio-liquids are described. Principle 6: "Compliance with article 15" and principle 7: "Energy uses of biomass, other than biofuels" have been left out. Principle 5 and 5a were so broad, the author decided to split up and divide the several issues addressed. EU-system focuses specifically on "Biofuels and other Bio-liquids". Principles for other biomass applications (e.g. seedcake) are announced in the document.

[22] (Roundtable on Sustainable Biofuels, 2008); Draft zero has 12 principles of which some are subdivided. The 12 principles have been used in this table.

[23] (Cramer *et al.*, 2007); Cramer works with six themes operationalized in 9 principles. The nine principles have been used in this table.

[24] Renewable Transport Fuel Obligation Programme (Dehue et al., 2007); 7 principles, subdivided in several criterion and indicators. The seven principles have been used in this table.

[25] Two yearly report of EC to European Parliament (first to be submitted in 2012. The Commission shall, if appropriate, propose corrective action, in particular if evidence shows that biofuel production has significant impact on food prices)

[26] Good Agricultural Practices

3.4 History of biofuel developments in Mozambique

The biofuel discussion in Mozambique started in 2004. During visits to the provinces, the government encouraged Mozambican farmers to produce Jatropha on all unused, marginal soils so the country could become oil-exporting instead of being 100% dependant on oil imports. The idea was that: "Biofuels will not dislocate Mozambican farmers from their lands, and that government policy will require the use of underutilized or empty lands, avoiding land used for food production, and that the country will refine its own raw materials" (Frontier Markets, 2008). The initial proposal was that five hectares of Jatropha was to be planted in each of Mozambique's 128 districts. The Mozambican extension service started organizing Jatropha seeds, mainly from Malawi. Most of the seeds had a very poor quality; they had been stored for a long time and often under adverse conditions, resulting in low germination rates (TechnoServe and ICRAF/IIAM, 2006 18). Apart from distributing the seeds, there was no real follow-up or agronomic knowledge on crop management. Hence, crop maintenance was neglected and many trees died. The few farmers who had some yield did not know what to do with the Jatropha seeds, as organized markets and supply chains were absent.

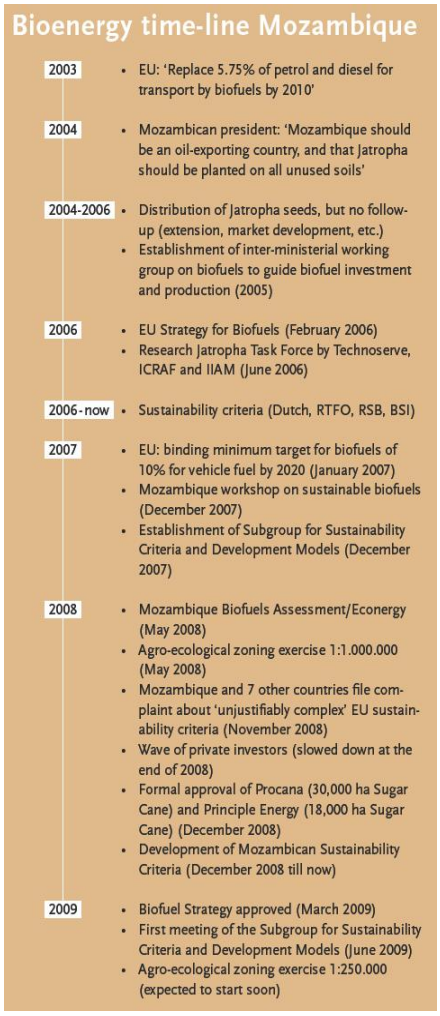


Figure 3: Biofuel time-line for Mozambique

Nevertheless, the promotion of biofuels by the Mozambican government had by that time attracted numerous private investors as well as biofuel-related development projects. Plantations of Jatropha were established on poor agronomic knowledge regarding seed varieties, nursery practice, system of production and disease control, together with weak business planning regarding to markets, scale of operations, and poor technical knowledge of processing. To aggravate it, the concept of marginal land was not defined and several of the initiatives were implemented in areas that were not suitable for growing Jatropha (personal communication with IIAM-researcher). The availability of sufficient land in Mozambique coupled with the large areas of what was considered marginal land and the belief that Jatropha is drought resistant and therefore more suitable for marginal land, continued to feed investments. While interest in Jatropha as a 'miracle crop' spearheaded the political promotion of biofuels, there was also significant private sector and government interest in the production of bioethanol. The principal feedstock was considered to be sugarcane, although an increasing level of interest began to be shown in sweet sorghum.

Concerns about potential pressure on land, water, food production and lack of control over this process resulted in an intense discussion between government, private sector, farmer, NGO and academic stakeholders. As a result, large-scale land requests were 'frozen' between October 2007 and May 2008, while the government undertook agro-ecological land zoning (see section 2.4.4). At the moment, the first projects have been formally approved and started their activities. The Mozambican government recently developed and approved a number of biofuel related policies which are described and analyzed in this report. Moreover, Mozambique and Brazil announced to increase cooperation in the production of biofuels. The two countries will implement a 'plan of action' to promote cooperation and exchange in the biofuels sector, with the participation of government staff and specialists, representatives of the private sector and the academic world (Macauhub, 2009b). Figure 3 provides a time-line of biofuel developments in Mozambique.

3.5 Mozambique's sustainability approach

As explained in section 3.3, several administrations, multi-stakeholder platforms and supra-national institutions have developed sustainability criteria as a way of dealing with the emerging competing claims around biofuel production. The implementation of such biofuel sustainability criteria will have clear consequences for African countries. Together with seven other development countries Mozambique filed a complaint at the WTO claiming that European Commission's (EC) sustainability criteria could be: "Illegal and discriminating development countries access to the world market" (BusinessGreen, 2008). Following all sustainability discussions, Mozambique organized a workshop on sustainable biofuels on December 5 and 6, 2007. Sixty-five people attended the workshop, representing different Ministries, private sector, NGOs, petroleum companies, researchers, foreign investors and development agencies. The general conclusions on the workshop were that:

1. It is important to establish rules of the game in the production of biofuels, independently of the target market for production, in order to guarantee the availability of natural resources for future generations and to maximize the social and economic benefits of production for Mozambique.
2. The existing legal framework in Mozambique covers some aspects mentioned in the EC proposal (and those of the UK and the Netherlands). However, it is difficult to analyze to what extent Mozambique's legal framework already upholds the sustainability criteria proposed by the EC.
3. This difficulty was aggravated by the low level of detail in the EC proposal.
4. There is a need to strengthen or improve the land administration system in Mozambique. Information on the government's current land mapping exercise was provided to the workshop participants.
5. How to proceed towards a set of principles to guide biofuel production in Mozambique. There was no specific discussion on whether or not the principles for the national system should take the form of a certification system.

On the content of the proposed EC-sustainability criteria the workshop concluded that implementing the sustainability criteria could undesirably disfavour countries like Mozambique. Though Mozambique could relatively easy comply with the GHG-emissions criteria, the 'ambitious' criteria on land use change and subsequent impact on soil, water and air quality – and additional costs related to that – could scare away potential investors. Moreover, the costs of compliance of the sustainability system should not undermine the comparative advantage that Mozambique has in biofuel production, acting as a non-tariff barrier to trade with the EU. Overall, the government concluded that it would be useful for the EC to consider its policy towards biofuels in light of its development agenda for Africa. To this end, it would be important that the EU look to a long-term commitment to ensure that the industry is sustainable economically and socially, as well as environmentally (Mozambican Ministry of Energy, 2007).

As a response the Mozambican government defined the necessary steps in order to develop their own national system of sustainability principles to guide biofuel investment and production (Mozambican Ministry of Energy, 2007 5). To elaborate on this an Inter-Ministerial Working Group on Biofuels[27] was formed. The group was divided in four subgroups (GTBC, 2007):

1. Development of raw material
2. Sustainability Criteria and Development Models
3. Legal framework
4. Investments

The subgroup sustainability criteria and development models (#2) has the general objective to guarantee that the production of biofuels is done in an environmental and social sustainable way. The subgroup defined the following objectives:

1. Develop different sustainability criteria for different levels of markets, and develop the Mozambican capacity so Mozambique can influence the debate through instant contact with the official representatives of key contacts in Mozambique and the promotion of cooperation with similar countries.

[27] Grupo Interministerial de Trabalho dos Bio-combustíveis (GTBC)

2. Develop a national strategy for sustainable biofuel production that reflects the Mozambican reality and requirements of the major market on the long term.
3. Assist the investment subgroup to develop criteria to select projects based on an evaluation that reflect social and environmental aspects.
4. To facilitate understanding and social and environmental analysis of the value chain of biofuels, as well as to ensure that the key stakeholders are well-informed about the principle aspects.
5. Assist the legal framework subgroup in modifying the Mozambican legislation in order to meet the needs for promoting a sustainable biofuel sector, by promoting social and environmental legislation, which is transparent and implementable for the sector.
6. Propose development models for biofuel production which ensures that the main objectives of biofuel developments are met (Sub-grupo de Sustentabilidade nos Biocombustíveis, 2008).

In order to achieve these objectives the subgroup Sustainability Criteria and Development Models intends to organize a series of multi-stakeholder discussion meetings. During these meetings, representatives of the ministries of agriculture, industry, environment and energy, private sector, civil society, farmer unions, development organizations and knowledge institutes should develop a framework that can facilitate and guide sustainable biofuel production in Mozambique.

4. Research framework

4.1 Research objective and question

The objective of this research is to provide insight in the expected dynamics, challenges and opportunities that accompany the development of a Mozambican sustainability framework for biofuel production. By learning from existing (inter-)national experiences with sustainable production of biofuels and other – related – commodities we hope to gather and analyze data that might support the work of the subgroup sustainability criteria and development models.

The research question that guided us during the research was: "What can we learn from existing sustainability practices for the Mozambican context?" Practical considerations made us decide to formulate three sub-objectives:

1. Learning from (sustainable) biofuel experiences from other countries;
2. Learning from other commodities produced in Mozambican under certification systems related to sustainability;
3. Learning from existing biofuel initiatives in Mozambique.

4.2 Concepts and definitions

Note: When referring to biofuels in this study, we refer to liquid biofuels (ethanol, biodiesel or PPO), not to all other biomass applications for energy usage (firewood, charcoal, natural gas, etc.).

We identified three relevant analytical areas to be incorporated in this research:

1. Multi-scale dynamics of sustainability and the interaction between scale-levels;
2. Feasibility/ applicability of sustainability issues;
3. Practical experiences from working with sustainability criteria and certification.

Developing sustainability principles or criteria is a process strongly related to expectations, assumptions, predictions and bridging different perceptions, knowledge and insights. Sustainability, a multi-scale approach and the interaction between these two concepts form the main building blocks for our theoretical framework.

4.2.1 Sustainability

There exist many different definitions of sustainability. In general, it can be seen as the ability to maintain a certain process, state, or system. In an ecological context, sustainability can be defined as the ability of an ecosystem to maintain ecological processes, functions, biodiversity and productivity into the future. The concept sustainable development became widely used during the 1980s, in the face of numerous environmental movements and concerns on poverty during that period. The concept became to dominate the field of environmental policies and politics. With the publication of the Brundtland report (1987) sustainability gained widespread recognition. The Brundtland report of the United Nations Commission on Environment and Development was a response to the major environmental problems the world was facing at that time, and – in our opinion – still is. The Brundtland report introduced an approach on how to integrate environmental protection and economic development (Dobson, 1999 21). The Brundtland commission, an independent commission brought into being by the UN, drafted the following famous definition of sustainable development: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987 27). Brundtland's key concepts regarding sustainability are:

- A direct link exists between the economy and environment;
- The needs of the poor in all nations must be met;
- In order for our environment to be protected, the economic conditions of the world's poor must be improved;
- In all our actions, we must consider the impact upon future generations.

The main result of this report was the widespread attention for sustainable development. It led to the emergence of several international agreements (Montreal and Kyoto Protocols, and Agenda 21), that further conceptualized 'environmentally sustainable development'.

We believe that there exists no ultimate state of sustainability. The only thing we can do is become more sustainable by developing sustainably, or maybe sometimes unsustainably. The state of sustainability is never reached, as the definition of sustainability changes over space and time; moving forward when we know more and can do more. The sustainability concept evolved from focus on environment and ecosystems, to a more consistent concept including ecology, economic, social and cultural dimensions and the interaction between them. However, the more solid the concepts became, the more complex it became to implement them. Sustainability can be applied to almost every facet of life; to different levels of biological organization (wetlands, forests, nature areas), as concept for human organization as; eco-cities (Register, 2002), cradle to cradle, and for human activities and disciplines, such as sustainable agriculture (Altieri, 1995), Sustainable fishery (Charles, 2000), and renewable energy.

4.2.2 Multi-scale approach

As the background on this study showed, biofuel developments have their own dynamics at different scale-levels. The realities, challenges and opportunities faced at the global scale are different from those experienced by a farmer who is close to, or part of the emerging biofuel sector in Mozambique. Between those two extremes we distinguish between a wide range of stakeholders who are linked to the sector. This does make the biofuel market (like any global market) a rather complex one to study.

The concept of sustainable biofuel production was initially put on the agenda by the international community to assure sustainable production and use, taking the economic, social and environmental issues throughout the entire value chain into account (United Nations Energy, 2007). By taking the entire value chain into account, indicates looking at the dynamics at the different scale levels. Therefore, we approach sustainability as multi-scale concept, assuming it has different meaning and dynamics at different scale levels (figure 4).

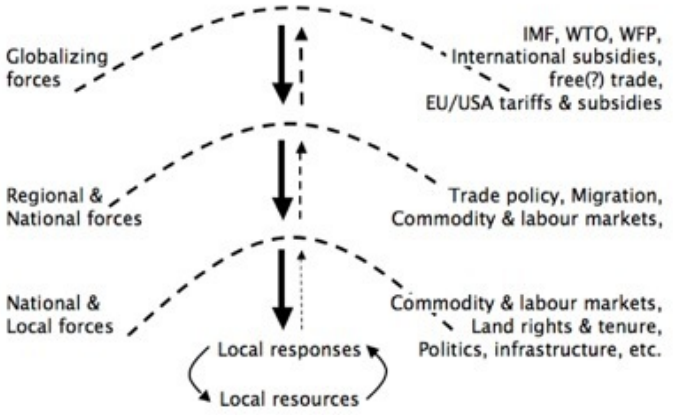


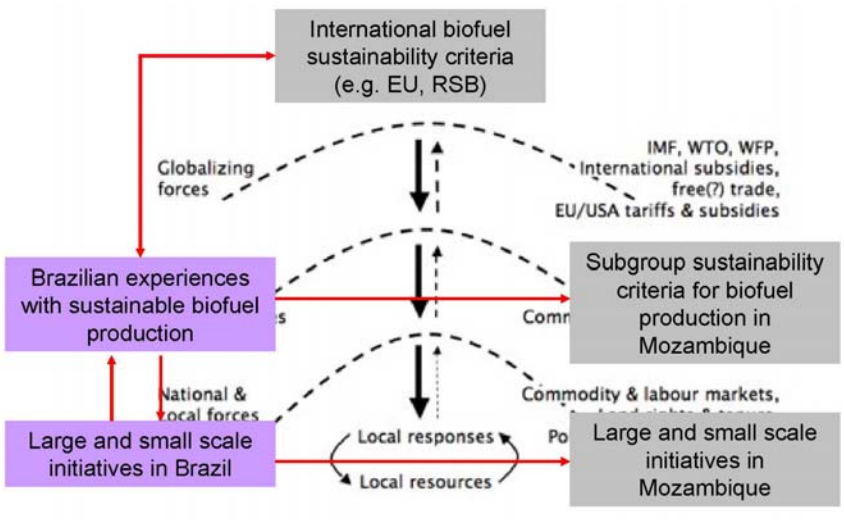
Figure 4: Dynamics of global-local interfaces and feedbacks (Giller et al., 2008)

4.3 A multi-scale approach to sustainability

As explained, this research has three strategies to answer its main research question; which we called research components. All components contribute to the main research objective, but were set up in different distinct ways.

1. Learning from (sustainable) biofuel experiences from other countries

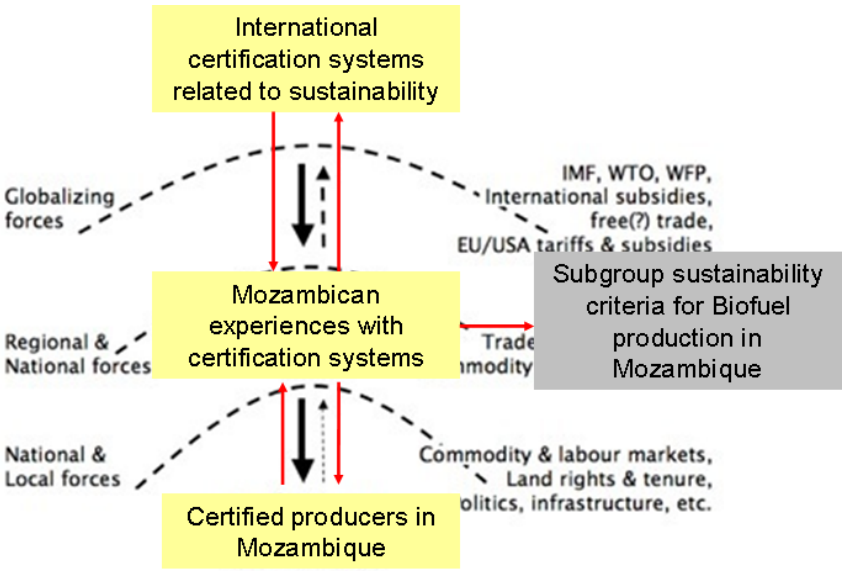
The first component of the research looks at learning experiences from other countries. We chose to focus on Brazil, as the country has years of experiences in ethanol production and is – unlike biofuel production in Africa – thoroughly studied by researchers which provides a good knowledge base to learn from.



Research question: What can we learn from Brazilian experiences with regard to sustainable biofuel production?

2. Learning from other commodities produced in Mozambican under certification systems related to sustainability.

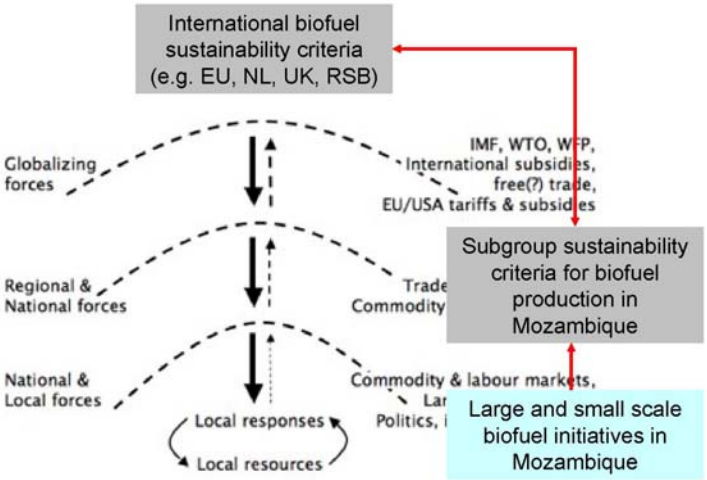
The second component of this research looks at experiences with other commodities and sectors, produced in Mozambique, that work with sustainability criteria and/ or certification; such as certified timber production in Mozambique. This commodity is also produced in a multi-stakeholder, competing claims context in which illegal logging, competition over resource use, land degradation, concerns over foreign investments, lack of added value before exporting, lack of regulation, and etc. play an important role. From our analysis of existing certification systems, we hope to provide insights in the challenges and opportunities related to the development and implementation of a sustainability framework in Mozambique.



Research question: What can be learned from other commodities produced in Mozambican under certification systems related to sustainability?

3. Learning from existing biofuel initiatives in Mozambique

Thirdly, we look at existing biofuel initiatives in Mozambique and the sustainability of the emerging sector. We analyze investment data, the geo-graphical spread of the biofuel developments and provide case studies that provide qualitative data on the sustainability of the sector. By describing the existing initiatives in Mozambique, we hope to contribute to developing a sustainability framework that take the Mozambican reality into account.



Research question: What can we learn from existing large and small-scale biofuel initiatives in Mozambique?

4.4 Research framework

When bringing the three components together, our research framework looks as follows (figure 5):

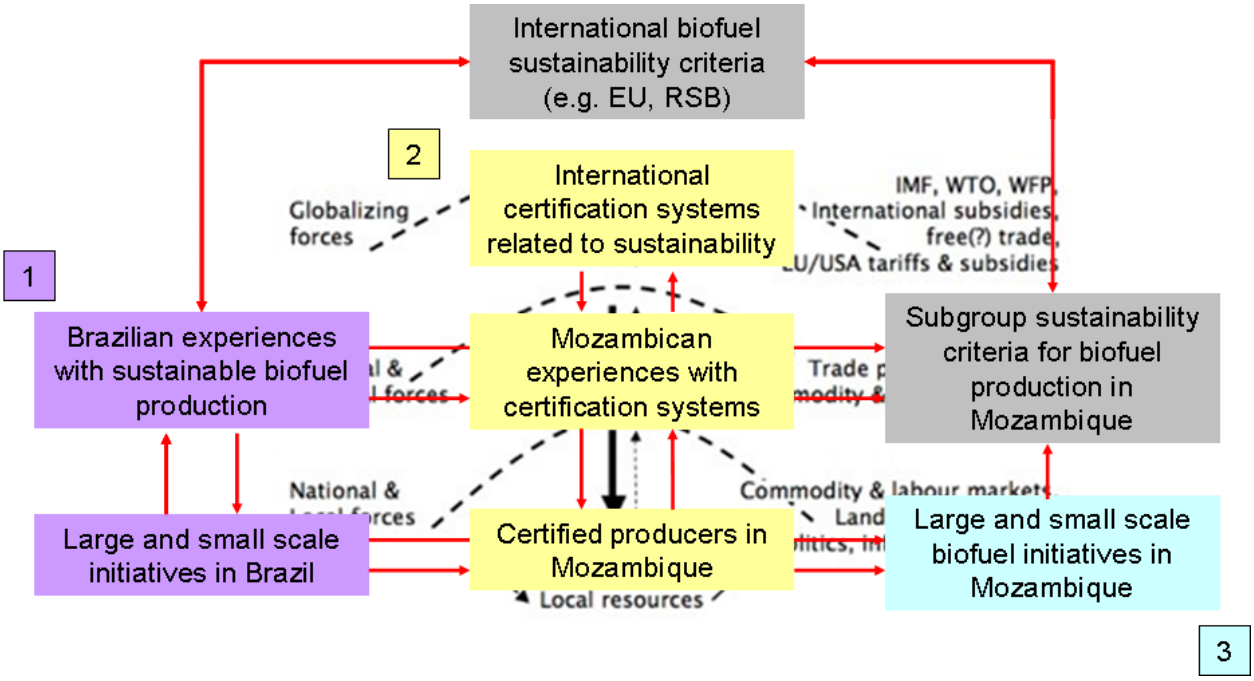


Figure 5: Research framework

The framework shows how the three research components are interrelated. This will be important when analyzing our data and to merge our conclusions and recommendations. The main objective of the research framework is providing insights for the subgroup sustainability criteria and developing models. As one can see, all red arrows eventually point towards this box!

Learning plays an important role in each of the three research components/ questions. We want to learn from Brazil, from other commodities and from existing biofuel experiences in Mozambique. We adopt the 'Learning History Approach' to organize data gathering. Learning history is part of constructivist monitoring and evaluation and focus on understanding the 'how'-question is the starting point (Arkensteijn et al., 2007). Learning histories try to 'tell the story' from different perspectives, which – for example – provide insight in the negotiation processes and trade-offs involved in the development and implementation of sustainability frameworks or certification systems. We will also focus on the direct and indirect consequences of implementing certification systems.

4.5 Methodology

4.5.1 Case study approach

The complexities and interrelatedness of biofuel dynamics require a holistic approach that tries to understand processes in its (historical) context. Case study is a methodology that permits to gain a profound insight in complex social phenomena or social processes permitting the researcher to gather holistic and meaningful characteristics of real life events (Yin, 1984; 2003). Yin (2003: 13-14) presents two reasons for doing case studies:

1. A case study investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. Using the case study methodology is particularly useful when "a 'how' or 'why' question is being asked about a contemporary set of events, over which the investigator has little or no control.
2. A case study copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiples sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis (Yin, 2003: 9).

Moreover, the case study approach: "Provides an opportunity for the intensive analysis of many specific details often overlooked by other methods" (Kumar, 2005: 113).

4.5.2 Data collection techniques

A case study approach uses different data collection techniques. The main techniques used in this research were:

Secondary data analysis: The analysis of secondary data is relevant to every case study topic. In this research, we expect to study secondary data of meetings, project proposals, project monitoring and evaluation reports, academic writings, policy documents, newspaper articles, media reports and maps. Secondary data will be relevant for all three research components. The first research question is mostly dependent on secondary data analysis, as the project had no budget to visit projects or interview stakeholders in Brazil. We do acknowledge that this limits ourselves to go beyond the discursive description of reality, although we did study critical literature that provided us with insights on the Brazilian dynamics and challenges.

Participant and non-participant observations: One of the basic principles for ensuring the validity of secondary data is collecting evidence that stakeholders act or speak as is claimed in the literature (Potter, 2004). Observations are essential for understanding discourses, behaviour, decision-making and power-relations. There are two types of observation: participant observation and non-participant observation. In participant observation the researcher participates in the activities of the group being observed in the same manner as its members. In non-participant observation the researcher remains a passive observer (Kumar, 2005: 120). In practice, participant and non-participant observation are often intertwined. Observations were documented in written jottings and field notes. Jottings are the brief words or phrases written down while at the field site or in a situation about which more complete notes will be written later. Usually recorded in a small notebook, jottings are intended to help us remember things we want to include when we write the full-fledged field notes (Chiseri-Strater and Stone-Sunstein, 1997). In total 13 field visits in five provinces were carried out.

Semi-structured interviews: Interviewing is the most important sources of case study information (Yin, 2003: 89), and "a commonly used method of collecting information from people" (Kumar, 2005: 123). Semi-structured interviewing can be positioned somewhere between structured and unstructured interviewing. The interviewer prepares a topic-list or some key-questions, but remains flexible enough to identify interesting storylines, which are relevant for the research. Semi-structured interviews may therefore provide interesting, unexpected, new perspectives on the issue at stake.

Semi-structured interviews will be used to triangulate and verify data gathered from secondary data analysis and (non-)participant observations. Triangulation refers to combining multiple theories, methods, observers, and empirical materials to produce a more accurate, comprehensive and objective representation of reality (Seale, 1999). Secondly, the interviews provide an opportunity to investigate issues that cannot be observed, such as: How did stakeholders experience the opportunities and challenges that accompanied the implementation of certification criteria? How did they perceive their own role and the role of others? What kind of knowledge did they found useful? We interviewed over 50 investors, entrepreneurs, farmers, extension-workers, researchers, NGO-representatives and policy-makers.

5. Sustainable biofuel production experiences from Brazil

The purpose of this chapter is to give a brief overview of Brazil's experience with biofuel production; (i) by providing a description of the evolution of the agro-energy sector; (ii) by discussing the role and involvement of government in the expansion of the sector; (iii) by analyzing how the country deals with biofuel sustainability; and (iv) explore what and how Mozambique can learn from these experiences. This chapter was mainly written by analyzing secondary data.

5.1 Evolution of the biofuel sector in Brazil

Brazil has been chosen for this study because it is one of the world's leading biofuel economies, which has been studied extensively. Some important similarities between Brazil and Mozambique that may facilitate the exchange of learning experiences include: (i) colonial history and language; (ii) climate – both are tropical countries; (iii) importance of agriculture as economic activity; and (iv) both promote biofuel production to cut down fuel imports and stimulate socio-economic development in its rural areas. Much attention will be given to social issues (employment and income generation, research and training and rural development) as well as to environmental issues, and how the Brazilian government is dealing with these.

5.1.1 Background on biofuels in Brazil

According to Chaddad and Jank (2006), the agri-food (agriculture and food) sector is one of the most dynamic in Brazil's economy: "The period between the mid 1960s to early 1980s was characterized by massive government intervention in agricultural commodity markets, primarily by means of subsidized rural credit and price support mechanisms, including government purchase and storage of excess supply." From the 1980s onwards, the sector gradually became more liberalized and market-based as a response to debt crisis and socio-political and economic changes in the global arena. Since 1995, there is increased attention for the alleviation of rural poverty through a set of policies known as PRONAF, which aimed at promoting land reforms and family farming. PRONAF also contributed to the promotion of agricultural research and capacity-building, establishment of credit lines for the sector, and the development of technologies which have flourished today, making Brazil the third largest agri-food exporter in the world. To some degree this has contributed and facilitated the evolution of Brazil's bioenergy sector, which has made the country a pioneer in the biofuel industry.

Brazil has been implementing biofuel promotion policies since the 1920s. Due to the crisis in the sugar industry and the economic recession, vegetable oil or Pure Plant Oil (PPO) was used in vehicles, and 5% of ethanol was added to regular petrol (British Consulate General, 2005 2; Nogueira, 2005 3). During the oil crisis in the 1970s, the Brazilian government introduced '*Proálcool*'. The program had to cover oil shortages and lead to reduced oil dependence by introducing sugarcane-based ethanol into the country's energy matrix (Lundgren, 2008 10). Moreover, the program aimed at increasing sugarcane production and the number of distilleries in the country. By the 1980s, during the second oil crisis, Brazil had already developed its first ethanol-fuel vehicles and since then there are almost no light vehicles running on pure gasoline alone. Ethanol and gasoline blends have fluctuated from 10% in 1976, to about 22% stipulated by law in 1993, to a mandatory 25% since July 2007 (cf. UNICA, 2009b). It is estimated that Brazil produced approximately 12.5 billion litres of ethanol in 2004, of which 7 billion litres was blended with petrol (British Consulate General, 2005 3). Ethanol is prominent in the automobile sector, especially because Brazilian car manufacturers have developed fuel-flexible vehicles that can run on any blend of ethanol and gasoline. The expansion of ethanol in the automobile sector, was stimulated by the availability of ethanol at almost all fuel stations. By 2007, ethanol contributed about 16.7% of the country's total energy consumption by the transport sector (Empresa de Pesquisa Energética, 2008). Today, Brazil is not only the worlds' largest but also the cheapest ethanol producer, which has been stimulated by Government incentives and legislation, as well as an internal market favouring the sector.

Besides ethanol, PPO also plays an increasingly important role in the Brazilian biofuel sector, especially for processing biodiesel (British Consulate General, 2005 3). The use of PPO also dates back to the 1970s when the Brazilian government created the Vegetal Oil Production Plan to Energy Uses (PRÓ-ÓLEO) (Soares et al., 2006). Although the biodiesel sector is not by far as successful as the ethanol sector, some progress is visible. Biodiesel production still faces major challenges such as the lack of producing large volumes necessary for the expansion of the industry.

5.1.2 Bioethanol production – Sugarcane

In Brazil, the main feedstock for ethanol production is sugarcane. The over 370 sugarcane plantations have a capacity of crushing about 538 million metric tons of sugarcane per year; both for ethanol and sugar. Of the total amount of sugarcane produced, 55% is used for ethanol production, 44% for sugar production, and 1% for alcohol production in 2006. To show the difference; in 1975, 86% of the sugarcane was used for sugar production. This clearly reflects the shift and importance of ethanol production in country.

