Situation Analysis on Biofuels Industry in Tanzania

Worldwide Biofuels and SWOT analysis

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Study Objective

To carry out a situation analysis on biofuels industry in Tanzania and elsewhere around the world and its existing and potential strengths, weakness, opportunities and threats to environment, bio-diversity conservation and socio-economic aspects in Tanzania as a whole.
Methodology

• **In-depth literature review**
  - Reviewed documents related to biofuels development in Tanzania and around the world - for a broad understanding of the sector;
    - National policy documents were obtained from the line ministries (e.g. MEM, MoAFC, VPO, MoLHS, MNRT, etc)
    - Reports on previous biofuels studies in Tanzania
    - Global biofuels development were obtained from the internet.

• **Structured interviews with key sector stakeholders**
  - Key government officials
  - Members of the National Biofuels Task Force and officials from Tanzania Investment Centre (TIC).
  - District officials of Kisarawe, Kilwa and Meru;
  - Officials of biofuels companies
  - Officials from NGOs, CBOs
  - Local communities.

• **Strength, weakness, opportunities and threat (SWOT) analysis**
  - Potential feedstock for biofuels
  - Ethanol and biodiesel
  - Biofuels
Biofuels Worldwide

World on the verge of unprecedented increase in production/use of biofuels

• Decisions made today will determine the positive and negative impacts of biofuels for a long time to come
• Net energy balance highly important
• If made from low yielding crops that need high inputs of petroleum based fertiliser they could generate more GHG than petroleum fuels do
What are biofuels?

- Biofuels are defined as energy carriers derived from the conversion of biomass to provide sustainable inputs for heat, power and transport applications. Biofuels can be liquid, solid or gaseous. The principle sources of biomass are agriculture and forestry.

UNIDO
What are biofuels?

• **Bio-ethanol** (blended with petrol)

• **Ethanol**
  Can be produced from:
  – Starch such as maize, sorghum, rice, millet, cassava, etc.
  – Root crops like as cassava, potatoes, etc.
  – Sugarcane and sugarbeet.
Bio-diesel (blended with diesel)
rapeseed, sunflower, jatropha, soya, and oil palm
2nd generation biofuels

- Cellulosic conversion technologies
- Use biomass from wood, tall grass and crop residues may include woody crops such as willow, hybrid popular, and eucalyptus.
- Tall perennial grasses such as miscanthus and switchgrass
- Ready for 2015?
Potential of ligno-cellulosic biomass for ethanol production

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Liters ethanol ton⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugarcane bagasse</td>
<td>500</td>
</tr>
<tr>
<td>Maize/sorghum/rice stover</td>
<td>500</td>
</tr>
<tr>
<td>Forest thinnings</td>
<td>370</td>
</tr>
<tr>
<td>Hardwood sawdust</td>
<td>450</td>
</tr>
<tr>
<td>Mixed paper</td>
<td>420</td>
</tr>
</tbody>
</table>

Source: Planning commission.nic.in/reports/genrep/cmtt_bio.pdf
Why now?

GHG emissions

Oil price increase to $124 USD

World economy at risk if oil supply at risk

Bioethanol from sugar cane may still be economically feasible if oil prices stay above $50 US per barrel
Biofuels and Food prices

• Biofuels debate has become polarised
  – Miracle or menace?
• Many arguing link between biofuels and food prices
  – Evidence for this?
  – The price of corn has more than doubled in the last two years, boosted in part by demand for ethanol.

» World Bank President Robert Zoellick - Demand for ethanol and other biofuels is a "significant contributor" to soaring food prices around the world. However droughts, financial market speculators, oil prices and increased demand for food also responsible.
Key Issues globally

- **Biodiversity**
  - Type of land cleared
  - Introduced species

- **The environment**
  - Soil
  - Water
  - Energy
  - Emissions

- **Social Issues**
  - Food crops
  - Farmers
  - Land
European Union

- EU top producer of bio-diesel, 4.5 billion litres (72%) of global production
- Favourable fiscal and regulatory policies
- Sweden
  - Over 1000 stations selling bio-ethanol
  - High sustainability standards
- Germany
  - was producing 50% of the world’s biodiesel
  - Biodiesel made from rapeseed
EU policy

- Target of 5.75% market share for biofuels by 2010
- Target set to 10% by 2020
- But now having reservations about these targets
- Currently drawing up sustainability standards
Brazil

