Feasibility Study on the Production of Biofuels in the UEMOA
Dakar, October 1st, 2015
Bain & Company, MMSO and ESALQ formed the consortium responsible for conducting the study

### BASIS FOR THE STUDY

- In 2007 Brazil and UEMOA signed a **Memorandum of Understanding**: Cooperation between Brazil & UEMOA in field of bioenergy
- **Technical cooperation** agreement BNDES-Min. Foreign Affairs
- **Consortium selected** based on experience

### MAIN OBJECTIVES

- **Feasibility analysis** and recommendation of the **most suitable business model** for the production of biofuels in the UEMOA region
- Proposal of **public policies** to develop the market

### CONSORTIUM

<table>
<thead>
<tr>
<th><strong>BAIN &amp; COMPANY</strong></th>
<th><strong>MACHADO MEYER</strong></th>
<th><strong>ESALQ</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Management consulting firm</td>
<td>Law firm</td>
<td><strong>Institute of Agronomic research</strong> of University of São Paulo</td>
</tr>
</tbody>
</table>

- **BAIN & COMPANY**
  - General & Business coordination

- **MACHADO MEYER**
  - Legal technical coordination

- **ESALQ**
  - Agricultural technical coordination
Study evaluated agronomic, economic, social and legal aspects related to the biofuels industry

May 2013

I. Kick-off

II. Data collection and understanding of current situation

1 month

5 months *

1st Visit

- Objective:
  - Data collection and validation of assumptions

- Results:
  - 70 Meetings
  - 5,000KM travelled

- Visited countries:
  - Benin, Togo, B. Faso, C. d'Ivoire and Senegal

II. Data collection and understanding of current situation

III. Selection of Business model

2 months *

1st Visit

- Objective:
  - Validation of the chosen business model

- Results:
  - Alignment of the model with UEMOA, governments and local producers

- Visited countries:
  - B. Faso and Senegal

IV. Quantification of impacts and proposition

2 months

2nd Visit

2nd Visit

- Objective:
  - Data collection and validation of assumptions

- Results:
  - 70 Meetings
  - 5,000KM travelled

- Visited countries:
  - Benin, Togo, B. Faso, C. d'Ivoire and Senegal

V. Detailing of the action plan

1 month

* Note: phases II and III have an intersection of 1 month
Our goals for today:

- Brief review of the global biofuels market and the context for biofuels in UEMOA

- Discuss attractive business models of biofuels in UEMOA

- Present public policies and deployment plan for the creation of the sector in UEMOA

- Discuss necessary changes in the regulatory framework
Agenda

- Global Biofuels market & lessons learned
- Evaluated business models
- Public policies and regulatory framework
The biofuels market has progressed since 2000, but is still small

**GLOBAL PRODUCTION OF ETHANOL**

- **USA** - 60%
- **Brazil** - 27%

**GLOBAL PRODUCTION OF BIODIESEL**

- **Europe** - 41%
- **Latin Am.** - 23%
- **North Am.** - 16%
- **Asia** - 20%

**Source:** EIA

- **% of gasoline consumption:** 1.5%, 1.9%, 2.4%, 3.3%, 5.7%, 6.9%, 6.5%
- **% of diesel consumption:** 0.1%, 0.1%, 0.2%, 0.5%, 1.0%, 1.3%, 1.6%
Main producers use different raw materials, leveraging locally strong cultures

Biofuel Production by raw material and geography, 2012 (Mt)

- **ETHANOL**
  - USA: 40 (Maize)
  - Brazil: 18 (Cane)

- **Biodiesel**
  - EU: 9 (Rapeseed)
  - USA: 3 (Soybeans)
  - Argentina: 2 (Soybeans)
  - Brazil: 2 (Soybeans)

Note: *Animal fat, sunflower and cottonseed oil.
Source: EIA, USDA
But none of the raw materials has a competitive cost position against fossil fuels.

