Management of Crop Residues

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8th January, 2015
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## Available Crop Residues in India

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop residue production</td>
<td>500 MT</td>
</tr>
<tr>
<td>Surplus Crop Residues</td>
<td>133 MT</td>
</tr>
<tr>
<td>Potential for power generation</td>
<td>16,000 MW</td>
</tr>
</tbody>
</table>

## Suitable crop residues for Energy Generation

<table>
<thead>
<tr>
<th>Agricultural residues</th>
<th>Agro-Industrial residues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton stalk</td>
<td>Groundnut shell</td>
</tr>
<tr>
<td>Pigeon pea stalk</td>
<td></td>
</tr>
<tr>
<td>Soybean stalk</td>
<td></td>
</tr>
<tr>
<td>Mustard stalk</td>
<td></td>
</tr>
<tr>
<td>Castor stick</td>
<td></td>
</tr>
<tr>
<td>Maize stalk</td>
<td></td>
</tr>
<tr>
<td>Millet straw</td>
<td></td>
</tr>
</tbody>
</table>
Residues Generation by Different Crops

- Cereal crops: 70%
- Sugarcane crop: 2%
- Pulses: 3%
- Fibre crops: 13%
- Oilseed crops: 6%
- Other crops: 6%

Cereal crops 70%
Potential Uses of Crop Residues

- Animal feed
- Composting
- Energy production
- Bio-fuel production
- Biogas
- Biochar production
- Conservation agriculture
## Surplus Crop Residues in India

<table>
<thead>
<tr>
<th>Crop Residue</th>
<th>kt/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>28129.1</td>
</tr>
<tr>
<td>Soybean</td>
<td>3258.8</td>
</tr>
<tr>
<td>Pigeon pea</td>
<td>999.6</td>
</tr>
<tr>
<td>Others</td>
<td>101034.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>133421.7</strong></td>
</tr>
</tbody>
</table>

![Pie chart showing the distribution of crop residues]
Cereal crops 58%
Sugarcane crop 2%
Pulses 2%
Fibre crops 23%
Oilseed crops 7%
Other crops 8%
Cereal crops 58%

Surplus / unutilised residues
Residues are wealth in some places.

In some other, these are waste.

About 90 Mt of crop residues are burned on-farm.
Why do farmers burn residues in field?

- Clearing of fields for next crop
- Use of harvesters
- Scattered, collection is time and labour consuming
- No economic alternate use
- Declining number of livestock
- Long period for composting
Why Crop Residues should not be Burned?

Negative consequences of burning

- Loss of C, nutrient and energy
- Emission of pollutants
- Adverse impacts on soil health
- Adverse impacts on human health

Positive consequences of soil application

- Reservoir of nutrients
- Improves soil health
- Conserves water, controls weeds
- GHGs mitigation
- Enhances crop yield and quality
Burning of Crop Residues and Emissions

One tonne straw on burning releases 3 kg particulate matter, 60 kg CO, 1460 kg CO$_2$, 199 kg ash and 2 kg SO$_2$.

Annual national emissions from rice and wheat straw open burning (all in Gg)

<table>
<thead>
<tr>
<th>Year</th>
<th>Rice and wheat straw</th>
<th>Quantity of dry residue</th>
<th>CH$_4$</th>
<th>CO</th>
<th>N$_2$O</th>
<th>NO$_x$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>145720</td>
<td>150576</td>
<td>102</td>
<td>2138</td>
<td>2.2</td>
<td>78</td>
</tr>
<tr>
<td>2010</td>
<td>156485</td>
<td>162125</td>
<td>110</td>
<td>2305</td>
<td>2.3</td>
<td>84</td>
</tr>
</tbody>
</table>

CO$_2$ is considered to be C natural and therefore, not included in estimation from agricultural residue.
# Residue management through CA Practices

