Innovative ways for managing crop residues to address episodic pollution from crop fires

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Satellite Image of India on April 11, 2017, where each red dot indicates a biomass based fire. Source: NASA MODIS data
Crop Residue Burning: Widespread

Limited information on magnitude of the problem

- Total crop residue burnt estimated at 100 Million Tonnes/yr in 2008-09 (IARI)
- More than half of this burning happens in 3 states – Punjab, Haryana and Uttar Pradesh
- 40% of all crop residue burning is attributable to Paddy Straw, 22% to Wheat Residue and 20% to Sugarcane
- Traditionally, most of the paddy stubble was burnt during October–November. India now has a second season of crop residue burning—April–May—from wheat and other Rabi crops.
- Satellite imaging and remote sensing data show large-scale biomass burning during April and May
Crop Residue Burning: Widespread

Area under rice and wheat crop in Haryana, Punjab and Uttar Pradesh

<table>
<thead>
<tr>
<th>States</th>
<th>Area under paddy (000 ha)</th>
<th>Area under wheat (000 ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haryana</td>
<td>1386</td>
<td>2538</td>
</tr>
<tr>
<td>Punjab</td>
<td>2756</td>
<td>3500</td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>5640</td>
<td>9885</td>
</tr>
</tbody>
</table>

Source: Ministry of Agriculture and Farmer Welfare
Local action can be compromised if regional action is weak

Odd-Even 2.0 proves the point

• Average PM2.5 level during the first week was 24% lower than the average of the preceding fortnight of April 2016. But pollution peaks during second week

Source: CSE analysis of DPCC real time data
Farm fires push up pollution

Figures:
NASA Satellite Images showing open crop burning in Punjab, Haryana (From April 1 – 30, 2016)

Source: NASA Fire Mapper
Limited assessment

- **IIT Kanpur’s 2015 Study**: 17% of PM10 and 26% of PM2.5 in Delhi from biomass burning in Winter.

- **Episodic pollution**

- **IARI 2008-09**: Large-scale loss of nutrients – 100% of carbon, 80–90% of the nitrogen, 25% of the phosphorus, 20% of the potassium and 50% of the sulphur in crop residues are lost through emissions.

- Burning crop residue in a year results in loss of 1.43 million tonnes of nutrients from topsoil layer.

- Soil fertility is lost – beneficial microorganisms are lost

Satellite Image of Punjab, Haryana and Delhi on November 9, 2016.

Source: NASA MODIS data
Why Farmers burn crop residues?

Shorter Cropping Cycles:
- Multiple cropping and shortened cropping intervals give a very short window of about 10–15 days. Not enough time to prepare for next crop. Or allow straw to be mixed with soil or use other methods of disposal.
- Punjab: Interval further shortened by rules, -- delay sowing of paddy till after the onset of rains to minimize use of groundwater for irrigation

Increased mechanization of harvesting:
Use of mechanized harvesters leaves stubble of 10–30 cm in the field, depending on the type of crop.

Labour shortage:
Use of expensive labour for stubble extraction is not feasible. Too expensive to hire labour to clear stubble. Costs are high in Punjab and Haryana. Burning of residues is cheaper and easier

No market for crop residue – useless to the farmer:
Local economy cannot absorb straw any more for roofing of houses etc.. Low commercial and economic value of crop residue and high costs of processing, reduces its value for farmers.
Towards solutions........
Policy action

National Policy for Management of Crop Residue, 2014:

- Remote sensing for detection and monitoring
- Mix residues with soil
- Compost, vermi compost and its use as farm manure
- Crop residue for mushroom cultivation
- Incentivise purchase of agricultural implements -- happy seeder etc
- In-situ management of crop residues and straw as surface mulching
- Incentive for hiring machineries
- Power generation, ethanol, paper making, packaging material, fodder etc
The National Green Tribunal (NGT) directions of 2015:

-- Enforce National Policy for Management of Crop Residue, 2014:
-- Mechanism for collection of crop residue, transportation and utilization.
-- Appropriate punitive action: environmental compensation
-- Incentives to farmers
-- Every state will provide machines, mechanism and equipments or its cost to the farmers to remove, collect and store straw.
-- Monitor ambient air quality and submit data to the Tribunal.
-- Use crop residue as fuel in plants
-- Real-time monitoring mechanism etc

EPCA:
Monitoring, subsidies for procuring agricultural equipment; alternative uses of residues. Inter-state coordination body.
Policy action

Punjab
-- Prohibited agri-residue burning under the Air Act. – 2200 FIRs lodged under kharif crop

-- Rural air-quality monitoring has started.

-- To build biomass-based power plants of 600 MW. Only 62.5 MW has been commissioned and 44 MW are in various stages of implementation.

-- To set up five bio refineries for cellulosic ethanol and use paddy straw

-- R&D is underway to use paddy straw as fuel in brick kilns and rice straw as compost.