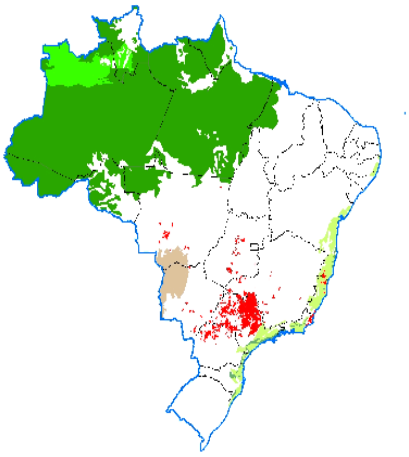


Figure 6: Location of sugarcane cultures in Brazil (areas in red) (Macedo, 2005)

As figure 6 shows, the production of sugarcane mainly takes place in the central and south-eastern regions, responsible for about 90% of the country's total ethanol production. The remaining 10% is produced in the northern region (Macedo Isaias et al., 2004; UNICA, 2009a). According to Ministry Labour and Employment's administrative records, Brazil's sugarcane, sugar and alcohol industry employed 982,604 people in 2005 (Dias de Moraes, 2007 152), even though mechanized harvesting has replaced manual cutting in many cases (see table 5)[28]. 'Cost-effective' manual harvesting of sugarcane, has been widely replace by mechanized harvesting for a number of reasons, ranging from reducing damages on infrastructure and forests, to reduction of GHG and reducing harmful health hazards caused by the burning process, and as a result of legislation and technological improvements (Smeets et al., 2006 49). The sugarcane burning process take place 12-18 months after planting and facilitates manual harvesting.

[28] The figures we present in table 5 suggest that employment of 982,604 people in 2005 seems unrealistic. This can possible be explained by the exclusion of employment related to the industrial, transport, and administrative sector

The introduction of mechanized harvesting (which does not require burning) in 1998, has reduced GHG-emissions by the Brazilian sugarcane. As table 5 demonstrates, it also reduced employment generation per hectare by 47.9% from 0.161 jobs per hectare in 1992 to 0.084 jobs per hectare in 2003.

Year	*Area harvested (ha)*[29]	*Employment*[30]	*Dropped employment (compared to 1992)*	*Employment per ha*	*Dropped employment per ha (compared to 1992)*
1992	4,202,600	674,630		0.161	
1993	3,863,700	616,669	-8.6%	0.160	-0.6%
1994	4,345,260	*No data*			
1995	4,559,060	618,896	-8.3%	0.136	-15.4%
1996	4,750,300	639,146	-5.3%	0.135	-16.2%
1997	4,814,080	559,711	-17.0%	0.116	-27.6%
1998[31]	4,985,820	455,969	-32.4%	0.091	-43.0%
1999	4,898,840	461,508	-31.6%	0.094	-41.3%
2000	4,845,990	*No data*			
2001	4,957,590	415,089	-38.5%	0.084	-47.8%
2002	5,100,480	451,357	-33.1%	0.088	-44.9%
2003	5,371,020	448,883	-33.5%	0.084	-47.9%

Table 5: Harvested area, employment and employment per hectare in the Brazilian sugarcane sector between 1992 and 2003

Land used for sugarcane production has increased drastically over the last decades, from 1,969,227 ha in 1975 to about 7,080,920 ha in 2007 (FAOSTAT, 2009b). The increase in sugarcane production was not only possible because of availability of land, but also the growing demand for ethanol and the development of new technologies for producing and processing biomass gave the sector an enormous boost (Lundgren, 2008 16). Subsequently, the increased domestic demand of ethanol has led to a reduction in sugar production, increasing the sugar prices from US$4 in 1985, to US$12.50 in 1996, and US$20.25 per 50 kg bag in 2007 (Lundgren, 2008 18). Although sugarcane sourced ethanol is relatively cheap, its actual price compared to the continuous fluctuating crude oil prices is worrying. According to Mitchell (2006): "The global sugar market is undergoing a major restructuring and prices may not return to previous lows." This might indicate that sugar is becoming more expensive, which might have negative implications for ethanol production at a certain stage.

Abundance of land for sugarcane plantations, 'cheap' labour, favourable climate, advanced techniques in agricultural management and government incentives allowed Brazil to be both the largest and cheapest ethanol producer in world, with ethanol production costs estimated between US$0.23 - US$0.29 per litre according to the World Bank (Econergy, 2008 362). Other advantages of sugarcane production include: (i) its juice may be used for ethanol or sugar production; (ii) bagasse can be used to generate electricity that may reduce the actual cost of sugar production; and (iii) molasses can be used to produce ethanol, alcohol and other products. The biggest disadvantage is its dependency on fossil crude oil prices. When fossil fuel prices drop to levels lower than the ethanol price, the demand for ethanol consequently decreases (unless legislative measures are taken to ensure an internal market – i.e. compulsory blends). This might lead to: "Large investments in ethanol becoming very unprofitable" (Mitchell, 2006).

Brazil's total land size is approximately 850 million hectares, of which (in 2007) 60 million hectares was found arable in 2007 (FAOSTAT, 2009a). According to government officials: "Brazil has more than enough land available to keep

[29] Data from FAOSTAT (2009b)
[30] Includes both permanent and temporal, seasonal labor. Data from PNAD in Macedo (2005); quoted in (Smeets et al., 2006 57)
[31] 1997 – onwards: Introduction of fully mechanized harvesting

planting sugar cane. Brazil's current sugar cane crop covers seven million hectares — 2.3 % of its arable land. And although that total is expected to grow by 12% a year over the next five years, there is still around 160 million hectares of arable land ready to be sown" (TIME, 2008). However, there are also concerns about the negative results of the expansion of large-scale monoculture sugarcane plantations[32], which may lead to the destruction of natural habitats and increase usage of agrochemicals as large plantations attract crop pests. The expansion of the sector may also have negative implications on food production and (food) crop prices in the popular regions for sugarcane production.

5.1.3 Biodiesel production – Soybean

Brazil's biodiesel plan has been developed to contribute to diversifying the country's energy matrix, reducing GHG, reduced dependence on oil imports, promoting family-based agriculture, and improving social and economic conditions in general. As already mentioned, the majority of Brazil's fuel imports account for diesel production; 650,000 barrels per day according to Xavier (2007). Biodiesel was authorized by Brazilian federal government in January 2005 (British Consulate General, 2005 4). As a response to a decree by President Lula and the National Production and Usage Program of Biodiesel (PNPB), an inter-ministerial partnership was established to undertake viability studies on the potential of vegetable oil for biodiesel production in Brazil. The proposed advice to the congress consisted of two legal instruments: (i) formally make biodiesel part of the Brazilian energy matrix, and (ii) the National Petroleum Agency (ANP) would be responsible for regulation, contracting and control of economic activities of renewable energy including biodiesel (Paulillo et al., 2007). The biodiesel program highlights three important aspects:

1. The production of biodiesel from different oil seeds from the diverse regions of the country;
2. The promotion of social inclusion through job creation; and,
3. The support of a new source of oil supply with competitive prices and appropriate quality (Soares et al., 2006 2).

Measures to promote the biodiesel sector are being taken by government, including incentives for both smallholder farmers and commercial companies. Brazil has developed an official 'social fuel seal' (see section 5.2.3) which recognizes those companies who buy raw materials for biodiesel from smallholder farmers. In exchange, those companies obtain tax breaks and other benefits from the Government (Xavier, 2007). The most favourable zones for biodiesel production are the North and Northeast of Brazil. Table 6 shows that the most viable feedstock for biodiesel production includes castor oil, palm and soybean oil. Every crop has specific characteristics as for the area needed to produce the necessary volume of biodiesel stipulated by legislation, and the amount of oil production from each crop. Based on the data, palm oil seems the best option from an efficiency point of view, as the energy value per hectare is the highest (Müller et al., 2007). However, palm oil is highly criticized for its negative environmental effects, replacing rainforest in Asia and releasing large amounts of GHG in doing so.

Plant	*Oil product*	*Oil content (%)*	*Harvest duration (months)*	*Oil production (tons/ha)*
Oil Palm (Elaeis quineensis N.)	nut	26	12	3.0 – 6.0
Babassu (Attalea speciosa M.)	nut	66	12	0.4 – 0.8
Sunflower (Helianthus annus)	seed	38 - 48	3	0.5 – 1.5
Rapeseed (Brassica campestris)	seed	40 - 48	3	0.5 – 0.9
Castor plant (Ricinus communis)	seed	43 - 45	3	0.5 – 1.0
Peanut (Arachis hipogaea)	seed	40 - 43	3	0.6 – 0.8
Soybean (Glycine max)	seed	17	3	0.2 – 0.6

Table 6: Feedstock alternatives for biodiesel production in Brazil (Nogueira, 2005)

[32] Monoculture: the growing of only one species of crop densely over a large land area (Cordonnier, 2009)

In Brazil, soybean is widely used as biodiesel feedstock. The main product of the soybean industry used to be soybean flour, with oil as by-product. Soybean for biodiesel production was chosen by the '*Escola Superior de Agricultura Luiz de Queiroz',* which is responsible for analyzing production systems and varieties that can be used for renewable energy (Paulillo et al., 2007). The advantage of soybean over other feedstocks for biodiesel production was that the soybean supply chain already existed in Brazil. Even though oil production potential per hectare is much lower as compared to other feedstocks, soybean was the only feedstock that could supply enough vegetable oil to support the compulsory 2% blend of biodiesel in the country. Moreover, farmers were familiar with soybean production, which facilitated the expansion of the sector.

The total land used for soybean cultivation has increased by a factor of 57 since 1961, and the volume of production has multiplied 138 times (Altieri and Bravo, 2007). Soybean is mainly produced in Brazil's central plateau region, close to the Amazon forest and fragile Cerrado areas, which are the country's main high value biodiversity areas. "The Cerrado has been extensively developed recently for soybean production as well as for corn, rice, cotton, coffee and ranching". In Brazil, sugarcane is moving into the Cerrado region. The expansion of sugarcane will likely displace other crops, including soybean production, to the north and further into the Cerrado and the Amazon. "It is estimated that nearly 60% of the Cerrado's original vegetation has now been completely destroyed and that the demand for both sugarcane and soybean for biofuel likely will accelerate the loss of biodiversity in this region" (Keeney and Nanninga, 2008 23). Soybean cultivation is said to have contributed to the deforestation of 21 million hectares in Brazil. Initiatives by the Round Table for Responsible Soy Association (RTRS) are trying to implement principles and standards to prevent soybean production in or near high conservation value areas.

Due to concerns about soybean production, different oil production chains, such as animal fat, cotton, coconut, fish oil and sunflower are being studied (Paulillo et al., 2007). A report by the British Consulate in Sao Paulo (2005 12) explains that: "The Brazilian government favours castor bean because of its adaptability with the country's climate, three harvests per year, and the ease for small farmers to handle it." Castor bean oil production in Brazil was close to 150,000 t $year^{-1}$ in 2005, but this quantity can only meet 10% of the demand needed for the compulsory 2% blend of biodiesel (B2), let alone the 5% blend (B5). Moreover, castor bean oil has specific characteristics that create access to high value markets such as cosmetics and pharmaceutical industry. Therefore, it would not be very logical to process it into biodiesel which pays a relatively low price. Today approximately 80% of Brazil's biodiesel is produced from soybean oil, 10% from animal fat, 5% from cottonseed and 5% from other sources.

Various researchers claim that the biodiesel program in Brazil has failed. According to the British Consulate Report, (2005): "Despite the country's huge potential for growing oil seed plants, Brazil lacks the capacity to produce the volume required to meet the expected demand of biodiesel per year." The high costs in usage of vegetable oil have led to exploring alternative sources of raw material such as animal fat and industrial residue, as well as non-edible oils such as Jatropha. In line with the slow development of the sector, biodiesel-related employment generation has been lower than anticipated.

5.2 Biofuel related policies in Brazil

5.2.1 Brazil's government objectives

According to the Brazilian National Agro-Energy Plan (Ministério da Agricultura, 2006 10-11), the country's objectives related to biofuels include:

1. Development of agro-energy – Through the expansion of the ethanol sector, implementation of the biodiesel production chain, re-usage of residues, expansion of bioenergy from cultivated forests in all regions, promoting efficiency and productivity, focussing on less developed regions.
2. Agro-energy and food production – Expanding agro-energy without affecting food production for domestic consumption. Also using agro-energy production to complement/expand food production.

3. Technological development – Development of agricultural and industrial research and technology adequate for the biofuel production chain, which may lead to the promotion of biofuel production by smallholders.
4. Community energy autonomy – To provide isolated communities with energy.
5. Employment and income generation – To promote social inclusion, reduce regional differences.
6. Leadership in international commercialization of biofuels – Brazil has comparative advantages, which permit it to be a leader on the international biofuel market. Expansion of exports may help consolidate the sector and accelerate development of the country.
7. Environmental sustainability.

5.2.2 Biofuel policies and instruments

Brazil's bioenergy sector is – amongst others – governed by the Program of Incentives for Alternative Electricity Sources (PROINFA), the National Program for the Use and Production of Biodiesel (PNPB), the National Agro-energy Policy, and the Clean Development Mechanism (CDM). PROINFA came into force in Brazil in April 2002 with the objective to encourage wind, biomass and small hydropower capacity. The PROINFA programme is implemented in two stages as described by the Organisation for Economic Co-operation and Development and International Energy Agency (OECD/IEA, 2002) in box 2.

Box 2: PROINFA

Stage I – 3,300 MW of renewable energy (from wind, biomass and small hydroelectric sources) [will be] brought on stream before the end of 2007 through a system of subsidies and incentives, which draw on an Energy Development Account funded by end-use consumers through an increase on energy bills (low-income sectors are exempt from this increase). Under the PROINFA rules, the programme will be operated by Electrobrás, which will buy energy at pre-set preferential prices and will market renewable electricity. Definitive economic values will be published at the end of October 2003 and will have a reference value floor of 70% of the national average supply tariff. Contracts between Electrobrás and the 'renewable' generator are valid for a period of 20 years, are applicable to plants that began production before 2007 and must be signed within 24 months of the publication of Law 10438. The *Banco Nacional de Desenvolvimento Econômico e Social* (BNDES, the Brazilian National Development Bank) will make special financing programs available for renewables projects that are eligible for PROINFA. BNDES can finance up to 70% of capital costs (excluding site acquisition and imported goods and services) at the basic national interest rates plus 2% of basic spread and up to 1.5% of risk spread. Interests are not charged during construction and amortization is of 10 years. Payments are due 6 months after commercial operation. Eletrobrás guarantees in the long-term electricity purchasing contracts, a minimum income of 70% of the contracted energy during the financing period, as well as a full coverage to exposure risks to the short-term market.

Stage II – Once the 3,300 MW objective has been met, PROINFA will target increasing the share of electricity produced by three renewable sources to 10% of annual consumption within 20 years. In Stage II, PROINFA renewable generators will be required, before December 30th of each year, to issue a number of Renewable Energy Certificates proportional to the amount of clean energy produced by the plant.

The National Program for the Use and Production of Biodiesel came into force in 2003, and was designed to integrate biodiesel into the Brazilian energy matrix. Article two of the policy describes the following objectives: (i) the availability of raw-material through large-scale biodiesel production, and the production of biodiesel from different oil seeds; (ii) participation of family-based agriculture in raw-material, supported by PRONAF and the social fuel seal (see section 5.2.3); (iii) reduction of regional inequity; and (iv) industrial policies and technological innovation.

The National Agro-energy Plan (*Plano Nacional de Agroenergia* – 2006-2011) is a collection of strategic actions by the Ministry of Agriculture to promote sustainable development by expanding agro-energy and increasing its

competiveness. The main objectives of the plan include: (i) to guarantee regional development based on expansion of energy agriculture; (ii) create opportunities to increase employment and income in the agro-energy sector with the participation of smallholder producers; (iii) contribute to Brazil's compromise to the Kyoto Protocol; (iv) create an international market for biofuels and guaranteeing Brazil's leadership in the sector; and (v) maximize the sustainability of production systems by identifying the most adequate crops, identifying regions with the most potential for production, and by developing agriculture technology (Ministério da Agricultura, 2006).

The CDM originates from the Kyoto Protocol and aims at reducing GHG in order to prevent further global warming. Article 12 of the protocol makes provisions for the creation of the CDM, which focuses on incentivizing states and organizations on compensating part of their GHG-emissions by promoting sustainable development (Azevedo et al., 2008 2). The CDM´s criteria focus on maximizing social and environmental benefits, as well as ensuring that mechanisms for the protection of the community involved and the environment are being followed.

5.2.3 Social Fuel Seal

The social fuel seal forms part of PRONAF, a government policy specifically designed to promote the integration of smallholder farmers in the emerging biodiesel sector. The *Selo Social de Combustível* or social fuel seals was introduced after drawbacks in family-based agriculture, especially low productivity (das Graças Pimentel and Nunes, 2008 36). The social fuel seal is a seal granted by the Ministry of Farming Development to industrial producers who buy their raw materials from smallholder producers (Tolmasquim, 2006 22). The government's main objective with the social fuel seal is to promote economic and social development of poor regions by generating employment and income. The industrial producers are required to draw up a formal agreement specifying the amount of payment, delivery schedule, and guaranteeing technical assistance and training they will provide to smallholders. For instance, for biodiesel producers to participate in public auctions (where they sell their product to Petrobras), they must comply with the social fuel seal. Under the seal, industrial producers are also entitled to tax-breaks and loans up to 90% from BNDES for projects involving any biodiesel production stage. To ensure that smallholders have a market for their produce, government has made provisions for a minimum percentage of raw materials to be provided by smallholders, according to the specific region they are located.

Smallholder farmers also have access to credits from PRONAF to purchase seeds, machinery and other items (das Graças Pimentel and Nunes, 2008 36).

5.3 Sustainability debate in Brazil

It is not surprising that the Brazilian biofuel sector has influenced the establishment of global schemes on sustainable biofuel production and vice-versa. Many concerns related to the biofuel sector find their origin in Brazil, but we should not underestimate the efforts Brazil is undertaking to make the sector more sustainable. For Brazil to secure its position as leader on the international biofuel market, there is no other option than to start paying more attention to issues related to the negative social, economic and environment impacts within the sector. Moreover: "The Brazilian sugarcane industry is also concerned about avoiding damages caused by strikes, sicknesses and lawsuits which could provoke reductions in production and affect the image of the sector abroad" (Rodrigues and Ortiz, 2006 15).

During the time when Brazil's ethanol industry was flourishing and it was about to become the world leader, sustainability became an important issue. Damage to biodiversity due to expanding biofuel feedstock production has drawn criticism from the EU, with proposals to restrict import of biofuel that has damaged the environment (Keeney and Nanninga, 2008). Additionally, EU officials have expressed their concerns that ethanol producers have been breaking local environmental and labour laws, in particular the use of slave labour in sugarcane harvest and the destruction of tropical forests (Keeney and Nanninga, 2008 23). In 2005, in response to global pressures, Brazil established the PNPB envisioning social, technical, environmental and economic development (das Graças Pimentel and Nunes, 2008 36). The government has also been taking steps for ethanol companies to comply with

environmental and industrial certificate before ethanol can be exported. Several studies have been conducted to inspected the 'sustainability' of the sector. One study was executed by the Netherlands Agency for Sustainable Development Innovation, and carried out by the Utrecht University and Brazil's State University of Campinas which benchmarked and compared the Dutch Sustainability Criteria with the 'Sustainability of Brazilian bioethanol'. The study concluded that present concerns are mainly related to competition with food-production and concerns about impacts on biodiversity (major bottleneck), and water pollution, soil erosion, GHG-emissions and energy balance, working conditions and worker rights, child labour and social responsibility and benefits (medium bottlenecks) (Smeets et al., 2008 801).

5.3.1 NGO and civil society sustainability proposal

The Brazilian Energy Working Group (GTE) and the Forum of NGOs and Social Movements (FBOMS) have been active in promoting sustainability criteria and indicators for creating a sustainable biofuel sector in Brazil (Moret et al., 2006). The criteria have mainly been developed to contribute to the national and international debates on sustainable production and use of biofuels, and to guide discussions between stakeholders involved in biomass energy according to social, economic, and environmental dimensions (Moret et al., 2006). The authors of the report refers to sustainability criteria as: "A set of definitions of the different aspects that should be considered in the evaluation of initiatives, in a complementary and interdependent manner, linked to goals and principles related to the socio-environmental development of the country and its different populations." Table 7 provides a summary of the sustainability criteria and indicators for the biomass energy sector. Please note that these were developed as a proposal, and at this point no information is available on what has been done with these criteria.

Criteria	*Desirable*	*Prerequisites*	*Undesirable*	*Indicators*
Social accountability	Local acceptance of who and what the energy is for; electrical generation for isolated communities	Information and capacity-building	Energy for internal use by energy –intensive industries	Participation of local population and national socio-environmental or organizations in project design
Participation in decision-making	Both beneficiaries and affected populations have influence in decision-making	Information and training, political forums for participation with real influence over decisions,	Public consultations with no commitment to consider demands and no influence on decisions	Number, sites, nature and types of consultations, form of publicity, access to information, language and accessibility of material used
Type of management	Cooperatives, community associations	Training for management of cooperatives, financing (PRONAF, BNDES)	Traditional agro-business, contracts involving integrated production systems that create unfair working and business conditions	Organizational structure and forms of decision-making, number of participants/decision-makers, involvement of organizations representing local workers, participation of women
Job creation and income generation	Family agriculture; jobs for local population, creation of conditions for youth employment	Training for creation of cooperatives; awareness and training of families with technical and political information	Capital intensive agribusiness; concentration of income and land ownership, local participation involved only in low-skilled jobs	Number of jobs per unit of energy (production chain, implementation and operation), profit sharing, generation of new local opportunities and sources of income, relation between local jobs before and after the project, indexes of increase in acquisitive power of the local population
Social inclusion	Capacity-building and training in technology, involvement of community surrounding the project; social support to the families involved; leads to improved quality of life of women and youth	Sharing of project benefits with local population	Absence of community involvement; disruption of traditional patterns of subsistence and culture	Number of families previously without access to energy who benefit from the project; measures of quality and compliance with accepted standards of the involuntary resettlements, when necessary and accepted; impact on quality of life of the communities; social programs, especially for health and education; epidemiological assessment and monitoring; contribution to access to services and infrastructure on the

				part of local populations to education, energy, garbage and sewage services, etc.; contribution to adult literacy and environmental education; reduction of violence and vulnerability of women and youth
Gender equality	Recognition of women and key actors in all stages of decision-making process	Education		Improvement in indoor air quality, reduction in hours of women's work in domestic tasks; existence of programs and policies for women and youth
Regulatory compliance	Compliance with municipal, state and national legislation as well as international agreements	Transparency		Publish audits
Financing	Rural credit for family farming	Financing through PRONAF, BNDES; access to land	Financing for intensive agri-business	Programs and lines of credit, conditions for government financing
Land use	Comply with economic/ ecological zoning (EEZ); region classified as suitable by strategic environmental assessment; defined limits for occupation of biomass; diversification and decentralization of economic activities	Existence of EEZ and Strategic Environmental Assessment for region, watershed or biomass; definition of ecological limits on economic activities in biomass, protection of natural areas	Occupation of inappropriate areas; over-exploitation of ecosystems; extreme territorial specialization	Decentralization and diversification of production systems in area/region; size of continuous areas of monocultures; distance from energy source to consumer; distance travelled and time spent by workers to the project site; time necessary off their land for workers to manage subsistence crops
Origins of biomass	Use of residues; products of agro-ecology and family agriculture		Monocultures, transgenic, alteration of natural biomass	Percentage of residues out of total biomass used in project
Environmental management	Use of best available practices; diversity of crops, agro-forestry systems; agro-ecology or elimination of pesticide use; reduction of soil loss	Training of producers and high capacity of extension personnel and support to rural workers	Green deserts, soil degradation and loss, environmental contamination; forms of production using extremely dangerous pesticides	Monoculture areas, soil loss, atmospheric emissions and effluents into water bodies
Organization of production/labour relations	Cooperatives; family agriculture		Contracts involving integrated production systems	Sharing of profits from biofuels production chain by family farmers; level of satisfaction with existing contracts
Food security	Crop diversity, agro-forestry, and/or companion planting		Monoculture production zones	
Technology	Decentralized generation and production; technology appropriation by local participation; new technology capable of reducing pressures of energy production on ecosystems; horizontal transfer (between communities) of technologies and knowledge; contributions to the diversification of the energy matrix			Relation between local workers and outsiders involved in project maintenance; application of clean technologies; technological innovations; capacity of reproduction of technology used; origin of equipment; existence of royalties and technology licenses; need for international technical support; change in use of sustainable energy; cogeneration
Use of biofuels	Creating more efficient transport systems; promotion of energy efficiency			Rates of reduction of consumption; increased end use conservation; capacity for reduction, reuse and recycling of inputs in the final activities for which the energy is destined; inclusion of demand management in the project planning horizon

Table 7: Sustainability criteria and indicators for biofuel production in Brazil as proposed by GTE-FBOMS (Moret et al., 2006 10-11)

5.3.2 Brazil's position in the biofuel sustainable debate

Brazil's biofuel sector is said to be sustainable by some analysts who emphasize its efficiency in GHG-emission reduction, creation of employment and quality working conditions. Numerous studies have been conducted on the sustainability of ethanol production. For this and many other reasons, Brazil is influencing the sustainability debate at the global level. Mainly the US and Sub-Saharan African countries like Mozambique are looking at Brazil for learning experiences and information-sharing on sustainable biofuel production. As Brazil's President recently stated: "Brazil's ethanol and biodiesel programs are a benchmark for alternative and renewable fuel sources. Partnerships are being established with developing countries seeking to follow Brazil's achievements" (The Economist, 2008).

Brazil's sugarcane ethanol industry is known to be more efficient than the US corn-based sector because the energy balance of sugarcane is seven times higher than that of corn (Lundgren, 2008 19-23). Over the last years, the USA has had a number of collaborations and agreements with Brazil in the energy sectors. An example is the Memorandum of Understanding (MoU) that the American and Brazilian Presidents signed in March 2007, bringing Brazil and the United States together in their energy policies. One of the main purposes of this MoU is that the American government is to attain know-how on sustainable production of sugarcane-based ethanol.

Experiences from Sub-Saharan countries in relation to crops such as cotton and tobacco raised concerns about setting up a sustainable biofuel sector in countries like Mozambique. Recently a number of countries have contacted Brazil in order to share learning experiences from the biofuels sector. This south-south cooperation began in 2006 with countries like Senegal, Nigeria and Sudan (Mongabay, 2007). Cooperation is also visible in the creation of a Brazilian Agricultural Research Centre for Africa in Accra, Ghana. Such initiatives could facilitate the development of the biofuel sector on the African continent. For this study it is important to mention that a MoU was signed between the Mozambique and the Brazilian governments in 2007. The agreement is mainly to help promote biofuel production in the country. According to internet sources UNICA stated that Mozambique: "Is on the same latitude as the most competitive Brazilian plantation areas and the regions chosen by the Mozambican government for ethanol production, and that they all have a climate similar to Brazil's" (Mongabay, 2007).

5.4 Reality of biofuel production in Brazil

Like many other countries, one of Brazil's main challenges is to stimulate sustainable economic growth and development, without hazarding the environment. With its bioenergy programs, Brazil has been successful in reducing its social and economic problems. The main achievements include: (i) attaining energy independence as the country has reduced dependency on oil imports and unstable prices in the sector, saving about US$4.2 billion yearly; (ii) creating employment throughout the country and improving job quality in farms and agro-fuel sectors; (iii) reducing carbon dioxide emissions in the country with the reduction of fossil fuels in vehicles; and (iv) generating income (Econergy, 2008 370). However, some prominent environmental, economic, and social challenges are still visible in the biofuel production chain. This section is predominantly based on work by Smeets et al. (2006; 2008).

5.4.1 Legal aspects: land and water rights

Although we did not analyze the Brazilian legislation on land and water rights, some general remarks with regard to their implementation and monitoring can be made. According to Smeets et al., (2006 59): "The land tenure law in Brazil is generally weak, giving little protection to smallholder farmers. Smallholder farmers and landlords frequently clashed over land rights and landlords often recruited the help of the police, resulting in human rights violations. On the other hand, legislation is in place which allows the state to possess unproductive lands. These lands can be offered to poor people. Nevertheless, landless poor people trying to illegally occupy land can be evicted." Rodrigues and Ortiz (2006 10) add that there is an absence of efficient judicial classification concerning the Brazilian land ownership structure, capable of regulating the uses and determining the limits of properties. Macedo et al. (2005) even claim that: "Apparently, there is no planning on land use regarding sugarcane production in Brazil". Concerning

water use, the Brazilian government has taken legislative measures with regard to water management and rights. These measures include billing agriculture and industrial activities.

5.4.2 Social aspects

In the social sphere, an important aspect is investment in agricultural research. Brazil has the most efficient agricultural technology for sugarcane cultivation in the world. Another focus areas has been employment and income generation. Sugarcane production has had a positive effect on some of the poorest people in Brazil by providing an income; usually above the minimum wage. It is also said that sugar production offers high incidence of migrant and temporary workers from other regions to where the plantations are.

Violations of working conditions for farmers and plantation workers form a major point of attention. It is said that fear of losing employment is one of the reasons why workers accept to work under terrible conditions, to accept lack of individual protection equipment, poor quality meals and other irregularities (Rodrigues and Ortiz, 2006). Nevertheless, legislation demands of the ethanol production sector that 1% of the net sugarcane price and 2% of the net ethanol price should be devoted to medical, dental, pharmaceutical, sanitary, and educational services for sugarcane workers. According to research by Smeets et al.: “Results show that more than 90% of the mills provide health and dental care, transportation and collective life insurance, and over 80% provide meals and pharmaceutical care. More than 84% have profit-sharing programs, accommodations and day-care units. However, for the low wage (temporary) labourers in cane cutting, these services may not be available” (Smeets et al., 2006 70).

In the 1990s, the Ministry of Agriculture recommended the formalization and organization of small sugarcane suppliers and promoted one representative to be in charge of administration and legal representation for all members. This is said to have damaged the collective representation of workers through unions, because many rural workers are organized in condominiums (Rodrigues and Ortiz, 2006). A partnership between UNICA and the Federation of Rural Workers has been established for continuous dialogue on the improvement of work conditions and remuneration for employees (Padiet, 2008). Government and UNICA have also developed: “A legal social responsibility mechanism, with frequent inspection for ensuring a fair remuneration package for the sugarcane labourers” (Padiet, 2008). Concerning the reduction in employment due to the introduction of mechanized harvesting, it is said that the sugarcane industry: “Provides rural workers with education and retraining projects that can keep the retrenched workers employable despite the introduction of mechanized planters and harvesters in sugarcane fields” (Padiet, 2008).

