MAPPING FOOD AND BIOENERGY IN AFRICA

A report Prepared for FARA

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1. Introduction and presentation of the report.

Bioenergy interest has gained much attention in the last years due to the positive issues that it can bring specially for developing countries but at the same time because of the many concerns on risks and trade-offs that could generate. FARA considers that the production of bioenergy crops will need to take into account a) a broader understanding of the extent of the issues and concerns surrounding food to bioenergy conversion and b) the accompanying policy/institutional dimensions as input to the development of an appropriate and truly responsive food and bioenergy programs in developing economies.

This report focuses on assessing Africa’s ability to fulfil the following objectives:

a. Generate regional evidence on the frequency of the conversion of cash food crops to biofuels.

b. Determine perceived issues and concerns of this conversion by sector (regional, national, household).

c. Establish early indication of the impact (trends, patterns) to anticipate future scenarios.

d. Undertake policy and institutional mapping as well as analysis to better understand the policy and institutional dimensions of the food and bioenergy interphase.

Report Approach:

According to the development of, and interest in bioenergy production in Africa, this report focuses on a selection of countries in order to cover different regions from Africa:

- West Africa: Senegal and Mali
- East Africa: Kenya and Tanzania
- Southern Africa: Mozambique and Zambia

Figure 1 shows the countries assessed in the report. Mapping of policies and institutions in Ghana is included as a reference. The selected countries are those where a core sub-set of data is available and where relevant biofuel production is taking place. Other countries such as South Africa also have biofuel production, but considering the GDPs of the continent, those with more risk for impacts were selected.
According to ERA-ARD\(^1\), the following are the expected outputs of the project:

1. Report on the impact of food-to-biofuel conversion inclusive of the;
   a. Detailed methodology, data summary and analysis
   b. Extent of cash food crops to biofuel conversion
   c. Issues and concerns of conversion phenomena
   d. Early indications of the impact of conversion on smallholder farmers’ food security and livelihood sustainability.

For each country the following points were included according to availability of data.

1. Summary characteristics:
   o location
   o geographical characteristics (including weather variables and fluctuations in recent past)
   o environmental characteristics (tendencies for desertification, flood and other natural disasters)

2. Population size and characteristics (gender)

3. Gross Domestic Product, Human Development Index and

4. Food sufficiency index including net importation / exportation of food items.

5. Main food crops (land, yields)

6. Predominant soil characteristics (soil type, primary rock, production potentials and resilient indicators)

7. Main agricultural and food crops imports/exports

8. Livelihoods characteristics: average income for farmers; type of property in farms (private, communal, tribal);

9. Policies: agriculture, energy, environment, land use, other. Link with the bioenergy sector

10. Biofuels industry/programmes development: main crops (potential crops), land used, projects associated, technical conversion practices

11. Crops used for biofuels:
   - Type and conversion technology (if known)
   - Market (raw material)
   - End use (community energy generation)
   - Price paid to the farmer (in assets or cash) or if farmer is employed average salary
   - Implications for land tenure, water and employment (these may be the most relevant)

12. If conversion of raw material is taking place mark the implications for:
   - Water use
   - Employment

13. For the mapping of policy and institutions:
   - First hand players (e.g. if an investor wants to start a project which institution needs to approached first)
   - National Ministries/Secretariats involved in the bioenergy planning/applications
   - Directions involved in the bioenergy planning/applications
   - Regional and Local authorities involved in bioenergy plans, programmes, projects
   - NGOS involved
   - Other stakeholders identified.

\(^1\) ERA-ARD is an FP6 Project of the European Commission’s ERA-NET Scheme. The Agricultural Research for Development (ARD) and Dimension of the European Research Area (ERA) information can be found in http://www.era-ard.org/.
The report on institutions follows a top-bottom approach in order to map institutions involved (or not involved) in biofuel development. The focus considered was based on government (particularly ministries of energy and agriculture), private sector, NGOs, and CBOs. If available data for case studies is possible to gather, it will be integrated for the better understanding of the development of the industry and relative impacts on food production or security.

The methodology for the mapping of policy and institutions firstly identifies the stakeholders for bioenergy crops and agriculture at national level. Then, stakeholders at the production level including NGOs, farmers, other civil organisations and the industry sector (including also farmers with different forms of participation (e.g. outgrowers).

We considered a four-way assessment matrix including stakeholders from the local government, the national government, NGOs (including other civil organisations) and industry. These last two may include also farmers but at different levels of organisation. The links between these different bodies and stakeholders are expressed with the lines as direct, indirect or needed and the closer these lines are the closer the relationship between the stakeholders is or should be.

Figure 2. Diagram for Mapping of policies and institutions.
2. African bioenergy development

Africa’s biomass energy resources vary geographically and are not uniformly distributed (Karekezi, et al. 2008). Biomass energy use depends on a number of issues including geographical location, land use patterns, preferences, cultural and social factors. Income distribution patterns also contribute to variations in biomass energy use, with poorer African countries relying on traditional forms of biomass, and wealthier African countries using more modern biomass energy technologies (Karekezi et al, 2008). Figure 3 shows comparative areas in different countries in Africa in 2005, where forest area and arable land extension is compared to overall land area data.

![Comparative areas in different African Countries in 2007](image)

Figure 3. Land area, arable land area and forest area in different countries in Africa (Source: FAOSTAT, 2010).

The low per capita national incomes as well as the slow growth in conventional energy use, influences the heavy reliance on biomass energy in Africa which is considered unlikely to change in the near future. Estimates indicate that by 2020, traditional biomass energy use is expected to increase roughly at the same rate as population growth rates (IEA, 2003), resulting in modest changes in the share of biomass in total final energy supply (Table 1). On the contrary, the share of biomass in total final energy supply in developing countries is expected to decrease in the same period. According to the IEA (in UNIDO, 2008), the absolute number of people relying on biomass energy in Africa is also expected to increase between the year 2000 and 2030 - from 583 million to 823 million, an increase of about 27% (Table 2). However, the actual quantity of energy provided from biomass is expected to increase in all cases.
Table 1. Projected Final Biomass Consumption in Relation to Total Energy Use, 2000 and 2020 (UNIDO, 2008).

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass Mtoe</td>
<td>Conventional Energy Mtoe</td>
<td>Total Mtoe</td>
<td>Biomass Mtoe</td>
<td>Conventional Energy Mtoe</td>
<td>Total Mtoe</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>214.48</td>
<td>943.4</td>
<td>1,157.9</td>
<td>18.50</td>
<td>224</td>
<td>1,524</td>
</tr>
<tr>
<td>Asia</td>
<td>343.20</td>
<td>467.74</td>
<td>810.94</td>
<td>42.30</td>
<td>394</td>
<td>1,336</td>
</tr>
<tr>
<td>Latin America</td>
<td>69.34</td>
<td>284.96</td>
<td>354.30</td>
<td>19.57</td>
<td>81</td>
<td>706</td>
</tr>
<tr>
<td>Africa</td>
<td>221.10</td>
<td>1,573.7</td>
<td>378.47</td>
<td>58.40</td>
<td>371</td>
<td>260</td>
</tr>
<tr>
<td>Total non OECD</td>
<td>859.65</td>
<td>2,417.86</td>
<td>3,277.51</td>
<td>26.23</td>
<td>1,097</td>
<td>5,494</td>
</tr>
<tr>
<td>OECD countries</td>
<td>126.17</td>
<td>3,551.32</td>
<td>3,677.49</td>
<td>3.40</td>
<td>96</td>
<td>3,872</td>
</tr>
<tr>
<td>World</td>
<td>985.2</td>
<td>5,969.18</td>
<td>6,955</td>
<td>14.20</td>
<td>1,193</td>
<td>9,365</td>
</tr>
</tbody>
</table>

Table 2. Total Final Energy Supply Including Biomass Energy in Africa (UNIDO, 2008).

<table>
<thead>
<tr>
<th>2020</th>
<th>Annual growth Rate (%) 2002-2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass (Mtoe)</td>
<td>Share of biomass in total supply (%)</td>
</tr>
<tr>
<td>Africa</td>
<td>367</td>
</tr>
<tr>
<td>Total developing countries</td>
<td>1,127</td>
</tr>
<tr>
<td>World</td>
<td>1,428</td>
</tr>
</tbody>
</table>


The production of biofuels (bioethanol and biodiesel) in Africa is likely to increase, in order to meet local demand and also external demand for biofuels in advanced economies in the EU and the Far East (Lula Da Silva, 2007 in Karekezi et al, 2008). Nevertheless, it is necessary to apply sensitive and equitable management as large-scale modern biomass energy development can lead to further marginalisation of the rural poor. However, the growth and development of modern technologies could provide better incomes particularly for smallholders. Mauritius provides a model example of where a share of the benefits from large-scale co-generation plants that flow to low-income farmers have increased over time through direct policy interventions and an innovative revenue sharing mechanism (Deepchand, 2002; Karekezi et al, 2002 in Karekezi, 2008).

3. Policy mechanisms to encourage the use of biofuels.

Policy and regulatory support is necessary for the successful implementation of improved and modern bioenergy projects as has been recommended by some international initiatives such as the Global Network on Energy for Sustainable Development (GNESD2). There are a number of international, national and regional initiatives in Africa regarding policies and plans. For instance, the 2007 Addis Abba Declaration that emanated from the First High Level meeting of African bioenergy stakeholders, committed the continent to sustainable bioenergy development. The Seminar was organised by The African Union Commission along with the United Nations Industrial Development Organisation (UNIDO) and the Brazilian government. The political declaration put out will, among other things, facilitate:

2 http://www.gnesd.org/
a) the development of enabling policy and regulatory frameworks for biofuels development in Africa
b) the formulation of guiding principles on biofuels to enhance Africa’s competitiveness while minimizing the risks of biofuels development for small-scale producers
c) the encouragement of the engagement of development partners to enable North-South and South-South cooperation in biofuels development (Jumbe and Msiska, 2007).

The meeting also called for the engagement of public financing institutions to support biofuels projects and proposed the establishment of a forum to promote access to biofuels information and knowledge (IISD/UNIDO, 2007).

Some examples of current legislation or programmes either directly related to biofuels production or related to issues regarding its production are presented in Table 3. Furthermore, some other initiatives are present in the continent, such as the South African Biofuel Association, the Biofuels Association of Zambia, the Programme for Basic Energy and Conservation (ProBEC) which is a Southern African Development Community (SADC) project, implemented by the German Development Co-operation (GTZ).

In contrast to the development of bioenergy policies in other regions of the world, Africa does not have a comprehensive regional policy on biofuels to regulate the growing industry. This lack of a regional policy and strategy has led to underinvestment into biofuels research and development in Africa. The regional economic communities in Africa such as ECOWAS, SADC, AU/NEPD and EAC are playing and must play an important role in supporting the development of the biofuels industry in Africa. A number of international aid organisations are collaborating with different countries in Africa on the generation of the policies (GTZ in Mozambique, SIDA (Swedish Development Agency) in Tanzania, CIRAD - Centre de Coopération Internationale en Recherche Agronomique pour le Développement- in Burkina Faso) (see Annex 1).
Table 3. Examples of national African policies, laws and programmes related to biofuels.

<table>
<thead>
<tr>
<th>Country</th>
<th>Policy Documents</th>
<th>Strategies on Biofuels Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanzania</td>
<td>• Forest policy (1998)</td>
<td>• To ensure sustainable supply of forest products and services by maintaining sufficient forest area under effective management</td>
</tr>
<tr>
<td></td>
<td>• Energy policy of (2003)</td>
<td>• Promote efficient biomass conversion and end-use technologies; reduce rate of deforestation and land degradation</td>
</tr>
<tr>
<td></td>
<td>• Environmental policy of (1997)</td>
<td>• Investment in Biomass development</td>
</tr>
<tr>
<td></td>
<td>• Land policy of (1997).</td>
<td>• Tanzania general underlying right to land, but clearly recognizing and clarifying customary and other use rights to land.</td>
</tr>
<tr>
<td></td>
<td>• Agriculture policy (1997).</td>
<td>• To promote sustainable food security, income generation, employment growth, and export</td>
</tr>
<tr>
<td></td>
<td>• National Biofuels Task Force (2006)</td>
<td>• To facilitate the ongoing and potential biofuels initiative; to conduct a Policy and regulatory Environmental scan; to develop guidelines for biofuels development.</td>
</tr>
<tr>
<td></td>
<td>• The Land Act (199) and the Village Act (1999)</td>
<td>• Land in Tanzania to be “Public land” and are held by the state for public purposes.</td>
</tr>
<tr>
<td>South Africa</td>
<td>• White Paper on Energy Policy (1998)</td>
<td>• To guarantee access to safe, reliable and affordable energy; to liberalise the energy sector and to introduce greater levels of competition in electricity markets.</td>
</tr>
<tr>
<td></td>
<td>• Draft Energy Efficiency Strategy (Dept of Minerals and Energy)</td>
<td>• Target for energy efficiency improvement of 12% by 2014</td>
</tr>
<tr>
<td></td>
<td>• White Paper on Renewable Energy (2003)</td>
<td>• Target of 10,000 GWh of renewable energy contribution to final energy consumption by 2013. The renewable energy is to be utilised for electricity generation (4% of projected electricity demand), heat and biofuel production.</td>
</tr>
<tr>
<td></td>
<td>• Draft Biofuel Strategy has been released and approved by DME in Dec 2006</td>
<td>• Addresses policy, regulations and incentives for biofuel industry. It proposes a 4.5 percent use of biofuels in liquid road transport fuels (gasoline and diesel) by 2013.</td>
</tr>
<tr>
<td></td>
<td>• Renewable Energy Subsidy Scheme (2006/07)</td>
<td>• Proposes a maximum capital subsidy of 16.7 SA¢/l provided for bio-ethanol plants and 27.3 SA¢/l for biodiesel</td>
</tr>
<tr>
<td></td>
<td>• Department of Agriculture</td>
<td>• Agriculture programmes to support small scale farmers and emerging farmers for better targeted biofuel production.</td>
</tr>
<tr>
<td></td>
<td>• Central Energy Fund (CEF)</td>
<td>• Originally created for promoting synthetic fuel production can be extended to the promotion of biofuel</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>• National Energy Sector</td>
<td>• Not regulated</td>
</tr>
<tr>
<td></td>
<td>• Law N°005/97/ADP from January 1997 on environmental issues</td>
<td>• To observe the interdependence between environment and socio-economic development; to ratify international agreements concerning environment conservation; to protect the future generations from environmental degradation.</td>
</tr>
<tr>
<td></td>
<td>• National Strategy under development</td>
<td>• For the regulation of wood fuel trade</td>
</tr>
<tr>
<td></td>
<td>• Energy and poverty alleviation</td>
<td>• To develop the energy administration (organisation capacity and policy formulation); to enhance efficient energy supply options (electricity, hydrocarbons, woody fuel, renewable energies); to provide socio-economic development and to alleviate poverty.</td>
</tr>
</tbody>
</table>
In terms of policies and regulations, one of the issues that deserves special attention are the land use tenure frameworks in some African countries. Land is often considered to be a national asset and can only be leased. Moreover, the right of occupancy can also be “revoked” if necessary (e.g. in Tanzania). In the case of Zambia, the National Energy Policy stipulates that there should not be sale of land involved in any development agreements entered into with the Minister of Energy. This enforces to keep the land resource rights in the country.

4. Land use

Using GIS (Geographical Information System) coupled to relevant databases, the COMPETE project - Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems - Africa (2007) assessed the available land resource base (arid and semiarid) for bioenergy including biofuels in Africa. As a precaution against detrimental impacts on biodiversity, all categories of protected areas, closed canopy forests and wetlands were designated as unavailable for bioenergy crop production and filtered out from the regions shown in the base map (Figure 4; Watson, 2008). Watson concluded that the land area remaining as available and/or suitable for bioenergy crop production are: closed or sparse grassland, open grassland with sparse shrubs, open deciduous shrubland, deciduous shrubland with sparse trees, deciduous woodland, mosaic forest/cropland and mosaic forest/savanna (Figure 5). Grasslands and woodlands particularly in sub Sahara’s semi arid and arid regions generally have a very high biodiversity and play a very significant role in environmental services and rural livelihoods (Watson, 2008).
Figures 6 and 7 show the variation in arable land area and forest area between 1970 and 2005 for a range of countries. The largest variation is observed in Tanzania, where the forest area has decreased by 6.2 million ha over this period. South Africa has seen the most noticeable change in arable land, during the 1990s.

Furthermore, the project presented case studies in South Africa, Botswana, Zambia, Tanzania, Kenya, Mali, Burkina Faso and Senegal. A second set of maps used the semi-arid and arid regions of each of these countries as a template on which available and suitable areas for bioenergy crop production, roads, railroads, rivers and populated places are sequentially shown and variously labelled (Watson, 2008). These maps also included data from ESRI (2006) on populated places.

This assessment shows that Mozambique has immense agricultural potential, with an estimated 36 million ha of arable land, of which only 10 percent is presently in productive use (figures 8 and 9). The wide diversity of soil types and the diverse climatic conditions in the country are suitable for a large variety of crops. Most of the agriculture practised in Mozambique is non-irrigated. However, Mozambique’s network of more than 60 rivers has allowed for the construction of irrigation schemes. Total potential irrigated area is estimated at 3.3 million ha. At present the agricultural sector is still dominated by the family sub-sector which accounts for 90 percent of the cultivated areas and includes 2.5 million households. This sub-sector relies on rain-fed farming using very basic techniques resulting in low yields. The remaining arable land is cultivated by large commercial farms that concentrate on cash and export crops (SADC, 2008).
The specific habitat requirements of various bioenergy crops needs to be evaluated in order to identify the best potential candidates in different parts of each country. The current area used for the main bioenergy crops (sugarcane, jatropha and sweet sorghum) is presented in the next section.

5. Existing and potential Biofuel Crops in Southern Africa

Smeets et al. (2004) revealed that compared to all the world’s major regions, sub-Saharan Africa has the greatest bioenergy potential as a result of large areas of suitable cropland, large areas of unused pasture land and the low productivity of land under agriculture (Watson, 2008). There are six main crops for producing conventional, so-called first generation, biofuels in Southern Africa: sugar cane, sweet sorghum, cassava, jatropha, maize, soybean and sunflower. The potential for each of these crops is assessed below.

Sugar Cane (Saccharum spp.)

Most of the land suitable for sugar cane production in the Republic of South Africa (RSA) is already being used as such and therefore its potential for expansion is limited (Watson, 2007). Irrigated land in RSA increased in late 1990s but now stringent legislation has been brought in to protect its scarce water resources. Therefore, unless drought tolerant varieties are introduced, this too will be a limiting factor in the country, making it an unlikely candidate for bioenergy in arid and semi-arid areas.

However, in southern Africa as a whole, Phillips (2002) estimated that a 50% increase in the region’s 2000 sugarcane production, would require expansion of 200 000 ha of land and create 100 000 jobs. Using GIS, it was discovered that large areas of land are available and suitable for sugar cane cultivation, especially in Mozambique, Malawi and Zambia. The analysis suggests that ‘land’ is unlikely to be a limiting factor in harnessing sugarcane’s bioenergy potential (Watson, 2007). Indeed, between the three mentioned countries, it was estimated that more than 3.7 million ha were available for sugar cane expansion, as illustrated in Table 4.

| Table 4. Land availability in Malawi, Mozambique and Zambia (Watson, 2008). |
|-------------------------------------|------------------|------------------|------------------|
| Country area | Malawi 1000ha | Mozambique 1000ha | Zambia 1000ha |
| Protected areas filtered out | 580 6.2 | 4530 5.8 | 2427 3.3 |
| Crops & wetlands filtered out | 316 3.4 | 3773 4.8 | 1726 2.3 |
| Existing sugarcane filtered out | 314 3.3 | 3771 4.8 | 1726 2.3 |
| Areas < 500 ha filtered out | 256 2.7 | 3470 4.4 | 1485 2.0 |
| Unsuitable soils & rainfall filtered out | 206 2.2 | 2338 3.0 | 1178 1.6 |

As Johnson et al. (2006) note, the potential of these countries alone is greater than the current production of cane in SADC. Furthermore, they draw attention to the fact that the areas identified in these countries are better suited for cane-growing than much of the land that is currently under cane in South Africa and Mauritius. The IGBP/IHDP (1995) data suggests that substantial areas of Angola are also suitable for sugarcane production. Now that the country is politically stable and cleared of landmines, a similar GIS analysis to that described above is currently being carried out under the Competence Platform on Energy
Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems – Africa (COMPETE, 2008).

According to a recent scoping study from E4tech (2006) for the DTI (BERR), southern (SADC) Africa and the rest of Africa have similar potential for sugar cane production. The scope was based on the assumption, validated by local experts from industry, academia and NGO’s, that it could be feasible to expand sugar cane production in Southern Africa (SADC region) from its current 0.7M ha to around 1.5M ha in the region within the next 10 to 15 years (E4Tech, 2006). This would be enough to satisfy twice as much the current regional consumption of sugar and in addition produce up to 7.3 billion litres of bioethanol each year. This volume of bioethanol could replace around 30% of the gasoline required by the projected southern African gasoline vehicle fleet of 17 million cars by 2020. Alternatively, if blended into gasoline at a 10% rate, it could fuel between 50 and 60 million gasoline cars (E4tech, 2006).

**Cassava (Manihot esculenta)**

Cassava also called manioc, tapioca or yuca, is one of the most important food crops in the humid tropics, being particularly suited to conditions of low nutrient availability and drought prone areas (Tonukari, 2004). Compared to other crops, cassava excels under suboptimal conditions, offering the possibility of using marginal land to increase total agricultural production (Cock, 1982, in Tonukari, 2004). Cassava is also used to produce starch for industrial use and other products used in processed food. Sub-Saharan Africa is expected to experience the most rapid growth in food demand in root and tubers averaging 2.6 percent per year through 2020 (Scott et al. 2000 in Tonukari, 2004). This growth will account for nearly 122 million metric tons with most of the increase coming largely from cassava, 80 million metric tons (66% of the total). Table 5 shows the Cassava production and use in 1993, and projected to 2020 (Scott et al. (2000) in Tonukari, 2008).


<table>
<thead>
<tr>
<th>Country Region</th>
<th>Area (million ha)</th>
<th>Yield (mt/ha)</th>
<th>Production (million mt)</th>
<th>Total use (million mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>11.9</td>
<td>15.9</td>
<td>7.4</td>
<td>10.6</td>
</tr>
<tr>
<td>Latin America</td>
<td>2.7</td>
<td>2.7</td>
<td>11.3</td>
<td>15.6</td>
</tr>
<tr>
<td>South East Asia</td>
<td>3.5</td>
<td>3.5</td>
<td>12.1</td>
<td>13.7</td>
</tr>
<tr>
<td>India</td>
<td>0.2</td>
<td>0.2</td>
<td>23.6</td>
<td>28.4</td>
</tr>
<tr>
<td>Other South Asia</td>
<td>0.1</td>
<td>0.1</td>
<td>9.4</td>
<td>13.5</td>
</tr>
<tr>
<td>China</td>
<td>0.3</td>
<td>0.3</td>
<td>15.1</td>
<td>20.2</td>
</tr>
<tr>
<td>Other East Asia</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Developing</td>
<td>18.8</td>
<td>22.9</td>
<td>9.2</td>
<td>12.0</td>
</tr>
<tr>
<td>Developed</td>
<td>---</td>
<td>---</td>
<td>12.1</td>
<td>14.7</td>
</tr>
<tr>
<td>World</td>
<td>18.8</td>
<td>22.9</td>
<td>9.2</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Ethanol can be produced from three main types of biomass raw materials: (a) sugar-bearing materials (such as sugarcane, molasses, and sweet sorghum); (b) starches (such as corn, cassava, and potatoes) and (c) cellulosics (such as in wood and agricultural residues) whose carbohydrate form is more complex and therefore more difficult to convert to ethanol (Thomas and Kwong, 2001). Some scenarios highlight the potential for a major future expansion of bioenergy, particularly in the domestic cooking market, in which ethanol – made maize, sugar cane, sweet sorghum, cassava, and sweet potatoes – would be used to make gel fuel that would substitute for fuel-wood or charcoal (Utria, 2004, in Johnson and Matsika, 2006). For
ethanol production purposes, the higher costs of producing ethanol from starch than form sugar need to be considered when evaluating the promotion of different supply pathways (Thomas and Kwong, 2001).

**Sorghum and Sweet Sorghum (Sorghum bicolor L. Moench)**

Sweet sorghum can be grown over a larger area of the RSA and can achieve high yields. It is currently grown for food and for alcohol by small scale farmers and trials started in the Eastern Cape in 2007 to assess its bioenergy potential. Sorghum has shown low production in some countries in southern Africa, for instance, in Botswana (Figure 8.a). In contrast, trials in Mozambique showed an increasing yield and production without increasing the area harvested (Figure 8.b). In Zimbabwe, the three aspects of production, yield and area harvested showed great fluctuation, which Eriksen et al (2004) considered the result of climatic conditions (Eriksen et al, 2004).

Sweet sorghum is more drought tolerant than sugar cane and can therefore be grown over a wider area whilst still achieving high yields. Trials have also been undertaken in other southern African countries where it has been used as a supplement to sugar cane for ethanol production. It has been shown capable of complementing sugar cane ethanol by extending the production season. Furthermore, the non-sugar fractions of the crop can be used as feed for livestock and the seeds are already a common staple food, helping to address the issues of biofuels competition with food production. Thus, sweet sorghum is seen as a biofuels crop with high potential for the future in the semi arid tropics, including southern Africa.

Figure 8. Production, yield and area harvested of grain sorghum in the four case study countries of Botswana, Mozambique, South Africa and Zimbabwe (source: FAOSTAT, 2004).
**Jatropha (Jatropha curcas L.)**

By 2004, 400 million *Jatropha curcas* L. trees were planted on 45,000 ha in North West Province of the Republic of South Africa. The South African Government then called for a moratorium on further commercial planting until it was convinced that (a) the plant was not at risk of becoming an invasive alien species, and; (b) its toxicity does not pose an environmental and health risk. Commercial plantings were given the go-ahead in 2007. A list of companies which have invested in jatropha in Africa is given in Annex 2. This includes companies such as D1 Oils, which plans to double their current area under the crop and Emerald Oil International (Pty) Ltd, who commenced construction of a biodiesel plant in Durban with a 100 000 tons per year capacity. In addition to obtaining feedstock from South Africa, this company will source *Jatropha curcas* seeds in Zimbabwe, Zambia, Malawi and Madagascar. It has an agreement with the KwaZulu Natal Agricultural Extension to facilitate the establishment of an extensive network of Jatropha hedges (Moodley, 2007). Owen Sithole College of Agriculture has a trial project involving 100 trees (Henning, 2006).

**Maize (Zea mays spp)**

In 2006, Ethanol Africa (with Ecofields, Grain Alcohol Investments and Sterling Waterford as key shareholders) became South Africa’s first bioethanol producer using surplus maize. Due to increased and improved inputs and improved cultivars, the country’s maize production exceeds domestic demand in most years—a demand that includes the needs of Botswana, Lesotho, Namibia and Swaziland as part of an agreement of the long standing South African Customs Union. In December 2007, Parliament decreed that maize would no longer be used for this purpose as it was considered a staple food crop.

**Soybean (Glycine max or G. soja)**

Soybean has been cultivated in several countries in Africa though in some of them the data shows it has only recently been incorporated into the agriculture systems. The only country which has shown an increment in area harvested, since the mid 1990s, has been South Africa. The production of soybeans in South Africa has increased from 770 t/year in 1970 to 424 000 t/year in 2006. The second ranked country in terms of harvested area is Zambia which also increased its production from 173 t/year in 1973 to 12 000 t/year in 2006 (FAOSTAT, 2008).

![Soybean area harvested](image)

Figure 9. Soybean area harvested for Southern African countries since 1970.
Sunflower (*Helianthus annuus*)

Sunflower production data is not reported for most of the countries reviewed in this report (see Figure 10). Nevertheless, South Africa has the greatest reported area harvested for sunflower seed (FAOSTAT, 2008). It is not clear if the fluctuations respond to the market or to internal changes in the agriculture system experienced in South Africa, especially at the end of the Apartheid (Eriksen et al., 2004).

In the FAO statistical system (2008) there is reference to some countries production of oil crops but it is not clear which crops are included (e.g. Zambia and Tanzania).

![Sunflower area harvested](chart.png)

Figure 10. Sunflower area harvested for Southern African countries since 1970.

Palm Oil (*Elaeis guineensis* Jacq.)

The palm oil tree (*Elaeis guineensis* Jacq.) is indigenous to West Africa, with natural stands occurring along a 300-mile wide coastal belt ranging from the Gambia to Angola. Oil palm also extends eastward through central Africa and into eastern Africa. In 2002, the African countries which held large areas covered by oil palms were Nigeria (2.6 million ha), Guinea (310,000 ha), D.R. of Congo (formerly Zaire) (220,000 ha), Cote d’Ivoire (190,000 ha), Ghana (125,000 ha), Cameroon (80,000 ha), and smaller areas in Benin, Burundi, Central African Republic, Republic of Congo, Equatorial Guinea, Gabon, Gambia, Guinea Bissau, Liberia, Senegal, Tanzania, Togo, and Uganda (USDA, 2002).

This area of palm oil has extended especially since a number of private initiatives have acquired land to plant oil palm and some international organisations, such as the World Bank, have promoted palm growing in Africa as well as the Malaysian Government (World Rainforest Movement, 2002).

With the controversy over palm oil and rainforest clearance, it is worth noting that FAO, in collaboration with breeders at ASD in Costa Rica, planted cold-tolerant palms in Africa. These palms were able to survive outside of rainforest areas and were planted in Malawi, Zambia, Ethiopia and the highlands of Kenya and Cameroon. In addition to not competing with rainforest, the precocious hybrid showed improved drought tolerance and gave high yields with minimal inputs (Griffee et al., 2004).
Potential Indigenous Biofuel Crops

*Pappea capensis* Eckl & Zey. and *Ximenia caffra* Sond. are trees indigenous to southern Africa. In 2006, South Africa’s Department of Mineral and Energy Affairs suggested that oil from their seeds may have potential for biodiesel production. This suggestion is based on their being able to grow in arid regions and their seeds containing high oil concentrations. Individual trees of both species can potentially produce up to 10 kg of seed, 65% of which can be converted into bio-oil or biodiesel. One ha of trees could supply 2400 l of oil, or 1560 l of biodiesel per year. Trees are more cost effective to cultivate than herbaceous crops, as they need fewer inputs.

5.1 Food and bioenergy crops in Africa.

The debate on fuel versus food that developed with the food prices in 2008 has produced some reports that have been looking at the potential problems at regional level. For instance, the report from UEMOA (2008) conducted in West Africa. The report concluded that region has the land, resources and demand to improve their agricultural and bioenergy production.

This report also considered that policy changes that improve agricultural productivity and include more arable land into sustainable use have the potential to improve food and fuel production. Furthermore, the use of waste and residues for bioenergy also contributes to the reduction on the problem of fuel and food production (UEMOA, 2008).

The following section covers the case studies considered for the report. These case studies look at the country characteristics, their potential for bioenergy crop productions including the stakeholders involved and the possibilities for food and fuel production without jeopardizing the current and future food production in Sub-Saharan countries.
CASE STUDIES
6. SENEGAL CASE STUDY

6.1 Country’s characteristic:

Location
Senegalese territory is located between 12° 8 and 16 ° 41 north latitude and 11 ° 21 and 17 ° 32 west longitude.
Senegal is the most western country in Africa and is bordering at south with Guinea and Guinea Bissau, at East with Mali, at North with Mauritania and at West with the North Atlantic Ocean.

Geographical characteristics:
- **Area**: Total surface: 196,190 km² with 192,000 km² of land and 4,190 km² of water. Coastline is of 531 km.
- **Terrain**: The country is generally flat with hills in Thies and foothills in the South oriental part.
- **Climate**: The country is characterized by a dry tropical climate. Temperatures are moderate along the coast (16-30°C) and rise gradually as one moves away towards the continent (35-45°C). Highest temperatures are observed in May-June.

From north to south, four areas stand out:
- An arid or semi-desert area with an annual precipitation not exceeding 350 mm;
- A semi-arid continental dry area with isohyets between 350 and 700 mm;
- A sub-humid zone, less hot and less dry than the previous ones, and characterized by an annual rainfall ranging between 700 and 900 mm;
- A wetland characterized by high rainfall of around 1000 to 1200 mm.

