

Increasing Level of Air Pollution in Winters Due To Stubble Burning and Its Impacts on Human Health: A Review Study of NCR

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Abstract

Stubble burning is intentionally setting fire to straw stubble (stems, leaves, seed pods) that are left out on the agricultural land after the crops like wheat, rice, sugarcane, etc. have been harvested as the farmer prepares the land for Rabi crop. Cereal crops contribute 70%, while rice crop alone contributes 34% to the crop residues. According to the Ministry of New and Renewable Energy report 2009, India alone produces around 500 million tonnes of crop residue per year out of which around 140 million tonnes is burned every year majorly in states like Uttar Pradesh, Punjab, and Haryana.

Crop residue burning produces smoke containing toxic chemicals which cause respiratory problems and other diseases. Burning of wheat and paddy straws alone contributes to about 42% of GHGs. 25-30% of air pollution in National Capital Region is caused by burning of crop residue in these states in October and November every year and pushes the air quality of the region down to 'very poor' category and becomes an important reason for about 84.5% of people's health problems.

The purpose of this paper is to review the literature relating to the burning of crop residues and to discuss its effect on air quality in NCR. The paper further discusses various techniques like Happy Seeder machines, Cloud seeding, room air cleaners and masks etc and later on provides suitable suggestions to limit the practice of stubble burning.

Keywords: Crop Residue, Stubble Burning, Air Pollution, Health Impacts, Greenhouse Gases, Delhi- NCR.

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I. Introduction

Crop residue burning is one of the major problems faced by our environment from the past many years. Rice is generally harvested during the period of September-October and wheat in April-May in north India. On harvesting, a lot of residue is generated which is termed as stubble and is removed majorly through burning. Stubble burning in Punjab, Haryana and Uttar Pradesh is considered one of the contributors to the poor air quality in Delhi and NCR during the months of October and November along with local sources of emissions like industrial emissions, vehicular emissions, road and soil dust, construction and demolition activities and adverse meteorological conditions during early winter months.

Stubble burning is also practised in countries like China, Philippines, Thailand, Indonesia, Pakistan, Nepal and Taiwan. India alone produces around 500 million tonnes of crop residue of which wheat constitutes 27-36% and paddy residue make up to around 51-57%. During harvesting periods, open burning of agricultural residue releases a large amount of pollutants to the atmosphere, including aerosols and hydrocarbons (Duan et al., 2004; Lemieux et al., 2004). Hayashi et al. and Gupta et al predicted the cumulative CO, CO₂ and N₂O emissions from rice and wheat straw burning are 0.11, 2.306, 0.002 and 0.084 Mt respectively.

As per System of Air Quality and Weather Forecasting and Research of Indian Institute of Tropical Meteorology, Pune, the estimated impact of stubble burning in PM_{2.5} levels of Delhi ranged between 2% to 46% in the months of October and November. National policy for management of crop residues (NPMCR) provides the details of the state-wise statistics of crop residue generated and excess residue burned.

Table I- States generating crop residue per Year

States	Residue generation (MT)	Residue surplus (MT)	Residue Burned (MT)
Punjab	50.75	24.83	19.67
Uttar Pradesh	59.97	13.53	11.92
Haryana	27.83	11.22	9.08
Maharashtra	46.45	14.67	7.42
Madhya Pradesh	33.18	10.22	6.91

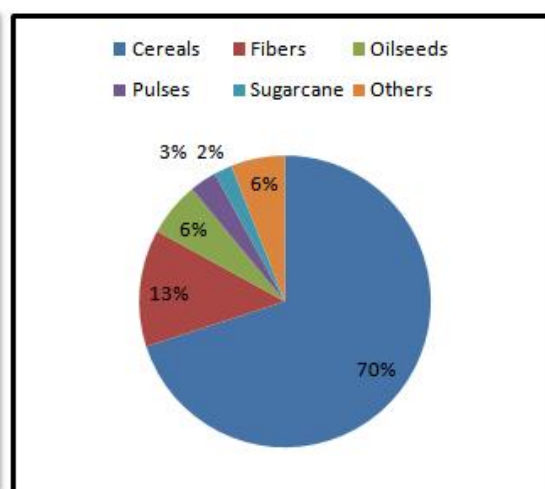
Source: NPMCR, 2014

Picture 1: Picture of Farmers burning fields



Source: Down to Earth magazine (8 Nov, 2019)