One of the positive impacts of developing the biodiesel sector in Brazil should be the generation of jobs and income. Government has offered economical support for small farmers (especially castor and palm producers) to incentivize the sector (Nogueira, 2005 7). According to Holanda (2004): “For every 1% substitution of diesel with biodiesel produced by family-based agriculture, over 45,000 jobs can be generated in the field (and 1 job in the field represents 3 in the city” (quoted in: das Graças Pimentel and Nunes, 2008 31). However, although smallholder-based production is being incentivized and protected by authorities through the social fuel seal, smallholder production is subject to competition with large-scale initiatives (das Graças Pimentel and Nunes, 2008 7). Ideally there should be cooperation between the company and the smallholder which offers farmers technical assistance, financial assistances at low costs, and a guarantee that the production will be bought by the company (Soares et al., 2006). However, in practice this might be different and loans might actually create more problems than they solve.

There are concerns on land-use include competition with food production or livestock production, especially in regions with higher average rainfall where a lot of sugarcane producers are located. In these areas it is: “Already possible to observe the reduced production of other crops and a reconfiguration of rural space” (Rodrigues and Ortiz, 2006 11).

5.4.3 Economic aspects

Concerning ethanol, Brazil has created an industry producing enough to meet the demands of the domestic market, whereas surplus is exported. In 2008 Brazil produced 24.5 billion litres of ethanol (Renewable Fuels Association, 2009), which represents 37.3% of the world's total ethanol used as fuel (World Bank, 2008a). Smeets et al. (2006 74) wrote: "Ethanol from sugarcane in Brazil is the cheapest biofuel in the world, and the price is competitive with fossil fuels." This was not only possible because of high production and technology available, but also because government provides support such as tax incentives, loans and mandatory blending requirements. According to Rodrigues and Ortiz (2006): "The cost of producing ethanol has been falling in real terms, over the last decades, principally motivated by government actions of *Proalcool*: a mandatory blending regime of 20% to 25% of ethanol;; the reduction of tributes on fuel; the reduction of the tax on industrialized products for cars which are fuelled by ethanol; the opening of subsidized lines of credit to the sugar & ethanol sector. These actions contributed to the technological advancement in the direction of eco-efficiency, and resulted in a reduction of costs per volume produced."

Moreover, economies of scale and competition led to a reduction in production costs; mainly to a significant increase in agricultural yield. Productivity gains and cost reductions were also achieved as a result of the introduction of operation research techniques in agricultural management and the use of satellite images for species identification in cultivated areas. Similar tools have been applied in relation to harvesting, planting and application rates for herbicides and fertilizers (Goldemberg, 2006). Also, this cost reduction was highly influenced by the use of sugarcane bagasse (a by-product of sugarcane crushing) for energy production, avoiding the use of any fossil fuel in the industrial project (Goldemberg, 2006).

It is said however that: "The costs of ethanol meeting sustainability criteria will be much higher as compared to standard ethanol as a result of the costs of compliance with criteria and the costs of certification" (Smeets et al., 2006 74). Moreover, when sugarcane is scarce, ethanol prices rise. In 2006 for instance, when there was lack of sugarcane in Sao Paolo, government was forced to temporarily increase the price of ethanol and to reduce blending of ethanol in gasoline from 25% to 20%. For ethanol to be competitive its price has to be at least 65% less than gasoline in gas stations (Rodrigues and Ortiz, 2006).

Concerning biodiesel, the government's objective is to produce about two billion litres of biodiesel by 2013 for the domestic market, which will reduce diesel imports and generate an annual income of US$1.2 billion. It is predicted that until 2015 all Brazilian biodiesel production will be used for domestic consumption only. However, there is a lack of technology for large-scale production of biodiesel – meaning the country has to invest substantially to meet its objectives (Paulillo et al., 2007). The economic feasibility of biofuels depends on a number of factors including the cost of oil and feedstock. Biofuels can put pressure on food prices through spillover effects. For example changes in corn prices lead to changes in the prices of soybean (Merrill Lynch, 2008 5).

5.4.4 Environmental aspects

Studies have been carried out that confirm that the energy balance for sugarcane ethanol is the best in the world for biofuels with commercially available technologies: up to 10 output units for each input unit (Goldemberg, 2006). Ethanol from sugarcane is also regarded to be the most efficient biofuel currently under commercial production in terms of GHG emission reduction: 80% or above if there is no significant land use change (Smeets et al., 2006 54). "Biofuel also reduces carbon monoxide emissions by 48%, black smoke by 47% and completely eliminates the sulphuric oxide emissions which are a main cause of acid rain" (British Consulate General, 2005 4). On the one hand, ethanol produced from sugarcane provides energy that is renewable and less carbon intensive than oil. The use of bioethanol reduces air pollution because of its cleaner emissions, and contributes to alleviate climate change by reducing greenhouse gas emissions. On the other hand, the most criticised practice in sugarcane production is sugarcane burning. According to Smeets et al. (2006 48) burning cane can: "Damage infrastructure and forests resulting in risks for electrical systems, railways, highways, and forest reserves"; and can cause "damage to the cane

plantation itself, as it can damage the cell tissue of the cane stem, and thus increase the risk of infection, destruction of organic matter, damage to the soil structure due to increased drying, and increased risks of soil erosion." Brazil, like every other country is going through 'external' pressures for the preservation of the environment for future generations. Studies have been undertaken to prove that sugarcane burning emissions are hazardous to human health, causing damage to the respiratory system of people who live close to, or work at sugarcane plantations. "This effect is higher for children and the elderly, and it is similar to that observed in urban areas due to exposure to industrial and vehicle-emitted air pollutants" (Cançado et al., 2006). As previously mentioned, Brazil has developed legislation to gradually ban sugarcane burning by 2030 (Smeets et al., 2006 50).

With regard to biodiversity, Brazilian legislation obliges each piece of agriculture land to have 20% of biodiversity reserve (Rodrigues and Ortiz, 2006). According to Smeets et al. (2006) cane production has limited direct impacts on biodiversity because: "Cane production replaces mainly pastures and/or food crop and sugarcane production takes place far from the major biomes in Brazil". "The production of ethanol could have a negative impact on biodiversity in various ways, either directly (e.g., through the conversion of undisturbed land to sugar cane production) or indirectly (e.g., through the pollution from agrochemical or through indirect impact on land use patterns). Positive impacts are also possible, e.g., the use ethanol reduces the emissions of greenhouse gasses and thus reduces biodiversity losses from GHG-emissions" (Smeets et al., 2006 35-36). The Cerrado is an important biome in Brazil, yet it is in this area that soybean production activities are taking place. It is said that approximately 60% of the Cerrado's original vegetation has been destroyed. The same applies for the Amazon region, where soybean has become a driver for deforestation (Keeney and Nanninga, 2008 24). The National Agro-energy Plan makes provisions for agro-ecological zoning to monitor private and public investments and the environmental impacts they may have.

Soil erosion is prominent in soybean plantations especially on fragile lands, especially in areas where long cycles of crop rotation are not implemented. It is said that in Brazil soil loss averages vary between 19-30 tons per hectare, depending on management practices, climate and incline (slope) (Altieri and Bravo, 2007). To avoid erosion zero tillage systems are planted and often mechanical weeding is replaced by using herbicides, which has negative implications for soil, water and air quality. Sugarcane and industrial production of ethanol is said to have: "Impacts on soil related to the reduction of water availability due the superficial capture of water and the induction of erosive processes. It also presents risks of contamination of soil and water resources because of the use of agrochemicals" (Rodrigues and Ortiz, 2006).

Most sugarcane plantations are located in or near water basin areas with access to sufficient fresh water for irrigation, industry and household-usage. Ethanol production leads to large amounts of water waste. Water shortages occur due to misuse or pollution, especially as a result of raw sewage, leaking landfills and industrial waste. Water pollution from farming and sugarcane industry is said to have affected Brazil's rivers, particularly in the Pantanal. In the Cerrado, water draining from the sugarcane fields has further decreased water quality (Keeney and Nanninga, 2008). Government has passed legislation to deal with water pollution by charging industries in some regions (Smeets et al., 2006 23-24). Concerning irrigation, Smeets et al. (2006) conclude that although it is used in some areas, it is not economically viable for the whole sugarcane sector. Experiments carried out by the sugarcane Technology Centre (CTC) showed that subsurface sprinkling is only economically feasible under certain conditions (Smeets et al., 2006 25).

Further exploration of renewable energy sources and the availability of environmental legislation shows how Brazil is preoccupied with the preservation of the environment. However, the sector continues to give rise to concerns regarding deforestation, water use and contamination and soil erosion, which have negative implications on the environment. It seems that the development of a biofuel sector that is economically viable and competitive, while at the same time being socially and environmentally responsible is not that simple.

5.5 Analysis and discussion

Table 8 provides an overview of the legal, social, economic and environmental challenges and opportunities we identified in the Brazilian biofuel sector

		Challenges		Opportunities	
Legalities					
Legal frameworks		Implementation and monitoring of (environmental) legislation (domestic and international)		Existence of policies and laws to govern biofuel supply chain	
Land and water rights		Protection of smallholder farmers with land tenures; determining specific areas for biofuel activities		Water use legislation i.e. billing agriculture and industry for water pollution	
Social					
Stakeholder participation		Involvement of small-scale stakeholders and local communities; maximising collaborations with rural farmers unions		PRONAF, social fuel seal, PNPB, National Agro-energy Program clearly defined stakeholder participation throughout all processes of the production chain	
Human and labour rights, and social well-being		Manual sugarcane cutting is a very hard and unhealthy job; workers are underpaid; lack of protection equipment for works; medical care and food; cases of child-labour Introduction of mechanized planting and harvesting will reduce employment in the sector Resettlement and displacements		Provisions to ban manual harvesting by 2030 Majority of companies are shifting to mechanical harvesting	
Food security		Shift from food crop and livestock production to energy crops; increase in food prices due to diversion of production crops		Technology and agrarian development induced increases in food production (i.e. soybean/ sunflower/ sugar)	
Economic					
Macro economy		Energy independence; economic growth; (self-) employment; further development of biodiesel market Biofuel market is highly-dependent on (unstable) fossil fuel prices Dependence on government subsidies		Availability of internal and external market; success of bioethanol sector: one of the world's leading producers, major reductions in gasoline imports, large exporter of ethanol (revenue); some developments in biodiesel production; income and employment generation	
Micro economy		Local biomass application for energy use Balancing micro- and macro economic spin-offs		Government incentives that stimulate the involvement of smallholder farmers/ income generation	
Environmental					
GHG-emission		Measuring GHG-emissions (domestically and international)	Lack of monitoring mechanisms to measure and the environmental performance and impact of biofuel production, processing and use	Sugarcane has an efficient energy balance	Availability of environmental legislation
Plant production systems/ agronomics/ biodiversity		Conservation of biomes and forests, as well as preventing biofuel projects from being established in high value conservation areas (e.g. Pantanal, Amazon and Cerrado)		Observance of 20% of the biodiversity reserve which Brazilian legislation obliges each piece of agricultural land to have.	
Soil	*Soil carbon stocks*	Conversion of land may release soil carbon stocks that impact the GHG-balance of biofuel production		Zero-tillage systems prevent mobilisation of soils/ erosion and conserves soil carbon stocks	
	Soil quality	Erosion Soil contamination through the use of agro-chemicals		Technological advancement which reduces quantity of agrochemicals used in the biofuel production	
Water and air		Reduced availability and contamination of water sources as a result of large-scale sugarcane plantations Air pollution through sugarcane burning and agrochemicals		Availability of legislation to manage water use Efficient use of water resources through irrigation	

Table 8: Analysis of learning experiences from the Brazilian biofuel sector

Based on our analysis, we conclude that Brazil has legislation to govern the production, processing of biofuels. However, strict monitoring and evaluation mechanisms sometimes lack to ensure that producers, whether small or large-scale, follow the established laws and legislation. As a result of expansion of production of soybean and sugarcane, the main challenges in Brazil are related to land rights, the displacement of households, destruction of biodiversity and deforestation, production shifts (from food crops/ pasteurization to production of energy crops); and labour issues related to working conditions, wages, health care and food for labourers.

5.6 Conclusions and recommendations

Importance of research: Like Müller et al. (2007) emphasized: "To really disclose the potential of bio-energy there will be a continuous need to invest in improving agricultural management in general, and improving the efficiency of agricultural production in particular". To facilitate further exploration of the opportunities of the biofuel sector, investment in research, technology and training for the identification of appropriate feedstock and areas for biofuel production is necessary. Research on biophysical, socio-cultural and economic issues related to biofuel production has to expand, involving universities, (agriculture) research bodies, NGOs, governments and the private sector. Feedstock diversification for the production of biofuel is necessary and can be promoted through government legislation, incentives and market regulation. Brazil's National Agro-energy Plan emphasizes that: "Investment in research is the basis for development of technologies for agricultural production as it permits the identification of more suitable crops and production systems." The Brazilian biofuel sector benefits from research by various multidisciplinary platforms, which contributes to continuous debate, constructive negotiations and realistic policy-making.

Legislation: Strict legislation appears to be necessary for the sustainable growth of the biofuel sector. Such legislation should provide realistic country-specific guidelines for the production and use of biofuels, that on the other hand take into account existing (inter)national policies and criteria relevant to the sector. These need to be monitored to ensure that stakeholders abide to them. Brazil has specific biofuel related policies such as the National Agro-energy Program to govern sustainable production and use of biofuels in the country. These are monitored by government, NGOs and other actors involved in the production chain through regular inspections.

Involvement of smallholders: To promote sustainable rural development (income and employment generation, and improvement in the lives of people living in rural areas where biofuel production takes place), the involvement of local stakeholder throughout all phases of decision-making is necessary – but complicated. There is a need for production subsidies and incentives, as well as guarantees for mutual benefits to attract and link smallholder and commercial producers. To create sustainable employment and good work conditions, it seems necessary to have strict labour laws. Biofuel feedstock also determines how sustainable rural development can be. Crops for which a value chain already exists are more likely to contribute to rural development; as farmers know how to grow them and have take-off on existing markets. In Brazil the existence of PRONAF and the social fuel seal are examples of how legislation can make provisions for the development of partnerships between smallholder and commercial producers. These partnerships should be put under law to ensure its implementation in practice, consequently leading to 'penal' measures if not complied (e.g. no access to auctions, low cost loans or tax exemptions). Subsequently policies like PRONAF and the social fuel seal promote rural development by providing training on agricultural and technical practices, providing loans and access to credit to smallholders, employment and income generation, and guaranteed off-take of production.

Availability of financial resources: Another important perquisite for the sustainable development of the sector is the availability of financial resources in the form of credit and loans (with little financial burdens) to fund and promote production. In Brazil, the BNDES is an example of financial support in the form of credit and loans from government for biofuel projects. BNDES can finance up to 70% of capital costs at the basic national interest rates. Interests are not charged during construction, and amortization is of 10 years. Payments are due six months after commercial operation.

Food versus fuel: To ensure the availability of food for affordable prices, Brazil is identifying new ways of biofuel production. Land zoning seeks to identify areas where competition with food production is low, accompanied by providing incentives to promote agricultural productivity and increase food production. Müller et al. (2007) state that:

"There is still substantial land and water in sub-Saharan Africa and South America to expand areas for agricultural production, for both food and fuel production." It is generally believed that there is a relation between biofuel and food production. Food production can benefit from technologies and innovations from the biofuel sector, but there are also concerns about the negative correlation as biofuel production might lead to higher food prices and reduced food security in rural areas. Careful monitoring and evaluation is needed!

Agro-ecological zoning and land-use: To deal with water and land management in the biofuel production chain, countries like Brazil and Mozambique need to look at experiences from different regions. It would be very useful to compare opportunities from different agro-ecological zones; e.g. the effectiveness of having sugarcane plantations in regions with low potential for rain-fed agriculture. In Brazil, the National Agro-energy Plan makes provisions for land-use and agro-ecological zoning. This is amongst others used to monitor investment in areas and to identify the environmental impacts they may have. The objective of agro-ecological zoning is to promote or restrict occupation of new land, as well as to diversify opportunities and maximize food crop sources.

Development of national market: Brazil has a stable internal market for biofuels (especially bioethanol), which has reduced the country's fuel dependency problems. A mandatory blending regime, the availability of ethanol at numerous gas stations, and the fact that 70% of all new cars in Brazil are flex-fuel vehicles, shows that it is possible to reduce fossil fuel consumption and to develop a domestic market for biofuels. Mozambique should prioritize the development of the domestic market and examine the possibilities of importing flex-fuel vehicles[33]; issues which are covered in the Mozambican national biofuel policy and strategy (Resolution 22/2009).

Concluding

Biofuels in Brazil have a long history, which provided us with valuable learning experiences on the legal, social, economic and environmental opportunities and challenges that have evolved. Economic development and energy independence are no longer the only main objectives of the country. The country now focuses on reducing the negative social and environmental impact of the biofuel sector. Although Brazil does not have a distinct set of sustainability criteria or rules, the country did develop some adequate mechanisms to promote a more sustainable sector. Brazil's biofuel sector is governed by a number of national and international outlined policies and legislation, such as the Clean Development Mechanism, the Program of Incentives for Alternative Electricity Sources, the National Biodiesel Program, and the National Agro-energy Policy. Brazil is also represented in several international sustainability platforms such as Round Tables for Responsible Soy Association (RTRS) and the Better Sugarcane Initiative (BSI) and the Round Table for Sustainable Biofuels (RSB).

As Mozambique is facing similar questions related to the establishment of a competitive biofuel sector, whilst addressing and reducing negative social and environmental impacts, we cherish the cooperation between the Brazilian and Mozambican governments. As learning inquires experimenting, making mistakes and changing on the basis of those insights, we believe there is nothing wrong with exchanging knowledge and experiences, which can speed-up the learning process.

[33] We should add that Brazil has the advantage of having a national automobile industry

6. Sustainability and certification in Mozambique

The objective of this chapter is to learn from existing experiences with certification in Mozambique. As mentioned in section 3.3, different institutions are currently developing and implementing criteria for sustainable biofuel production. One way of implementing a sustainability framework is through certification. There already exist proposals for the certification of sustainability, and several researchers have compared the usefulness of existing certification systems for sustainable biofuel production (UNCTAD, 2008; van Dam et al., 2008). The aim of this chapter is not to repeat existing research, but to go beyond and look for practical certification experiences that exist in Mozambican. With these insights, we hope to contribute to the development of a sustainability framework that reflects the Mozambican reality.

Three different examples of existing certification systems in Mozambique were identified and studied: FSC-certification, GlobalGAP-certification and fair-trade certification. Data collection for this part of the study was done through literature study, 14 semi-structured interviews and four field visits. Through this data, we gained more insights in what it requires to become certified in the Mozambican context, and subsequently insight in the challenges and the opportunities.

6.1 Introduction

With the fast growing biofuel market, concerns about the potential social and environmental impacts of biofuels production have driven the development of biofuel certification by a wide variety of public and private stakeholders (Econergy, 2008 251). Although the initiatives are in different phases of development, most are presented as guidelines. As already mentioned in section 3.5, the Mozambican government has responded concerned to these developments, as implementing the criteria could disfavour countries like Mozambique. Therefore, the Mozambican government is developing their own national system of sustainability principles. The government is aware that this also means that institutional and technical capacity should be created in order to implement a sustainability framework in practice (Econergy, 2008 ES18).

According to the Mozambican biofuel assessment (Econergy, 2008 259), the definition and implementation of such certification systems face some challenges. Firstly, the proposed sustainability initiatives overlap due to a lack of international coordination. Furthermore, from the perspective of developing countries, meeting the international sustainability criteria is costly and difficult to comply with due to a lack of capacity. If international sustainability standards are developed without input from developing countries they risk to act excluding and prevent developing countries for participating on the international biofuels market (Lerner, 2007). Another concern raised is the risk of proliferation and possible competition that may damage the credibility and efficiency of certification (UNCTAD, 2008 v), and will add significant cost to biofuel production, especially for smallholders.

6.2 Certification and certification systems in Mozambique

Certification is often related to a system of voluntary standardization and/ or governmental regulation. Both are important for international trade and define what can or cannot be exchanged. Moreover, it provides guidelines under which such exchanges are, or are not permitted. Certification can be defined as: “The procedure in which a third party gives a written guarantee that a product, process or service conforms to a standard. Certification can be seen as a way by which actors in the chain (producers-traders-consumers) relate to each other to ensure the safety and quality of a product” (Trade Standards Practitioners Network, 2009). Standards are the: “Set of rules that control how people develop and manage materials, products, services, technologies, processes, and systems” (ibid.). Standards are established by organizations or countries and can focus on environmental issues, social issues, or other aspects as food safety and quality.

Governmental regulations are requirements established by the importing country. Some important governmental regulations focus for example on phytosanitary and environmental safety regulations, customs clearance and food safety regulations. Governmental regulations are state-driven and exporting countries need to comply with them in order to sell their products. Voluntary standards are usually private sector (e.g. retailers) and/ or civil society driven (e.g. environmental NGOs), and are not mandatory. However, in practice, voluntary standards can become a

necessity in order to access certain markets, or can become mandatory when being incorporated into law. Voluntary standards seek to contribute to food safety, the protection of natural resources, and improve livelihood of workers and local producers.

Standards and governmental regulations are mainly introduced by the western world. Wilson and Abiola (2003 v) identified a number of reasons why African countries face difficulties in meeting these western quality standards, such as: western agricultural subsidies, the gap between enforcement capacity in Africa compared to international norms, and the high western consumer demands. According to Wilson and Abiola (2003 xix): "The burden of standards compliance appears to be shifting to producers. Therefore, complying with standards (both voluntary and mandatory) is a great challenge for African producers, especially smallholders."

Mozambique is member of several international bodies (World Trade Organization – WTO and International Organization for Standardization – ISO), which means they have to comply with certain safety measures. In the last decade, Mozambique has improved their standard and regulation system. The country has implemented the Sanitary and Phytosanitary Measures agreement (SPS), and Technical Barriers to Trade agreement (TBT) (Rebello Da Silva and L. Da Silva Garrilho, 2003 66). SPS and TBT are WTO regulation that were established in 1995. The agreement on the application of SPS-measures concerns the application of food safety, and animal and plant health regulations (WTO, 1998). The TBT-agreement covers technical regulations and standards, including packaging, marking and labelling requirements, and procedures to ensure these are met. TBT-measures cover any subjects (from cars, human health, to cigarettes) except those measurements covered by SPS (UNCTAD, 2008 42).

There are some organizations in Mozambique working on the promotion of standardization and quality control. Standardization is under the responsibility of the *Instituto Nacional de Normalização e Qualidade* (INNOQ), which was established in 1993 as an autonomous body operating under the Ministry of Industry and Trade since 2000. The main functions of INNOQ are the promotion of standardization and quality in the manufacturing of products and the performance of services, and cooperation with regional and international organizations working in the fields of standardization and quality. The INNOQ acts as the central body responsible for defining and implementing quality policy and for coordinating all standardization and quality activities at the national level.

Another National institution involved in issues related to certification is IPEX (*Instututo para a Promoção de Exportações*); the institute for export promotion. IPEX supports the government on issues related to export and trade policies, and supports small-scale and medium producers. Currently, IPEX is running some pilot projects to promote certification important for entering the European market. They support three Mozambican commercial companies that are in the process of applying for GlobalGAP and organic certification. In practice, most certified companies in Mozambique are run by foreign owners and/ or investors. In Mozambique, the number of companies and/or facilities that could support certification and standardization is limited. Companies that do audits are mainly foreign and there is lack of facilities that can provide standardization services (such as laboratories, etc.) (Awasthi, 2005; IPEX, 2009).

The main problems as identified by the Standard and Trade Development Facility (2008 3) are: "The high percentage of small-scale importation by small traders and the lack of inspection and control at the border." Mozambique's control system is weak, causing major annual losses to pest damage and restrictions to export markets (Standards and Trade Development Facility, 2008). This is one of the reasons why there are few companies in Mozambique that enter premium markets in Europe, which are often regulated through private standard systems.

6.3 Experiences with certification systems in Mozambique

In this section we describe and analyze existing experiences with three different standards; FSC-certification, GlobalGAP-certification and fair-trade certification. Leading questions were: What does it mean to develop and implement certification systems? What can be learned from experiences of certified producers? In addition, how can we use these lessons when developing a Mozambican sustainability framework for biofuel production?

6.3.1 FSC-certification

The reason to select Forest Stewardship Council (FSC) certification for this study is two-folded. Firstly, a very practical reason, FSC-certification, like the other two certification systems discussed in this chapter, is one of the few Mozambican examples of certification. Secondly, FSC-certification is identified as useful foundation for biofuel certification, as it covers similar areas (van Dam et al., 2008 766/751).

6.3.1.1 FSC-background

The Forest Stewardship Council is an independent, non-governmental, non-profit organization which promotes responsible forest management. FSC is an association of members consisting of a diverse group of representatives from environmental and social groups, the timber trade, indigenous people's organizations, responsible corporations, community forestry groups and forest product certification organizations from around the world (FSC, 2009a). FSC was established in 1993 as a response to the concerns on global deforestation and the large public debates in the 1980s about irresponsible industrial logging and the failure of governments to tackle this problem (Auld et al., 2008 189). During the 1992 UN conference on Environment and Development (UNCED, 1992), governments agreed upon the formulation of Forest Principles and general guidelines, but were not able to negotiate it into a legally binding global forest agreement. These principles were perceived as political and legally weak they did not clarify how forest conservation and utilization should be balanced (Auld et al., 2008 189). This gave reason for the NGO-sector to seek for alternative solutions. In 1993, the non-governmental Forest Stewardship Council was officially founded by WWF and other environmental NGOs, progressive timber traders and forest companies, indigenous people groups, forest workers organizations, and some other stakeholders to promote sustainable forest management. More than criticizing poor practices, they used a market approach to promote socially beneficial, environmentally appropriate and economically viable forest management. Voluntary standards were developed for certifying and labelling forests and forest products, with requirements focusing on sustainable forest management, environmental impact, indigenous rights, land rights, and equity of benefits. In 1994, the first certification contract was signed and the first certified timber products were sold in the UK. Nowadays, there are almost 1000 certified companies, distributed over 82 countries, covering more than 100 million ha of forest, which represents 5% of the worlds production forests (FSC, 2009c). About six percent of the total certified forest area is located in Africa distributed over 46 certified companies of which two are located in Mozambique.

Box 3: Overview of the FSC-standards (FSC, 2009e)

Principle 1	Compliance with all applicable laws and international treaties
Principle 2	Demonstrated and uncontested, clearly defined, long–term land tenure and use rights
Principle 3	Recognition and respect of indigenous peoples' rights
Principle 4	Maintenance or enhancement of long-term social and economic well-being of forest workers and local communities and respect of worker's rights in compliance with International Labour Organisation (ILO) conventions
Principle 5	Equitable use and sharing of benefits derived from the forest
Principle 6	Reduction of environmental impact of logging activities and maintenance of the ecological functions and integrity of the forest
Principle 7	Appropriate and continuously updated management plan
Principle 8	Appropriate monitoring and assessment activities to assess the condition of the forest, management activities and their social and environmental impacts
Principle 9	Maintenance of High Conservation Value Forests (HCVFs) defined as environmental and social values that are considered to be of outstanding significance or critical importance
Principle 10	In addition to compliance with all of the above, plantations must contribute to reduce the pressures on and promote the restoration and conservation of natural forests.

The FSC system consist of a body of standards (box 3), an independent inspection and certifying body, and a product label, and asserts social and environmental goals into the governance of the wood commodity networks (Klooster, 2008 1). The main focus of FSC-standards is on environmental (conservation and maintenance of conservation forest, reducing impact of logging, reforestation) and social (indigenous rights, labour conditions,

equitable use of forest) aspects. Forest managers who want to ensure that their forest operation is socially beneficial, and managed in an environmentally friendly and economic viable way, can apply for Forest Management (FM) certification. This involves an inspection by an independent certified body that assesses the FSC criteria. In order to sell forest products under the FSC-logo, the forest manager has to apply for Chain of Custody Certification (COC). COC tracks FSC-certified material through the production process – from the forest to the consumer. To be FSC-certified has several advantages; it can improve competitiveness and facilitate access to new markets and clients for certified products. Furthermore, it develops and enhances the public image of the timber company, and it can be an incentive for responsible forest management and good management practice (Sal & Caldeira Advogados e Consultores). The objective is to limit the market for products that are not produced sustainably (Doornbosch and Steenblik, 2007 41). In practice, it remains difficult to ensure a guarantied COC and decrease of non-sustainable forest products. The OECD report: "Biofuels: Is the Cure Worse than the Disease" by Doornbosch and Steenblik describes the following reasons: "Wood is processed into many different products and sourced from many different wood species, origins and owners. Shipping documents are easy to falsify and the laundering of illegal products through trade between countries is relatively easy. Secondly, as certification is conducted on a voluntary basis, it has merely led to a segmentation of the market. Wood products from sustainable sources are supplying the small higher priced market segment that demands certified products, whereas non-sustainably produced resources are serving the rest of the market" (Doornbosch and Steenblik, 2007 41). According to the OECD, this explains why only a small percentage of the market for certified wood is supplied by non-OECD countries.

Alternative procedures: FSC recognized that applying for certification can be difficult for small and low intensity managed forests (due to great differences in scale and intensity, and procedural barriers). In 2002, FSC launched a 'flexible' procedure appropriate to deal with small-scale and low intensity forest operations (SLIMF). Small-scale forest operations can be seen as operations that are occupying a small area, and are low intensity operations run by communities, non-industrial companies, cooperatives, forest associations (FSC, 2009f). This procedure focuses more on criteria regarding responsible management of biodiversity and identifying, managing and monitoring of high conservation value forests (see box 3; FSC-standards 6 and 9). As the scale and intensity of small-scale operations is lower than that of the commercial forest concessions, this procedure also requires less time and resources to comply with FSC-requirements. Furthermore, FSC offers a procedure for group certification for small-scale owners, that allow groups of owners to apply jointly and share the certification costs (FSC, 2009d). In 2006, there were 39 SLIMF-certified initiatives (FSC, 2009g). These two procedures provide opportunities for small-scale, non-commercial initiatives. However, in practice the SLIMF-certification have not been widely applied, as small forest operations below 1,000 ha face discrepancies between the amount of timber they extract (mostly outsourced to contractors) and the FSC-requirements of harvesting only every 20 till 30 year (International Forest Industry, 2008).

Procedure and costs: In a country where no FSC-certification exists, first the standards have to be translated to fit the national standards and reality. These standards are formulated by the certifying body, the applying forest operation and national institutes involved in the forest sector, subsequently to be approved by FSC. The procedure for applying for FSC-certification is not issued by FSC itself. The certification process is carried out by independent certification bodies. In the case of Mozambique, SGS-South Africa issues the FSC certification. The certification bodies assess forest management and COC-operations against FSC standards. Firstly, a pre-assessment is carried out that is prepared by the forest operation itself. On basis of the outcome of the pre-assessment, the forest operation can implement changes, if necessary, and apply for the official audit. Once the audit is carried out and approved, the FSC-certificate is valid for five years. The certification body will conduct annual surveillance audits to verify continued compliance with the FSC requirements (FSC, 2009b).

The costs, time and resources required for FSC-certification vary considerably as it depends on the size and complexity of the consession. Therefore, no fixed prices can be listed. If we take the Mozambican example, an audit of a forest operation of the size (24,000 ha) and complexity of TCT Dalmann (section 6.3.1.3), costs are more or less US$14,000. Taking all cost into account (administration, documentation, including audit costs), a forest operation of this size has to invest about US$25,000 on an annual base to maintain FSC-certification.

