Zero Waste Agriculture for Jatropha Plantation

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THAILAND

• zero waste philosophy
• Example of MTEC initiatives projects on Utilization of Jatropha Biomass
  1. Plantation / Acidic Soil
  2. Oil extraction
  3. Biodiesel from Jatropha oil
  4. Utilisation of glycerol by product of BDF process
  5. Jatropha biomass gasification to syn-gas
     BTL synthesis liquid fuels by Fischer-Tropsch synthesis
  6. Other value-added products: feed, particle board, hand made paper and compost
• Conclusion
• Kasetsart University: KU (Plantation & Value-added products)
• Thai Machinery Association: TMA (Oil extraction)
• Thailand Institute of Scientific Technological Research: TISTR (Biodiesel conversion)
• Prince Songkla University (Glycerol Utilisation)
• Chulalongkorn University: CU (Gasification)
• King Mongkut’s Institute of Technology North Bangkok: KMITNB (Fischer-Tropsch synthesis)
Zero waste is

“philosophy that aims to guide people in the redesign of their resource-use system with the aim of reducing waste to zero. Put simply zero waste is an idea to extend the current ideas of recycling to form a circular system where as much waste as possible is reused, similar to the way it is in nature”

---wikipedia
Biomass Community Project  2006-2008

Rangsit acidic soil area
(North-East of Bangkok)
Biomass from Jatropha plant

Leaves

Flower

Fruit

stem

Seeds and Shells

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A Driving Force for National Science and Technology Development Authority (NSTDA)

NSTDA
Biomass from 1 Jatropha tree in 1 Year

1 Jatropha plant

1 Kg. seed

3 Kg. shell

10 Kg. leaves

20 Kg. stem

Oil 250 cc.

Seed cake 750 g.

Dry shell 1 Kg.

Dry leaves 2.5 Kg.

Dry stem 5 Kg.

Biodiesel production

Power/electricity generation

Other value added products
2. Jatropha Oil Extraction & Pelletizing machine
Production of oil and solid fuel from Jatropha fruit

1. Jatropha Fruit → Shelling machine → Husk Cracking (Seed Separation) → Jatropha Husk
2. Jatropha Seed → Oil Extraction → Jatropha Oil (Crude Oil)
3. Jatropha Seed → Pellet Compress → Jatropha Cake

Legend:
- Raw material
- Processing
- Product
- By-product

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Jatropha oil extraction machine

Experienced engineering work

Manual extraction → Motorized extraction

Agricultural communes
Jatropha oil extraction machine

**MANUAL EXTRACTION**
Cycle time approximately 2 mins

**MOTORISED EXTRACTION**
Single screw press oil expeller
(10-15 kg.(seed)/hour)

Jatropha oil extracted

Single screw press oil expeller (50-70 kg.(seed)/hour)
Training

เครื่องหีบสบู่แบบต่อเนื่องขนาดเล็ก

เครื่องหีบสบู่แบบต่อเนื่องขนาดกลาง

A Driving Force for National Science and Technology Capability
Pelletising Machines

- Pelletising Machines
- Seed cake
- Jatropha pellet
- Powder & Binder
3. Biodiesel from Jatropha oil
5 Steps of Biodiesel Production

1. Mix MeOH+NaOH with Jatropha @ 60 C, 1 hr

2. Remove Glycerol

3. Wash BD with water

4. Setting and remove waste water

5. Heat for remove water then move to BD storage tank
4. Utilization of Glycerol by-product of Biodiesel Production

1,3 Propanediol from Glycerol
Isolation and Selection of Microorganism Enable to Produce 1,3 Propanediol from Glycerol

1. isolate and identify bacterial strains for 1,3 propanediol production

2. select the best strain producing the highest 1,3 propanediol
5. Utilisation of Jatropha cake Solid Fuel for Biomass Gasification

BTL : Biomass To Liquid
Biomass Gasification Research at MTEC
### Gross specific energy in each Jatropha Biomass VS others biomass & fuel (ASTM D5865-02a)

<table>
<thead>
<tr>
<th>Biomass</th>
<th>Gross specific energy Kcal/Kg</th>
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</thead>
<tbody>
<tr>
<td>Seed cake</td>
<td>4,496</td>
</tr>
<tr>
<td>Shell</td>
<td>3,123</td>
</tr>
<tr>
<td>Leaves</td>
<td>3,624</td>
</tr>
<tr>
<td>Stem</td>
<td>3,932</td>
</tr>
<tr>
<td>Rice Husk</td>
<td>3,000</td>
</tr>
<tr>
<td>Palm Shell</td>
<td>4,200</td>
</tr>
<tr>
<td>coal</td>
<td>5,500</td>
</tr>
<tr>
<td>Heavy Oil</td>
<td>9,900</td>
</tr>
</tbody>
</table>

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Biomass to Syn-gas /Fuel Gas and to synthesis liquid fuel

4m- Pilot scale fluidized bed gasification

- Jatropha Biomass Feed
- Hopper/Feeder
- Gasifier
- Cyclone
- Condensers
- Bio-oil
- Fuel gas
- Burner
- Blower
- Stack
- Flue gas
- Steam
- Air
- Ash
- Fischer Tropsch synthesis
- Novel catalyst

GASIFICATION PROCESS DEVELOPMENT UNIT

MTEC & CU

- Biomass to Syn-gas Gasification
- Pyrolysis
- Catalytic Gas separation
- Catalytic gas upgrading
**Biomass to Syn-gas/Fuel Gas**

4m- Pilot scale fluidized bed gasification

Pilot scale swirling bed gasifier of 50 kW

MTEC & CU & KMITNB

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**Syn-gas to Synthesis Fuels**

**Fischer-Tropsch Synthesis Catalytic Rig**

Catalyst is selective forward to higher hydrocarbons (>C10)
6. Other Value-Added Products from Jatropha Biomass
Value added from branch and stem

stems from cutting propagation

Hand made paper & Particle board from stem

solid fuel
charcoal
### Macronutrient in each Jatropha parts

<table>
<thead>
<tr>
<th>Parts</th>
<th>Nitrogen (%)</th>
<th>Phosphorous (%)</th>
<th>Potassium (%)</th>
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</thead>
<tbody>
<tr>
<td>Stem and branch</td>
<td>0.50</td>
<td>0.25</td>
<td>1.74</td>
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<tr>
<td>Leaves</td>
<td>1.77</td>
<td>0.53</td>
<td>2.43</td>
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<tr>
<td>Shell</td>
<td>0.86</td>
<td>0.14</td>
<td>7.10</td>
</tr>
<tr>
<td>Cake</td>
<td>3.94</td>
<td>0.77</td>
<td>1.93</td>
</tr>
</tbody>
</table>

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Value added of Jatropha cake

Detoxificated cake

Organic fertilizer

Jatropha cake
Jatropha shell

Compost (stems/tops)

animal feed (after detoxification by steaming)
Conclusions

• Zero waste philosophy for jatropha plantation is demonstrated
• Plan to deploy biomass-to-bioenergy concept or Bio-refinery to Complete-Cycle Biodiesel Pilot Plant
• Plan to extend the concept to palm plantation in Rangsit acidic soil area
• Issues & Concern of Promotion Jatropha
Issues & Concern of Promotion Jatropha

- R&D in harvesting method to reduce harvesting cost
- R&D in new variety of non-toxic and machinability harvesting
- R&D in conversion toxic chemicals to pharmaceutical / cosmetic products
- Adding algae technology to reduce CO2 /GHG from gasifier and waste water treatment
Thank You for Your Attention

สวัสดีค่ะ