The Bioenergy and Food Security (BEFS) project and its approach

NR Seminar, FAO HQ Rome, 25 November 2010
The NRC Seminar today

• Overview

• BEFS in practice: the case of Tanzania

• Concluding remarks
Bioenergy and Food Security

Bioenergy

Food Security

Can bioenergy be a catalyst for growth?
Policy information basis:
The BEFS Analytical Framework (BEFS AF)

1. **Diagnostic analysis**
   - Agricultural outlook

2. **Natural resource analysis**
   - Land assessment
   - Water resource management
   - Woody biomass and residues

3. **Techno-economic and environmental analysis**
   - Biofuel production costs
   - Greenhouse gas emissions

4. **Socio-economic analysis**
   - Economy-wide impacts
   - Household food security & vulnerability

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- Agriculture baseline?
- Natural resource availability and constraints?
- Economically viable and competitive?
- Impacts on national economy? Vulnerable groups?

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Supporting government in national biofuel policy development
BEFS support, countries and the policy spectrum

BEFS ➔ Evidence

Informing policy
Building capacity

Tanzania ➔ Peru ➔ Thailand

Guidelines in place and policy under development; agriculture sector plays a key role

Biofuel policy in place; mandate for bioethanol and biodiesel (implementation)

Biofuel policy in place with stepping up production targets
BEFS’ core message

...per se biofuels is neither good nor bad

...what matters is the management of the sector!
# BEFS AF implementation in the countries

<table>
<thead>
<tr>
<th>BEFS Analytical Components</th>
<th>PERU</th>
<th>TANZANIA</th>
<th>THAILAND</th>
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<tr>
<td><strong>Diagnostic analysis</strong></td>
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<td>Agricultural markets outlook</td>
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<td><strong>Natural resource analysis</strong></td>
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<td>‘Best practices’ bioenergy projects</td>
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BEFS in practice: Tanzania

• **Context**
  Low income, high dependence on agriculture, high poverty and undernourishment rates, limited energy access, heavy reliance on traditional biomass, very rural

• **Potential bioenergy crops**: sugar cane, molasses, sweet sorghum, cassava, palm oil, sunflower, jatropha

• **Food security staples**: **Maize** and **Cassava**

<table>
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<tr>
<th>Ranking</th>
<th>Commodity</th>
<th>Calorie Share</th>
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<tbody>
<tr>
<td>1</td>
<td>Maize</td>
<td>33.4</td>
</tr>
<tr>
<td>2</td>
<td>Cassava</td>
<td>15.2</td>
</tr>
<tr>
<td>3</td>
<td>Rice (Milled Equivalent)</td>
<td>7.9</td>
</tr>
<tr>
<td>4</td>
<td>Wheat</td>
<td>4.0</td>
</tr>
<tr>
<td>5</td>
<td>Sorghum</td>
<td>4.0</td>
</tr>
<tr>
<td>6</td>
<td>Sweet Potatoes</td>
<td>3.3</td>
</tr>
<tr>
<td>7</td>
<td>Sugar (Raw Equivalent)</td>
<td>3.3</td>
</tr>
<tr>
<td>8</td>
<td>Palm Oil</td>
<td>3.0</td>
</tr>
<tr>
<td>9</td>
<td>Beans</td>
<td>2.9</td>
</tr>
<tr>
<td>10</td>
<td>Beverages, Fermented</td>
<td>2.7</td>
</tr>
<tr>
<td>11</td>
<td>Milk – Excluding Butter</td>
<td>2.2</td>
</tr>
<tr>
<td>12</td>
<td>Bovine Meat</td>
<td>1.8</td>
</tr>
<tr>
<td>13</td>
<td>Pulses, Other</td>
<td>1.7</td>
</tr>
<tr>
<td>14</td>
<td>Plantains</td>
<td>1.5</td>
</tr>
<tr>
<td>15</td>
<td>Millet</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Subtotal share for selected items: 88.5
Total Calories per capita: 1959

Source: FAOSTAT

**Bioenergy no go crop: maize**
Diagnostic analysis: Agricultural Outlook
Component 1 of the BEFS AF

Key questions
• How will agricultural markets evolve and what are the likely impacts of bioenergy developments on this?
• Is food security going to be a problem in the next ten years?