6.3.1.2 Background Mozambican forest sector

The forest sector in Mozambique faces many challenges, mainly due to rapid deforestation. Many of the losses are caused by agriculture (slash and burn activities), traditional beekeeping, illegal timber cut and charcoal production,

and fires. The war in Mozambique has had a lasting impact on the timber sector. Many concession areas are not easily accessible due to landmines. Indirectly, it even has an effect on the operation of sawmills, as trees have still bullets embedded in them. After the war, many of the roads were un-tarred, which made transport of timber difficult. For a forest concession owner this means large investments in infrastructure (TCT certification report, 2005). The total forest cover (data from 1990) in Mozambique is estimated at 30.9 million ha or 38.8% of the total land area (Nielsen et al., 2006 37). The annual wood production in Mozambique in 2000 was estimated at 18 million m^3; about 16.7 million m^3 for the production for charcoal and fuel-wood and 1.2 million m^3 for commercial timber use. This shows that commercial wood production only covers a small percentage of the total forest production. Data from 2003 shows that approximately 1.9 million ha is used by 46 concession holders (Sitoe et al., 2003). No up to date records exist of the exact number of forest operations or commercial timber production. Commercial timber production may be substantially higher than these numbers indicate as illegal logging is estimated between 40% and 50% of the total volume of timber extracted from the forest (Kloeck-Jensen, 1998). The Mozambican timber sector produces mainly for the Asian, South African and European Market. From the leading Asian market, there is hardly any demand for certified timber. Currently, the EU is putting pressure on sustainable tropical timber, which might increase the demand for sustainable timber on the long term. By August 2009, only two forest concessions were FSC-certified, although a few other concessions are applying for FSC-certification (SGS, 2009). Furthermore, some NGOs are promoting FSC-certification to private forest concessions (e.g. the Malalone Foundation in Niassa province). There are also examples of forest community concessions that are supported by NGOs to prepare for FSC-certification. This can be a long process, which requires facilitation of the communities, as human resources (low literacy rates and education levels) and financial resources are limited.

The Mozambican law (Law on Forest and Wildlife policy, 1997) offers opportunities for communities that live in the forest, as they can receive 20% tax-revenue (paid by private forest companies to the government). This should provide an incentive to start alternative income generating activities besides hunting activities and the use of forest for agricultural purpose. However, in practice it is rather difficult for a community to claim this money due to the administrative and bureaucratic requirements, and communities lack organization to invest the money sustainably. The amount of revenue can be very high, depending on the size and activities of the tax paying companies. In the case of the communities on the TCT Dalmann forest concession US$20,000 was received, but in many other cases communities were not facilitated in claiming and spending the money. For example in Sofala, only 29% of the total tax revenues actually reach the communities (personal communication WWF). NGOs like WWF and GTZ[34] are involved in this process. WWF started a 10-year program in 2008 to facilitate several communities in the province of Manica to use the tax revenues to prepare and apply for FSC-certification.

The Mozambican Law on Forest and Wildlife is generally perceived as very good by the interviewed respondents. According to the forest manager of TCT Dalmann and NGOs involved in forest activities (WWF, GTZ) the law encourages sustainable use of the forest and promoting social development. However, limited resources do not always allow a sufficient number of forest officials to be working in the field. According to national regulations, a forest concession is expected to have a management plan to ensure responsible and efficient timber extraction. Furthermore, a concession should have an on-location sawmill to create local employment and enhance sustainable production and processing of timber. However, in practice companies are hardly inspected, and it is known that only the two certified forest concession (TCT Dalmann and Levasflor) have sawmills on location. According to Sitoe et al. (2003) only few concessions are executed in line with national regulation, due to limited incentives for operators to carry the costs of developing the management plan, poor financial capacity of concession holders, lack of technical capacity to implement the management plan, and insufficient monitoring of the management of concessions.

Most of the field visits and interviews for this study were carried out in Sofala province. The forest sector in Sofala consists of 18 concessions, of which TCT Dalmann is one of the smaller concessions. Besides the concessions there are 140 simple cutting licenses. A simple license implies that a license holder can cut 500m^3 per year. Most interviewed respondents mentioned the problems with these licenses, as cutting can be done without any requirements, resulting in major damage to the forest. Most simple license holders cut for the Asian market, and timber logs are shipped in small-size containers, which cause in-efficient timber extraction. According to the respondents, sustainable forest management can improve, by reducing the number of simple cutting licenses. However, as long as the market for unsustainable timber remains increasing, the system of simple cutting licenses

[34] Deutsche Gesellschaft für Technische Zusammenarbeit

will enforce unsustainable practices. According to TCT: “The Chinese market is ripping out the hart of natural resources in Mozambique.” However, decreasing the number of simple licenses is not enough. There is a need for improved law enforcement to monitor management practices of forest concessions. However, the respondents also argue that law enforcement is not easy to accomplish. You need qualified forest managers who actually work in the forest. WWF-Beira mentioned that they have great difficulties with recruiting forest managers: “Due to the fragmentation of the current Mozambican education system and the lack of institutional resources to work in the field.”

6.3.1.3 The case of TCT Dalmann

TCT Dalmann was the first FSC-certified company in Mozambique. It is a family business run by family White. They came from Zimbabwe to Mozambique in 1996 to start a new business. They settled in Beira as the port offered opportunities for entrepreneurs to start new businesses for harbour supply. They bought a timber-factory, inclusing sawmill at a state auction. By surprise and without forestry background they started their business. They hired some people with forest experience, got access to land and started cutting timber with a simple license. In 1997, the law on forest land division was implemented, and in 1998 they got their concession Catapu near Caia, where they are still based. They have a forest concession contract to use the forest area for a period of 25 years, granted in 2001 by the Provincial Government of Sofala. The forest concession is about 24,000 ha and is home to four communities. When they started, the area was very remote as the EN1 was not yet there and the railway was destroyed during the war. Over the last six years, the EN1 was being rebuilt, the area is connected to the electricity network and there is telephone, which facilitates their business. The timber products they produce are; rough timber produced at Catapu sawmill, wooden products as bee hives, cabin panels, bar counters, articraft produced at the Catapu workshop, and wooden furniture and parquet floors produced at the Beira factory. They own three furniture shops in Beira, Maputo and Chimoio. Since 2005, the company is FSC certified for forest management and chain of custody for their sawmill and the furniture.

“FSC-certification works as an encouragement”: When the company got access to the Catapu concession, they decided to work ’properly’ from the beginning onwards. Becoming FSC-certified was the result. FSC-certification for them was a way of getting recognition and required a lot of work. However, as they have been working according to law requirements (management plan for extracting timber, involvement of local communities, having a sawmill on the concession), 85% of the requirements were already covered when they applied for FSC-certification. The other 15% of the work was, amongst others, creating an endangered species list, describing the high conservation value, waste and chemicals disposal, and developing and maintaining workers reports. Throughout the years, it became easier to maintain the FSC-certificate. For TCT Dalmann the FSC-certification system works as an encouragement. There are some aspects that are difficult to implement, for example the safety issues. The safety of their machines would definitely be rejected in European context, but the company is strong on environmental issues if you would make the same comparison. FSC-certification balances these differences more or less. It is like an ongoing process, as they have to show improvements at each audit.

Economic benefits: The costs of certifying are around US$25,000 per year. They do not have direct economic benefits since they are certified, but it could open new windows for the future. They still operate on the same market as before they got certified; they are specialized in high quality furniture for the national market. Their main costumers are the international community in Maputo and a wide range of (inter)national agencies and NGOs in Mozambique that purchase sustainable products because of their socially and environmental friendly internal policies. As they are the only certified company producing high quality, sustainable furniture for the national market, they have created a niche market. Since they have moved the sawmill from Beira to the Catapu concession, it made the company more cost effective as it decreased the extraction of timber trees significantly, reduces wastage and transport costs.

Environmental sustainability: The philosophy of the company is to reduce their carbon footprint, by compensating (through reforestation) the impact the have as commercial company. An area of 1,200 ha on their concession is marked as high conservation area and remains untouched. They have involved the communities in reforestation activities to provide income generating activities (community receives 15 Meticais for every mature seedling that is planted successfully in the forest after four years). These activities do not have a direct benefit for the company, but will have on the long term as the forest will remain healthy and therefore can be exploited longer. It took some time

before the community trusted the agreement. The first year the activities failed, but eventually it grew from 7 to 60 farmers in four years, planting about 5,000 seedlings on the concession per year.

Involvement of communities: Two major environmental threats to the concession are illegal hunting and poaching, and fires. TCT Dalmann is aware that they cannot control these threats without involving the communities. Therefore, they train community members to become environmental guards, and equip them with bicycle and official uniforms. Furthermore, they provide training on carpentry, using the grinning mill, and road management. The objective of these trainings is skill development. Both the company as the communities will benefit on the long term, as it will create more local business development and more environmental awareness. This will eventually result in less poaching, illegal logging and corruption activities. The company organizes meetings within the communities two times a year. They sit together with the local leaders and the local rural development committees to discuss what new activities they could develop together. TCT Dalmann noticed that these activities are fruitful; during our field-visit (April 2009) the community guards caught a truck load of illegal goods, and handed the persons over to the company, who contacted the police. This example shows that the mindsets of communities are changing. Furthermore, there is a significant decrease of fire-outbreaks. They used to have fires every year, but the last six years there have not been any. This indicates that their fire management strategy is successful, but might also indicate that the communities have changed their activities (for example traditional bee-keeping causes a lot of bush fires).

The certifying body: The two certified companies in Mozambique are both certified by the South African certifying body SGS. SGS has offices in Mozambique, but FSC-certification is done by its South African office. Besides certifying companies, SGS also organizes training on FSC-certification to interested companies, forest organizations and institutions. It was through the SGS training that TCT Dalmann got interested for FSC-certification.

Relationship with other actors in forest sector: There are several NGOs working in the same area as TCT Dalmann. TCT Dalmann is sometimes frustrated by the fact that NGOs are not very willing to start public private partnerships. Although NGOs have access to a lot of public money, they often see the private sector as 'bad guys whose only goal is making profit'. TCT Dalmann thinks that NGOs and the private sector could complement each

other in the field of sustainable forest management. The role of NGOs can be to support communities and provide them with training. The private sector can also contribute to this as the companies know exactly what is needed in practice. The relationship between TCT Dalmann and the communities located on their concession has been improving over the last 12 years. The NGO-sector should start to work together with private sector in developing sustainable forest practices, but in practice this hardly happens.

6.3.1.4 Lessons learned from FSC-certification in Mozambique

Based on the experiences with FSC-certification in Mozambique, the following challenges and opportunities can be identified:

	Challenges	Opportunities
Main points of FSC certification system	There is a lack of knowledge about FSC-certification and/ or sustainable forest management in Africa. This explains the small percentage of certified companies and the small market for sustainable timber. Promoting FSC-certification could be one of the possibilities to promote FSC amongst producers and consumers. FSC products mainly serve the high segment market due to high prices. Non-sustainable products serve the majority of the timber market and therefore remain mainstream.	SLIMF and group certification provides opportunities to address heterogeneity and involve small producers or producers' groups. The costumers of FSC-products have great influence on promoting FSC. When there is consumer demand, more producers will enter into sustainable timber production. FSC-certification is an ongoing process of optimizing. This allows a company to start preparing for certification on a basic level and to maintain their certificate by improving each year. After five years, certification is assessed on a higher level.
Certifying in the Mozambican context	Lack of law enforcement. Forest practices are not well monitored due to a lack of resources and forest officials working in the field. Revenues not always reach the communities, neither are communities facilitated in managing this money. Demanding Asian market for tropical timber decreases the demand for sustainable timber. The system of simple cutting license is more attractive as this is more profitable on the short term.	National law on forest and wildlife policy offers good opportunities for forest communities. 20% of the tax revenues of the private forest sector is allocated to communities. This money could be invested in creating more sustainable forest activities. There already exist examples of NGOs facilitating communities to use this to apply for forest certification. The law promotes sustainable forest management, as companies have to work according to a management plan and are encouraged to locate their sawmill on the plantation to stimulate local employment.
Main points of FSC-certified company	Only few companies in Mozambique are FSC-certified. To combat unsustainable forest activities, the focus on FSC-certification will not be enough. Other approaches such as awareness campaigns, social ventures with communities, reforestation projects with carbon off-sale are needed. No Mozambican owned companies are involved in FSC-certification. The good results with conservation activities on the forest concession of TCT Dalmann attracts illegal business such as poaching (wildlife is flourishing) FSC-certification did not bring economic benefit for TCT-Dalmann, as their market remains the same. It is mainly the cost effective way of working that resulted in economic benefits. For an average forest company this is a very small incentive There is a lack of knowledge on sustainable ecological practices in Mozambique. This means that a company has to develop and finance their own research and development activities.	In the case of TCT Dalmann, the involvement of the communities in employment, creation of local business, and environmental training led to a significant decrease unsustainable forest activities and environmental threats (fires, illegal logging, etc.) because of an increased awareness of the value of natural resources. In this case, the close collaboration between the company and the communities created a win-win situation. Sustainable forest management goes hand in hand with the local users of the forest and the exploiting company. FSC-certification changed the philosophy of TCT-Dalmann on sustainability. They became very conscious of sustainability and the impact of their activities. It offered more insight into their management. Furthermore, the company started voluntary conservations activities as ongoing research on vegetation (living plant and tree herbarium).

Table 9: Analysis of FSC-certification in Mozambique

6.3.2 GlobalGAP-certification

GlobalGAP-certification (Global Partnership for Good Agricultural Practice) was selected for this study, as it provides an interesting example of the requirements needed for entering the European market. Just like FSC-certification, there are not many examples of GlobalGAP-certification in Mozambique. There are two known GlobalGAP-certified companies: Companhia Vandúzi (Vandúzi district, Manica province) which produces fresh vegetables for the UK-market, and EAM Lda. (Dombe district, Manica province) which produces mangoes for the EU-market. Furthermore, there are some companies preparing to obtain GlobalGAP-certification. This section provides background information on GlobalGAP-certification, its procedures and standards. Moreover we describe and analyze the experiences of two companies; GlobalGAP-certified company 'Vandúzi', and the company 'Pinto Agro-pecúaria' which is in the process of obtaining the certificate.

6.3.2.1 GlobalGAP background

GlobalGAP (formerly known as EurepGAP) sets standards for the certification of agricultural products. GlobalGAP is a voluntary system driven by private sector. Initially, it was created by the European Retailer Produce Working Group (EUREP), consisting of large supermarket chains operating in Western Europe. The GlobalGAP standard is primarily designed to increase consumers' confidence in food production by ensuring hygiene and food safety. GlobalGAP focuses on food safety and traceability. However, it also covers requirements related to the use of pesticides, workers safety and compliance with national labour regulations.

The establishment of GlobalGAP emerged in the social and political context of Europe in the 1990s. Due to the globalization of the food market (food export and import, rapid increase of quality standards and product differentiation), it became increasingly difficult for governments to regulate food safety (Hatanaka et al., 2005 356). Furthermore, the 1990s dealt with several food crises as BSE (commonly known as mad-cow disease), pesticide contamination, the introduction of Genetic Modified (GMO) food-crops, resulting in consumer distrust throughout the world. Quality standardization led to a gradual global shift from public to private governance of food safety regulation (Campbell, 2005 2). International bodies such as the WTO and private sectors (mainly retailers) became the major forces in developing 'safe' and 'sustainable' labels for food products. For these reasons, the EUREP commenced the development of a common standards for Good Agricultural Practices that could guaranty food safety worldwide (Bagasha, 2008 6). The first EurepGAP certificate was issued in October 2001. Since then the number of certified producers and countries have been growing to more than 92,000 producers, spread over 85 countries (News Good Agricultural Practice, 2008). Although GlobalGAP is a voluntary system, compliance is seen as a requirement for entering the European market as the majority of European retailers are GlobalGAP member. Therefore, the GlobalGAP system could be seen as a business to business system. Advocates argue that GlobalGAP-certification offers opportunities for more socially and environmentally sustainable practices (Hatanaka et al., 2005 354). On the other hand, antagonists argue that social sustainability will be difficult to achieve as the contribution of small-scale producers to the European export market has dropped in several developing countries as a results of the introduction of global food safety measurements (Freidberg, 2003 34). Freidberg discusses the case of Kenyan small-scale producers who traditionally supplied the UK-market with fresh vegetables (75% in 1991). In 1998, after the introduction of the strict safety measurements, only 30% of the market was supplied by small-scale producers. The remaining 45% was replaced by commercial, foreign companies who started their business in Kenya.

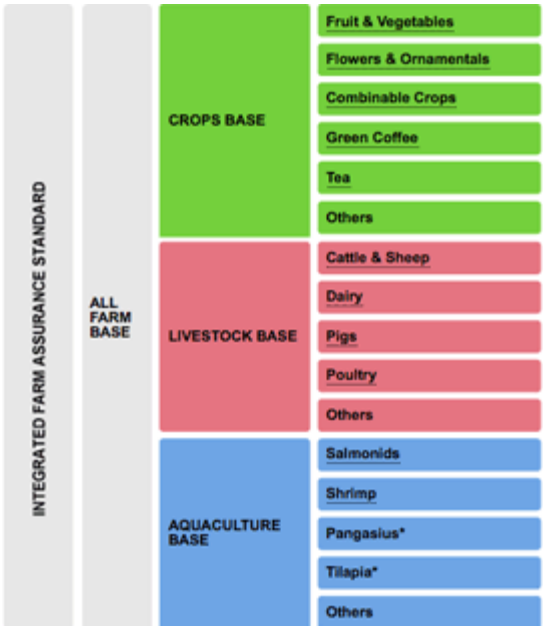


Figure 7: GlobalGAP standard model: Integrated farm assurance standard (GlobalGAP, 2009)

System and procedure: GlobalGAP certification is a pre-farm-gate standard, which means the certificate covers the process of the certified product from before the seed is planted until it leaves the farm. In order to obtain and maintain the GlobalGAP-certificate, producers should comply with several requirements on different scope levels, these are called the control points and compliance criteria within the GlobalGAP terminology (see figure 7 for the GlobalGAP model with the 3 scope levels of requirements). All applying producers (or producer groups) have to comply with the first scope level 'all farm base standards'. According to the agricultural sector of production, the producer has to comply with the control points and compliance criteria for crops, livestock or aquaculture. Within this specific scope level, the producer has to comply with the specific requirements for the type of product produced.

Three levels of standards: Table 10 visualizes the standards of GlobalGAP. The GlobalGAP system works with three scope level, each scope with its specific requirements. Some standards are repeated for the different scope levels. This means they have to be specified for the specific unit of analysis. All of the three scope levels consist of control points and criteria, which the producer is required to comply with in order to obtain GlobalGAP-certification. These are 'major musts', 'minor musts' and 'recommendations'. Major musts are compulsory control points and have to be complied with for 100%. For the minor musts, the producer needs a compliance of 95% for all scopes. The third category is recommendations, for which no minimum percentage of compliance is set, but has to improve through the years. The standards on safety and hygiene are very strict. If we look at the standard focusing on plant protection products (see table 10, standards scope level crops base), there are 62 control points that have to be complied with, which shows the complexity of the system.

	Standards scope level all farm base	*Standards scope level crops base*	*Standards scope level fruit and vegetables*
1	Record keeping and internal self-assessment/ internal inspection	Traceability	Propagation material
2	Site history and site management	Propagation material	Soil and substrate management
3	Workers health, safety and welfare	Site history and site management	Irrigation/ fertigation
4	Waste and pollution management, recycling and re-use	Soil management	Harvesting
5	Environment and conservation	Fertiliser use	Produce handling
6	Complaints	Irrigation/ fertigation[35]	
7		Integrated pest management	
8		Plant Protection Products	

Table 10: The three scope levels of GlobalGAP-standards

There are three different procedures for inspection of the certified producer:

1. Internal self-assessment: This assessment is carried out once a year under the responsibility of the producer. The self-assessment is done through a checklist covering all the applicable scopes. The self-assessment must be available for review by the inspector during external inspection.
2. External inspection by a GlobalGAP approved certifying body: An annual announced external inspection carried out by the certifying body. The inspector will inspect the complete checklist.
3. Unannounced surveillance inspection: The certifying body will annually carry out an unannounced inspection of the major and minor musts. The producer is informed within 48 hours in advance.

Alternative procedures: GlobalGAP is currently developing an adapted certification system to improve the involvement of small-scale producers. In general, mostly medium size and large agro-industrial companies apply for GlobalGAP-certification. To comply with GlobalGAP-certification, the producer needs to maintain a complete administrative system to keep track of all farm activities. This requires a sufficient administrative and financial capacity. It is easier for large-scale producers to comply with these requirements (FAO, 2006 30). This renewed system and alternative procedure should assist smaller producers and producer groups to apply for GlobalGAP-certification.

Costs: The costs vary per certifying body and depend on the size and character of the company. There are three types of external costs covered by the producer: Certification fees including all expenses charged by certification

[35] Fertigation is the application of fertilizers, soil amendments, or other water soluble products through an irrigation system

body, GlobalGAP registration fees paid to FoodPlus (Secretariat GlobalGAP), and certification license fee per each completed inspection. It is not known what the total costs are.

6.3.2.2 GlobalGAP case studies in Mozambique

Case 1: Companhia Vandúzi

Companhia Vandúzi is part of the Mocfer holding, a British hold company that also has a rice company in Chokwe. Vandúzi is located in Vandúzi district, Manica province, and produces fresh vegetables such as baby corn, chilly, green beans. Vandúzi is the major contributor to Mozambique's total export (Noticias, August 21, 2009c); 95% of their production goes to the UK-market, 5% to South African and Mozambican market. In order to become certified, the started in 2004 with a specialized technical team of three persons who were committed to prepare the company for certification. Since then, they obtained certification for GlobalGAP, Tesco, Leave, Food and Fork (Marc and Spencer) and fair-trade. They applied for these certification systems to get access to the UK market, also because their investors are UK-based. According to the technical manager for certification, it works like a 'competition among retailers'. The stricter the requirements get, the more 'competitive' they become on the market, and the more 'ethical' they become for consumers. However, for producers it seems to become more complex. For the 'over-qualified' Vandúzi it is difficult to sell their products in Mozambique itself, as they cannot compete with other national producers.

Global GAP: Since 2005, Vandúzi is GlobalGAP certified. Every year they are inspected to renew the certificate. The technical team was hired especially for their expertise on working with certifying companies in Zimbabwe. They work with a UK-agent who distributes everything in the UK. To apply for GlobalGAP-certification a company can either do the process itself, or hire an external organisation to prepare the pre-audit. The technical team was responsible for the analysis and implementation of all requirements within Vandúzi. The pre-audit is being assessed by an independent certifying body, which the company can select themselves. They work with a South African certifying body, which can also do other audits besides GlobalGAP. Firstly, they had to prepare for the audit themselves, and when all requirements were met, they invited the certifying body and paid the auditing fees. The audit started with a management meeting. The auditor organized this and explained what he needs and how he is going to work. During the audit, the auditor checks documents, policies, commitments with costumers, does field visits, interviews farmers, and analyses the harvesting process. After the audit there is a closing meeting where major, minor and recommendation are presented and discussed.

Difficulties preparing certification: According to technical team, the most difficult part was developing the infrastructure; building pesticide stores, fertilizer storage rooms, storage for pesticides, toilets, a washing and first aid facility. Also training its employees was a lot of work. All workers had to be trained on housekeeping, safety issues, diseases, harvesting, and growing and packing. During this early stage there were no other parties than Vandúzi involved. At a certain moment, they encountered a discrepancy between the standards and the Mozambican context. According to the standards you can only use the pesticides which are registered by law, but in Mozambique such legislation on pesticide use did not exist. Eventually, they could use pesticide legislation from the region (South Africa). They can import these products but have to put Portuguese-language labels on them. All import of pesticides has to be reported to the government. Reason why pesticide legislation did not exist in Mozambique, was that Vandúzi is the first company to produce and export for the European market. For Vandúzi this process was very time consuming and difficult to organize. Other constraints they faced were importing small quantities of pesticide from abroad. Foreign pesticide companies were not very willing to sell small quantities, or only for a very high price. Being the only company to be GlobalGAP-certified has some logistic disadvantages.

Difficulty dealing with 'European' system: After the first audit, there were some minor adjustments. However, they were not satisfied with the outcome, as the minors were not realistic for the Mozambican context. The auditor had never been in Africa before and was not capable to grasp the Mozambican reality. They were able to get a second opinion. Through the years, the GlobalGAP standards have improved and became more applicable/ realistic for the Mozambican context. According to Vandúzi, GlobalGAP is open for suggestions and considers recommendations.

The first few years were very intensive for the technical team. It took some years for the company to get used to a certification process, but eventually the process became more effective. In the beginning, the financial costs of compliance were enormously high. Now they are more cost-effective. On the question if it 'is worth all the efforts', the company replied that it is not a question of choice, as it is the only way to enter the European market. They perceive it as a strong trade barrier. The company is proud of its achievements. In the first year, people did not understand the process, but after some years they start to see the benefits. Nowadays, there is a natural tendency to make sustainable decisions and changes. For example, due to the requirements of GlobalGAP, they had to put a lot of effort in land preparation. Now they have the insights in how to improve and they are challenged to go beyond the minimum. Land preparations became more environmental friendly as they use organic fertilizers and Integrated Pest Management practices. Moreover, the irrigation system was improved that allowed the company to use the water more efficient. Because of required measurements on crop and soil, they now know much more about growing conditions. It is not only about being environmental friendly; it also reduces costs by working more efficient. Other improvements are related to the recycling of waste material from the package factory. The compost is of good quality and apply it on the same spot from where they took it originally.

Certifying smallholder farmers: Vandúzi works with large, independent outgrowers, who are also certificated through the company. They are also running a pilot project with 30 small-scale farmers to get them certified. In this case they make use of group certification with support of technical manager. They have to prepare and train the farmers to deal with all the safety issues. This requires a lot of money and time. For farmers it is not possible to pay for something like this, therefore Vandúzi bares the cost. The technical team explained that in practice it is very hard to certify small-scale farmers. There are some examples that it can work after the first audit, but without the proper support it often fails. There are NGOs who are focusing on these processes, but the certification process is so specific and technical that you need technical managers. NGOs often have the financial resources, but they do not have the technical know-how. At the moment, it is very difficult for Vandúzi to find qualified technicians in Mozambique.

Case 2: Pinto Agro-pecúaria

Mister Matavel started this mango farm Pinto Agro-pecúaria about four years ago in 2005. His company is located in Manica province, near Dombe. This is the fifth year in which he will have his first harvest. His farm is about 100 ha, with a DUAT for five years. He has planted 30 ha. Pinto Agro-pecúaria grows three different mango varieties. Matavel plants with seeds from his own nursery because than the trees are more resistant to pests and diseases. On his company he has 1st, 2nd, and 3rd year plants. The 3rd year plants will be harvested from November onwards. He does not irrigate, as rainfall seems to be sufficient in the area. He has not been using any agrochemical inputs, which he tries to continue until he faces pests. He also wants to explore the requirements of organic certification. At the moment he is exploring other crops to diversify his company. He has a small plot with pineapple as experiment. As his company has just started, he first needs some harvest to find out to whom and where he can sell; then he can start thinking of new activities. Selling his first harvest will be the big challenge for this year.

Applying for GlobalGAP certification: Pinto Agro-pecúaria is aiming at supplying the South African market for two reasons. Firstly, he can sell it to the South African market, as mangoes in Mozambique are about one month earlier ready for harvesting than the South African mangoes due to the climate. Secondly, he can sell to South African wholesalers who export it before or after processing. In order to export, GlobalGAP-certification is required. In the application process for GlobalGAP-certification he is supported by IPEX. IPEX runs pilot projects with three companies to promote certification for export (GlobalGAP and organic certification). All of the cases are still in the process of preparation, but Matavel recently had his first pre-audit. This resulted in a list with minor improvements. The main issues were:

- Building a storage facility for pesticides, fertilizers, etc.;
- Social security issues;
- Training people in how to deal with agrochemicals;
- Register and document all the inputs and outputs for at least the last year.

IPEX has promised to contribute financially to the storage facility and to pay for at least the first audit. The company's major concern is to find trained people. They are difficult to find in Mozambique. Especially for a smaller company.

Collaboration: Pinto Agro-pecúaria works together with a neighbouring company, EAM. EAM is a GlobalGAP-certified mango producer owned by a South African. This company exist for 10 years now and produces 100 ha of mangoes. The two companies have a good relationship; they discuss common problems and Matavel gets his information on mangoes through his neighbour. EAM works with mango data from South Africa. Furthermore, they monitor fruit-fly problems together. There is some support from the Ministry of Agriculture and University of Eduardo Mondlane to do research on controlling the fruit fly. However, monitoring and controlling is their own responsibility and they have to pay it themselves. This is a necessity; otherwise they will not be able to export anything to South Africa. EAM convinced Matavel to start investing in Mangoes in the area. In the first year, he started with seeds bought from EAM.

Labour: Pinto Agro-pecúaria employs eight permanent workers on the farm. One works as guard and farm manager. During the low season they maintaining the nursery, do weeding and insect control. Planting happens during the rainy season (December – March). Harvesting season is between November till January. The three varieties have different harvesting times and are harvested two weeks after each other. Mangoes are picked by

hand when they are still green (not ready to eat). During harvesting season, 50 people will be working for him daily. They pick around one hectare per day, using 15/20 kg crates. He expects yield of approximately 25 t ha^{-1}. Usually the mangoes are stored in a cooled room to slow down the maturation. Pinto Agro-pecúaria does not own cooled rooms or a package house yet. He might try to organize this with EAM as he cannot invest in this on the moment. Matavel does not think it will be possible to work with outgrowers, especially when they have to comply with GlobalGAP-certification. Maybe with organic certification this could be possible.

Difficulties related to exporting from Mozambique: According to Matavel, the only way to export his mangoes is through GlobalGAP-certification. This is a major constraint for the majority of Mozambican entrepreneurs. On the other hand, for a commercial mongo company it is almost easier to export than to sell on the national market. Matavel gives the example that it will take him three months to sell six tons of mangoes on the local market in Chimoio. If you produce large quantities (depending on the crop), the only option is to export. It might be that the mangoes you export to South Africa will be sold in Chimoio later in the season. Reason for the underdeveloped national market in Mozambique is the lack of companies. According to Matavel, there are no real programs which support the private sector in Mozambique, and it is also very difficult to access loans from banks. Matavel has invested in this company with his own money. There are not many Mozambican entrepreneurs who could do the same.