Fig 1: Crop Residue Generation in India



Source: MNRE report, 2009

Table2- Comparing Air Quality of major NCR Towns (October 2019)

CATEGORY (AQI)	DELHI	FARIDABAD	GURUGRAM	GHAZIABAD	NOIDA
	Number Of Days				
Good	0	1	0	0	0
Satisfactory	4	0	7	2	1
Moderate	6	5	8	8	10
Poor	14	14	11	10	12
Very Poor	5	3	4	8	5
Severe	2	2	0	3	3

Source: Ministry of Environment, Forest and Climate Change, Govt. Of India

II. Study Area

Wheat is the staple food in this region and is grown in cool and dry winter season and another staple food of this region is rice which is grown in hot and wet monsoon season. This has made rice-wheat the predominant cropping system- encompassing 35% of the rice- wheat system area in the Indo- Gangetic Plains, with Punjab alone contributing 26.5%. (Sharma et, al., 2004).

The National Capital Region is a planning region centred upon the National Capital Territory of India. The coordinates of the study area are as follows: 28°39'38"N-77°06'32"E. It encompasses the entire National Capital Territory of Delhi and a total of 24 districts surrounding it from the states of Haryana, Uttar Pradesh and Rajasthan, as defined in National capital Region Planning Board (NCPRB) Act, 1985. It is a rural- urban region with a population of over 46 million and an urbanization level of 62.6%.

Districts included in NCR from each state with NCT as well are mentioned below-

- Delhi: Delhi constitutes about 2.9 percent of the land area of the Region.
- Areas under Uttar Pradesh: Meerut, Ghaziabad, Gautam Budh Nagar, Bulandshahr, Baghpat, Hapur and Muzaffarnagar.
- Areas under Haryana: Faridabad, Gurgaon, Mewat, Rohtak, Sonipat, Rewari, Jhajjar, Panipat, Palwal, Mahendragarh, Bhiwani, Jind and Karnal.
- Areas under Rajasthan: Bharatpur and Alwar.

Picture 2: Map showing National Capital Region



III. Objectives-

1. To showcase the practice of crop residue burning along with the magnitude of pollution caused in NCR.
2. To discuss the impact of smoke coming from stubble burning on human health and environment.
3. To discuss the related technologies developed for residue management.

