Strategies to reduce crop residue burning for air pollution mitigation: Key highlights

1. Air pollution from crop residue burning

The large-scale burning of crop residues from the rice–wheat systems of Punjab, Haryana and western Uttar Pradesh contributes significantly to the regional air pollution. This is a serious seasonal problem with severe public health consequences in cities and rural areas of the National Capital Region of Delhi. According to the 2015 IIT Kanpur Report on air pollution in Delhi, the overall contribution of biomass burning to particulate pollution during winter is fairly high—17 per cent for PM10 and 26 per cent for PM2.5. Emissions from crop residue burning contribute to this.

Further, while estimating the amount of pollutants emitted from crop residue burning during 2008–09, the Indian Agricultural Research Institute (IARI) has pointed out that burning results in loss of nutrients present in residues. The total carbon, 80–90 per cent of the nitrogen, 25 per cent of the phosphorus, 20 per cent of the potassium and 50 per cent of the sulphur in crop residues are lost through emissions. Burning crop residue in one year alone results in the loss of 1.43 million tonnes of nutrients from the topsoil layer.

According to the IARI study, in 2008–09, Punjab, Uttar Pradesh and Haryana accounted for nearly 53 per cent of the country's total crop residue burnt. During that time, burning of paddy crop residue accounted for 40 per cent of the total residue burnt, while wheat was 22 per cent and sugar cane 20 per cent.

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. Wheat residue, which has many traditional uses— it is used mainly as animal fodder—is also being increasingly burnt.

Agricultural residue burning is a national problem now. Satellite imaging and remote sensing data show large swathes of fire in central, southern and eastern India. Higher rates of mechanization of harvesting and crop diversification, resulting in shorter periods of fields lying fallow, have perhaps also contributed to this increase in crop residue burning.

2. Why are farmers burning crop residues?

Shorter cropping cycles: Multiple cropping and shortened intervals between crops give a very short window of about 10–15 days during which the field needs to be prepared for the next crop. This does not give enough time for farmers to allow straw to be incorporated in the soil or use other methods of disposal. In Punjab, this interval is further shortened by the rules, which delays the sowing of paddy till after the onset of rains to minimize dependence on groundwater for irrigation.

Increased mechanization of harvesting: The use of mechanized harvesters leaves stubble of 10–30 cm in the field, depending on the type of crop, which was not the case earlier with manual harvesting. It is too expensive to hire labour to clear this stubble.

Labour shortage: Use of expensive labour for stubble extraction is not feasible. Costs are especially high in Punjab and Haryana, where farm sizes are large and use of mechanized harvesters is common. Burning of residues is a cheaper and easier option.

No market for crop residue: The local economy cannot absorb straw any more for roofing of houses etc., as it did earlier. The low commercial and economic value of crop residue, coupled with the high costs of processing, reduces its value for farmers. Although the quantities of residue produced are equivalent to the total crop output, this entire volume of residue has little or no economic value. But it can be raw material for a variety of products that have not been adequately explored yet.

Unless these factors are addressed, any external ban/fine/penalty imposed on crop residue burning will not work.

3. Policy mandate

National Policy for Management of Crop Residue, 2014: The Ministry of Agriculture, Government of India, prepared a National Policy for the Management of Crop Residue in 2014. This document details the policies to minimize incidence of crop residue burning. In practice, states have not implemented this in its entirety. Several components, such as the use of remote sensing technology for detection and monitoring, have been enforced to some extent, but very little has happened to reduce the incidence rates of crop residue burning.