6.3.2.3 Lessons learned from GlobalGAP-certification in Mozambican

From the case studies on GlobalGAP-certification in Mozambique, we can identify the following challenges and opportunities:

	Challenges	Opportunities
Main points of GlobalGAP certification system	System is very strict, is labour intensive and has high financial and administrative burden due to annual audits and recordkeeping. GlobalGAP is a business-to-business system which is promoted as an ethical label. However, there is little involvement of consumers and civil society. Consumers also do not have knowledge about the strict production measurements. Besides GlobalGAP, retailers are also developing new labels as a 'competition tool' that are stricter than GlobalGAP. Therefore one of the initial objectives of introducing GlobalGAP (providing one common system for food safety labels) seems to be outdated. GlobalGAP does not take market development into account for the producing country. In Kenya it led to homogenization of the horticulture sector (Freidberg, 2003 34).	GlobalGAP is currently adapting their system to the situation of small-scale producers. With GlobalGAP-certification it becomes possible to enter high value markets, although they do not receive premium prices. GlobalGAP-certification works with a farm-gate price. This means that the producer is responsible for risks and losses of the product till it leaves the farm gate.
GlobalGAP in the Mozambican context:	Mozambican legislation lacks certain GlobalGAP-requirements (agrochemicals). This makes the certification process complex for producers GlobalGAP-certified products are not competitive on the Mozambican market due to the large differences in quality and production-costs. The Mozambican market for fruits and vegetable is underdeveloped, therefore producers cannot sell large quantities and are obliged to export their products and therefore have to comply with certification.	The introduction of GlobalGAP certification in Mozambique provided an incentive for developing policy on legislation for agrochemicals Some first initiatives are developed by national institutes for promoting GlobalGAP certification (pilot projects IPEX).
Main points of GlobalGAP-certified companies	The implementation of GlobalGAP-certification requires qualified workers, trained by a qualified person. Both are difficult to find in Mozambique. Expertise is often brought in from abroad. Being one of the few certified companies (in the case of Vandúzi) leads to logistic disadvantages and high costs.	Collaboration between companies works motivating as they have to deal with similar pioneering problems (lack of infrastructure, market, agricultural inputs, certified seeds, lack of existing knowledge). Furthermore, collaboration could lead to considerable decrease in costs (shared storage, transport, buying supplies and inputs, etc.). GlobalGAP certification provides good insight in the company's processes, that might lead to working more cost effecient. Becoming GlobalGAP certified is especially interesting for new companies as requirements on the infrastructure can be implemented directly. Otherwise, the application process will become costly due to many adjustments.

Table 11: Analysis of GlobalGAP-certification in Mozambique

6.3.3 Fair-trade certification

There are some examples of fair-trade initiatives in Mozambique. The farmer owned company Ikuru produces fair-trade peanuts in the province of Nampula. Ikuru has an export agreement with the organic- and fair-trade market in the UK, and they can be seen as the most established fair-trade organization in Mozambique. Furthermore, the farmers' organization Miruku, also based in Nampula, is preparing fair-trade certification at the moment. Besides the fair-trade initiatives for agricultural products, there exist examples of fair-trade handicraft in Mozambique, and the possibilities for fair-trade tourism are being explored at the moment (Sriven, 2008).

Although fair-trade certification was not studied profoundly, we decided to include some information about the certification system itself, and some experiences of fair-trade from the cashew sector. We believe it will provide some new insights that will complement experiences from FSC and GlobalGAP.

6.3.3.1 Fair-trade background

Fair-trade organizations have the objective to improve market access and trading conditions for small-scale producers and plantation workers. In order to do this, fair-trade organizations pay a minimum guaranteed price to the producer, plus a fair-trade premium, which must be used for organizational strengthening and community development (FAO, 2006 25). Fair-trade's Labelling Organization International is the worldwide umbrella organization for fair-trade standard setting and certification.

Overview fair-trade Standards

1. Social Development	Fair-trade adds to Development Members are Small Producers Democracy, Participation and Transparency Non-Discrimination
2. Socioeconomic Development	Fair-trade Premium Economic Strengthening of the Organization
3. Environmental Development	Impact Assessment, Planning and Monitoring Agrochemicals Waste Soil and Water Fire Genetically Modified Organisms (GMO)
4. Labour Conditions	Employment Policy Freedom from Discrimination Freedom of Labour Freedom of Association and Collective Bargaining Conditions of Employment Occupational Health and Safety

Table 12: Overview fair-trade standards for small producers groups (Fair-trade, 2009c)

The first fair-trade certification was launched in 1988 providing fair-trade coffee under the name of Max Havelaar. It found its origin in the 1960s' social movement 'fair-trade', seeking to address the structural inequalities of North-South relations by giving farmers a better price for their products (FAO, 2006 25). The Dutch development agency Solidaridad started the first label for 'Fair' products. The first Max Havelaar coffee came from Mexico and was sold in Dutch supermarkets. From 1988 onwards, the Max Havelaar initiative was replicated in several other markets across Europe and North America under different names (Max Havelaar, Transfair, fair-trade Mark, Rättvisemärkt and Reilu Kauppa). In 1997 the fair-trade Labelling Organizations (FLO) was established to unite all the different initiatives to one common standard. In 2004 the FLO was split into two independent organizations; the FLO, which sets the standards and provide producers support. And the FLO-CERT, which inspects and certifies producer organizations and audits traders (Fair-trade, 2009b). Currently, there are 872 fair-trade certified producer organizations in 58 producing countries, representing around 1.5 million farmers and workers (Fair-trade, 2009a). Traditionally, fair-trade products were sold in 'fair-trade' shops. Nowadays, fair-trade has partnerships with companies such as Starbucks (which offers 100% fair-trade coffee) and Ben and Jerry's. According to Whatmore and Thorne (1997), fair-trade labels have historically: "Testified to long-term relations of solidarity between groups of producers, consumers and intermediaries committed to alternative trade networks."

The standards: To become certified, producer associations must comply with fair-trade standards. As fair-trade certification is concerned with producers and traders, they have distinguished the standards. Producers can be classified as small producers organizations, contract producers (not yet established as organization) and hired labourers; each with their specific set of generic standards. The same applies for traders of fair-trade products who have their own set of standards. Table 12 gives an overview of the generic standards for small producers organizations (Fair-trade, 2009c). This set of standards is used as example, as comparable standards will be used in the case of the producers' organizations in Nampula, Mozambique. Besides the generic standards, there are specified standards for each of the fair-trade-products, varying from fruits, vegetables, tea, coffee, wine, herbs, etc. These are additional requirements related to aspects such as the scope of the product (primer product or processed), traceability, pricing and contract agreements (pre-financing, shipments). As the standards show, there is a strong focus on social aspects.

System and procedure: Different types of producers can apply for fair-trade certification; (1) groups of producers in a cooperative, (2) farmers' associations and (3) large farms with an organized labour force. Local auditors inspect the farm, and the certification agency FLO-CERT eventually approves the certification of the producer association or plantation. Once certified, there is an annual inspection to check whether the producers comply with the fair-trade minimum and progress requirements and how the fair-trade premium has been used. Traders located in importing countries, who use the FLO-label on their packages, pay the certification cost through a license fee. Minimum requirements must be met by producers to become certified. The progress requirements encourage producers to continuously improve and to invest in the development of their organizations and their workers. The objective of the progress requirements is to encourage sustainable, social, economic and environmental development of producers and their organizations (Fair-trade, 2009c).
The certification process starts with an on-site inspection. Many fair-trade producer organizations are large, including hundreds and sometimes thousands of farmers. This makes it impossible for the auditor to visit every single farm. Therefore, the audit of the producers' organization randomly checks individual farmers. A full fair-trade audit can last from four days for a small producer organization and up to six or seven weeks for large cooperatives.

Costs: The costs for the audit are paid by the producer organization. The cost depends on the size of the producer organization. After being certified, the producers are inspected annually. In case of a small producers' organization applying for fair-trade certification, the costs are calculated as follows:

- Producer has to pay the application fee of € 500,-
- Producer has to pay the initial certification fee (costs for the first inspection to become certified). These costs depend on the kind of organization, number of members, and number of products to be sold as fair-trade. These costs are charged on a daily base for a rate of €400 for the auditor. If you have a producers group with less than 50 members, it will take about three to four days. The costs will be approximately €1,400. For a producers' organization with between 500 – 1,000 members, it will cost approximately €3,000. These costs are calculated for one product.
- If a producer wants to certify an additional product, they estimate half a day extra (€200).
- Furthermore, there could be some additional cost, like auditing processing facilities

According to FAO (2006 26) the major constraint in the fair-trade system, is that a group of producers can only get certified for existing markets. This means that producers can only certify products that already exist as fair-trade. Although the conditions are 'fair', the market is not guaranteed neither is there a guaranty that the whole production will be sold and marketed as fair-trade.

6.3.3.2 Fair-trade certification in Mozambique

Fairmatch Support is a Dutch organization that focuses on chain development for products like cashew, cacao and fruit. In their approach, they connect retailers with producers' organizations. Furthermore, they are working on the improvement of new certification systems. They started their activities in Mozambique 10 years ago in 1999, focusing on the improvement of the cashew market. Mozambique used to have a large national cashew market, being one of the world's biggest exporters. However in 1995, as a condition for a large loaning program, Worldbank demanded the liberalization of raw cashew trade. This resulted in a collapse of the Mozambican market. Fairmatch Support started with an analysis of the Mozambican cashew market that exported 98% of their nuts to India for processing, from where they were sold to EU. Main problems are that cashew growers receive very low price for

this labour intensive nut, and that the cashew value chain is long and difficult to trace. After the analysis, Fairmatch Support started to develop activities in Mozambique, Ghana, Benin and Burkina Faso to establish short and closed value chains. In order to establish such a chain, producers, importers, and processors had to be found and connected. In Mozambique, fair-trade Support facilitated the alliance between processing factories in Nampula, and the Dutch importing company 'Global Trading'. Last year they started preparing producers groups for fair-trade certification, using funding from, amongst others, GTZ and the Bill Gates foundation. Currently they work with approximately 2,000 producers.

Collaboration with Miruku: To prepare the producers for certification, one of the main issues is to organize them in producers associations or cooperatives. Fairmatch Support works with local organizations that work together with the farmers. To be effective, they work with farmers which are interested and are willing to invest in fair-trade certification. At the moment, the pilot phase has started and they are busy organizing the farmers. So far, the results are good. Within a year, they have organized more than 1,700 farmers. The work of Fairmatch Support covers the whole production chain. They initiated the project and arranged funds. Moreover they look where in the chain actors have to be connected. Local producers are supported to become certified. Subsequently it is the challenge to link the local producers to processors and retailers. Miruku is the local partner that prepares the farmers for fair-trade certification. Reason for working with a local organization like Miruku is that they have a broker function in connecting the farmers to the processors, as frames and ideas of farmers and processing industry are quite different. The work of Fairmatch Support mainly focuses on coordinating new trajectories with local partners and collaborations with retailers.

Preparing for certification: The strategy focus primarily on organizing producers. Organizing 1,700 farmers in the first year could only be realized because farmers in Nampula already had a high degree of organization. Approaching the farmers happens through market-focus; the farmers have to be willing to invest. It takes approximately six till eight months to get a company/ organization certified. While this study was conducted the producer group had applied for certification. The activities in the preparation-phase focus on preparing the farmers on working along the standards of certification. To start the process, Fairmatch paid the initial costs for certification. The farmers' organizations have to pay around €5,000. In practice, this amount is divided amongst its members.

Until now, Miruku has not encountered any difficulties in the process of preparing for certification. The level of local organization contributes to this. Furthermore, Mozambique has a good governmental structure that promotes the cashew sector by supporting producers' groups (Personal communication Fairmatch Support 17 July, 2009). As cashew requires investments to cover the first few years until the tree is ready for harvest, farmers often cannot make this initial investment, not to mention applying for certification. The national cashew institute INCAJU supports small producers, companies, processors and exporters of cashew. INCAJU provides inputs, technical assistance to farmers, and helps farmers to organize themselves in groups. Subsequently, they provide seedlings to the farmers so that they only have to invest labour in the crop. This decreases the risk for the farmers. The public institution is funded by an export tax paid by the cashew companies (Van Baren, 2009 91).

According to Fairmatch Support, there are, however constraints in the system that could create difficulties for the producers. The FOB-price (free on board) is not very useful in the Mozambican context. Free on board means that the seller delivers when the goods pass the ship's rail at the port of shipment. This means that the seller is responsible for all risks for loss or damage to the goods, and is required to clear the goods for export (FLO-CERT, 2007).

6.3.3.3 Lessons learned from fair-trade certification in Mozambique

Based on our analysis of fair-trade certification, the following challenges and opportunities can be identified:

	Challenges	Opportunities
Main points of fair-trade certification system	Will fair-trade certification be possible without NGO-involvement? There is no guarantied market (FAO, 2006 25) and producers can only get certified for products for which there already exist a fair-trade market.	Focus of fair-trade certification is mainly on small-scale producers and farmers groups. Farmers receive a guaranteed price and a premium on top of that. The premium price is used for local development. Fair-trade-certification system differs from the other certification systems as it pays attention to economic sustainability such as organizational strengthening, using the premium price for local and/ or organizational development to empower their members. Fair-trade works with progress requirements; which focus on the improvement and investment of the organization/ the workers (a more process-oriented approach)
Fair-trade in the Mozambican context	The Free on Board price does not seem realistic for Mozambican context (especially in the case of small-scale producers). A farm-gate price would be more appropriate.	High level of farmers' organization in Northern Mozambique (experiences in Nampula and Cabo Delgado) The Mozambican cashew sector gives valuable insights on how to involve small producers in the value chain (national cashew program INCAJU)

Table 13: Analysis of fair-trade certification in Mozambique

6.3.4 Comparing the three certification systems

In table 14 the standards and criteria of the three certification systems are summarized and compared.

Standards	FSC	GlobalGAP	Fair-trade
Legalities			
National & regional laws	- Compliance with all national and regional laws and administrative requirements on forestry (endangered species, illegal logging), wildlife, land-use	- National or local law on water and use on inputs	
International agreements	- All international agreements such as CITES, ILO conventions, ITTA, and Convention on Biological Diversity shall be respected	- EU legislation on agricultural inputs	- ILO conventions and national laws on labour conditions and human rights shall be respected
Indigenous people rights	The legal and customary rights of indigenous peoples to own use and manage their lands, territories, and resources shall be recognized and respected		
Social			
Social wellbeing and social development	- Forest management shall not threaten the resources of indigenous people - Sites of special cultural, ecological, economic or religious significance to indigenous people/ communities shall be clearly identified, recognized and protected by forest managers - Communities within the forest concession should give the opportunity for employment (40%), training and contracting - On-location saw mills stimulates local employment creation - Support is provided for local infrastructure and facilities (training, schooling, medical, income generating activities) at a level appropriate to the scale of the forest resources		- Fair-trade production should lead to empowerment of environmental sustainable, social and economic development of producers and their communities - Focus on small-scale producers: 50% of the producers are small-scale farmers and 50% of the products should be produced by small-scale farmers
Stakeholder participation	- Local people are informed of any activities that have impact on their resources through consultation with representatives - Issues raised by stakeholders are treated constructively and objective	- Regular communication meetings with organization and workers take place	- The participation of members in the organization's administration and internal control is promoted through training and education
Democracy, transparency			- Organization must have a democratic structure and a transparent administration is in place
Human rights	- Freedom of labour (no child labour or forced labour) - Freedom of workers and employers organizations		- No discrimination. - Positive discrimination towards small producers is intended - Freedom of labour (no child labour or forced labour) according to ILO-conventions
Labour conditions	- Equal employment conditions according to wage, working hours and contract		- Freedom of workers and employers organizations - Equal employment conditions according to (wage, hours, contract)
Health, Safety, Hygiene	- Safety and health policy, and access to medical services - Risk and hazard assessment	- Healthy (clean sanitation and access to water) and safety conditions (safe and responsible use of equipment, first aid facilities) - Hazard and First Aid procedures (signs, emergency information) - Training for workers on health and safety conditions - Policy for safety, health and hygiene for workers, all production activities, subcontractors and visitors - Workers are equipped with protective clothing which are cleaned and stored to prevent contamination	- Health (clean sanitation and access to water) and safety conditions (safe and responsible use of equipment, first aid facilities) - Training for workers on health and safety conditions

Economic			
Economic viability	- Efficient use of forests' multiple products and services		
Economic strengthening	- On-location sawmill reduces waste and losses and creates local employment - Standardization provides insight in company's processes which subsequently allow the company to work more cost-efficient	- Standardization provides insight in company's processes which subsequently allow the company to work more cost-efficient	- Organization develops gradually economic sustainable by assuming more control over trade process
Pricing and markets	- Niche-market/ high segment markets	- Mainstream market	- Fair-trade Premium price is meant for sustainability investment in the producers organization and its members
Environmental			
Environmental impact assessment	Forest concession is committed to long term forest management with long harvesting cycles. Forest manager is responsible to control illegal harvesting, settling and other illegal activities	Assessment/ conservation plan of the environmental impact of the operation	- Assessment/ conservation plan of the environmental impact of the operation - No plant material is gathered from protected areas, no planting in virgin forests - Conservation areas are identified and will not be cultivated, buffer zones are maintained
Agricultural production		- Organization promotes agricultural diversification and the improvement of environmental and agricultural sustainability practices - All agricultural practices (harvesting, processing, etc.) are carried out according to GlobalGAP hygiene standards (clean equipment, transport) - Quality control on all the production activities, produce, stock facilities etc. (light, temperature, humidity) - Use of certified plant/ seed material - Crop rotation to control pest and disease control and integrated pest management	- Organization promotes agricultural diversification and the improvement of environmental and agricultural sustainability practices
Flora and Fauna	- Changes in flora and fauna are monitored & conservation activities for threatened and endangered species	- Nature conservation with respect to flora and fauna	- Nature conservation with respect to flora and fauna
Agrochemicals	- Avoid use of chemical pesticides. If chemicals are used, proper training and equipment shall be used	- Responsible application of all inputs (correct use, qualified workers, safe and separate storage) - No use of human sewage sludge - Use of products registered in the country of use - Advice on agrochemicals and application by qualified persons	- Sustainable (reduced) and responsible (storage, package) use of agrochemicals in production
Waste	- Re-use and waste collection	- Adequate waste disposal and identification/ storage of litter - Farm/ production side is clear of litter and waste	- Producers are expected to reduce, reuse, recycle and compost waste
Soil	- Maintain or improve soil structure, fertility and biological activity	- Producers are expected to maintain and enhance the fertility and structure of soil (prevent erosion)	- Producers are expected to maintain and enhance the fertility and structure of soil (prevent erosion)
Water	- Buffer zones are maintained along watercourses and around water bodies the choice of species shall not result in adverse impacts on water quality, quantity or substantial deviation from stream course drainage patterns	- Water is used from a sustainable source - High quality of irrigation water (no use of untreated sewage water)	- Water resources are managed with the objectives of conservation (efficient use) and non-contamination.
Fire	- Fire prevention activities (fire protection plan, fire breaks, control procedure, etc.)		- Prevent use of fire or responsible use of fire for clearing (by trained people)
GMO	GMO material is prohibited	- GMO material comply with the countries legislation - GMO material are kept separately to avoid mixing	- Producers do not use GMOs in either the production or processing of products
Energy use		- Monitoring of energy use	- Reduce use of energy from non-renewable sources
Traceability			
Traceability of products	- Chain of custody; documentation shall be provided by manager to enable traceability of each forest product	- Recall procedure to manage withdrawal of products from the market - Products can be traced back and forth from producer to consumer	
Record keeping		- All activities, applications, inputs and outputs are recorded by time, quantity, location, consistence, person, etc. - Up to date internal self-assessment is available	

Table 14: Overview of the different certification systems

6.4 Analyses and discussion

Traceability and record keeping versus exclusiveness: Traceability and record keeping are important within both GlobalGAP and FSC, as the quality of the product must be guaranteed throughout the whole value chain. During interviews with two producers, traceability and record keeping were initially seen as a burden, but eventually turned out to be mechanisms that drive efficient and sustainable business. On the other hand, traceability and record keeping, can exclude smallholder producers in Mozambique due to a lack of trained people, illiteracy, lack of communication infrastructure or financial resources. For example the GlobalGAP for agro-chemical inputs are extremely strict (62 criteria on plant protection products) to ensure food safety, responsible use, storage, waste disposal, equipment and application mixing. For the average smallholder producer in Mozambique this will be difficult to comply with.

Law and legislation compliance: Law compliance receives most attention within FSC-certification, mostly related to natural resource management such as forest, wildlife, and land-use. Moreover, there is attention for indigenous rights. Fair-trade certification specifically focuses on human, community and workers' rights. GlobalGAP is guided by EU-legislation on safety legislation and input-use, which does include health of employees and their families with regard to safety, risks and information provision (signs, training, washing facilities, etc). Overall fair-trade and FSC have more attention for the rights of employees.

Consumers' influence on value chain: Both FSC- and fair-trade certification have their origin in strong public concerns about un-sustainability and inequality. Due to strong social movements, led by environmental organizations, a transparent, voluntary system was created, which seems to respect producers in its local context. This means considerable attention for the local inhabitants of the production area. In the case of biofuel production this may also become a major issue. GlobalGAP certification is a business-to-business system, mainly between commercial producers and retailers.

Dealing with heterogeneity: At a certain stage, both FSC-certification and GlobalGAP-certification identified the need for a more flexible system to deal with the highly diversified reality of producers worldwide. Both systems were lacking the flexibility to also address small-scale producers or low intensity operations, and still face difficulties in bridging their system to the realty of small producers. Developing a new certification system should address the diversified realities of biofuel producers in Mozambique to make sure that a new system does not exclude smallholder producers.
Both FSC and fair-trade certification have created a transparent, voluntary system, which seeks to respect producers in their local context. FSC-certification offers a *gradual system* that allows starting companies to grow within the system. It allows a starting company to comply with the basic standard, whereas more 'mature' companies can expect stricter audits.

Address different markets: The forest sector in Mozambique taught us a very clear lesson that certifying sustainability will not be enough to decrease unsustainable production. Therefore, certification should not be the only way forward. Other fundamental issues that need attention are awareness raising, training of qualified people, law enforcement, attention for alternative models such as social venturing with local communities, and stimulate private-public partnerships.

Implementation and monitoring of certification: The enforcement of laws, regulations and standards form a huge challenge in the Mozambican context. From our interviews we heard of many examples where the governance and legislative system could not support the introduction of additional regulatory frameworks.

Attention for economic sustainability: None of the three certification systems has considerable attention for economic sustainability. Learning from the experiences with FSC-certification provided us the following insights: One of the FSC-criteria is to have on-location sawmill on the concession. This resulted in the reduction of high transport cost (due to poor infrastructure in Mozambique), and contributed to local employment. Moreover, it increased environmental sustainability due to reduced timber losses. Fair-trade certification offers premium-prices that producers have to invest in organizational or social development. This could improve economic sustainability by optimizing organizational processes.

6.5 Conclusions

If we relate the issues addressed in section 6.4 to the Mozambican debate on sustainable biofuel production, the following conclusions can be drawn:

All certification systems provided us with useful insights in the strategies that could facilitate the sustainable development of the emerging biofuel sector in Mozambique. FSC and fair-trade gave us ideas about how to protect the rights of smallholders and communities, and how standardization can deal with social issues such as human and labour rights. Both GlobalGAP and FSC have develop alternative procedures and a gradual system to deal with diversity in the sector. This will be particularly interesting for the biofuel sector, where both smallholder and commercial producers are active, and subsequently the differences between ethanol and biodiesel producers are clearly visible.
Standardization and traceability makes company-processes transparent, of which interviewed companies claim also allowed them to optimize their management and produce more cost-efficient. This will be important for the development of a competitive and economically viable biofuel sector in Mozambique.
On-site processing had several advantages. It created local employment, reduced wastage and transportation costs, providing win-win situation both for the companies, as well as the areas in which they are operating.

Both FSC and fair-trade systems merely supply high-price markets. For fair-trade this resulted in an un-guaranteed market, whereas FSC only supplies a small segment of the mainstream market, whilst the other part is still supplied with unsustainable and illegal extracted timber. GlobalGAP did manage to supply the mainstream market without premium prices or price guarantees.

Based on our experiences, one could argue that mainstream certification systems in practice will always be an obstacle for the integration of smallholder producers. Even with a certification system as fair-trade, which is especially designed for smallholder producers, incentives are required. Without support from government and/ or NGO-sector, the majority of Mozambican farmers (both smallholder and commercial) may well not be able to comply as the financial and administrative burden is too high. It seems that a certification system especially fits well-developed market economies. For Mozambique some interesting mechanisms to create the preconditions for smallholder certification could be:

- INCAJU: strengthening of Mozambican cashew sector by involving smallholder producers;
- Community-Private-Public partnerships between smallholders, private sector and NGO-sector: NGO sector could have a valuable contribution in preparing smallholders or outgrowers for certification.

In Mozambique, the enforcement of laws, regulations and standards form a huge challenge. From our interviews we heard of many examples where the governance and legislative system could often not support the introduction of certification or regulatory frameworks. Governments should promote the sustainable production by providing incentives to make sustainable production more attractive.

7. Biofuel developments in Mozambique

This chapter contributes to research question 3: "What can we learn from existing large and small-scale biofuel developments in Mozambique?" The objective of this chapter is twofold. Firstly, we provide an overview of existing and planned biofuel projects, processing and storage facilities, and analyze these by comparing them with studies on biomass potential per province, and policy objectives as described in chapter 2. Secondly, we offer case studies to provide practice-based experiences about biofuel production in Mozambique.

7.1 Biofuels in Mozambique

This section provides an overview of biofuel developments in Mozambique. Firstly, we describe and analyze biofuel projects that formally submitted investment proposals to the Mozambican government at the national level (section 7.1.1). Some of these projects are already approved and implemented, while others are under consideration prior to potential approval. In section 7.1.2 we describe other implemented biofuel projects (of which some are approved at provincial level) and expressions of interests. In section 7.1.3 we analyze existing and planned processing and storage facilities related to the emerging biofuel sector in Mozambique. All data is gathered and analyzed in 7.1.4, providing an image of the geographical spread of biofuel development in Mozambique compared to the agro-ecological zoning, and the main government objectives for promoting biofuel developments in the country.

7.1.1 Formally submitted biofuel proposals

This section provides an analysis of investment-data, which was gathered in collaboration with the *Centro de Promoção da Agricultura* or Agriculture Promotion Centre (CEPAGRI). We used data available up to December 2008 as benchmark. Knowing that individual investment proposals contain sensitive information, we have accumulated and generalized the data in such a way that confidentiality remained assured, but that valuable lessons could be learned. Up to January 2010, the government had officially approved four large-scale biofuel projects. These projects are described in more detail in table 16.

Up to December 2008, the Government of Mozambique had officially received 17 biofuel-related investment proposals, covering nine of Mozambique's ten provinces[36] (no investments proposals for Tete province; one of the poorest provinces of Mozambique). Of the projects, twelve were related to biodiesel production, five to bioethanol production. The core business of nearly all biodiesel projects is retrieving vegetable oil from Jatropha for the production of biodiesel. The bioethanol projects mainly focus on sugarcane production to produce bioethanol. Some of the projects have side-activities such as production of seedlings or food production. The biodiesel projects applied for 179,404 ha of land, the bioethanol projects for 66,000 ha.

	Bioethanol projects		*Biodiesel projects*		*Total:*
#	5	29%	12	71%	17
Land formally requested (ha)	66,000	27%	179,404	73%	245,404
Investment (US$)	1,003,000,000	77%	298,000,000	23%	1,301,000,000
Average investment per requested hectare (US$)	15,197		1,663		5,303
Employment (jobs)	Between 8,925 and 11,956	26% - 28%	Between 25,093 and 30,264	74% - 72%	Between 34,018 and 42,220
Employment per requested ha	Between 0.14 and 0.18		Between 0.14 and 0.17		Between 0.14 and 0.17
Main crop	Sugarcane		Jatropha		-
Other crops	Sweet sorghum, cassava		-		-
Average estimated yields	113.3 t cane ha^{-1}		2.64 t Jatropha oil ha^{-1}		-
Market	Mostly EU		Mostly EU		-

Table 15: Analysis of the 17 biofuel investment proposals based on collaboration with CEPAGRI

[36] Maputo City Province is officially Mozambique's 11th province, but for practical reasons we did not distinguish between Maputo Province and Maputo City Province in our analysis

The proposed biodiesel projects account for a total investment of US$298 million, the bioethanol projects US$1,003 million. Investment costs per ha show that that sugarcane production is far more capital-intensive than producing Jatropha. Total employment creation will be between 34,018 and 42,220. The available data shows that the biodiesel projects intent to create between 25,093 and 30,263 employment places (around 73% of total). The bioethanol projects account for between 8,925 and 11,956 jobs (around 27%); mainly depending on whether cane will be harvested manually or mechanically. Numbers vary as some projects distinguished between minimum and maximum expected employment creation, as well as the number of seasonal labourers needed. Average employment per hectare does not differ much between the bioethanol and biodiesel sector. For the whole biofuel sector, estimated employment potential is between 0.14 and 0.17 jobs ha^{-1}. Our analysis of the only formally approved Jatropha project Enerterra shows much higher employment per hectare if seasonal labour is included (0.27 jobs ha^{-1} – see table 16).

The 12 biodiesel projects aim at an average production of 2.64 t Jatropha oil ha^{-1} $year^{-1}$. The majority of projects aim at 1.5 and 2.5 t Jatropha oil ha^{-1}. The average is relatively high because three projects expect between 3.5 and 6 t Jatropha oil ha^{-1}. Research shows that yields highly depend on the growth conditions of the crop. Recent studies indicate maxima of 2.72 t Jatropha oil ha^{-1} $year^{-1}$, calculated on the basis of full radiation, high temperatures and year-round canopy cover, no limitations due to lack of water or nutrients, and the absence of plagues and diseases (Jongschaap et al., 2007 28). According to Jongschaap (WUR Plant Research International – personal communication): "Achieving these yields in practice will be extremely difficult, if not impossible." The average expected harvest for the three biggest sugarcane projects is 113.3 t of cane ha^{-1}. By comparison, the best average yield for the Mozambican industry over the past five years was 72 t ha^{-1} and the best average company yield over the same period was 87 t ha^{-1} (CEPAGRI, 2009). Data from the Brazilian sugarcane sector shows averages of 77.6 t ha^{-1} in 2007 (FAOSTAT, 2009c).

Most projects claim to focus on supplying the domestic, regional (SADC), as well as the EU and broader international market. Since the EU has announced its renewable energy targets for 2020 (20% renewables, 10% blending of biofuels for transport sector), and in the absence of a Mozambican domestic market, the European market is the premium market, where the highest prices will be paid. Most interviewed investors and experts confirm that initially: "Most of the ethanol is expected to be exported to the European Union" (Engineering News/ Reuters, 2009). The majority of investors find their origin in Europe or South Africa, often engaged in partnerships with Mozambican counterparts.