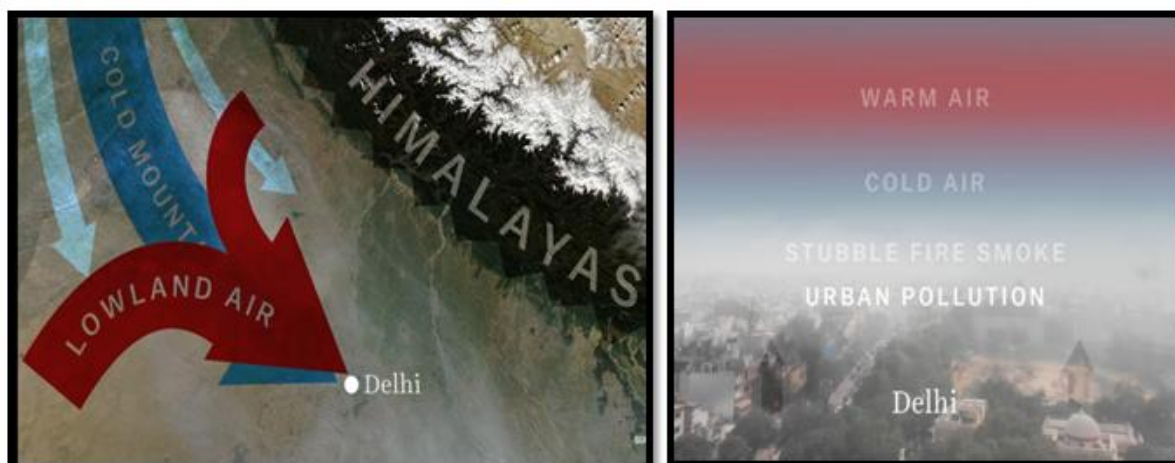
IV. Discussion-

This section describes the reasons of increased smoke in NCR, its impact on human health and environment, the steps taken by the government to curb the problem of stubble burning majorly in north-western states of India and finally the suggestions and recommendations for future strategies.

I. Conditions leading to increased smoke in NCR

- A. Geography- Himalayas act like a barrier which directs the smoke to Delhi.
- B. Weather- During the winter cold mountain air rushes down from the Himalayas towards Delhi, riding beneath the layer of warm lowland air that creates a dome over the city which keeps pollution trapped on the ground so when the stubble fire smoke arrives in Delhi it mixes with the urban pollution forming a toxic smog which sits in the region.
- C. Management of crop residue or stubble is really a complex and time consuming task for farmers as they do not have enough time to make the fields ready for next crop and also there is no single solution available which could be effectively employed by all farmers so they prefer the cheap and easy way out that is burning the stubble.
- D. Poor storage facilities for straw and lack of market utilities of residue forces them to burn the stubble in the fields to get rid of it.
- E. High labour cost as workers are hired for harvesting the crops.

Picture 3: Showing geographical and climatic conditions leading to increased smoke in NCR.



The Moderate Resolution Imaging Spectro-Radiometer (MODIS) of NASA's Aqua satellite captured a natural-colour image of haze and fog blanketing the northern states region of India and the second image depicts aerosol optical depth, a measure of how airborne particles affect the reflection and absorption of light by the atmosphere. Red-brown colours indicate skies thick with aerosol pollution.

II. Harmful effects of crop residue burning-

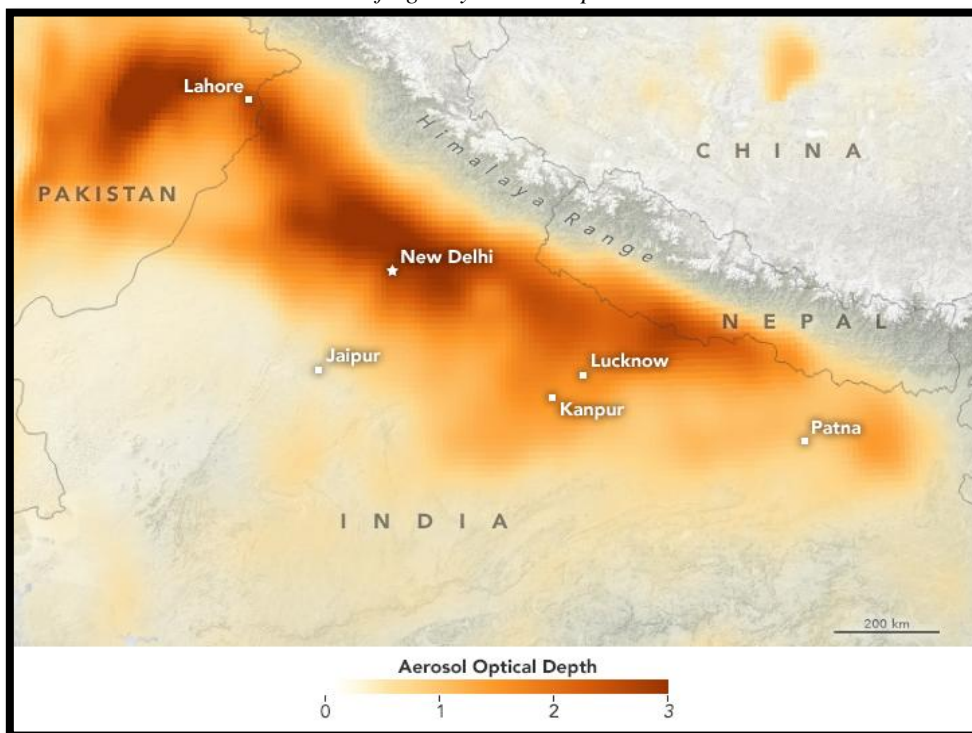
- A. The practice of burning stubble in the field releases 70% carbon dioxide, 0.66% methane and 2.09% nitrous oxide in the air. The impact of first two gases remains for 100 years and impact of third gas remains for 170 years in the ecosystem.
- B. According to agricultural experts, due to fire, the top layer of soil becomes red hot and loses its moisture and fertility of soil is reduced and thus hampers the growth rate of crops.
- C. Smoke and harmful gases when inhaled leads to many respiratory ailments and heart diseases.
- D. Smoke causes irritation in eyes and thus causes eye-problems.
- E. Due to increase in the concentration of greenhouse gases in the environment, the preventive measures taken to prevent ozone depletion are being hampered.
- F. According to the data from AQI India, air quality in several areas in the national capital region was recorded as 'severe' on November 15, 2019.