- Pioneers in bioethanol
- The government have supported bioethanol from sugar cane since the 1970s
- Brazil is the number 1 cane producer in the world
- Flexible-Fuel Vehicles (FFVs) in Brazil can use different mixtures of ethanol and petrol
- Energy independence
- Sugar cane industry employs 1 million people
USA

• World leaders in bioethanol
• Maize
• Production 18 billion liters in 2006, 23 billion 2007
• Subsidies and incentives
• Clean air act
• Aim 28.4 billion litres by 2012
• US Dept of Energy initiative for cellulosic ethanol
• Biodiesel industry much smaller 1 billion litres produced in 2006
Malaysia and Indonesia

- Malaysia and Indonesia account for 84% global palm oil production
- Palm oil driver of deforestation, resulting in the loss of 10 million hectares of primary rainforest
- Rural peoples displaced
- Many undesirable impacts due to lack of regulation of industry
- Resulted in a chinese investment of 8 billion US in Malaysia being blocked
Thailand

- Sugarcane/molasses, cassava
- 150 million litres produced in 2006
- Blending plan of using 10% ethanol in all government vehicles
- Aim to increase gasohol consumption to 20 million litres by 2011
- Out growers programs
India

- Produced 1.65 billion litres of ethanol in 2006, 200 million used for fuel
- Molasses and sugar cane
- E5 blending policy for part of country, increased to E10 by October 2008
- Biodiesel from jatropha and pongamia
- Biodiesel production 100 million tons in 2007
Ethiopia

- Currently 8 million litres produced per year bioethanol
- Molasses, potential
- Aiming to blend 5% ethanol into country’s petrol pipeline
- UNDP project looking at using ethanol for home cooking
- Ethiopian government wants to commit 24 million hectares of land (more than 20%) to Jatropha
- Less than 1,700 hectares committed by plantation developers
Mali

- Mali-Folkecentre (MFC) has been developing “energy service centres”
- 20 hectare jatropha plantations provide local energy for activities such as millet grinding and battery charging
- Multi-Functional Platform (MFP)
- 15 year program to use 1000 hectares of *Jatropha* to provide power to 10,000 residents
- Mali Biocarburant company aiming to create an economically viable biodiesel company without central plantation
**South Africa**

- Accounts for 70% of total ethanol production in Africa from coal and gas
- Has adopted a national biofuels strategy
- Planning 3 large biodiesel plants with a total production of more than 300 million litres per year
- Biofuels industrial strategy
  - Biofuels target of 2% petroleum consumption in 5 years
  - Blending ratio 2% for biodiesel, 8% ethanol
  - Expects biofuels to create 25,000 jobs
- Proposed crops sugarcane and sugar beet for ethanol
- Sunflower, rapeseed and soya for biodiesel
- Maize and Jatropha excluded
Malawi

- Ethanol production started in 1982 at Dwangwa sugar mill
- 2004 Nchalo sugar mill
- Combined production of 30 million litres per year
Nigeria

- Producing ethanol since 1973
- 10% blending policy
- Cassava (yields of 15 tons per hectare)
- Nigeria Yeast & Alcohol Manufacturing 30 million litres in 2006
- Plan to build $200 million ethanol plant, with annual production of 30 million tons
Kenya

• 1978 Agro Chemical and Food Cooperation started but collapsed in 1990s
• 2001 - Sector revived, with current production 60,000 litres per day of industrial ethanol
• Sold to local market and Uganda, Rwanda and Central Africa
Potential Feedstock for Biofuels Production

Agricultural crops like sorghum, cassava and sugarcane as potential feedstock for ethanol production in Tanzania (GTZ, 2005).
Biodiesel

At the moment, oil palm, *Croton megalocarpus* jatropha and palm oil are potential feedstock for biodiesel production in Tanzania.
III SWOT analysis Method

• Strategic planning tool used to evaluate strengths, weaknesses, opportunities and threats primarily in business

• Here we evaluate the different biofuels crops in relation to biodiversity, the environment and socio-economic impacts in Tanzania
Jatropha

- *Jatropha curcas*
- Originally from Central America
- Inedible
- Known in Tanzania as mmbono kaburi or nyonyo kaburi
- Plant needs 4 to 5 years to mature, only few seeds produced before maturity

Recovery rates of oil from seed show 15-20% from limited studies in Tanzania
# Jatropha