The National Green Tribunal (NGT) has issued the following directions in 2015:

- Immediate implementation of the National Policy for Management of Crop Residue, 2014 prepared by the Ministry of Agriculture.
- Steps to be taken by state governments and NCT Delhi to educate and advise farmers through media, gram panchayats and corporations on utilization of agricultural residues—in boards, fodder, rough-paper manufacturing, power generation etc.
- Mechanism for collection of crop residue, transportation and utilization to be evolved.
- For persistent defaulters of crop residue burning, appropriate coercive and punitive action could be taken.
- Incentives to be provided for farmers to not burn agricultural residue in the open and assistance withdrawn if they continue to default.
- Fines in the form of environmental compensation must be enforced on any offenders as follows: Small landholders with area less than 2 acres (0.81 hectares) to pay environmental compensation of Rs 2,500 per incidence; landholders with land area more than 2 acres but less than 5 acres (2.02 hectares) to pay environmental compensation of Rs 5,000 per incidence; and landholders with land area more than 5 acres to pay environmental compensation of Rs 15,000 per incidence.
- Every state will provide machines, mechanism and equipments or its cost to the farmers to remove, collect and store straw. Happy seeders to be provided to small farmers having land area less than 2 acres free of cost; for farmers with more than 2 acres but less than 5 acres, cost for such machines is to be Rs 5,000; for those with land area more than 5 acres, the cost is to be Rs 15,000.
- All Pollution Control Boards to monitor ambient air quality of major cities and submit the data to the Tribunal.
- The District Magistrate to constitute a special team to monitor and physically inspect at regular intervals and submit inspection reports to the respective Pollution Control Boards, which in turn would provide comparative statements based on inspections and air quality samples.
- The state governments and Pollution Control Boards should ensure that small-landholding farmers are provided with aid and machines for extracting agricultural crop residue in their respective fields and transporting them to designated sites in districts. Crop residue should be used as fuel in plants or for manufacturing straw/fibre boards convert into manure wherever possible.
- An alert system should be created for the concerned authorities about agricultural crop residue.
- The District Magistrate, Secretary Environment and Member Secretary of the respective Pollution Control Boards should be personally responsible for implementation of these directions.
- State governments should in coordination with the Indian Space Research Organization (ISRO), National Remote Sensing Agency (NRSA) and State Remote Sensing Agency (SRSA) develop a real-time monitoring mechanism to monitor the place, date and time of burning agricultural residues and issue alerts to all district-level functionaries.

The Environment Pollution (Control and Prevention) Authority (EPCA) has coordinated with the concerned state governments to review the status of the problem and implementation of the solutions. These include monitoring of burning incidences through remote sensing. Subsidies and financial aid should be given for procuring agricultural equipment that mixes residues with soil while drilling seed to put carbon back in the soil. State departments should look into alternative uses of agricultural residue

and establishment of biomass-to-energy plants. The EPCA has created an inter-state coordination body.

4. State of action in Punjab and Haryana

Policy decisions in Punjab

- The state administration has prohibited agri-residue burning under the Air Act and commenced on public awareness drives, education campaigns and enforcement through village-level officials.
- The Central Electricity Regulatory Commission (CERC), under the Union Ministry of Power, has in order to incentivize such plants notified favourable tariffs to biomass-based power plants. In Punjab, this tariff has been determined at Rs 8.17 per unit and is even higher than competing sources of renewable energy, such as solar energy or wind-based power projects.

Status of implementation in Punjab

- Rural air-quality monitoring has started and four rural ambient monitoring stations have been set up.
- There are plans to build biomass-based power plants of 600 MW. But only 62.5 MW has been commissioned through seven power projects so far and another 44 MW through five projects are in various stages of planning and implementation.
- Seven currently operational biomass-based power projects of total capacity 62.5 MW consume 0.5 million tonnes per year of paddy straw. Five additional biomass-based power projects of total capacity of 44 MW are in various stages of planning, which will use an additional 0.72 million tonnes per year of paddy straw. However, the currently operational and planned projects in Punjab would cumulatively utilize just 1.22 million tonnes of paddy straw against estimated 17–18 million tonnes produced.
- There is a proposal to set up five bio refineries for the production of cellulosic ethanol, each of capacity 75,000 kilo litre/year, using paddy straw as feedstock. About 1.5 million tonnes per year of paddy straw shall be used in these bio refineries.
- Currently, 0.62 million tonnes out of 17–18 million tonnes of paddy straw is utilized. There are proposals to utilize an additional 3.49 million tonnes of paddy straw through various usages.
- The state has also approached the Central government for funds to increase the subsidy amount to farmers.
- R&D is underway to use paddy straw as fuel in brick kilns and rice straw as compost.