Picture 4: NASA Earth Observatory of fog and haze distribution over the northern states of India on 8 November, 2017



Source: Obtained from visibleearth.nasa.gov

Picture 5: NASA Earth Observatory image showing how airborne particles affect the reflection and absorption of light by the atmosphere



Source: Obtained from visibleearth.nasa.gov

III. Government Actions-

A. Implemented Laws-

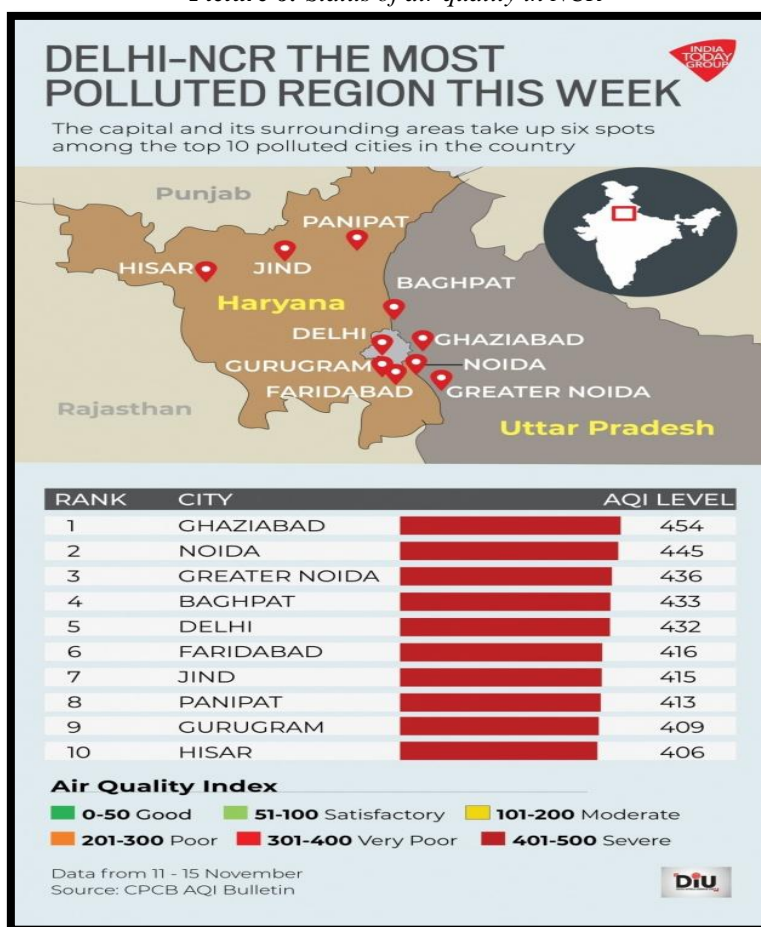
Some of the laws that are in process pertaining to crop residue burning are:

The Section 144 of the Civil Procedure Code (CPC), which is to ban the burning of paddy; The Air Prevention and Control of Pollution Act, 1981; The Environment Protection Act, 1986; The National Tribunal Act, 1995; and The National Environment Appellate Authority Act, 1997. Particularly, in the states of Rajasthan, Uttar Pradesh, Haryana and Punjab rigorous measures have been taken by the National Green Tribunal (NGT) to curb the crop residue burning.