Outline
• Medium-term agricultural outlook
  • International
  • Tanzania
• Biofuel scenarios
  • Mandates
  • Land expansion
  • Crude oil prices
• Global biofuel support policies
Agricultural outlook

• The *OECD-FAO Agricultural Outlook* provides a 10 year projection of prices, production, consumption and trade for international and domestic commodity markets.

• The Outlook is a consensus projection based on a global partial equilibrium model.

• The model approach allows scenario analysis with respect to key variables impacting agricultural markets.
Baseline projections

Agriculture in Tanzania:
• Low productivity, poor rural infrastructure
• Population and income growth drive the sector

No biofuel sector

2008 – 2017:
• Maize, cassava and rice continue to dominate production and food consumption
• Growing reliance on imports for wheat and vegetable oil
• Persistent low consumption of meat and dairy
Scenario simulations 1

Baseline – No biofuel

Ethanol
Sugar cane
Cassava
10% blend
80 mill ltr.

Biodiesel
5% blend
50 mill ltr.
Palm oil
Jatropha

Scenario 1 – No land expansion
Scenario 1
Biofuel mandates – no land expansion

• Small feedstock use by biofuel sector → compensated through imports or productivity improvements to maintain food use
• Net importer of sugar and vegetable oils → additional imports
• Self-sufficient in cassava, only small amount of current production required → yield increase
• No jatropha yet → new planting of 27 tha

Biofuel mandates require productivity improvements to avoid import expansions
Scenario simulations 2

Baseline – No biofuel

Ethanol
- Sugar cane
- Cassava
- 10% blend 80 mill ltr.

Biodiesel
- 5% blend 50 mill ltr.
- Palm oil Jatropha

Scenario 1 – No land expansion
- 66 tha sugar cane
- 100 tha cassava

Scenario 2 – Land expansion
- 22 tha oil palm
- 126 tha jatropha
Scenario 2
Biofuel mandate – land expansion

• Biofuel production exceeds domestic demand and permits entry into global biofuel markets
  • *Ethanol*: 800 million litres (2017)
  • *Biodiesel*: 700 million litres (2017)

• No impact on supply and demand of food

• Global biofuel market situation, crude oil price, foreign and international biofuel policies (e.g. EBA Initiative, EU blending rates) become relevant drivers
Scenario simulations 3

Baseline – No biofuel

Ethanol
Sugar cane
Cassava
10% blend
80 mill ltr.

Biodiesel
5% blend
50 mill ltr.
Palm oil
Jatropha

Scenario 1 – No land expansion

Scenario 2 – Land expansion

66 tha sugar cane
100 tha cassava

Scenario 3 – Land expansion +
30% lower oil price
OECD Study

22 tha oil palm
126 tha jatropha
Concluding remarks

• Biofuels present opportunities and challenges
• Domestic mandates could be supplied without compromising national food security
• Large-scale biofuel production would be export oriented - linked to oil prices and international policies
• Agricultural sector needs investments into productivity to reduce undernourishment and to utilize the biofuel potential as an emerging source of income
• In its current state of productivity and market development, agriculture should focus on food supply; careful development of a biofuel sector could have complementary benefits
Land and Crop Production Assessment
Component 2 of BEFS AF

Key questions

• Which bioenergy crops should be grown?
• Where best to grow them?
• Is there enough suitable land to fulfil mandates?
• How much can be produced?
• Can productivity be increased?
• Which are the risks and opportunities?
Suitable land

CASSAVA - Low input level
- Tillage-based
  - Max attain. yield 3.7 tons/ha (dry)

CASSAVA - High input level
- Tillage-based
  - Max attain. yield 15 tons/ha (dry)

Conservation Agriculture
- Max attain. yield 4.7 tons/ha (dry)

Conservation Agriculture
- Max attain. yield 17.2 tons/ha (dry)

Cost matters!

Suitability Index
- High (> 60%)
- Moderate (40-60%)
- Marginal (< 40%)
- Not Suitable
- Water
But....
Available suitable land

CASSAVA - Low input level

Tillage-based
max attain. yield 3.7 tons/ha (dry)

Conservation Agriculture
max attain. yield 4.7 tons/ha (dry)

CASSAVA - High input level

Tillage-based
max attain. yield 15 tons/ha (dry)

Conservation Agriculture
max attain. yield 17.2 tons/ha (dry)

Suitability Index
- High (> 60%)
- Moderate (40-60%)
- Marginal (< 40%)
- Not Suitable or Excluded
- Water
Potential area and production for cassava

Biofuel mandates: small displacement of cassava food use

- There is land already under cassava where productivity could be improved limiting the effects on food security

- Targeted policy intervention/support should be oriented in north-western and south-eastern part of the country

Export scenario: 100,000 ha of land expansion under cassava

- It is feasible under all four configurations

- Particular attention should be paid to potential conflict with pastoral activities
But what else should be said....

