Partnership for RTB post-harvest project

- CIAT
- IITA, ILRI
- CIRAD
- NRI
- Univalle (Colombia)
- Kasetsart University, KMUTT (Thailand)
- Clayuca

Started 2013:
Complementary funding RTB Post-harvest project
RTBs are processed at large and small scales.

- Nigeria 0.3t gari/day
- Nigeria 2t HQCF/day
- Colombia 2-3t starch/day
- Paraguay 25-100t starch/day
- Tanzania 2t HQCF /day
- Vietnam 3-11t starch/day
- Thailand 200t starch/day
Thailand produces 2-3 million tons cassava starch/year

25-30 million tons cassava roots / year (3rd producer)

10-12 millions tons roots processed into starch

Factories use:
Electricity: 900 - 1000 MJ/t starch
Thermal energy: 1600 - 2500 MJ/t starch

Since 2004, 90% of factories switched from fuel oil to biogas for starch drying
Typical factory 200t starch/24 hours, 9-12 months/year
Cassava starch production

Washing and peeling

Rasping

Cassava roots 600-800 t/day

Photos: G. Da, T. Tran
Cassava starch production

Extraction - centrifugation

Drying

Dry starch 150-200 t/day

Photos: G. Da, T. Tran
By-products

Peels → Sun-drying → Compost Fuel

Fibres (50% fibre / 50% starch db) → Drying → Animal feed

Photos: T. Tran
Wastewater

Open lagoon

Covered lagoon for Biogas

Biogas

Open lagoon

Photos: T. Tran
4 steps of Life Cycle Assessment (LCA)

- System definition (boundaries, function…)
- Inputs / outputs inventory
- Assessment of impacts
- Interpretation
System boundaries: Cradle to factory gate

Objective: Assess the reduction of Carbon footprint of cassava starch by biogas technology

- Boundaries: Farming to factory gate
- Functional unit: 1 ton of starch with 13% water
## Life cycle inventory

<table>
<thead>
<tr>
<th>Life cycle stages</th>
<th>Source of Data</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Primary Data</td>
<td>Secondary Data</td>
<td></td>
</tr>
<tr>
<td>Cassava farming</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Transportation of cassava root and other materials</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cassava starch processing</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

**3 factories**

**LCIA: Carbon footprint method of TGO; IPCC**
Equivalences for the Fuel oil scenario

**FUEL OIL**
- Biogas for starch drying: 49, 130, 61 m³/FU (F1, F2, F3 resp.)
- Heating values of biogas: 21, 19, 23 MJ/m³ (F1, F2, F3 resp.)
- Heating value of fuel oil: 40 MJ/L
  ➔ Fuel oil replaces biogas (MJ for MJ)

**ELECTRICITY**
- Factories 1 and 3 generate electricity from biogas
  ➔ Grid electricity replaces biogas electricity (kWh for kWh)

**WASTEWATER**
- Wastewater contains organic matter (COD), which ferments and releases methane (CH₄).
  ➔ Methane emitted to atmosphere replaces methane captured for biogas production.
Biogas reduces GHG emissions

Factory 1

- Less fuel oil
- Less grid electricity
- Much less CH₄ emissions

Factory 2

Savings:
430 - 660 kg CO₂eq/t starch
26000 - 40000 t CO₂eq/year/factory
Carbon footprint of cassava starch: 599kg CO$_2$eq/t starch

60% come from farming: 359kg CO$_2$eq/t starch

→ High sensitivity of farming practices

Farming practices vary by a factor 7!
95 farms surveyed (50 km radius):

10 farms with lowest inputs:
134kg CO$_2$eq/t starch

10 farms with highest inputs:
939kg CO$_2$eq/t starch

→ Check the representativeness of the farms surveyed

Nguyen 2007:
204kg CO$_2$eq/t starch

Soni et al. 2013:
177kg CO$_2$eq/t starch
1000 kg starch @ 13%mc
→ 100% of total weight
→ CF = 599 kg CO₂eq/t starch
Allocation between products

Cassava roots

Starch

Pulp

1000 kg starch @ 13% mc
→ 36% of total weight
→ CF = 215 kg CO₂ eq/t starch

1785 kg pulp @ 75% mc
→ 64% of total weight
→ CF = 384 kg CO₂ eq/t starch

870 kg dry matter
→ 66% of total weight
→ CF = 396 kg CO₂ eq/t starch

446 kg dry matter
→ 34% of total weight
→ CF = 203 kg CO₂ eq/t starch

Total CF

599 kg CO₂ eq/t starch
Conclusions

Biogas reduced carbon footprint of cassava starch by 31-42%.

Savings:

26000 - 40000 t CO$_2$eq/year per factory
2.5 - 3.0 million tons CO$_2$eq/year at country level

CF:
600 - 960 kg CO$_2$eq/t starch

Thailand – Europe flight:
1600 kg CO$_2$eq

Variability of carbon footprint:
- Variability of fertilizer use
- Choice of allocation method
Contributors and donors

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Equipment manufacturers and cassava starch factories in Thailand
Thank you
Thank you

BILL & MELINDA GATES foundation