Note: *domestic production priced as export parity and imports as import parity
Despite the additional cost, other benefits led countries to adopt biofuels

**ECONOMIC**
- Reduction of dependence on imported fuels
- Incentive to trade balance

**SOCIAL**
- Creation of jobs
- Redistribution of income
- Form of indirect subsidy to the agriculture

**ENVIRONMENTAL**
- Adoption of renewable energy
- Reduction of the emission of pollutants
  - Sulfur, particulate matter, CO₂

Source: interviews with experts

Adoption of mandatory blend to lever the adoption of biofuels
Countries that succeeded in the production of biofuels have certain common characteristics

**CASE STUDIES**

- **Brazil**
- **China**
- **USA**
- **Thailand**
- **Argentina**
- **Colombia**
- **Indonesia**
- **Malaysia**
- **European Union**

**Agriculture**

- **Surplus of raw materials**, high productivity, competitive prices

**Fuels**

- **Imports of fossil fuels** with high prices on the internal markets
- **Capacity to absorb the additional costs** via subsidies, tax exemptions or by the final consumer

**Legislation**

- **Mandatory blending** to ensure demand
- **Robust regulatory framework**, with clear roles and price definition
Agenda

• Global Biofuels market & lessons learned

• Evaluated business models

• Public policies and regulatory framework
Based on the global learnings & the local priorities mapped, we identified key success factors for the biofuels industry in UEMOA:

**Agriculture**
- Increase agricultural productivity to generate surplus of raw materials
- Work with local governments to ensure access to land
- Search for cultures that minimize costs / additional subsidies to fuels
  - Imports of fossil fuel are a sign that there is space for local generation

**Fuels**
- Offer cogenerated energy for domestic supply, reducing costs
- Establish mandatory blending to generate demand
- Incorporate socioeconomic benefits, offsetting costs
- Search regulatory support from UEMOA to facilitate rapid deployment

**Electricity**
- Increase agricultural productivity to generate surplus of raw materials
- Work with local governments to ensure access to land
- Search for cultures that minimize costs / additional subsidies to fuels
  - Imports of fossil fuel are a sign that there is space for local generation
- Offer cogenerated energy for domestic supply, reducing costs
- Establish mandatory blending to generate demand
- Incorporate socioeconomic benefits, offsetting costs
- Search regulatory support from UEMOA to facilitate rapid deployment

**Sources:**
- Case Studies
- Interviews with experts
- Government information
- Local visits
- Legislation
- Benchmarks
- Literature

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Feasibility analysis of the production of biofuels from each culture was divided in 3 steps:

1. **Agricultural Analysis**
   - Soil conditions
   - Handling and agricultural inputs

2. **Business Model**
   - Potential demand
   - Cost of opportunity
   - Production Risks
   - Profitability

3. **Impacts on Economy**
   - Replacement of imports
   - Generation of jobs
   - Changes in market prices
   - Generation of value
Feasibility analysis of the production of biofuels from each culture was divided in 3 steps:

1. **Agricultural Analysis**
   - **Soybeans**, **Sunflower**, **Castor oil**, **Sorghum**, **Elephant Grass**, **Eucalyptus**, **Jatropha**, **Palm**, **Peanut**, **Cotton-seed**, **Sugar Cane**

2. **Business Model**
   - **Soybeans**, **Sunflower**, **Castor oil**, **Sorghum**, **Elephant Grass**, **Eucalyptus**, **Jatropha**, **Palm**, **Peanut**, **Cotton-seed**

3. **Impacts on Economy**
   - **Jatropha**, **Palm**, **Peanut**, **Cotton-seed**, **Sugar Cane**

**Sugar Cane** is the only crop that passed all three steps.
Sugar cane has 5 agronomic characteristics favorable to the production of biofuels ...

