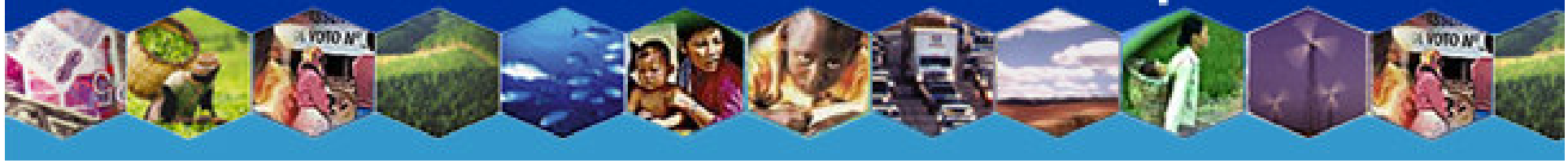
Small-Scale Production and Use of Liquid Biofuels in Sub-Saharan Africa: Perspectives for Sustainable Development

Background Information and Discussion Paper

Energy and Transport Branch

UN Department of Economic and Social Affairs

Division for Sustainable Development



Expert Group Objectives

- Focus on the local production and uses of biofuels and resultant opportunities for enhancing access to energy for poverty reduction and sustainable development in Sub-Saharan Africa (SSA)
- Assess potential for small-scale biofuel production and use for sustainable development and draw conclusions for policy options that can be used in other localities and countries replication
  - Recognizing every community represents a case on its own
- Review and finalize paper on small-scale liquid biofuel production and development in SSA
  - To be presented as background paper to the 15th Session of the Commission on Sustainable Development (CSD-15)

Approach

- Review each section of the report via power point and reference to the document
- Briefly discuss each section
- Obtain your comments/inputs
- Don’t necessarily need to come to agreement on all the points but do want to capture your views
- Discuss report recommendations/conclusions

Study Outline

I. Introduction: Access to energy for sustainable development
II. Overview on liquid biofuels
III. Essential dimensions of sustainable development
IV. Experiences and case studies from Sub-Saharan Africa and Other Countries
    I. Jatropha
    II. Other non-edible energy crops
    III. Edible cash crops
V. Lessons learned and policy options
VI. Conclusions

I. Rationale: Access to Energy for Sustainable Development

- Energy linked to economic growth, poverty reduction, sustainable development
- 1.6 billion people lacking access to electricity; 3 billion people rely on traditional biomass
  - IEA predicts that 1.3 billion without access to electricity by 2030
  - Problem most acute in Africa, particularly in rural areas
  - Traditional approaches, e.g., grid extension are not working: costly, difficult
- Impacts of traditional biomass in Sub-Saharan Africa
  - Environment: deforestation, soil erosion, desertification, flooding, biodiversity loss
  - Health: indoor air pollution leads to 1.5 million deaths per year
  - Social: women/children spend up to 1/3rd their day on collection/transport of wood
- Many renewable energy sources not affordable
- More efficient production and use of solid biomass is well documented
  - Fuel wood cultivation, improved cook stoves, electricity/heat /co-generation
- **Gap in the area of biofuels**
  - **Focus of Expert Group Report**
  - **Concentrates on liquid biofuels and sustainable development in SSA**

II. Alternative Forms of Bioenergy

- **Solid Biomass:** wood, vegetal waste (including wood waste and crops), conventional crops (oil and starch crops), charcoal, animal wastes, other wastes (including the biodegradable fraction of municipal solid wastes) used for energy production
- **Liquid Biofuel:**
  - **Vegetable/Plant Oil:** Can be used in diesel engines, generators, pumps. Use for cooking and lighting possible. Produced from crops, seeds.
  - **Biodiesel:** Can be used in pure form or blended with petroleum diesel at any concentration for use in most modern diesel engines. Can be produced from a variety of feedstock, such as oil feedstock (rapeseed, soybean oils, jatropha, palm oil, hemp, algae, canola, flax and mustard); animal fats or waste vegetable oil.
  - **Bioethanol:** Largest single use is as fuel for transportation or fuel additive. Can be produced from a variety of feedstocks as sugar cane, corn and sugar beet. Can also be produced from cassava, sweet sorghum, sunflower, potatoes, hemp or cotton seeds, or be derived from cellulose waste.
- **Biogas:** methane and carbon dioxide produced by anaerobic digestion or fermentation of biomass. i.e. landfill gas and digester gas

Biodiesel

- Direct use of plant oils for cooking or lighting is possible--requires modified cook stoves or lamps
  - Not widely used for cooking purposes
- Can be used in most diesel engines without major modifications
- Processing
  - Oilseeds crushed to extract oil
  - Raw plant oils filtered and mixed with ethanol or methanol to separate fatty acids and glycerin
- Small-scale cultivation more economical if by-products used economically or commercially
  - Glycerin -- soap manufacture
  - Residue cake -- fertilizer or animal feed
- Technology for extracting oil has remained the same the last 10-15 years
- Simple, but economic small-scale production requires sufficient feedstock, some equipment, capital, and skills

Ethanol

- **Sugar cane or sugar beet:** Primarily produced by fermentation of feedstock. Feedstock is crushed and soluble sugars are extracted with water.
- **Wheat:** Requires initial milling and malting (hydrolysis). Enzymes present in the wheat break down starches into sugars.
- **Corn:** A similar fermentation process, but corn is first milled by a wet milling or by a dry milling process. Enzymes are used to break down starches into sugars which are fermented and distilled. Residues from milling can be used as animal feed.
- **Wood or straw:** Using acid hydrolysis and enzyme fermentation. Process is more complex and expensive.

