Integrated Straw Management Solutions for South Asia

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Crop straw in South Asian countries

Crop Straw produced per year

- India - 500 MT
- Bangladesh - 50 MT
- Nepal - 10.5 MT
- Sri Lanka - 2.5 MT
Major Crops in south Asian countries

India-
- Rice,
- Wheat,
- Sugarcane
- etc.

Nepal-
- Rice,
- Maize
- etc.

Bangladesh-
- Rice,
- Maize
- etc.

(FAOSTAT, 2014)
# Distributions of main crop straw in South Asia

<table>
<thead>
<tr>
<th>Countries</th>
<th>Straw distribution regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Orissa, Bihar, Chhattisgarh, Tamil Nadu, Assam, Haryana, Madhya Pradesh, Bihar, Maharashtra, Rajasthan states</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Barisal, Chittagong, Khulna, Rajshahi and Rangpur Divisions</td>
</tr>
<tr>
<td>Nepal</td>
<td>Eastern, Western and Central regions</td>
</tr>
<tr>
<td>Shri Lanka</td>
<td>Anuradhapura, Kurunegala, Polonnaruwa, Hambantota, Ampara, Monaragala, Badulla, Matale, Puttalam and Trincomalee districts</td>
</tr>
</tbody>
</table>
Crop straw management pattern

- **Straw used as fertilizer**
  - Straw poorly utilized for fertilizer.
  - In India, crop straw left in field (15-20%) after harvesting is directly incorporated by ploughing.
  - Only 5-10% straw recycled back to the field as compost manure or as decomposed material.
  - Combine harvested paddy field, in-situ incorporation of straw using chopper, demonstrated in few fields since 3-4 years.
  - In other south Asian countries, situation almost same.
Crop straw management pattern contd..

- **Straw used as fodder**
  - Wheat straw and chopped maize stalk - most favoured fodder for animal in India and Nepal.
  - Paddy straw and maize stalk also used as fodder crop for animals
    - South, East and N-W parts of India
    - Almost all parts of Sri Lanka and Bangladesh
  - Ground nut and sorghum stalk - as fodder in Western and north-western parts of India.
Straw used as industry material

- About 30% of India’s paper is made from agricultural residue and/or non-wood fibers (Jain et al., 2005; Anonymous, 2017).
- In Sri Lanka 2-3% of paddy straw used in paper industry (Jayasuriya, 1983).
- In Bangladesh, paper industry uses mostly bamboo and mixed hardwood.
Straw used as **New Energy Resource**

Biomass Power/Co-generation Projects in India (MW) (MNRE, India, 2016)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>363.25</td>
<td>17.5</td>
<td></td>
<td></td>
<td></td>
<td>380.75</td>
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<tr>
<td>Bihar</td>
<td>15.5</td>
<td>27.92</td>
<td></td>
<td></td>
<td></td>
<td>43.42</td>
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<tr>
<td>Chattisgarh</td>
<td>249.9</td>
<td></td>
<td>15</td>
<td>15</td>
<td></td>
<td>279.9</td>
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<tr>
<td>Gujarat</td>
<td>20.5</td>
<td>10</td>
<td>13.4</td>
<td>12.4</td>
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<td>56.3</td>
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<tr>
<td>Haryana</td>
<td>35.8</td>
<td>9.5</td>
<td></td>
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<td></td>
<td>45.3</td>
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<tr>
<td>Karnataka</td>
<td>441.18</td>
<td>50</td>
<td>112</td>
<td>111</td>
<td>158</td>
<td>872.18</td>
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<td>Madhya Pradesh</td>
<td>8.5</td>
<td>7.5</td>
<td>10</td>
<td>9</td>
<td></td>
<td>35</td>
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<tr>
<td>Maharashtra</td>
<td>603.7</td>
<td>151.2</td>
<td>185.5</td>
<td>184</td>
<td>96.38</td>
<td>1220.78</td>
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<td>Odisha</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
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<tr>
<td>Punjab</td>
<td>90.5</td>
<td>34</td>
<td>16</td>
<td>15</td>
<td></td>
<td>155.5</td>
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<tr>
<td>Rajasthan</td>
<td>83.3</td>
<td>10</td>
<td>8</td>
<td>7</td>
<td></td>
<td>108.3</td>
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<tr>
<td>Tamil Nadu</td>
<td>532.7</td>
<td>6</td>
<td>32.6</td>
<td>31.6</td>
<td>39</td>
<td>626.9</td>
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<tr>
<td>Uttarakhand</td>
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<td>20</td>
<td>20</td>
<td>13</td>
<td></td>
<td>50</td>
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<tr>
<td>Uttar Pradesh</td>
<td>644.5</td>
<td>132</td>
<td></td>
<td>93.5</td>
<td></td>
<td>842</td>
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<tr>
<td>West Bengal</td>
<td>16</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>26</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>3135.33</strong></td>
<td><strong>465.6</strong></td>
<td><strong>412.5</strong></td>
<td><strong>405</strong></td>
<td><strong>400</strong></td>
<td><strong>4831.33</strong></td>
</tr>
</tbody>
</table>

- In Bangladesh, biomass based power generation capacity <1 MW (Ahmed and Tanin, 2013).
Overall Status / Use of paddy straw

- In South Asia, **only 20% of rice straw** used for fodder, paper, production of ethanol, fertilizers etc.

