Crop Residue Management in South Asia
Advancing Sub-Regional Cooperation for Sustainable, Climate-smart and Integrated Management of Crop Residues

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Hybrid mode
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Large variability exists in the estimates of production, utilization and on-farm burning of crop residues in the region.
Crop-wise Residue Production in the Region

Biomass in the Region (Mt)

- Nepal: 5.98 Mt (53%)
- Bangladesh: 2.23 Mt (20%)
- Pakistan: 7.95 Mt (14%)
- India: 225.48 Mt (39%)

Crop-wise Production:

- Rice
  - Nepal: 3.08 Mt (27%)
  - Bangladesh: 5.70 Mt (8%)
  - Pakistan: 145.45 Mt (25%)
  - India: 66.58 Mt (11%)

- Wheat
  - Nepal: 5.98 Mt (53%)
  - Bangladesh: 2.23 Mt (20%)
  - Pakistan: 7.95 Mt (14%)
  - India: 119.17 Mt (20%)

- Maize
  - Nepal: 5.30 Mt (10%)
  - Bangladesh: 1.86 Mt (2%)
  - Pakistan: 9.85 Mt (18%)
  - India: 27.88 Mt (5%)

- Sugarcane
  - Nepal: 2.78 Mt (5%)
  - Bangladesh: 3.08 Mt (5%)
  - Pakistan: 25.25 Mt (45%)
  - India: 145.45 Mt (25%)

- Cotton
  - Nepal: 65.90 Mt (90%)
  - Bangladesh: 77.18 Mt (90%)
  - Pakistan: 7.95 Mt (53%)
  - India: 66.58 Mt (11%)

Note: The values are in millions of tons (Mt).
## Utilization of Crop Residue in the Region

<table>
<thead>
<tr>
<th>Straw uses</th>
<th>Nepal</th>
<th>Bangladesh</th>
<th>Pakistan</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal feed</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Bedding material for cattle</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Residue incorporation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Residue mulching</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Domestic fuel</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Value added items</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Compost making</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Paper production</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Building material</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Mushroom production</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Bio-gas production</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Briquetting of crop residues</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Bio-CNG/Compressed bio-gas (CBG)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Power generation from biomass</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Bio-ethanol production</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>Bio-char</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✓</td>
</tr>
</tbody>
</table>
Crop residue burning is influenced by the agricultural practices that include:

- Crop cycle and type,
- Harvesting season,
- Potential use of residues,
- Agricultural mechanization,
- Feasibility of on-farm residue collection and transportation and
- Profitability of alternate options

### Crop Residue Burning in the Region

<table>
<thead>
<tr>
<th>Country</th>
<th>Crop residue burning (Mt/year) (Total)</th>
<th>Major crops residue burning</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>140 (683)</td>
<td>Rice, wheat, cotton, sugarcane</td>
</tr>
<tr>
<td>Pakistan</td>
<td>- (56)</td>
<td>Rice, sugarcane</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>0.22 (73)</td>
<td>Wheat, <em>Aman</em> rice</td>
</tr>
<tr>
<td>Nepal</td>
<td>- (11)</td>
<td>Rice (Tarai)</td>
</tr>
</tbody>
</table>
Crop Residue Burning in the Region – Main Reasons

• Very short time interval (10–20 days) and resources for sowing of next crop (Rice-wheat cropping system) – India, Pakistan and Nepal
• Use of combine harvesters and lack of straw management machinery
• Easiest and cheapest way for quick disposal of crop residues
• Labour scarcity and high cost of collection and storage
• Lack of storage facilities and market opportunities
• High cost to plough back stubbles mechanically
• Paddy straw is less preferred as ruminant feed – India and Pakistan
• Lack of awareness about the downside of crop residue burning
• Disproportionate incentives/subsidies to manage crop residues
• Low level of skills and knowledge about CRM machinery
Consequences of Crop Residue Burning - Highlights

- Burning of 23 million tonnes of rice residues in **north-west India** - loss of about **9.2 Mt of C equivalent (34 Mt CO$_2$ equivalent)** and a loss of about **1.4×10$^5$ t of N** per year.
- Over **60,000 people died in Pakistan from high level of fine particles in the air**, one of the world's highest death tolls from air pollution (WHO, 2015)
- Total agricultural emissions from **Bangladesh** are expected to reach **87 Mt CO$_2$e by 2030** and **100 Mt CO$_2$e by 2050** (CIMMYT, 2021)
- Burning of wheat straw in **Bangladesh** results in loss of **100% nitrogen, 70-90% sulphur, and 20-40% phosphorous and potassium**.
- In **Nepal**, emission from crop residue burning increased from **85 ktCO$_2$e in 1961 to 160 ktCO$_2$e in 2018**.