Impact of policy action in Punjab

It is not possible to assess clearly the impact of these strategies as the scale of implementation is still very small and data on crop residue burning incidence is very limited. However, the Punjab Remote Sensing Centre, Ludhiana reports a 39 per cent decrease in detection of agricultural fires—from 12,368 incidences in 2014–15 to 7,553 in 2015–16.

Haryana

Policy decisions in Haryana

- The state administration has notified prohibition of agri-residue burning under the Code of Criminal Procedure (CrPC). As per the state administration, this has been more effective than the enforcement of the Air Act as the enforcing body is the State Police Department.
- Public awareness drives, education campaigns and enforcement through village-level officials are being carried out.

Status of implementation in Haryana

- Three rural ambient monitoring stations have been set up. Remote sensing is to expand to 10 major districts.
- The state is considering a paddy-straw-based biomass power project, along with procurement market and supply chain.
- Bio-fertilizer plants using biomass is also being considered.

Impact of policy action in Haryana

- The Haryana Space Application Centre (HARSAC) reports a 20 per cent reduction in stubble burning practices in 2015–16 compared to 2013–14.
- The state administration has reported 1029 incidences of cop residue burning in March–May 2017. Fines amounting to Rs 1,15,000 have been collected from 41 cases.

The state administrations of Punjab and Haryana have begun using satellite-based remote sensing technology to detect and monitor incidences of crop residue burning. Various State Remote Sensing Centres, under the Aegis of the National Remote Sensing Centre, supervise this. This helps to identify exact tracts of land where fires have occurred or are currently occurring, and have the capability to alert the local village-/district-level enforcement authorities within 10 minutes of the incident.

At the village level, the states of Punjab and Haryana have been asked to define the role of SDMs, tehsildars, BDOs, patwaris and village-level workers in addition to the Department of Agriculture and the State Pollution Control Board to achieve zero stubble-burning in fields.

5. Address barriers to promote solutions

The solution to the problem of crop residue burning is fairly well known. But there are several barriers to the implementation of these strategies. The commercial supply chain and ecosystem for alternative utilization is currently nearly non-existent, and needs to be created and sustained through appropriate policy changes. Enforcement is also challenging due to the sheer extent of incidence of burning, which is often beyond the capacity of the existing resources. Fines, penalties and charges regularly prove ineffective, mainly due to lack of effective alternatives.

5.1. Promote agri-implements with subsidy

The cost of agri-implements needed to reduce burning is high. As these implements are used only for two to three weeks a year, farmers do not consider these worth investing. The state government has rolled out schemes for providing subsidy for mechanical implements that can mix the crop residue with soil to improve fertility. In spite of subsidies, only a small number of farmers can access them. The subsidy amount can be augmented.

Currently, Punjab proposes to provide subsidy for 67,750 units of agricultural implements per year and Haryana has notified a scheme in May 2016 to subsidize 1,810 units of agricultural implements. This is not sufficient, considering 56–57 million tonnes and 36–37 million tonnes of crop residue are generated in Punjab and Haryana, respectively. This subsidy for agricultural equipment, which will retill the straw or bale it for use in energy and paper plants, needs to be stepped up immediately.

BOX: Type of equipment to be 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.

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.

Recommendation on agri-implements

- **Augment subsidy and make it accessible to larger number of farmers**
- **Promote co-ownership models for the agri-implements:** 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. These agencies can make such implements accessible to farmers. It is important that farmers understands the value of crop residues and use these implements for extraction and packaging.

5.2. Utilize crop-residues fuel in biomass-based power plants

Crop residue can be used as fuel to generate electricity through biomass-based power plants. Such plants aggregate the combustion of crop residues. The emissions from these are much easier to control and mitigate. Punjab has a plan to build biomass-based power plants of 600 MW. So far, only 62.5 MW has been commissioned and another 44 MW is in various stages of planning and implementation.