Central Electricity Regulatory Commission has notified favourable tariffs to biomass-based power plants.

**Impact:** Punjab Remote Sensing Centre, Ludhiana reports a 39% reduction in detection of agricultural fires—from 12,368 incidences in 2014–15 to 7,553 in 2015–16. But latest information is not available.
Haryana
-- Notified prohibition of agri-residue burning under the Code of Criminal Procedure (CrPC). -- 1797 FIR lodged in 2016 kharif season
-- Public awareness drives, education campaigns.
-- Three rural ambient monitoring stations. Remote sensing is to expand to 10 major districts.
-- Considering paddy-straw-based biomass power project; Bio-fertilizer
-- Village level -- to define role of SDMs, tehsildars, BDOs, patwaris and village-level workers, SPCB to achieve zero stubble-burning

Impact: -- Haryana Space Application Centre (HARSAC) reports a 20 per cent reduction in stubble burning practices in 2015 compared to 2013. Latest information is not available
National Budget 2018-19

National government: Focus on in-situ management

- In **Budget 2018-19**, the following announcement made: In March 2018, GOI declared outlay for the scheme – **Total Outlay of Rs 1,151 Crore**: Over 2 years, Punjab to receive Rs. 695 Crore, and Haryana, Uttar Pradesh & Delhi to receive Rs. 457 Crore

- **Financial assistance of 80% of the project cost to set up ‘Farm Machinery Banks’ for custom hiring** will be provided to cooperative societies of the farmers, FPOs, SHGs, registered farmers societies/farmers group, private entrepreneurs and group of women farmers. For individual farmers, assistance of 50% on cost of machinery

**State governments**

- **Punjab Govt.** to provide Rs. 395 Crore in 2018-19 and Rs. 270 Crore in 2019-20 from its own revenue. Total outlay including state allocation sufficient for 66,141 agro machines to control crop residue burning on 18.9 Lakh hectares across 22 districts

- **Haryana Govt.** -- Rs. 215 Crore from its own revenue to set up 900 co-operative societies to hire agro machineries across 18 districts

- **GOI outlay for Uttar Pradesh** sufficient for 12,020 agro machines to control crop residue burning on 12 lakh hectare in 71 districts. **GOI outlay for Haryana** sufficient for 16,102 agro machines to control crop residue burning on 36.6 Lakh hectares across 20 districts.
Implementation structure of the scheme

Mechanism for implementation

• Scheme to be administered by the Union Agriculture Ministry

• National Steering Committee to give guidance for implementation of the scheme and it will also monitor and review the progress.

• State level nodal implementing agency and State Level Executive Committee (SLEC) to implement the scheme and to ensure that no crop residue burning takes place.

• District Level Executive Committee (DLEC), Surveillance Committees involving farmers group/progressive farmers to implement scheme at district level, identify various beneficiaries and location–specific agricultural equipment requirements

• DLEC will identify and select beneficiaries for establishment of farm machinery bank for custom hiring and procurement of machines on individual ownership basis to avail the benefit in transparent and time bound manner.
Understanding and enabling solutions........
For in-situ management: Type of equipment being promoted to control crop residue burning

• **Zero-till seed-drill** (cost: Rs 35,000–45,000): Zero-till farming (also called zero tillage or direct drilling) is a way of growing wheat crops without tillage or disturbing the soil in paddy-harvested fields.

• **Happy Seeder** (cost: Rs 55,000 [approx.]): A rotavator unit is attached to this machine that tills the soil of seeding row. It can help sow without burning residues.

• **Straw chopper** (cost: Rs 2,00,000 [approx.]): This in a single operation chops stubbles and spreads it on the ground. The chopped and spread stubbles are then easily buried in the soil in single operation of rotavator or disc harrow that decays after irrigation.

• **Hay rakes** (cost: Rs 2,00,000 [approx.]): A hay rake cuts hay or straw into windrows for collection (e.g. by a baler or a loader wagon). It is also used in the evenings to protect hay from morning dew.
Type of equipment to be promoted to control crop residue burning

- **Straw reaper** (cost: Rs 2,25,000 [approx.]): This cuts, threshes and cleans the straw in one operation. The remaining wheat stalks after combine harvesting are cut and threshed. The cut stalks are blown out with the straw to the trolley attached and separated from the dust particles.

- **Balers** (cost: Rs 2,25,000–18,00,000 [approx.]): A baler is used to compress, cut and rake crops such as rice, wheat, fodders and legume crops into compact bales that are easy to handle, transport and store. Two different types of bale, rectangular or cylindrical, of various sizes, are bound with twine, strapping, netting or wire. The bales are used for animal feeding as well as bio fuels.