![Map of Senegal showing location relative to its neighbouring countries](image)

Figure 6.1 Map of Senegal showing location relative to its neighbouring countries

The climate is divided into two seasons: A rainy season, from July to October and a dry season from November to June. In the oriental part of Senegal, rains start from end of May. Senegal is characterized by high rainfall variability from one year to another with the peak of the rainfall in August.

**Winds**: The climate is influenced by three air masses:
• The Alize, a sea breeze from Azores anticyclone, is a damp and cool wind but enable to give rainfall.
• The Harmattan, a wind especially hot and dry, coming from the continent.
• The Monsoon is a very humid wind coming from the St. Helena anticyclone. It brings rains from the South-West.

Hydrography: The country is crossed from east to west by three rivers: The Senegal (1700km), The Gambia (750km) and The Casamance (300km). The Senegal River is the main water resource of the country and feeds the groundwater and the lake Guiers. This one is the largest permanent freshwater reserve in the country. Significant groundwater resources are available for the implementation of a comprehensive water program. This water can be used in further potential hydraulic programs. The renewable water resources are estimated to 39.4 km$^3$ (1987).

Environmental characteristics: The key environmental challenges are illustrated by a fauna and a flora threatened by poaching, deforestation, overgrazing, soil erosion, desertification and overexploitation of fishing resources.

6.2 Population size and characteristics
• Population: 12,893,259 habitants in 2008
• Population density: 65 hab/km$^2$
• Urban population: 51%
• Rural population: 49%
• Women in 2008: 51%
• Men in 2008: 49%

6.3 Gross Domestic Product, Human development Index:
• GDP (official exchange rate): 13 900 million USD (2008)
• GDP per habitants : 1600 USD (2008)
• Human development index : 0.499 (2005)
• Growth rate : 3.3% (2008)

• GDP - Composition per sector (2008):
  o Agriculture : 16.1%
  o Industry : 19.3%
  o Services : 64.6%
• Population below poverty line: 54% (2008)

6.4 Main food crops:
According to Matsumoto-Izadifar (2008), Senegal has seen some agricultural products, such as cereals and horticulture, growing. Production of rice, maize and manioc has increased in recent years to meet rising local demands in urban areas. The fruit and vegetables sub-sector presents the main hope of diversifying Senegal’s agricultural export structure. Grown mainly in the Niayes, the Senegal River Valley, Casamance and Dakar regions, fruits and vegetables for export have done well since the 1994 devaluation of the CFA franc. Senegal’s geographical and climatic situation enables out-of-season crops to be grown for the European market. The primary sector grew annually at an average 6.2 per cent between 2002 and 2005 (Matsumoto-Izadifar, 2008). Despite Senegal’s huge potential in horticultural exports, market opportunities at national, regional and international levels remain
underexploited. Groundnuts earn less foreign revenue, with a 60 per cent drop in output over the past 20 years and do not make it any more a reliable market.

According to the FAO (FAOstat data, 2009) millet and peanuts are the main crops produced in Senegal Table

Table 6.1 Main crops in Senegal by hectare and tons

<table>
<thead>
<tr>
<th>Product</th>
<th>Has</th>
<th>tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peanuts</td>
<td>607,195</td>
<td>331,195</td>
</tr>
<tr>
<td>Millet</td>
<td>686,892</td>
<td>318,822</td>
</tr>
<tr>
<td>Maize</td>
<td>143,769</td>
<td>158,266</td>
</tr>
<tr>
<td>Sorghum</td>
<td>155,919</td>
<td>100,704</td>
</tr>
<tr>
<td>Rice</td>
<td>80,312</td>
<td>193,379</td>
</tr>
<tr>
<td>Tomato</td>
<td>6,594</td>
<td>178,600</td>
</tr>
<tr>
<td>Onions</td>
<td>5,100</td>
<td>142,000</td>
</tr>
</tbody>
</table>

Source: (FAOstatdata, 2009).

Several food crops are imported and exported to and from Senegal (FAOstat, 2009). The following tables show these products by ton and value in USD.

Table 6.2 Top 10 main agricultural and food crops imports

<table>
<thead>
<tr>
<th>Rank</th>
<th>Commodities</th>
<th>Quantity (tonnes)</th>
<th>Value (1000$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rice Broken</td>
<td>1018729</td>
<td>350397</td>
</tr>
<tr>
<td>2</td>
<td>Wheat</td>
<td>395742</td>
<td>133974</td>
</tr>
<tr>
<td>3</td>
<td>Soybean oil</td>
<td>101776</td>
<td>93160</td>
</tr>
<tr>
<td>4</td>
<td>Milk Whole Dried</td>
<td>21444</td>
<td>79722</td>
</tr>
<tr>
<td>5</td>
<td>Malt Extract</td>
<td>17455</td>
<td>54255</td>
</tr>
<tr>
<td>6</td>
<td>Food Prep Nes</td>
<td>20204</td>
<td>53684</td>
</tr>
<tr>
<td>7</td>
<td>Sugar Refined</td>
<td>69387</td>
<td>41377</td>
</tr>
<tr>
<td>8</td>
<td>Palm oil</td>
<td>34885</td>
<td>30454</td>
</tr>
<tr>
<td>9</td>
<td>Tobacco, unmanufactured</td>
<td>3276</td>
<td>28481</td>
</tr>
<tr>
<td>10</td>
<td>Maize</td>
<td>97272</td>
<td>24421</td>
</tr>
</tbody>
</table>

Table 6.3 Top 10 export of main agricultural and food crops

<table>
<thead>
<tr>
<th>Rank</th>
<th>Commodities</th>
<th>Quantity (tonnes)</th>
<th>Value (1000$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Groundnut oil</td>
<td>68675</td>
<td>67617</td>
</tr>
<tr>
<td>2</td>
<td>Food Prep Nes</td>
<td>11627</td>
<td>32189</td>
</tr>
<tr>
<td>3</td>
<td>Cotton lint</td>
<td>21415</td>
<td>28522</td>
</tr>
<tr>
<td>4</td>
<td>Rice Broken</td>
<td>73139</td>
<td>24729</td>
</tr>
<tr>
<td>5</td>
<td>Tobacco Products Nes</td>
<td>1337</td>
<td>16972</td>
</tr>
<tr>
<td>6</td>
<td>Tobacco, unmanufactured</td>
<td>1758</td>
<td>15984</td>
</tr>
<tr>
<td>7</td>
<td>Cigarettes</td>
<td>1783</td>
<td>13710</td>
</tr>
<tr>
<td>8</td>
<td>Tomatoes</td>
<td>8858</td>
<td>8639</td>
</tr>
<tr>
<td>9</td>
<td>Beans, green</td>
<td>6685</td>
<td>6512</td>
</tr>
<tr>
<td>10</td>
<td>Pastry</td>
<td>6581</td>
<td>6069</td>
</tr>
</tbody>
</table>

(Faostat, 2009)
6.5 Predominant land characteristics:

Near 45 percent of Senegal is forested. Of this, near 18 percent is considered pristine primary forest, one of the higher rates in West Africa. While Senegal lost some 675,000 hectares of forest between 1990 and 2005, the country's deforestation rate has only increased by 5 percent since the 1990s. Deforestation is mostly the result of clearing for fuelwood, charcoal, and logging, though poaching, wildlife trafficking, and hydroelectric projects have further degraded forest areas. Government officials have blamed deforestation for increased soil erosion, flooding, and periodic drought which has had an adverse impact on regional agriculture (Mongabay, 2009). To slow the encroaching Sahara desert, Senegal announced in 2005 that it planned to promote a "Great Green Wall" of trees stretching for nearly 7,000 km (4,375 miles), from Dakar to Djibouti along the Sahel. Other African countries said they will participate in the massive reforestation project as well.

Agriculture occupies 77 percent of the economically active population. However, only 12 percent of the land area is cultivated. Senegal is among the world's largest producers of peanuts (NADEV, 2009).

Land access, encompassing access to natural resources such as soil and water, is governed through land tenure systems legally or customarily defined. Regulations of land tenure govern who can use what resources, either land, water, livestock or trees, and under what conditions (Platteau et al, 2005). In Senegal the land tenure system is largely a customary one in which a Chef de Terre, or Land Chief, acts as custodian of community land and distributes it among households as needed. This land is then inherited through family lineage from father to son. In recent decades, a shift to intensive agriculture and private tenure has reduced the powers of the lineage land chief. Yet the practice of collective management of family land is still largely observed (Platteau et al. 2000 in Platteau et al 2005) In many sub-Saharan African countries, including Senegal and Burkina Faso, land tenure is determined by both statutory and customary laws.

6.6 Characteristics of livelihoods:

Despite of a good economic performance and sustained growth in recent years, the standard of living of the Senegalese remains very low. Inadequate agricultural production, low capacity of the economy to create sustainable jobs and inadequate resources allocated to social services contribute to poverty, which already affects nearly 54% of the population.

- Gross national income (GNI): $ 540 per capita,
- Life expectancy is just 56 years,
- Literacy rate that does not exceed 40% of the adult population,
- UNDP Human Development ranking in 2009: Senegal ranks 166th from 182 countries.

Rural areas are characterized by poverty making 75% of the rural population poor. They are mainly farmers, women and young people who survive on subsistence crops and livestock on small plots that are often not sufficient to cover the needs of their families. Groundnut production accounts for around 40 per cent of cultivated land, taking up 2 million hectares, and provides employment for as many as 1 million people.

6.7 Policies in place and link with the bioenergy sector.

Agricultural policy
The agricultural policy in Senegal relies mainly on the “Agro-forestry-pastoral Guidance Law” (Loi d’Orientation Agro-sylvo-pastorale) which was initiated by the Government and adopted
in National Assembly by May 25, 2004. This Guidance Law has defined the national agricultural and rural development policy for the next twenty years. Its specific objectives are:

- Formal recognition of agro-forestry-pastoral professions and professional organizations, social protection and the definition of a legal status for farm exploitations as well as for land assets security and water control;
- The diversification of production, the integration of streams, market regulation and the development of infrastructures and public services in rural areas;
- The promotion of social equity in rural areas and protection against natural calamities and hazards related to agro-forestry-pastoral activities;
- The development of agricultural information, education and training; capacity-building for rural organizations;
- The development and sustainable financing of agricultural services.

In order to implement this national policy, the Government has elaborated some development programs such as the Plan REVA (2006) and the GOANA (Great Agricultural Offensive for Food and Abundance, 2008). The Plan REVA or Return to Agriculture aims to establish populations including youth and women in their land in particular migrants and returnees. It aims also to increase significantly agricultural production including diversification crops. Plan REVA tries to meet the objectives of (i) the Accelerated Growth Strategy, (ii) the Millennium Development Goals and (iii) the fight against poverty (Strategy Document for Poverty Reduction). Within the framework of crop diversification, the Plan REVA has developed an important Biofuel production program at national level.

**Energy policy**

Access to energy services remains a problem despite the increase in the rate of electrification in particular that of rural electrification which increased from 6% in 2000 to 14.2% in 2006, while for urban areas, this rate is only 74.1%. Electricity is of thermal origin. SENELEC (production, supply and sale) has the monopole of electricity distribution in Senegal: SENELEC possesses a total settled power of 295, 6 MW for an annual consumption of 300000 T of oil.

Some industrial entities such as CSS, SONACOS, ICS, SAR, Grands Moulins and SNTI, produce electricity for their own needs and resell the surplus to SENELEC. Strong energy dependence is a bottleneck for the economy. The oil bill of Senegal, which rose from 158 million USD in 2000 to 620 million USD in 2006, leads to a high output negatively affecting currency on the country's trade balance. Facing a rising crude price, subsidy equivalent to a power plant (234 million USD) has been paid to hold the price of electricity in 2005-2006. In order to find a solution to these problems, the Government has adopted a new energy orientation based on the development and use of renewable energies such as solar, wind, Biofuel and hydroelectricity.

**Environment policy**

The problems and constraints related to environmental management in Senegal derived from unsustainable practices: obsolete industries, average age of vehicles about 15 years old, unsustainable agricultural methods, forest degradation and difficulties in waste removal. This situation exacerbates substantially population’s poverty and vulnerability.

To find a solution to these problems, Senegal has taken various initiatives including the development of a sustainable development strategy and a Sector Policy Letter for Environment (LPSE) for the reversal of trends in perspective of achieving the Millennium Development Goals. Senegal has signed the Kyoto Protocol and a legislative and regulatory framework for environmental protection has been adopted since 2005.
Biomass consumption (40% for firewood and 16% for charcoal) represents a strong forest attack. Senegal has decided therefore to support any initiative aimed at diversifying energy sources, including renewable energies.

It is in this sense that Senegal has adopted a new energy policy that aims to:
• develop the institutional capacity and energy production
• promote the driving force in productive activities• involve private operators, village associations and local governments in infrastructure development and energy service
• ensure the financing of energy sector development;
• diversify energy sources and technologies;
• promote energy efficiency and renewable energy implement a program investment for access to energy services for economic and human development
• improve and secure access of populations to domestic fuels in a perspective of biomass transition;
• increasing access to energy services in rural and sub-urban areas in order to facilitate the functionality of basic infrastructures (schools, health facilities, storage facilities etc.)
• improve access to oil.

6.8 Biofuel industries/programmes development:

Biofuel program
Since 2006, Senegal has launched a National Program for Biofuel Production, with the aim of contributing to national energy self-sufficiency in the production of bio energy alternatives. This program provides, by 2012, to cover 321000ha of Jatropha plantation in the 321 Rural Communities that form the country, with a production goal of 1190.000.000 litres of refined oil from seeds.

The objectives of the Senegal Biofuel program are:
• Crop Diversification
• Reducing household and state oil invoice.
• Energy Independence
• Sufficiency in diesel from 2012 through satisfaction of national needs
• Production of ethanol from crops like sugar cane.
• Bioelectricity production from power plants that operate with Jatropha crude oil.
• Jobs creation and agricultural jobs sufficiently paying. (about 100 000 direct jobs)
• Accelerate the modernization of agriculture.
• Creation of an attractive and appealing environment in rural areas.
• Improvement of balance of trade and payments.
• Improving the environment.
• Reducing poverty and disparity between rural and urban world.

The programme will be implemented in three phases:
- Phase 1: Production of raw material (Jatropha seeds) 2007 - 2012.
- Phase 2: Processing Jatropha seeds into oil
- Phase 3: Biofuel distribution

In the first phase, the programme has already planted 5293 ha (2007-2008) and is expecting to plant 10 000ha in 2009 while producers demand is for 15,500 ha. Rural producers and organizations are now keener to the crop. Demands generally come from individuals, rural associations, industries (SOCOCIM), NGOs, and rural association, women and youth groups.

Program organization:
A National Technical Committee, headed by the Minister of Agriculture is responsible for implementing the seed production at national level. The technical committee has also technicians from the Ministry Department, peasant organizations, professional agricultural organizations, elected officials; deputy Governors for Development, youth and women village association’s representatives, partners in Development (NGOs), projects and programs. At departmental and local levels, supervisors are nominated by the farmers’ organizations. Technical coordination is ensured by the Senegalese Institute for Agricultural Research (ISRA). A National Program Supervisor represented by the President of the National Rural Councillors Association in Senegal (ANCS) is responsible for the sensitization component towards rural authorities and rural producers. He should feedback their expressions of needs to the program’s National Coordination.

6.9 Crops used for Biofuel:

Types: Jatropha curcas for biodiesel and crude oil fuel; Sugarcane for ethanol production. Biofuel conversion technology from Jatropha seed has not started yet. However CSS (Senegalese Sugar Company) has inaugurated in 2008 a new bioethanol plant. The distillery from molasses has an annual production capacity of 10 to 12 million liters of ethanol, intended for the company consumption and Senegalese market supply (clean fuel, pharmaceutical alcohol and drinks).

For its second phase (processing Jatropha seeds into oil), the National Biofuel Program has the intention to use oil presses or light expeller units for on-farm or community Biofuel production. Biodiesel production plants will be used at industrial level.

Market: The Biofuel program is actually at plantation stage. However, actors involved in the production (rural producers, private actors and institutions) are already organizing themselves into a professional network in order to anticipate and prepare market dispositions as well as production and supply chain unionization. The founding general assembly of the Biofuel sector was held on September 2009.

6.10 Implications for land tenure, water and employment:

Land tenure: In its scope, Senegal is composed of 321 rural communities (rural administrative zones). The national Biofuel program has planned to cover 1 000ha of Jatropha in each rural community. This very arithmetic orientation may create land tenure problems because, some of the rural communities do not have enough land to host 1 000ha for this new additional crop, unless there is land expropriation or potential conversion from land-for-food crops to land-for-energy crops.

Food security may also be affected when good oil price conditions can attract peasants to switch their traditional food crops to Jatropha cash crop. National Biofuel program’s approach should give consideration to this situation and reformulate its position about land tenure.

Water: In order to mitigate water problems or conflicts with food crop irrigation, Senegal has opted for rain fed cultivation of Jatropha which is a plant with less water need. Though it is important to notice that, in areas with rainfall less than 700mm, young Jatropha plantations, for survival, need to be watered in the first two years. Water problems may then occur in most rural communities comprised within these isohyets. In these agro-pastoral areas, conflicts in water affectation can be expected if Jatropha is planted at large scale as planned in the Biofuel program.

Employment: The National Biofuel Program has the aim to boost employment in rural areas.
6.11 Mapping of policy and institutions

First hand player.
APIX – Agence Nationale pour la Promotion des Investissements et des Grands Travaux (National agency for the promotion of investment and major works programs)
- Mission:
  • Improving the Senegalese business environment
  • Promoting Senegal, as an investment destination
  • Researching and identifying national and foreign investors
  • Follow-up of contacts and evaluation of investment projects
- Services:
  • Providing economic, business-related and technological information on a permanent basis
  • Welcoming and supporting investors throughout the investment chain
  • Supporting investors for the formalities of registration and for obtaining the various administrative authorizations
  • Directing towards financing structures/ Providing assistance in the search for partnership;
  • Solving of administrative problems.

Besides this, APIX fulfills all the functions of a one-stop office by:
- Issuing in 10 days the certification to the Investment Code and providing the exemption certificate for the customs formalities
- Issuing in 21 days the certificate to the status of an off-shore export company
- Carrying out within 48 hours formalities for administrative registration (NINEA - National Identification Number for companies and administrations, IPRES-pension fund-, Social Security fund, in the same place, and in the same form
- Ensuring a follow-up of the approved investment projects

National Ministries/Secretariats involved:
The Government’s political will to develop Bioenergy is real and is illustrated by the creation of a ministry in charge of Biofuel. However, instability is denoted in the research of adequate ministerial supervision for hosting this Biofuel department. Since its beginning in 2007, Biofuel program has been hosted successively by the following ministries:
- Ministry of Agriculture and Aquaculture and Biofuel (2007)
- Ministry of Energy and Biofuel (October – December 2009)
- Ministry of Biofuel and Aquaculture (since December 2009)
Though the Biofuel program will be run by the later ministry, other ministries still remain involved in the bioenergy planning and application: Agriculture, Energy, and Scientific Research.

• Directions and institutions involved
ANCAR (National Agency for Rural and Agricultural Advisory). The Agency’s main task is to establish an advisory service to producers and to meet their needs through contractual arrangements. The approach to agricultural and rural council is based on a true partnership with farmers and key stakeholders in rural development.
ANCAR intervenes in all sectors (agriculture, forestry, and environment) and includes several functions (advisory support, transfer of appropriate technology, awareness, training, information, and intermediation) and activities (production, marketing, supply, credit, processing, crafts…). ANCAR has been officially assigned as a public partner in the implementation of the National Biofuel program

ISRA (Senegalese Institute for Research in Agriculture). Its main task consists of designing and implementing of research programs on crop production, forestry, animal and fishery and
rural economy. The coordination of the National Biofuel program is carried out by ISRA. Important research on Jatropha is being implemented particularly on selection, multiplication and agronomy. In the program, Jatropha seedling production and propagation is under ISRA’s prerogatives.

National Technical Committee is created at the beginning of the Biofuel program by the ministry of Agriculture. The Committee is responsible for the implementation of the program, particularly seed production in rural areas. It is headed by a national coordinator (ISRA) and supervised by the President of the National Rural Councillors Association.

Regional and Local authorities involved in bioenergy plans, programmes, projects:
Chief of rural communities: These elected administrative authorities, in collaboration with their local community council, are the only one to have ability to identify, select and allocate land. One their mission is to facilitate in place, state programs implementation; that is why they are playing an important role in the National Biofuel program.
Women groups and youth associations: With the enthusiasm created by the new bioenergy sector, most women and youth groups are organizing themselves in order to take full advantage in opportunities offered the Biofuel program. They are already implicated in the multiplication of Jatropha plants they sell to the program. Few women groups have already signed MOU with the Biofuel program for Jatropha plants production and supply.
Farmer’s organisations: At departmental and local levels, supervisors are nominated by the farmers’ organizations.

NGOs involved
• ENDA Energy aims to contribute to a better understanding of energy and development issues in Africa from technical, economic, political and social standpoint. ENDA has also the objective to contribute at the definition of conditions for better access to energy services as a priority for the poorest people; and also to participate to the development and implementation of Multilateral Agreements on Environment by African countries: Conventions "Desertification", "Climate Change", "biodiversity", etc.
• CULTESA (Centre for Research in Biotechnology –Spain) is helping the Biofuel program to get adequate needed infrastructures in biotechnology for its multiplication activities of planting materials. A modern shade house of 5 000m² is created for acclimatizing of Jatropha vitroplants, and a training plan in the use of biotechnology for Jatropha propagation, is adopted and is actually in execution for Senegalese technicians.

Other stakeholders identified.
Some local industries are involved in Biofuel production but mainly for their own use. These are:
• CSS (Senegalese Sugar Company) is producing Ethanol from Sugarcane
• SOCCOCIM (Local cement Company) aims, in very short term, to use Jatropha as additional energy feedstock for its operation. Plantation of Jatropha has started since 2007.
• SODEFITEX (Local cotton Company) is experimenting cultivation of sunflower for Biofuel production. For the company, irrigated sunflower, as annual crop, can integrate local crop rotation and bring additional revenues to their partners (cotton producers) during dry season.

6.12 Links in biofuels development in Senegal
Legend:

- **Direct** (Documents product submission required)
- **Indirect**
- **Needed**

- Min Biof & Aqu: Ministry for Biofuel and Aquaculture
- Min. Energy: Ministry for Energy
- Min Agricult: Ministry of Agriculture
- Chief rural comm.: Chiefs of rural communities
- APIX: National agency for the promotion of investment and major works programs
- ISRA: Senegalese Institute for Research in Agriculture
- NTC: National Technical Committee
- WYG: Women and Youth groups
- F. org: Farmers organization
- ANCAR: National Agency for Rural and Agricultural Advisory
- Cultesa: Centre for Research in Biotechnology – Tenerife - Spain
- SOCO CIM: Local cement industry
- CSS: Senegalese Sugar Company
- SFTX: Cotton industry
6.13 Summary of biofuels activities implications in Senegal

<table>
<thead>
<tr>
<th>Issues</th>
<th>INDUSTRY Jatropha for oil and biodiesel</th>
<th>FARM Predominance of small and marginal farmers</th>
<th>MARKET DState and organisms officially recognized by State Ethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Enough marginal lands suitable for Jatropha cultivation.</td>
<td>- Biofuel conversion technology from Jatropha seed has not started yet</td>
<td>- No market supply yet; untested market</td>
<td>- In NBP conditions, biodiesel will be sold to the State or to private market organizations in a price fixed by a State/partners agreement.</td>
</tr>
<tr>
<td>- Jatropha is locally adapted and well known as fence crop.</td>
<td>- NBP has opted for light expeller units for on-farm biofuel production and encourage the development of biodiesel production plants at industrial level</td>
<td>- Real market potential for local consumption.</td>
<td>-</td>
</tr>
<tr>
<td>- Raising demand from farmers to join the national Biofuel program (NBP).</td>
<td>- Government through APIX (Agency for the promotion of Investments) provides needed administrative, informative and counseling supports to investors.</td>
<td>- Many on-going agricultural research.</td>
<td>- Private actors and structures are already organizing themselves into a professional network in order to anticipate and prepare future market dispositions</td>
</tr>
<tr>
<td>Policies</td>
<td>- Strong Government political will, illustrated by a new ministry for Biofuel and by the NBP implementation</td>
<td>- Expansion of small scale expelling units is expected in rural areas.</td>
<td>-</td>
</tr>
<tr>
<td>- The NBP provides seeds and seedlings with high yield varieties to partners. It offers also technical support</td>
<td>- Raising interest and demands from local and foreign investors, on investing to biofuel</td>
<td>- For biodiesel plants, two types of feedstock from farmers is planned: oil and seeds</td>
<td>-</td>
</tr>
<tr>
<td>- Many on-going agricultural research.</td>
<td>- Government through APIX (Agency for the promotion of Investments) provides needed administrative, informative and counseling supports to investors.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Emergent patterns/relationships</td>
<td>- Professionalization of the Biofuel sector: A Biofuel chain network has been launched in 2009.</td>
<td>- Expansion of small scale expelling units is expected in rural areas.</td>
<td>-</td>
</tr>
<tr>
<td>- Emergence of new private Jatropha nurseries run by trained rural women groups and youth groups.</td>
<td>- Raising interest and demands from local and foreign investors, on investing to biofuel</td>
<td>- For biodiesel plants, two types of feedstock from farmers is planned: oil and seeds</td>
<td>- Private actors and structures are already organizing themselves into a professional network in order to anticipate and prepare future market dispositions</td>
</tr>
<tr>
<td>- Land tenure based on protection of national patrimony: land belongs to the state and is not subject for sale or lease.</td>
<td>- Acquisition of new technical skills for rural populations involved in on-farm biofuel production.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Impact/future implications</td>
<td>- Valorization of poor lands in this desert margin country.</td>
<td>- Boost employment and increase income in rural areas.</td>
<td>- New source of income for Jatropha seed and oil rural producers.</td>
</tr>
<tr>
<td>- Soil fixation against land erosion.</td>
<td>- Acquisition of new technical skills for rural populations involved in on-farm biofuel production.</td>
<td>- Protection of the national economy: For any biodiesel industry establishment, 51% of the capital should belong to Senegalese (according to the NBP conditions).</td>
<td>- Significant reduction of mineral oil invoice at national level</td>
</tr>
<tr>
<td>- New income generation for rural population.</td>
<td>- Acquisition of new technical skills for rural populations involved in on-farm biofuel production.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>- Risk for food to Biofuel conversion because of lack of policy protecting food production areas.</td>
<td>- Boost employment and increase income in rural areas.</td>
<td>- Protection of the national economy: For any biodiesel industry establishment, 51% of the capital should belong to Senegalese (according to the NBP conditions).</td>
<td>-</td>
</tr>
</tbody>
</table>

6.14 Conclusions

Senegal’s interest in promoting a biofuels programme (NBP) responds to the ongoing activities mainly with Jatropha. The country does have restrictions on energy access and most of the fossil fuel needs to be imported. There are areas in Senegal where water availability does not represent a problem for agriculture while the extension of the Sahel continues to be a problem. Considering the development of biofuels as an activity in the agriculture sector, there is still a need to link the objectives and in-field activities of the Agriculture Ministry, the Biofuel Ministry and with the Energy Ministry.

According to the research more rural communities are engaging in the cultivation of Jatropha but there is still little evidence of the mechanisms necessary to fully incorporate farmers in a more skilled manner in these activities. Despite the imports on food products (e.g. rice) there is also no evidence of a threat of food production regarding the biofuels activities in the country. Nevertheless, the future activities (considering the Biofuel Program) need to be
cautious for large scale production. The Biofuel Programme is focused on one single crop (Jatropha) and despite that one of the objectives is to look for crop diversification, there might be the risk of putting all efforts into one single crop.

However, Senegal should take opportunity from this less water needed crop (Jatropha) to revalorize its marginal Sahelian lands. Large scale production and the increasing number of demands from foreign investors could be oriented toward these lands. While in rural farms and in food production areas policy should be better focused to crops that can assure food and energy. Sweet sorghum and *Moringa oleifera* are adapted and well known by local farmers. These two food/energy crops will at the same time contribute to the achievement of diversification objectives.

The country is continuing an Agricultural reform process focused on food products but also on other crops (e.g. groundnuts). These reforms may have a benefit in terms of agricultural production such as improving the yields. If adequate measures are taken there is no need to compromise food and biofuel production at the farm level, benefiting the farmers with additional income and if possible access to electricity.
7. MALI CASE STUDY

7.1 Country’s characteristics.

Location
Located in West Africa, Mali is lying between 10° and 25° N and 4° and 12° E. Neighbouring countries are Algeria, Niger, Burkina Faso, Ivory Coast, the Republic of Guinea, Mauritania and Senegal.

Geographical characteristics
Surface: 1,241,328 km² out of which 65% is desertic or semi-desertic. Country divided in three decentralised layers of government: regions (8), cercles (49) and communes (703) plus the capital district of Bamako.

Environmental characteristics
Food production in Mali has historically been highly variable due to fluctuating rainfall, which also influences river levels and hence irrigated as well as rainfed agriculture. This variability, combined with a low percentage of total production entering the market, makes market rises and quantities highly volatile. For example, during the 1980s and 1990s, millet and sorghum prices sometimes varied by a factor of 1:4 from year to year (Dembele and Staatz, 1999). Such instability makes food, and especially cereal, marketing risky, whether carried out by the public or private sector.

7.2 Population Size and Characteristics

Provisional data from the 4th General Census of the Population and Habitat (INSTAT, 2009), April 2009 showed a total population of 14,517,176 inhabitants. This represents an averaged
annual population growth of 3.6% since 1998 when the population was 9,818,911 inhabitants. Women account for 50.4% of the population. The census also counted a total of 2,369,866 households and 11,453, settlements (villages, fractions, quartiers). Hence, in average 6.1 people live in one household and around 1,268 persons compose a mean Malian settlement. Population is not evenly distributed through the Malian territory. The most populated region is Sikasso (18%), followed by Koulikoro (16.7%) and Segou (16.1%). The less populated is Kidal (0.5%). The capital district of Bamako represents 10% of the total population (UNDAF, 2009).

7.3 Gross Domestic Product and Human Development Index

The human development index (HDI) for Mali is 0.371, which gives the country a rank of 178th out of 182 countries (UNDP, 2009). Touched by the financial and food crisis the Malian government has employed important fiscal resources to ensure that primary necessity articles remain accessible to the population. Economic growth has slowed down from 8% in 2008 to around 4.1% for 2009. Similarly inflation has changed from 1.4% in 2007 to 9.2% in 2008. The hike of fuel prices during 2008 was taken by the Malian state through substantial fuel subsidies to remain competitive in the subregion. Despite being a net fuel importer and landlocked, fuel prices in Mali are lower than in neighbouring coastal countries. During 2008 the prices of cereals was increased by 33% (UNDAF, 2009).

7.4 Main food crops

The main crops in Mali are rice, cotton, millet, sorghum, karite (sheanuts), maize and vegetables.

Table 7.2 Agricultural production in Mali (Thousands of Tons)

<table>
<thead>
<tr>
<th>Year</th>
<th>Groundnuts</th>
<th>Millet</th>
<th>Rice, paddy</th>
<th>Sorghum</th>
<th>Maize</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>23,426</td>
<td>44,875</td>
<td>41,248</td>
<td>27,511</td>
<td>16339</td>
</tr>
<tr>
<td>2006</td>
<td>23,138</td>
<td>47,588</td>
<td>39,186</td>
<td>32,707</td>
<td>16396</td>
</tr>
<tr>
<td>2007</td>
<td>23,170</td>
<td>48,464</td>
<td>48,391</td>
<td>29,591</td>
<td>13160</td>
</tr>
</tbody>
</table>

Source: FAO Stats (2009)

Figure 7.2 Evolution of selected agricultural products in Mali
Rice production is concentrated in the Office du Niger (ON) Zone with the rest of the production is done in rain feed fields and draught resistant rice varieties such “Nerica” (Nouveau Riz pour l’Afrique) in the southern regions of Mali (Kayes, Koulikoro et Sikasso) with a pluviometry above 900mm per year. Mali exports rice to Burkina Faso, Mauritania and Nigeria and has made some progress in recapturing the regional market from imported Asian rice3 (Coulibaly et al, 2009).