<table>
<thead>
<tr>
<th><strong>Stubble shaver</strong></th>
<th>Cuts and mixes the straw in the field and reduced subsequent farm operations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Happy combo seeder</strong></td>
<td>Simultaneously cuts the standing straw, plants wheat and throw the straw on the planted seeds</td>
</tr>
<tr>
<td><strong>Straw baler</strong></td>
<td>It cuts the straw from combine harvested fields and makes bundles. Straw burning causes environmental pollution</td>
</tr>
<tr>
<td><strong>Straw reaper</strong></td>
<td>It cuts the standing straw left in the field after combining and throw it in a trolley at the rear. 1000 kg of straw/ha &amp; 40-50 kg/ha grain can be recovered.</td>
</tr>
</tbody>
</table>
Happy seeder

Straw baler

Straw reaper
Happy Seeder direct drills seeds in the presence of surface residue up to 10 t ha$^{-1}$.

Benefits of residues retention on soil

1. Moisture conservation
2. Nutrient supply
3. Weed control
4. Soil temp. moderation
5. Pollution control
6. Reduced GHGs emission
7. Carbon sequestration
8. Pest control
Straw Combine

Cost

Cost of harvesting
1. Straw combine: INR 2.5 lakhs
2. Straw reaper: INR 66/quintal
3. Height of cut: 80 mm
4. Time for filling: 30 min for crop density of 80 kg/m³
Constraints of Use of Residues in Conservation Agriculture

- Difficulties in sowing and application of fertilizer and pesticides
- Problems of pest infestation
- Additional management skill
- Apprehension of lower crop yields

Need for Research, Development and Policy
Surplus crop residues in MP

<table>
<thead>
<tr>
<th>Crop residues</th>
<th>kt/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean</td>
<td>1893.4</td>
</tr>
<tr>
<td>Cotton</td>
<td>3775.9</td>
</tr>
<tr>
<td>Pigeon pea</td>
<td>308.0</td>
</tr>
<tr>
<td>Others</td>
<td>4102.3</td>
</tr>
<tr>
<td>Total</td>
<td>10079.6</td>
</tr>
</tbody>
</table>
Crop burnt and un burnt field in Satellite Imagery
Biomass Burning in Selected Districts

<table>
<thead>
<tr>
<th>Selected districts</th>
<th>Soybean stalk (kt/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sehore</td>
<td>36.2</td>
</tr>
<tr>
<td>Seoni</td>
<td>12.2</td>
</tr>
<tr>
<td>Bhopal</td>
<td>9.73</td>
</tr>
<tr>
<td>Raisen</td>
<td>9.7</td>
</tr>
</tbody>
</table>

The selected districts include Sehore, Seoni, Bhopal, and Raisen. The chart indicates the amount of soybean stalk burnt and collected in these districts.
Biomass Status: Raisen District

<table>
<thead>
<tr>
<th>Taluk</th>
<th>Generation</th>
<th>Surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Udaipura</td>
<td>148.7</td>
<td>51.6</td>
</tr>
<tr>
<td>Silwani</td>
<td>60.9</td>
<td>11.1</td>
</tr>
<tr>
<td>Raisen</td>
<td>112.0</td>
<td>30.1</td>
</tr>
<tr>
<td>Goharganj</td>
<td>99.0</td>
<td>21.4</td>
</tr>
<tr>
<td>Begumganj</td>
<td>39.8</td>
<td>9.6</td>
</tr>
<tr>
<td>Barelly</td>
<td>244.3</td>
<td>64.1</td>
</tr>
</tbody>
</table>

Crop residue
Potential of (100 kW) Power plant (Nos.)

| Crop residue | 68 |

Surplus crop residue: Udaipura

- Others 41%
- Pigeon pea 59%
Study on selected crop residue

- Soybean straw
- Pigeon pea straw
- Cotton stalk
- Lantana forest weed

Parameters studied
- Harvesting
- Collection
- Transportation
- Storage
- Value addition
Experiments on Pigeon pea stalk
Experiments on collection of forest weed (Lantana) available at site
Evaluation of Shredding machine

Out Put of Machine : 1000-1200kg/h
Bailing of soybean stalk

- Weight of bale: 30 - 33 kg
- Time required for production of one bail: 2-2.5 min
- Number of bales per hectare: 24-28
Combine harvesting + Bailing Operation: 51.43
Combine harvesting + manual collection: 43.1
Manual harvesting + manual collection: 45.33

