Biomass-based Bioenergy Investment for Poverty Reduction

Sununtar Setboonsarng
Principal Natural Resources and Agriculture Economist
Asian Development Bank
23 July 2014
Outline

• Energy and Food Security
• Energy input in agriculture
• Agriculture and Climate Change
• ADB program on Efficient Utilization of Biomass and Bioenergy and Food Security
Energy and Food Security

• 1.9 billion poor depend on traditional burning of biomass for energy
• Clean energy is essential for economic growth, particularly inclusive growth
• Over 1 billion poor are food insecure when food is foundation of life
• Rural population face both energy and food insecurity
Traditional Use of Biomass

- Environmental damage
  - deforestation
  - biodiversity reduction
  - damage to watersheds
- Serious air pollution
  - health risks for women and children
- Green house gas emission
Agriculture and Energy
Food and Oil Price

Food and Oil Prices are Correlated

FAO Food Price Index 100 = 2002-2004

Brent oil price in US$ per barrel

Food Price
Oil Price
Fossil Fuel Based Agriculture

• Conventional agriculture is fossil fuel based.
• The Green Revolution increased the energy flow to agriculture by an average of 50 to 100 times the energy input of traditional agriculture.
It takes an average of **7 to 10 calories of energy input** to produce one calorie of food.
# Energy in Agricultural Value Chain

<table>
<thead>
<tr>
<th>Input supply industry</th>
<th>Agricultural Production</th>
<th>Processing</th>
<th>Marketing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer Production</td>
<td>Tractors and machinery</td>
<td>Drying</td>
<td>Cooling</td>
</tr>
<tr>
<td>Crop protection</td>
<td>Irrigation</td>
<td>Cooling</td>
<td>Distribution</td>
</tr>
<tr>
<td>Fodder</td>
<td>Fertilizer</td>
<td>Storage</td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>Conservation agr.</td>
<td>Food and beverage processing</td>
<td></td>
</tr>
<tr>
<td>Livestock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protected Cropping</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Transport

- Machinery manufacturers, agrochemical, feed Industry
- Farmers, Cooperatives
- Small-scale processing, Agri-Food Industry
- Logistic companies, Wholesale and retail

Creative Commons Attribution-Share Alike 3.0
Agriculture and Climate Change
Green House Gas Contribution of Agriculture Sector

- **Production** ≈ 14%
- **Forestry** + **Burning of biomass** ≈ 35%
- **Transport** + **Agro-chemicals** ≈ >45%
Heat-Trapping Ability

- Carbon dioxide is baseline GHG
  - One unit of CO$_2$ = 1
- Methane is 25 times of CO$_2$*
- Nitrous oxide is 298 times of CO$_2$*
- Black carbon is 10,000 times of CO$_2$

*100-year Global Warming Potential (GWP) based on IPCC Assessment Report 2007 (AR4)
Increased use of Biomass for Energy

• Potential to undermine sustainable agriculture practices and thus food security
Importance of Biomass on Soil Quality

• Restores soil quality: increases soil fertility, improves soil structure and tilth, retains soil moisture, and enhances soil biodiversity

• Enriches soil organic carbon pool

• Reduces susceptibility to soil erosion and degradation
Food or Fuel?
Win-Win Strategies
Do Exist !!
Asian Development Bank and Program on Efficient Utilization of Biomass
ADB

- A multilateral development finance institution owned by 67 countries
- Active investments in economically sound projects for poverty reduction
- One of the few international financial institutions with “AAA” credit
- Provide long-term loans and guarantees under credit crunch
ADB’s Bioenergy-Food Security Policies

- Feedstock use is not a food crop,
- Land cannot be used for food crops,
- No deforestation is associated with development,
- Net energy balance is positive.
Greater Mekong Subregion Regional Cooperation Program

Sectors
1. Agriculture
2. Energy
3. Environment
4. Human Resource Development
5. Tourism
6. Trade and Transport Facilitation
Core Agriculture Support Program (CASP)

(2011-2020)

ADB
Vision

The Greater Mekong Subregion is recognized as the leading producer of safe food, using climate friendly agricultural practices and integrated into global markets through regional economic corridors.