7.5 Predominant land characteristics

Mali depends on small family exploitation (68% of farmers cultivate less than 5ha) (Samake et al, 2009). Out of a total area of approximately 124 million of hectares, Mali has 5.5 million hectares of forest, 43.7 million of hectares of land suitable for the agriculture and livestock production and 74.8 million of hectares of desert. Mali has an estimated potential of 2.2 million hectares of land suitable for irrigation, out of which 960,000 hectares are attributed to the Office du Niger (ON). Mali’s agricultural sector is thwarted by numerous constraints relative notably to: a) its physical and institutional environment characterised by: (i) a deficit in rainfall, drought and irregular water levels; (ii) repeated locust outbreaks and invasion by floating plants; (iii) insufficient water control and non-mastery of the technical conditions of production, attested by a low level of productivity and agricultural wages; and b) issues relative to land security, factor costs and financing. Land composition and productivity vary from north to south following a rainfall gradient and according to soil quality and their topographical position.

Land not occupied by crops is generally considered as having a sylvopastoral use. Pastures under these conditions cover about 49 million hectares. Their composition and productivity vary from north to south following a rainfall gradient and according to soil quality and their topographical position.

7.6 Characteristics of livelihoods

It is estimated that a fourth of the households in Mali are in a chronic situation of food insecurity with cereal consumption representing around 50% of household expenses (UNDAF, 2009). Economic poverty4 according to official figures in 2006 was 47.4% (Mise, 2009).

The Malian land tenure is complex and characterised by the co-existence of customary and modern land tenure laws. Land tenure is governed by the “Code domanial et foncier” of 2002 (Ordonnance, 2002). This law in principle recognises customary law but grants ownership of land to the State, while individuals or groups of individuals only have the right of usufruct. Land can be accessed in three ways: renting, allocation or grant. Each of these methods has specific problems, mostly related to fulfilling commitments and complying with the agreed development period.

Customary laws are oral, vague, variable, unpublished; and their co-existence with modern law is still conflictual. Customary tenure is based on kinship, gerontocracy, seniority, indigenousness and gender, to the disadvantage of women(Mali, Country Strategy Paper, 2005). Although women represent the majority of the agricultural work force less than 2% of women have registered property rights (Foncier, 2009). Land conflicts which occur on a

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3 Currently, 60% of the demand for rice in West Africa is supplied by imports, mainly from Asia
4 Share of the population that consume less than the equivalent of 157,920 FCFA (240 EUR) per year, per person.
permanent basis, are exacerbated by demographic growth, high urbanisation rate, recurrent drought and poor land management practices.

7.7 Policies in place and link with the bioenergy sector

National level
The Poverty Reduction Strategy of the GoM (IMF, 2008), highlights 3 main strategic orientations policies which the country intends to implement for 2007-2011 period. These orientations are:
- Development of infrastructures and the productive sector;
- Pursuance and consolidation of structural reforms;
- Strengthening of the social sector (education, health, water access).

These 3 orientations are detailed in 13 priority areas, being the 3 first: (1) Food security and rural development; (2) development of small and medium size enterprises; (3) protection and sustainable management of natural resources.

Private sector
New investments in Mali are governed by the Mali’s Investment Code (Code, 2005). This code encourages companies to settle investments in Mali, principally in the industry and agro forestry and pastoral business. Importation taxes on materials and machinery and other taxes such as the industrial and commercial benefits can be exonerated for periods depending on the size of the investment. The code also encourages settlement in regions with low industrialization, the consumption of local materials, the investment in research and development and training of qualified personnel.

Agriculture and environment
In 2006 Mali adopted the Agriculture Orientation Law (Loi, 2006) with the objectives of ensuring food security, promote sustainable agricultural production and enhance environment protection through more involvement of local municipalities (decentralization) and coherence with UOEMA regional legislation. Although this law is especially meant to minimize impacts of risk and calamities on agricultural development, no specific subsidies exist for environmental friendly enterprises. Further, there is little reliable information and weak functioning of different parts of the government to include environmental aspects into projects and programs evaluation and enforcement (Mise, ny).

The Malian government has launched important initiatives to increase rice\(^5\) (in 2008) and maize (in 2009) output. However, despite a general increase of production, availability of such products and price reduction to consumers have been produced, mainly to weak supply chains and inefficient internal markets.

A state secretary has been created to develop and increase the productivity of the ON and its institutional and management capacity. Water use, including irrigation and industrial use, is governed by the Code of Water (Loi, 2002). The GoM foresees the development of a total of 100,000 ha for 2012 of irrigated land, mostly at the ON (60,000 ha).

Energy
Mali has important energy needs as only 23% of Malian households have access to electricity (58% in urban areas and 11.23% in rural areas). In 2006 a National Strategy on Renewable Energy, promoted by Ministry of Energy and Water (MEE) in collaboration with the ministries of Agriculture, Finance, Commerce and Environment, was set up to obtain a

\(^5\) Official estimations are the production of 1.6 million tons of rice for 2008-2009 and 2 millions tons of rice for 2009-2010.
10% reduction in fossil fuel imports by 2014, a 15% reduction by 2019, and a 20% reduction by 2024.

This energy policy is defined by 5 major objectives:
- to improve access to energy especially from renewable sources
- to rationalise the use of existing energy sources
- to make more efficient the use of existing natural resources to produce energy
- to promote the sustainable use of biomass resources through the conservation and protection of forests
- to strengthen government capacity and streamline administrative procedures within the energy sector

7.8 Biofuels industry/programmes development

Biofuels play a major role to achieve the objectives of the National Strategy on Renewable Energy. These objectives have been synthesised in the National Strategy on Biofuels that will be implemented in by the National Agency for the Development of Biofuels (ANADEB) legally established on 5th June 2009\(^6\). ANADEB will develop and then oversee a legal framework to promote investments and development on biofuels.

Biofuel production programmes in Mali are centred in two crops: 1) small scale production of Jatropha Curcas oil and biodiesel through groups of farmers and small private farms; 2) industrial ethanol production as by-product of sugar production, from irrigated sugar cane plantations on the Office du Niger (ON) zone. Other vegetable oils, such as cotton and peanut oil, have a high demanded (and margins) in an unsatisfied local alimentary oil market, which makes them unsuitable candidates for biofuel operations.

7.9 Crops used for biofuels

Jatropha Curcas

Mali has been at the centre of Jatropha oil as biofuel development in West Africa. Jatropha was introduced in Mali with a role as live fence, territory demarcation and erosion protection (Yossi et al, 2006).

Although it estimated that Mali has more than 20,000 km of Jatropha hedges (UNIDO, 2008) they are geographically dispersed and with little or no maintenance. Hedges yields are estimated between 1 and 2 kg per lineal meter. However, few seed collection is carried out due to the virtual inexistence of formal Jatropha seeds markets and limited awareness of its commercial value. Collected seeds are used locally for traditional soap manufacture, both task mostly carried out by women. The main zones with Jatropha concentration are the regions of Kayes, Koulikoro and Sikasso.

Several private ventures and NGO projects have been initiated over the past 5 years to increase the intensity of Jatropha seed production and develop oil extraction to power agricultural machinery and small-scale electrification. One private venture has also started to produce biodiesel (fatty-acid methyl esthers) from Jatropha oil. These ventures and projects are active in specific regions, collaborating with formal farmers associations or informal village level organisations, such as the cotton production committees (developed by the CMDT) and women groups. However, in all the cases, intense work has to be carried out to offer extension services to farmers to improve their agroforestry techniques to produce Jatropha. Outside the ON zone large extensions of private land developed with Jatropha by

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\(^6\) ANADEB was created with the law N° 09-006/P-RM agreed by the General Assembly (Parliament) on 04 march 2009 and promulgated by the President on 05 June 2009.
a single individual or company are not well documented and very unlikely due to the Malian land tenure system. In the ON zone, various Jatropha ventures are in the process to start-up with land allocated but Jatropha planting and development of infrastructure has yet to materialise (see more in ANDEB’s registered projects).

**Sugar cane**
The development of sugar cane production in Mali has been important only since 1972 thanks to financial and technical cooperation with China in the ON zone. In 1996, the Malian state sold its majority stake of Sukala SA to a state-owned Chinese company. Sugar production in Mali is only 23% of that of its estimated 150,000 tons per year requirements. Sukala SA who owns and exploits around 5000 ha of sugar cane in two plantation sites for the primary production of sugar and ethanol for the alimentary and pharmaceutical industries. In recent years the GoM has worked to ensure foreign investments to boost the sugar production. At the end of 2009 two new large projects have been formalised to produce sugar and ethanol in the ON: N-Sukala (NS) and the Markala Sugar Project (PSM).

It is necessary to note that the ethanol produced by Sukala SA and future ethanol production of the N-Sukala and the Markala Sugar Project is ethanol with a purity of 95-96% (hydric ethanol) used in the pharmaceutical and beverage industries. However, such ethanol quality is not suitable as fuel additive as is not totally miscible in gasoline. Further treatment of the ethanol has to be carried out to remove the water (normally referred as drying the ethanol) for its use as fuel additive for internal combustion engines.

**Other crops suitable for biofuels**

**Cotton**
Cotton yields in Mali are approximately 1 ton per hectare, out of which 43% is fibre and the rest is cottonseed. From 1 ton of cottonseed a total of 100 litres of cotton oil can be extracted and the press cake is a very appreciated protein meal on animal feed husbandry (CIRAD, 2008). Tests on diesel engines running straight cotton oil have been carried out by the NGO GERES in the Koutiala cercle of Mali and by CIRAD in Burkina Faso.

Cotton production in Mali is organised principally by the activities of CMDT and OHVN mobilising thousands of small producers (average cotton exploitation is smaller than 3 ha). Mali has seen a dramatic decline of cotton production in the past 3 years, which has been detrimental to the local oilseed extraction industry. The 2008/09 harvest of 201,000 tons of seed cotton and approximately 85,000 tons of fibre and 285,000 bales is the lowest production level in over 20 years (Hanson, 2009). This situation has been translated to deficits on the vegetable oil production for the alimentary market and protein meal for livestock industry. Similar shortages of cottonseed in neighbouring Burkina Faso and Cote d'Ivoire pose a grim picture to private oil extractors. As a result, alimentary grade palm oil imports are expected to rise dramatically and animal feed products could become dearer.

The process of privatization of CMDT has significantly increased uncertainty in a sector that was already mired in high debts, structural problems and decrease in yields. A weak dollar in relation to the FCFA (the Franc CFA is pegged to the euro) and the global market situation has exacerbated the situation in Mali. Lower prices (between 160 and 200 FCFA /kg paid for the 2008/2009 harvest) and late payments are eroding the incentives for millions of smaller producers to continue producing cotton. The Malian government has installed initiatives to subsidize inputs although only a small amount of NPK fertilizer is currently available for distribution and its benefits have not been yet evaluated.

The cotton industry is in the process of reorganisation through coordinated efforts of international donors and by the eventual division of the CMDT in 4 regional companies

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7 Cost of NPK fertilizer is around 12 500 FCFA per 50 kg
Groundnuts (Peanuts)
Groundnuts are grown by a large majority of Malian farmers and as such, peanuts play an important role in the economy and diet in Mali. Groundnut hulls are used as fuel, and the burned ashes are used in local soap and lye production. Groundnut plants are important forage during the dry season. Groundnuts are grown throughout most parts of the country, although the major production regions are the west, southwest, and the centre of the country. About 6% of Mali’s arable land is under groundnuts cultivation. There are many small groundnuts transformation units producing mainly paste. Modern paste transformation is done by SOSIMAPA (Chinese capital) with a capacity of 1000 tonnes. Industrial groundnut oil extraction is done by Huicoma (around 5000 tonnes in 2001) (Smacke et al, 2009). This share is likely to increase as the company seeks to offset the fall of production and the cost increase of cottonseed.

Sorghum and millet
Millet represents 40% (about 1.5 million hectares) and sorghum 21% (about 0.8 million hectares) of the total Mali’s cereal production in 2008 that is almost entirely rainfed. Millet and sorghum yields average only 0.66 and 0.89 tons per hectare, respectively (Toure et al, 2006). By comparison, rice yields average 1.7 tons per hectare, and maize about 1 ton per hectare. IER has been testing sweet sorghum varieties for the production of sugar and ethanol. However, these tests are only small scale.

Sunflower
Sunflower cultivation in Mali is not very well documented, but a USAID Mali report quotes an expected production of 50,000 tons in 2008. The cultivation of sunflower is restricted to the southern parts of Mali (Sikasso region) and for the alimentary oil production market.

7.10 Implications of conversion of Biofuel raw material

Land tenure
A recent review of four small Jatropha producers projects and ventures (Mali Folkecentre’s Garalo project, Mali Biocarburant SA, the Jatropha Mali Initiative, and GERES) showed that the impacts of these programmes on land tenure and food security, are inexistent, albeit in the medium term (Palliere and Fauveaud, 2009). In all these initiatives, land ownership remains with small Jatropha farmers who normally produce less than 1 ha (many times on intercropped fashion). However, Jatropha adoption is slow due to the land delimiting character of Jatropha (internal land claims need to be solved before planting and limit the number of adopters) and extension services need to be offered, which translates into higher costs for these projects. Land tenure in the ON for biofuel production is through long term land concessions or holdings, which many times include the development of land for irrigation.

Water use
Mali Biocarburant SA has identified water access as one of the main barriers for Jatropha adoption, as it produces overlapping of agricultural calendars between Jatropha and cash crops. However, after cultivation, water use for Jatropha fields outside the ON is likely to negligible impact as few or no irrigation would be implemented. Farmers in the ON region have large family-based plots cultivating in a low-risk environment as part of a commercial strategy. They produce two crops a year, with rice only in the main
season and a mix of rice and shallots or onions in the counter season. The main problem for family farmers in the ON is a high water loss and inadequate drainage. Channel irrigation maintenance in the ON is carried out by 3 layers of responsibility, with the State in charge of the principal channels, the ON of secondary channels and private farmers of tertiary channels that irrigate their fields. However, a recent evaluation of the maintenance objectives found that none of the parties respects their contractual commitments (31% by farmers, 45% by the ON and 70% by the State) (Office du Niger, 2007). Further conflicts with water allocation can exist when the water requirements by the new large projects at the ON start to become operational in the following 2 to 3 years, especially during the counter season.

Employment
Jatropha based projects produce direct employment through extension services and oil extraction. Mali Biocarburant SA, for example, has around 50 salaried personnel for its operations. Indirect employment, through seed production, collection and commercialization has great potential to generate real sources of income. Most of the players in the Jatropha sector in Mali agree that a price of 50 FCFA per kg (0.08 EUR/kg) of Jatropha seed is necessary to make competitive straight vegetable oil extraction and biodiesel production in relation to Diesel costs. Comparative studies value the Jatropha production costs for small farmers between 18 and 42 FCFA, hence producing real benefits to farmers (Latapie, 2007).

Market
The demand for Jatropha grains greatly surpasses the supply. As mentioned before, the Jatropha seed market is virtually inexistent outside the areas of the different project interventions, where most of the seeds are used to sustain planting campaigns and local soap production. Due to this weakness, it has been reported that informal buyers trade seeds up to 10 times more expensive the price the buy with local farmers (usually less than 50 FCFA per kg). In order to meet its fossil fuel reduction targets, the Ministry of Energy estimates that 75,000 ha of Jatropha need to be planted, which would displace 84 million liters of Diesel (Klarsfield at al, 2009). Mali Biocarburant, has started biodiesel production on its 2000 litres per day facility since the summer 2009, albeit supplemented with imported palm oil from Ivory Coast. The actual Sukala ethanol production is 2.3 million litres of ethanol per year. However, none of this ethanol production is used as fuel.

End use
As mentioned before, most Jatropha projects are intended for local production of energy and local consumption of biodiesel. At least 3 factors promote this type of use: 1) the costly and logistically difficult exportation of goods from Mali (land-locked country), 2) projected internal growth and energy needs superior to fuel production, 3) Strong euro value which makes the exportation, if possible, unattractive outside the ECOWAS region. The actual ethanol production is consumed in Mali and Burkina Faso for the pharmaceutical and beverage industry. The biodiesel produced by Mali Biocarburant is mainly sold locally to private users and Grands Moulins du Mali (Flower mill). Mali Biocarburant also supplies straight Jatropha oil to a pilot programme of 10 Multifunctional Platforms (MFP) in collaboration with the National Multifunctional Platform Programme.

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8 For comparison the official cost of 1L of Diesel on January 2010 was 555 FCFA (8.84 EUR). In average, around 4kg of Jatropha seed are needed to produce 1L of oil.
9 Information from the Agency for the Promotion of the Investments in Mali (API)
7.11 Mapping of the institutions:

First hand players
The first hand player for the production of biofuel in Mali is the new National Agency for the Development of Biofuels (ANADEB), once a new biofuel law is approved by Mali’s General Assembly (possibly late May 2010).

ANADEB
The ANADEB is attached to the Ministry of Energy and created with the following objectives:

- To establish a centralized and harmonized framework for biofuel promotion;
- To increase the number of professionals working in the biofuels field;
- To enact production licensing requirements and technical quality standards for biofuels;
- To create a dialogue between main public and private actors in the field;
- To maintain trade between international partners in biofuels;

ANADEB efforts for the time being are focused on the development of 2 principal feedstock sources: Jatropha and sugarcane.

A draft of the legal framework for biofuel production is in consultation with other parts of the government and ANADEB. It is expected that the National Assembly pass it during the spring 2010. Some of the main characteristics of the draft pursued by ANADEB are:

- Tax free importation for biofuel producing equipment (presses, reactors, etc). However, importation taxes at UEMOA level would apply.
- Comply with the investment code (ministry of economy and finance). Tax breaks for up to 5 years will be encouraged inside the new introduced in the strategy of renewable energies allowed to private investors.
- Promote the production of biomass for the co-generation of electricity
- Establishment of quotas (to be defined) of biofuels produced in Mali for national consumption.
- Quality control in line with European and American standards
- The creation of a laboratory for testing of biofuels

ANADEB is carrying out public awareness campaigns with the conversion of agricultural machinery to use straight Jatropha oil and collaboration with other parts of the government, NGOs and private sector.

Office de Niger (ON)
The Office de Niger zone (ON) is one of the oldest and largest gravity-fed irrigation areas in sub-Saharan Africa. The ON is a State owned establishment with industrial and commercial character that comprises the area between the river Niger and Bani, in the circles of Segu and Niono, in the Segou region of Mali. This zone alone accounts for half of the Mali’s rice production. Historically, the ON has been considered as a ‘state within the state’ in reference to specific economic, political and social organisations that exists there (al AOE, 2007). A long story of reforms have transformed the ON from a closed state-run company to a more open to the private sector. Indeed, the ON has withdrawn itself from all crop harvesting and marketing functions but remains the critical actor for water access and

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10 Latitudes (13°54’29” N to 13°40’58” N) and longitudes (6°4’13” W – 5°50’7” W)
11 The Segou region, which includes both the ON lands and the adjacent smaller Office Riz Segou (ORS), has a central role in the production of rice supplying 87% of the total rice available for trade outside the region of production after local consumption needs are met.
fertilizer supply, albeit there has been a formal transfer of such responsibility to farmer organisations. International cooperation, notably French and Dutch, have pledged for the continuation and improvement of household farming and the production intensification supported by technical improvements.

Relations between the ON and many farmers and farmer organizations in its zone of intervention are generally poor. The ON is responsible for the allocation of irrigated parcels to users in the zone. However, final land ownership rests with the State and the ON functions as its agent. With a special derogation from this principle, farmers in the MCA Alatona project zone will be able to obtain actual land titles. Most ON land is held by family farms under 2 types of arrangements: 1) annually renewable farming leases that are not transmittable and 2) “farming permits” that are transmittable. These types of land holdings can be, and are commonly revoked, by the ON if farmers fail to pay an annual water use fee meant to finance ON-contracted work to maintain irrigation infrastructure. Water use fee payment is usually above 95 percent because ON evicts farm families with revoked permits. Accusations of non-transparency for the attribution of new parcels are common as the demand for such attributions outstrip the supply ON can offer.

Especially since 2002, other types of lease holdings exist to attract private investors who will construct new irrigation channels in return for long term (50 or 30 years) occupation rights granted as a reward for investment. One of the most high profile case under this scheme is the allocation of 100,000 hectares in the cercle of west Macina to Malibya Agriculture, a state owned company from Libya, for the production of rice, livestock farming and industry. Under this agreement a 40km supply channel with a capacity of 130 cubic meters per second will be developed.

**Multilateral**

**UEMOA**
The West Africa Economic and Monetary Union (UEMOA) is a regional organization seeking the economic integration of the state members. The UEMOA members (Benin, Burkina Faso, Côte d’Ivoire, Mali, Niger, Senegal, Togo and Guinea-Bissau) share the same currency, the Franc CFA, whose exchange rate is tied to that of the euro and is guaranteed by the French Treasury. The UEMOA promotes greater competitiveness of the economic activities with the framework of open markets and juridical environment rationalized and homogenised.

**European Commission (EC)**
Under the programmes for environment and rural development, the EC supports the activities at the ON with the development and integration of information systems (Vision project).

**The UN system (UN)**
The United Nations (UN) system in Mali, through UNDP (United Nations Development Programme) and UNEP (United Nations Environment Programme), have introduced programmes to help the GoM to tackle environmental issues and their link to poverty. These activities have had a major role in the development of the national strategy for renewable energy and support programmes, such as the Multifunctional Platform Programme and AMADER, to enable sustainable energy access in rural communities.

**Bilateral**

**United States of America (US)**
Through the United States Agency for International Development (USAID) in Mali and the Millennium Challenge Account (MCA) a 234.6 million USD irrigation project (Alatona

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12 Farmers with a history of maintaining annual leases are generally able to transform these into farming permits
irrigation project) has started at the ON (MCMali, 2009). This project consists on the redevelopment of 14,000 ha of agricultural land for increased productivity and production, through diversification of high-value crops such as sugar cane. The programme will upgrade 81km of roads (Niono-Goma Coura), support the ON water management, allocated new irrigated land to family farmers, women market gardeners, and farming companies in private ownership. Recipients will purchase the land by making annual payments over a 15-20 year period. The project will follow the process of parcel creation, land rights education, registration system upgrade, land parcel allocation and titling, and management of land revenues and will compensate families residing in the perimeter or with rights to land therein consistent with World Bank’s Operational Policy on Involuntary Resettlement by offering land in the irrigation perimeter or, if the land option is not chosen, other compensation alternatives. Social infrastructure, agricultural services and lending facilities are also part of the programme.

The redevelopment of the first 5200 ha started in July 2009 and will be completed in 20 months by the French company Sogea Satom-Razel. Another component of the project is the rehabilitation of the main irrigation channels and regulators by the Chinese company Synohydro Corporation Limited, which would increase the water delivery from 180 to 300 cubic meters per second.

**China (CN)**
China has become a leading trading partner with Mali with the involvement on more than 80 projects, including sugar, textiles, pharmaceutics, the, cigars and matches, rice dehulling equipment and sponsor of important infrastructure projects such a 3rd bridge in Bamako and the construction of the University of Mali infrastructure. State owned Chinese companies are active as contractors for infrastructure projects, notably in hydraulic and road works.

**Denmark (DK)**
The kingdom of Denmark is a technical and financial sponsor of ANADEB. Historically, the Danish cooperation has been very active in the areas of renewable energy and environment with funding to the NGO sector such as Mali Folkecentre.

**France (FR)**
The French Development Agency (AFD) has supported various initiatives in the ON for many years and is one of its lead donor. It currently carries out the project PADON which supports the ON on water administration and land redevelopment and supports producers via the regional agricultural chambers. The proposed expansion of the main channel systems will complement a planned AFD project to strengthen certain sections in the area.

**Netherlands (NL)**
The international cooperation from kingdom of the Netherlands has historically been very active in the agricultural sector and worked closely with the ON for the last 30 years. The Dutch cooperation has committed 3.1 billion FCFA for the “Programme d’appui au contrat Plan Office du Niger 2008-2012” that tries to strengthen the capacity of the ON through feasibility studies for redevelopment of irrigated land and extension work.

**Government of Mali (GoM)**
**Prime Minister Office**  
**Secretary of State in charge of the Integral Development of the Zone Office du Niger (SEDITION)**
The SEDIZON, created in April 2009, has as mission to transform the ON into an economic, social and cultural development driver for Mali. Before the creation of the SEDIZON, the Ministry of Agriculture had the guardianship of the ON.

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13 Before the creation of the SEDIZON, the Ministry of Agriculture had the guardianship of the ON.
during 2009 show the political will that the GoM has to attract important foreign investment in the agricultural business.

**Ministry of Energy and Water (MEE)**

**National directorate of energy (DNE)**

The DNA is in charge to administrate policy related to energy supply. The main objectives of the NDE are:
- To ensure that the greater number of the population has access to energy both in quantity and at low cost;
- To develop the national potential of renewable energy;
- To protect and preserve the existing wood fuel resources;
- To liberalize the sector by mobilizing more initiatives of the decentralized communities and private funds;
- To adapt institutions to the energy sector requirements through oriented capacities building, and the State strategic control.

**CENESOLER**

CENESOLER is the National Research Centre on Solar and Renewable Energies of Mali. CENESOLER has a large experience in biofuels, especially with Jatropha, since the late 80’s when it hosted and collaborated with various Jatropha initiatives including GTZ’s Jatropha project and the former National Program for the Energetic Valorisation of Jatropha. The activities related to Jatropha are now under the supervision of ANADEB\(^{14}\). The CENESOLER is trying to become a regional centre for biofuels that could supply technical services with support of the UEOMA.

**AMADER**

Created in 2003, AMADER is the Malian Agency for the Development of Domestic Energy and Rural Electrification. It is a Public Administrative Establishment (EPA) set up as part of a World Bank/GEF/GoM project to support rural energy development. AMADER main activities are to promote private and non-profit sector ability to develop and operate viable electrification projects in rural and suburban areas through technical assistance and financial support (investment subsidies). AMADER also acts as de facto energy regulator in rural and suburban areas. Fuel costs in rural settings and the low level of constant payment subscribers are one of the recurrent problems for the profitability of many of the AMADER projects.

**EDM SA**

Electricité du Mali SA is the national electricity company in charge of production, transportation and distribution of electricity in the district of Bamako and the principal urban areas of Mali. Mali’s share of electricity production from thermal stations has increased from 23% in 2006 to around 45% in 2007 supported entirely by importation of fossil fuels (Diarra, 2009). The rest of the electricity production is produced through hydroelectric generation.

**Ministry of Mines (MM)**

The Ministry of Mines is in charge of managing policies for the exploitation of mineral resources in Mali, being the most notable gold, diamonds, phosphate and uranium.

**National Direction of Geology and Mines (DNGM)**

The National Direction of Geology and Mines is in charge of produce the policy documents related to research, development, exploitation and transformation of the mineral resources. The DNGM has a division for hydrocarbons and facilities for testing of minerals. Initial work with ANADEB is foreseen to help to draft national standards in terms of biofuel quality requirements.

\(^{14}\) The actual director of ANADEB is the former director of CENESOLER
Ministry of the Industry, the Investments and Commerce (MIIC)
API
The Agency for the promotion of the investments (API) has been recently created to collaborate assist different investment in Mali. It also offers a 'one-stop' window to register companies under the Malian Law.

Ministry of Economy and Finance (MEF)
ONAP
The National Office of Petrol Products (ONAP) is a EPA organization with moral and financial autonomy. ONAP seeks to ensure the availability of oil products in Mali, contribute to the definition of pricing policies and national stocks, fight against fraud in the oil subproducts sector and collect, organise and disseminate statistical and research information about the oil sector. Other attributes to ONAP are the definition of norms and control quality of oil based products in Mali.

Ministry of promotion of Women, Child and Family (MPFEF)
The MPFEF has under its guidance the Multifunctional Platform Program (PTFM) that has been a mayor player in the development of Jatropha oil as fuel in Mali.

Multifunctional Platform Program (PTFM)
The concept of a Multifunctional Platform was developed in Mali and is now a UNDP regional programme (Senegal, Ghana, Burkina Faso, Ghana, Mali). It consists of a small stationary diesel engine powering different productive modules (cereal thresher, cereal mill, water pump, battery charger, electricity generator). A PTFM is managed and owned by women groups that benefit from important time reductions of agro processing activities. The program has important impacts such as local employment, health improvement through better diet and increased school attendance of young girls. The PTFM programme traces its roots to the German Technical Cooperation (GTZ) in Mali during the late 80's where pioneering work was carried out to use Jatropha oil as fuel for its engines. PTFM programme has installed around of 600 platforms in Mali and has the commitment to install another 300 in a 3-year period. Since October 2008 the PTFM program collaborates with MBSA for the set-up of 10 PTFM running on Jatropha oil through the intensification of Jatropha cultivation in those villages. The PTFM programme also works closely with AMADER to develop rural electrification programs where successful PTFMs are upgraded to small electricity suppliers.

Ministry of Environment and Sanitation (MES)
Agency for the basin of the Niger River (ABFN)
The mission of ABFN is the protection, promotion and sustainable management of the Niger river and prevention of natural risks (flooding, erosion and draughts).

Ministry of Agriculture (MA)
Institute of Rural Economy (IER)
Mali’s Institute of Rural Economy is a research organisation with technical expertise on agronomy, livestock, forestry, fisheries and systems of rural production and agricultural land development. The IER is active in the transfer of technologies and research staff training (including demonstration fields, seeds improvements) through 6 research centres, 8 stations and 12 sub-stations in the Malian Territory. The IER is carrying out tests with sweet sorghum for production of sugar and methanol.

CMDT
The Malian Company for the Development of Textiles (CMDT) was founded 1974 by the Malian state to administrate the national cotton production. CMDT is finalising a long privatisation process and remains the biggest supplier of inputs for cotton crops (such as NPK, seeds) and market price for cotton. The capital of the company belongs to the Malian
state (60%) and to the French organization DAGRIS (Développement des Agro-Industries du Sud). The CMDT intervenes principally in the regions south of the Niger river (Cercle of Dioila in the Koulikoro region, circles of Baroueli, Bla and San in the Segu region and the entire Sikasso region) and the East of Mali ( cercle of Kita). This zone comprises around 28% of the national population of Mali. The cotton cultivation is carried out during the rainy season of May to beginning of October. The CMDT is the principal player for ginning (separation of seed from fibre) the cotton. Cottonseeds are then sold to private oils extractors, such as Huicoma. Local transformation of cotton fibre into textile products is carried out by COMATEX and FITINA. However, this accounts only about 1% of the fibre production. The CMDT works closely with the producers, through a large network or village agents and farmers organised cooperatives. Village agents and cooperatives participate in the acquisition of fertiliser and pesticides needed for the cotton production. They also set prices before the season, manage credit to farmers and organise the transport of the harvest.

**OHVN**
The Office of the High Valley of the Niger (OHVN) develops the cultivation of cotton and other agricultural products in the circles of Kati, Koulikoro and Kangaba. OHNV is the second producer and trader of cotton in Mali. However, OHVN is not involved in any transformation process, leaving it to the CMDT.

**Ministry of Secondary and Higher Education and Scientific Research (MESSRS)**
This ministry manages and orients higher education of the University of Mali. Within the University of Mali, two high education schools produce activities related to biofuels: IPR/IFRA and ENI.

**The National School of Engineers (ENI)**
ENI is active in the promotion and testing of vegetable oils as alternative fuels. It collaborates with ANADEB in the realisation of comparative tests of engines using Diesel and Jatropha oil.

**IPR/IFRA**
The Polytechnic Institute of Rural of Training and Applied Research (IPR/IFRA) focus its work on research and teaching of agronomy and animal husbandry. Located in Katibougou, region of Koulikoro, this centre is active in agronomic research on Jatropha curcas and local oil extraction.

**Non-governmental sector (NGO)**
The NGO sector involved in the production of biofuels is concentrated on Jatropha production.

**African Association for the Promotion of Biofuels (AAPB)**
The AAPB is an umbrella organization integrating biofuel producers. Although it’s main office is in Ouagadougou, Burkina Faso it has a representation office in Bamako, Mali.

**AEDR-Teriyabougou**
Teriyabougou is a sustainable tourism initiative and local development in the shores of the River Bani in the commune of Korodougou, cercle de Bla in the region of Segou. The project has planted 230ha in collaboration with neighbouring villages. Teriyabougou counts with a

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15 Former Compagnie Française pour le Développement des Textiles (CFDT)
16 ITEMA (Industrie Textile du Mali) is another cotton fibre transformation company that is in the process to re-start activities.
18 Teriyabougou (Association Mali Aqua Viva) was started by the late priest Barnard Verspieren, who carried out some of Mali’s most important campaigns for providing drinking to rural populations.
Jatropha oil extraction facility and intents to supplement its diesel consumption with Jatropha oil.