Cropping zones

Infrastructure

Malnutrition
Concluding remarks

• Cassava, sunflower and sweet sorghum have the greatest potential. Very limited potential for sugar cane and palm oil under rainfed condition.

• Initiatives to sustainably improve the productivity should be prioritized through R&D, extension services and incentives to farmers.

• Best practices in agricultural management could improve productivity, and favour long-term sustainable use of the natural resources

• Poor infrastructure is currently a constraint
Techno-economic analysis on the production of biofuels: A “social” Dimension
Component 3 of the BEFS AF

Key Questions:

Once suitable areas have been identified, then the questions are: ....

- Can biofuels be produced profitably?

- Can biofuels be profitable with smallholders participation?
The Analysis

- Total of 13 scenarios studied for ethanol and biodiesel with different crops:
  - Ethanol: 4 sugarcane, 2 molasses, 3 cassava
  - Biodiesel: 1 palm oil and 3 jatropha

Who provides Feedstock?
- Smallholder
- Combined Smallholder: Commercial
- Cassava

How is industrial operation?
- Ethanol only

What is production scale?
- 53 mill liter
- 53 mil liter
- 101 mil liter

Scenario
- A
- B
- C
Example of Results
Ethanol-cassava production costs

Under recommended technology, it does not include co-product credits

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Ethanol from cassava</th>
<th>0.37-0.47 USD/litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallholder Only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>Dried</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>Smallholder &amp; commercial 40:60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dried</td>
<td>0.37</td>
<td></td>
</tr>
</tbody>
</table>
None of the estimates include profit margin.
Concluding remarks

Human capital
• Development of human capital to service new industry

Production capabilities
• Agricultural side:
  ➢ Increase yield in agricultural production
  ➢ Technical and institutional support to smallholders
• Industrial side: market development for byproducts

Explore policy interventions including:
• Introducing regulations to “jump start” domestic biofuel industry
• Special incentives/support for integrating smallholders
Biofuels, poverty and growth
Component 4 of the BEFS AF

• Will establishing a biofuels sector stimulate economic growth?

• Which feedstock is the most effective at generating national economic growth and poverty reduction?

• What is the preferred combination of large-scale estate and small-scale outgrower schemes?

• How do the benefits of biofuels change under intensive and extensive production strategies?
Summary of results

• Both large-scale and small-scale biofuel production approaches stimulate economic growth (GDP)

• All production options reduce poverty, but small-scale outgrower approaches are most pro-poor

• Cassava is most pro-poor under low tech options

• There is little evidence of a food vs. biofuel trade-off

• Rather it is non-biofuel export crops that will be displaced by new biofuels exports
1. Biofuels production options

Alternatives considered

• Ethanol production using sugarcane or cassava
  – Different estimated production efficiencies and costs

• Smallholder outgrower vs. large estates/plantations
  – Outgrower schemes have lower yields and use more labor and less capital

• Increase feedstock productivity versus expanding harvested land area
  – No additional land is needed for intensive production strategy
  – BUT extensification displaces land that is currently used for food and non-biofuel export crops
1. Biofuels production options
Modeled scenarios

- All scenarios produce 3mil. liters of ethanol per day
- Differ according to production technologies/strategies
  - Feedstock; scale of production; intensive/extensive
  - Assume half of feedstock is on land already used for crops

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Scale of feedstock production</th>
<th>Feedstock yield level</th>
<th>Land expansion (% land displaced)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar 1</td>
<td>Small</td>
<td>43 mt/ha</td>
<td>50%</td>
</tr>
<tr>
<td>Sugar 2</td>
<td>Large</td>
<td>84 mt/ha</td>
<td>50%</td>
</tr>
<tr>
<td>Sugar 3</td>
<td>Small</td>
<td>70 mt/ha</td>
<td>-</td>
</tr>
<tr>
<td>Cassava 1</td>
<td>Small</td>
<td>10 mt/ha</td>
<td>50%</td>
</tr>
<tr>
<td>Cassava 2</td>
<td>Small</td>
<td>20 mt/ha</td>
<td>-</td>
</tr>
</tbody>
</table>

