Traditional Biomass Use and Improved Cook Stoves

WISER Workshop
Afghan Clean Energy Access

Shannon Cowlin

23 March 2010

Image source: Saluki times
What is traditional biomass use?

Use of biomass fuel in basic cook stoves

- Crop residues
- Wood
- Dung

Health issues also of concern with household coal use

2.4 billion people rely on traditional biomass use for cooking and heating

>95% of Afghans rely on solid fuels

Sources: WRI, IEA
Concerns with Traditional Biomass Use

Human health, Environmental Health, Gender Dimensions

Source: Practical Action

Source: NASA

Source: Matthew Logelin
Incomplete Combustion

\[ C_xH_yO_z + aO_2 = bCO_2 + cH_2O + \text{heat} \]

Incomplete Combustion

\[ C_xH_yO_z + aO_2 = bCO_2 + cCO + dCH_4 + \\
+ e\text{NMHC} + fH_2O + \text{soot/ash/char} + \text{heat} \]
Products of Incomplete Combustion

Carbon Monoxide (CO)
- colorless, odorless, toxic gas

Hydrocarbons (HC)
- CH$_4$, strong GWP
- Non-Methane HC

Particulate Matter (PM)
- Irritant
- Carcinogenic

Credit: D.M. Smith, University of Denver
### WHO Guidelines for PM (24-hr avg)

<table>
<thead>
<tr>
<th></th>
<th>$\text{PM}_{10}$ (μg/m$^3$)</th>
<th>$\text{PM}_{2.5}$ (μg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interim target-1</td>
<td>150</td>
<td>75</td>
</tr>
<tr>
<td>Interim target-2</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Interim target-3</td>
<td>75</td>
<td>37.5</td>
</tr>
<tr>
<td>Air quality Guideline</td>
<td>50</td>
<td>25</td>
</tr>
</tbody>
</table>

### Typical indoor concentrations in biomass burning homes
- 24-hour average $\text{PM}_{10}$ 300-3,000 μg/m$^3$
- Peak $\text{PM}_{10}$ concentrations up to 10,000 μg/m$^3$

**Rule of 1000:** a pollutant released indoors is 1000x more likely to reach a person’s lung than a pollutant released outdoors

*Source: WHO*
Health impacts of Indoor Air Pollution

Strongest Evidence

• Acute Lower Respiratory Infections (ALRI) in children
• Chronic Obstructive Pulmonary Disease (COPD) in women
• Lung Cancer (coal) in women

Moderate Evidence

• COPD in men
• Lung cancer (coal) in men
• Lung cancer (biomass) in women
• Asthma in women and children
• Cataracts
• Tuberculosis

Source: WHO
Efficiency: Mud stove burning wood

1-kg wood
15.1 MJ

Heat into pot
2.75 MJ
18.2%

Source: WHO

Adapted from Smith et al. 2000
Efficiency: Improved mud stove with chimney burning wood

Source: Hedon

1-kg wood
15.1 MJ

Heat into pot
3.6 MJ
23.5%

Adapted from Smith et al. 2000
Efficiency: Biogas Stove

Heat into pot
10.2 MJ
57.4%

1-kg biogas
17.7 MJ

Source: WWF

Adapted from Smith et al. 2000
Unsustainable biomass harvesting

Afghanistan provinces woodland: Takhar and Kunduz, 1977 and 2002

Legend
- National capital
- Administrative capital
- International border
- Province boundary
- Rivers
- Lakes
- Closed woodland (40% < woodland)
- Open woodland (20% < woodland < 40%)
- Sparse woodland (10% < woodland < 20%)
- Digital Elevation Model backdrop (GTOPO30)

About the map
Changes in forest cover and density derived from Landsat MSS and ETM+ satellite imagery.
Date of image acquisitions:
11 September 1977 and 12 September 1977 (MSS)
18 August 2002 and 22 September 2002 (ETM+)
Image processing: DIGITECH Intl.

UNOSAT
Satellite Imagery for All

UNEP
National Renewable Energy Laboratory
Innovation for Our Energy Future
Women’s Time

Hours spent and volume collected by sex in Ghana (1989), Tanzania (1989) and Zambia (1991)

Note: “Other” hours and “Other” volume include children’s collection of fuelwood and various combinations of men’s, women’s and children’s collection efforts.

Source: Maimberg Calvo 1994
Biomass use and Afghanistan Millennium Development Goals

Reduce Child Mortality
• “Most deaths among children under five years of age in Afghanistan result from vaccine preventable diseases, diarrhoea, and acute respiratory infections which together account for nearly 60% of deaths.”

Ensure Environmental Stability
• “Forest cover appears to have been cut in half since 1978 as a result of lack of energy alternatives to firewood”
Energy Ladder for Cooking

Increasing efficiency, cleanliness, and capital costs

Increasing Prosperity

Adapted from WHO, 2006
# Improved Cook Stoves: Why and How

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximize Efficiency</td>
<td>Improve Combustion Efficiency</td>
</tr>
<tr>
<td>Minimize Impacts on:</td>
<td>Improve Heat Transfer</td>
</tr>
<tr>
<td>Health</td>
<td>Vent Pollutants From Human Environment</td>
</tr>
<tr>
<td>Time</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td></td>
</tr>
</tbody>
</table>

Caution: *Enclosed stoves are not always better than 3-stone fire*
Design: Insulated Short Chimney

Insulate Around Fire
- Lightweight materials
- Keeps fire hot
- Reduces emissions

Short Chimney Over Flame
- Height = 3 x Diameter
- Flames reach smoke
- Pots placed above chimney

Source: Aprovecho
Burn Tips and Adjust Heat with Number of Sticks

Burn Only Tips
- Move wood tips into the fire as it burns
- Keep the rest of the wood cold

Adjust Heat With Number of Sticks
- Add more sticks for higher heat

Source: Aprovecho
Chimney stoves and Smoke Hoods

Chimney stoves must be precisely designed and cleaned regularly.

Smoke hoods are less sensitive to design but do not reduce fuel usage.

Source: Practical Action
Create a Draft

Strong draft keeps fire hot and reduces emissions

Too little draft increases smoke

Help maintain draft by

Create a grate for wood and fire

Create a constant area cross-sectional area for air flow

– Opening for wood
– Spaces within stove
– Exhaust chimney

Source: Aprovecho
Maximize Heat Transfer to Pot

Choose pots with large diameter to place over fire
Use a pot skirt
Submerge pot
Locally Manufactured vs. Commercial

Local Manufacture

• Enterprise opportunity for local artisans
• Maintenance likely if local repairs are possible
• Often less expensive

Commercial Models

• May perform more consistently if machine manufactured
• Often more expensive
• Repairs may be difficult without local service contractors
Fuel Switching: Gas Fuels

LPG & Biogas

- Cleaner burning
- Extra costs
  - Equipment
  - Fuel
- Unable to cook some traditional foods
Fuel Switching: Solar Cookers

Requirements
- Dark pot to absorb energy
- Heat trap (glass or plastic)
- Reflective surfaces to direct extra sun energy to pot

Challenges
- Time requirements
- Cooking traditional meals

Source: Solar Cooking International
Summary: Biomass Use & Improved Cook Stoves

Moving away from traditional biomass use benefits:

• Health
• Resources
• Women and children

Advanced technologies help but face challenges with:

• Costs
• Maintenance
• Changing traditions
For more information visit
www.hedon.info
www.aprovecho.net
www.who.int/indoorair/en/