Analysis of the potential for sustainable, cassava-based bio-ethanol production in Mali

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Questions

- Are there land resources available to avoid the negative impacts of competition on food security?
- What will be the overall effect on food security, locally, regionally, nationally and globally, of increasing cassava production for bio-ethanol?
- Will large-scale production of cassava for bio-ethanol be environmentally sustainable?
- Is it realistic that farmers will be able and willing to increase cassava production at a price making such a production possible and profitable?
- What will the impacts be on household incomes and equality?
- Who are the key actors in Mali’s value chain for cassava, and what will be the effect on these actors of establishing a bio-ethanol production?
Assumptions made

• The market (in Mali or the nearest neighboring countries) can absorb a production of 10 million liters of bio-ethanol

• A facility is located in the vicinity of a concentrated cassava production area capable of producing in the order of 50-70,000 tons/year

• In this area the production of cassava should take place in parallel with a food crop production large enough to assure food security

• The yields obtained should be a minimum of 10 tons/ha, or it should be feasible to attain this (or preferably a higher) level by greater use of inputs and agronomic expertise

• The smallholders should be willing to produce a guaranteed amount at a guaranteed price of no more than 30-40 CFA/kg
Selection of study site – criteria:

- The availability of the basic production factors required to increase the production of cassava. These include mainly suitable land and labour resources.

- Environmental criteria, including
  - Suitable soil and climatic conditions
  - Acceptable impacts of increased cassava production on ecosystems, biodiversity and water resources
  - Acceptable impacts on carbon stocks in vegetation and crops

- Institutional criteria (in a broad sense), including
  - The presence and competence of local institutions, public as well as private, providing a framework for involving smallholders in the production
  - Experience with contract farming
  - Land rights, allowing flexible expansion of cassava production

- Economic criteria, not the least an actual or potential price of cassava allowing economically sound bio-ethanol production

- Infra-structural factors, including
  - Possibilities of transporting the cassava from fields and villages to the processing site at reasonable cost
  - Access to relevant markets, in Mali and/or neighbouring countries
High-resolution satellite image
Landscape units

- Study villages
- A) Interfluvies with gravelly and stony lateritic soils
- B) Escarpment and high plateau with gravelly and stony lateritic soils
- C) Plains with sandy soils (Le tientien)
- D) Seasonally flooded wetlands and river valleys with silty soils (Le bogo)
Selection of households for the questionnaire survey

Siéouba
Facokourou-Kourani - 35 HH

Perasso - 30 HH
Cassava varieties

**Bonouma (12 month crop cycle)**
- is almost exclusively produced in wetlands (Bas-fond)
- intensively cultivated with many types of crops (sweet potatoes, rice, yams).
- therefore the dominant variety in villages with access to large wetland areas, where it covers 70-90% of the cassava area
- sweet cassava which can be consumed after limited preparation (e.g. boiled)

**Attièkè (6-12 month crop cycle)**
- which can be cultivated on dryland soil
- a flexible crop which is adapted to different environments
- in villages with limited access to bas-fonds, it may cover 80-90% of the cassava area
- known as a bitter variety and needs several steps of processing before it can be consumed, to reduce the content of cyanide glucosides
Landscape and land use
### Percent land within each land use class

<table>
<thead>
<tr>
<th>Land Use Class</th>
<th>Site I (%)</th>
<th>Site II (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava on lowland-fields</td>
<td>17.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Lowland-fields (mostly rice)</td>
<td>20.3</td>
<td>5.8</td>
</tr>
<tr>
<td>Cassava on upland-fields</td>
<td>3.2</td>
<td>5.4</td>
</tr>
<tr>
<td>Fruit tree plantation</td>
<td>1.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Fallow land</td>
<td>25.8</td>
<td>14.6</td>
</tr>
<tr>
<td>Secondary forest or bush</td>
<td>4.9</td>
<td>42.9</td>
</tr>
<tr>
<td>Cultivated upland-fields with valuable trees</td>
<td>26.5</td>
<td>29.6</td>
</tr>
</tbody>
</table>

Total area of each site = 1.8 sq.km.

### Legend
- Homesteads
- Cassava on lowland-fields
- Cassava on upland-fields
- Lowland-fields (mostly rice)
- Fallow land
- Secondary forest or bushland
- Cultivated upland-fields with valuable trees

- Fruit tree plantation

Department of Geography & Geology
Effects on carbon in the vegetation

Methods

- Questionnaires and interviews:
  - Are farmers willing to expand cassava cultivation?
  - If yes, into what areas?
- Counting and measurements of trees
- What trees will be cleared?
Above-ground carbon stock in trees

![Graph showing carbon stock in the biomass (Mg C/ha) for different categories and estimations.](image)

- **Carbon in preserved biomass**
- **Carbon in removed biomass**

<table>
<thead>
<tr>
<th>Category</th>
<th>Maximum Estimation</th>
<th>Minimum Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallow areas with a maximum age of 5 years</td>
<td>12,00</td>
<td>8,00</td>
</tr>
<tr>
<td>All sampled fallow areas</td>
<td>18,00</td>
<td>14,00</td>
</tr>
</tbody>
</table>
‘Pay-back’ period of carbon debt when converting fallow into cassava

Carbon debt allocated to changes in above-ground biomass and fertilizer use (Mg C/ha)

Time to repay carbon debt (Years)

<table>
<thead>
<tr>
<th></th>
<th>Min estimation</th>
<th>Max estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of non-useful trees at fallow areas with a max age of 5 years</td>
<td>4 Mg C/ha</td>
<td>5 Mg C/ha</td>
</tr>
<tr>
<td>Removal of non-useful trees at all sampled fallow areas</td>
<td>8 Mg C/ha</td>
<td>9 Mg C/ha</td>
</tr>
<tr>
<td>Total removal of all trees</td>
<td>12 Mg C/ha</td>
<td>13 Mg C/ha</td>
</tr>
</tbody>
</table>
Selected conclusions

• Expansion of cassava production for bio-ethanol is likely to lead to conversion of fallow areas, some formerly cultivated with cotton, to cassava. The ‘repayment time’ for the ‘carbon debt’ is in the order of 8–25 years for these areas.

• It is likely that farmers will respond positively to a guaranteed price in the order of 30 CFA/kg.

• No negative impacts of a bio-ethanol production facility on local food security are likely.

• The important supply of bonouma to the Segou-Mopti area in the rainy season is likely to be unaffected, if the bio-ethanol production is based only on attieké.
Recommendations

• A proper analysis of the potential national market for bio-ethanol is needed, building on experience from other African countries

• A feasibility study will be required to assess the economic viability of bio-ethanol production