Av. collection cost (Rs./q)
Transportation cost at different lead distance
Energy from Crop Residue

- Gasification of crop residues for power generation
- Bio-methanation
- Bio-char
- Composting of crop residues for manure
Biomass Based Decentralized Power Generation System

- Collection and Transportation
- Crop Residues
- Briquetting
- Gasifier Plant
- Electricity Generation
- Agro Enterprises
- Production Activities
- Domestic Activity
Feed stock Preparation

Production of briquettes at site (Mana)
Raw Material used: Pigeon pea stalk, Lantana camera and Soybean straw.
Economics of production briquettes

- Fixed Cost: Rs 0.20
- Raw Material Cost: Rs 1.5 per kg
- Operational cost: Rs 0.75
- Production cost: Rs 2.45
- Market Price: Rs 3.5 to 4.0
- Coal price: Rs 8.0/kg
- Wood price: Rs 4.0/kg
Value addition in soybean stalk through technological interventions

- Collection: Rs. 200/tonne
- Collection + Briquetting: Rs. 1067/tonne
- Collection + Briquetting + Power generation: Rs. 1407/tonne
Earn Don’t Burn
Technological and Policy Options

- *In-situ* management through incorporation in soil or conservation agriculture: Providing equipment, Agril. Service Center, Motivating youth

- Utilization for power generation

- Utilization as industrial raw material

- Development of mineralized fodder
Farm Machinery Provided and Targets in Punjab

![Graph showing the number of machines provided over four years (2013-14 to 2016-17) for Rotavator, Zero till Drill, and Other Machinery.]

- **Rotavator**
  - 2013-14: 20,104
  - 2014-15: 22,604
  - 2015-16: 25,104
  - 2016-17: 27,604

- **Zero till Drill**
  - 2013-14: 13,017
  - 2014-15: 14,517
  - 2015-16: 16,017
  - 2016-17: 17,517

- **Other Machinery**
  - 2013-14: 638
  - 2014-15: 1,163
  - 2015-16: 1,813
  - 2016-17: 2,513
Targets of Utilizing Rice Straw by 2016-17

- **Biomass to energy**: 4.5
- **Balance straw**: 9.27
- **Ethanol (Pilot)**: 0.03
- **Reincorp. in soil**: 1.1
- **Other uses**: 0.1
Constraints of Use of Residues in Conservation Agriculture

- Difficulties in sowing and application of fertilizer and pesticides
- Problems of pest infestation
- Additional management skill
- Apprehension of lower crop yields

Need for Research, Development and Policy
Current Limitations

• The most important limitation is the lack of knowledge.

• There is no blueprint available for conservation agriculture, as all agro-ecosystems are different.

• The success or failure of conservation agriculture depends on the flexibility and creativity of the practitioners and extension and research services.
Zero tillage

- Cost saving effect - 15-16% saving on operational costs
- Drastic reduction in tractor time and fuel
- Yield effect - enhanced timeliness (1-1.5% after 20th November)
- Approximately 30% wheat cultivation - late sowing in IGP
- Water saving (wheat) - average 36%
- First irrigation - 30-50%, subsequent irrigations - 15-20%
- Further reduced if ZT & laser land levelling/raised bed planting
- Direct seeded rice - more cost effective (77%), more water efficient (20-30%), less labour intensive (8%), and more eco-friendly – lowering methane emission by 77%
Zero tillage

- Major constraints for adoption of ZT technology
  - Weed control
    - In conventional agriculture - increased use of chemical fertilisers/pesticides - control weeds, maintain yields
    - In organic farming – increased machine traffic for weed control - increasing labour, time and energy costs
    - In temperate climates, soil compaction can occur due to climatic and soil conditions

Redesigning the cropping systems - better control weeds, necessary to rethink the cropping system as a whole - modify the crop choice/crop rotations
Zero Seeding Wheat Crop
THANK YOU