Pillar 1: Food Safety Trade Modernization

Pillar 2: Climate Friendly Agriculture

Pillar 3: Bioenergy and Biomass Management

Agricultural Research and Development

Private Sector Involvement

Institutional Mechanisms for Regional Cooperation
Pillar 3: Promote Agriculture as Leader in Providing Rural Renewable Energy

- Regional bioenergy related standards e.g. biodigester, biochar, ICS…
- Promote biomass management for bioenergy and food security
- Promote FDI of eco-friendly supply chain for 3Ps: People, Planet, Profit
Abundant biomass residues in the GMS include: rice husk and rice straw, sugarcane and maize crop residues, crude palm oil waste, wood waste, and animal manure are currently underutilized.
Opportunities

• Reduce emission of Green House Gas (GHG) : N2O, methane, black carbon
• Absorb atmospheric carbon in soil
• Lower import bill for fossil fuel
• Lower cost of external inputs
• New employment opportunity
• …
Improved Utilization of Biomass can address several problems
Pathways

- Converting agricultural and forestry residues to energy and organic fertilizers, including biochar;
- Use of improved cook stoves to reduce fuel demand and reduce black carbon emissions
Biogas - Fuel for Cooking

Methane burned in kitchen to carbon dioxide
Carbon dioxide released to the atmosphere
Manure

Methane generated in biogas generator
Carbon dioxide absorbed by plants through photosynthesis

http://www.inverter-china.com/blog/articles/green-energy/what-is-biogas.html
http://www.nbp.org.kh/gallery.php
Biogas – Electricity for Lighting

Aussie Andrew Williamson from the Dutch SNV, and Bounthavy Sengtakoun, his Laotian compatriot, examine a biogas lamp in Laos. This house has electricity but biogas is cheaper. A biogas lamp, similar to an LPG camping lantern, can cost anywhere from US$3 to US$15 depending on quality.

http://www.michaelyon-online.com/gobar-gas-ii/page-3.htm
Bioslurry – as Organic Fertilizer

Extension worker monitor experimental plot

Farmer showing the effect of slurry
Biochar for Energy and for Carbon Sequestration

- Biochar (charcoal from biomass) is produced by baking biomass at about 320-500ºC under low or no oxygen (pyrolysis).
- The combustion process releases gas or oil as clean renewable energy.
- Biochar remains stable in soils for hundreds to thousands of years.

FAO (2009)
Effects of Biochar
Improved Cook Stoves

GERES Programme in Cambodia – earning carbon credit from New Lao stoves

- 2 million improved cook stoves were distributed between 2003-2013, corresponding to savings of over 1,200,000 tons of fuelwood


Bioenergy Potential

Cambodia: 24 provinces, 2013
- Rice husk = 1,765,279 t
- Rice straw = 26,199,708 t

Lao PDR: 18 provinces, 2011
- Rice husk = 545,000 t
- Rice straw = 2,529,000 t

Viet Nam: 2 districts, 2013
(Ung Hoa & Ha Hoa)
- Rice husk = 171,395 t
- Rice straw = 34,279 t
Lao PDR: Bioassessment of Crops

<table>
<thead>
<tr>
<th>CROPS ('000 T)</th>
<th>RICE</th>
<th>MAIZE</th>
<th>CASSAVA</th>
<th>SUGARCANE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>259.3</td>
<td>25.9</td>
<td>59.8</td>
<td>1.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Harvesting</th>
<th>STRAW</th>
<th>HUSK</th>
<th>BRAN</th>
<th>STALKS</th>
<th>COB</th>
<th>HUSK</th>
<th>STALKS</th>
<th>TOPS</th>
<th>BAGASSE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>259.3</td>
<td>51.8</td>
<td>28.5</td>
<td>51.9</td>
<td>7.1</td>
<td>5.2</td>
<td>3.7</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy Extraction</th>
<th>POTENTIAL ENERGY (10^6 GJ)</th>
<th>RICE</th>
<th>MAIZE</th>
<th>CASSAVA</th>
<th>SUGARCANE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3.63</td>
<td>0.67</td>
<td>0.88</td>
<td>0.12</td>
</tr>
</tbody>
</table>

VTE Province, Lao PDR, 2012-13

GREATER MEKONG SUBREGION
CORE AGRICULTURE SUPPORT PROGRAM
## Lao PDR: Bioassessment of Animal Waste