Sugar Cane

AGRONOMIC POINT OF VIEW

• Easy **local implementation** technology
  - Vegetative propagation
  - High adaptability for productivity

• **Cheaper** dry matter
  - Low protein content
  - Low oil content

• **Resistant** culture
  - Less dependent on handling and inputs
  - Less vulnerable to pests and diseases

• **Productive Efficiency**
  - Smaller area needed for high biomass production

• Culture **responsive to local irrigation**
  - Possibility to achieve high productivity with irrigation

Note: ETC> rain
... and a business model with competitive cost position able to tap into 3 distinct markets

Sugar Cane

BUSINESS MODEL POINT OF VIEW

• Best cost position among analyzed cultures
  - High productivity in **irrigated model**: 100 ton/ha
  - **Local labor** has lower cost
  - **Brazilian technology** can reduce costs

• Focus on the domestic market for sugar and ethanol, in addition to the potential for cogeneration
  - **Sugar**: Eliminate need to import (950kta)
  - **Ethanol**: Production for **E10 mix** (600k m³)
  - **Cogeneration**: Energy for own use and for sale

• Demand can be supplied by **1 plant in each country** (except in Guinea-Bissau)
  - Area harvested: **18-34k ha** (~40k ha average mill in Brazil)
  - Industrial capacity: ~**2.1Mt/harvest** (~4Mt in Brazil)
The demand for Ethanol (E10) and sugar in UEMOA can reach 16.5 Mt or 165k hectares of cane in 2030.

<table>
<thead>
<tr>
<th>Cane (Mt)</th>
<th>Area (k ha)</th>
<th>Benin</th>
<th>Senegal</th>
<th>Togo</th>
<th>B. Faso</th>
<th>Niger</th>
<th>C. Ivoire</th>
<th>Mali</th>
<th>G. Bissau</th>
<th>Total</th>
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<tbody>
<tr>
<td>3.4</td>
<td>34</td>
<td>397</td>
<td>219</td>
<td>108</td>
<td>141</td>
<td>81</td>
<td>98</td>
<td>69</td>
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<td>2.6</td>
<td>26</td>
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<tr>
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<td></td>
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Despite the irrigated model, cash cost of production in UEMOA is lower than in Brazil.

Cash Cost of production (US$ /t TRS)

- Labor is the main lever to reduce the production cost.
- Productivity gains compensate for irrigation cost.
- 20% of irrigated area for population; +Schools for local population.

*Includes cost of labor for maintenance of assets of irrigation. Source: Interviews with experts, technical visits to countries, ESALQ, Ministry of Agriculture, clipping, Bain Analysis.
New mills could even reduce domestic price of sugar and generate attractive return

Sales price** of crystal sugar, ex-taxes (US$/kg, Jul/2013)

Note: * Ex-mil price defined as the average price of Cote d’Ivoire, Mali, Senegal and Burkina Faso due to the unavailability of data.
Note: **Sold in bags of 50 kg. Ethanol from molasses priced as industrial ethanol.
Source: interviews with experts, clipping, ministries and local governments, visit to sugar mills in the region.

Average reduction of 17% in local sugar price
E10 blend generates additional cost of US$2-5 ¢/L vs. the current price of petrol

Current gasoline price vs. E10 price (US$c/L)

**Increase of 2-6% in fuel price**

Note: Ethanol price considers 10% IRR and no demand incentives. Source: Bain Analysis.

Add. cost (US$c/L E10)

<table>
<thead>
<tr>
<th>Country</th>
<th>Add. cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benin</td>
<td>3</td>
</tr>
<tr>
<td>Togo</td>
<td>2</td>
</tr>
<tr>
<td>G. Bissau</td>
<td>4</td>
</tr>
<tr>
<td>Senegal</td>
<td>4</td>
</tr>
<tr>
<td>Niger</td>
<td>5</td>
</tr>
<tr>
<td>Mali</td>
<td>5</td>
</tr>
<tr>
<td>C. Ivoire</td>
<td>5</td>
</tr>
<tr>
<td>B. Faso</td>
<td>6</td>
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</table>

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Cogeneration can bring attractive return and reduce the cost of electricity in countries

Current cost of electricity generation and price of cogeneration for IRR of 10-15% (US$/MWh)

Source: AfDB, IZF, companies and governments websites, clipping, World Bank, Bain analysis.