- The rest **80% of rice straw** – removed, burnt, piled up, incorporated in soil, spread out or used as mulch for following crop (Hanafi et al., 2012).
## Straw burning problems

Crop straw burnt (>5%) by farmers in south Asian countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Crop straw</th>
<th>Main reason</th>
<th>Major negative impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>Rice and wheat</td>
<td>Easy &amp; quick method of disposal</td>
<td>Polluting air</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Harmful to human health</td>
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<td></td>
<td></td>
<td></td>
<td>Loss of nutrients</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Damage soil micro organisms</td>
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<tr>
<td>Sri Lanka</td>
<td>Rice and Maize</td>
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<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>wheat</td>
<td></td>
<td></td>
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<tr>
<td>Nepal</td>
<td>Wheat</td>
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</tr>
</tbody>
</table>
India: major problem in Punjab, Haryana, western Uttar Pradesh

Punjab and Haryana - about 23 MT of paddy straw (out of 30 MT) is burnt in field - easy and quick disposal.

Burning straw causes atmospheric pollution, huge nutritional loss and physical health deterioration to the soil.

Time available between rice harvesting and wheat sowing is 20-30 days.
Options: Integrated Straw Management

- In situ crop residue management - Mulching and incorporation in the soil
- Feed block making for animals
- Biomethanation of straw for biogas production and recycling compost in the soil
- Rapid composting of straw and recycling in the soil
- Mushroom cultivation
- Production of Bio-ethanol
- Utilization of straw for power generation
- Utilization of straw as other industrial raw material
Pilot sites and partners in South Asia

- **Country:** India - major agricultural country in South Asia region
- **Pilot Sites:** Punjab Agricultural University, Ludhiana
  - Establish straw management technology
  - Strong scientific research strength, 22 KVKs, laboratory facilities.
  - Punjab worst affected by straw burning.
- **Co-Partner:** C.I.A.E., Bhopal
  - Leading National institute, AICRPs
  - Rich experienced scientists and technical staff
  - Design and implement pilots and related tasks.
In situ crop residue management

- **Straw mulching and sowing**: combine harvester fitted with Super Straw Management System and Happy Seeder

- **Straw chopping and incorporation in soil and sowing seed** with normal seed drill / planter
Straw mulching and sowing for Rice-Wheat cropping system

- Attachment of Super Straw Management System in Existing Combines

- Wheat sowing with Happy Seeder directly in combine harvested rice fields
  - Straw management rotor to cut and chop straw in front of furrow openers and guide the cut material between the sowing tynes thus leaving a clear space for sowing while leaving the chopped straw as mulch in between the seed rows.
Viable and scalable solution for Rice-Wheat cropping -

Combine harvester with Super SMS and Happy Seeder
Wheat crop sown by happy seeder –
yield at par with conventional sowing
Removal/collection of paddy straw

- **Farm residue collector**
  - Field capacity: 0.3 ha/h

- **Baling of paddy straw**
  - Field capacity: 0.36-0.39 ha/h
  - Weight of bales: 15 to 35 kg
  (depending on moisture content of straw and length of bales).
Straw incorporation for Rice-Potato / vegetable or rice-wheat cropping

- Paddy straw Chopper-cum-spreader + Reversible Mould Board Plough + Rotavator + Sowing
Other Options
Animal Feed Block Formation Machine

- Capacity: 250 kg/h
- Power: 25 hp electric motor
- Inputs: Crop residues, essential nutrients

Advantages:
- Shelf life - one year
- Saving in transport cost
- Saving in storage space
Mobile Animal Feed Block Machine

- Easy transport
- Capacity: 1-1.2 kg/h
- Power: 6.5 hp diesel engine
- Bulk density of blocks – 400 kg/m³
Animal feed block making plant at a Milk Chilling Centre, Adaspur, Cuttack (Odisha)
PADDY STRAW BASED BIOGAS PLANT

Bio-Gas plant for dry fermentation of Paddy Straw

Installation cost = Rs.1,20,000/-

Biomass input:
* Paddy straw = 1.6 t
* Cattle dung = 0.4 t
* Water = up to saturation

Biogas output:
* 4 to 5 m$^3$ per day
* Period ~3 months
* LPG cylinder equivalence is 3 to 4 per month

Sequence of filling paddy straw and cattle dung
PADDY STRAW BALE GEYSER- for water heating

100 litres of water heated to 45-50°C in 3-4 hours
WHITE BUTTON MUSHROOM

➢ Wheat straw : paddy straw

1 : 2
Thank You All

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