<table>
<thead>
<tr>
<th>VTE Province, Lao PDR, 2012-13</th>
<th>LIVESTOCK ('000)</th>
<th>MANURE ('000 T)</th>
<th>POTENTIAL ENERGY (10^6 Gj)</th>
<th>BIO-SLURRY ('000 m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PIGS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>125.9</td>
<td>138.4</td>
<td>2.34</td>
<td>147.6</td>
</tr>
<tr>
<td></td>
<td>CATTLE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>189.4</td>
<td>833.5</td>
<td>13.5</td>
<td>889.0</td>
</tr>
<tr>
<td></td>
<td>CHICKENS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2,177.5</td>
<td>43.5</td>
<td>0.69</td>
<td>46.4</td>
</tr>
<tr>
<td></td>
<td>BUFFALO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>71.5</td>
<td>457.7</td>
<td>7.41</td>
<td>488.2</td>
</tr>
</tbody>
</table>
Feasibility Studies on Pilot Investments

• Cambodia: Demonstrating Biochar Production and Use
• Cambodia: Biogas Technology and Efficient Bioslurry Management Practices
• Cambodia: Adoption of Improved Cook Stoves
• Viet Nam: Use of Biochar from Rice Husks in Climate-Friendly Rice Production
• Viet Nam: Efficient Bioslurry Management Practices within the Viet Nam National Biogas Program
• Viet Nam: Improved Cookstove Use
Cambodia: Biochar Production and Use

Provinces covered: Takeo and Kampot
• A minimum of 20% biochar from rice residue can produce 5.6 mt biochar and 3.4 million kWh net electricity
• Pilot demonstration introduced biochar as soil amendment ➔ rice husk biochar increased yields of grain and straw by 30% and 40% respectively
Cambodia: Biogas Technology & Efficient Bioslurry Mgmt

- Provinces covered: Takeo (Tramkak) & Samroang
- Biodigester users can save around $10/month and on chemical fertilizer by reducing 2 bags around $50/month
## Cambodia: Improved Cookstoves

Locations: Kampong Thom and Kandal

<table>
<thead>
<tr>
<th>District</th>
<th>S'Ang district, Kandal province</th>
<th>Sandan district, Kompong Thom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>41,515 households</td>
<td>10,862 households</td>
</tr>
<tr>
<td>N of Communes</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>No of selected communes</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Name of Selected communes</td>
<td>KrangYov, PreaekKoy</td>
<td>Tumring, Mean Rith</td>
</tr>
<tr>
<td>Poverty rate</td>
<td>KrangYov (18.8%), PreaekKoy (10.7%)</td>
<td>Tumring (31.6%), Mean Rith (33.7%)</td>
</tr>
<tr>
<td>Population</td>
<td>KrangYov (3,723 hhs) Preaek Koy (2,869 hhs)</td>
<td>Tumring (1,123 hhs), Mean Rith (1,346 hhs)</td>
</tr>
</tbody>
</table>

Source: CDB online 2010
Viet Nam: Use of Biochar from Rice Husks

Cost and Income from Brick Production with Rice Husk
(For 120,000 brick) - An Giang Oct 2013

<table>
<thead>
<tr>
<th>Expenditure</th>
<th>Unit</th>
<th>Quantity</th>
<th>Price unit</th>
<th>Cost and income (VND)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production cost</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unheating brick</td>
<td>Individual</td>
<td>120.000</td>
<td>250</td>
<td>30.000.000</td>
</tr>
<tr>
<td>Rice husk</td>
<td>Ton</td>
<td>24</td>
<td>500.000</td>
<td>12.000.000</td>
</tr>
<tr>
<td>Labour cost for loading brick</td>
<td>Labour day</td>
<td>15</td>
<td>200.000</td>
<td>3.000.000</td>
</tr>
<tr>
<td>Labour cost for husk supplying</td>
<td>Labour day</td>
<td>10</td>
<td>200.000</td>
<td>2.000.000</td>
</tr>
<tr>
<td>Labour cost for unloading</td>
<td>Labour day</td>
<td>15</td>
<td>200.000</td>
<td>3.000.000</td>
</tr>
<tr>
<td>Cost for transportation</td>
<td>Labour day</td>
<td>10</td>
<td>200.000</td>
<td>2.000.000</td>
</tr>
<tr>
<td>Tax</td>
<td></td>
<td></td>
<td></td>
<td>2.000.000</td>
</tr>
<tr>
<td><strong>Total cost</strong></td>
<td></td>
<td></td>
<td></td>
<td>54.000.000</td>
</tr>
<tr>
<td><strong>Income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brick selling</td>
<td>Individual</td>
<td>120.000</td>
<td>500</td>
<td>60.000.000</td>
</tr>
<tr>
<td>Benefit</td>
<td></td>
<td></td>
<td></td>
<td>6.000.000</td>
</tr>
</tbody>
</table>
Viet Nam: Efficient Bioslurry Management Practices