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survives arid environments</td>
<td>Needs water and fertilizers/pesticides to achieve profitable production</td>
</tr>
<tr>
<td>Yields of 32% Jatropha oil recorded in India.</td>
<td>Lack of reliable data on Jatropha</td>
</tr>
<tr>
<td>Out growers schemes</td>
<td>Inefficient conversion to biodiesel</td>
</tr>
</tbody>
</table>

## Opportunities
- Locally produced energy and MFP
- Restore degraded habitats
- Intercropping with food crops and livelihood activities eg. bee-keeping

## Threats
- Deforestation for planting
- Food security
- Areas cleared for unsuccessful crop
Sugar Cane

Genus - *Sacharum* 6 to 37 species depending on taxonomy
Brazil, India largest producers
Bagasse produced has multiple uses
## Sugar cane

<table>
<thead>
<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficient conversion to bio-ethanol - power from bagasse</td>
<td>Blending petrol and ethanol produces emissions</td>
</tr>
<tr>
<td>Detailed research and experience</td>
<td>High water requirements</td>
</tr>
<tr>
<td>High productivity</td>
<td>Energy for drip irrigation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Opportunities</strong></th>
<th><strong>Threats</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Locally available bio-ethanol</td>
<td>High water demand</td>
</tr>
<tr>
<td>Out grower schemes eg Swaziland</td>
<td>Forest clearance</td>
</tr>
<tr>
<td>Can be grown with low amount of agricultural inputs</td>
<td>Replace rainforest</td>
</tr>
</tbody>
</table>
Maize

*Zea mays*

Many varieties
  – Promise of tropical maize

Origin Central America

But water requirements mean it's not an option in Tanzania
Oil Palm

• Genus *Elaeis*
• The African Oil Palm *Elaeis guineensis* is native to west Africa
## Oil Palm

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated for long period of time</td>
<td>Negative environmental impact in South East Asia</td>
</tr>
<tr>
<td>Multi cropping</td>
<td>Infrastructure built around plantations has large impact</td>
</tr>
<tr>
<td>Some biodiversity can survive on plantations</td>
<td>Production of bio-diesel from pail oil is energy-intensive.</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td><strong>Threats</strong></td>
</tr>
<tr>
<td>Out growers scheme</td>
<td>Palm oil industry is estimated to have led to the destruction of 10 million hectares of rainforest - what for Tanzania?</td>
</tr>
<tr>
<td>Palm oil available for cooking</td>
<td>Land displacement in Asia may set a precedent</td>
</tr>
</tbody>
</table>
**Cassava**

*Manihot esculenta*

Second most grown crop in Africa

Production in Tanzania around 3 tons per hectare

- But yields of 25 tons per ha reported from Thailand and 15 in Nigeria
## Cassava

<table>
<thead>
<tr>
<th><strong>Strengths</strong></th>
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</tr>
</thead>
<tbody>
<tr>
<td>No irrigation needed</td>
<td>Yields of ethanol lower than sugar cane</td>
</tr>
<tr>
<td>Traditional small holder crop</td>
<td>Labour intensive</td>
</tr>
<tr>
<td>Proven crop</td>
<td>Processing complex</td>
</tr>
</tbody>
</table>

**Opportunities**
- Yields can be increased
- Develop local knowledge
- Out growers schemes

**Threats**
- Food security - Important food crop being used for fuel
- Diseases
- Forest clearing
Sorghum

Genus *Sorghum*
Origin - Egypt/ Africa
Many varieties
Annual grass
Sweet sorghum
– Harvested/crushed in similar way to sugar cane
# Sorghum

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought/ saline/ temp tolerant</td>
<td>May need irrigation in dry season</td>
</tr>
<tr>
<td>Potentially 2-3 crops per year, growing period 3-5 months</td>
<td>Sucrose peak shorter for sweet sorghum</td>
</tr>
<tr>
<td>Adequate experience/ research</td>
<td>Vulnerable to stem borer and shoot fly infestation</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td><strong>Threats</strong></td>
</tr>
<tr>
<td>Food and fuel - sugar from stem and grains can be used</td>
<td>Important food crop</td>
</tr>
<tr>
<td>Capability of high energy varieties to be efficient bio-energy crop</td>
<td>Chemical runoff</td>
</tr>
</tbody>
</table>
Croton megalocaropus