	Principle Energy Ltd.	*Procana Ltd.*[37]	*Enerterra SA*		*Grown Energy Zambeze Ltd.*		*Total:*
Province	Manica	Gaza	Sofala		Sofala		
Land (ha)	18,000	30,000	18,920		15,000		81,920
Investment (US$ million)	290	500	53		212		1,055
Investment per ha (US$)	16,111	16,667	2,801		14,133		
Employment (seasonal) Employment (permanent) Mozambican Foreign	Two projects should generate between 7,000 and 10,000 jobs		5,000 20 5	5,025	 2,104 34	2,138	Between 14,163 and 17,163
Average employment per ha	0.15 – 0.21		0.27[38]		0.14		0.17 – 0.21
Main crop	Sugarcane	Sugarcane	Jatropha		Sugarcane		
Production (per year)	212 million litres of ethanol	298 million litres of ethanol	*No data*		100 million litres of ethanol		
Market	Mostly EU	Mostly EU	10% domestically/ 90% EU		10% domestically/ 90% EU, USA, Japan		

Table 16: Analysis of the four formally approved biofuel investment proposals (Based on: Allafrica.com, 2007; 2009a; Engineering News/ Reuters, 2009; Noticias, August 21, 2009b)

[37] In December 2009, the government voided the contract of Procana Ltd. because the company failed to comply with its contractual obligations (United Press International, 2009).
[38] Average employment per hectare is high because of seasonal labor is included

In October 2007, the first large-scale bioethanol project was formally approved. Procana Ltd., with a total investment of around US$500 million according to Allafrica.com (2007), is a Mozambican company in which the London-based Bioenergy Africa Ltd. is the main shareholder. Procana obtained a DUAT for 30,000 ha for irrigated sugarcane production southeast of Massingir (Gaza province). In July 2008, Principle Energy Ltd., also a London-based renewables energy company, was granted access to 18,000 ha in Dombe (Manica province). Like Procana, Principle Energy's main objective is to produce irrigated sugarcane for bioethanol production. Both projects intend to build on-site ethanol distilleries where the sugarcane can be processed, and should generate between 7,000 and 10,000 jobs, depending on whether cane is harvested manually or mechanically (Allafrica.com, 2009b).

On October 6, 2009 one of the major shareholders in Procana, Bioenergy Africa Ltd., announced its proposed adoption of investing policy and change of name. Based on a review of a 23 month period ending on March 31, 2009, the Directors believed that: "The global economic climate and current reduced interest in non-carbon related fuel products will make it difficult for the Company to raise the necessary financing required under the Massingir Investment Agreement" (BioEnergy Africa Ltd, 2009b). For the 23 month period under review, BioEnergy Africa is reporting a pre-tax loss of US$7.7 million (Bioenergy Africa Ltd, 2009a). The company intends to suspend further material investment in the Massingir Project, adopt the investing policy and change its name. By the end of November 2009, the company's name and website had already been changed to Sable Mining Africa Ltd. (www.sableminingafrica.com). In December 2009, the government voided the contract of Procana Ltd. because the company failed to comply with its contractual obligations (United Press International, 2009).

In August 2009, the Council of Ministers granted DUATs for Enerterra SA and Grown Energy Zambeze Limited. "Both Enerterra SA, a company with Portuguese and Mozambican interests, and Grown Energy Zambeze Ltd., with Mozambican, Asian and South African interests, are located in Sofala province. According to the Council of Ministers spokesperson, Luis Covane, Enerterra has been granted an area covering 18,920 ha for the production of Jatropha in the locality of Mazamba, administrative post of Inhaminga, district of Cheringoma. This project is budgeted US$53 million, and is expected to employ 5,000 seasonal workers, and 25 permanent staff, of which 20 Mozambicans, and five foreigners" (Noticias, August 21, 2009b). Our analysis of Enerterra shows much higher employment per hectare (0.27 jobs per ha) than the averages from other biodiesel projects (0.14 – 0.17 jobs per ha). Maybe this is because seasonal labour is included. Ten percent of biodiesel produced, which quantity was not disclosed, will be used for domestic consumption and the balance, 90% will be for export, mainly to Europe (Allafrica.com, 2009a; Noticias, August 21, 2009b).

As for Grown Energy Zambeze Ltd., the government granted 15,000 hectares in the district of Chemba, for the production of sugarcane for ethanol and energy generation. Additionally beans and soya will be grown, in combination with cattle production. The project is budgeted at US$212 million and aimed to produce 100 million litres of ethanol annually. "Of the 100 million litres of alcohol produced per year, 10 percent will be sold in the domestic market and the balance exported to Europe, USA and Japan, while the electricity produced will be integrated into the national grid," said Covane. According to the investors, the project will employ 2,104 Mozambicans and 34 foreigners" (Allafrica.com, 2009a). The project has a social fund of US$2.7 million to support education, health, infrastructure and electrification of the area (Noticias, August 21, 2009b). Analysis of the four formally approved biofuel projects can be found in table 16.

The other investment proposals are still to be approved or are in the process of conducting baseline studies and Environmental and Social Impact Analysis. From interviews, we know of one biodiesel project officially withdrew from the application procedure (this project is however included in our analysis of the investment data in table 15). While some projects are close to formal approval, others face difficulties getting their activities financed or are 'shelved'. The fact that a project is not formally approved does not mean that no activities are being undertaken. Some of the projects have been granted land rights to start experiments and nurseries. However, fieldwork experiences showed us that other projects have already started bush-clearing, infrastructure, housing and plantation activities. We know of at least one biodiesel project that started operating on land-rights transferred from another company. However, formal titles are linked to an approved production plan, such that investors have to receive authorization from the government if land acquired in this way is intended for other use.

Dropping fossil-fuel prices and the financial crises have had their impact on the biofuel sector in Mozambique. In 2009, only five biofuel-related investment proposals have been received, which is much lower as compared to the proposals received in 2008.

Figure 8 shows the geographical spread of the 17 biofuel projects that were formally submitted to the Government of Mozambique. For reasons of confidentiality, we have only explicitly named the biofuel projects that have been formally approved. As one project works at two different locations, the map contains 18 dots!

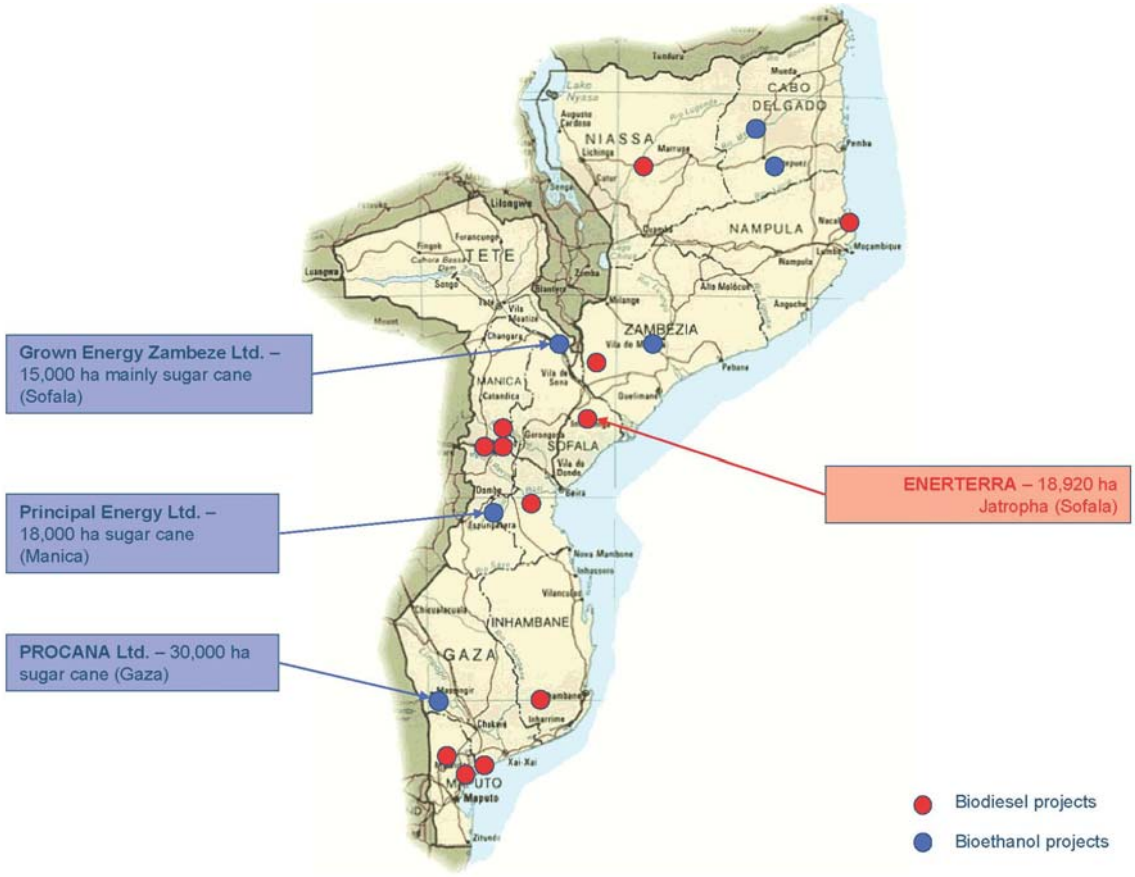


Figure 8: Geographical spread of biofuel projects that formally submitted investment proposals to the Government of Mozambique, and the four biofuel projects that have been officially approved at national level[39]

[39] In December 2009, the government voided the contract of Procana Ltd. because the company failed to comply with its contractual obligations (United Press International, 2009).

In table 17 we compare land requested by the formally submitted proposals per province with the land availability per province as was identified through the 2008 agro-ecological land zoning (scale 1:1,000,000). As indicated in section 2.4.4, currently a more detailed land zoning is being undertaken (scale 1:250,000).

	Agro-ecological land zoning exercise (IIAM & DNTF, 2008)		*Investment proposals*		
Province	*Total land availability (ha)*	*% of total land available*	*Formal land requests (ha)*	*% of total formal land requested*	*% of land requested compared to land availability (zoning)*
Zambézia	1,365,300	19.6%	72,618	30%	5.3%
Niassa	1,220,400	17.5%	1,300	1%	0.1%
Inhambane	1,071,660	15.4%	11,000	4%	1.0%
Gaza	866,780	12.4%	30,138	12%	3.5%
Nampula	709,160	10.2%	15,050	6%	2.1%
Tete	661,730	9.5%	0	0%	0.0%
Sofala	408,650	5.9%	43,920	18%	10.7%
Manica	381,950	5.5%	57,122	23%	15.0%
Cabo Delgado	269,400	3.9%	2,000	1%	0.7%
Maputo	11,000	0.2%	12,256	5%	111.4%
Total:	6,966,030	100.0%	245,404	100%	3.5%

Table 17: Land availability (agro-ecological zoning) versus request per province (17 investment proposals)[40]

Except for Maputo province, the requests are still within the amount of land available per province. In total, investors requested 3.5% of the total available land identified during the agro-ecological zoning of 2008.

As our analysis shows, the majority of land identified in during the agro-ecological zoning exercise can be found in the northern provinces of Mozambique; as Zambézia, Niassa, Tete, Nampula and Cabo Delgado represent 4,225,990 ha or 61% of the total land identified as 'available'. The central and southern provinces Manica, Sofala, Inhambane, Gaza and Maputo represent the remaining 2,740,040 ha or 39% of the total 6,966,030 ha. When looking at the formal land-requests by biofuel investors, we find that 63% or 154,436 ha of the total land requested is located in Manica, Sofala, Inhambane, Gaza and Maputo provinces, and the remaining 90,969 ha (37%) in Zambézia, Niassa, Tete, Nampula and Cabo Delgado provinces.

	Agro-ecological land zoning (IIAM & DNTF, 2008)		*Investment proposals*	
Provinces	*Land identified as available (ha)*	*% of total land available*	*Requested land (ha)*	*% of total land requested*
Maputo, Gaza, Inhambane, Manica and Sofala	2,740,040	39%	154,436	63%
Tete, Niassa, Cabo Delgado, Zambézia and Nampula	4,225,990	61%	90,968	37%
Total:	6,966,030		245,404	

Table 18: Land requested compared to land availability per region

Table 18 demonstrates that central and southern provinces have the main interest of biofuel investors, whereas the majority of available land according to the 2008 agro-ecological land zoning can be found in the northern provinces.

[40] Requested land is not in all cases equal to approved land-use (DUAT) by the Mozambican government

7.1.2 Other implemented biofuel projects and expressions of interest

Besides the projects that formally submitted investments proposals to the Government of Mozambique, a wide variety of other biofuel initiatives are being implemented and explored in Mozambique. Data for this section was gathered through analysis of documentation and reports (cf. Econergy, 2008 38; GEXSI, 2008; Justiça Ambiental and UNAC, 2009 46-48), media and internet-search, fieldwork throughout Mozambique and interviews. The projects in figure 9 are very heterogeneous, ranging from large-scale commercial projects, to smallholder development projects each with their own specific approach and objectives. As said, some are already implemented, others are just expressions of interest. Although data about these projects is limited, a distinction could be made between bioethanol and biodiesel projects, and projects that focus on producing Pure Plant Oil (PPO), which are mainly projects with smallholder producers. We plotted the projects on the map of Mozambique, so the geographical spread could be analyzed (figure 9).

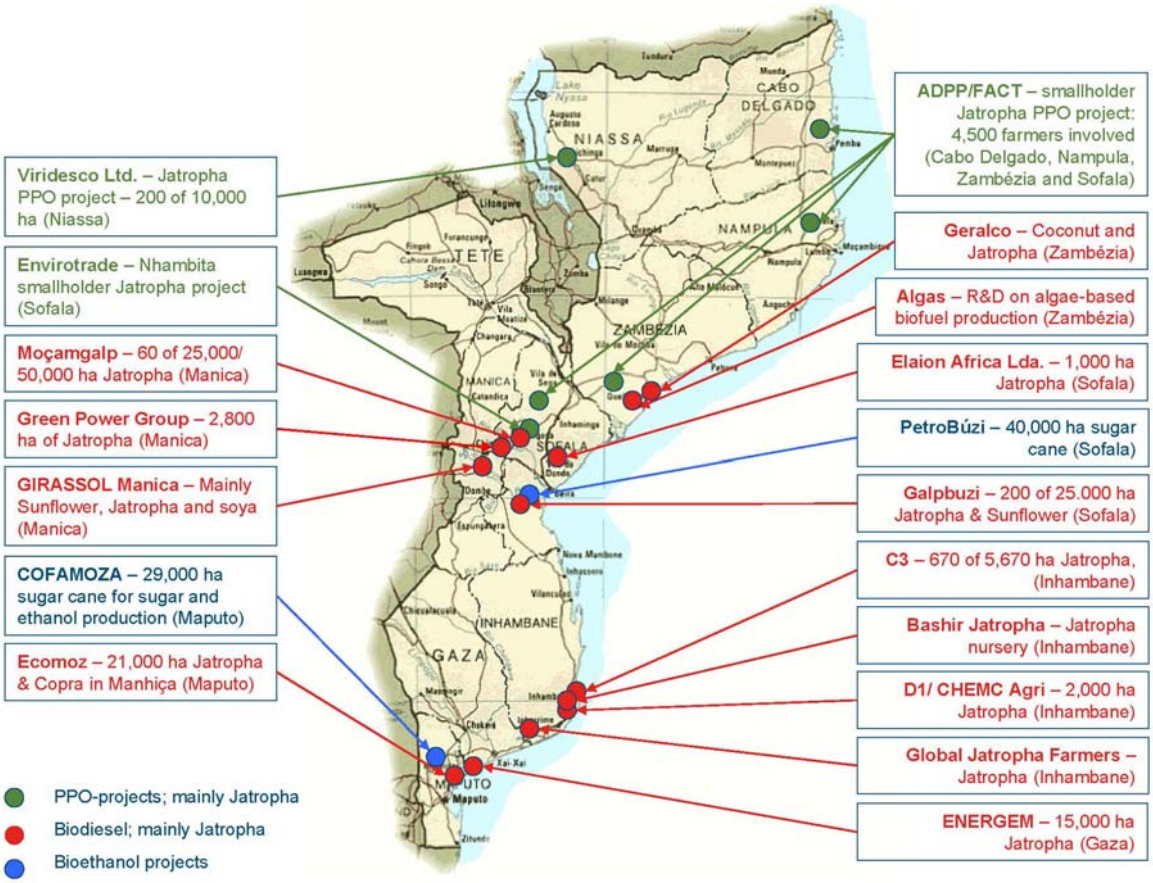


Figure 9: Geographical spread of other implemented biofuel projects and expressions of interest (based on fieldwork, interviews, media and internet research and Econergy, 2008 38; GEXSI, 2008; Justiça Ambiental and UNAC, 2009 46-48)

In line with the formally submitted projects, figure 9 demonstrates a concentration of biofuel activities in the Beira-corridor, around Quelimane and along the southern coast between Maputo and Inhambane. The majority of projects focus on Jatropha as feedstock, either to produce PPO or biodiesel. Envirotrade's Nhambita Jatropha project and ADPP are prominent smallholder projects. More information on these projects can be found in section 7.2.2 as both were visited during fieldwork.

7.1.3 Existing and planned biofuel-related processing and storage facilities

One of the reasons for including existing biofuel-related processing and storage facilities in this study, is to indicate which areas potentially provide access to goods and services related to the emerging biofuel sector in Mozambique. Mozambique currently has five sugar mills; Marromeu, Mafambisse and Búzi Sugar Mill (Sofala province), Xinavane and Maragra sugar mill (Maputo province). Of these five mills, the Búzi Sugar Mill is currently not operational. None of these sugar mills is currently producing ethanol, but Tongaat Hulett (with shareholding in Mafambisse and Xinavane sugar estates and mills) expressed intention to move vigorously into the bioethanol market over the next few years, but added that they need a mandatory 10% blending regime to kick-start renewable energy programs (BusinessReport, 2009). There is currently one operating ethanol distillery in Mozambique in the Búzi region about 50 kilometres from the Beira port. The distillery produces roughly 10,000 litres per day of ethanol for beverages and pharmaceutical applications using molasses as a feedstock" (Econergy, 2008 192).

There exists an embryonic biodiesel sector in Mozambique, all using coconut oil, and occasionally palm oil as feedstock (Econergy, 2008 131-132). As the prices of coconut oil went up significantly, the opportunity cost of using the oil for biodiesel rather than sale on the international market was too high. The most prominent biodiesel project is Ecomoz, in which Mozambique's oil company PetroMoc has a 30% share. Ecomoz started operating in 2007 using coconut oil, and occasionally palm oil as feedstock. The product is refined in Matola, Maputo province. The capacity of the refinery is 100,000 liters per day, but lacking quantity and quality of feedstock is preventing this potential from being achieved. Currently, Ecomoz sells its biodiesel to PetroMoc, using it in their company's cars while awaiting approval of the blending license to sell to the market. Ecomoz is planning to expand production, and use 21,000 ha in Manhiça district (Maputo province) to produce Jatropha and Copra[41] (PetroMoc, 2009).

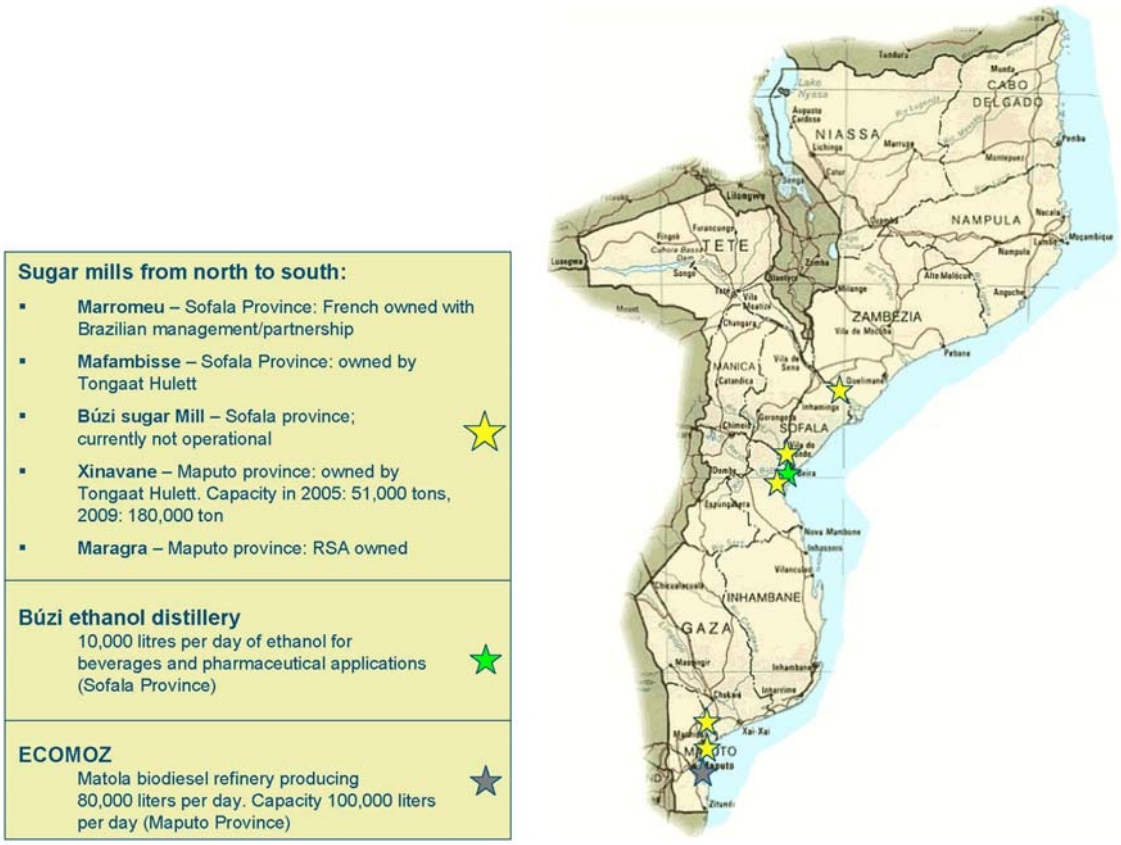


Figure 10: Locations of existing biofuel-related processing facilities

[41] Copra is the dried meat, or kernel of the coconut

Besides the existing facilities, the Mozambican government is rehabilitating, expanding and modernizing three existing PetroMoc facilities in Nacala (Nampula province – 100,000m^3 storage facility), Beira (Sofala province – 50,000m^3 storage facility) and Maputo (Maputo province – 500,000m^3 storage facility), while a new facility of 95,000m^3 is constructed in Beira. In study/ exploration are:

- Vandúzi (Manica province) – 7,000m^3 storage facility PetroBeira
- Beira – 77,000m^3 storage facility PetroMoc
- Maputo/ Porto de Dobela – 1,500,000m^3 storage facility PetroMoc (PetroMoc, 2009)

These facilities are not specifically designed for biofuels but to be versatile and accommodate normal fossil fuel, gas, biofuels and all kind of liquid fuels that will be necessary (personal communication PetroMoc). Moreover, there are other fuel storage and distribution facilities in Mozambique (e.g. in Chimoio), but the above mentioned were specifically related to the expansion of biofuel activities in Mozambique (for example in PetroMoc-documents and presentations).

Galpbuzi, a consortium made up of Mozambican company *Companhia do Búzi* and Portugal's Galp Energia, presented its long term plans to set up a biofuel refinery in the town of Búzi, in Mozambique's Sofala province. Mentioning that the project needed an area of land of 8,000 hectares for Jatropha and sunflower, the director general of the consortium said they are planning to invest €100,000, with part of production expected to be exported and the remainder used for domestic consumption (Macauhub, 2009a). Another biofuel producer, British company Sun Biofuels, also announced the construction of a factory to process biofuel made from Jatropha in the Gondola district in Manica province. When fully operational, the company expects to produce just over 20,000 liters of biofuel per year (Macauhub, 2009c). Petrobuzi intends to construct an on-site ethanol distillery (CPI, 2009), just like Procana, Principle Energy and Grown Energy Zambeze. As Procana's contract was voided by the government in December 2009, it is unlikely this facility will be constructed.

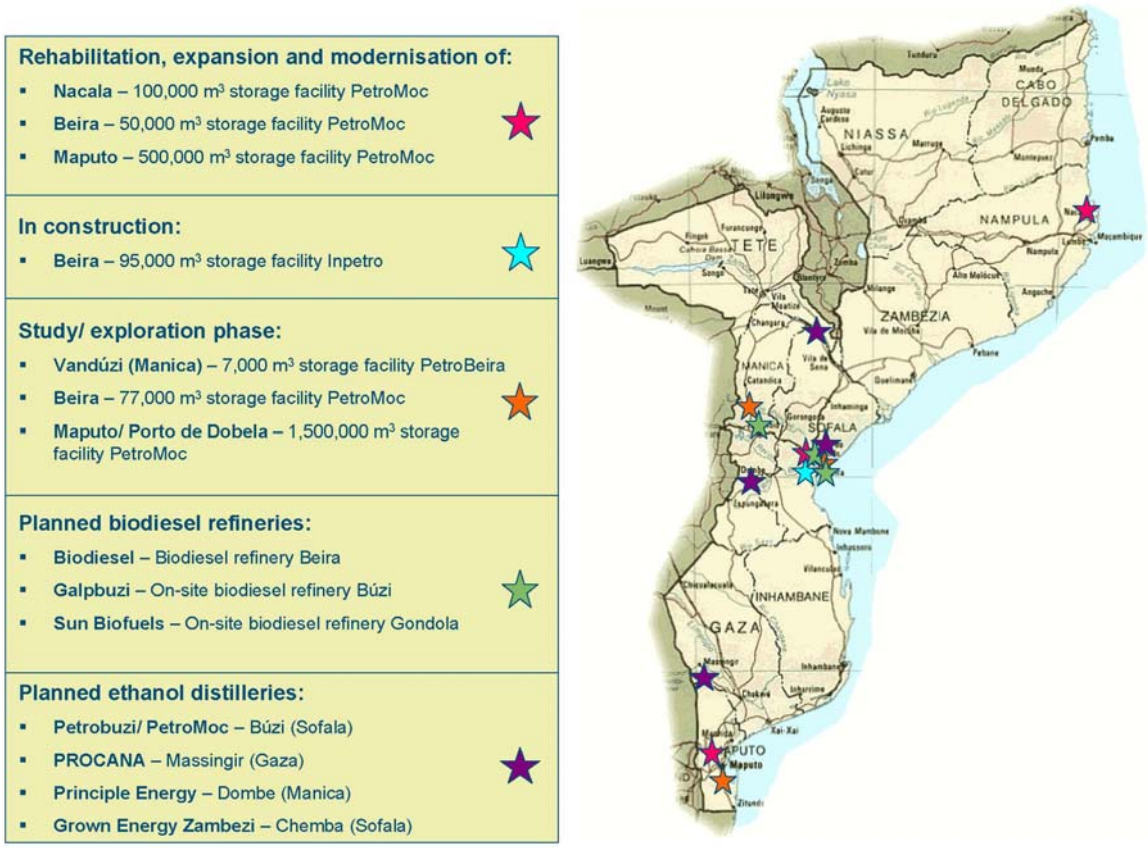


Figure 11: Location of existing and planned biofuel-related processing and storage facilities

7.1.4 Overview of biofuel developments in Mozambique

Figure 12 provides an overview of all implemented biofuel projects and expressions of interest. We added existing and planned biofuel-related processing and storage facilities, and indicated concentration of activities.

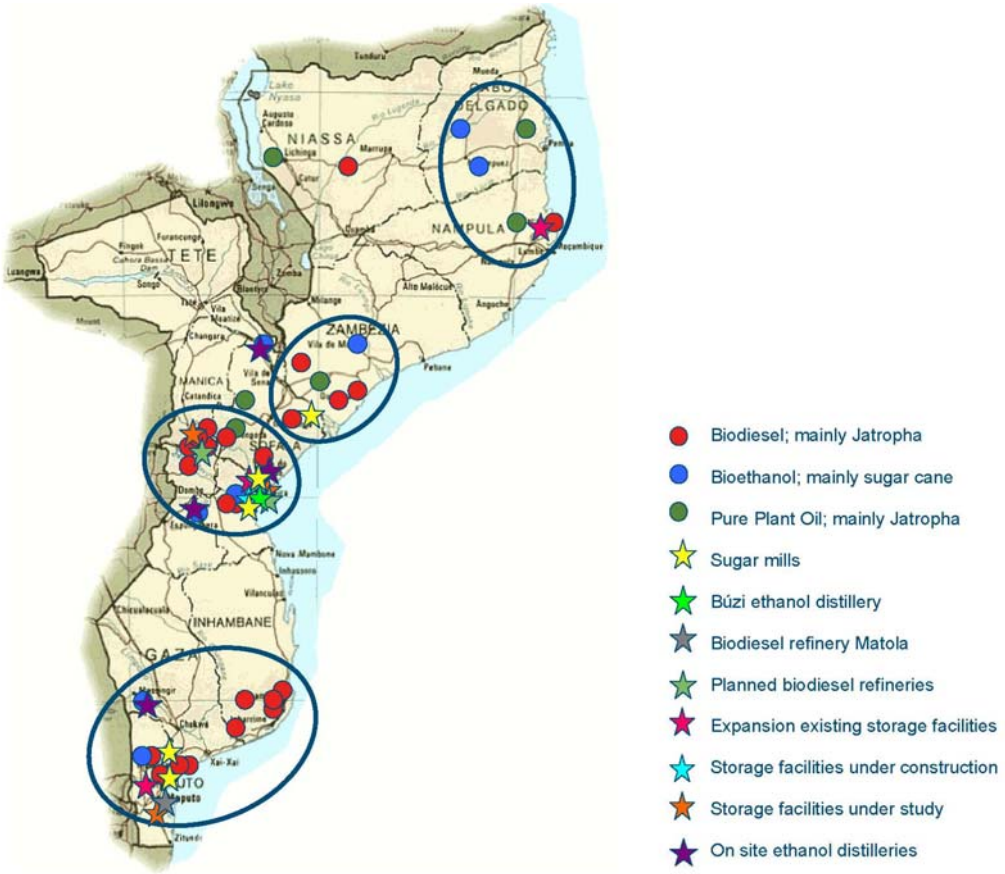


Figure 12: Geographical spread of biofuel developments in Mozambique

In table 19 we summarized the inventory of formally submitted proposals, and other biofuel planned and implemented biofuel projects, and existing and planned biofuel-related facilities per Mozambican province.

	Bioethanol projects				*Biodiesel and PPO projects*				*Total projects*		*Processing and storage facilities*		*Total*	
Province:	# *formal*	# *other*	# *total*	*%*	# *formal*	# *other*	# *total*	*%*	#	*%*	# *total*	*%*	#	*%*
Maputo	0	1	1	14%	2	1	3	10%	4	11%	5	24%	9	15.3%
Gaza	1	0	1	14%	1	1	2	6%	3	8%	1	5%	4	6.8%
Inhambane	0	0	0	0%	1	4	5	16%	5	13%	0	0%	5	8.5%
Sofala	1	1	2	29%	2	4	6	19%	8	21%	11	52%	19	32.2%
Manica	1	0	1	14%	3	3	6	19%	7	18%	3	14%	10	16.9%
Tete	0	0	0	0%	0	0	0	0%	0	0%	0	0%	0	0.0%
Zambézia	1	0	1	14%	1	3	4	13%	5	13%	0	0%	5	8.5%
Niassa	0	0	0	0%	1	1	2	6%	2	5%	0	0%	2	3.4%
Nampula	0	0	0	0%	1	1	2	6%	2	5%	1	5%	3	5.1%
Cabo Delgado	1	0	1	14%	0	1	1	3%	2	5%	0	0%	2	3.4%
Total:	5	2	7	100%	12	19	31	100%	38	100%	21	100%	59	100%

Table 19: Analysis of biofuel developments per Mozambican province

As table 19 shows, 71% of biofuel projects (formally submitted, other implemented projects and expression of interest) are located in Maputo, Gaza and Inhambane, Sofala and Manica provinces. The remaining 29% are located in Zambézia, Niassa, Nampula and Cabo Delgado provinces.