**GERES**

Groupe Energies Renouvelables, Environnement et Solidarités (GERES) is a French NGO working in Koutiala, region of Sikasso. GERES has planted around half a million Jatropha shrubs for research of production, transformation and consumption within a very delimited area of straight Jatropha oil. GERES works with a private rural electrification concessionaries to evaluate the economic viability of Jatropha oil produced locally.

**MFC Nyetaa,**

Mali-Folkecenter Nyetaa (MFC) is a Malian NGO founded in 1998 with roots linked to the Danish Folkecenter for Renewable Energy. MFC is very active in development of local use of straight Jatropha oil and has assisted in the transformation of multifunctional platforms on Jatropha oil and for the construction of oil presses in Mali. Its flagship project, Garalo Bagani Yelen, is a rural electrification venture of different partners such as ACCESS S.A.R.L. (a Malian rural energy service company), AMADER, FACT Foundation, the Stichting Het Groene Woudt and Stichting DOEN funds. Located in the village of Garalo, region of Sikaso, the Garalo Bagani Yelen project has planted 480 ha of intercropped Jatropha, installed a Jatropha pressing facility and 3 generators of 100kW serving around 230 clients (households, small business and government buildings). Plans are underway to replicate this model in other villages and expand the Jatropha plantation.

**Private Sector**  
**Sugar cane**  
**Sukala**

In 1996, the China Light Industrial Corporation for Foreign Economic and Technical Cooperation (CLETC) bought the majority stake (70%) of the state company Sukala SA (Forum on China, 2006) and has assure its independent management. Sukala SA produces ethanol in their installations of Dougabougou and Siribala, in the Segu region. Sugar production is around 35,000 tonnes per year, and between 8,000 and 10,000 tonnes of molasses per year (UNIDO, 2008). Around half these molasses are used to produce around 2.3 million litres of ethanol by distillation per year. The remainder of the molasses are important inputs for animal feed production. The ethanol produced is sold to the pharmaceutical, food and beverage industries in Mali and Burkina Faso.

**N-Sukala**

On 13th November 2009, Mali’s National Assembly (Parliament) approved the creation of a new company denominated N-Sukala (Nouveau complexe sucrier du Kala supérieur), where the Malian State is shareholder (40%) together CLETC (60%). The share of the Malian state is composed by the cession of 857ha for the construction of a sugar factory, the leasehold of 19,143 ha for sugar cane cultivation and capital contribution of 5.262 billion FCFA (8.022 million EUR) payable with a delay of 3 years after the legal registration of the company (Lam, 2009). The estimated capacity production of this project will be around 103 680 tonnes of sugar and 9.6 million litres of ethanol per year. The generation of 639 permanent and 10,000 seasonal jobs are expected with this project.

**PSM**

A third project is the Markala Sugar Project (PSM) is a public private partnership installed in the ON. It consists on the irrigation of 14,000 ha of sugar cane plantations and the construction of a factory producing 190,000 tons of sugar per year. The project is composed of the following partners:
a) SoSuMar: the Markala Sugar Company (Société Sucrière de Markala), responsible for the industrial and private component of the Project, whose shareholders are: ILLOVO\(^{19}\) : 70% ; Schaffer : 4% ; Private Malians: 22% ; the GoM: 4% , and
b) CaneCo: the Sugarcane Production Company (Société de production de canne à sucre), responsible for the agricultural aspect. The State of Mali is the majority shareholder of CaneCo with 90% of the shares (while SoSuMar holds the remaining 10%). CaneCo is the State-owned component of the project. A third entity, known as “CommCo” will be established to benefit the community. It will be responsible for developing 5,600 hectares for the exclusive benefit of the specific communities to which they will be allotted. These 5,600 hectares will all be allocated to the communities as compensation (1,465 ha) and for their development through the introduction of sugarcane cultivation (4,135 ha). This component will enable peasant farmers to become sugarcane farmers. The establishment of this entity will make a three-pronged partnership structure: GoM/SoSuMar /Community.

SoSuMar will have installations to produce 460,000 tons of bagasse, which will be used for co-generation of 30MW electricity, including 3 MW that will be transferred to EDMs network. Around 60,000 tons of molasses will be produced for the creation of 15 millions of liters of ethanol. It is also estimated that the project will generate 95,886 tons of compost per year. The project has yet to raise significant money to finance the start-up of operations\(^{20}\).

Cotton
HUICOMA
The Cotton Oil Factory of Mali (Huicoma) is the largest cotton oil factory in West Africa with a capacity of over 340,000 tonnes of seeds per year. Huicoma was founded in 1979 by the state owned CMDT that ensured its management until 1998 when a new autonomous management was appointed. In December 2002, the Malian group Tomota bought a majority share of the company (Tomota, 2009). The Malian state retains 12% of the company. Huicoma owns three production factories (Koulikoro, Kita and Koutiala) with an annual production capacity to produce of over 40,000 tonnes of refined cotton oil; 15,000 tonnes of soap and over 230,000 tonnes of meal cake. At full capacity, Huicoma employs 855 people in full time and 300 seasonal cookers. However, in the last 2 years Huicoma has struggle to continue normal operations due to elevated price and unavailability of cotton seed, forcing to substantial workforce reduction and technical stops of their factories (Privatisation, 2008).

Jatropha
Jatropha Mali Initiative (Eco-Carbone)
The Jatropha Mali Initiative (JMI) is a private venture composed of three shareholders: Eco-Carbone (60%), DégueSSi Vert, a Malian company, (21%) and Novartis (19%). The venture plans to plant 12,000 ha around the cercle of Kita (West of Mali) for the production of straight Jatropha oil. JMI has realised the plantation of 1200 ha of intercropped Jatropha and the installation of a pressing pilot pressing unit.

Mali Biocarburant SA (MBSA)
Mali Biocarburant SA (MBSA) is a biodiesel producer established in 2007 with the integration of private Malian and Dutch investors, including the Royal Tropical Institute (KIT), the Dutch Railway Company Pension Fund, Power Pack Plus, Interagro and a Jatropha farmer’s union, ULSPP. In February 2008 MBSA inaugurated a 2000 litres a day biodiesel refining unit in the city of Koulikoro.

MBSA strategy is geared towards benefiting small producers of Jatropha Curcas through innovative agro-forestry practices and business approach. MBSA does not own Jatropha plantations but ensures its feedstock from farmers unions that benefit directly through the

\(^{19}\) http://www.illovo.co.za/

\(^{20}\) The MSP is having a meeting 8-9 December in Bamako for a round of meetings with potential financing institutions.
sale of Jatropha nuts they harvest. The additional income for small producers is estimated at 1250 FCFA/day (€1.90/day) compared to current alternative sources of income of maximum €1.15/day. MBSA is the first company in West Africa that has contracted its carbon reduction on the Voluntary Carbon Credit market to Trees for Travel who in turn has signed a contract with KIA Motors Netherlands. MBSA promotes a pro-poor carbon offset scheme and reinvested 75% of its 2007 carbon credit income in strengthening the capacities of its farmers. MBSA also valorises subproducts like the glycerine and Jatropha press cake, used in the cosmetic industry and as valuable fertilizer, respectively. MBSA currently gives direct jobs to over 50 people and partners with over 3000 farmers in three zones of Mali (Koulikoro, Kita and Ouelessembogou) and Burkina Faso (Leo region).

**Sud Agro-industrie (SAi)**
Sud Agro-Industrie is a Malian company working in the Sikasso region of Mali using Jatropha plantations. The company has as ambition to develop 50,000 ha of Jatropha.

**Bagani SA (BSA)**
Bagani SA is a trader of Jatropha seeds based in the region of Sikasso. Bagani SA counts with a network of traders that obtain their supply from existing Jatropha hedges and plans to enter into the development of Jatropha cultivation and oil production.

**Tomota Group (TG)**
The Tomota group, principal shareholder of HUICOMA, also intends to produce Jatropha at large scale in the Mecina cercle, inside of the ON. An amount of 100 000 Ha are projected for this development.

### 7.12 Links in biofuels development in Mali
<table>
<thead>
<tr>
<th>Acronyms</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA</td>
<td>Ministre de l'Agriculture</td>
</tr>
<tr>
<td>IER</td>
<td>Institute d’Economie Rurale</td>
</tr>
<tr>
<td>MIIC</td>
<td>Ministre de l'Industrie, des Investissements et du Commerce</td>
</tr>
<tr>
<td>MEE</td>
<td>Ministre de l'Energie et de l'Eau (MEE)</td>
</tr>
<tr>
<td>DNE</td>
<td>Direction National d’Energie</td>
</tr>
<tr>
<td>CENESOLER</td>
<td>Centre National des Energies Solaires et Renouvelables</td>
</tr>
<tr>
<td>AMADER</td>
<td>Agence Malienne pour le Développement de l'Energie Domestique et l'Electrification Rurale</td>
</tr>
<tr>
<td>PJ</td>
<td>Jatropha Project</td>
</tr>
<tr>
<td>EDM</td>
<td>Electricité du Mali SA</td>
</tr>
<tr>
<td>ANADEB</td>
<td>Agence National de Développement des Biocarburants</td>
</tr>
<tr>
<td>MET</td>
<td>Ministre de l'Equipement et des Transports</td>
</tr>
<tr>
<td>MAT</td>
<td>Ministere de la Administration Territoriale</td>
</tr>
<tr>
<td>MEF</td>
<td>Ministre de l'Economie et des Finances</td>
</tr>
<tr>
<td>ONAP</td>
<td>Office National des Produits Pétroliers</td>
</tr>
<tr>
<td>MEA</td>
<td>Ministre de l'Environnement et de l'Assainissement</td>
</tr>
<tr>
<td>SEP-DIZON</td>
<td>Secrétaire d’Etat auprès du Premier ministre, chargé du Développement Intégré de la Zone Office du Niger</td>
</tr>
<tr>
<td>MPFEF</td>
<td>Ministre de la Promotion de la Femme, de l'Enfant et de la Famille</td>
</tr>
<tr>
<td>MESRC</td>
<td>Ministre des Enseignements Supérieur et de la Recherche Scientifique</td>
</tr>
<tr>
<td>MMEIA</td>
<td>Ministre des Maliens de l'Extérieur et de l'Intégration Africaine'</td>
</tr>
<tr>
<td>OdN</td>
<td>Office du Niger</td>
</tr>
<tr>
<td>IPR</td>
<td>Institute Polytechnique Rurale de Formation et de Recherche Applique</td>
</tr>
<tr>
<td>International</td>
<td>African Development Bank</td>
</tr>
<tr>
<td>BAD</td>
<td>United Nations</td>
</tr>
<tr>
<td>UN</td>
<td>UN Development Programme</td>
</tr>
<tr>
<td>UNDP</td>
<td>UN Food and Agriculture Organization</td>
</tr>
<tr>
<td>FAO</td>
<td>European Comission, External Cooperation Programmes</td>
</tr>
<tr>
<td>GEF</td>
<td>West African Economic and Monetary Union</td>
</tr>
<tr>
<td>EC</td>
<td>Economic Community Of West African States</td>
</tr>
<tr>
<td>UECOMA</td>
<td>Bilateral</td>
</tr>
<tr>
<td>ECOWAS</td>
<td>France Agence Française de Développement (AFD)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>The Netherlands cooperation</td>
</tr>
<tr>
<td>FR</td>
<td>PSM</td>
</tr>
<tr>
<td>NL</td>
<td>Project Sucier Markala</td>
</tr>
<tr>
<td>PRIVATE</td>
<td>SUKALA</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>Complexxe Sucier Du Kala Superieur SA</td>
</tr>
<tr>
<td>Cotton</td>
<td>Et</td>
</tr>
<tr>
<td></td>
<td>Ethanol</td>
</tr>
<tr>
<td></td>
<td>OdN</td>
</tr>
<tr>
<td></td>
<td>Office du Niger</td>
</tr>
<tr>
<td></td>
<td>PP</td>
</tr>
<tr>
<td></td>
<td>Private Producers</td>
</tr>
<tr>
<td>Jatropha</td>
<td>MBSA</td>
</tr>
<tr>
<td></td>
<td>Mali Biocarburant SA</td>
</tr>
<tr>
<td></td>
<td>GERES</td>
</tr>
<tr>
<td></td>
<td>Groupe Energies Renouvelables Environnement et Solidarités</td>
</tr>
<tr>
<td></td>
<td>BSA</td>
</tr>
<tr>
<td></td>
<td>Bagani SA</td>
</tr>
<tr>
<td></td>
<td>MFC</td>
</tr>
<tr>
<td></td>
<td>Mali Folke Centre Nyeeta</td>
</tr>
</tbody>
</table>

- **Sugar cane:** Project Sucier Markala, Complexxe Sucier Du Kala Superieur SA, Ethanol, Office du Niger, Private Producers.
- **Cotton:** Compagnie Malienne du Développement des Textiles, Huicoma SA.
- **Jatropha:** Mali Biocarburant SA, Groupe Energies Renouvelables Environnement et Solidarités, Bagani SA, Mali Folke Centre Nyeeta.
7.13 Summary of biofuels activities implications in Mali

<table>
<thead>
<tr>
<th>Issues</th>
<th>FARM</th>
<th>INDUSTRY</th>
<th>MARKET</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low land productivity and poor water access challenges Jatropha adoption</td>
<td>Predominance of small and marginal farmers</td>
<td>Jatropha for oil and biodiesel</td>
<td>Direct sell of Jatropha oil, Biodiesel and Ethanol</td>
</tr>
<tr>
<td>• Water management and relations between small producers and the ON</td>
<td></td>
<td>Sugarcane for ethanol</td>
<td></td>
</tr>
<tr>
<td>• Land tenure conflicts is exacerbated with a young decentralization process</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Inefficient agricultural markets</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Policies</th>
<th>• Biofuel Policy highlights sustainable production and food security</th>
<th>• Promotion of renewable in country energy strategy</th>
<th>• Missing biofuel regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Development of irrigated land at the ON</td>
<td>• Promotion of investment and improved operations at the ON assisted by international donors</td>
<td>• High demand of fossil fuels for energy production</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Lower fossil fuel prices in landlocked Mali than in the coastal neighboring countries</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Unsatisfied demand of alimentary oil</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emerging Patterns/relationships</th>
<th>• Long term leaseholds for agribusiness at the ON</th>
<th>• Pro-poor strategies (outside ON) and large industrial developments (inside ON)</th>
<th>• Local energy projects driving interests for Jatropha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• R&amp;D related to pro-poor benefits, environment and agronomic techniques</td>
<td>• Public Private Partnerships</td>
<td>• Sugar demand driving ethanol production</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Regional approach</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact/future implications</th>
<th>• Increase in food output thanks to development of irrigation potential</th>
<th>• Assured feedstock sources from farms and village level production</th>
<th>• Substitution of fossil fuel importation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Increase of income and diversification of rural economies</td>
<td>• Synergies with the alimentary oil extraction industry</td>
<td>• Viability of rural energy projects</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

7.14 Conclusion

Biofuels play an important role in the energy strategy and growth in Mali. Political support favours food security, economic development and environmental protection. However, the relative young government decentralisation process, lack of resources and low administration capacities hinder good natural resources management.

Sugarcane production is intended to satisfy sugar demand. Ethanol is not yet used as fuel but for the pharmaceutical and beverage industries.

In terms of natural resources, particularly water availability, Mali presents large developments of irrigated land at the ON which can boost food and fuel production.
Nevertheless, water and environmental management are main concerns in the country due to the Sahel area.

Mali is one of the countries in West Africa with more experience on the use of biofuels for electricity generation at community level. International donors follow with particular attention these developments. The experience with Jatropha programs has shown that it can benefit small holder farmers without compromising food production at local level. These developments include commercial production of Jatropha (e.g. Mali Biocarburants) and not only community level initiatives (e.g. Mali Folk Center).

Although Mali has a number of initiatives for pro-poor energy production, Jatropha seed supply is still very limited. The challenge for Mali is also in the agriculture sector, specially for the efficient use of water, water access, costly extension services in need and low yields for all crops and not just energy crops.
8. TANZANIA CASE STUDY

8.1 Country’s Characteristics

Location
Tanzania is located in Eastern Africa between longitude 29° and 41° East, Latitude 1° and 12° South. It is situated in East Africa just south of the equator; mainland Tanzania lies between the area of the great lakes—Victoria, Tanganyika, and Malawi (Nyasa)—and the Indian Ocean. It contains a total area of 945,087 sq km (364,900 sq mi), including 59,050 sq km (22,799 sq mi) of inland water. It is bounded on the North by Uganda and Kenya, on the East by the Indian Ocean, on the South by Mozambique and Malawi, on the SW by Zambia, and on the West by Zaire, Burundi, and Rwanda, with a total boundary length of 4,826 km (2,999 mi), of which 1,424 km (885 mi) is coastline.

The section of the United Republic known as Zanzibar comprises the islands of Zanzibar and Pemba and all islets within 19 km (12 mi) of their coasts, as well as uninhabited Latham Island, 58 km (36 mi) south of Zanzibar Island. Zanzibar Island lies 35 km (22 mi) off the coast, and Pemba Island is about 40 km (25 mi) to the NE. The former has an area of 1,657 sq km (640 sq mi), and the latter 984 sq km (380 sq mi). Tanzania's commercial capital city, Dar es Salaam, is located on the Indian Ocean coast while Dodoma is the political capital and seat of government. Dodoma is situated on the eastern edge of the southern highlands.

Figure 8.1 Map of Tanzania showing location relative to its neighbouring countries

Geographical Characteristics
Tanzania is the biggest of the East Africa countries (i.e. Kenya, Uganda, Tanzania, Rwanda and Burundi). Tanzania contains three of Africa's best-known lakes - Victoria in the north, Tanganyika in the west, and Nyasa (Malawi) in the south. Mount Kilimanjaro in the north, 19,340 ft (5,895 m), is the highest point in Africa. The island of Zanzibar is separated from the mainland by a 22-mile channel.

The Great Rift Valley runs to the south of Tanzania splitting at Lake Nyasa; one branch runs down beyond Lake Nyasa to Mozambique; and another branch to north-west alongside Burundi, Rwanda, Tanzania and western part of Uganda. The valley is dotted with unique lakes which include Lakes Rukwa, Tanganyika, Nyasa, Kitangiri, Eyasi and Manyara. The
uplands include Kipengere, Udzungwa, Matogoro, Livingstone, and the Fipa plateau forming the southern highlands. The Usambara, Pare, Meru, Kilimanjaro, the Ngorongoro Crater and the Oldonyo Lengai, all form the northern highlands. From these highlands and the central saucer plateau flow the drainage system to the Indian Ocean, Atlantic Ocean, Mediterranean Sea and the inland drainage system.

**Climate**
Tanzania has a tropical type of climate. In the highlands, temperatures range between 10°C and 20°C during cold and hot seasons respectively. The rest of the country has temperatures never falling lower than 20°C. The hottest period spreads between November and February (25°C - 31°C) while the coldest period occurs between May and August (15°C - 20°C).

Two rainfall regimes exist over Tanzania. One is unimodal (December - April) and the other is bimodal (October - December and March - May). The former is experienced in southern, south-west, central and western parts of the country, and the later is found to the north and northern coast.

**Administration**
Tanzania is divided into 26 administrative regions (21 on the mainland and 5 in Zanzibar) and 130 administrative districts (Zanzibar has 10 and Mainland has 120 administrative districts).

**Environmental Characteristics**
Tanzania has extensive forest cover, most of which is savannah woodland and montane forest, with scattered patches of lowland forest. Much of this forest has high biodiversity and endemism—especially in the southern highlands region. However, these forests are increasingly threatened by fuelwood collection by the rapidly expanding population, as well as by commercial felling of timber and expanding agriculture. However, the country loses 91,000 hectares to illegal felling each year. In early 2006, the Tanzanian government reinforced the export ban logs and sandalwood in an effort to reduce deforestation. The country planted 100 million trees between 1999 and 2006. Although 40 percent of the country is preserved in parks, forests cover is reducing rapidly in some regions. Overall forest cover fell by 15 percent between 1990 and 2005, but deforestation rates have increased significantly since 2000.

A recent survey (2009) among the ice fields on Mount Kilimanjaro found that the ice atop Africa's most famous mountain could be gone in twenty years or less. The study discovered that between 1912 and 2007, 85 percent of the ice that covered Mount Kilimanjaro vanished. When using 2000 as baseline the mountain has lost 26 percent of its ice.

In Tanzania's major towns and cities, solid and liquid wastes are left untreated. As a result, air and water are contaminated with pollutants, a major health hazard especially for those who live in low-income areas. In Dar es Salaam for example, few people are connected to a sewage system. The few sewage systems that exist discharge their waste directly into the ocean, affecting marine habitats and species.

Wildlife poaching is also a problem in rural Tanzania. Sometimes, this happens in retaliation to wildlife attacks which destroy crops, and hence livelihoods. Both poaching and human-wildlife conflicts add to the country's environmental concerns.

To make matters worse, Tanzania currently confronts issues of soil degradation, deforestation, and desertification.

**8.2 Population Size and Characteristics**
Tanzania's population as per 2009 estimates is 41,048,532 with a growth rate of 3.0%. About 51% of the country's population is women and 46% are under the age of 15. The birth rate is 34.2 per 1000 while the infant mortality rate is 84 per 1000; under five mortality Rate
is 133.8. Total life expectancy is 54 years (but varies between males and females, i.e. 53 and 56, respectively) and the population density per sq kilometre is 46.

According to Tanzania’s National Bureau of Statistics (2008), the country’s population trends over the years can be summarized as shown in the table below:

Table 8.1 Population trend in Tanzania

<table>
<thead>
<tr>
<th>Number of Inhabitants ('000)</th>
<th>1978 Census</th>
<th>1988 Census</th>
<th>2002 Census</th>
<th>2008 Projection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanzania Mainland</td>
<td>17,036</td>
<td>22,584</td>
<td>33,462</td>
<td>39,475</td>
</tr>
<tr>
<td>Tanzania Zanzibar</td>
<td>476</td>
<td>641</td>
<td>982</td>
<td>1,193</td>
</tr>
<tr>
<td>Tanzania</td>
<td>17,512</td>
<td>23,225</td>
<td>34,444</td>
<td>40,668</td>
</tr>
<tr>
<td>Population Density (pop./sq. km)</td>
<td>20</td>
<td>26</td>
<td>39</td>
<td>46</td>
</tr>
</tbody>
</table>

8.3 Gross Domestic Product, Human Development Index and Poverty Levels

The Per Capital GDP is estimated at US$ 424. The share of GDP by main sectors is as shown in the figure below.

![Figure 8.2 Tanzania’s GDP](image)

About 50% of the population is living below the poverty line. The United Nations Development Programme’s (UNDP) Human Development Index (HDI) listing, which arranges countries according to their overall level of human development, ranks Tanzania 151st out of a total of 174 nations. The HDI (0.530 for Tanzania) provides a composite measure of three dimensions of human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and gross enrolment in education) and having a decent standard of living (measured by purchasing power parity, PPP, income).

Tanzania’s economy is highly dependent on natural resources which include:

**Minerals** - gold, diamonds, tanzanite and various other gemstones, natural gas, iron ore, coal, spring water, phosphates, soda ash and salt.

**Wildlife and Tourism** - 12 National Parks, the Ngorongoro conservation Area, 13 Game reserves, 38 Game Controlled Areas: National Cultural Heritage Sites (about 120 sites).

**Fisheries** - three large lakes: Victoria, Tanganyika and Nyasa, the Indian Ocean coastline, rivers and wetlands. Potential yield of fish from natural waters is estimated to be 730,000 metric tons annually; present catch is 350,000 metric tons.
Forestry and Beekeeping: Non-reserved forest-land (1,903.8 km²), forest/woodlands with national parks etc (200 km²), and Gazetted forest reserves (1,251.7 km²).

8.4 Main food crops
A recent Agriculture Census showed that the crop sector plays an important role in the Tanzania economy providing jobs, sustenance and income to 4,858,810 rural households growing crops (representing 99% of the total number of farming households in the rural areas and 95 percent of the total rural households). The total planted area with annual crops was 7,818,620 hectares and 1,234,999 hectares for permanent crops giving a total planted area of 9,053,619 hectares. There is a wide variety of crops grown in the country (over 95 types); however, small holder crop production is very much dominated by maize. Other important food crops are cassava, bananas, paddy, beans and groundnuts. Maize is grown extensively and in every region of the country. With the exception of seed, there is virtually no investment in crop production. Crop yields are very low because minor amounts of fertilizer are being applied and pesticide use is virtually absent especially on food crops. The average planted area of 1.61 hectares per household for annual crops is low to support an average size smallholder household and is insufficient to allow smallholders to move beyond subsistence existence. The best crop producing areas in Tanzania have less available land for cultivation.

8.5 Main Agricultural and Food Crops Imports/Exports
The main agricultural products including food and non-food crops are coffee, sisal, tea, cotton, pyrethrum, cashew nuts, tobacco, cloves, corn, wheat, cassava (tapioca), bananas, fruits, and vegetable. The table below shows the major agricultural crops marketed and their production trends over the last five years:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Production in '000 Metric tons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
</tr>
<tr>
<td>Sisal fibre</td>
<td>27</td>
</tr>
<tr>
<td>Coffee</td>
<td>39</td>
</tr>
<tr>
<td>Tobacco</td>
<td>44</td>
</tr>
<tr>
<td>Cashew nuts</td>
<td>80</td>
</tr>
<tr>
<td>Pyrethrum</td>
<td>1</td>
</tr>
<tr>
<td>Green tea leaves</td>
<td>1278</td>
</tr>
<tr>
<td>Seed cotton</td>
<td>140</td>
</tr>
</tbody>
</table>

The main agricultural exports include coffee, cotton, tea, sisal, cashew nuts, tobacco, cut flowers, seaweed, cloves and horticultural products.

8.6 Characteristics of Livelihoods in Farming Systems
The majority of crop-growing households in Tanzania are subsistence farmers. Capital investment in smallholder agriculture is virtually absent. Incomes are low, about 100 USD per household annually. The average land area per household is only 2 hectares. The percent of utilised land compared to available land is high and in some regions all available land is utilised. Although the last ten years has seen an increase in planted land area, the large increase in planted area has been offset by a reduction in productivity resulting in only a comparatively small increase in the quantity produced. Land ownership through formal titles/deeds is at a very low level with most of the land under customary rights.
8.7 Policies in Place and Link with the Bioenergy Sector

The government of Tanzania has within her energy, agriculture, land environment and forest policies, statements of intentions to improve the supply and demand of bioenergy and ensure its sustainability. In 2006, the Government of Tanzania created the National Biofuels Task Force to promote development of the sector and develop legislation to stimulate use of biofuels. Furthermore, a statement on blending biofuels with mineral petrol has been slotted in the New Petroleum Supply Act.

Agriculture Policy

For many years, Tanzania’s agricultural policies were based on government control of trade and production. However, the sector has now been substantially liberalized and market forces have been allowed to prevail. The government has withdrawn from direct involvement in production, processing and marketing and has retained only its role in setting policies. The overall agricultural policy of Tanzania recognizes the need to improve agricultural Technologies and practices to enhance productivity. Therefore labour-augmenting technology is a key to agricultural development. Tanzania’s main agricultural policy objectives are:

- To ensure basic food security for the nation and increase nutritional standards.
- To improve standards of living in rural areas through increased income from Agriculture and livestock.
- To increase foreign exchange earnings for the nation by increased production and exportation of cash crops.
- To produce and supply raw materials required by the local Industries both from crops and livestock.
- To develop and introduce new technologies to increase the productivity of labour and land.
- To promote integrated and sustainable use and management of natural resources.
- To develop human resources within the sector in order to increase the productivity of labour.
- To provide support services to agricultural sector.
- To promote specifically the access of women and youth to land, credit, education and information.

Energy Policy

In Tanzania, bioenergy, and in particular traditional solid bioenergy i.e. woodfuels (charcoal firewood), agro residues remains the dominant energy source for cooking in most rural and urban households. These contribute more than 90% of the total energy consumed in Tanzania. The National Energy Policy of the United Republic of Tanzania was adopted in 2003 and replaced the previous energy policy from 1992. The main elements of the Energy Policy and strategy are to:

- Develop domestic energy resources which are shown to be least cost options.
- Promote economic energy pricing.
- Improve energy reliability and security and enhance energy efficiency. Encourage commercialization and private sector participation.
- Reduce forest depletion.
- Develop human resources.

However, there is limited interface between energy policy and plans relating to national economic planning.

Forest Policy
The Forest policy (1998) Objective is to ensure sustainable supply of forest products and services by maintaining sufficient forest area under effective management. It also aims to enable participation of all stakeholders in forest management and conservation, through joint forest management agreements, with appropriate user rights and benefits. Sustainable bioenergy production can be achieved through sustainable forest management.

**Land Policy**
The Land policy of (1997) recognized the confusion and uncertainty regarding land tenure and management authority over most land in Tanzania. The policy sought to dispel this confusion by reiterating government of Tanzania general underlying right to land, but clearly recognizing and clarifying customary and other use rights to land. This policy has major implications on large scale bioenergy production. In Tanzania land belongs to Government and a lease for specific period is given to person(s)/company/institution(s).

**Environmental Policy and Environment Management Act**
The Environmental policy of (1997) advocates for investment in Biomass development in Tanzania. It recognizes that this is vital for environmental protection and poverty reduction. The Environment Management Act (EMA) No. 20 of 2004, the part VI of the EMA deals with Impact Assessment (EIA) and other Assessments, and directs that EIA is mandatory for all development projects. Section 81 (2) states that “An environment Impact Assessment study shall be carried prior to the commencement of financing of a project or undertaking”.


**8.8 Biofuels Industry/Programmes Development**
Presently there are a few small-scale ongoing bioenergy projects aiming at improving the supply and use of solid and liquid bioenergy in Tanzania, including:

**Programme on Integrated Wood-fuel Services for Poverty Reduction in Tanzania**
This programme is being implemented by Tanzania Traditional Energy Development and Environment Organisation (TaTEDO0 with financial support from the EU and the HIVOs. It will be implemented over a period of four years from January 2006. The objective of this programme is to increase income of the rural and urban beneficiaries through reduced costs and increased efficiency of wood–fuel stoves, ovens and charcoal production kiln. The beneficiaries of this programme are households, social service centres, and small and medium enterprises.

**Program for Biomass Energy Conservation (PROBEC)**
This is a SADC programme implemented by governments with some technical assistance from GTZ. It is being implemented in eight SADC member countries namely Lesotho, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe. In Tanzania the programme implementation started in 2004 with the objective of improving access to improved wood fuels stoves for households, institutions and productive sectors.

**Liquid Bioenergy Initiatives**
There exist several initiatives from the national to the local levels with the objective of developing, policies, regulations and programme aiming at ensuring sustainable development of liquid bioenergy in Tanzania. The government through a Biofuels Task Force is working on the preparations of policies, regulations for creating enabling environment for stakeholders to participate in the development of biofuels. Several actors (e.g.
multinationals, companies, NGOs, institutions and small holders farmers) are implementing projects aimed at increasing the supply of liquid biofuels in the country. More than ten companies already are at different stages of establishing farms for biofuels farming.

8.9 Crops Used for Biofuels:

Type and Conversion Technology
Biofuel development in Tanzania is still at infancy stage. Current efforts are mostly focused on biodiesel from jatropha. The jatropha oil can be used either as Straight Vegetable Oil (SVO) or refined and blended with petro-diesel.

Potential Crops (Biofuel Feedstocks)
Tanzania has ideal geographic and climatic conditions for growing a wide range of biofuel crops: sugar cane, sorghum, cassava, palm oil, jatropha, soy, cotton, pongamia, croton and others. Experts agree that Government policy should focus on non-staple food crops as a feedstock like Jatropha and pongamia in mitigating the direct impact of biofuel on food security.

Market for raw material
Tanzania is a net fuel importer. Tanzania has therefore a high potential to become a significant biofuel producer. The many initiatives started will create market opportunities. Some investors have started biofuel production at least on the experimental stage. It is reported that there is currently a dramatic increase in demand for biofuels, attracting the interest of investors from within and outside of Tanzania. The trend shows that multinational investors/companies are increasing their investments into the cultivation of crops for biofuels production in the country. At the moment however, no commercial scale production or processing has been reported. Currently there is no market information available. Biofuel feedstocks are sold like other crops, and often without any deliberate intention to use them for biofuel.