➢ **Air pollution from straw burning is a cross border/trans-boundary issue – need sub-regional cooperation**
Examples of Best Practices in the Region

In-situ Management of Crop Residues

- **Residue mulching** - Zero till drill and Happy seeder machine, preferably after operation of combine with SMS system (India, Pakistan & Nepal)
- **Residue incorporation** - Paddy chopper cum spreader and MB plough/Disc plough/Rotary tiller - require lot of energy (India, Pakistan & Nepal)

**In-situ method of straw management**
- Saving of 30 - 35% nitrogen, 20 - 25% potassium and 25% of irrigation water
- Increase in organic carbon, and
- Help in restoring microbial activities in the soil.
Examples of Best CRM Practices in the Region

In-situ Management of Crop Residues – Equipment/Machinery being used

INDIA
- Mulcher
- Combine with SMS
- Sugarcane trash chopper-spreader
- Zero till drill
- Happy seeder
- Super seeder

PAKISTAN
- PTO powered disc plough
- Stubble chopper
- Combine straw spreading kit
- Rocket seeder
- Pak seeder

Provided subsidy on straw chopper and Pak seeder (2021)

NEPAL
- Rotary mulcher
- PT roto till drill
- Zero till drill
- Happy seeder

Used some implements on limited scale

BANGLADESH
- Strip till planter
- Zero till planter

Used some implements under CIMMYT
Examples of Best CRM Practices in the Region

Equipment used for Ex-situ Management of Crop Residues

- Straw Reaper
- Straw Rake
- Combine with Straw Reaper Attachment
- Straw Baler-Round
- Straw Baler - Rectangular

• Help in collection of straw for different uses
Examples of Best CRM Practices in the Region

Ex-situ Management Practices of Crop Residues

- Composting of paddy straw
- Biogas plants for paddy straw at domestic/community level
- Biomass pellets from crop residues for use as fuel in power plants
- Briquetting of crop residues as an industrial fuel supplement
- Power generation from biomass
- Bio-CNG production from paddy straw
- Ethanol production from crop residues
Common Challenges & Gaps in Management of Crop Residues

<table>
<thead>
<tr>
<th>In-Situ Management</th>
<th>Ex-Situ Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Lack of adoption of CA</td>
<td>▪ High cost of collection and transportation of residues</td>
</tr>
<tr>
<td>▪ Non-availability of high hp (≥ 50) tractors</td>
<td>▪ Lack of assured supply of residue</td>
</tr>
<tr>
<td>▪ Expensive and seasonal use of CRM machinery</td>
<td>▪ Lack of assured markets for processed by-products</td>
</tr>
<tr>
<td>▪ Use of combine harvesters</td>
<td>▪ Lack of network of collection centres and supply chain management (SCM) facilities</td>
</tr>
<tr>
<td>▪ Demand-supply gap - local manufacturers unable to meet needs of farmers</td>
<td>▪ Lack of technical and economic feasibility studies</td>
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<tr>
<td>▪ Additional management skills</td>
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<tr>
<td>▪ Apprehension of yield loss/returns</td>
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<tr>
<td>▪ Negative attitudes or perceptions</td>
<td></td>
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</tbody>
</table>

Other common issues

| ▪ Lack of relevant statistical information on availability, utilization and surplus straw resources |
| ▪ Lack of crop residue management policy |
| ▪ Subsidy & financial support to farmers and entrepreneurs |
| ▪ Incentives to farmers for not burning crop residues |
### Action Plan and Way Forward

- Any solutions involving **long-haul transportation, expensive technology, or high capital investment** are less likely to succeed.
- Sustainable solutions - methods to feed the **nutrients in crop residues back into the soil**

**In-situ management is to be preferred over ex-situ management**

| Mechanization Intervention | Promotion of CRM machinery through promotion of CA practice  
Dev. of small tractors/power tiller operated CRM machinery for small farmers  
Dev. of multi-functional CRM farm machinery – increase use  
Improve access to CA machinery at subsidized rates, promoting custom hiring system and providing soft loans to purchase implements  
Large scale demonstrations, trainings and workshops |
|---------------------------|---------------------------------------------------------------|
| Institutional Interventions | Conduct **survey** to collect information on availability, utilization and surplus straw resources  
**Need of crop residues management policy** for rationalizing various issues  
Develop mechanism for crop residue biomass aggregation  
Carbon credit schemes for farmers using CA and not burning residue  
Enforcing appropriate legislation on **prevention of burning through incentives and deterrence** |
### Action Plan and Way Forward

<table>
<thead>
<tr>
<th>Socio-economic Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Bio-gas production from crop residues at domestic/community level (Bringing back fertilizer to field)</td>
</tr>
<tr>
<td>• Awareness creation about negative impacts of crop residue burning on human health and the environment through media campaigns and community programmes</td>
</tr>
<tr>
<td>• Capacity building on adaption of conservation agricultural practices</td>
</tr>
<tr>
<td>• Establishing self-help groups and encouraging unemployed youths to take up custom hiring of CRM machineries as a profession</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Technical Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In-situ management is to be supplemented with ex-situ management techniques</strong></td>
</tr>
<tr>
<td>• Biomass pellets from crop residues as a fuel substitution in thermal power plants</td>
</tr>
<tr>
<td>• Industrial level production of Bio-CNG/Compressed Biogas (CBG) from paddy straw</td>
</tr>
<tr>
<td>• Incentivise power generation from bio-mass</td>
</tr>
<tr>
<td>• Promote 2G biomass based ethanol plants in PPP mode.</td>
</tr>
</tbody>
</table>
Common Framework for Sub-regional Cooperation

- Conduct study on availability, utilization, surplus and burning of crop residues in South Asia
- Share equipment/technologies for in-situ management of crop residues
- Share knowledge of best practices of CRM in different countries through workshops/seminars/visits organised by CSAM
- Harmonization of testing standards for CRM machinery
- Explore policy harmonization for adaptation of CRM machinery.

➢ Need for a combination of technologies and incentives.
➢ Strategy - assign a real economic and commercial value to the crop residue and making burning an economic loss to the farmer.
Thank you