Existing and planned processing and storage facilities are mainly located in Maputo, Manica and Sofala provinces. In these three provinces 90% of all developments related to biofuel processing and storage take place. There seems to be a relation between the location of processing and storage facilities and the geographical interest of the projects, as 50% of the implemented and planned biofuel projects are also located in Maputo, Manica and Sofala provinces.

If we combine our geographical data on implemented projects and expressions of interest with data on existing and planned processing and storage facilities, the differences between North and South Mozambique become even more evident; 80% of the total biofuel developments take place or are planned in Maputo, Gaza and Inhambane, Sofala and Manica provinces. The remaining 20% of the total biofuel developments take place or are planned in Zambézia, Niassa, Nampula and Cabo Delgado provinces. Tete is the only Mozambican province where no biofuel developments take place (see also figure 13).

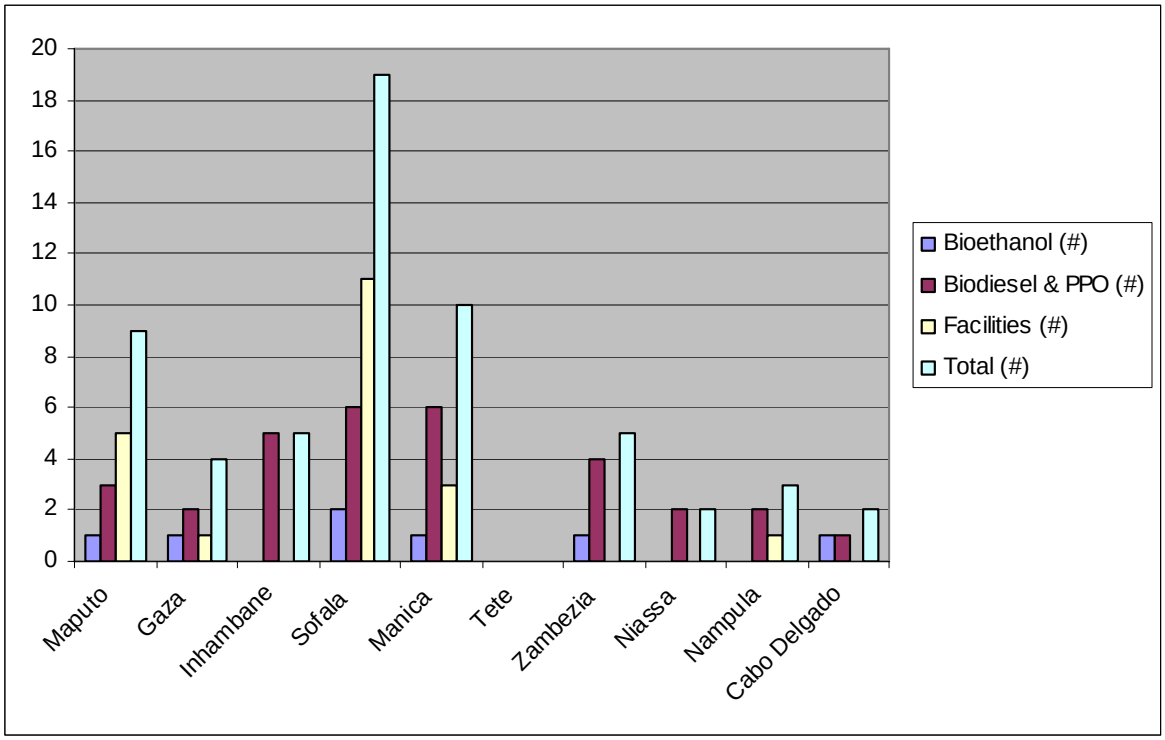


Figure 13: Overview of biofuel developments per Mozambican province

7.1.5 Geographical spread versus agro-ecological zoning

Subsequently we have plotted our data on the agro-ecological zoning map that indicates the nearly seven million ha of land identified as available (see also section 2.4.4).

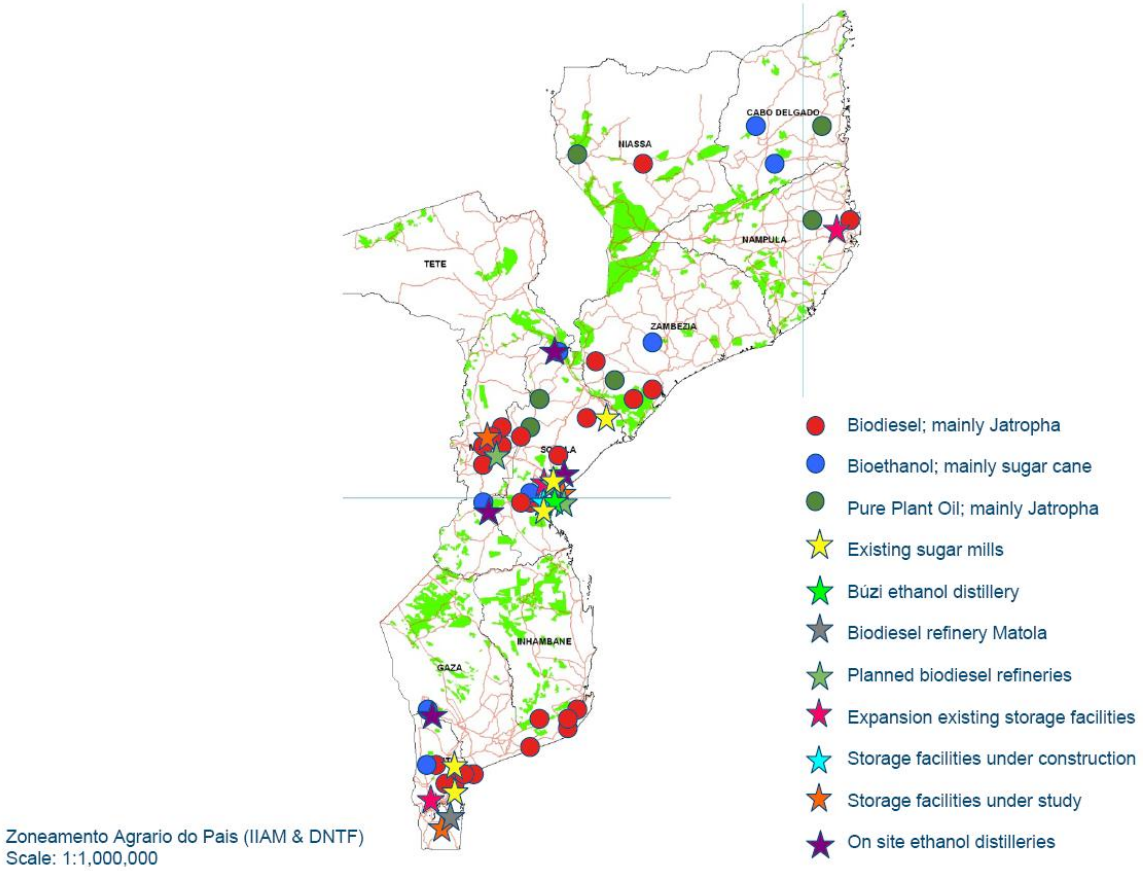


Figure 14: Geographical spread of biofuel developments versus agro-ecological zoning in Mozambique (IIAM & DNTF, 2008)

The land zoning exercise from 2008 identified 6,966,030 ha of land available for commercial agricultural activities (IIAM & DNTF, 2008). The general scale of the zoning (1:1,000,000) does not allow us to draw very firm conclusions about whether or not biofuel projects are located in the available areas. However, we can observe that the provinces with highest interest for biofuel projects[42] – Maputo, Gaza, Inhambane, Manica and Sofala (71% of implemented and planned projects) – only represent 39% of available land. This difference becomes even more visible if we zoom in on Maputo, Manica and Sofala provinces. In these provinces, 50% of the implemented and planned biofuel projects are located, whereas the provinces only represent 11.6% of the 6,966,030 ha identified as available during the zoning. Maputo, for example, only has 11,000 ha of land available, whereas 12,256 ha (111.4%) was requested by investors (see table 17). Currently, a new phase of zoning has started. The scale of 1:250,000 should provide a more secure framework for any future agricultural investments.

Another observation we can make from figure 14 is that most existing and planned processing and storage facilities are relatively far from the areas identified as available. On-site processing of bioethanol and biodiesel or PPO is therefore probably the cheapest way of processing fuels as it lowers transaction costs. After processing, the ethanol, diesel or PPO can be transported to Maputo, Beira and Nacala from where further distribution can take place.

[42] Note: existing and planned processing and storage facilities are excluded

7.1.6 Analysis and discussion

We find the highest concentration of biofuel projects around the Maputo-corridor up to Massingir and Inhambane, and between the Zimbabwe border-town Manica (Manica province) and Beira (Sofala province), the so-called Beira-corridor. Around Maputo and up to the city of Inhambane infrastructure is reasonably good[43], and there is relatively easy access to a wide range of goods and services, mainly coming from South Africa. The area is densely populated and agricultural conditions are relatively good. Maputo is approximately one hour from the South African border Ressano Garcia and has a deep-sea harbour, which creates good opportunities for export.

Similar conditions can be found around the Beira-corridor, where we found the highest concentration of biofuel projects and processing and storage facilities. Beira also has a deep-sea harbour, although it is very shallow and is constantly being silted up, needing regular dredging if reasonably large vessels are to be able to go in. The road from coastal Beira to Manica forms an important fuel-corridor to supply landlocked countries like Zimbabwe, Zambia and Malawi with fuel. Fuel processing and storage facilities are present in Beira, which makes it an interesting area for biofuel producers who want to export their product. The road is reasonably good, but because of the large number of heavy trucks passing it every day, it needs maintenance (especially just outside Beira). Manica province is known for its relative high agricultural productivity. The province has more than average rainfall and the soils are good for growing food crops, such as cassava, maize, sweet potato and sorghum (World Bank, 2006b). In Manica and Sofala there is relatively easy access to agricultural inputs.

Other concentrations of biofuel activities we find in the south of Zambézia province; around Quelimane, and in the north of Nampula province and Cabo Delgado. Zambézia province has Quelimane port, which is mainly used by smaller vessels. Nampula province has Nacala deep-sea port and Cabo Delgado has Pemba port, which is also mainly used by small vessels. More information on supposed domestic and international biomass flows can be found in Batidzirai et al. (2006 64).

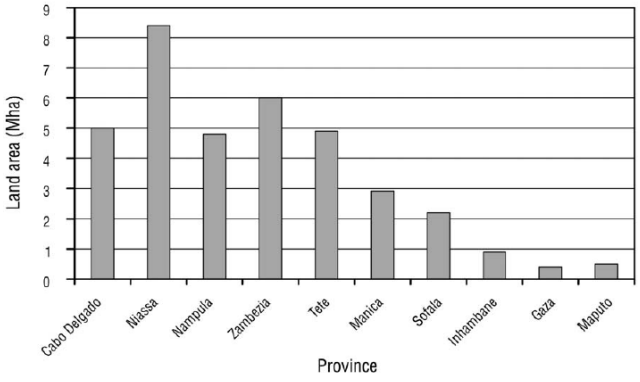


Figure 15: Distribution of land suitable for rain-fed agriculture (Batidzirai et al., 2006 60)

Although Tete and Niassa are amongst the provinces with largest amounts of land suitable for rain-fed agriculture (figure 15), we hardly see any interest for biofuel developments in these provinces (only 5%). This is likely to be explained by the almost absence of infrastructure and low population density in these provinces; between 6.2 and 11.3 people per km^2 (table 1). Lack of infrastructure makes it difficult to supply projects with the necessary inputs and increases transportation costs. On the contrary, provinces with lowest land availability for rain-fed agriculture; Maputo, Gaza, Inhambane, Sofala and Manica are the most popular to locate biofuel projects as we have seen on our maps. 71% of the implemented and planned projects are located in these provinces. For Maputo province investors formally submitted proposals for 12,256 ha, whereas the agro-ecologic land zoning exercise indicated that there is only 11,000 ha available (table 17).

[43] A new road is being constructed between Xai Xai and Chidenguele

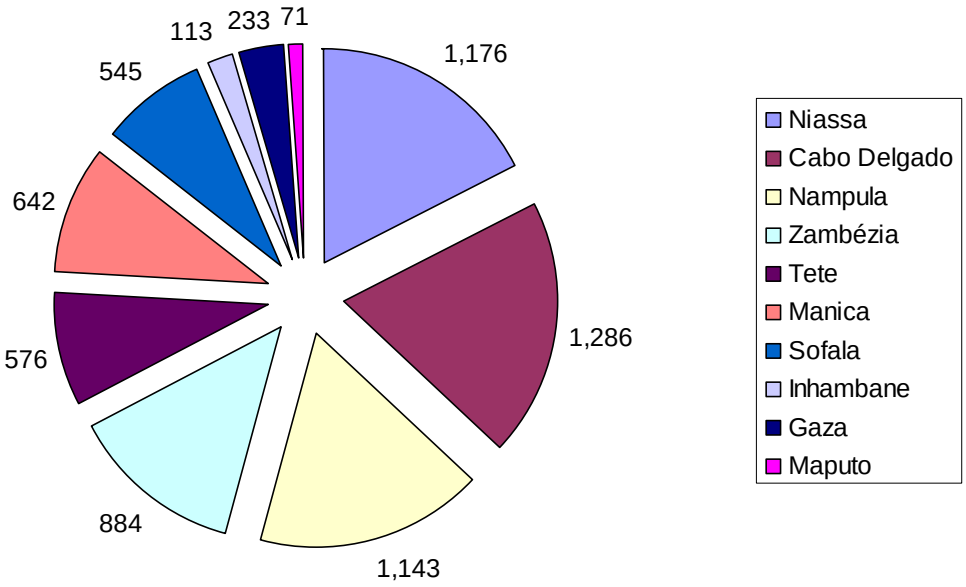


Figure 16: Estimated annual biomass production potential by Mozambican province (in PJ – petajoule; projected for 2015) after Batidzirai et al. (2006 61-62)

We can draw a similar conclusion if we compare our findings with the projection of provincial biomass annual production potential for 2015 (figure 16). We see that 32% of the biofuel projects[44] are located in Maputo, Gaza and Inhambane provinces, whereas these provinces only represent 6.3% of the country's total annual biomass production potential according to Batidzirai et al. (2006 61-62). Provinces with highest annual biomass production potential such as Niassa, Cabo Delgado and Nampula (54.1% of total annual biomass production potential), are not very popular among projects, as only 16% of the biofuel projects have interest in locating themselves in these provinces.

Moreover, the southern provinces ones are more prone to natural disasters such as floods and droughts, while most fertile lands can be found in the northern regions, where there is also higher average annual rainfall.

If we compare the Mozambican government's objectives for the promotion of biofuel developments with our analysis, we can identify some differences that should be taken into account:

Creating employment and business opportunities in rural areas:

As said, the majority of commercial projects are situated around existing good infrastructure (roads and ports), processing and storage facilities, where there is access to (tele) communication, (skilled) labour, services and goods. When comparing this with the government's objective for promoting biofuel production as a way to respond to the National Poverty Alleviation Agenda (especially in rural areas), we conclude that the majority of commercial biofuel projects have no interest of locating themselves in remote rural areas in Mozambique. However, it is not always clear how rural areas are conceptualised, as 10 kilometres from the main road can also be very rural.

Although it is still early to comment conclusively, job creation might be lower than expected. The 17 formally submitted proposals intent to create between 34,018 and 42,220 new jobs for 245,404 ha; an average of

[44] 'Biofuel projects' relate to the formal and other implemented biofuel projects and expressions of interests. It does not include the existing and planned processing and storage facilities

between 0.14 and 0.17 jobs per ha for the whole biofuel sector. Averages of the four formally approved projects are a bit higher between 0.17 and 0.21 jobs per ha (see table 16), but still much lower compared to government projections of 150,000 new jobs for 450,000 ha (0.33 new jobs per ha) (Government of Mozambique, 2009 18). Although the government figures include self-employment for entrepreneurs, it is unlikely that this will double biofuel-related employment in Mozambique on the short term. Experiences from the field show us that goods, skilled expertise and services are mainly 'imported' from countries where the investors have their origin.

If we compare estimated job creation potential of the Mozambican sugarcane projects (between 0.14 and 0.18 jobs per ha) with data from the Brazilian sugarcane sector (table 5 in section 5.1.2) we see that employment of the total number of permanent and temporary workers in Brazilian sugarcane production fell with 33.5% between 1992 and 2003, which can partly be explained by the introduction of fully mechanized harvesting. During the same period employment per ha dropped with 47.9% from 0.161 in 1992 to 0.084 jobs per hectare in 2003. As many investors are exploring the opportunities for mechanized harvesting, these figures might be more realistic on the long term. The Econergy report which assessed the potential competitiveness of Mozambique's biofuels for the Mozambican government claims an estimated job creation potential of 1 industrial and agricultural jobs per hectare per year for the sugarcane sector (Econergy, 2008 254), which might explain the government's high expectations.

Analysis of the only formally approved Jatropha project Enerterra shows 0.27 jobs per ha, including seasonal labour (table 16). This number is more in line with Econergy's estimated job creation potential of 0.3 industrial and agricultural jobs per hectare per year in the Jatropha sector (Econergy, 2008 254).

Diversification of the energy-matrix/ reduce dependency on oil-imports:

The Mozambican national biofuel policy and strategy aims at promoting biofuels for both domestic processing and use, as well as for export to create tax-revenues and foreign currency. At the moment, most investors – in absence of any domestic or regional markets – focus on supplying external markets. The majority of commercial projects are located close to ports aiming at exporting to premium markets in the EU. Although this partly contributes to the government's objectives, it does not yet contribute to solving the energy dependency problem Mozambique is facing. For biofuels to play a role in diversifying the country's energy matrix, the rapid development of the domestic biofuel market is therefore essential.

7.2 Case studies

In this section, we add hands-on experiences gathered during field visits to biofuel projects in Mozambique. Through the below case studies we want to describe what the current situation is, and subsequently the challenges and opportunities towards developing a sustainable biofuel sector in Mozambique. In order to write this chapter we visited nine biofuel projects. These were large-scale commercial and smaller-scale biofuel projects all with their specific commercial and/or development objectives and activities. Moreover, we have interviewed over 50 policy-makers, investors, farmers, NGO-representatives and researchers. We subdivided between commercial projects (seven were visited) and the small-scale development projects (two were visited).

7.2.1 Commercial, large-scale biofuel projects

Most of the visited projects are located in areas with access to a river or dam to provide the nursery and plantation with water. Water rights are usually respected, but it is not clear how water usage is measured. The sugarcane plantations will be fully irrigated, whereas Jatropha plantations are mainly rain-fed. Jatropha nurseries are often irrigated and therefore located near rivers or other water sources. The location of the visited projects was very diverse. Some located themselves along main roads, while others went for the rural areas. The projects that are located in the rural areas invested heavily in the construction of new infrastructure, (tele)communication, access to goods and services, of which also the local communities benefit (mobile phone network/ roads). To achieve this bush had to be cleared and some farmers' land was relocated. In most cases land and water rights were acquired through formal legal structures and procedures. However, we know of at least one project that already started operating on land transferred from another company, without having DUAT for the production of biofuel feedstock. Investments in infrastructure affect the competitiveness of the eventual biofuel project, as investors do have commercial ideas about return-on-investments.

Generally speaking community consultation mainly takes place through the local leaders, who are supposed to represent the communities. In some cases this representation is contested, as local leaders are compensated in products or services of which the communities in general do not benefit from. Resettlement of communities, households and/ or their farmland can usually be avoided, although there are some resettlement cases. Resettlement has huge consequences for smallholders, as affects both their farming practices (local knowledge on farm-land), and social relations (labour exchange). In general, investors try to avoid resettlement processes, as they cost a lot of negotiation, time and energy. However, we have also seen cases where households have resettled themselves closer to new roads or plantation in order to benefit from the infrastructure or to live closer to the farm.

Many of the projects provide direct employment opportunities for nearby communities. Although labour availability is not a problem yet, many investors complained about the absence of skilled labour. Many people cannot make calculations, read or write which creates problems. Many labourers are not used to work on a contract-basis and have different work ethics than expected by the (foreign) investor (e.g. not showing up for work after payday). Some projects employ skilled foreigners, who moreover had experience in working on large-scale plantations. Engineers and technicians were mostly non-Mozambican workers. Machinery and (construction) materials are mainly imported. Although this market does exist in Mozambique, most investors preferred to import them from or through their country of origin. On-the-job training was provided for pesticide spraying and tractor driving. Most of the projects have no formal training or education programs. Within the majority of projects, labourers had to identify themselves before they could start working on the plantations – amongst others to prevent child-labour. Permanent staff was offered clothing, boots and protection where necessary; this was not the case for casual labourers. The workers work 45 hours a week, spread over five or six working days. All the projects pay at least minimum wage to their workers. Some projects, especially in the more remote areas were concerned about labour availability when plantations would expand. Ideas on how to solve this varied from constructing housing for non-local workers, or providing daily transport for them. We got the idea that most projects were quite optimistic in relation to the number of employment places they think to create. As the majority of companies are very much in favour of mechanization, the actual employment for Mozambicans might be lower than expected. Most projects claim they will explore working with outgrowers in the future, but that expanding the boundaries of their business costs a lot of extra energy and can actually complicate compliance with sustainability criteria.

It is very difficult to say something on how existing biofuel projects do or do not compete with food production or other biomass applications. Some projects really focused on the so-called marginal soils, while others were established in areas with better soil quality. Ofcourse one could claim that these projects could also focus on producing food crops for Mozambique, but the market-demand has determined otherwise. Our personal opinion is that the current scale of activities does not directly endanger (local) food-security on the short term. On the long term this has to be monitored carefully. There should be special attention for the reallocation of labour. Many farmers, who started working on biofuel plantations, are likely to spend less time on their own fields, resulting in decreasing food self-sufficiency (cf. Peters, 2009). It is important to monitor if income is sufficient to cover this gap, especially in years when yields are low. Although biofuel developments could contribute to agricultural modernization, there are only a few projects who initiated food-security projects with surrounding communities. Part of the plantation was designed for food production where communities could benefit from the existing irrigation and technical expertise. It is generally not the main concern of projects and without appropriate policy mechanism biofuel plantations will not automatically contribute to increased food security.

Although it is difficult to say anything about the long-term positive and negative side-effects of commercial biofuel developments in Mozambique, the projects do have impact in the region where they are established. Besides creating direct employment, we saw other spin-offs such as; access to infrastructure, new shops opening up along the newly created roads, and people getting a job as housekeeper, guard or cook at the project. Contribution of the projects to local prosperity is expected to increase as the projects expand. Projects should be encouraged to locally purchase food, drinks, construction materials and other goods instead of importing them from nearby countries such as South Africa.

As for the agronomic side, most Jatropha initiatives are investing a lot of time and energy in Research and Development. The sugarcane initiatives depend on the crop's extended research data available from South Africa and other parts of the world. Although we were provided the opportunity to visit several projects, investors were quite secretive about their work. We were shown many on-farm experiments, ranging form plant distances, different nursery and breeding techniques, intercropping systems, planting and weeding techniques. During our field visits we saw similar experiments are being carried out by the Jatropha companies. We were also told a lot of contradictory messages on yields and 'best practices', for example with regard to whether prunings or seedlings would provide better planting material[45].

Although most companies are concerned about the landscape and environment, the projects require large pieces of land, from which natural vegetation is cleared. Some Jatropha projects left indigenous trees, but if this leads to reduced growth on the land surrounding the tree, or if it would obstruct mechanized harvesting they would remove them. Two of the visited projects are located near high-biodiversity areas. With regard to the application of pesticides and fertilizers, the commercial companies have similar objectives; in order to be competitive; you need to make sure the plant received the appropriate nutrients and plant-protection when necessary. Especially for the Jatropha farmers pests and viruses are an unknown factor. Although there are no long-term data available, we saw the damage golden flee beetle, leave miner and termites can do to the plant. Highly toxic pesticides are applied to the plants, in one case it was sprayed from the air, but usually it is applied by workers using backpack-sprayers. Nevertheless the use of external inputs is problematic from an economic point of view, because the transport of the bags is more costly that the fertilizer itself. It is difficult to evaluate the environmental impact of projects. Most projects conducted Environmental and Social Impact Studies, but it is unrealistic to think that the projects do not affect soil, water and air conditions. Similar argumentation can be used for the impact of the projects on GHG-emissions. It is hard to imagine that the current changes in the landscape (both the clearing of bush, as well as the huge amounts of fossil fuels needed for this) contribute positively to the GHG-balance. However, on the long term once the plantation starts producing raw material for biodiesel, there might be a break-even point.

Concluding; although we were able to identify similarities between the projects, it turned out to be very difficult to generalize commercial large-scale biofuel initiatives as every project has its own dynamics, challenges and

[45] Later we learned that planting cuttings is highly unusual, as seedlings develop a stronger root system that provides easier access to water and nutrients

opportunities. Although it was very difficult to draw preliminary conclusions on the positive and negative side-effects of the projects, it should be said that these projects do have impact on their surrounding environments. They do bring change and development; create employment, opportunities and infrastructure to region. Moreover, these projects have a pioneering function; they are making areas accessible, and try to smoothen the path for future biofuel investors. Ofcourse it can always be done better, cleaner, more social or efficient, but like many investors say: “The alternative is doing nothing, which is also not going to help the country.” However, careful monitoring of developments is needed to make sure that multi-level (local to national, but also international) objectives will be met in the future. The sustainability debate will mainly be focused around the negotiation and trade-off between these objectives. The biggest threats for the large-scale commercial projects lie in the unstable investment environment and financial crisis, as some projects already experienced difficulties financing their activities due to cash-flow problems. If projects are suspended or cancelled during the process of establishment this could have huge negative side-affects for the area. Surprisingly, none of the western biofuel sustainability schemes includes any criteria on (corporate) economic sustainability.

7.2.2 Smallholder biofuel projects

Within the smallholder projects, rural development is often the main driver. Usually these projects were funded by government or donor-money, focusing on Jatropha production as cash crop to provide smallholder farmers with income.

Jatropha project in Nhambita Community

Between November 2005 and January 2006 a communal Jatropha trial plot was planted within the community at the request of the Sofala Agricultural Department. Between February and April 2006 the Jatropha trial plot increased to six and later to seven hectares. This trial has attracted a considerable amount of attention, both locally and from afar as the first organized plantation in Mozambique. Radio Moçambique and National newspaper followed with favorable reviews of Jatropha program. Between May and July 2006, 250 other farmers in and around Nhambita community showed interest in planting Jatropha for the possible bio-fuel market that is constantly being raised by Government. During that same time also the first seeds were collected from the trail plots (Envirotrade, 2006). Several sources told us that the plants grew beautifully during the first years. In 2008, the Ministry of Energy, granted a loan to Envirotrade consisting of an oil seed press running on diesel. Envirotrade has the right to use this press during its operational time in the community.

At the time the first pruning was needed, little knowledge was present on how and when to prune effectively. From our interviews we learned that at the time of the pruning it had been dry for some time, whereas after the Jatropha plants were pruned a time of humidity followed. It was since the pruning that the plants started to have problems. The plants did not continue to grow, but started rotting inwards. Samples were analyzed in South Africa for bacterial infections, but they came out negative. It could however also been viral plant infections that affected the Jatropha. During our fieldwork we observed that only few plants were still alive on the plot. Limited availability of Jatropha seeds is preventing optimal use of the press, which is therefore not well maintained and in bad condition (see photo).

There is another Jatropha-plot of 0.7 ha in the community. The plot is not owned by one of the farmers from Nhambita, but by the son of Envirotrade's manager. At the time of the mission, the plot seemed in reasonable condition. There were no leaves on the plants, but that was perceived as normal during winter/ dry-season. Moreover, we found two older Jatropha trees close to the river, which apparently had been there long before the Jatropha initiative in the Nhambita community started.

In the three areas where Jatropha was grown, bio-physical conditions (soil type, water availability, and fertility status) did not seem to be limiting factors for Jatropha production. Some of the fields used were left fallow for long time, however, the lack of crop management skills such as time and height for pruning appear to have hampered the fulfillment of Jatropha potential in the area. It's important to point out that the Jatropha on the communal plot initially was very successful, but after the pruning the plants were hit by bacterial or viral plant infections which devastated the majority of the crop (FACT, 2009).

During the successful days of Jatropha production in Nhambita (May-July 2006), almost 250 farmers from the area showed interest in planting Jatropha on their land. At the time of our study (September 2009) only one individual farmer was growing Jatropha, while the majority of other farmers did not allocate land or labor to growing the crop. They described Jatropha as difficult to grow, and a crop they had little knowledge about. On the other side, they remained interested if others would also start to grow it.

The Nhambita case study shows that farmers are not reluctant to adopt new (cash) crops as part of their farming strategy (Bos et al., 2010). Both Pigeon Pea and Jatropha were introduced at the same time, but where Pigeon Pea is grown by almost every farmer in the community, Jatropha production could not live up to its expectations. Pigeon Pea is easily to grow, does not require strict and complicated crop management skills, and moreover has the advantage that it can be used both as food and cash crop. As most subsistence farmers are already struggling to make a living, it is unlikely that they will allocate resources to non-edible crops of which they have little agronomic knowledge and both yields as well as markets are uncertain.

The case of Jatropha production in Nhambita shows us that subsistence farmers apply a low-risk strategy, characterized by only investing their resources in activities of which they feel will have a return. Only farmers with access to many resources can allow themselves to experiment. It is these farmers, which could re-establish trust in Jatropha production. However, due to the absence of a market for their seeds, this seems unlikely to happen. More information on Nhambita smallholder farming systems and their potential for Jatropha production can be found in Bos et al. (2010).

ADPP smallholder Jatropha project

The ADPP-project was initially founded in Sussendenga (Manica province) funded by a Dutch NGO called FACT-Foundation. When growing conditions in Manica province turned out to be far from optimal (heavy soils and problems with Yellow Flee Beetle) farmers in the area were not enthusiastic to produce Jatropha. Shortly thereafter the activities were moved to Cabo Delgado province. The project is implemented through ADPP's Farmers Clubs. ADPP (*Ajuda de Desenvolvimento de Povo para Povo*) has started with small nurseries and plantations in conjunction with its teacher training colleges (EPF) and small farmers. The target groups are small vulnerable subsistent farmers, who have very little opportunities to generate cash. The project has a strong research component, mainly around Bilibiza. Bilibiza is located in the Quirimbas National Park, Cabo

Delgado, Mozambique. The park is relatively new – and was designated as National Park in 2002 (FACT Foundation, 2009).

The project has initiated the local production of Jatropha seeds and the development of a local market. The creation of capacity among the local small farmers and technicians is an important component of the project. The overall objective the project is: "To build an infrastructure and capacity to enable the autonomous up scaling of the activities after termination of the project. The project will initiate the local production of Jatropha seeds and develop a local market of end-users of the oil. The creation of capacity among the local small farmers and technicians is an important component of the project" (Nielsen, 2007 2).

At the ADPP is involved in four smallholders Jatropha projects. ADPP works in all Mozambican provinces except for Gaza, Tete and Inhambane. Reason is the absence of Teacher Training Colleges, through which the Farmers Clubs (FC) are usually implemented. The Bilibiza-project was the first project and the only project that includes a research component. The other projects have similar set-up; planting Jatropha hedges and for local oil-production.