Auction Brazil Dec/13 CoGen (US$58/MWh)

Between US$55-68/MWh
Benefits generated by the construction of the mill compensate for the higher cost of ethanol

Socioeconomic impact of the construction of a sugar/ethanol plant in Togo (US$M/year)

- 66k m³ of gasoline at US$ 821/m³ (US$ 131/bbl)
- 108kt of sugar at US$ 522/t

Surplus of 70GWh at US$ 61/MWh (IRR 10%) vs. current cost US$ 137/MWh

13,000 Jobs, with an average cost of US$ 1,753/year

Source: ANP, Brazilian IRS, Bain Analysis.
**Expected Impact is of 1-5% of GDP, for the most part due to the production of sugar**

<table>
<thead>
<tr>
<th>Country</th>
<th>CAPEX (US$ M)</th>
<th>% of GDP</th>
<th>Socioeconomic Impact (US$M/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senegal</td>
<td>512</td>
<td>2%</td>
<td>257</td>
</tr>
<tr>
<td>Benin</td>
<td>663</td>
<td>3%</td>
<td>229</td>
</tr>
<tr>
<td>B. Faso</td>
<td>412</td>
<td>2%</td>
<td>207</td>
</tr>
<tr>
<td>Niger</td>
<td>397</td>
<td>3%</td>
<td>202</td>
</tr>
<tr>
<td>C. Ivoire</td>
<td>410</td>
<td>1%</td>
<td>190</td>
</tr>
<tr>
<td>Togo</td>
<td>425</td>
<td>5%</td>
<td>187</td>
</tr>
<tr>
<td>Mali</td>
<td>346</td>
<td>2%</td>
<td>165</td>
</tr>
<tr>
<td>G. Bissau</td>
<td>75</td>
<td>4%</td>
<td>39</td>
</tr>
</tbody>
</table>

**Additional Social Benefits**

- Construction of schools to local population
- Irrigation of 20% additional area for common use

Source: ANP, Federal Revenue, analysis Bain
Selection of suitable areas for the installation of new sugar mills was made based on 5 criteria:

### FACTORS CONSIDERED IN SELECTION OF SUITABLE AREAS

- **Agricultural** and environmental aptitude
  - Minimum productivity
  - Exclusion of areas of environmental protection
- **Access to irrigation**
  - Proximity to perennial rivers
- **Availability of land**
  - Exclusion of areas occupied by other crops or already populated
- **Access to labor**
  - Exclusion of isolated areas
- **Access to infrastructure**
  - Proximity of logistic corridors and power transmission lines

### SUITABLE MACRO REGIONS IN UEMOA

Definition of exact areas for planting should be made by the investor after refinement of the proposed suitable regions.
Agenda

- Global Biofuels market & lessons learned
- Evaluated business models
- Public policies and regulatory framework
We divided the necessary public policies for the adjustment and structuring of the sector in 3 phases.

**PHASE 1: DEFINITION OF SECTOR AND REGULATORY FRAMEWORK**
- Define productive areas and simplify access to **LAND** to ensure offer.
- Establish **MANDATORY BLENDING** of Ethanol to ensure demand.
- Establish **RULES OF OPERATION** and **PRICING**.

**PHASE 2: CREATION OF VALUE CHAIN**
- Obtain and distribute **CAPITAL** (treasury, multilateral and commercial).
- Coordinate public and private investment in **INFRASTRUCTURE**.
- Create **PRODUCT CONSORTIUM** to support blend and pricing.
- Facilitate imports of equipment and inputs from **SUPPLIERS**.

**PHASE 3: LOCAL STRENGTHENING AND DEVELOPMENT**
- Educate specialized local **LABOR FORCE**.
- Promote development of local **TECHNOLOGY**.
- Promote expansion of the **DISTRIBUTORS** network.
- Boost association in **CLUSTERS**.

