Biofuel industry in Sudan: Experience and Future Prospects

Abdelmoneim Taha Ahmed,
Sudan

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The Purpose of Presentation

- Take stock of the available resources in Sudan which support initiatives for biofuel industry
- Review the practical experience of Sudan in biofuel industry
- Examines the need for, and the tools for conducting a detailed feasibility study for biodiesel industry
The potential for biofuel industry in Sudan

Sudan potential for developing a technically feasible and socially viable biodiesel industry is supported by:

- Availability of basic natural resources – land & water
- A wide range of crop candidates for biomass production
- Would support food security
- Practical experience
- Supportive legal / regulatory frameworks
Availability of Basic Natural Resources

- Huge resources of water (rain fed & irrigation) and land
- **Potential rain fed areas**
- A rainfall of 500 mm or more;
  - East, South, south east & south west
- Semi-mechanized & traditional systems
- Sorghum dominates (kind of mono-cropping); some sesame, sunflower & cotton
- Low yielding; loss of fertility
A wide Range of Crop Candidates for Biomass Production

- Soybean, sunflower, maize, sesame, cotton, & groundnut - soya bean & sunflower the favored candidates

**Soybean:** Soybean oil is the second-largest biodiesel feedstock after rapeseed oil

- Global experience: USA, Latin America and China
- Legume crop with high protein content (40%) and high-quality oil (20%)
- Promising crop: improves soil fertility, provide a high-protein feed source and produce biodiesel
- In 2012, 2 varieties released; high average yield (2540 & 2460 kg/ha) and high oil content (16% & 17%)
Crop Candidates for Biomass (cont)

- **Sunflower** is also a good candidate as biomass for production of biodiesel.

- **Currently, commercial production is concentrated in rain fed areas**

- can also be produced under irrigation.

- can be produced as a winter crop under irrigation and can improve crop intensification in the irrigated pump schemes where wheat (the main winter field crop) can not be cultivated due to warm temperatures.
Potential Irrigated Areas

• Sudan has not exhausted its share in the 1959 water treaty with Egypt - around 6 milliards cubic meters of water is not used

• Heightening of Rosieres dam the storage capacity increased by 4 milliard cubic meters

• Under irrigation there are two potential candidates for biodiesel production:
  (i) Existing sugar cane production schemes
  (ii) Irrigated pump schemes along the white and blue Niles
(i) Production in Sugarcane Production Schemes

- 6 sugar sugarcane plantations with a total land area of around 360,000 acres
- Fallow lands in sugar cane fields about 60,000 acres
- Soya bean (a biofuel candidate crop) can be introduced as a break crop to improve soil characteristics
- Kenana Sugar Company has already commenced the soybean plantation as a research program
(ii) Production in Irrigated Pump Schemes

• Total areas around 575,000 acres
• Cotton-based production systems
• Inherent irrigation problem; improved recently
• Sorghum become the dominant crop
• Currently subsistence system
• Efforts are underway to introduce other crops
• Good potential to integrate soya bean & /or sunflower in the rotation as up to 190,000 acres
• Benefits: Cash crops; produce biodiesel & add value; cake / animal feed
An Initiative, Supports Food Security

- May not jeopardize FS – availability, accessibility, affordability
- Not at the expense of other food crops resources
- Both are oil / food crops, with well established substitutes (sesame, ground nuts and cotton)
- Cash crops, improve small farmers’ income; processing add value & improves income & employment source; by-products provide a source of protein-rich feed
- Import substitution (saving foreign exchange);
- Source of power for agriculture, electrification, transportation, (contributes to rural development)
Practical Experience

- Sudan has started an ambitious non-hydrous bio-ethanol production plan
- The first bio-ethanol plan in Sudan (2009)
- High value added product with high export potential
- Brazilian technology; State of the art, fully computerized plant
- Uses molasses as feedstock with flexibility to use juice
- Production Capacity: 200,000L/day, 65 m L/year.
- Market: Domestic - 10%; Export - 90% (to EU)
Ethanol Production

Product
- Ethanol – Anhydrous Alcohol

By products
- Yeast
- 2nd Grade Alcohol
- Vinasse
- CO₂ (Carbon Dioxide)
Ethanol Production / Specifications