Location: Tam Xa commune, Dong Anh District, Hanoi

Investment activities

• Research and Analysis for construction of biogas use of bioslurry for compost, fertilizer
• Use of bioslurry for crop
• Use bioslurry for fishponds
• Capacity building and training for enhanced knowledge and technology development and transfer systems
## Viet Nam: Improved Cookstove

### ESTIMATION OF BIOMASS AVAILABILITY VS COOKING NEEDS IN UNG HOA DISTRICT, HANOI

<table>
<thead>
<tr>
<th>Biomass source</th>
<th>Heat value (GJ/ton)</th>
<th>Available biomass for cooking &amp; burnt out</th>
<th>Unit</th>
<th>No of residents can cook, 1.3 kg firewood/person</th>
<th>No of households can cook with additional purposes, 7.7 kg firewood/household</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice straw</td>
<td>14.6</td>
<td>105,888</td>
<td>ton</td>
<td>210,200</td>
<td>35,488</td>
</tr>
<tr>
<td>Rice husk</td>
<td>14.4</td>
<td>21,446</td>
<td>ton</td>
<td>41,989</td>
<td>7,089</td>
</tr>
<tr>
<td>Corn stalk &amp; leave</td>
<td>14.7</td>
<td>7,320</td>
<td>ton</td>
<td>14,631</td>
<td>2,470</td>
</tr>
<tr>
<td>Corn cob</td>
<td>15.4</td>
<td>3,050</td>
<td>ton</td>
<td>6,386</td>
<td>1,078</td>
</tr>
<tr>
<td>Firewood</td>
<td>15.5</td>
<td>704</td>
<td>ton</td>
<td>1,483</td>
<td>250</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>138,408</strong></td>
<td>ton</td>
<td><strong>274,689</strong></td>
<td><strong>46,376</strong></td>
</tr>
<tr>
<td><strong>No of residents and households</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>198,000</strong></td>
<td><strong>56,788</strong></td>
</tr>
<tr>
<td><strong>Coverage</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>139%</strong></td>
<td><strong>82%</strong></td>
</tr>
</tbody>
</table>
Using the Women’s Union to connect consumers to improved technologies in Lao PDR
Women’s Union in Lao PDR

• District level agreement to participate
• Receive training
  – Stove types and benefits, business planning, product demonstration and training on use
  – Stove producer agreement support
  – Sales and marketing training
• Receive initial inventory of stoves
• Undertake sales programs using revenues and margins to restock inventory
• Receive output based payment for achieving minimum sales targets
Stove Producers

- Supply and purchase agreement
- No subsidy price to women's union is negotiated between parties
- Potential to reduce number of buyers sharing some market risk with women's union

- Access to technical production grant for upgrading equipment
- Intensive stove production training for improved stoves

Future ??
- Possible cashflow assistance for transition between stove types
Vision – Strategy

Women’s Union to be an IA for future up scaling:

• Provision of technical and business support
• National or Provincial Women’s Union provides an output based (sales targets) financial incentive to district to reward participation
• Stove producer support program using a revolving fund available to producers with women’s union supply agreements
Biomass Conversion Technologies in Cambodia and Viet Nam
Biomass Conversion Technologies in Lao PDR
Studies on GMS Biofuels and Rural Renewable Energy

- Integrating Biofuel and Rural renewable Energy Production in Agriculture for Poverty Reduction in the GMS: An Overview and Strategic Framework for Biofuel Development
- Global and Regional Development and Impact of Biofuels: A Focus on the GMS
ADB’s investment in energy access increased year to year with a goal to connect modern energy to 100 million households by 2015.