Project on Converting Waste Agricultural Biomass into an Energy/Material Source

Monaragala & Buttala DS Divisions
Monaragala District
Sri Lanka

Overview
Project Areas: 2 of the Divisional Secretariat (DS) divisions of the Monaragala district
• Monaragala DS division
  – Situated in the centre of the Monaragala District
  – Area of 255 km$^2$
  – Main Administrative Centre for the District.
  – Population: 50,018

• The Buttala DS division
  – Situated south of the Monaragala DS
  – 685 km$^2$ in area.
  – Population: 44,874

• Reasons for selection
  – Large quantities of waste agriculture biomass generated
  – High poverty level is considerably high
  – High untapped natural resources
Baseline Data
# Generation Vs. Availability of WAB

<table>
<thead>
<tr>
<th>Type</th>
<th>WAB Generation (Tons/Yr)</th>
<th>WAB Consumed (Tons/Yr)</th>
<th>WAB Available (Tons/Yr)</th>
<th>Period of Availability</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy Husk</td>
<td>7,106</td>
<td>4,308</td>
<td>2,798</td>
<td>6 to 12 months</td>
<td>40%</td>
</tr>
<tr>
<td>Banana</td>
<td>4,500</td>
<td>0</td>
<td>4,500</td>
<td>12 months</td>
<td>100%</td>
</tr>
<tr>
<td>Market Waste</td>
<td>544</td>
<td>0</td>
<td>544</td>
<td>12 months</td>
<td>100%</td>
</tr>
</tbody>
</table>
Future Generation for Paddy Husk

Maha Period: September - March
Yala Period: May August
Future Availability of Paddy Husk

![Graph showing the future availability of paddy husk from 2005 to 2030. The graph includes lines for Maha, Yala, and Total availability, with the total availability expected to increase over time.]
UNEP Guidelines

Quantification
Characterization

Current Waste Management System & Gaps Therein

Stakeholder Issues of Concern and Constraints

Technology Selection Through SAT Methodology
- Issues of Concern and Targets
- Initial Screening of Applicable Technologies
- Detailed Screening
- Scoping
- Ranking

Selection of Pilot Project
Preparation of Project Plan

Implementation
# Technology Description

<table>
<thead>
<tr>
<th>Rank</th>
<th>Technology Description</th>
<th>Residue/Waste</th>
<th>Application</th>
<th>Process / Technology</th>
<th>Equipment Description</th>
<th>Capacity</th>
<th>Performance</th>
<th>Installation Cost (Approx. USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N</td>
<td>Rejected/ Waste Banana Fruits</td>
<td>Electricity Generation</td>
<td>Anaerobic digestion of waste / Biogas generation</td>
<td>Biogas digester (Continuous type) / Internal combustion engine</td>
<td>1 t/day of waste input Plant capacity : 4 kWe Biogas yield : 95 m³/day, Electricity generation : 125 kWh/day</td>
<td>Energy conversion efficiency ; Digester : 13.5%, Engine : 20%</td>
<td>22,000</td>
</tr>
<tr>
<td>2</td>
<td>E</td>
<td>Paddy Husk</td>
<td>Process Heat Generation for vegetable / fruit drying</td>
<td>Direct combustion / Indirect heating</td>
<td>Paddy husk stove coupled to tray dryer</td>
<td>Product Input : 100 kg/batch, Drying time : 12 to 18 hr, Fuel input : 54 kg/load, Fuel input rate : 3 kg/hr; Stove capacity : 8kWth</td>
<td>Energy conversion efficiency; Drying : 40%, Stove : 65%</td>
<td>4,000</td>
</tr>
<tr>
<td>3</td>
<td>D</td>
<td>Paddy Husk</td>
<td>Process Heat Generation for smoking/drying lime fruits</td>
<td>Direct combustion / Direct heating</td>
<td>Paddy husk stove coupled to tray dryer</td>
<td>Product Input : 200 kg/batch, Drying time : 36 hr, Fuel input : 72 kg/load, Fuel input rate : 2 kg/hr; Stove capacity : 5 kWth</td>
<td>Energy conversion efficiency; Drying : 60%, Stove : 65%</td>
<td>5,300</td>
</tr>
<tr>
<td>4</td>
<td>L</td>
<td>Market Waste (Fruit and Vegetables)</td>
<td>Cooking and Lighting</td>
<td>Anaerobic digestion of waste / Biogas Generation</td>
<td>Biogas digester (Continuous type)</td>
<td>500 kg/day of waste input; Tank volume: 60 m³, Biogas yield : 47 m³/day</td>
<td>Sufficient for cooking and lighting for 15 families</td>
<td>8,000</td>
</tr>
</tbody>
</table>
Schematic Diagram of Paddy Husk Fired Indirect Heating Dryer (not to scale).
Design Parameters

- Requirement: Dry/Dehydrate vegetable/fruit products.
- The initial and final properties of the product vary from type to type, but for the system sizing, following design parameters are selected:
  - Capacity: 100 kg of fresh product/load
  - Initial Moisture Content: 85% on wet basis
  - Final Moisture Content: 10% on wet basis
  - Efficiency of Drying: 40%
  - Efficiency of Heat generation: 64%
  - Drying Time: 18 hrs
  - Calorific value of Paddy husk: 14 MJ/kg (@ 10% moisture level)
Based on the above data, following parameters could be estimated:

- Heat Rate into the drying chamber: 7.5 kWth
- Fuel consumption: 3.0 kg/hr
- Total Fuel Requirement: 54 kg/load

During the drying period of 18 hrs, it is assumed that two stoves operate simultaneously for 9 hrs and recharge once. Therefore the fuel load per charge per stove is 13 kg.

The total electricity requirement for the plant is 338 W (air supply and circulation).
Paddy Husk Stove

Fuel weight per load: 13 kg (paddy husk)
Fuel weight per batch: 52 kg
Fuel consumption: 2.89 kg/hr
Heat Exchanger and Exhaust System

- **Temp of flue gas**: 900°C
- **Flue gas Temp. at outlet**: 150°C
- **Overall Efficiency**: 64%
- **Total heat transfer area required**: 2.15 m²
- **Mean temperature rise of air**: 40 deg C
- **Dimensions of a tube**: 1.0 m length, 50.8 mm diameter
- **Number of tubes required**: 13
- **Fuel rate (52 kg per 18 hrs)**: 2.89 kg of paddy husk/hr
Drying Chamber (Efficiency 39%)

Three air circulation fans (capacity 0.3 $m^3/s$) mounted within and between the two compartments to enhance air circulation and moisture evaporation.

Two equal compartments of size 1.2 m wide, 1.25 m tall and 1.0 m long each.

Each compartment accommodates 16 trays

Overall dimensions : 1.2 m wide, 1.25 m tall and 2.0 m long
• Fabrication and Construction costs - Rs. 450,000/- (USD 4,000)
• Total annual variable cost - Rs 570,636/- (USD 5,000)
• Estimated annual income - Rs.751,500/- (USD 6,700)
• Lifetime of the dryer: 10 years
• Cost of capital: 18%
• Annual selling price increment: 5%
• Annual cost increment: 7%
Inputs from Discussions

• Analysis of impacts, benefits and costs for the three scenarios
  – If husk is not used and is dumped/burnt
  – Husk used in the existing technology
  – Husk used for the proposed technology
• Policy issues that can impact the implementation as well as the sustainability of the project
• Investigate the transportation and collection costs for the husk (distances)
• Financial payback need not be a major concern as this is a pilot project
Thank You