- Ethanol – Anhydrous Alcohol
- Appearance Clear, bright, free of suspended or settle material Ethanol, V/V 99.6 – 99.8 %
- Methanol 1.0 % WT, max
- Involatile matter at 105 °C 10 mg / 100 ml, max
- Higher saturated monoalcohols (C₃ – C₅) 2.0 % WT, max
- Total acidity (As Acetic Acid) 0.007 % WT, max
- Copper 0.1 mg/kg, max
- Water content, V/V 0.3 % WT, max
- Inorganic chloride 20 mg/l, max
- Phosphorus 0.5 mg/l, max
- Sulfur 10 mg/kg, max
Ethanol Production

Two principal processes:

**Fermentation**: by yeast to produce ethanol and carbon dioxide

**Distillation**: of the beer or wort to concentrate the alcohol content
A variety of viable systems exist to ferment the sugar:

- Simple batch fermentation, with or without yeast recycling,
- Batch cascade and continuous fermentation, and
- in some cases including sophisticated vacuum fermentation and distillation systems
Ethanol Production / Distillation:

- The "beer," (7% - 10% alcohol), & all the non-fermentable solids from the molasses and yeast cells, is pumped to the continuous flow, multicolumn distillation system.
- The ethanol boiled off from the solids and the water.
- The ethanol leaves the top of the final column at about 96% strength.
- The residual beer, called "vinasse", is transferred from the base of the column to the by-product processing area.
Supportive Legal / Regulatory Frameworks

- There are political and regulatory frameworks that support and encourage investment in biofuel industry in Sudan.
- Sudan has ratified the Kyoto Protocol in 2005, thereby, opening the door to clean development projects;
- Legislations for biofuels industry and ethanol blend with gasoline (E10) put forward for approval by the Council of Ministers in March 2013 through the office of the Minister of Petroleum.
The Proposed Project

- Sudan has good potential to produce biodiesel,
- But a rigorous quantitative and qualitative analysis is needed, to:
- Evaluate the technical, social, & economic feasibilities,
- Analyze the interplay between bioenergy & food security

FAO Bioenergy & Food Security (BEFS) Analytical Framework (AF)

- Permit policy-makers to make informed decisions
- BEFS AF consists of five modules
The Feasibility of Producing Bioenergy

• BEFS allows the country to identify:
  • The areas potentially most suitable for bioenergy production excluding those that are environmentally protected or are under alternative uses.
  • The smallholder-integrated production chains that are technically viable and most competitive;
The economy-wide and food security effects of bioenergy development

BEFS allows the country to assess:

- How the agriculture markets will evolve and how bioenergy might impact them;
- The extent to which bioenergy developments in the country can lead to economic growth and poverty reduction;
- The nature of trade-off that arise from pursuing particular bioenergy pathways;
- Household level food security and vulnerability;
- The extent to which bioenergy crop production might compete with food production.
Module 1: Biomass Potential

Assessing biophysical criteria:

- Identify the areas suitable and available for growing the relevant bioenergy crops;
- Establish production and yields of different biofuel crops;
- Illustrate the advantages and disadvantages of different agricultural production systems;
- Establish in which areas there might be a conflict between food and bioenergy production.
Module 2: Biofuel Supply Chain Production Costs

Assessing techno-economic feasibility

- Costs of production of the biofuel at the factory gate and distribution to domestic and international markets;
- Accessibility of technology and availability of infrastructure and the required human skills;
- Opportunities for rural development through production systems inclusive of out grower and combined plantations-out grower schemes;
- Processing of waste by-products into valuable co-products focusing on use in local settings.
Module 3: Agriculture Markets Outlook

Gives stakeholders an understanding of how international and domestic policies on biofuels may impact the domestic industry with implications for food security.

Will help assess:
- What is the domestic market outlook;
- What is the impact of bioenergy development on the domestic agriculture market;
- What is the influence of international policies.
Module 4: Economy-wide Effects

Examines whether the implementation of a new sector, such as bioenergy, can be beneficial for economic growth and poverty reduction.

Will help assess:

- The economy-wide trade-offs bioenergy poses;
- Which bioenergy production chain is most growth enhancing;
- Which bioenergy production chain is most poverty reducing;
- Which sector loses and how the allocation of resources change.
Module 5: Household-level Food Security

From a policy perspective, it is necessary to understand how the price changes can impact the country as a whole and which price changes the poorer segments are most vulnerable to.

This Module will help assess:

- The most important food crops;
- Recent price trends in key food crops;
- Which price changes the country as a whole is most vulnerable to;
- Which are the most vulnerable segments of the population
Thank you