End use
There is potential to use biofuels at all levels (households, public facilities, transport and industry including power generation).

Implications for land tenure, water and employment
Tanzania has over 88 million hectares of suitable agricultural land, of which less than 6% is currently utilized. Unlike many alternative countries, the vast majority of land in Tanzania that is available for cultivation is not virgin forest or environmentally sensitive. A recent study (FAO, 2007) estimated Tanzania to have more than 30 million hectares of land suitable for the cultivation of energy crops, whereby corresponding areas for sugarcane, cereals and root crops are 570,000 ha, 24 million ha and 14 million ha respectively.

There are fears nevertheless that the sheer speed of biofuel expansion may generate new pressures on land tenure arrangements, leading to alienation. There are also fears that poor households may either sell or be forced to relocate as the rush to meet increasing demand gathers momentum. Competition for inputs (e.g. land, water, fertilizers) and other factors that might be diverted from food production might lead to a food crisis.

However, opportunities exist for income generation and diversification by producing and selling biofuel feedstocks. Employment opportunities will be created through agro-industrializations. This will lead to improved standard of living and linkages with others sectors in the economy. Energy supply in rural areas will also stimulate rural development and reduce pollution caused by fire wood. Reduced time spent by women and children on
basic survival activities (gathering firewood, fetching water, cooking, etc.). The development of biofuel as a source of energy, when grown on a large scale, could also represent a paradigm shift in agricultural development.

### 8.10 Implications of Conversion of Raw Materials to Biofuels

Conversion of raw materials is still at an early stage but a number of actors and developers are at various stages of developing/promoting biofuels. Examples include:

1. Sekab Biofuels (T) Ltd (Swedish) – to promote sugarcane based bioethanol
3. WILMA from USA [Croton spp.] [- Biharamulo, Kagera];
4. Mitsubishi Corporation of Japan – Jatropha [Arusha and Dar es Salaam];
5. Farming for Energy Livelihood in Southern Africa (FELISA) [Oil palm - Kigoma];
6. KAKUTE\(^\text{21}\) [jatropha] – Arusha;
7. Diligent – Dutch Firm [jatropha Oil];
8. TaTEDO of Tanzania [jatropha];
9. SunBiofuels (T) of UK [jatropha - Kisarawe]

As such no significant impacts can be attributed to biofuels at the moment.

**Implications for Water use**

Three of the ten largest lakes in the world are found in Tanzania, and a large network of rivers, making most areas of Tanzania suitable for irrigated agriculture. Tanzania has significant potential for irrigated land and several areas apt for oil palm and jatropha have already been identified.

**Implications for Employment**

As already stated, employment opportunities will be created through agro-industrializations. Some have already been created as a result of the aforementioned biofuel initiatives and are expected to increase as the sector grows.

### 8.11 Mapping of Policy and Institutions and Links with Bioenergy

The institutions involved in the development of biofuels in Tanzania include a variety of Government ministries and other government institutions including Tanzania Investment Centre (TIC), Attorney Generals chambers, (AGC), Tanzania Petroleum Development Corporation (TPDC) and Community Finance Limited (CFC). There are several Developmental organizations that are at the forefront of the development of biofuels, they include, TaTEDO, Sugar Producers Association, Envirocare and several other locally based NGOs and CBOs. Also there is increasing private sector participation from inside and outside the country. Some of such companies include Felisa, Kakute, Sun Energy LTD, Deligent, Wilma, Prokon, Bio-Alcohol Fuel foundation (BAFF), SEKAB.

**First hand players**

There is currently no coordination of biofuels policy within Tanzania, although the Tanzanian Biofuels Task Force is in the process of drawing up policy guidelines. Investors are able to receive necessary investment, land and environmental approvals to start plantations without any concrete government policy. Foreign investment in Tanzanian biofuels is being

\(^{21}\) KAKUTE – Kampuni ya Kusambaza Teknoljia Tanzania
encouraged as it has the potential to aid rural development and local livelihoods, improve energy security and reduce oil imports.

All enterprises, whatever their legal forms, operating in Tanzania must register with the Business Registration and Licensing Agency (BRELA) of the Ministry of Industries and Trade. The first step is to obtain name clearance from BRELA. The investor will then register with the Tanzania Investment Centre (TIC) which assists foreign investors in setting up businesses in Tanzania. A Certificate of Incentives is then granted to those who have qualified. TIC performs a facilitative role for inward investment. In order to strengthen and expedite facilitation services, senior officers from Government Departments and other Government Agencies are permanently stationed and operating within TIC’s premises, representing the Lands Department, Tanzania Revenue Authority, Immigration Department, Labour Division, Directorate of Trade, and the Business Registration and Licensing Agency. TIC grants Certificates of Incentives to all bona fide investors. Extensive guarantees are provided to investors under TIC Certificate of Incentives. Such guarantees cover ownership of properties, dispensation of assets, repatriation of income and others.

Ministries/Secretariats Involved in the Bioenergy Planning/Applications
The National Biofuels Taskforce is the key government body involved in promoting biofuels in Tanzania. It is made up of several ministries and government institutions including:

i. Ministry responsible for Planning, Economy and Empowerment,
ii. Ministry of Energy and Minerals
iii. Ministry responsible for Agriculture and Food Security
iv. Ministry of Labor, Employment and Youth Development,
v. Ministry of Finance,
vi. Vice President’s Office –Division of Environment
vii. Ministry of Water and Irrigation,
viii. Ministry of Lands, Housing and Settlement Development,
ix. Attorney General’s Chambers,
x. Tanzania Investment Center,
xi. Tanzania Petroleum Development Corporation,
xii. Community Finance Limited,
xiii. Tanzania Sugar Producers’ Association

NGOs Involved
• The Tanzania Traditional Energy and Environment Development Organization (TaTEDO)
TaTEDO is a local NGO based in Dar es Salaam, registered in 1990 and working in more than ten regions of Tanzania. TaTEDO is widely sensitizing rural and urban communities on the potential use of Jatropha. The main focus has been to provide information and extension services to smallholder farmers.

• Jatropha Products Tanzania Limited (JPTL)
JPTL is a not-for-profit organization registered in 2005, based in Arusha but operating in five regions; Arusha, Tanga, Kilimanjaro, Manyara and Singida. It targets working with 2,000 households, and its main objective is to link research and development in areas of knowledge, skills, information and technology transfer to small scale farmers and enterprises interested in the Jatropha plant, seeds and products. Also, JPTL promotes the use of Jatropha oil in lanterns, stoves, and for soap making.

• Envirocare
The Environmental, Human Rights Care and Gender Organization (Envirocare) is a local, non-governmental organization formed and registered in 1993. The organization promotes small-scale farming of Jatropha to realize its objective of environmental conservation and improved livelihoods with a gender and human rights based approach. Currently, Envirocare works in Kilimanjaro, Tanga, Morogoro, Regions and in Dar es Salaam.

8.12 Links in Biofuels Development in Tanzania

Key:
Direct links (--------)
Indirect links (•••••••••)
Needed links (.........)
8.13 Summary of the biofuels activities in Tanzania

The following figure presents the analysis and summary of the information gathered for the case study of Tanzania.

<table>
<thead>
<tr>
<th>Issues</th>
<th>FARM</th>
<th>INDUSTRY</th>
<th>MARKET</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low crop yields due to non-existent/low investment in crop production.</td>
<td>Typically subsistence farming with low capital investment. Land area per household ≈ 2ha. Ownership of formal titles/deeds very low.</td>
<td>Still in nascent stages. Current efforts mostly focused on biodiesel from jatropha.</td>
<td>• Market information lacking</td>
</tr>
<tr>
<td>• Average planted area of 1.61 hectares per household for annual crops is low to support an average size smallholder household.</td>
<td>• Insufficient feedstock supply</td>
<td>• Few processing facilities</td>
<td>• Dramatic increase in demand for biofuels but no commercial supply</td>
</tr>
<tr>
<td>• The best crop producing areas have less available land for cultivation.</td>
<td>• No technical capacity</td>
<td>• Economic feasibility still not assured</td>
<td></td>
</tr>
<tr>
<td>Policies</td>
<td>• Liberalization of agricultural sector</td>
<td>• Limited interface between energy policy and plans relating to national economic planning.</td>
<td>• Energy policy aims to promote economic energy pricing.</td>
</tr>
<tr>
<td>• Focus on food security</td>
<td>• Policy promotes cash crops and production of industrial raw material sustainably</td>
<td>• Biofuels Task Force is working on the preparations of policies &amp; regulations on biofuels.</td>
<td>• Develop domestic energy resources which are shown to be least cost options</td>
</tr>
<tr>
<td>• Promote integrated and sustainable use of natural resources.</td>
<td>• Land policy of 1997 clearly recognizes and clarifies customary and other use rights to land</td>
<td>• Energy Policy encourages commercialization and private sector participation.</td>
<td></td>
</tr>
<tr>
<td>Emerging Patterns/relationships</td>
<td>• Several actors (e.g. multinationals, NGOs, institutions and small holders farmers) are implementing biofuel projects.</td>
<td>• More than ten companies establishing farms for biofuels farming</td>
<td>• A statement on blending biofuels with mineral petrol has been slotted in the New Petroleum Supply Act.</td>
</tr>
<tr>
<td>• Significant potential for irrigated land and several areas apt for oil palm and jatropha.</td>
<td>• Improved standard of living and linkages with others sectors in the economy</td>
<td>• Growth in agro-industrialization</td>
<td></td>
</tr>
<tr>
<td>Impact/ future implications</td>
<td>• Employment opportunities will be created through agro-industrializations</td>
<td>• Private-sector-led development</td>
<td>• Initiatives started will create market opportunities</td>
</tr>
<tr>
<td>• Opportunities for income generation and diversification by producing and selling biofuel feedstocks</td>
<td>• Opportunities for income generation and diversification by producing and selling mineral petrol has been slotted in the New Petroleum Supply Act.</td>
<td></td>
<td>• Tanzania is a net fuel importer hence high potential to become a significant biofuel producer.</td>
</tr>
<tr>
<td>• Energy supply in rural areas will stimulate rural development and reduce pollution caused by fire wood</td>
<td>• Reduced time spent by women and children on gathering firewood, fetching water, cooking, etc.</td>
<td>• Biofuel development could represent a paradigm shift in agricultural development.</td>
<td></td>
</tr>
<tr>
<td>• May generate new pressures on land tenure arrangements, leading to alienation</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Poor households may either sell or be forced to relocate as the rush to meet increasing demand gathers momentum</td>
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<td></td>
<td></td>
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<tr>
<td>• Competition for inputs (e.g. land, water, fertilizers) that might be diverted from food production might precipitate a food crisis.</td>
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<td></td>
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</tbody>
</table>

8.14 Conclusions

Tanzania has received major attention from investors for large scale biofuel production forcing the government to accelerate the process of the creation of a Biomass Task Force in the absence of a biofuel policy. As in the previous case studies, the problem in the country
lays in the issues regarding the willingness to grow bioenergy crops in the absence of low or non-existant investment that reflect in low yields.

There is also a will to expand production arising in the industrial sector with major investors for this area. Nevertheless, issues regarding land tenure and the average size of farms for small holders will make difficult in certain areas to work with large scale initiatives. This could be related to the issue of either displacement of farmers or convincing the farmers of an alternative crop to work as out-growers.

The stakeholder assessment demonstrated that there is need for cross-cutting activities at policy and planning level and with main actors such as farmers, in-spite of the existence of the Task Force.

The potential market for biofuels is big at all levels in Tanzania and with adequate enforcement of the policies and guidelines, it will be possible to produce bioenergy crops without jeopardising food production. At any rate, a case-by-case approach to each of the initiatives need to be adopted.
9. KENYA CASE STUDY

9.1 Country’s characteristics

Location

Kenya is located on the eastern part of the African continent. It lies across the equator at latitude of 4° North to 4° South and Longitude 34° East to 41° East. The country is bordered by Sudan and Ethiopia in the north and Uganda to the west. Somalia lies to the east of the country while Indian Ocean borders the country in the south-eastern part. To the southwest of the country lies Tanzania while to the west lies Lake Victoria and Uganda. It contains a total area of 582,650 sq km including 13,400 sq km of inland water and a 536km coastline.

![Map of Kenya showing location relative to its neighbouring countries](image)

Figure 9.1: Map of Kenya showing location relative to its neighbouring countries

Geographical Characteristics

Kenya’s geography is diverse and varied. The coast is a low-lying area and extremely fertile. It has a coral reef supported by a dry coastal plain that is covered by thorny bushes and savannah. The terrain of the country gradually changes from the low-lying coastal plains to the Kenyan highlands. The highest point of the country lies in Mount Kenya, which is 5,199 meters high.

The Great Rift Valley is located in the central and western part of the country and basically dissects the Kenyan highlands into east and west. The highlands have a cool climate and are known for their fertile soil, forming one of the major agricultural regions of the country. However, about 80% of the land area is Arid and Semi Arid. A large number of swamps are in the Loraine Plain, situated in the north-eastern part of the country.

There are also a number of lakes and rivers; most of the lakes are located in the Rift Valley. On the northern part of the country is Lake Turkana. On the western part of the country is Lake Victoria. Other major Rift Valley lakes include Lake Naivasha and Lake Nakuru. The rivers Tana and Athi flow in the south-eastern part of the country while Nzoia, Yala and Gori, flow across the country before draining into Lake Victoria. Ewaso Ng’iro River is found in the north-eastern part of the country.
A large number of rainforests are found in the east of the country, including the Kakamega Forest and the Mau Forest.

Kenya is divided into seven agro-ecological zones ranging from humid to very arid. Less than 20% of the land is suitable for cultivation, of which only 12% is classified as high potential (adequate rainfall) agricultural land and about 8% is medium potential land. The rest of the land is arid or semi-arid. Furthermore, only 60% of the high potential land is devoted for crop farming and intensive livestock production while the rest is used for food and cash crop production, leaving the rest for grazing and as protected.

The agro-ecological zones (ACZ) are as shown in Figure 2 below:

![Agro-Climatic Zones of Kenya](Source: Kenya Soil Survey)

### Climate

Kenya's climate is fairly warm throughout most of the country. Most of the country has a tropical climate. Exceptions to this are the coastal belt and the northern parts, which are generally arid and hot. It is hot and humid at the coast, temperate inland and very dry in the north and northeast parts of the country.

The average annual rainfall at the coast is 1200mm and the average daily temperature ranges from 27°C to 31°C. Nairobi, the capital city, has an altitude 1,661 metres and has a temperature range of 25.20 -13.60°C. Eldoret is found in the Rift valley at an altitude of 3,085m, with a temperature range of 23.60 - 9.50°C. Lodwar, also in the Rift Valley but near the northern-most extremity is at an altitude of 506 m above seal level, with a temperature range of 34.80 - 23.70°C.

There are 2 rainy seasons; the long rains occur from April to June and short rains from October to December. The rainfall is sometimes heavy and when it does come it often falls in the afternoons and evenings. The hottest period is from February to March and coldest in July to August.

The majority of the country receives less than adequate rainfall needed to support crop cultivation. Over two-thirds of the country receives less than 500mm of rainfall per year and 79% has less then 700mm annually. Only 11% of the country receives more than 1000mm per year. The mean annual rainfall shows a wide spatial variation, ranging from about

<table>
<thead>
<tr>
<th>ACZ</th>
<th>CLASS</th>
<th>RAINFALL (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Humid</td>
<td>1100 - 2700</td>
</tr>
<tr>
<td>II</td>
<td>Sub-Humid</td>
<td>1000 - 1600</td>
</tr>
<tr>
<td>III</td>
<td>Semi-Humid</td>
<td>800 - 1400</td>
</tr>
<tr>
<td>IV</td>
<td>Semi Humid Semi Arid</td>
<td>600 - 1100</td>
</tr>
<tr>
<td>V</td>
<td>Semi Arid</td>
<td>450 - 900</td>
</tr>
<tr>
<td>VI</td>
<td>Arid</td>
<td>300 - 550</td>
</tr>
<tr>
<td>VII</td>
<td>Very Arid</td>
<td>150 - 350</td>
</tr>
</tbody>
</table>
200mm in the driest areas in northwestern and eastern parts of Kenya to the wetter areas with rainfall of 1200-2000 mm in areas bordering Lake Victoria and Central Highlands east of the Rift Valley. As a result, the Central Highlands, parts of Rift Valley, the Lake Victoria region and the coastal area boast the most intensive agriculture and greatest concentration of people. Pastoral farming dominates the remaining drier regions of Kenya.

**Administration**

Kenya is divided into 8 provinces; the provinces are subdivided into more than 71 districts which are then subdivided into more than 260 divisions. The divisions are subdivided into about 2500 locations which in turn are sub-divided into more than 6,600 sub-locations. Kenyan local authorities mostly do not follow common boundaries with divisions. They are classified as City, Municipality, Town or County councils. There are 210 constituencies which form the basis of parliamentary representation.

**Environmental Characteristics**

The environment is an increasingly important issue in Kenya as the poor directly rely on the water and land resources surrounding their communities. With only 8% of arable land and 75% of its workforce engaged in agriculture, Kenyan farmers face growing problems of soil erosion, deforestation, water pollution, and desertification. The recent drought (2008/9) left 3.5 million people without enough food to survive. In Northern Kenya, pastoralists have lost their herds to starvation and conflicts are mounting over scarce water resources.

The most important current environmental issues include water pollution from urban and industrial wastes; degradation of water quality from increased use of pesticides and fertilizers; water hyacinth infestation in Lake Victoria; deforestation; soil erosion; desertification; and wildlife poaching for game meat and animal trophies.

Kenya currently has approximately 1.24 million hectares of closed canopy indigenous forest. The majority of these forests are managed by the Kenya Forest Service, whilst the Kenya Wildlife Service (KWS) manages other forests in National Parks and Nature Reserves. Coastal forests play an important role in shoreline protection (particularly mangroves) whilst the five water towers (Cherangani Hills, Mount Elgon, Mount Keny, Aberdares, and Mau Forest Complex) play an essential role in water management both nationally and internationally. The montane forests of Kenya’s five water towers are surrounded by some of the most densely populated areas of Kenya and are therefore under significant pressure for new settlements and the supply of timber and non timber products to those communities despite their designation as protected areas. Approximately 5% of the remaining forest area was lost between 1990 and 2005. The most threatened forests currently include Kakamega, the Mau Forest Complex and coastal forests. There are also currently approximately 165,000 hectares of plantation forestry in Kenya, which are generally poorly managed. One of the key identified drivers of deforestation and land degradation in Kenya is the demand for fuelwood which accounts for 70% of all energy consumed (90% in rural areas).

About 80% of the total land area in Kenya is classified as arid and semi arid lands (ASAL) which comprises savannah and grassland ecosystems traditionally used as pastoral lands. Woodlands, bushlands and grasslands cover approximately 40 million hectares of land in Kenya and constitute significant carbon sinks. The ASALs are subject to recurring droughts and resource pressure resulting in high vulnerability to land degradation and desertification threatening livelihoods as well as resulting in high levels of greenhouse gas emissions. Approximately 30% of the land area in Kenya is affected by severe to very severe land degradation and an estimated 12 million people (one third of current population), depend directly on land that is being degraded. Besides forest lands 16% of the land cover in Kenya is classified as agricultural (arable) land.
9.2 Population Size and Characteristics

Kenya’s population has grown by an average of one million people per year in the past 10 years. The data, based on the national census in August 2009, shows that the number of people in the country grew by 37.43%, from 28,686,607 at the 1999 census to 39,423,264 in 2009. The figures also show that the country has a population density of 67 people per square kilometer, with an annual population growth rate of approximately 2.7%. The infant mortality rate recorded in the survey was 52 deaths per 1,000 live births. The under-five-mortality rate decreased to 74 deaths per 1,000 live births in 2008-09 from 115 in 2003.

The Age structure is as follows: 0-14 years - 42.3% of which males are 8,300,393 compared to 8,181,898 female; 15-64 years - 55.1%; 65 years and over: 2.6%. Seventy-five percent of Kenya’s population is under 30 years of age. Young people (15 - 30 years) number 10.8million or about 32% of the 2005 population projection. Of these, 57% are female and they form about 60% of the total active labor force in the country.

The Birth rate by 2009 estimates is 36.64 births/1,000 of the population. The Death rate on the other hand is 9.72 deaths/1,000 of the population.

The sex ratio at birth is 1.02 male(s)/female; under 15 years: 1.01 male(s)/female; 15-64 years: 1.01 male(s)/female; 65 years and over: 0.84 male(s)/female; total population: 1 male(s)/female.

The total Infant mortality rate is 54.7 deaths/1,000 live births, for males 57.56 deaths/1,000 live births while the female mortality rate is 51.78 deaths/1,000 live births.

The total life expectancy at birth is 57.86 years and is slightly lower for males at 57.49 years compared to the female mortality rate which is 58.24 years. The Total fertility rate on the other hand is 4.56 children born/woman.

9.3 Gross Domestic Product, Human Development Index and Poverty Levels

According to the Kenya Institute of Public Policy Research and Analysis (KIPPRA), Kenya’s poverty levels declined in 2006/07 but there are significant differences within and across provinces. Data available from the Kenya Integrated 2005 Household Budget Survey (KIHBS) show that national absolute poverty declined to about 46 per cent in 2005/06 from 55.5 per cent in 2000. Although the proportion of the population living in poverty has declined, the number of those living below the poverty line is estimated to have increased from 13.4 million in 1997 to about 16.6 million in 2006. Furthermore, although inequality situation in Kenya has improved over the last couple of years, it remains a policy concern. Analysis of household consumption expenditure distribution reveals that the poorest 10 per cent of rural households control only 1.63 per cent of the total expenditure, while the richest 10 per cent control 35.9 per cent of total household expenditure.

There has been a remarkable improvement in the country’s economic performance in the last five years up to 2007. It is only in 2006 and 2007 that per capita income of Kenyans exceeded the levels registered in 1997. In June 2998, Kenya launched the Vision 2030, which is an economic development plan by the Kenyan government to develop several different economic zones in various parts of the country. The Vision 2030 targets a GDP growth of 10 per cent per annum, which implies that Kenya’s income per capita would double by 2018.

The GDP (purchasing power parity) for 2008 was estimated to be 61.83 billion US Dollars, growing at a rate of 2.2% while the GDP per capita is 1, 600 US dollars. The GDP composition by sector is as follows:
The Post-election violence in early 2008, coupled with the effects of the global financial crisis on remittance and exports, reduced GDP growth to 2.2% in 2008, down from 7% in 2007. The labor force is estimated to be 9.45 million, out of which 75% is employed in the agriculture sector.

The Human Development Index (HDI) of the UNDP provides a composite measure of three dimensions of human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and gross enrolment in education) and having a decent standard of living (measured by purchasing power parity, PPP, income). By this measure, Kenya’s HDI in 2009 is 0.541, which gives the country a rank of 147th out of 182 countries with data. Between 2000 and 2007 Kenya’s HDI rose by 0.51% annually from 0.522 to 0.541 today.

9.4 Main food crops
The main food crops in Kenya are maize, beans, cassava, potatoes, sorghum, bananas and other fruits. These crops are mainly produced for subsistence. Maize is the main staple food and on average 1.5 million hectares is planted with maize annually, with an annual production ranging between 16.6 and 34.8 million bags (1.5 and 3.1 million MT) depending on the prevailing weather and market conditions. Annual national maize consumption requirement is about 32 million bags (2.9 million MT). The shortfall in production is met through exports.

9.5 Main Agricultural and Food Crops Imports/Exports
Food products dominate Kenya’s agricultural imports (88% of the total), but account for only a quarter of agricultural exports. During the 10 years 1985-94 food imports were on a strongly upward trend, rising at a linear rate of US$27 million per year. They declined in 1995 and 1996 and surged in 1997, to remain at that level in the following year. Food exports also rose during the 10-year period, at the linear rate of US$19 million per year. They started to rise in 1992 and remained high in the subsequent years till now. The overall outcome, in terms of net food imports, was highly negative: net imports in 1995-98 were 45 percent higher than in 1990-94 level and 15 percent above the extrapolated trend value. The main food imports include: rice, wheat, maize, other cereals, vegetable oils, sugar, fruits, vegetable, and dairy products.
Major cash crops produced in Kenya include tea, horticultural produce, coffee, pyrethrum, cotton, cashew nuts, and coconuts among others. In addition to coffee, tea and horticultural produce, Kenya is the world's largest producer and exporter of pyrethrum. Most of these are produced in small holder farming systems. Sugarcane and wheat are mainly produced for the local market. Kenya also produces sisal, tobacco, and Bixa natto (a natural food coloring agent) for export.

Kenya is Africa’s leading tea producer, with black tea being Kenya’s leading agricultural foreign exchange earner. Production in 1999 reached 220,000 tons. Tea exports were valued at $404.1 million in 2001, or nearly 18% of total exports. The tea industry is divided between small farms and large estates. Coffee is Kenya’s third leading foreign exchange earner, after tourism and tea. In 2001, coffee earnings totaled $91.8 million. Production in 2001/02 amounted to 52,140 tons. Similar to the tea sector, coffee is produced on many small farms and a few large estates. All coffee is marketed through the parastatal Coffee Board of Kenya.

Kenyan horticulture has become prominent in recent years, and is now the third leading agricultural export, following tea and coffee. Fresh produce accounted for about 30% of horticultural exports, and included green beans, onions, cabbages, snow peas, avocados, mangoes, and passion fruit. Flowers exported include roses, carnations, statice, astromeria, and lilies.

9.6 Characteristics of Livelihoods in Farming Systems

Land tenure in Kenya falls into four different entities namely government (public), County councils (local authorities), Individuals (private) and groups (communal). Different legal instruments govern different categories of land and owners thereof. To date, land ownership in over 40% of Kenya still remains informal.

According to Kenya’s Ministry of Agriculture, the bulk (98%) of the farm holdings in Kenya are small (<10 ha) and lie mainly in the high potential areas. The medium and large scale farms account for about 2% of the holdings, but cover about 54% of the area farmed. Nationally, the average farm size is about 2.5 ha. On these small farms most of what they produce is to meet their family's needs. Some crops are grown for sale to raise money to buy consumer items. Typically a farmer grows several different crops together in the same field: a grain such as corn; a legume such as beans; and perhaps a few trees producing coffee, bananas, or mangoes. This allows the family to harvest a variety of foods for a balanced diet. Some farmers also keep a few animals such as cattle and goats, and many raise poultry.

9.7 Policies in Place and Link with the Bioenergy Sector

Kenya has a regulatory framework in the fields of biomass, biodiesel, bioethanol, charcoal, fuel wood, biogas and municipal waste.

Energy Policy

The Energy Policy is contained in Sessional Paper no. 4 of 2004 and focuses on all forms of energy including bioenergy. Article 103, Part V, of the Energy Act 2006 addresses renewable energies, energy efficiency and conservation. Specifically, it mandates the Minister for Energy to do the following duties that are directly relevant to biofuels development:

- Formulating a national strategy for coordinating research in renewable energy;
- Providing an enabling framework for the efficient and sustainable production, distribution and marketing of biomass, solar, wind, small hydro, municipal waste, geothermal and charcoal;
• Promoting the use of fast maturing trees for energy including biofuels and the establishment of commercial woodlots including peri-urban plantations;
• Promoting the development of appropriate local capacity for the manufacture, installation, maintenance and operation of basic renewable technologies such as bio-digesters, solar systems and hydro turbines;
• Promoting international co-operation on programmes focusing on renewable energy sources;
• Harnessing opportunities offered under clean development mechanism and other mechanisms including, but not limited to, carbon credit trading to promote the development and exploitation of renewable energy sources;
• Promoting the utilization of renewable energy sources for either power generation or transportation;
• Promoting the production and use of gasohol and biodiesel.

Bioenergy Policy
The bioenergy policy objective is to ensure sufficient bioenergy supplies to meet demand on sustained basis while minimizing environmental impacts associated with usage. It has specific objectives which include to:
• Formulate national strategies;
• Support and development of biofuels
• Promote private sector participation;
• Increase rate of adoption of efficient stoves
• Use of fast growing trees for energy production

Fiscal Incentives
There are also fiscal incentives which are intended to promote biofuels in Kenya through the following mechanisms:
• Provide tax incentives to producers of renewable energy technologies and related accessories to promote their widespread use
• A 10 year tax holiday for power plants using renewable energy including biomass
• Allow duty free importation of renewable energy hardware to promote widespread usage
• Provide fiscal incentives to financial institutions to provide credit facilities to consumers and entrepreneurs.

Development of National Strategies
There are also a number of initiatives under the biofuel policy, but three of specific relevance to biofuels are:
• Biodiesel strategy
• Bioethanol strategy
• National Task Force on Accelerated Development of Green Energy

National Biodiesel Strategy
The National Biofuels Committee (NBC) was set up in 2006 to coordinate all biodiesel stakeholders. The committee first focused on developing biodiesel strategy for 2008-2012. The Stakeholders included Line Ministries (e.g. Energy, Agriculture), Research institutions, Academia, NGOs, and Private organizations. The NBC was later launched as the National Biodiesel Strategy. The crop of choice was Jatropha but the strategy also encourages research on other crops such as castor and croton. The purpose of the strategy is to:
• Fast track development of the biodiesel energy resource in Kenya;
• Increase security of energy supply by reducing vulnerability resulting from dependence on imported fossil fuels;
• Achieve a blending ratio of B5 by 2012 and B10 by 2020;
• Diversify rural energy sources by supplementing / substituting kerosene with biodiesel;
• To contribute to poverty alleviation through diversification of income sources;
• Address global warming through substitution of petroleum fuels.

**National Bioethanol Strategy**

Kenya also has a Bioethanol Strategy whose purpose is to:

• Fast track development of the bioethanol energy resource;
• achieve blending ratio of E-10 (bioethanol with petrol) by December 31st 2010;
• Increase security of energy supply by reducing reliance on imported fuels;
• Diversify the sugar industry base and strengthen competitiveness of sugar factories;
• Minimize pollutant effects of woodfuel and kerosene by substituting these fuels with bioethanol.

**National Task Force on Accelerated Development of Green Energy**

Kenya is fast-tracking its plan to boost renewable energy and recently launched the National Task Force on Accelerated Development of Green Energy. The initiative is being coordinated by the office of the Prime Minister. In adopting renewable energy, Kenya hopes to reap added gains of turning the country into a green economy. On top of benefiting from carbon finance, the renewable energy generation in Kenya will inject additional power to the national grid to assuage fears of the manufacturing sector and potential investors. By June 2012, according to the Office of the Prime Minister, the country will have boosted its energy capacity by up to 2,000MW through geothermal, wind, bio-fuel, and solid waste and coal-driven power plants.

The Prime Minister chairs a taskforce that is to advise the government on the projects to be implemented. The taskforce’s chief task is establishing financing partnerships with the private investors. Members of the steering committee of the taskforce include the Prime Minister, the two Deputy Prime Ministers and the ministers for Energy, Industrialization, Environment and Agriculture. Others are the Prime Minister’s Permanent Secretary and the chairpersons of Kenya Private Sector Alliance and Association of Large Power Consumers. The experts group is chaired by Energy Permanent Secretary with his counterpart at Treasury and the Prime Minister’s economic adviser acting as alternative chairs.

**Agriculture Policy**

Agricultural policy in Kenya revolves around the main goals of increasing productivity and income growth, especially for smallholders; enhanced food security and equity, emphasis on irrigation to introduce stability in agricultural output, commercialisation and intensification of production especially among small scale farmers; appropriate and participatory policy formulation and environmental sustainability. The key areas of policy concern, therefore, include:

• Increasing agricultural productivity and incomes, especially for small-holder farmers;
• Emphasis on irrigation to reduce over-reliance on rain-fed agriculture in the face of limited high potential agricultural land;
• Encouraging diversification into non-traditional agricultural commodities and value addition to reduce vulnerability;
• Enhancing the food security and a reduction in the number of those suffering from hunger and hence the achievement of MDGs;
• Encouraging private-sector-led development of the sector. Ensuring environmental sustainability.

Within the context of the policy therefore, biofuels production can be achieved not only as a way of enhancing farmer incomes but also ensuring environmental integrity.
Forest Policy
The Kenya Forest Policy of 2005 also advocates for environmental conservation and provision of sustainable biomass energy. This is also supportive of biofuels development in the country.