- **Super straw management system** (super SMS) (cost: Rs 1,00,000–1,25,000 [approx.], only for attachment): Super SMS is an attachment to the rear side of a combine harvester to spread loose straw uniformly across harvested fields. It facilitates the use of a zero-till drill and Happy Seeders to increase output, and reduce wear and tear of critical management uniformity in moisture, depth management and crop establishment.
Taking forward in-situ management by incentivising agricultural implements

• **Challenges:**
  - Agri-implements, (Happy seeders, Choppers and Bailers etc) for processing of crop residue to prepare it for utilization – either on the field or in industries
  - As these implements are used only for two to three weeks a year, farmers do not consider these worth investing.
  - Financial support to meet the cost of agri-implements.

**Step forward**

**Augment subsidy and make it accessible to larger number of farmers**

**Promote co-ownership models for the agri-implements - banks:** In Punjab, there are more than 1,700 cooperative and privately run Agricultural Machinery Service Centres (AMSC), which can be supported with subsidies on purchase of agri-implements. They can make implements accessible to farmers. It is important that farmers understand the value of crop residues and use these implements for extraction and packaging.

**Establishing farm machinery banks (Sub-mission on Agricultural Mechanisation) – to be available on hiring basis – Central support**

**Delay in procurement of machinery – strategy for access**
Production of biofuels and fertilizers

- Crop residue contains high concentrations of organic nutrients, which ought to be returned to the soil in order to retain its fertility and yield potential.

- Use either in a decentralized small-scale ex-situ unit or through organized commercialization for the production of fertilizers.

- They can be used to produce biofuels/ethanol etc.

Challenges

- The scale of currently operational production facilities for biofuel and biomass-based fertilizers is very small. Expand them by incentivizing startups/entrepreneurs for manufacturing and supply chain of the above technologies.

Step forward

- **Prioritize biofuels and biomass based fertilizers by mandating its use in specific sectors:** Incentivize utilization of biofuels. Strengthen market linkages
Biomass-based power plants

Challenges
• There are 7 plants – 62.50 MW – using 0.5 million MT/year of paddy straw. 13 more plants (182.50 MW) to be set up by 2018
• The existing power plants in Punjab facing problems of low demand
• Inability to sign long-term power purchase agreements with state governments.
• Partially attributable to the power surplus situation.

Step forward
• Incentivize biomass-based power plants through fiscal policies and prioritization.
• Long-term purchase contracts for power
• Central Electricity Regulatory Commission has notified favourable tariffs to biomass-based power plants
• Several social entrepreneurs aiming to develop business model. Enable them.
• Requires enabling infrastructure and policy support
Raw material for biomass pellets and other biomass based products

Uses

• Biomass pellets can be sold commercially as the main fuel for industrial boilers and replace coal. Micro-pelletization should be incentivized and its local usage promoted.

• Small-scale industries such as paper and cardboard manufacturing and mattress production can utilize straw. (High silica level in paddy straw limits its use for paper, power etc). Link with emissions control strategies

• Straw for substrata for mushroom cultivation etc

Step forward:

• **Fiscal support to promote biomass-based products in specific sectors:** Popularize biomass-based paper and other such products made from crop residue.

• Develop market and a commercial supply chain.

• Industry partnership
R&D and crop diversification

Why are we growing and supporting paddy cultivation in water challenged zones?

• Promote locally appropriate crops and develop alternative variety of crops.
  • For example, Punjab Agricultural University is developing a variant of paddy straw that has lower silica content, more suitable for biomass-based power plants.

• Using crop variants that have a shorter maturity period allows for more time for farmers to prepare field, mix crop residue with soil.

• Design of mechanical harvesters to reduce height of crop residue -- reduce generation of crop residue.

Step forward:

• Support research projects that can work towards reducing crop residue generation

• Support crop diversification programme
Crop residue collection mechanism

- **No mechanism for collection and storage of straw** for commercial sale to support all initiatives and enterprises.
  - Makes procurement of raw material very difficult.
  - Companies are dependent on specific farmers for supply of biomass fuel.
  - Uncertainty around availability of crop residue due to its seasonal nature -- lack of infrastructure.
  - Transportation cost of straw a burden on farmers

Step forward:

- Create a uniform decentralized mechanism for the collection, and storage for commercial sale of crop residue.
Need cohesive action

Promote crop residue processing using agricultural implements:
- Augment subsidy and make it accessible to larger number of farmers
- Promote co-ownership models for the agri-implements

Utilize crop-residues fuel in biomass-based power plants
- Prioritize Biomass based Power plants

Use of crop residues for production of biofuels and fertilizers
- Prioritize biofuel and biomass based fertilizers by mandating its use in specific sectors

Utilize as raw material for biomass pellets and other uses
- Fiscal support to promote biomass-based products in specific sectors

R&D and crop diversification
- Support research projects that can work towards reducing crop residue generation

Crop residue collection mechanism
- Create a uniform decentralized mechanism for the collection, storage and commercial sale of crop residue
Assign real economic and commercial value to the agricultural residue so that burning is an economic loss to the farmer........

Thank You