First generation (conventional) biofuels				
Biofuel type	**Specific names**	**Biomass feedstock**	**Production process**	**Uses**
Vegetable/ Plant Oil	Straight Vegetable Oil (SVO)/ Pure Plant Oil (PPO)	Oil crops (e.g. Rape seed, Corn, Sunflower, Soybean, Jatropha, Jojoba, Coconut, Cotton, Palm, etc.)	Cold pressing/ extraction	Diesel engines, generators, pumping (all after modifications); Use for cooking and lighting, as possible
Biodiesel	Biodiesel from energy crops		Cold pressing/ extraction & trans-esterification	Diesel engines for power generation, mechanical applications, pumping; Transportation (diesel engines)
	Rape seed methyl ester (RME), fatty acid methyl/ethyl ester (FAME/FAEE)			
	Biodiesel from waste FAME/FAEE	Waste/cooking/ frying oil/animal fat	Trans-esterification	
Bioethanol	Conventional bioethanol	Sugar cane Sweet sorghum Sugar beet Cassava Grains	Hydrolysis & fermentation	Internal combustion engine for motorized transport
Bio-ETBE	Ethyl Tertiary Butyl Ether	Bioethanol	Chemical synthesis	
Second generation biofuels				
Biodiesel	Hydro-treated biodiesel	Vegetable oils and animal fat	Hydro-treatment	Internal combustion engine for motorized transport
Bioethanol	Cellulosic bioethanol	Lignocellulosic material	Advanced hydrolysis & fermentation	
Synthetic biofuels	Biomass-to-liquids (BTL): Fischer-Tropsch (FT) diesel Biomethanol Heavier (mixed) alcohols Biodimethyl-ether (Bio-DME)	Lignocellulosic material	Gasification & synthesis	
Bio-hydrogen		Lignocellulosic material	Gasification & synthesis or biol.	

III. Why Biofuels: Contribution to Sustainable Development

- Rural development
- Gender issues
- Reduction of indoor air pollution
- Reduction in harmful pollutants from transport sector
- Energy security
- Climate change mitigation

Sustainable Development Concerns

- Competitive uses of agricultural land
- Competitive use of scarce water resources
- Soil erosion
- Biodiversity concerns
- Socio-economic dimensions and equity concerns
- Energy intensity of biofuel production
- Biofuel trade

Criteria for Sustainability

Economic Dimensions	Social Dimensions	Environmental Dimensions
•Economic feasibility/ affordability •Income generation •Availability of financing •Management skills •Technology availability •Skills •Seasonality of feedstock	•Increased standard of living •Income generation •Training •Gender aspects •Access to water and sanitation •Improving health •Combating rural migration •Better education	•Land requirements •Water requirements •Fertilizer use •Soil protection •Reduction of deforestation •Reduction of GHG emissions •Biodiversity concerns

Criteria for Sustainability

- Crop is suitable under local conditions
- Can grow on marginal and arid lands, requiring limited inputs
- Select, if available and compatible with conditions, non edible crops
- Focus on enabling income generation and production of by-products
- Choose crops that can easily be propagated and require limited initial investment for seeds
- Consider availability and affordability of the processing technology
- Favor small-scale projects that focus on basic energy needs for rural communities
- Benefit women and children

IV. Biofuels SSA Experiences & Case Studies

Feedstock	Experiences	Case Study	
a. Jatropha	➢Ghana ➢Zambia ➢Senegal ➢Madagascar ➢Cookstoves	➢Mali MFP ➢Tanzania MFP	
b. Non-edible Crops	➢Invader bush, Namibia ➢Jojoba, none ➢Neem tree, E., S. Africa ➢Water Hyacinth, Kenya, Rwanda, Tanzania ➢Nipa Fruitcans, Nigeria ➢Algae, S. Africa		
c. Edible Cash Crops	➢Sugar Cane, S. Africa, Mauritius ➢Ethanol in Cookstoves, World Bank ➢Cassava, N/A ➢Sweet Sorghum	➢Zambia Sugar Cane and Sweet Sorghum	➢ h e D u t c h

Barriers to Small Scale Production of Biofuels in SSA

- Cost
- Feedstock
  - Limited experience to date (jatropha)
  - Feedstock choice/availability
  - Storage issues
- Land Ownership
  - Vary country-to-country
  - Common vs private ownership
- Lack of policy/regulatory frameworks
- Institutional
  - Range of stakeholders (govt, farmers, NGOs, credit providers)
  - Lack of coordination
- Technology Transfer
  - Across the supply chain
  - Feedstock availability, infrastructure, delivery, financing, utilization

V. Lessons Learned

- Assessment of local needs, development potentials and constraints
  - Do your market research
- Social Development
- Crop Selection
  - Do field research, perennial vs. annual crops, seasonality, climate, water issues
- Agricultural extension services and capacity building
- Fiscal Policies affect the economic feasibility of crop cultivation
- Financing is needed
- Setting-up Indicators
- Bottom-up approach
- Scaling-up what works?

VI. Conclusions-To Be Developed

- Questions to Consider:
  - What are most promising energy crops for Africa, considering small farmers, sustainability?
  - What are necessary socio-economic pre-conditions (e.g., land ownership, capital access, community organizations, etc) for small scale energy crop farming?
  - What is the minimum scale for economically viable cultivation of fuel crops?
  - What is the scope for expanding pure plant oil utilization for cooking?
    - Can rural communities reduce reliance on firewood via biofuels
  - What farming and technical skills are needed; what is role of entrepreneurs from farming thru processing?
  - What policy options are available (regional, national, local) to support sustainable production/use of biofuels?
  - What is the role for international cooperation: N/S and S/S for more effective promotion of biofuels in sustainable manner?