- Small-scale low yield
- Large-scale low yield
- Small-scale high yield
- Small-scale high yield
2. Economywide framework
Simulating biofuels expansion

- Jointly model feedstock and downstream processing
  - Sectors start small and are expanded by injecting FDI
  - All profits are repatriated

- Biofuels sectors compete for land, labor, and other intermediate inputs

- All biofuels are exported
  - Equivalent to reducing expenditures on fuel imports
3. Results
Economic growth, 2007-2015

- Overall GDP growth rate increases (0.3%-0.4% p.a.)
- Large increase in biofuel exports
- Exchange rate appreciates, reducing non-biofuel export crops’ competitiveness
- Food crops expand as non-biofuel exports release land and labor
- Industry expands due to biofuels processing
3. Results
Agricultural land use, 2007-2015

• Smallholders have lower yields and so need more feedstock land than large-scale farmers

• Cassava needs more new land and displaces more existing crops

• Intensive feedstock strategies eliminate need for new lands
3. Results
Household incomes and poverty, 2007-2015

- Biofuels reduce the national poverty headcount rate by 1.1 - 2.4% depending on scenario
- This is as many as 0.9m people lifted out of poverty
- Outgrower schemes and cassava are more pro-poor
- Both rural and urban poverty declines
4. Key messages
Policy implications

• Large-scale sugarcane production is better than small-scale at increasing economic growth (GDP)
  – BUT intensive small-scale strategies still generate growth

• All production options reduce poverty
  – BUT small-scale outgrower approaches are most pro-poor

• Cassava is most pro-poor under low tech options
  – BUT sugarcane is as pro-poor under intensive strategies

• There is unlikely to be a food vs. biofuel trade-off
  – RATHER export crops are displaced by exchange rate effects
  – BUT this is a medium-term assessment - there may be short-term adjustment costs
Changes in food prices and the impacts
Component 4 of the BEFS AF

- Food prices can change because of international and domestic supply and demand shocks
  - This can also include changes in biofuel demand
- Key issue:
  - How does the price change impact households?
  - Are any groups vulnerable?
The food security crops

- **Food security commodities:**
  Selected based on calorie consumption data.
  Main focus on **Maize** and **Cassava**
Maize and cassava: Price trends

- World and domestic maize prices are linked
- Cassava and maize prices are linked

...maize and cassava market are interlinked

<table>
<thead>
<tr>
<th>Commodity and Marketing Level</th>
<th>Domestic Retail Fresh Cassava</th>
<th>Domestic Retail Dried Cassava</th>
<th>Domestic Maize Wholesale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Percent change between 2003 - 2008</td>
<td>+50%</td>
<td>+42%</td>
<td>+44%</td>
</tr>
</tbody>
</table>

Source: Ministry of Trade, Calculations by the authors
Household impacts and the household dataset in Tanzania

- The resulting change in food prices affects households
  - Net consumers: Those who buy more food than they sell will be hurt by higher prices
  - Net producers: Those who sell more food than they buy benefit from higher prices

....data....

- The household survey data:
  - 2003-2004 partial regional data set
  - total 2000 rural households from a poor region (Ruvuma) and less poor region (Kilimanjaro)
Household welfare impacts by quintile
Maize, Ruvuma

Assuming 10% producer price increase
Household welfare impacts by quintile
Maize and Cassava, Ruvuma

Assuming 10% producer price increase
Concluding remarks

• Policy conclusions cannot be drawn due to limited dataset, now to run the analysis for a country representative dataset
• To be integrated into country food security monitoring system
Key messages

- **Bioenergy** developments could be an important **catalyst** to spur **agricultural growth**

- **Food crops can be used** for bioenergy production without hampering food security

- Involving **smallholders** in bioenergy development can be **economically feasible** and contributes to **poverty reduction**

- **For the above to happen**
  - policies that foster agriculture investment need to be in place
  - market development
  - mechanisms that guarantee benefits to smallholders
  - policies that safeguard food security
  - bioenergy development pathways need to be integrated into the current development agenda and strategies
In short...

From BEFS...

... Bioenergy per se is neither good nor bad, it depends on how you manage the system
FAO’s BEFS Project

Bioenergy and Food Security Project

www.fao.org/bioenergy/foodsecurity/befs
Thank you!

Heiner Thofern, NRC
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