Location:	*District:*	*Province:*	*# of FC*	*# of Farmers*	*Remarks:*
Bilibiza	Bilibiza	Cabo Delgado	36	1,800	Inside Quirimbas National Park
Itoculo	Monapo	Nampula	34	1,700	
Macuse	Namacurra	Zambézia	10	500	
Gorongosa	Gorongosa	Sofala	10	500	Inside Gorongosa National Park
		Total:	90[46]	4,500	

Table 20: Overview of ADPP's smallholder Jatropha projects in Mozambique

The Bilibiza project is reaching 1,800 farmers now, spread over 36 Farmers Clubs. The original project goal was working with 25 Farmers Clubs. Total number of Farmers Clubs in Mozambique is 220, spread over most of the Mozambican provinces (except for Gaza, Inhambane and Zambézia). One of the extensionists explained that more and more farmers want to join the network to grow Jatropha.




[46] Total # of Farmers Clubs in Mozambique is 220, so 41% of the Farmers Clubs is involved in the Jatropha project (Personal communication Jacob Zulu, National coordinator Farmers Clubs Mozambique, April 4, 2009)

The projects started with the identification of Farmers Clubs and trials both on the ADPP-complex as well as in farmer's fields. Seeds were collected from different parts of the country. The initial idea was planting Jatropha on plots, but farmers turned out to prefer hedges around the plots where they grow food crops. This turned out to be successful as hedges: (1) keep smaller animals out of the plots while not being eaten (toxicity of Jatropha), (2) Jatropha hedges do not compete with food production, (3) hedges form a natural intercropping system, which also prevents the spreading of pests. Moreover, planting hedges reduces the risk for small farmers, for whom Jatropha was (and in many cases still is) a black box with regard to the knowledge they have about the plant.
The project uses no fertilizer and/or pesticides, also because the farmers cannot afford it. Although pest problems within the project have so far been low and manageable, there is a 'big concern' for huge pest outbreak. You often see that it takes some time for pests to become active in plants. During the first years you hardly see any problems, but after pressure has been build up, new pests might become a potential threat.

The project has a strong research component. Data is gathered in a participatory manner, at the ADPP-station in Bilibiza and on-site in four communities. In Bilibiza, also a small factory is constructed where seeds can be pressed in the future. The project has a press, which was – by the time we visited the project – still in Maputo. Research mainly focuses on nursery activities, planting distances, pests and diseases, different growing conditions, weed management, yield and harvesting methods, intercropping, pricing of harvest, collection of seeds, pricing of the diesel, testing the diesel, cropping calendars, but also more social issues such as social organization, wealth-ranking within the farmers clubs. Moreover, the project provides low-technology water pumps (see photo) to the farmers clubs which can be used to irrigate the Jatropha nurseries.

Concluding, we have experienced huge diversity in the growth and development of Jatropha in the different regions. This seemed to depend on, soil fertility, water availability and agricultural practices such as pruning and weeding. These factors seem to influence the overall growing speed, development of the plant (# of branches), and subsequently the quantity and quality of fruits. The implementation of the projects might also play an important role. The ADPP-project has a clear organizational structure where extensionist work with farmers clubs on a regular basis, monitor progress and provide technical assistance to the farmers. Nevertheless, the biggest challenge will be how to deal with pests and viruses in the project. Because the project does not work with fertilizers and agro-chemicals (not available and farmers cannot afford buying these inputs), it is the question how the project, but especially the participating farmers will respond to these challenges.

More smallholder case studies can be found in the FAO/ PISCES study addressing the common goal of improving international understanding with regard to small-scale bioenergy Initiatives and their impacts on rural livelihoods (Practical Action Consulting, 2009). Another report that assessed the potential of bio-energy production in smallholder farming systems was carried out by Bos et al. (2010).

7.2.3 Analysis and discussion

We have tried to summarize our fieldwork findings in table 21. We distinguished between the commercial and smallholder biofuel projects and the legal, social, economic and environmental challenges and opportunities they provide. Our framework is similar to the sustainability framework presented in section 3.3, table 4. Reason is that this will enhance the comparison between the different sustainability frameworks and our research findings.

	Commercial, large-scale biofuel projects			Smallholder biofuel projects	
	Challenges		Opportunities	Challenges	Opportunities
Legalities					
Legal frameworks	- Bureaucratic system, complicated laws and procedures - Project objectives differ from other stakeholders' objectives	Monitoring of investment proposals, proposed water/ land use and their implementation	- Investor-friendly government - Improved communication between government, civil society and private sector on how to make biofuel market sustainable	- Bureaucratic system; licenses and permits, registration/ legalization of the farmers' cooperatives - Fuel-tax, bookkeeping of oil sales - Government policy might focus too much on promoting the commercial sector - Overwhelming publicity for projects that work	- Scale of operations makes it possible to start low profile, it is easier to adapt strategies based on new findings and developments - Opportunities to integrate smallholder biofuel projects with PARPA and Biofuel Strategy objectives
Land and water rights	- Investors start biofuel-projects on 'other' DUAT - Inaccuracy of 2008 agro-ecologic zoning		- New agro-ecological zoning should provide a more secure framework for investors	Jatropha hedges provide boundaries that mark customary land use (could also be a challenge in relation to shifting cultivation practices)	
Social					
Stakeholder participation	- Representation of local stakeholders is problematic		- Joint ventures or other collaborations between investors and smallholders	- Lack of social organization makes it difficult to work with groups of smallholders	- Projects may stimulates representation, organization and collaboration among farmers
Human and labour rights, and social well-being	- Manual sugarcane cutting is a very hard and unhealthy job - Resettlement of households and fields		- Projects can bring (access to) infrastructure, healthcare, education, and induce local business	- Gender issues - Jatropha is a poisonous plant	- Benefits flow back into community projects (sanitation, health care, education)
Food security	- Labour competition as labourers spend less time on own fields - Fertile soils used for biofuel production		- Projects develop activities related to food production and agricultural development - Projects promote better agricultural practices	- Jatropha can be a host for pests and viruses for other (food) crops - Labour allocation to food/ fuel crops	- Jatropha hedges provide less competition with food production
Economic					
Macro economy	- Financial crisis; getting projects and activities financed - Dependencies on outside, unstable markets - Competitiveness of biofuel production in remote rural areas that lack infrastructure		- Government incentives for locating projects in rural areas - EU's blending policy (guaranteed market) - Reduce fuel import dependency on long term	- Increasing negative publicity on biofuel production potential by smallholders - Continuity of development projects	- Producing biofuels is an interesting and potential profitable market for smallholders as fuel prices historically have gone up, where food prices have gone down
Micro economy	- Mechanization will create less employment than expected - Lack of skilled labour - Contract farming and working with outgrowers is complex (quality of product, inputs, financing)		- Create market access for smallholders - Direct and indirect employment opportunities	- Lack of markets - Seed and oil collection in rural areas - Guaranteed quantity and quality of seed and/or oil	- Fuel prices are higher in rural areas - Jatropha seeds as cash-crop to generate income - Self-sufficiency with regard to soap, lamp-oil and fuel

Environmental						
GHG-emission		- Manual cutting requires burning of sugarcane which will impact GHG-balance of projects -GHG-emissions related to direct and indirect land-use change		- Energy balance for sugarcane ethanol is the best in the world - Ethanol from sugarcane is highly efficient in terms of GHG emission reduction: 80% or above		- Small projects do not negatively impact GHG-emissions
Plant production systems/ agronomics		- Large-scale monocrop brings enormous pest pressure - Little agronomic knowledge on Jatropha - No sharing of experiences and agronomic data between investors - Competitiveness of producing on marginal soils - Natural disasters (floods and droughts) in some areas		- Sugarcane is broadly studied and therefore a reliable crop (as compared to Jatropha)	- Pests and viruses - Little agronomic knowledge on Jatropha - No trust in Jatropha production as pilot-projects have failed - Jatropha production (as perennial crop) could disturb traditional shifting cultivation practices	- Opportunities for intercropping - Jatropha is a low value crop, for smallholder farmers it will not pay off to invest on external inputs
Biodiversity		- Projects in rural areas require bush clearing which might have negative impact on indigenous flora and fauna	Impact of large-scale application of agro-chemicals on biodiversity soil, air and (drinking) water quality		- Some smallholder projects are situated in National Parks - Impact of Jatropha as invasive species on biodiversity - Lack of agro-ecological knowledge and technical support for smallholders	
Soil	*Soil carbon stocks*	- Large-scale land clearing and ploughing		- Little soil mobilization after establishment plantation (Sugarcane/ Jatropha are perennial crops)		- Little soil mobilization (Sugarcane and Jatropha are both perennial crops)
	Soil quality	- First land zoning exercise (2008) based on outdated soil suitability data		- Jatropha press-cake can be used as organic fertilizer		- Prevent soil erosion - Jatropha press-cake as organic fertilizer
Water and air		- Downstream water shortage - Land zoning based on out-dated rainfall data		- Efficient water use through (drip) irrigation		

Table 21: Analysis of existing commercial and smallholder biofuel initiatives in Mozambique

Our analysis shows the two systems (commercial and smallholder) are different, but also very much interrelated as they face similar challenges. Even within commercial sector and smallholder projects the differences are huge, which makes it very difficult to generalize about the positive and negative side-effects and impacts. Although table 21 only touches upon some of the (mainly direct) impacts of commercial and smallholder biofuel projects, it does tell us something about the trade-offs that will be the focus of the sustainability debate in Mozambique. To make our analysis a bit more tangible we decided to distinguish time and space or scale-level. With time we subdivide in short, middle and long term objectives, and scale-levels range from local, national, regional and global (figure 17).

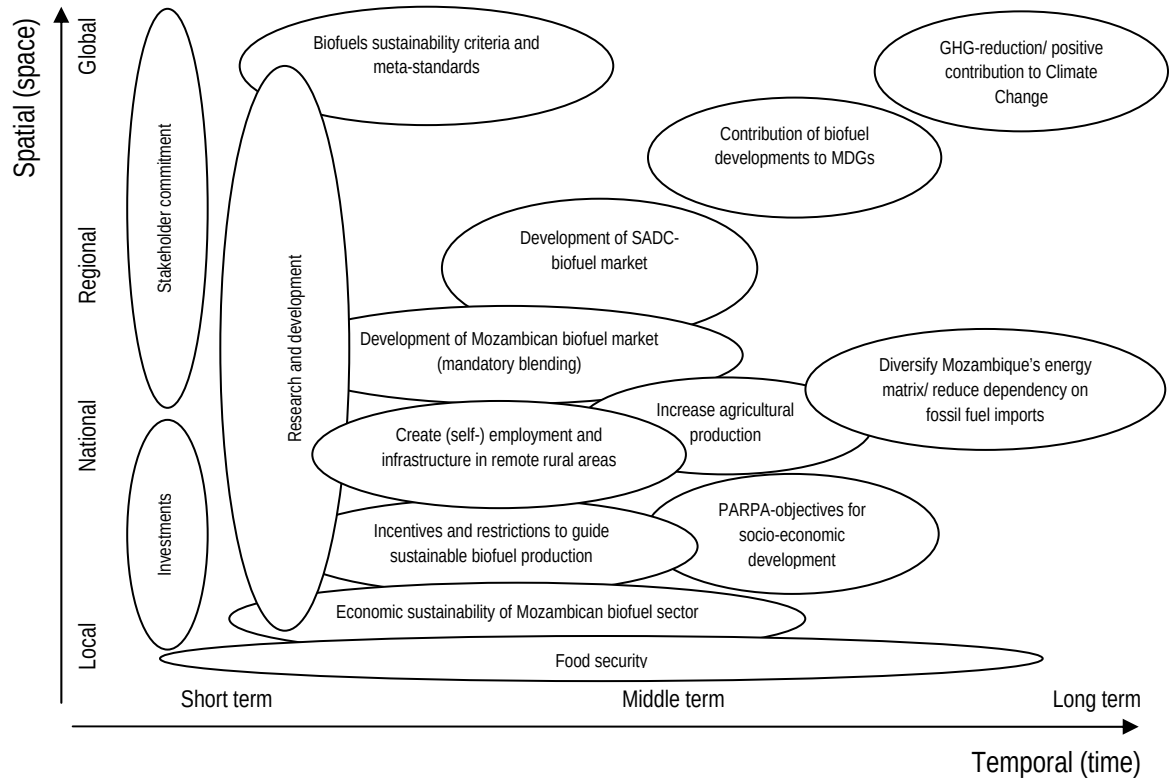


Figure 17: Spatial and temporal biofuel dynamics towards sustainable biofuel production

In relation to the different objectives for biofuel production in Mozambique, we distinguished between operational (short-term) and strategic (long-term) sustainability at different scale-levels. It is important that operational sustainability objectives contribute towards developing a strategic sustainable biofuel sector in Mozambique, but also that long-term sustainability does not restrict the development of the sector on the shorter term. It supports our idea that sustainability is a process in which the objective is to optimize systems, to subsequently adapt and upgrade sustainability objectives. One of the biggest short- and middle-term challenges the sector is facing is to develop a biofuel sector that is economically viable and competitive. If this is not the case, biofuel developments can never contribute to longer term national and international objectives such as poverty-reduction and reducing GHG-emissions. We know that some projects are facing financial difficulties. By the end of 2009, Procana Ltd. was abandoned by its main investors (BioEnergy Africa Ltd, 2009b; 2009a), after which the project was voided by the government for not complying with its contractual obligations (United Press International, 2009).

Subsequently long-term impacts like the net GHG balance or indirect land-use change as a result from current biofuel developments cannot be assessed with certainty, but this does not mean that opportunities should not be explored. Another discrepancy might be the existence of smallholder projects in National Parks, whereas international sustainability criteria explicitly state that biofuels should not be made from raw materials obtained

from land with high biodiversity value. In these cases evidence should be provided that the production of that raw material did not interfere with those nature protection purpose (Council of the European Union, 2008 56).

Our case studies showed that biofuel developments are heterogeneous and surrounded by uncertainty. Because of the number of projects and their size, the smaller-scale projects appear to be easier to monitor, evaluate and adapt to new research and insights. The challenge is to balance and bring together the multi-scale realities and dynamics, while at the same time addressing the short-, middle- and long-term objectives related to these scale-levels. Only through transparency and sharing learning experiences can speed up the learning curve towards developing a competitive and long-term sustainable Mozambican biofuel sector.

7.3 Conclusions

The objective of this chapter was twofold. Firstly, we described the current situation of biofuel developments in Mozambique based on the geographical spread and analysis of investment data. Secondly, we described and analyzed qualitative fieldwork data, which we linked to the sustainability debate. To some extend we have compared our data with existing studies on biofuel potential (Batidzirai et al., 2006), policy objectives (section 2.2, 2.3 and 2.4), and existing sustainability criteria and meta-standards which were described in section 3.3.

From our geographical mapping, we can conclude that most biofuel developments take place around existing good infrastructure (roads and ports), existing processing, and storage facilities, where there is (skilled) labour available, and access to services and goods; and not per se in areas characterized by high biophysical potential, or within the identified agro-ecological zones. In the absence of domestic and regional biofuel markets, most commercial projects focus on supplying external markets. In relation to the Mozambican policy objectives of responding to the National Poverty Alleviation Agenda in rural areas, and reducing dependency on fuel import, we conclude that these developments require careful monitoring.

When analyzing our case study experiences from a sustainability point of view, our major concern is not so much whether or not the Mozambican biofuel sector is or can be sustainable, but more if objectives of multi-level stakeholders and their time-horizon can be compatible. The EC's sustainability framework focus mainly on long term, global impact, which might obstruct national and regional mechanisms, necessary to sustain that sector on the short-term. For example, most sustainability schemes have little to no attention for the economic sustainability of the sector, whereas this seems to be crucial for developing the biofuel sector in Mozambique. Although CPI evaluates the financial viability of the investment proposals, ongoing monitoring and evaluation mechanisms should be strengthened. The impact of recent developments on the financial market is already tangible, and at least one project has been abandoned by its main investor after which their contract was voided by the government (United Press International, 2009). These kinds of developments only created environmental and socio-cultural disturbance without creating any kind benefit; both locally and at national level. Moreover, focussing on remote rural areas influences the competitiveness of biofuel production in Mozambique. As one can expect, the production of biofuels in remote areas is more costly as compared to areas near processing and storage facilities, with good infrastructure, access to (skilled) labour, goods and services. Additional mechanisms for providing incentives should be put in place to make biofuel production in remote rural areas more attractive.

The existing sustainability standards do not distinguish between commercial and smallholder biofuel initiatives, which might result in undesirable side effects for the smallholder projects or the integration of outgrowers in the system. If commercial projects expand their boundaries and decide to work with outgrowers, it might become more difficult to comply with sustainability criteria. This consequently might reduce the opportunities for linking smallholder producers to the biofuel-market. Moreover, we believe a sustainability framework should distinguish between the bioethanol and biodiesel sector, as both face different levels of risks and uncertainties.

8. Conclusions and recommendations

Since the initial promotion of Jatropha production by smallholders in 2004, a lot has changed in Mozambique. The focus changed from promoting biofuel production by smallholders for domestic purposes, to foreign commercial investors that wish to supply the European market. We have identified a number of areas, which require careful attention for the sustainable development of the biofuel sector in Mozambique. Many of these requirements are interrelated, crosscutting and touch upon legal, social, economic and environmental dynamics.

Integration of smallholders

One of the challenges we encountered during the research is linking and integrating smallholders to the biofuel sector. As said, one of the government's objectives is for the promotion of biofuels production, is to respond to their National Poverty Alleviation Agenda, especially in rural areas by creating employment and business opportunities. Many investors have expressed the intention to work with outgrowers, but first establish their plantations, which provides security on the required quantity and quality of feedstock necessary to be competitive. Working with outgrowers makes complying with certification systems or sustainability criteria more complex. By expanding the boundaries of production (from plantation to working with outgrowers), the complexity and transaction costs of complying with criteria related to control, traceability and transparency increases. From the development of the Brazilian biodiesel sector we learnt that government incentives (PRONAF and the social fuel seal) can promote beneficial collaboration between commercial companies and smallholder farmers. Smallholders are provided access to credit and training, and guaranteed off-take, whereas the companies receive tax breaks, access to low-cost loans, and can participate in the Brazilian biodiesel auctions (companies that do not comply with the social fuel seal are excluded from the auctions). To enhance biofuel production by smallholders an alternative system for group-certification (after the example of FSC) should be examined.

Research by Van Baren proposes that similar mechanisms could work for Jatropha production in Mozambique. He presents several governance structures in which farmers can rely on the experiences acquired by commercial farmers, and which reduce the uncertainty about whether there is a market for harvested Jatropha seeds. Moreover the establishment of producer organizations (such as INCAJU) could help commercial producers to reduce transaction costs of involving outgrowers, by selecting the farmers who are capable, organize the farmers in groups, aiming at collective provision of inputs, provide technical training and collection of harvests (Bijman et al., 2009; Van Baren, 2009 103).

If appropriate support mechanisms and off-take markets are absent, involving smallholder producers would be irresponsible as the biofuel sector, and especially Jatropha production, is characterised by high risk and uncertainty (Bos et al., 2010).

Promoting local spin-offs

With regard to biofuel-related employment creation, this study shows that expectations by the government differ from estimations made by companies. The estimated direct employment per hectare seems to be lower than described in the national biofuel policy and strategy, and are and expected to drop due to mechanization and a decreased labour-demand in the years after plantations have been established. Employment figures from the Brazilian sugarcane sector support our findings (table 5, section 5.1.2). It implicates that other mechanisms should be developed and implemented to achieve PARPA and other biofuel-related policy objectives. FSC provides a useful framework to deal with some of these challenges. On-site processing of biofuels could increase local benefit and employment creation, and enhance sustainable production by reducing wastage and transportation costs. Moreover, it could enhance traceability and transparency in biofuel production. To stimulate employment creation and local spin-offs, biofuel companies could be obliged to employ a certain percentage of

its employees from local areas. Government policies could provide incentives that promote part of tax-incentives being reinvested in local capacity building, and income-generating activities for communities living near plantations to enhance rural development.

Dealing with heterogeneity

A second problem that is closely related to integration of smallholders is how a sustainability framework could respect the huge diversity in the biofuel sector in Mozambique. Our main concern is that any kind of certification system might exclude smallholders from having access to the biofuel-market, which is unfeasible according to the government's objectives for promoting biofuel production in Mozambique. Adding to that, we want to make clear that it is not merely a question of diversifying between commercial and smallholder projects, as we also witnessed huge diversity within these two groups, for example the different risks of commercial sugarcane or Jatropha production. The challenge becomes how certification can go hand in hand with respecting the heterogeneity of developments. For example; excluding biofuel projects from high biodiversity or conservation value areas, can have huge consequences for sustainable smallholder development projects located in or near National Parks in Mozambique. Fortunately, experiences from other certification systems provide insights in how sustainability can be adapted to local realities.

Respecting local realities formed one of the reasons why FSC and GlobalGAP launched a more 'flexible' alternative procedure appropriate to deal with small-scale and low intensity operations (such as SLIMF) that are run by communities, non-industrial companies, cooperatives or associations. The biofuel sector could benefit from this model, as its alternative procedure respects diversity within the system and aims at creating opportunities for smallholders. This approach to certification offers a gradual system that allows companies to grow within the system. It allows a starting company to comply with the basic standard, whereas more 'mature' companies can expect stricter audits. This supports our idea about sustainability, not being an ultimate state, but an optimization process. The implementation of sustainability criteria should not become an obstacle for the development of the biofuel sector in Mozambique on the short-term, as this provides the foundation for achieving strategic, long-term sustainability (see section 7.2.3, figure 17).

Sustainability and market-access

The Kenyan example described in section 6.3.2.1 showed that the implementation of certification systems can easily become artificial, as financial resources determine whether you can buy in or not. Any implementation of certification creates both access, as well as barriers to markets. The introduction of quality labels disadvantaged Kenyan small-scale producers who traditionally supplied the UK-market with fresh vegetables (75% in 1991). In 1998, after the introduction of these labels, only 30% of the market was supplied by small-scale producers. Smallholder producers could simply not comply with the system because of lack of resources. Another example comes from Mozambique where GlobalGAP-certified company Vandúzi cannot produce for the domestic market, because their production-costs are much higher than non-GlobalGAP-certified colleagues. These examples show the consequences certification can have on market-access. Producing biofuel sustainability is a costly business. If the Mozambican government would decide to adopt a sustainability framework which are less strict than existing western sustainability standards, this could mean that Mozambican companies that have already invested a lot in producing sustainably, would be disadvantaged on the domestic market, because they cannot be competitive with other biofuels produced in Mozambique. If Mozambique succeeds in developing a domestic market, these Mozambican-based companies should not be discriminated for trying to work sustainably from the beginning onwards. Moreover, the Mozambican government should promote in-country processing and use of biofuel, so the country can benefit from its potential.

Speed up the learning curve

Many concerns are related to the uncertainty related to biofuel developments, especially in the biodiesel sector. Uncertainty should not mean that exploring the potential for biofuel production in Mozambique should be put on hold, but it might ask for a different approach.

The choice of crop is very important and needs close monitoring. Brazil's choice of soybean for biodiesel was logical since supply chains, infrastructure and knowledge already existed. It did create major concerns related to its low energy content; produced in high biodiversity areas; negative impact on soil quality; causing soil erosion; negative effect on land-use; resettlement of people and crop production. Linking this to the uncertainty surrounding Jatropha-production in Mozambique, we highly recommend the integration of research, development and policymaking. In Brazil investments on research are seen as: "The basis for development of technologies for agri-production as it permits the identification of more suitable crops and production systems." Brazil's Ministry of Science and Technology has been allocated money to invest in research on biodiesel and industrial processes, and a Brazilian Biodiesel Technology Network has been formed, comprising 23 universities across the country alongside traditional research institutions such as the Petrobras Research Center, the National Technology Institute, and the National Biofuel Complex. In Mozambique, public Universities could play this role. Universities like Eduardo Mondlane have already conducted studies on Jatropha-related pests and viruses in different parts of the country. IIAM and DNTF have conducted agro-ecological land zoning so the foundations for collaboration are present. We also know that some research programs were put on hold due to lack of funds, so this should simultaneously be addressed. Mozambique and Brazil have announced to implement a "plan of action" to promote cooperation and exchange in the biofuels sector, with the participation of government staff and specialists, representatives of the private sector and the academic world (Macauhub, 2009b).

As our case studies showed, many initiatives (both smallholder and commercial) happen isolated from each other. Companies are afraid for bad publicity regarding resettlement, land-use change and food-feed-fuel. Moreover the sharing of knowledge with colleagues and researchers carries financial implications for profit-making for commercial companies, so they will most probably not make their research public (cf. Puente-Rodríguez, 2009). Especially in the Jatropha sector sharing of information is crucial as Jatropha-based biodiesel can only be successful when there is sufficient volume to comply with future national blending targets. As there is hardly any competition with regard to the quantities necessary to fulfil these blending targets, not sharing of information resulting in slow development and limited productivity seems to be the biggest obstacle for the development and success of the sector. The smallholder Jatropha projects are starting to cooperate; as some farmers from the Nhambita Community joined a Jatropha workshop organized by ADPP and FACT-foundation in Bilibiza (Cabo Delgado) in September 2009.

Biofuel production offers many opportunities for Mozambique, but we identified the need for speeding up the learning curve. We believe that Community-Private-Public partnerships would provide a useful platform to facilitate learning within the sector. Government and private sector should be collaborating in planning of country's infrastructure and government should provide incentives that support the sustainable development of the biofuel sector in Mozambique. Around successful private biofuel companies, entities similar to INCAJU should be developed to support collaboration with outgrowers by establishing cooperatives, provide them with training, and prepare them for group certification.

At several occasions, we have heard the idea of developing 'biofuel learning projects' to operationalize Community-Public-Private partnerships. Learning projects are transparent projects with room for experimentation, making mistakes, learning from them and share experiences with others. It can be projects where different stakeholders (NGOs, private sector, government, farmers organization, researchers, media, etc.) actively work together to provide input for learning. Such projects should be able to depend on institutional

support and commitment to provide incentives and financial compensation (e.g. joint infrastructure projects, low costs loans, guaranteed off-take) that creates space for innovation and development.

Economic sustainability

In our study, we have described and compared some criteria for sustainable biofuel production (EU, RSB, Dutch Cramer Criteria and RTFO (UK)). Our comparison and experiences from Mozambique show that there is very little attention for the economic sustainability of the sector, also not within FSC and GlobalGAP-certification. As we have seen, low fossil-fuel prices and the financial crises have hit the biofuel sector, as some projects have difficulties getting their activities financed. Unless legislative measures are implemented to ensure an internal market – i.e. through mandatory ethanol and/or diesel blends, large biofuel investments could become very unprofitable (cf. Mitchell, 2006).

Other than environmental and social issues, it is generally assumed that economic sustainability is a company's responsibility. Recent developments have shown this is not as obvious as it seems. With the introduction of sustainability criteria and self-imposed blending-targets we believe there should be more attention for the economic sustainability of the sector. Working sustainably goes hand in hand with substantial investments on all sorts of impact assessments and audits[47], which affects production costs and return-on-investment. Suspension or – in the worst case – discontinuity of biofuel projects will have an extremely negative impact at the local level, and will moreover not contribute to the long-term sustainability objectives such as reducing GHG-emissions. We know that several Development Banks (World Bank, African Development Bank) are interested in supporting the private sector; but their conditions for working with the private sector are strict. In Brazil, the Brazilian Development Bank (BNDES) provides financial support in the form of credits and loans for biofuel projects. BNDES can finance up to 70% of capital costs at the basic national interest rates. Interests are not charged during construction and amortization is of 10 years. It is unknown if this could be realistic for a country like Mozambique, but the government could lobby for multi-lateral support as biofuel-related objectives such as reducing GHG-emissions are at the interest of the global community. To reach the government's objectives related to promoting biofuel development in Mozambique's remote rural areas, incentives have to be provided. Moreover, investment proposals should be analyzed and monitored carefully and regularly, as most projects only have limited guaranteed investments.

Field experiences with FSC- and GlobalGAP-certified companies made clear that certification indirectly makes it possible to work more cost-efficient. While respondents often complained about the bureaucratic work involved, they did recognize that it made money-flows and other processes within the company more transparent. On the long term this allowed them to work more cost-efficient.

Implementation and monitoring of a standard

One respondent of our interviews explained that: "The Mozambican Forest and Wildlife Law is so good, if you would work according to the law you would be able to certify for FSC without any problem."

The enforcement of laws, regulations and standards forms a challenge in the Mozambican context (cf. World Bank, 2009a). The country is big and there are biophysical and social differences within the country. We know of examples from different sectors, where the governance and legislative could not support the introduction of additional regulatory frameworks. Mozambique can learn from Brazil that government does not necessarily need to adopt an additional certification system for the biofuel sector if their and biofuel-related policies and laws concerning production, distribution and usage of biofuels deal with the social, economic and environmental issues. This would also be in line with international sustainability criteria that require compliance with national

[47] According to some investors and Environmental and Social Impact Analysis for a large-scale project can cost up to one million US$

laws and regulations relevant to biomass production and the area where biomass production takes place (Cramer et al., 2007; Dehue et al., 2008).

As the biofuel sector is still in development, and characterised by high uncertainty, we also propose flexibility in biofuel-related policy-making; leaving enough space for adaptation based on future research-findings and experiences.

Concluding remarks

The objective of this research was to provide insight in the expected dynamics, challenges and opportunities that accompany the development of a Mozambican framework for sustainable biofuel production. We conclude that sustainability should be approached as a negotiation process, where trade-offs between different temporal and spatial scales need to be addressed. One of the challenges is to identify innovative policies that allow investors to take risk and create the basis for a sustainable Mozambican biofuel sector, but simultaneously make sure that they do not transfer/down-scale these risks to already vulnerable smallholder farmers that represent 85% of the population. In the case of Jatropha production we face a challenge here. As biodiesel markets and infrastructure are yet to be established, and knowledge about good agronomic management is scarce, risks are still high. Farmers involved in smallholder Jatropha projects (e.g. ADPP-FACT) might be in a privileged position, as they are already know how to grow the crop, and can use it for local purposes until they can become part of an outgrowers-network. On the other hand, the Nhambita case showed us that if knowledge, appropriate support mechanisms and markets are absent, involving smallholder producers at this stage could be irresponsible.

The Mozambican national biofuel policy and strategy covers some of the concerns raised in this study. It stimulates the development of the domestic market, focuses on certain feedstock, adopt national mandatory blending targets, promote local processing capacity to add value, biofuel tax to the build up the sector, and land approval in designated agro-ecological zones. A major challenge will remain how to deal with the heterogeneity in the sector and specifically how sustainability principles could stimulate the responsible integration of smallholder farmers and stimulate rural development, while remaining economically competitive. The examples from Brazil, and FSC, GlobalGAP and fair-trade in Mozambique provide interesting mechanisms that could support that. Stimulating the collaboration between communities, public and private stakeholders could speed up the learning curve and create a more secure framework for future investments and developments.

As the definition of sustainability changes over space and time, it is useful to approach it as an optimization and learning process, rather than an ultimate state. Our advice is that potential risks should not stop exploring the opportunities for biofuel production in Mozambique, as they provides valuable learning experiences necessary for the sustainable development of the sector. However, optimizing learning requires close monitoring and evaluation, so that findings from practice and research can be used to facilitate policy-making, but also to adjust existing policies if necessary.

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