Tree native to Tanzania
Nuts reported to contain 32% oil by volume
## Croton megalocarpaceus

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native species to Tanzania</td>
<td>Little scientific research carried out on large scale cultivation</td>
</tr>
<tr>
<td>Drought resistant</td>
<td>Diseases</td>
</tr>
<tr>
<td>Detailed local knowledge of the crop</td>
<td></td>
</tr>
<tr>
<td>Seed oil content reported to be 30%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derivative products glycerol, biogas, animal feed</td>
<td>Seeds edible by local fauna - potential conflict</td>
</tr>
<tr>
<td>Reclaim degraded lands</td>
<td>Clear land for food crops</td>
</tr>
<tr>
<td>Agro forestry</td>
<td></td>
</tr>
</tbody>
</table>
# Fossil energy balance

<table>
<thead>
<tr>
<th>Fuel (feedstock)</th>
<th>Fossil energy balance (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulosic ethanol</td>
<td>2-36</td>
</tr>
<tr>
<td>Biodiesel (palm oil)</td>
<td>9</td>
</tr>
<tr>
<td>Ethanol (sugar cane)</td>
<td>8</td>
</tr>
<tr>
<td>Biodiesel (waste vegetable oil)</td>
<td>5-6</td>
</tr>
<tr>
<td>Ethanol (sweet sorghum)</td>
<td>1</td>
</tr>
<tr>
<td>Diesel (Crude oil)</td>
<td>0.8-0.9</td>
</tr>
<tr>
<td>Gasoline (Crude oil)</td>
<td>0.8</td>
</tr>
</tbody>
</table>
### Biodiesel

<table>
<thead>
<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodegradable</td>
<td>Processing uses large quantities of water</td>
</tr>
<tr>
<td>Lower emissions than diesel, esp. sulphur, hydrocarbons, CO and toxins</td>
<td>Processing needs methane more imported petrochemicals</td>
</tr>
<tr>
<td>Byproducts of manufacturing such as soap</td>
<td>Emissions from processing - hexane</td>
</tr>
<tr>
<td>Low toxicity</td>
<td>Increased emissions of $\text{No}_x$, linked to acid rain</td>
</tr>
</tbody>
</table>

### Opportunities

- Non petroleum based fertilizers
- Reduce imports of oil

### Threats

- Spills
- Burning glycerin for energy has high environmental risks
## Bioethanol

<table>
<thead>
<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar easily processed to alcohol</td>
<td>Low blends of ethanol can increase emissions of volatile organic compounds</td>
</tr>
<tr>
<td>Extensive experience of bioethanol in Brazil</td>
<td>Characterised by high vapour pressures</td>
</tr>
<tr>
<td>Contains no sulphur, olefins and benzene</td>
<td>Processing uses large quantities of water</td>
</tr>
<tr>
<td>Small amounts not toxic, biodegradable</td>
<td>Increased emissions of No\textsubscript{x} linked to acid rain, depends on feedstock</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Opportunities</strong></th>
<th><strong>Threats</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Non petroleum based fertilizers</td>
<td>Large volumes of nutrient rich waste water - eutrophication</td>
</tr>
<tr>
<td>Local energy security</td>
<td>Spills</td>
</tr>
</tbody>
</table>
# Biofuels in general

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve Tanzanian energy security</td>
<td>Yields/ crop varieties</td>
</tr>
<tr>
<td>Promotion of rural development</td>
<td>Lack of government coordination</td>
</tr>
<tr>
<td>Carbon sequestration and emissions reduction</td>
<td>Land clearance</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td><strong>Threats</strong></td>
</tr>
<tr>
<td>Out growers schemes</td>
<td>Land acquisition/ communities lose land</td>
</tr>
<tr>
<td>Planned agricultural development that has</td>
<td>Fluctuations in oil price - biofuels market</td>
</tr>
<tr>
<td>wildlife corridors</td>
<td>could crash like sisal</td>
</tr>
</tbody>
</table>

**Out growers schemes** could lead to communities losing land. Planned agricultural development that has wildlife corridors might also be threatened by fluctuations in oil prices, leading to a crash in the biofuels market.
Key issues highlighted by SWOT analysis

- Lack of government coordination
- Unknown crops with unknown risks
- Land clearing
- Water and energy
- False promises (Ghana); employment generation, out grower schemes