Land Policy
Kenya has not had a clearly defined or codified national land Policy since independence. However, in 2009 the Government embarked on formulation of a National Lands Policy whose goal is to guide the country through the sustainable and equitable use of land. The policy emphasizes the need to address environmental degradation and the need for security of tenure for all Kenyans, including all marginalized groups, communities and women. The policy designates all land in Kenya as either Public, private or Communal land. The policy was adopted by parliament on 3rd December 2009.

Environmental Policy and Environment Management Act
Kenya does not yet have an Environmental policy, although a Draft Environmental Policy is in the final stages before adoption. The Draft National Environmental Policy (NEP), 2008 treats climate change and disaster management as an emerging environmental issue and states that the government will adopt two approaches in combating climate change – mitigation and adaptation. The NEP suggests following measures that are of relevance to biofuels development:

- Identify and raise awareness of opportunities for adaptation measures through promotion of appropriate technology transfer and capacity building;
- Develop and implement under the Kyoto Protocol's Clean Development Mechanism (CDM) programmes and projects that encourage significant levels of investment and technology transfer for sustainable development;
- Build and strengthen research capacity on climate change and related environmental issues.

Environmental Management and Coordination Act (EMCA)
The legal framework for environmental concerns within Kenya is the Environmental Management and Coordination Act No. 8 (EMCA) of 1999. The act recognizes the need to promote renewable energy.

Biofuels Industry/Programmes Development in Kenya
Although the biofuel industry is not highly developed in Kenya, there currently exist many initiatives and programmes that are meant to promote the development of the sector. These initiatives involve the government, private sector, NGOs and research institutions.

Bioethanol Programmes
The pioneer industry in bioethanol production was the Agro-Chemical and Food Complex (ACFC) in Muhoroni which in the 1980s started production of ethanol from molasses for blending with petrol. This collapsed in 1993 due to lack of policy and unsustainable pricing. ACFC still produces ethanol albeit it is mostly exported for manufacture of potable alcohol. Together with Spectre International, the two companies produce respectively, 60,000 and 65,000 litres daily. Mumias Sugar Company is set to start integrated ethanol production in 2013, with a capacity of 80,000 litres daily.

9.8 Biodiesel Programmes
Although still in its nascent stage, a flurry of activities within government agencies, NGOs and the private sector indicate potential to develop the biodiesel sub-sector. The focus is currently on jatropha as a feedstock although castor, croton and coconut are also being considered.
Examples of private sector, government agency and NGO involvement in biodiesel include:

- Better Globe Forestry Limited which has planted 48 hectares of jatropha trial in Kiambere in Eastern Kenya.
- Green Fuels Kenya Limited also has a trial jatropha plantation in Thika in Central Kenya.
- Energy Africa Limited has worked with over 200 farmers since 2006 and more than 200,000 jatropha trees have been planted.
- Agri-Business Group is an agricultural consulting company based in Nakuru and has been working with farmers that is working with farmers throughout Kenya.
- Green Power East Africa Limited is currently producing biodiesel on a small scale using a BioKing reactor with a capacity of about 1,000 litres per day.
- Kenya Industrial Research and Development Institute is experimenting with crude home-made reactors using a variety of feedstock.
- Kenya Forestry Research Institute has also been conducting research on various trees and shrub species to evaluate their potential for biodiesel.
- The Ministry of Energy established the National Biodiesel Committee with representation from the petroleum industry, line ministries, NGOs and agricultural producers.
- ICRAF, the Aga Khan Foundation’s Coastal Rural Support Programme (CRSP), Vanilla Jatropha Development Foundation (VJDF), Norwegian Church Aid (NCA), Green Africa Foundation (GAF) and other NGOs are working with local farmers to promote jatropha for biodiesel in various parts of the country.
- Initiative for the Promotion of Biomass is lead by the Institute for Research in Sustainable Energy and Development (IRSEAD) with membership from the Monitoring and Evaluation Consulting Engineers, Ministry of Energy, Kenya Sugar Board, sugar factories and sugar farmers. It is supported by AFEPREN and the Heinrich Böll Foundation to increase the use of renewable energy in the region in the next 10-15 years.
- Initiative to Promote Renewable Energies for Poverty Alleviation lead by the Ministry of Energy and involves the participation of other ministries, NGOs, industries and bilateral donors.
- Jatropha Project in Kenya initiated by Biwako Bio-Laboratory Inc. and Hydronet Energy Company Limited and aims to grow up to 100,000 hectares of jatropha.

9.9 Crops Used for Biofuels

Type and Conversion Technology

Kenya has been producing ethanol for over twenty years in modest quantities and in the 1980s was blending it in a petrol distribution network as ‘gasohol’. Production was undertaken by Agro-Chemical and Food Complex in Muoroni in the Western Region of Kenya. A new entrant to the ethanol production industry is Spectre International in Kisumu, also in the western region. Although Spectre International has invested in some state-of-the-art technologies, ethanol production is still low-efficiency and costly in Kenya. Ethanol in Kenya is currently being produced from sugar processing residue known as molasses in stand-alone facilities rather than as an integrated process with sugar manufacture (as is done in countries where power alcohol production is at advanced stages). Mumias Sugar Company is making plans to start an integrated ethanol production facility by 2013. The molasses is fermented and then distilled to produce concentrated (up to 98%) alcohol. Feedstock for ethanol includes starchy crops such as grains (maize, sorghum), tubers like cassava and sugarcane.

The biodiesel industry in Kenya is not as well-developed and is still in its nascent stages, although a few small industries process and sell the biodiesel to operators in the matatu
(public transport vehicles) industry. A process called trans-esterification is used, in which the vegetable oil is mixed with alcohol and a catalyst to produce biodiesel and glycerol. Straight vegetable oil (unprocessed biodiesel) is also used in lighting and cooking and running stationary engines such as power generators. Feedstocks for biodiesel include oil bearing seeds such as cottonseed, jatropha, coconut, croton, rapeseed and castor.

**Potential Crops (Biofuel Feedstocks)**

A 2008 study by ESD (now Camco) commissioned by GTZ identified the most viable biofuel crops in Kenya and shows that the following yields are possible based on real-world scenarios as shown in the table below:

Table 9.1 Viable Biofuel crops in Kenya

<table>
<thead>
<tr>
<th></th>
<th>New Farmlands</th>
<th></th>
<th>Existing Farmlands</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield (T/Ha)</td>
<td>Land Ha ('000)</td>
<td>Production ('000 tonnes)</td>
<td>Biofuel ('000 liters)</td>
</tr>
<tr>
<td>Ethanol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cassava</td>
<td>9.6</td>
<td>2.08</td>
<td>19.97</td>
<td>3.395</td>
</tr>
<tr>
<td>Sorgum</td>
<td>35.0</td>
<td>5.09</td>
<td>206.50</td>
<td>8.260</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>33.4</td>
<td>0.09</td>
<td>3.01</td>
<td>30</td>
</tr>
<tr>
<td>Biodiesel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Castor</td>
<td>0.23</td>
<td>6.82</td>
<td>1.57</td>
<td>703</td>
</tr>
<tr>
<td>Coconut</td>
<td>1.64</td>
<td>0.03</td>
<td>0.05</td>
<td>18</td>
</tr>
<tr>
<td>Cottonseed</td>
<td>0.6</td>
<td>1.42</td>
<td>0.85</td>
<td>124</td>
</tr>
<tr>
<td>Croton</td>
<td>2.50</td>
<td>0.65</td>
<td>1.63</td>
<td>548</td>
</tr>
<tr>
<td>Jatropha</td>
<td>2.50</td>
<td>6.26</td>
<td>15.65</td>
<td>5.258</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>2.00</td>
<td>0.16</td>
<td>0.32</td>
<td>125</td>
</tr>
<tr>
<td>Sunflower</td>
<td>0.92</td>
<td>3.48</td>
<td>3.20</td>
<td>1,325</td>
</tr>
</tbody>
</table>

According to this study, sorghum would provide the greatest opportunity to increase ethanol production without competing existing agricultural production. Other feedstock may not be viable in the short-term but in the long term would ensure sustainable production. Castor and rapeseed were identified as possible large sources of feedstock in the near term, with castor maximising more semi-arid areas and rapeseed being grown in conjunction – as rotational crop – with wheat, barley and other staples. The study also showed that if the production is optimized based on scientific literature and from other arts of the world, it is possible to more than double these figures.

**Market for Raw Material**

An economic analysis shows that the feedstock costs in Kenya are 60% lower than in Brazil, but the cost of biofuel production is 75% higher in Kenya due to poor infrastructure and inefficiency in production. With the exception of ethanol, the market for biofuels is still in its infancy. Even for ethanol, with the collapse of the power alcohol programme in the early 1990s due to lack of policy and unsustainable pricing, the bulk of ethanol produced in the country is either exported or used as an intermediate feedstock for other industrial products.

The prices of most potential feedstocks are therefore not based on their sale for biofuel manufacture, but for other more ‘conventional’ uses. The data in the table gives indicative figures on the cost of potential biofuel feedstocks as at 2008 (from both food and non-food crops) as shown in the table below. The prices are based on conversations with farmers, data from the Ministry of Agriculture, Kenya Agricultural Research Institute and FAOSTAT.
### Table 9.2 Biofuel feedstocks prices in 2008 in Kenya

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Price/ton of feedstock (USD at exchange rate of Ksh 70/USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molasses (sugar processing waste)</td>
<td>28 - 35</td>
</tr>
<tr>
<td>Cassava</td>
<td>92.8</td>
</tr>
<tr>
<td>Sorghum</td>
<td>17</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>35</td>
</tr>
<tr>
<td>Castor</td>
<td>285.7</td>
</tr>
<tr>
<td>Coconut</td>
<td>419</td>
</tr>
<tr>
<td>Cottonseed</td>
<td>285.7</td>
</tr>
<tr>
<td>Croton</td>
<td>214.3</td>
</tr>
<tr>
<td>Jatropha</td>
<td>214.3</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>371.4</td>
</tr>
<tr>
<td>Sunflower</td>
<td>456.9</td>
</tr>
</tbody>
</table>

**End use**

Currently, most of the ethanol produced in Kenya is exported to Uganda and the Democratic Republic of Congo (DRC) for beverage use. However, there is potential to use the ethanol as petrol blend, and fuel for lighting and cooking. A little biodiesel is currently produced and used to run cars and stationary engines in Kenya. Efforts have also been expended at the Kenyan coast by UNDP to promote the use of Straight Vegetable Oil for lighting and cooking as a substitute for kerosene, firewood and charcoal.

### 9.10 Implications of Conversion of Biofuels Raw Material

Ethanol production is a relatively mature technology in Kenya although the production capacity is low and currently is not used for fuel. Biodiesel, however, is still in its infancy and therefore few impacts can currently be attributing to it. However, with increasing investment in the biofuels industry, there are bound to major implications.

**Implications for Water use**

Although there are numerous environmental benefits of using biofuels, the processing of feedstock requires large amounts of water. Data shows that 1,000 – 2,000 litres of water is required to process one tonne of sugar to ethanol. Kenya is already classified as a water-stressed country with very little stored water per capita. When severe droughts occur, water storage areas are rapidly drawn down; and where boreholes and wells have been dug up, these dry up during droughts due to poor or low recharge. Additionally, huge investments need to be made in treatment plants to ensure compliance with established water quality standards. Information from Agro-Chemical and Food Complex Company, one of the largest ethanol manufacturers in Kenya shows that the spent wash from ethanol production has a malodorous smell and dark colour that often attracts complaints for the surrounding community.

**Implications for Employment**

Potential employment and incomes benefits are enormous for Kenya. A 2008 report showed that the jobs-to-investment ratio for biofuels is about 100 higher than for petroleum refineries. Employment opportunities will be created through agro-industrializations. Additionally, there are opportunities to provide farm jobs as well as expanded income through adoption of new cash crops.
Data from Mumias Sugar Company, the biggest sugar producer in Kenya, shows that producing an additional 93 million litres of ethanol in Western Kenya (as is planned for 2013) would create 500 -1000 new jobs in the manufacturing and transport sector. In Mumias alone, up to 100 people including 20 professionals earning an average of Ksh 100, 000 (1, 430 USD) will be required. The other workers would earn 15, 000 – 35, 000 kshs (214 – 500 USD). It is estimated that one wage farm job will be created for every 54.9 hectares planted with ethanol feedstock, and one casual farm job for every 30.4 hectares planted. For biodiesel, it is estimated that one non-farm job will be created for every 100, 000 – 180, 000 litres of biodiesel produced.

**Implications for land tenure**

Analysis shows that depending on the type of feedstock, there might or might not be enough land to produce enough feedstock to meet the required fossil fuel substitution/blending. Some feedstock can only grow on high potential arable land, while others can be grown in low potential land and therefore not compete with food crops for land. For example, growing more sugarcane will require one fifth of potentially suitable land that is not currently being used for food or cash crops. The analysis also shows that not enough land exists for producing the required amount of ethanol from molasses. However, ample, non-competitive but suitable land exists for cassava and sorghum. For biodiesel, ample land exists for croton, jatropha, sunflower and castor. Cottonseed, rapeseed and coconut are limited by land availability.

**9.11Mapping of Policy and Institutions and Links with Bioenergy**

**First hand players**
The Ministry of Energy is in charge of all energy initiatives in the country and must be involved in all investments in the energy sector. In addition to dealing with the Ministry of Energy, there are certain standard procedures that every investor must comply with prior to commencing business in Kenya:

i. Obtain an investment certificate form the Kenya Investment Authority. The certificates entitle one to several licences (about 71) that one must have before investing Kenya, including entry and employment permits under the Immigration Act. The KIA’s purpose if threefold – to aid investors in the bureaucratic requirements of starting a business, keep track of investments and protect local investors from detrimental investments.

ii. Acquiring land – biofuel investors can obtain feedstock from freehold land owned by the investor; leasehold ownership; a contract with a landowner where the investor has rights to the crop, or by purchasing feedstock from farmers or on the open market.

iii. The Environmental Management and Coordination Act requires an Environmental and Social Impact Assessment before the start of any development project.

iv. Equipment purchase and importation which requires the approval of the Kenya Bureau of Standards (KEBS) to ensure conformity with Kenya standards.

v. Since establishment of biofuel crops may require importation of plant material and/or seed, there is need for compliance with the Seed and Plant Varieties Act and the Protection Act. Under these acts, the Kenya Plant Health Inspectorate Service (KEPHIS) has the duty to carry out testing, certification, quarantine and grading of seed and plant material.

**Ministries/Secretariats Involved in the Bioenergy Planning/Applications**
The Ministries involved include the Ministry of Energy, Ministry of Agriculture, Ministry of Trade and Industry, Ministry of Immigration, Ministry of Finance, Ministry of Environment and Mineral Resources, Ministry of Lands. Other agencies which although inked to parent
ministries are autonomous bodies include National Environment Management Authority (NEMA), KEBS, KEPHIS, KIA and the various agencies under the lands Ministry.

**NGOs Involved**

NGO involvement in biofuels is limited to biodiesel. The following are some of the NGOs that are involved in biofuels initiatives in Kenya:

- Green Africa Foundation (GAF) works in partnership with the private sectors, individuals, self-help groups and the government. GAF is working in partnership with Japanese investors who are planning to establish jatropha plantations and set up processing plants.
- The Vanilla Jatropha Development Foundation (VJDF) also works with government, private sector and farmers to increase jatropha production around the country. It has projects in Koibatek (in the mid-Rift Valley), Kisumu (in the Lake Victoria Basin) and Kibwezi (and ASAL area).
- The Norwegian Church Aid (NCA) is working in Mpektoni with the Lamu Cotton Growers Association and ESDA (now Camco) to develop an integrated jatropha energy system that involves growing jatropha, extracting the straight vegetable oil and using it to generate electricity.
- Other non-governmental organisations include ICRAF, the UNDP small Grants Programme and the Aga Khan Foundation through the Coastal Rural Support Programme working with farmers at the Coast.

**Other Stakeholders Identified**

Other stakeholders identified include:

**Kenya Biodiesel Association**

The association was formed to:

- Coordinate stake-holders including feedstock producers, processor, marketers, distributors etc.
- Establishment of buying centres
- Price setting of feedstock
- Assist small scale farmers to acquire technology and services
- Provide an avenue for lobbying
- Monitoring and evaluation.

**Petroleum Institute of East Africa (PIEA)**

PIEA was launched in 199 and has corporate, individual and associate membership of players in the petroleum industry. Its mission is to provide a forum for expertise and excellence in the oil industry in the East African region with the aim of promoting professionalism and free enterprise in petroleum business supported by the highest business and operating standards, adherence to Environment, Health and Safety ideals.

**Kenya Private Sector Alliance (KEPSA)**

Kenya Private Sector Alliance (KEPSA) is the umbrella body of the private sector. It exists to pursue an enabling business environment, policies and laws for the large as well as the micro, small and medium size enterprises.

**Kenya Renewable Energy Association (KEREA)**

KEREA was formed in 2002 when members of the Renewable Energy Resources Technical Committee at the Kenya Bureau of Standards realized the need for an industry association comprising of businesses involved with renewable energy, consultants, educational institutional staff, government institutions and individuals. Objectives of KEREA include:

- To promote the interests of members of the renewable energy industry, Donor organizations, NGOs, General etc.
• To create increased public awareness in renewable energy.
• To assist the Government and industry on all issues related to renewable energy.
• To promote better business practices and professionalism in the sector.
• To apply for, acquire and hold charters, Acts of Parliament, privileges, monopolies, licenses, concessions, and patents or other rights or powers from the Kenya Government or local authority or any other statutory body.
• To protect the consumer of Renewable Energy products by encouraging conformity with standards and safety of components and systems.

Parliamentary Network on Renewable Energy and Climate Change (PANERECC)
PANERECC was established by Members of the Parliamentary Committee on Energy, Communications and Public Works in December 2006 to promote New and Renewable Energy (NRE) as a tool for combating climate change and ensuring development using sustainable pathways. It is open to all Members of Parliament with an interest in cleaner technologies, renewable energy, the environment and sustainable development. Associate membership is allowed for members of the public from private sector, civil society and multilateral organizations. The purpose of PANERECC is to ensure that parliamentarians are educated and better informed on the need for improved energy policy instruments and legal frameworks that address climate change mitigation as well as adaptation and that foster the accelerated development of renewable energy.
9.12 Links in Biofuels Development in Tanzania

Key:
- Government office performing both policy development and oversight functions – Prime Minister’s
- Government Line Ministries, Parliamentary Committees and Taskforces responsible for policy development & securing funding
- Autonomous Government Agencies performing regulatory and oversight functions including licensing and compliance
- International agencies providing support to government programmes through funding and capacity development
- Industry representative bodies and NGOs responsible for advocacy and extension services to farmers and industry
- Investors and farmers responsible for actual implementation of biofuel projects including growing and processing
- Various biorefinery programmes and initiatives being implemented by various entries
### Legend

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Name</th>
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</thead>
<tbody>
<tr>
<td>CBO</td>
<td>Community Based Organization</td>
</tr>
<tr>
<td>ICRAF</td>
<td>International Centre for Research in Agroforestry (World Agroforestry Centre)</td>
</tr>
<tr>
<td>INGO</td>
<td>International Non-Governmental Organization</td>
</tr>
<tr>
<td>KBA</td>
<td>Kenya Biodiesel Association</td>
</tr>
<tr>
<td>KEBS</td>
<td>Kenya Bureau of Standards</td>
</tr>
<tr>
<td>KEPHIS</td>
<td>Kenya Plant Health Inspectorate Service</td>
</tr>
<tr>
<td>KEPSA</td>
<td>Kenya Private Sector Alliance</td>
</tr>
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<td>KEREA</td>
<td>Kenya Renewable Energy Association</td>
</tr>
<tr>
<td>KIA</td>
<td>Kenya Investment Authority</td>
</tr>
<tr>
<td>KSB</td>
<td>Kenya Sugar Board</td>
</tr>
<tr>
<td>KSPA</td>
<td>Kenya Sugar Producers Association</td>
</tr>
<tr>
<td>MEMR</td>
<td>Ministry of Environment &amp; Mineral Resources</td>
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<tr>
<td>MOA</td>
<td>Ministry of Finance</td>
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<td>MOI</td>
<td>Ministry of Immigration</td>
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<td>MOInd</td>
<td>Ministry of Industrialization</td>
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<td>MOL</td>
<td>Ministry of Lands</td>
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<td>MOT</td>
<td>Ministry of Trade</td>
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<tr>
<td>NEMA</td>
<td>National Environment Management Authority</td>
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<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
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<tr>
<td>NTFADGE</td>
<td>National Task Force for Accelerated Development of Green Energy</td>
</tr>
<tr>
<td>PANERECC</td>
<td>Parliamentary Network on Renewable Energy &amp; Climate Change</td>
</tr>
<tr>
<td>PIEA</td>
<td>Petroleum Institute of East Africa</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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9.13 Summary of the biofuels activities implications in Kenya

<table>
<thead>
<tr>
<th>FARM</th>
<th>INDUSTRY</th>
<th>MARKET</th>
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<tbody>
<tr>
<td><strong>Issues</strong></td>
<td><strong>Issues</strong></td>
<td><strong>Issues</strong></td>
</tr>
<tr>
<td>About 20% of the land is suitable for cultivation, predominantly for subsistence farming</td>
<td>Insufficient feedstock supply</td>
<td>Competition for ethanol for beverage use.</td>
</tr>
<tr>
<td>Limited land.</td>
<td>Few processing facilities</td>
<td>Unsustainable pricing</td>
</tr>
<tr>
<td>98% of the farm holdings are small (&lt;10 ha) hence cannot support sustainable feedstock production.</td>
<td>No technical capacity</td>
<td>Prices of potential feedstocks not based on their sale for biofuel manufacture, but for other more 'conventional' uses</td>
</tr>
<tr>
<td>Problems with sugar farming</td>
<td>Economic feasibility still not assured</td>
<td>Market for biofuels is still in its infancy</td>
</tr>
<tr>
<td>Maize, a potential ethanol feedstock is the staple food and is in short supply</td>
<td>Poor infrastructure and inefficiency in production hampers growth</td>
<td></td>
</tr>
<tr>
<td>60% of farming systems is subsistence</td>
<td>Ethanol produced from sugar molasses in stand-alone facilities rather than as an integrated process with sugar manufacture – more costly</td>
<td></td>
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<tr>
<td>Food insecurity</td>
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<tr>
<th>Policies</th>
<th>Policies</th>
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<tbody>
<tr>
<td>Agriculture policy aims to increase productivity and income growth and enhanced food security and equity</td>
<td>Establishment of Tax incentives – tax holidays and fiscal incentives for green energy investment</td>
<td>Establishing financing partnerships with the private investors</td>
</tr>
<tr>
<td>Agriculture, Energy, Forest, Draft Environment propose sustainable biofuel feedstock production</td>
<td>Build and strengthen research capacity</td>
<td>Diversify the sugar industry base and strengthen competitiveness of sugar factories</td>
</tr>
<tr>
<td>ICRF, other NGOs and companies working with farmers to promote jatropha</td>
<td>Promote CDM and carbon trade</td>
<td>Achieve blending ratio of E-10 (bioethanol with petrol) by December 31st 2010</td>
</tr>
<tr>
<td>Focus on jatropha castor, croton and coconut as biodiesel feedstock</td>
<td></td>
<td>Promoting the utilization of renewable energy sources for power generation or transportation</td>
</tr>
<tr>
<td>Kenya Forestry Research Institute conducting research on various species to evaluate biodiesel potential.</td>
<td></td>
<td>National Biodiesel Committee with membership of petroleum industry, line ministries, NGOs and agricultural producers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emerging Patterns/relationships</th>
<th>Emerging Patterns/relationships</th>
<th>Emerging Patterns/relationships</th>
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</thead>
<tbody>
<tr>
<td>Opportunities to provide farm jobs</td>
<td>Initiative for the Promotion of Biomass lead by the Institute for Research in Sustainable Energy and Development (IRSEAD)</td>
<td>National Biodiesel Committee with membership of petroleum industry, line ministries, NGOs and agricultural producers.</td>
</tr>
<tr>
<td>Environmental benefits of using biofuels</td>
<td>Biodiesel strategy</td>
<td></td>
</tr>
<tr>
<td>Expanded income through adoption of new cash crops.</td>
<td>Bioethanol strategy</td>
<td></td>
</tr>
<tr>
<td>Irrigated feedstock production to create more demand for water</td>
<td>National Task Force on Accelerated Development of Green Energy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Active participation in R &amp; D and actual feedstock production</td>
<td></td>
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<tbody>
<tr>
<td>Growth in agro-industrialization</td>
<td>Growth in agro-industrialization</td>
<td>Straight Vegetable Oil for lighting and cooking to substitute kerosene, firewood and charcoal.</td>
</tr>
<tr>
<td>Huge investments needed in treatment plants to ensure compliance with water quality standards.</td>
<td>Private-sector-led development</td>
<td>Integrated ethanol production to increase efficiency and lower costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diversify the sugar industry base and strengthen competitiveness of sugar factories</td>
</tr>
</tbody>
</table>

9.14 Conclusions

The case of Kenya is most relevant as has been producing bioethanol for nearly 20 years. The production has not been steady and tends to be exported for drinks to its neighbouring countries. It has been reported that land will not be sufficient to produce the amount of ethanol needed for the transport sector in Kenya. Nevertheless, alternative crops have been considered that do not compete with food or can produce both food and fuel (e.g. sweet sorghum, jatropha, castor oil). With the experience already in place and the different policy mechanisms (e.g Task Force, Biofuels Programmes) it is possible that Kenya could produce
biofuels in adequate areas that do not jeopardise food production in the country and do allow to rural development and a better income to the country. Positive impacts can be expected at local level with job creation in some areas where conflict with other resources (such as water) is not an issue.
10. ZAMBIA CASE STUDY

10.1. Country’s Characteristics

Location
Zambia occupies a near central location on the southern African sub-continent between 7° 30’ and 18° 45’ south latitude, and 22° 00’ and 33° 30’ east longitude. It is surrounded by the Democratic Republic of Congo in the north, Tanzania in the northeast, Malawi and Mozambique in the east, Zimbabwe, Botswana and Namibia in the south, and Angola in the west. It is divided into nine provinces. Lusaka is the capital and largest city (Figure 10.1).

Figure 10.1: Map of Zambia showing surrounding countries, provinces, population nodes, transport infrastructure, and main topographic features (UN, 2004).

Geographical characteristics
Zambia covers an area of 752,614 km². Most of the western and central regions of the country are situated on the great plateau of central Africa. The plateau rises eastward from 915 to 1,520 m.a.m.s.l. and has an average altitude of 1,200 m.a.m.s.l. A faulted escarpment zone known as the Muchinga Mountains, traverses most of Northern Province. Its highest point is 2,170 m.a.m.s.l. North of the escarpment the topography is dominated by the Bangweulu swamps, Lake Bangweulu, Lake Mweru Wantipa, the eastern half of Lake Mweru, the southern extremity of Lake Tanganyika, and the Chambeshi River valley. East of the escarpment towards the border with Tanzania and Malawi, the land rises to over 1,800 m.a.m.s.l. South of the escarpment the deep rift trough of the Luangwa River dominates the area. Most of the western part of the country is drained by the Zambezi River and its tributaries. The river forms most of Zambia’s southern boundary with Zimbabwe. Key features of the river include the Victoria Falls, the Kariba Dam and the deep rift trough of the Middle Zambezi Valley. Most of central Zambia is drained by the Kafue River and its tributaries (Aregheore, 2003, FAO, 2005). The Kafue is dammed above a gorge just south of Lusaka. The country has a further 1,700 medium to large concrete dams as well as about
3000 small earth dams. The lakes, dams, and rivers comprise a water surface equivalent to 1.6% of the country’s total area. Expansive wetlands, covering almost 5% of the country’s total area, are located on the alluvial plains of the main rivers. The Kafue Gorge Dam, Lake Kariba and Victoria Falls are equipped for hydroelectric power generation and generate more than 90% of the country’s electricity (Batidzirai et al., 1998).

Zambia’s subtropical climate is characterized by three distinct seasons (1) The cool dry season from May to August when maximum temperatures range from 16°C to 21°C and frost occurs in the high altitude areas, (2) The hot dry season from September to November when maximum temperatures range from 27°C at high altitude, to 38°C in the river valleys. During both these dry seasons rainfall is minimal or absent, and relative humidity averages 40%. (3) The rainy season extends from late November to April with December, January and February being the wettest months. Although maximum temperatures during this season average 21°C, relative humidity is generally high. The distribution of moisture-laden winds driven into the country by the Inter-Tropical Convergence Zone is predominately influenced by changes in altitude and latitude. The country as a whole receives a mean annual rainfall (MAP) of 1020mm. However, the MAP increases from 750mm in the southern region, to between 900 to 1200mm in the central region, to 1400mm in the northern region. In the latter, heavy rains may fall for 15 to 24 days per month during the rainy season (Chapman and Walmsley, 2003; FAO, 2005).

Figure 10.2: Relative importance of Zambia’s economic activities in 1996 (Europa Publications, 2010).

Agriculture is Zambia’s second most important economic activity (Figure 10.2). About 70% of the country’s economically active population is employed in the agricultural sector as compared to 7% in industry and 23% in services (ECZ, 2001). In 1997/98, crop failure due to flooding in the northern region and due to drought in the southern and western regions as well as considerable loss of livestock, saw the country’s growth rate plummet from +7% in 1996/97 to -2%. Good weather and good crop harvests during 1998/99 and 1999/2000, saw the growth rate recover to almost +4%. As Chapman and Walmsley (2003, pg. 6) note the country’s “economic performance is closely correlated to agriculture, which, in turn, is critically dependent on weather conditions”. This close correlation does not bode well for the future. According to GEF (2008), the later onset and earlier cessation of rains, the increased frequency and spatial extent of droughts and floods, and the occurrence of droughts during the rainy season, experienced since the late 1980s are due to climate change. These trends as well as an increase in temperature, are likely to become more prevalent. From 1988 onwards, the total area under cultivation and the total agricultural production declined. In addition to repeated droughts and floods, and loss of work oxen making farming unpredictable and risky, these decreases can be ascribed to the early 1990s removal of subsidies on agricultural inputs that forced most smallholder farmers to stop applying
chemical fertilizers. There has been a significant switch from cultivating maize as the main food crop, to cultivating drought resistant food crops that require less fertilizer such as sorghum, cassava, millet, groundnuts and tubers (SIDA, 2004; Perret, 2006). Perret’s (2006) assertion that maize is no longer a suitable crop for Zambia’s bioclimatic and socioeconomic conditions, is substantiated by GEF’s (2008) predictions of average yield decreases of 66% for rainfed maize and 16% for irrigated maize, under the most probable climate change scenario applicable in the country in 2030.

Environmental Characteristics
Zambia has four major vegetation categories. Closed forests covering 6% of the country are restricted to the higher rainfall regions. Savanna woodlands cover 64% of the country and are predominately classed as Miombo woodland. The tree component of the woodlands range from sparsely scattered in the drier south to tall dense tickets in the moister north and northwest. Although Termitaria (anthill vegetation) is distributed throughout the country, it only covers about 3% of its area. Grasslands cover 27% of the country and range from those found in the drier south to those associated with wetlands, to open grassy plains the high eastern escarpments. Deforestation is proceeding at the rate of about 200,000 ha per year. Coupled with overgrazing, it has contributed to severe soil degradation (ECZ, 2001, Aregheore, 2003). Approximately 30% of the land surface has been altered for agriculture, forestry and settlements (Chapman and Walmsley, 2003).

On the basis of the combined influence of rainfall, temperature, altitude, topography and soils, on the length of the growing season and hence crop options, Zambia is divided into three major agro-ecological zones (Figure 10.3).

Figure 10.3 Map showing Zambia’s three major agro-ecological zones (ECZ, 2001).

Zone 1 includes the major river valleys in the southwest, south, and southeastern parts of the country which experience very high summer temperatures and are prone to flooding. For the zone as a whole, MAP is 750 mm, the risk of drought is medium to high, the growing season is short (80 to 120 days), land degradation is widespread and the fertility of the soils is low. In addition, the soils are either characterized by an impermeable clay horizon which dependent on depth can make them difficult to plough and prone to cracking when dry, or a high sodium and base content which renders them highly erodible. Most of this zone has a poor agricultural potential.
**Zone 2** covers most of the central full extent of the country. It has a MAP of 800 to 1,000 mm, a growing season of 100 to 140 days and a medium to low risk of drought. In the Western Province on both the plateau and Zambezi flood plain infertile, weakly developed, sandy soils predominate. The soils in the central and eastern parts of this zone generally have a better texture, structure and fertility status. The zone does have a severe water deficit during several periods of the cropping calendar. Although 87% of this zone has a good agricultural potential only half of it is accessible for this purpose. The balance has been set aside for national parks, game management areas and forests.