Governments define basic conditions of market.
Investors are mobilized and Governments define fiscal and financial incentives.
Investors and Governments refine policies for greater sustainability of the value chain.
Phase 1 - Definition by the Government of the basic market conditions

PHASE 1
DEFINITION OF SECTOR AND REGULATORY FRAMEWORK

- **Production** areas for cane
- Plan of population **expropriation and relocation**, minimizing the impacts

Establish **MANDATORY BLENDING** of Ethanol to ensure demand

- **Institution of the mandatory blend** in gasoline (at least the equivalent to the production of molasses)
- Promotion of **sugar cane as the main source for ethanol**
- **Maximum and minimum limits** of blending
- **Commission for management of mix**

Establish **RULES OF OPERATION** and **PRICING**

- **Roles and limits of the actors of the chain** (mainly for sugar and ethanol)
- Commission for **supervision of the commercial rules**
Phase 2 - Creation of the productive chain and definition of fiscal and financial incentives for the industry

PHASE 2
CREATION OF VALUE CHAIN

- **Investors:** presentations for major commercial banks
- **UEMOA:** involve development banks and create technical committee for the evaluation of projects
- **Governments:** Assess interest in direct investment

Coordinate public and private investment in INFRASTRUCTURE

- **UEMOA:** Integrated infrastructure plan
- **Differentiated credit and/or tax exemptions** for projects that require construction of infrastructure

Create PRODUCT CONSORTIUM to support blend and pricing

- **Consortium of investors** to coordinate the application of pricing rules and production planning

Facilitate imports of equipment and inputs from SUPPLIERS

- **Adjust the import and local incentives policies**
  - Facilitation of imports of equipment and inputs
  - Development of local suppliers and tariff protections
Role of UEMOA in the definition of the sector is based on 3 tools: guidelines, additional act and regulation

Today

- **Basic Policies:**
  - Agriculture
  - Industry
  - Renewable energy

- **Study on biofuels regulatory framework** in 2010

Definition of the regulatory framework

- **Guidelines:**
  - Directing the member States
    - Goals of production and mix
    - Manual of best practices

- **Additional Act:**
  - Definition of common policy for biofuels

- **Customs Code:**
  - Exemption of taxes on imports of equipment and technology

Industry Strengthening

- **Regulation:**
  - Mandatory for all member states
    - Percentages of mixture
    - Licenses
    - Environmental Impacts

Source: interviews with experts and governmental agencies, research of local laws
Relevant guidelines to be included in local regulatory framework by the use of tools of different levels

<table>
<thead>
<tr>
<th>Law</th>
<th>Decree</th>
<th>Infra-legal Normative Acts</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Overarching principles to stimulate market</td>
<td>• Rules of matters already defined in the law</td>
<td>• Definition of technical standards</td>
</tr>
<tr>
<td>• Low flexibility for changes</td>
<td>• Greater flexibility for changes</td>
<td>• Need for improvement during development</td>
</tr>
<tr>
<td>• Essential clauses of land contracts</td>
<td>• Rules applicable to friendly expropriation of land</td>
<td>• Definition of blending percentage</td>
</tr>
<tr>
<td>• Minimum and maximum blend percentage</td>
<td>• Criteria to fix percentage of blending and premium of ethanol price vs. sugar</td>
<td>• Definition of price premium</td>
</tr>
<tr>
<td>• Range of premiums linked to internal price of sugar</td>
<td>• Rules of operation and deliberation of the Ministerial Council</td>
<td>• Quality standards of ethanol</td>
</tr>
<tr>
<td>• Simplified procedures for running the business</td>
<td></td>
<td>• Supervision and application of penalties</td>
</tr>
<tr>
<td>• Fiscal incentives for biofuels</td>
<td></td>
<td>Rules must be edited by Ministerial Council established by law</td>
</tr>
</tbody>
</table>

Examples:

- Existing rules in countries can be used

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Main conclusions of the study

Agro-energetic focus is important

• Production of biofuels should ensure **food supply** and generate energy from **cogeneration**, priorities of local governments

Model of Ethanol from sugar cane is feasible

• Culture with **best cost position** in the region
• Business Model generates **positive financial and socioeconomic results**

However, mobilization of governments is necessary for implementation

• Ensure **access to land**, establish **mandatory blending**, structure **pricing** and create awareness of population