Haryana needs to formulate a policy for biomass-based power plants and set targets.

The existing power plants in Punjab are facing problems of low demand and the inability to sign long-term power purchase agreements with state governments. This is partially attributable to the power surplus situation.

Currently, operational and planned projects in Punjab would cumulatively utilize just 1.22 million tonnes of paddy straw against an estimated 17–18 million tonnes produced. This is clearly not good enough and the government needs to step up its utilization of straw and set up power plants expeditiously.

It may also be noted that there are some variants of high-silica content paddy that are unsuitable as fuel in power plants. Along with some other kinds of crop residue, these cannot be utilized effectively for biomass-based power generation. Further, technology innovation is needed in this regard.

Recommendation: Prioritize biomass-based power: State governments need to incentivize establishment of biomass-based power plants through fiscal interventions and prioritization. Along with long-term purchase contracts for the power generated thus, this will effectively promote the development of a market for crop residue and build a commercial supply chain around it. Several social entrepreneurs have come forward to develop business model. But this requires enabling infrastructure and policy support.

5.3. Use of crop residues for 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. These can be used either in a decentralized small-scale ex-situ unit or through organized commercialization for the production of fertilizers. Similarly, they can be used to produce biofuels.

The scale of currently operational production facilities for biofuel and biomass-based fertilizers is very small. This needs to be expanded by incentivizing startups/entrepreneurs for manufacturing and supply chain of the above technologies. Collection mechanism remains a problem.

Recommendation: Prioritize biofuel by mandating its use in specific sectors: The state governments, along with appropriate policy interventions from the central government need to incentivize utilization of biofuels. For example, higher levels of biodiesel can be permitted for blending with regular diesel and made available commercially.

5.4. Utilize as raw material for biomass pellets and other 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.

There are other small-scale industries such as cardboard manufacturing and mattress production that can utilize straw. Straw can also be used for substrata for mushroom cultivation. Sugar cane residue or bagasse is used as the raw material for the production of paper.

Recommendation: Fiscal support to promote biomass-based products in specific sectors: State governments, along with appropriate policy interventions from the Central government, need to popularize biomass-based paper and other such products made from crop residue. This has to be supported, along with the development of markets for such products and a commercial supply chain built around it. Industry partnership is important.

5.5. R&D and crop diversification

In the long term, there is a need to develop a range of alternatives. For example, Punjab Agricultural University is developing a variant of paddy straw that has lower silica content, thereby making it suitable for utilization in biomass-based power plants. Similarly, using crop variants that have a shorter maturity period allows for more time for farmers to prepare field, allowing in-situ re-assimilation of the crop residue into the soil. Such research needs to be promoted and popularized rapidly.

There is also ongoing research into the design of mechanical harvesters, which will reduce the length of the crop residue that remains on the field, thereby ensuring reduced generation of crop residue. This needs to be speed tracked, along with being made popular. R&D efforts require intensive investments in terms of time and resources. The results will only be visible in the medium to long term and will require intensive efforts to execute.

Recommendation: Support research projects that can work towards reducing crop residue generation

5.6. Crop residue collection mechanism

There is no centralized or uniform decentralized mechanism for the collection, storage and commercial sale of crop residues to support all the initiatives and enterprises that are possible around the reuse and recycling of crop residues. This makes procurement of raw material very difficult. For instance, power producing companies are dependent on specific farmers for supply of biomass fuel. There is also uncertainty of year-round availability of crop residue due to its seasonal nature, coupled with the lack of infrastructure.

Recommendation: Create a uniform decentralized mechanism for the collection, storage and commercial sale of crop residue. This will facilitate easy procurement of biomass fuel for power generation and other uses. The strategy, broadly, is to assign a real economic and commercial value to the agricultural residue and making burning it an economic loss to the farmer.