**Zone 3** covers the full extent of the northern part of the country and is the largest zone. MAP ranges from 1,000 to 1,400 mm, and drought risk is low. However, frosts are prevalent at high altitudes and floods at low altitudes, and the soils are generally highly leached and acidic. About half the zone has a good agricultural potential (ECZ, 2001; Aregheore, 2003; SIDA, 2004; FAO, 2005).

### 10.2. Population characteristics

Over the past three decades Zambia’s population has more than doubled from 5.7 million people in 1980 (UN-HABITAT, 2005) to 12 million people in 2009 (DFAT, 2009). Population growth rates are however declining from the peak of 3.1 in the 1970s, to 2.7 in the 1980s, to 2.4 in the 1990s (UN-HABITAT, 2005), to 2.1 from 2000 to 2006 (CSO, 2007). In 2000, the average population density (inhabitants/km²) in the agro-ecological zones 1, 2 and 3, were 3.11 and less than one, respectively (SIDA, 2004). The population densities of Lusaka and Copperbelt provinces where people are concentrated in urban, industrial and mining centres and along the major transportation corridors are 65 and 53, respectively. In 2000, 44% of Zambia’s population lived in these concentrated areas. Although the population is comprised of an almost equal number of males and females (CSO, 2001), 65% of the rural population is female (SIDA, 2004).

The 2000 census revealed that 20% of urban households were headed by women and that 45.5% of them were widowed. The average household size was five people. While 49% and 38% of them had access to safe water and garbage disposal respectively, only 15% and 16.7% had access to safe toilets and electricity, respectively. Wood for cooking and kerosene for lighting was used by 60.9% and 50% of the households, respectively (CSO 2001, UN-HABITAT, 2005).

In 2002, 45.6, 53.7 and 2.3% of Zambia’s population was less than 14 years of age, between 15 and 64, and over 65, respectively (UN-HABITAT, 2005). By 2004, 21.5% of Zambians were HIV positive or had AIDS – 60% of whom were women aged between 15 and 49 years, and over 100 thousand people had already died from the pandemic (UN-HABITAT, 2005). According to UNDP (2007) there were 845,546 children orphaned by AIDS in 2006, and this figure was projected to increase to 936,167 by 2010. HIV infection rates as well as life spans of people with AIDS, are however improving. CSO (2001) noted that life expectancy in Zambia rose from 47 years in 1990 to 50 years in 2000. During this decade it has remained about 50 years (UNDP, 2007).

### 10.3. Gross Domestic Product, Human Development Index and Poverty Levels

When Zambia gained independence in 1964, it was a middle-income country with copper responsible for approximately 80% of export earnings. During the 1970s and early 1980s its Human Development Index (HDI) grew slowly. Then, copper lost almost half its value on world markets resulting in a rapid reversal of the HDI to the extent that the 1995 value was
less than the 1975 value (UNDP, 2007). In addition to increasing poverty, the country experienced increasing disparities between rich and poor (Chapman and Walmsley, 2003). Between 1989 and 2000, 56.5% of Zambia’s income was distributed amongst the country’s richest 20% of the population. By contrast only 3.3% was distributed amongst the poorest 20% of the population. Through until 1991 when the Movement for Multiparty Democracy Government (MMD) took office, Zambia’s economy was state-dominated and crippled by a lack of investment. The MMD abolished foreign exchange controls and subsidies on locally produced products and imports. It also embarked on a programme to privatize most government-owned copper mines thus freeing itself of enormous industry losses as the value of the metal continued to dip (Chapman and Walmsley, 2003). Although conditions were improving, in 2000 only 42% of Zambians were generating an income and most of them were doing so on an informal basis in the agricultural sector (UNDP, 2001). By 2004, 64% of Zambians were still living on less than the poverty threshold of US$ 1/day (UN-HABITAT, 2005). Comparing poverty in 1991 and 2004, Bigsten and Tengstam (2008) found that it decreased in rural areas from 88% to 78% but increased in urban areas from 49% to 53%. They attribute this to the greater diversity of income opportunities available to rural households.

Since 2004, copper output has increased steadily due to a recovery of the value of the metal and increased foreign investment. In 2005, Zambia acquired US$ 6 billion in debt relief under the Highly Indebted Poor Country Initiative. In 2007, Zambia experienced a bumper harvest which boosted the GDP and agricultural exports. As is evident from Table 1, from 2004 to 2008 Zambia experienced strong growth with real GDP growth of about 6% per year, single-digit inflation, a relatively stable currency, decreasing interest rates, and increasing levels of trade. The weaker 2009 values given in Table 1 are IMF projections based on the world recession driven decline in commodity prices and the fact that elections were destined for 2009. Zambia’s HDI (0.481) in 2007 was finally better than in 1975 (0.448) when it was first estimated (UNDP, 2007, DFAT, 2009).

Table 10.1 Zambia’s Economic Indicators (adapted from DFAT, 2009)

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<tbody>
<tr>
<td>GDP (US$bn) current prices</td>
<td></td>
<td></td>
<td>5.4</td>
<td>7.3</td>
<td>10.9</td>
<td>11.4</td>
<td>14.7</td>
<td>12.3</td>
</tr>
<tr>
<td>GDP PPP*</td>
<td></td>
<td></td>
<td>12.4</td>
<td>13.4</td>
<td>14.7</td>
<td>16.1</td>
<td>17.4</td>
<td>18.5</td>
</tr>
<tr>
<td>GDP per capita (US$)</td>
<td>240</td>
<td>232</td>
<td>480</td>
<td>627</td>
<td>917</td>
<td>990</td>
<td>1,248</td>
<td>1,027</td>
</tr>
<tr>
<td>GDP per capita PPP*(US$)</td>
<td>1,099</td>
<td>1,159</td>
<td>1,2422</td>
<td>1,399</td>
<td>1,482</td>
<td>1,544</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real GDP growth**</td>
<td>-3</td>
<td>2</td>
<td>5.4</td>
<td>5.3</td>
<td>6.2</td>
<td>6.3</td>
<td>5.8</td>
<td>4.5</td>
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<tr>
<td>Inflation **</td>
<td>46</td>
<td>21</td>
<td>18.0</td>
<td>18.3</td>
<td>9.0</td>
<td>10.7</td>
<td>12.4</td>
<td>14.0</td>
</tr>
</tbody>
</table>

* Purchasing power parity
** (% change yoy)

b from UN-HABITAT (2005).
10.4. Food security

Zambia has a serious food security problem. Chiwele’s (2005) analysis of the period from 1989 to 2004 revealed that the country’s total annual production of cereals, and roots and tubers, consistently failed to meet the national market demand, while maize production was only capable of meeting this demand in 2003 and 2004, and exceeding it in 1989, 1993 and 1996, when the surplus was exported. Focusing on cereals over the period from 1999 to 2003, Chiwele (2005) gave the following statistics in $10^3$ metric tonnes: domestic requirement = 1 467, production = 1 095, imports = 111, and food aid = 71, showing that there was a shortfall of 190 or 12.9% between supply and demand. Chiwele (2005) cited a 1998 malnutrition survey of children under the age of five which found 53% were stunted, 26% were under weight and 5% were wasted, as well as a household survey carried out in August 2003 which found 34% had run out of staple food, and 20% would run out within a month. BiofuelWatch (2006) attributed the survival of 1.1 million Zambians in 2005 to food aid.

The reasons for Zambia’s persistent food security problem are multifaceted and dynamic, and evidently unrelated to the availability of arable land and water. In 2003, only 5.3 million ha of land was cultivated out of 35.4 million ha of potentially arable land. Likewise, only 46 400 ha were irrigated out of 523 000 ha with irrigation potential (Aregheore, 2003; BOZ, 2003). Estimates of potential arable land vary with Biopact’s (2006) 58 million ha, the highest found in the literature used.

As noted in section 1.2 and evidenced in Figure 4, from the early 1990s onwards the area under maize production contracted in favour of other staples like cassava, sorghum and millet, and export crops such as cotton, tobacco and paprika. Despite mostly using improved varieties, in the absence of fertilizers average small holder farmers’ maize yields were low (0.5 to 1.0 t ha$^{-1}$). In 2006 and 2007, maize production recovered due to good rains, the resumption of fertilizer subsidies and large-scale government maize procurement through the newly reconstituted Food Reserve Agency (Dorosh et al., 2009). Average small holder farmers’ maize yields increased to 4.0 t ha$^{-1}$. Government breeders released their first wave of highly productive new cassava varieties in the early 1990s, rapidly doubling the production of the crop. However, IITA (2007) note that it’s performance could be even better. Pests, disease, late and insufficient weeding, and other poor cultural practices reduce its potential yields by as much as 50%.

![Figure 10.4: Production trends in food staples in Zambia (Dorosh et al., 2009).](image)
As a consequence of the release of several new cultivars of sweet potatoes, there has been a rapid increase in their production over the past decade (Dorosh et al., 2009). Improved varieties of sorghum and millet have been widely and increasingly adopted by all categories of farmers since their initial release in 1989. Although they perform better than maize under water stressed conditions and poor soils, they are more vulnerable to destruction by birds. Small holders generally grown them for home consumption and maize for cash income (even during droughts) because opportunities for them to market these crops are not as good as they are for maize (SIDA, 2004). Edible caterpillars of the Emperor moth (Saturniidae) picked from Miombo woodland play a significant role in ameliorating rural livelihoods. A substantial proportion of the harvest is dried and sold in urban centers. Crop residues and agro industrial by-products such as molasses, brewer’s grain, bone and fish meal, etc. play an important role in the nutrition of ruminant livestock (Aregheore, 2003, FAO, 2005).

10.5. Main Crops: Production, Imports/Exports.

In 2003, the agricultural sector’s contribution to the gross domestic product (GDP) was 21% while 2% of the export earnings originated from agriculture (SIDA, 2004). Small holder farms - most of which are female headed – produce most of Zambia’s food and a substantial proportion of its cash crops. The figures in brackets are SIDA’s (2004) estimates of the proportion of the country’s total production contributed by women - millet (95%), cotton (95%), sorghum (85%), groundnut (75%), maize (65%) and sunflower (55%).

Table 10.2. shows the typical crops grown in Zambia’s three agro-ecological zones listed in decreasing order of potential and priority (adapted from Chalabesa et al., 1999).

<table>
<thead>
<tr>
<th>Type of crops</th>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 3</th>
</tr>
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<tbody>
<tr>
<td>Staple crops</td>
<td>1. sorghum</td>
<td>1. maize</td>
<td>1. maize</td>
</tr>
<tr>
<td></td>
<td>2. maize</td>
<td>2. sorghum</td>
<td>2. cassava</td>
</tr>
<tr>
<td></td>
<td>3. Pearl millet</td>
<td>3. cassava</td>
<td>3. Finger millet</td>
</tr>
<tr>
<td></td>
<td>4. cassava</td>
<td>4. Pearl millet</td>
<td>4. sorghum</td>
</tr>
<tr>
<td>Food legumes</td>
<td>1. groundnut</td>
<td>1. groundnut</td>
<td>1. bean</td>
</tr>
<tr>
<td></td>
<td>2. cowpea</td>
<td>2. bean</td>
<td>2. groundnut</td>
</tr>
<tr>
<td></td>
<td>4. cowpea</td>
<td>4. cowpea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Pigeon pea</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Chick pea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash crops</td>
<td>1. cotton</td>
<td>1. soybean</td>
<td>1. soybean</td>
</tr>
<tr>
<td></td>
<td>2. soybean</td>
<td>2. wheat</td>
<td>2. wheat</td>
</tr>
<tr>
<td></td>
<td>3. sunflower</td>
<td>3. cotton</td>
<td>3. exotic vegetables</td>
</tr>
<tr>
<td></td>
<td>4. exotic vegetables</td>
<td>4. exotic vegetables</td>
<td>4. rice</td>
</tr>
<tr>
<td></td>
<td>5. wheat</td>
<td>5. sunflower</td>
<td>5. sunflower</td>
</tr>
<tr>
<td></td>
<td>6. rice</td>
<td>6. rice</td>
<td>6. potato</td>
</tr>
<tr>
<td></td>
<td>7. castor</td>
<td>7. tobacco</td>
<td>7. spices</td>
</tr>
<tr>
<td></td>
<td>8. spices</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9. flowers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plantation crops</td>
<td>1. fruits</td>
<td>1. sugar cane</td>
<td>1. fruits</td>
</tr>
</tbody>
</table>
Zambia’s main exports are copper and cobalt. However, since 1991 it has increasingly exported electricity, copper rods, gemstones and cement as well as the following agricultural produce: tobacco, sugar, beer, fruit juices, cold drinks, cotton, cotton yarn, cut flowers, specialty vegetables, spices, coffee, bone and fish meal, and live fish. Its main export partners are the UK, Switzerland, Tanzania, Zimbabwe, South Africa, The Netherlands, Germany and Australia. Since 1991, Zambia has been a net importer of goods. Its main imports are crude oil and fertilizer. Other significant imports include mining equipment, machines and their component parts, transport equipment and parts, motor vehicles and electricity. Dairy products and processed foods are routinely imported. As noted in section 4, dependent on domestic production maize, cereals etc are periodically imported. The main imports partners are the UK, UAE and South Africa. Goods are also imported from Saudi Arabia, Japan, and Malawi (DFAT, 2009).

10.6 Characteristics of Livelihoods

According to SIDA (2004) and FAO (2005) Zambia has four categories of farmers:-

1. **Small Holders**: 75% of the farmers are subsistence producers of staple foods on farms ranging from 0.5 to 9 ha. Although they only market an occasional surplus, they account for 51% of the agricultural GDP.

2. **Emergent Farmers**: 20% of the farmers produce food and cash crops on farms ranging from more than 9 to 20 ha,

3. **Medium Scale**: about 4% of the farmers produce food and cash crops on farms ranging from more than 20 to 60 ha. Together with the emergent farmers, they produce 25% of the agricultural GDP.

4. **Large Scale**: constituting less than 1% of the farmers and numbering less than 800 individuals or companies, these farmers grow cash crops on farms larger than 60 ha. Together with the medium scale farmers, they are commercial farmers characterized by high mechanization and have a well organized farmer network which facilitates the acquisition of inputs.

Prior to independence 6% of Zambia was Crown Land and 94% Reserves and Trust Land. In 1964, the Crown Land became State Land and it was nationalized requiring State consent for all dealings. This requirement hampered development of unused land. In 1991, the MMD reintroduced the economic value of undeveloped land and the right of private land ownership. The Reserves and Trust Land became Customary Lands where the community owns all the land on behalf of its members, and the consent of the Chief is required to settle in the area (UN-HABITAT, 2005). Most small holders have customary land use rights. Most land in opened-up areas is occupied but unexploited agricultural land, which is generally distant from where minimal infrastructure is developed, still remains unoccupied (FAO, 2005). The Commissioner of Lands attached to the Ministry of Lands is responsible for granting State Land. However, the Ministry of Agriculture and Cooperatives is responsible for identifying, planning, demarcating, and recommending land for agriculture purposes, as well as monitoring land use change (UN-HABITAT, 2005).
10.7 Policies Linked to Bioenergy Sector

According to Mr Oscar Kalumiana the current Director of the Department of Energy (DE) (Kalumiana, 2009), Zambia's Government is committed to ensuring environmentally sustainable exploitation of biomass resources in order to (a) secure supplies and stabilize prices of transport fuels, (b) increase investment in the agricultural sector, and (c) contribute to socioeconomic development. While the DE's specific policy goals in respect of biomass resources are (a) to improve the management of woodlands for sustainable firewood production, (b) to improve the efficiency of charcoal production, and (c) to promote alternatives to firewood, the Department recognizes that conditions in the country are favourable for the development of the bioenergy sector. The DE attributes the current dependency of the country on food imports to the lack of infrastructure and investment in the agricultural sector, and perceives bioenergy as an excellent opportunity to significantly enhance the production potential of feedstock for both food and biomass production. The DE is initially focusing on transport rather than electricity, and plans to introduce biodiesel to be used straight or blended with diesel, and ethanol to blend with petrol. Biofuels are defined as ‘fuel’ and regulated under the Energy Regulation Act of 2008. The Ministry of Energy and Water Development is developing a long-term strategy (2009 – 2030) which includes biofuels as a priority sub-sector, and which foresees close cooperation between the DE and the Environmental Council because Environmental and Social Impact Assessments (ESIA) will be required for bioenergy projects.

The most recent policies or Acts of the following Ministries/Departments were scanned for reference to the use of biomass, crops or trees for bioenergy, biofuels, or electricity:- Agriculture, Food and Fisheries - Agriculture and Cooperatives; Environment, Natural Resources and Tourism; Forestry; Lands; Mines and Mineral Development; Transport; and Commerce, Trade and Industry. None was found.

10.8 Biofuels Development Status

Research

Under the leadership of Professor Francis Yamba, the Centre for Energy, Environment and Engineering (CEEEZ) and the University of Zambia, assessed the performance of 9 varieties of sweet sorghum as a supplementary feedstock to ethanol production. The research was carried out in association with Dr Jeremy Woods of the Porter Institute and ICEPT, at Imperial College, London. Between 2004 and 2007, trials of these varieties were monitored on 8 small holder farms distributed across all three agro-ecological zones, at Kafue Sugar, and at the University research farm. Similar yields were obtained in Zone 1 and 2. Stem yields in Zone 3 were poor and this was attributed to the acidic soils and the lower number of sunshine hours. The highest sugar contents were obtained with Wray, Keller, GE2 and TS1, and lowest with Madhura. GE2, Praj-1 and GE3 should be grown by commercial farmers as they were the most responsive varieties to input applications. Yield differences between sub-optimal and optimal input applications, and across different environments were insignificant with Sima and Wray, suggesting they are best suited low-resource farmers (Woods, 2007).

Takavarasha et al’s (2005) feasibility study for the production and use of biofuel in Zambia found that the area needed to be put under biofuel feedstocks in order to meet the domestic biofuel demand was equivalent to 4% of the area already under crops, 1.3% of the country’s potentially arable land, and 0.27% of the country’s total land surface.

Von Maltitz and Brent (2009) estimated that Zambia needed to put 56 286 ha under biofuel feedstocks in order to meet their biofuel targets. This represents 4% of the country’s arable land, 6% of its available arable land and 0.8% of its total land area.
Walimwipi (2009) asserts that policies and business decisions required for biofuels implementation strategies are influenced by various and complex factors. The policymakers need to ensure that the environmental and socio-economic sustainability of the biofuel production, while those involved in the biofuels production chain want a meaningful return on their investments, as well as incentives to compete with gasoline and diesel fuels. Recognizing the need for an objective mechanism to guide the decision-making process, CEEEZ used an Integrated Decision Support Tool (DST) to assess the economic performance of different feedstocks for ethanol and biodiesel production. The DST was developed by UNIDO and technical support was provided by the German Biomass Research Institute. Sweet sorghum, sugarcane and maize were competitive at 50, 60 and 80 US$/barrel, respectively. However, to produce 20 million litres of bioethanol per annum from maize requires 24 000 ha of land, as compared to 5 000 ha for sweet sorghum and for sugarcane. Apart from being the most competitive in production costs, Jatropha also requires less land than sunflowers, and substantially less than soyabeans.

**Implementation Progress**

In November 2005, D1 Oils – a UK based company – established a partnership with the Zambian Government to plant 15 000 ha of *Jatropha curcas* in northern Zambia. The company provided farmers with tree seedlings, assisted in arranging finance for them to cover other planting costs, entered into a contract with them guaranteeing to buy their seeds, and continues to provide extension advice (Anon, 2005). In June 2006, D1 Oils was allocated 155 000 ha for planting (Anon, 2006). By June 2007, D1 Oils had established a managed plantation of 2411 ha, had contract farming taking place on 20 760 ha, was pleased with the performance of the trees and was on-track with its’ plans to expand (Le Roux, 2007). Unfortunately, the company has not responded yet to several requests for an update on its current status.

Marli Investments – a Zambian company – initiated a *Jatropha* out-grower scheme near Kabwe and using cuttings, seeds and seedlings from trees already growing in the country, commenced planting in November 2004. As of November 2009, the company had distributed over 12 million seedlings and seeds to 25 000 out-growers at schemes covering 18 500 ha set up throughout the country. All seed yields to date have been used to extend the planted areas. As with D1 Oils, Marli Investments has entered into a contract with the out-growers guaranteeing to buy their seeds, and provides ongoing extension advice. Marli Investments planned to commence constructing a 600 000 tons per year biodiesel production plant in 2009 to be operational by 2011. Unfortunately, with the global recession it has been unable to attract the necessary funding to implement this plan (Desai, 2009).

**10.9 Crops Used for Biofuels**

Table 10.3: shows the 2004 production status of potential biofuels feedstocks in Zambia (Takavarasha *et al*, 2005).

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area cultivated ha</th>
<th>Yields mt</th>
<th>Kg oil/ha</th>
<th>L oil/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunflower</td>
<td>26 000</td>
<td>8 000</td>
<td>800</td>
<td>952</td>
</tr>
<tr>
<td>Soyabean</td>
<td>15 000</td>
<td>15 000</td>
<td>375</td>
<td>446</td>
</tr>
<tr>
<td>Maize</td>
<td>750 000</td>
<td>1 161 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorghum</td>
<td>22 000</td>
<td>19 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugarcane</td>
<td>17 000</td>
<td>1 800 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cassava</td>
<td>165 000</td>
<td>950 000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
\[\begin{array}{|c|c|c|} \hline \text{Crop} & \text{1 590} & \text{1 892} \\ \hline \text{Jatropha} & \text{5 000} & \text{5 950} \\ \hline \end{array} \]

10.10 Implications of Biofuels Production on Water and Employment.

In areas where the MAP is greater than 800 mm rainfed sugar cane production is economically viable. The same applies to sweet sorghum where the MAP is greater than 600 mm. However, irrigation substantially improves the yields of both crops (Watson et al., 2007). The survival rate of Jatropha seeds, seedlings and cuttings is substantially improved if they are watered for the first three years (Mudede, 2010). Given that Aregheore (2003) and BOZ (2003) estimated that less than 9% of the land with irrigation potential was irrigated (as noted in section 4), it would appear that Zambia can withstand a substantial production of biofuel feedstocks even under irrigated conditions, without detrimentally affecting national water availability.

Biofuels production is likely to generate employment in both the informal and formal sectors. Von Maltitz and Brent (2009) estimated that Zambia would create 27,046 jobs in meeting its biofuel targets. However, they cautioned that “fuel production must provide jobs of sufficient quality to ensure that workers are able to achieve security through their remuneration from biofuel endeavours”.

10.11 Stakeholder Roles and Views

Against Biofuel Developments in Zambia:

1. Scott (2009) representing Practical Action a UK based NGO, claims that investors are levying charges for extension services and scheme membership fees, and that growers have to pay to replace trees that die.
2. ABN (2007) noting that the Zambian Commission for Catholic Justice and Peace concluded that for most farmers growing tobacco and cotton, the outgrower schemes have perpetuated or increased poverty, questions whether Jatropha outgrower schemes will not be any different.
3. Biofuelwatch (2006) falsely claims that D1 Oils plans to have the Jatropha seeds grown in Zambia, processed into oil in South Africa for export to the European Union.
4. Sibanda (2006) quotes Clement Chipokolo of the Participatory Ecological Land Use Management Association as saying "The increase in this type of plantation production will certainly affect the already unstable food production in Zambia where farming and food crises are common. Zambia will have to choose between feeding its population... or its ever growing number of cars and industries”.

In Favour of Biofuel Developments in Zambia:

1. Takavarasha et al. (2005) reported that Ministry of Agriculture was fully supportive of biofuels as an alternative market for crops, and believed that the seed industry and investment in irrigation would benefit from biofuels.
2. Sibanda (2006) quotes Dr Judith Lungu – the Dean of the School of Agriculture at the University of Zambia as saying "I never saw cotton replace maize, so I think the farmers will continue to grow food alongside their Jatropha crops”.
3. The National Association for Peasant and Small-Scale Farmers of Zambia (2006) urged small-scale farmers to start growing biofuel crops in order to reduce rural poverty and cut energy costs.
(4) The Biofuels Association of Zambia (2007) asserts that Jatropha cultivation creates a positive reciprocity between raw material/energy production and environment/food production. They refer to this reciprocity as the Jatropha System, and conceive of it as having four equal aspects: Renewable energy, Erosion control, Women promotion and Rural Income.

(5) Sinkala (2009): notes that Zambia’s mine dumps cover a total area of more than 10,000 Km² and asserts that Jatropha should be used to rehabilitate them. Doing so would generate huge income. He goes on to suggest that deforestation in the country could be abated by engaging communities to make charcoal from Jatropha cake. He is adamant that biofuel crops have not and will not adversely affect food security in Zambia.

(6) Desai (2009) points out that small holder farmers who have become part of Marli Investments’ Jatropha outgrower schemes, have not used any of the land on which they grow their food crops. While the land that they have used for Jatropha may have previously been used for grazing or collecting fuelwood etc, because planting Jatropha does not involve total land clearance, these activities can continue to some degree thereafter. He also claims that many have already benefited from the additional income from the sale of their seeds.

(7) Von Maltitz and Brent (2009) concluded Zambia has the potential to meet all local liquid fuel needs as well as supporting an export market of fuels and food. The fact that there is both available land and the ability to intensify food production would seem to indicate that there would be limited competition between food and fuel, provided that fuel production does not displace current food production.

10.12 Links in biofuels development in Zambia

- Local Chief
- Other community reps
- Existing Community reps
- Existing Outgrower Scheme

Customary Lands

Women’s Groups

NGO’s

Producers

- Sugar Companies
- Marli Investments
- OIL Oils
- Individual Commercial farmers
- Commercial Farmer Associations
- Individual Outgrower Schemes
- Outgrower Scheme Associations
- Other National/Foreign Investors

Environmental Social Impact Assessment

State Lands

Industry

- Ministry Agriculture, Food and Fisheries – Agriculture & Cooperatives
- Ministry of Legal Affairs
- Ministry of Lands, Commissioner of Lands
- Ministry of Energy & Water Development
- Ministry Environment, Natural Resources & Tourism - Environmental Council of Zambia

Govt Depts

Transport
- Energy Regulation Board
- Zambia Electrical Supply Company
- Food Regulation Agency
- Forestry
- Mines and mineral development
- Commerce, Trade & Industry
- National Science & Technology Council
- Water Development Board
- Zambia Investment Centre
- Zambia Wildlife Authority

Mandatory connection between stakeholders

Connection commonly made between stakeholders dependent on how whether proposed biofuels feedstocks production is perceived as a threat to their interests or goals.

Connections Needed

Institutions listed in order of the frequency and significance of their connections.
10.13 Summary of biofuels activities implications in Zambia

Zambia’s initial steps into biofuel production still seem to be controversial. This is one of the countries that provides an example of the need for energy alternatives as it is a landlocked country with no indigenous oil reserves. The country has had a food security crisis for a number of years despite around 12% of the arable land being dedicated to agriculture. It seems that the dependency of the country on food imports is due to the lack of infrastructure and investment in the agricultural sector. The Energy Ministry considers that bioenergy could be an excellent opportunity to significantly enhance the production potential of feedstock for both food and biomass production. Zambia is an agricultural country with nearly 70% of the active population dedicated to this sector and has been looking at different crops for biofuel production such as sweet sorghum and cassava. The biofuels Association in Zambia is a strong organization and could play an important role in the promotion of biofuels and food production. The opposing perspectives of different stakeholders continue to be an issue that hinders the future development of biofuels and bioenergy in the country.

10.14 Conclusions

Zambia’s initial steps into biofuel production still seem to be controversial. This is one of the countries that provides an example of the need for energy alternatives as it is a landlocked country with no indigenous oil reserves. The country has had a food security crisis for a number of years despite around 12% of the arable land being dedicated to agriculture. It seems that the dependency of the country on food imports is due to the lack of infrastructure and investment in the agricultural sector. The Energy Ministry considers that bioenergy could be an excellent opportunity to significantly enhance the production potential of feedstock for both food and biomass production. Zambia is an agricultural country with nearly 70% of the active population dedicated to this sector and has been looking at different crops for biofuel production such as sweet sorghum and cassava. The biofuels Association in Zambia is a strong organization and could play an important role in the promotion of biofuels and food production. The opposing perspectives of different stakeholders continue to be an issue that hinders the future development of biofuels and bioenergy in the country.
11. MOZAMBIQUE CASE STUDY

11.1 Location
Mozambique is located on coordinates 18° 15’ S, 35° 00’ E in south-east Africa and borders the United Republic of Tanzania to the north, Malawi, Zambia, Zimbabwe, South Africa, Swaziland, and the Indian Ocean. It has a coastline of nearly 2,750km. The country is divided into eleven provinces (from south to north): Maputo, Maputo city, Gaza, Inhambane, Manica, Sofala, Zambézia, Tete, Nampula, Niassa, and Cabo Delgado. It has a total area of 801,590 sq km of which 784,090 sq km is land and 17,500 sq km is water.

![Figure 11.1: Map of Mozambique showing surrounding countries.](image)

Geographical Characteristics
Mozambique occupies the eastern fringe of the great southern African escarpment. The mountains of the interior fall to a broad plateau which descends to coastal hills and plain. Rivers generally run west to east. The coastal beaches are fringed by lagoons coral reefs and strings of islands. The extensive low plateau covers nearly half the land area. The Zambezi is the largest of 25 main rivers.

Vegetation
The plateau is savannah – dry and open bushveld and wide stretches of grassland. There are patches of forest in the western and northern highlands. Dense subtropical bush characterizes the coastal plain. Forest covers approximately 25% of the land area, having declined at 0.3% p.a. between in the period 1990 - 2005. Arable land comprises 5.6% and permanent cropland 0.3% of the total land area.
Wildlife
Mozambique has four national parks. Gorongosa, the biggest, extends to 3,770 sq km. There are also many forest and game reserves harboring zebra, water buffalo, giraffe, lions, elephants and rhinos, and many varieties of tropical water birds such as flamingos, cranes, storks and pelicans.

Climate
Climate ranges from tropical to subtropical. The inland is cooler than the coast and rainfall generally increases with altitude (which ranges from 0 meters above sea level to Monte Binga, the highest point, which 2,436 m high. Mean annual rainfall ranges from 800 mm to 1,000 mm along the coast; 1,200 mm in the central region of the country; and between 1,000 mm and 2,000 mm in the northern region. The hottest and wettest season is October to March. From April to September the coast has warm, mainly dry weather, tempered by sea breezes. The country is vulnerable to cyclones.

Administration
Mozambique is divided into 10 provinces: Cabo Delgado, Gaza, Inhambane, Manica, Maputo, Nampula, Niassa, Sofala, Tete, Zambezia. Maputo is the administrative capital.

Environmental Characteristics
The most significant environmental issues are desertification, pollution of surface and coastal waters, and persistent migration of people from the hinterland to urban and coastal areas caused mainly by a long civil war and recurrent drought in the hinterlands.

11.2 Population Size and Characteristics
The July 2009 population estimate for Mozambique is 21,669,278 people. The population density is estimated to be 28 people per sq km land area. The population estimates for Mozambique explicitly take into account the effects of excess mortality due to AIDS and are based on projections for 2009. Mozambique has very high HIV/AIDS prevalence rates. The adult prevalence rate is 12.5% by 2007 estimates with approximately 1.5 million people living with HIV/AIDS. In the same year, about 81,000 deaths from AIDS were reported.

Age structure (2009 estimates): 0-14 years - 44.3% (male 4,829,272/female 4,773,209); 15-64 years - 52.8% (male 5,605,227/female 5,842,679); 65 years and over - 2.9% (male 257,119/female 361,772).

The population growth rate is 1.791% while the birth rate is 37.98 births per 1,000. The death rate by 2008 estimates is 20.29 deaths per 1,000. The urban population is estimated to be 37% of total population at 4.1% annual rate of urbanization. The Sex ratio at birth is 1.02 male(s)/female under 15 years; 1.01 male(s)/female 15-64 years; 0.96 male(s)/female 65 years and over; 0.71 male(s)/female total population: 0.97 male(s)/female. The total Infant mortality rate is 105.8 deaths per 1,000 live births (108.57 deaths/1,000 live births for males and 103 deaths/1,000 live births for females). The total Life expectancy at birth is very low, at 41.18 years (41.83 years for males and 40.53 years for females). The Total fertility rate is 5.18 children born per woman.

11.3 Gross domestic product
Although it has considerable mineral reserves, Mozambique is a highly indebted, poverty-stricken country. It is richly endowed with natural resources, including arable land, forest, grasslands, inland water resources from its network of rivers including the Zambezi, marine fisheries, minerals and hydroelectricity. As a result, the economy is diversified, and
agriculture, transport, manufacturing, energy, fisheries, tourism and wage remittances all make important contributions to the economy. Following the rapid growth of the industrial sector in the past few years, the share of agriculture in national Gross Domestic Product (GDP) has been falling, down from over 27 percent in 1998 to below 21 percent in 2008. The sector, however, still employs about 81 percent of the total labour force and provides major export earnings from commodities such as prawns and fish, cotton, sugar, timber and cashew nuts. Other exports include aluminium and electricity.

The poor status is largely due to Civil war, ineffective socialist economic policies, and severe droughts that plagued Mozambique's economy throughout the 1980s. The GDP is 9.735 million US dollars while the GDP per capita in 2009 is estimated to be $456 US dollars. Mozambique remains dependent upon foreign assistance for much of its annual budget, and the majority of the population remains below the poverty line (70%). Subsistence agriculture continues to employ the vast majority of the country's work force. A substantial trade imbalance exists. Between 1980 and 2007 Mozambique's Human Development Index (HDI) rose by 1.34% annually from 0.280 to 0.402 today. The HDI provides a composite measure of three dimensions of human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and gross enrolment in education) and having a decent standard of living (measured by purchasing power parity, PPP, income).

However, recent shifts in economic policy toward a market economy and a resolution of the civil war have laid the foundation for an economic recovery helping the economy to grow on average by 4.7% yearly between 1988 and 1998. In 2001, it stood at 9.2%.

10.4 Main food crops

The main food crops in Mozambique comprise cereals (maize, sorghum, millet and paddy rice) and cassava, supplemented by bananas and cashew nuts. According to FAO, the average yields of the main food crops are as follows:

- Maize: 0.4-1.3 tonnes/hectare
- Cassava: 4-5 tonnes/hectare
- Beans: 0.3-0.6 tonnes/hectare
- Sorghum: 0.3-0.6 tonnes/hectare
- Rice: 0.5-1.8 tonnes/hectare

About 4 million hectares of land equal to about 10% of arable land is under cultivation, out of which 97% is cultivated by smallholder farmers. About 3.2 million smallholder farmers are responsible for 95% of all agricultural production. Each household cultivates an average of 2 hectares. Approximately 91% of the land is tilled by small and medium scale farmers and is used for annual crops which include maize, cassava, rice, sorghum, millet, cowpeas and groundnuts. Maize, cassava and cowpeas were the most common food crops, cultivated by 79%, 73% and 50% of the farmers respectively. Of the maize produced in the country 99% is produced by the small-scale farmers in Zambézia, Nampula, Niassa, Manica, Tete Provinces including selected areas of Maputo and Gaza.

11.5 Main Agricultural food products imports and exports

The main agricultural products include cotton, cashew nuts, sugarcane, tea, cassava, corn, coconuts, sisal, citrus and tropical fruits, potatoes, and sunflowers. Industrial crops include tobacco, cotton, cashew, coconuts, tea, paprika, soybeans, sesame, sunflower and citrus.
Mozambique is a net importer of food commodities, especially rice, wheat and, to a lesser extent, maize. Mozambique relies on imports for all its domestic wheat requirements. Imports of rice account for about 75 per cent of total domestic consumption, and those of maize (mostly from South Africa) account for about 13 per cent of total domestic consumption.

Main agricultural exports include cotton, cashew nuts, sugarcane, tea, cassava (tapioca), corn, coconuts, sisal, citrus and tropical fruits, potatoes, sunflowers.

### 11.6 Characteristics of livelihoods

The majority, i.e. 80%, of the population is active in agriculture. Of these, about 90% work in the family farm sector. The family agriculture system is characterized by family labor force and low mechanization. Agricultural inputs such as tractors, ploughs, fertilizers, pesticides and others are low, or almost zero. The number of irrigated areas is mainly limited to bigger farms in lowland areas (rice) and mainly directed to vegetable production in small areas. In addition productivity per hectare is low. Hence, the potential for agricultural growth is significant. Fertilizer use is very low, used only for cash crops and is approximately 2kg of fertilizer per hectare of arable land. The table below shows some agricultural statistics.

<table>
<thead>
<tr>
<th>Table 11.1 Mozambique’s agriculture statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural land - % of land area:</td>
</tr>
<tr>
<td>Agricultural land - sq. km:</td>
</tr>
<tr>
<td>Agricultural machinery - tractors:</td>
</tr>
<tr>
<td>Arable and permanent cropland:</td>
</tr>
<tr>
<td>Arable land - % of land area:</td>
</tr>
<tr>
<td>Arable land - hectares:</td>
</tr>
<tr>
<td>Cereal production:</td>
</tr>
<tr>
<td>Cereal yield - kg per hectare:</td>
</tr>
<tr>
<td>Food production index:</td>
</tr>
<tr>
<td>Labour share:</td>
</tr>
</tbody>
</table>

Land may not be sold; access is free of charge, but once occupied the land can be inherited to the occupant's direct descendants. Slash and burn techniques for preparing fields are still the main agricultural technique used. Main production constraints are pests, seed shortages and labour shortage, for both cash and food crops, since most of the cash crops serve as food crops.

### 11.7 Policies in place

#### Energy Policies and Strategies

The energy Policy (1998) provides a clear statement on the need for providing energy to the household and productive sectors, building capacity and improving management in the

---

sector, increasing exports and efficiency. The Energy Sector Strategy (2000) focuses on how to implement the policy, involving the private sector and the development of more competitive markets and the need for regulation. The strategy complements the Energy Policy, outlining and making explicit the intentions of the government in the development of plans of actions, programmes, projects, investments and other actions for the various energy sub sectors and for the guidance of operators in the sector, financial institutions and investors. However, the strategy is not fully developed and clear. The Poverty Reduction Strategy also has energy as one of the six pillars. There is also a policy for Rural Energy Development which aims to promote rural energy development by giving access to the poor to intermediate (Kerosene) and modern forms of energy (Electricity).

Mozambique also has recently developed a Biofuels Policy and Strategy. The initiative was launched on 24 March 2009, and establishes guidelines for both the public and private sector to better participate in the biofuels industry. The purpose for adopting the measure is to reduce the country’s dependence on imported fossil fuels. Other factors include the need to ensure energy security, advantageous conditions for agriculture, and need to promote sustainable economic growth.

Concerns over food security issues in relation to growing food crops for biofuels were highlighted in parliamentary discussions on the issue, and parliament agreed to produce biofuels without compromising food. The parliamentary session that voted to approve the document also agreed to create a National Biofuels Council which will be responsible for monitoring the implementation of policies targeting the sector. In an effort to promote the development of biofuel production, Mozambique has engaged governments and businesses in other countries, namely biofuels giant Brazil.

Mozambique has already concluded agreements on trade cooperation, investment, and technology transfer for several years. More recently, Mozambican biofuels policies designed to stimulate the sector have led to the approval of three export-oriented projects in the south, north, and centre of the country. In order to stimulate domestic consumption, the government plans to establish a mandatory 15 percent blend of biofuel to petrol and diesel within five years.

**Land Policy**

A new law was passed in 1997 to ensure that Mozambicans are able to use land fairly and securely. Under the 1997 law, land in Mozambique is still owned by the state, and cannot be bought or sold. However, the law recognizes the rights of people or communities to use the land and sell assets on it. Long-term use rights can be obtained through occupation by communities, through occupation in good faith for at least 10 years or through a land allocation procedure, where the state can give user right title for various kinds of investment projects.

**11.8 Biofuels industry programmes development**

The development of large-scale renewable energy projects in Mozambique is still in its infancy. Mozambique’s huge untapped potential of renewable energy technologies is well-suited for both urban and rural energy development. The first ethanol plant in Mozambique, inaugurated in October 2007, received some US$510 million in support from the UK. The plant currently produces 120 million litres of ethanol per year. The National Biofuels Strategy has outlined an Action Plan that envisions commercialization of biofuels in the period 2009 – 2015 which will involve feedstock production, establishing processing industries and distribution networks.
Data from the Investment Promotion Centre (CPI) and Ministry of Energy indicate that there are at least 5 serious players who had been investigating the potential of biofuel in Mozambique. The Ministry of Agriculture also reports that they are many enquiries from around companies interested in acquiring land to establish biofuel plantations. A number of companies are already involved in biofuels production or processing in Mozambique, including:

- Sun Biofuels
- Green Fuels
- Ginwala
- Chemc
- Geralco/Boror
- Alif Quemica
- Climate Change Corporation
- Petromoc
- Grupo Madal
- Nhacoongo
- Somoil
- Olimax

11.9 Crops used for biofuels

Potential feedstocks include sugarcane, Sweet sorghum, cassava, maize (for ethanol), *Jatropha curcas*, coconut, sunflower, soy, groundnuts (for biodiesel). However based on sustainability of feedstock as well as evaluating their potential for income generation, cost of production, socioeconomic and environmental impacts the chosen crops for biofuel production in Mozambique are the following: sugarcane and sweet sorghum for ethanol, *Jatropha curcas* and coconut for biodiesel.

11.10 Expected end use of biofuels

Final use of biofuels in Mozambique will be for cars and industry, agricultural and home electrical equipment. Ethanol will be used as direct blend with fossil fuels. Ethanol can also be used to produce gel fuel as a domestic energy source to reduce over-dependence on Charcoal and wood. Biodiesel can be used in generators. Straight vegetable oil can be used in Stationary diesel equipments. For the use of cars, a blending of up to 20% biofuels can be implemented with out modifications to the engines.

11.11 Mapping of policies and institutions

Ministries/Secretariats Involved in the Bioenergy Planning/Applications

The major government institution overseeing the energy sector in Mozambique is the Ministry of Energy. Three directorates (Electricity Directorate, Fuels Directorate and Renewable Energy Directorate) within the ministry formulate policy, regulation and are responsible for energy planning and management.

The Ministry of Energy (MoE) and the renewable energy and fuels directorate have the responsibility for formulating biofuel policy in Mozambique. Any investment in the sector would need to be cleared by the ministries. For instance a project to develop industrial capacity would and/or import / export oil need be reviewed by the Ministry of Trade and Industry. The Environment Ministry would need to be satisfied with the environmental impact of the project.
NGOs Involved

Technoserve: This is a US-funded Private Voluntary Organisation (PVO), and one of the few organisations active in developing extension services to small holders in the coconut sector. They are active in the coconut sector. GreenFuels are currently working with Technoserve, and the Ministry of Agriculture – small producers of biodiesel can obtain a license through a government approved Technoserve process.

Other Key Stakeholders Identified

Other key stakeholders include Petromoc, the largest fuel distributor and owner of storage facilities at Maputo Port and the Investment Promotion Centre (CPI) who aim to offer a ‘one-stop shop’ for investors.

11.12 Links in Biofuels Development in Mozambique
### 11.13 Summary Mozambique

<table>
<thead>
<tr>
<th>Issues</th>
<th>Policies</th>
<th>Emerging Patterns/relationships</th>
<th>Impact/ future implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Poverty Reduction Strategy has energy as one of the six pillars. • Biofuels Policy and Strategy establishes guidelines for the public and private sector to better participate in the biofuels industry.</td>
<td>• Family agriculture system characterized by family labor force and low mechanization • Fertilizer use is very low, used only for cash crops • Agricultural inputs such as tractors, ploughs, fertilizers, pesticides and others are low, or almost zero • Production constrained by pests, seed shortages and labor shortage • Concerns over food security issues in relation to growing food crops for biofuels</td>
<td>• Mozambique has engaged governments and businesses in other countries with successful biofuel programmes, e.g. Brazil. • Agreements on trade cooperation, investment, and technology transfer concluded between Mozambique and European countries.</td>
<td>• Opportunities to provide farm jobs • Environmental benefits of using biofuels • Expanded income through adoption of new cash crops. • Irrigated feedstock production to create more demand for water • Unavailability of feedstock and infrastructure</td>
</tr>
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</table>

### 11.14 Conclusions

Mozambique has been the recipient of numerous investors in the last years for bioenergy crops production. The National Government has followed a conscious path into the development of their policies and the mapping of the country to better identify the areas where this production is possible without generating negative impacts in local resources and food production. At farmer level the infrastructure and investment for agriculture is very limited or nearly null affecting the yields. Mozambique is a net importer of food commodities, especially rice, wheat and, to a lesser extent, maize. At the same time the country relies on imports for all its domestic wheat requirements. Imports of rice account for about 75 per cent of total domestic consumption, and those of maize (mostly from South Africa) account for about 13 per cent of total domestic consumption. Nevertheless, there are reports about the land availability for food and bioenergy crop production.
Since most of the bioenergy initiatives have recently started it is difficult to assess how the local communities are engaging with the production.
12. GENERAL CONCLUSIONS

The production and possibilities for investment on biofuels in Africa need to consider the differences and collection of factors at regional and local level including geographical location, land use patterns, preferences, income distribution patterns, cultural and social aspects. With these assumptions it is possible to consider that in Africa, there is much scope for improving agricultural productivity. Furthermore, many countries already have policies in place or are on the way to produce their own policies regarding biofuels production. Nevertheless, as some of the case study countries showed, these policies are sophisticated, although the capacity to implement and monitor them may be limited. This is an issue that needs to be considered for the standards and certification issues and for the efforts that the Global Bioenergy Partnership (GBEP) is trying to pursue.

Although we acknowledge that Africa is a continent with 61 territories and that the number of case studies in this report is limited, the literature review and the regional experiences point out to the issue that Africa has the potential to meet both its food and fuel needs from biomass. The food vs / and fuel debate and the reality in the continent is more acute and nuanced than in any other region, and African leaders struggle with a combination of urgent drivers and obstacles that require unique and carefully thought through policies.

Another important issue to be considered is the need for directed investment (both internal and external) for the development of this industry and the careful stimulation that local markets need. This will require further studies specially for the consideration of the diversification of products related to bioenergy crops in the local markets Exporting some biomass and biofuels may be necessary to encourage the investment required to expand food and fuel production but great care needs to be taken to add value locally and protect local land and labour rights.

Biofuels can be grown on significant scales without indirect effects on food production or natural habitats though some considerations on production, sustainability and policy should be taken into account as follows:

- The stakeholder mapping in all the case studies showed the lack of interaction between all of them (government, private, NGOs, farmers) despite that the bioenergy production activities show clear cross cuttings in different areas such as Agriculture, Energy, Industry, Transport, Social, Environment agencies and Ministries.
- The case studies reviewed in this document do not represent the total activities and situation of the rest of the countries in the continent but are some of the most relevant examples in different regions in the continent.
- On land currently under cultivation, in the less developed countries it can be possible to triple yields by using improved management practices, potentially freeing up more land for biofuel production.
- It is estimated that the area under sugar cane in the region could be doubled without reducing food production or destroying valuable habitats. Sweet sorghum shows promise for integration with sugar cane and extending production into drier areas.
- Jatropha is being planted in southern Africa with plans for expansion, but is relatively unproven and has yet to reach commercial-scale oil production. Oil palm is mostly grown in West Africa but cold-tolerant varieties have been successfully demonstrated in southern Africa.
- If biofuel production brings investment in land, infrastructure and human resources, it could help to unlock southern Africa’s latent potential and positively increase food production.
Investors and Governments in the EU should look not just at local Policies but also at Regional Policies in Africa which create an umbrella for countries who do not have a dedicated policy on biofuels. Enacting a legal and regulatory framework that allows for the development of modern biomass is also necessary in African countries and EU countries can contribute to promote this and enforce regulations where available.

In South Africa, expansion of agriculture may be limited, but in Mozambique, only 10% of arable land is currently under cultivation.

It is necessary to look for subsidy policies, equitable power prices and consistent trade and taxation policies.

Private investors should comply with international agreements, local policies and regulatory frameworks on trade, agriculture and sustainability issues.

International agreements on land use and resources considerations (conservation areas, definition of idle land, suitable land for biofuels, water) will help to strength the sustainability considerations at local level.

Secondary effects should be avoided strengthening the use of traditional environmental management methodologies (EIA, SEA, SIA) with local research groups and professional bodies.

Recommendations:

- The involvement of stakeholders should be not only for the decision-making process but also for the enforcement and monitoring of the bioenergy activities.
- Food security involves many aspects that are not strictly related to land availability, crop selection and production. These other aspects such as trends in national and international markets, speculation, activities of middleman and others should also be considered as causes and not just the development of bioenergy industry.
- It cannot be denied that negative impacts have occurred in some areas (not whole countries), such as displacement, and these should not only be avoided but legally penalised.
- National Governments should also look at case by case for the decision making of investments not only for bioenergy crops but also for other agricultural and industrial developments, specially where these activities are increasing.
- Adequate investment for these activities should favour not just the National Economies but also the small producers.
- Further research is still needed including the local capacities (Universities and Research Institutes) in order to assess the possibilities of the extension of local markets and the forms of investment to contribute to the expansion and further development of the agriculture, industry and economy sectors in Africa with a positive contribution to the population and the environment.
13. GENERAL REFERENCES


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**SENEGAL**


MALI

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UNIDO, Sustainable Bioenergy Development in UEMOA Member Countries. 2008, UNIDO.

KENYA


**MOZAMBIQUE**

Mozambique National Biofuels Strategy

ZAMBIA


Africa
14. ANNEXES

**Annex 1.**
Regional Programmes related to biofuels.

<table>
<thead>
<tr>
<th>Region</th>
<th>Regional Policy Document</th>
<th>Year</th>
<th>Objectives</th>
<th>Strategies on Renewable Energy</th>
<th>Strategies on Biofuels Implementation</th>
<th>Framework</th>
</tr>
</thead>
</table>
| ECOWAS(West Africa)     | White Paper for a Regional Policy in West Africa | 2006  | Increase access to domestic cooking fuels for rural and peri urban populations of the region. Increase access to production energy services in villages, particularly motive power for productivity and improved community services. Increase access to electricity services. | Actions: 1. Build capacities of public and private actors. 2. Help mobilise soft loans and funds from the private sector for projects to extend energy services to rural & peri urban areas. 3. Sharing promoting and disseminating sub-regional experiences relating to the supply of energy services. 4. Promotion of local production of energy goods and services. | Establish a regional Biofuels Centre of excellence to serve as a research hub for the region | Managing the energy and regional development information system  
• Helping Member States set up systems for assessing the impact of policies and programmes.  
• Holding regional workshops, training sessions and discussions on sustainable energy policies that will bring energy supplies to the poor.  
• Helping Member States to raise funds through project development and donor conferences.  
• Establish and manage an innovation fund to encourage innovation. |
<p>| SADC                   | SADC Protocol on Energy          |       | It has six objectives amongst which are: To co-operate in the development and utilisation of energy in the Region in the following sub-sectors: coal, new and renewable energy sources, energy efficiency and conservation, and other cross-cutting themes of interest to member states. To co-operate in the research, development, adaptation, dissemination and transfer of low-cost energy technologies. | None besides mention of renewable energy in the major objectives.                                                          | None                                                       | N/A                                                                                                      |
| East African Community  |                                 | Oct 2006 | No specific regional energy policy                                                                                                                  | None                                                                                                                     | None                                                       |                                                                                                          |</p>
<table>
<thead>
<tr>
<th>Community</th>
<th>Treaty</th>
<th>Objectives; energy priorities such as: the EAC partner states shall in particular promote within the Community all measures to supply affordable energy to their people taking cognizance of the protection of the environment as provided for by this Treaty</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The African Union</strong></td>
<td>Addis Ababa Declaration on Sustainable Biofuels Development in Africa</td>
<td>August 2007</td>
</tr>
<tr>
<td><strong>COMESA Region</strong></td>
<td>e-COMESA newsletter</td>
<td>July 2007</td>
</tr>
<tr>
<td>Biomass Energy Conservation (PROBE)</td>
<td>SADC countries, specially Lesotho, Malawi, Mozambique, Namibia, South</td>
<td>2004</td>
</tr>
</tbody>
</table>
| C) | Africa, Tanzania, Zambia and Zimbabwe | SADC region. | • Sustainability criteria for biofuels  
• Socio-economic aspects of biofuels  
Build ProBEC, SADC Secretariat and other partner knowledge |

Source: Modified from Jumbe and Msiska, 2007.
Annex 2. Case study Ghana

The case of Ghana was included due to the biofuels activity that the country has been experiencing in the last five years. It does not cover all the information as the other case studies and focuses only on the policy analysis and the stakeholder mapping.

National Ministries/Secretariats involved in the bioenergy planning/applications

Ministry of Energy

Due to increasing foreign exchange deficit and the domestic demand for diesel consumption in transport sector, many African nations have recognised the potential positive contribution of biofuels for its domestic diesel supply as liquid fuel also for electricity supply. However it has recently realised that biofuels can be a highly sensitive subject in most of African countries where agriculture is its major industry. In particular, when it comes to land planning and rural livelihood, many governments understood that they should adopt a highly careful approach. Nonetheless, renewable energy is gaining more and more attention globally and it is widely seen that the biofuels can be one of the ways of diversifying energy supply, in particular, fuels sector, whose demand is consistently growing. It still faces several challenges such as financial issues and technical inefficiency, they can be solved with an appropriate stakeholder consultation and polished policy push up.

Ministry of Energy is planning to offer a series of advantages to renewable energy project developers such as subsidies, loan and a removal of delivery barrier. Furthermore it is addressed by the Ministry of Energy that to create a domestic market and a mandatory target have to be prioritised for supporting the renewable energy projects.

Energy Commission (EC)

The role of the Energy Commission is to assist the Ministry of Energy in developing legislation based on stakeholder consultation by providing below

1. Policy recommendations
2. Develop regulations
3. Develop standards in collaboration with GSB
4. Carry on a pilot farm
5. Compile and stall the database
6. Monitor operation

The Energy Commission has been actively involved in creating biofuels legislation from the publication of Strategic National Energy Plan to the most recently established final draft for renewable energy, that is currently under the EC’s revision and stakeholder consultation before it is passed onto the parliament.

EC argues that the biofuels industry in Ghana is now on initial stage emerging quickly, therefore, it needs certain form of regulations in order to prevent abuse of monopoly, or domination of foreign capital. Energy Commission can provide those services and help the industry to grow in a more structured and organised way, and increase the potential, which make the EC to be most intimately interacting with biofuel project developers or investors.

Ministry of Food and Agriculture (MoFA)

MoFA primarily aims to create an environment for sustainable growth and development in agriculture sector. Its major considerations are provision of food security, supply of raw
materials for industry, creation of agricultural employment and an establishment of wealth based on agricultural activity. Therefore, biofuel projects which involves a large size of land and plantation, is certainly of MoFA’s interests.

The current position of the Ministry for biofuels project has turned rather cautious, but still hopeful. The ministry has made several points clear. Specifically:

- Appropriate local community consultation and comprehensible land planning in order not to undermine, rural livelihood for traditional cash crop such as shea nut tree, cashu and dawadawa,
- a partial loss of productive land social incentives (travel cost due to the size of the farm),
- clear written agreement on social responsibility and improvement in rural employment, and
- sufficient information on and required training

To summarise, the MoFA is keen on making progress with biofuels project, ensuring marginal land utilisation and an increase in women employment. The Ministry intends to involve more local people for these projects, also raise the ownership and awareness amongst them. That would be the way which benefit both the investors and the local people, and integrate them so that they can increase the labour efficiency and motivation.

**Council of Scientific and Industrial Research (CSIR)**

The CSIR is a research institute under the Government. As biofuel projects have already grown quite fast, the CSIR would like to set off the scientific and technical research collaboration with other policy researchers in order to verify the suitability of biofuel production from Jatropha and other biofuel crops on Ghanaian soil, mostly for yield, high oil contents and water draught figure of the crops. Furthermore, the CSIR would like to propose the certification scheme for the biofuel that will enable the domestically produced biofuel to meet the foreign markets quality requirements. Currently there is no ongoing collaborations reported. The role of collaboration between the industry and the research institute for further R&D activities is likely to be significant for future development.

**Ghana Standard Boards (GSB)**

GSB is a national statutory body responsible for the development promulgation of Ghana standards, as a member of the African Regional Organisation for Standardisation (ARSO), and the International Organisation for Standardisation. The current biofuels certification has primarily referred to ISO. The standards set for biodiesel specify the quality requirements and test methods for marketed and delivered biodiesel to be used either as automotive fuel for diesel engines at 100 per cent concentration, or biodiesel (B100) Grades S15 and S100 to be used as a blend component with middle distillate fuels.

The company has to submit the sample of seeds and oil, get them tested, inspected. As the standards are only to verify the technical and scientific features, GSB conducts various lab experiments with the supplied oil. It also involves the visit to the plant and refinery facility. When the fuel passes all quality tests, certification is issued to the biofuel supplier to be able to be a legitimate supplier within the country. Furthermore, GSB is likely to be responsible for introducing Sustainability criteria if it happens.

**Ghana Investment Promotion Centre (GIPC)**

The GIPA is responsible for investments in all sectors of the economy. Any foreign companies, wanting to initiate a business in Ghana, have to be registered at the GIPC. Once registration is completed, the GIPC provides a series of services such as tax incentives in a form of corporate tax rebates or tax exemptions if applicable. GIPC also assists foreign companies to ensure the transfer of dividends and bilateral investment treaties. Agro-processing from crops such as Cotton, Sorghum, Soya beans, Oil Palms, have already been identified as key investment opportunities. Even though biofuels itself has not been
strongly promoted by GIPC, the interests from foreign investment are increasingly growing for the recent years.

Environmental Protection Agency (EPA)
EPA is a public body for protecting and improving the environment in Ghana. It seeks to ensure environmentally sound and efficient use of both renewable and non-renewable resources in the process of national development. EPA is also responsible for implementing environmental policy and planning consistent with the country’s desire for effective, long-term maintenance of environmental quality. EPA has an authority at the competent regional level.
As discussed earlier, EPA plays a very important role in developing biofuel projects, as any biofuel project developer with farms above 10 hectares is mandated to submit EIA in prior to the commencement of development to obtain certification from EPA. EMP (Environment Management Plan), which can actually bring in the practical mitigation actions, should also be included in EIA. EPA also expects a periodic report by a project developer about any operations and activities concerning environmental sustainability and local livelihood. The whole procedure should be documented for the further monitoring, and the project should be willingly in compliance with any legal requirements. The EPA believes that the EIA should not just remain as a requirement for a permit, but that it should go beyond paper works. EPA can be the most important agency for success of the project.

Forest Commission (FC)
Timber is one of the major export products for many African countries. The FC is competent for managing and developing forest in Ghana, also utilising and regulating the forest resources.
The FC recently has recently revealed a large potential for carbon credits opportunities in association with this reforestation programme. Currently, the FC only promotes forest trees such as cassia, senna simea; that is because these trees can be utilised by the local community for the cooking also timber sale, whilst they also can be exported to the international market at high price. Biofuels tress such as Jatropha, which is labelled as an agricultural tree, therefore, cannot be planted for reforestation programme and carbon credits in Ghana. However, recent research has been unveiling that Jatropha can grow up to 5 metre, also highly dry climate resistant. FC would be keen to conduct experiment and do more research to find out if Jatropha curcas L. can be as effective as other forest trees for carbon sinks.

Land Commission (LC)
The procedure of obtaining the land ownership in developing countries requires a more systematic approach as the buyer has to contend with both the traditional rules governed by the chief and the modern government institutions.
It may vary depending on the regions. Generally speaking, however, chiefs have the legal authority to place commercial value, and to plan change in the terms and conditions of contract for the land. Once the deal is closed with the chief and the fee is paid, the land should be registered at the Land Commission. The buyers are given 99-year leases in conformity with the constitution of Ghana.

Regional and Local authorities involved in bio-energy plans, programmes, projects
Local farmers (out-growers)
Farmers and local communities appear to be very enthusiastic about the unprecedented increasing attention paid to them and the potential of new income source. Yet, at the same time, farmers and project developers claim that the promised benefits such as local
employment, improving infrastructure and electricity generator installation have not been fully addressed yet. Several reasons have been identified here.

For instance, the plantation management and generator installed tend to be a very slow process, as it is highly capital intensive. Quite often, local farmers are unable to deal with the investors or project managers directly, and there are always middle-men taking charge of the commission.

Nonetheless, most of the local communities agreed that biofuel projects are highly welcome in rural area for encouraging the economic activities of rural area, even as a secondary income source. Farmers are keen to utilise marginal land for large scale plantation, as it provides them with stable employment and necessary farm equipments. At the same time they still have their small household scale farm for maize or peanuts, which is manageable in their spare time or at the weekend.

It can be concluded that a systematic short/long term plan with a comprehensible sustainable land management. Also it is crucial to build up a cordial relationship with the community

Women Group
Women group in the local area can play a significant role with some educational and technical supports from NGOs or international organisations. As they have a strong bondage for years, the group is willing to collaborate and enjoy the benefits collectively. For instance seeds could be planted and harvested individually, and the milling machinery is used collectively. The oil is either used in the community for soap making, or sold at the market. The oil cake was utilised fertiliser and insecticides. The some portion of benefits could be used for communal purposes such as funeral and supporting school fee for a poor household.

Chief of the community

International organisations and NGOs involved

UNDP
As the UN supports systematic bioenergy development and renewable energy promotion in developing countries, the UNDP has recently created Energy, Environment and Sustainable Rural Livelihood division, that is designed to be providing necessary assistance with the EC and the MoE of the national government.

It aims to play an important role as a bridge between the government and the local community and the investors, facilitating the opinions of each stakeholders, and harmonise them, so that eventually to ensure that farmers work individually but also be engaged in the project communally, enjoy benefits collectively.

GEF(Global Environmental Funds)
GEF is sub organisation of UNDP. GEF, in its principles, is created to support a project conducted by NGOs, fallen under 4 themes; biodiversity, climate change, sustainable land management, organic products. GEF has a timeframe for each project and only provides initial investment such as funds, training, expertise to help the project settle in and the community to manage it by itself. After that, usually in the first 2 -3 years, GEF projects network can provide further technical assistance or intervened when necessary. The provided funds are not paid back, all given as a form of grants. In biofuel projects contexts, the GEF’s operations are mainly in association with NGOs’ rural sustainability project and the local women group for providing technical trainings with the farmers and scaling up the out growers scheme.
Foreign government funded project
Ohayo project funded by Japanese government (ongoing project in Ghana)

Energy Foundation
EU funded Jatropha project development (ongoing project in Ghana)

KITE
EU funded research on biofuel via phone interview (ongoing project in Ghana)

Other stakeholders identified

Petroleum Industry (Domestic petroleum distributor)
Whilst to establish the legal justice for biofuels projects and to construct a domestic oil infrastructure, such as refinery and bulk storage facilities are discussed as a national strategy, the supply and distribution of the crude oil products such as diesel, gasoline and aviation fuel are left for private petroleum industry’s realm for business.

Despite a certain challenges such as a lack of infrastructure and a low awareness for bioenergy, the petroleum industry perceives that biofuels blending is strategically required to strengthen energy security. Therefore, the petroleum industry would be keen to engage in the development of the bioenergy projects and construction for biodiesel storage facility in Ghana, also to provide a financial back up to certain extent as a form of investment.

Local vegetable oil milling plants
Particular agricultural projects such as Palm oil involves development of local vegetable oil milling plants, as vegetable oil and the press cake are quite attractive market products in many developing countries. Due to a lack of technical advance and high costs for chemicals requirement, traditional mechanical expelling, which presents 27-30% oil extraction rate, is widely deployed in Africa, rather than solvent method. It is a small industry but can be fully utilised at local level, returning the profits straight back to the community.
Mapping of stakeholders and institutions

- MoE: Ministry of Energy
- MoFA: Ministry of Food and Agriculture
- GSB: Ghana Standards Board
- EC: Energy Commission
- FC: Forest Commission
- LC: Land Commission
- GIPC: Ghana Investment Promotion Centre
- CSIR: Council for Scientific and Industrial Research
- EPA: Environmental Protection Agency
- UNDP: United National Development Programme
- GEF: Global Environmental Funds