B. Biogas Plants-

The past governmental interventions mainly focus on the use of crop residue as a source of energy in the form of biogas as well as a supplement for thermal power plants. The government is now planning to set up more than 100 biogas plants in India and provide thousands of farmers with machines to dispose of crop stubble in a bid to limit the pollution generating from crop residue burning that disturbs the country every winter. Government-backed Indian Oil Corp has taken the initiative to invite private companies to apply to set up 140 biogas plants that will use rice stubble as feed stock.

Picture 6: Status of air quality in NCR



Source: India Today magazine (November 15, 2019)

C. Advance technology/machinery-

According to Hindustan times dated- Oct 05, 2018, the Centre assigned Rs 269.4 crore, Rs 137.8 crore and Rs 148.6 crore respectively to Punjab, Haryana and Uttar Pradesh for agricultural mechanisation. The scheme has provided happy seeders, paddy straw choppers, super straw management systems and rotavators with equipments to dispose of the stubble generated after every harvest. These technologies are exceptionally useful for managing crop residues for controlling of weeds, conserving soil moisture content and nutrients.

The happy seeder technology represented a burst through for paddy-wheat crop rotation in North West India. For uniform spreading of paddy straw after harvesting of paddy by combine harvester, a Straw Management System (SMS) had also been developed by Punjab Agricultural University. Artificial rain can also be created through cloud seeding technology to minimize the effect of air pollution.

D. Introducing Swedish technology 'Torrification'-

Torrification is a Swedish technology that can convert rice stubble into bio-coal. 'Bioendev', a Swedish company has set up a pilot plant at National Agri-Food Biotechnology Institute at Mohali. The plant has a potential to convert two tonnes of paddy straw per hour to bio-coal.

E. Alternative use of crop residue-

Instead of burning of the stubble, it can be used in different ways like cattle feed, compost manure, roofing in rural areas, biomass energy, mushroom cultivation, packing materials, fuel, paper, bio-ethanol and industrial production, etc

Picture 7: News from Times of India farmer in Punjab



Source: Times of India (12th Aug, 2019)

Picture 8: Use of Happy Seeder by a farmer in Punjab



Source: India Today magazine

V. Suggestions and recommendations for future strategies-

Following suggestions and recommendations are required to curb the prevalent practice of stubble burning leading to pollution and wastage of potential resources.

- Establishment of energy plants should be encouraged to utilize the surplus crop residue for energy generation in a sustainable, environment friendly and cost effective way.
- Funding of higher subsidy rate to farmers should be given who preserve their residue in the field as crop residues are a supplement to chemical fertilizers.
- In-situ management in the field, fast decomposition by chemical or biological means and the use of machines like, zero tillage and happy seeder which helps in mulching the crop stubble must be promoted.
- Paddy residue could be used for formulating useful products like making compost, organic manure and bio-char to improve soil health, soil fertility and gasification as an alternate fuel for power generation.
- Use of high horse-power segment of tractor for deep cutting may be facilitated to small farmers on cooperative basis.
- Provision of incentives to farmers should be introduced so that they do not burn up the paddy residues in the open.

VI. Conclusion

The mass agricultural residue burning is seriously damaging the environment and natural resources of the state as well. The residues can be put to various productive usages such as incorporation in the fields, bio-energy etc. and this is possible only if residue is collected and managed properly. The Indian Government has attempted many interventions to curtail the amount of crop residue burning through different campaigns. The Indian Agricultural Research institute (IARI), Indian Ministry of New and Renewable Energy (MNRE) are continuously promoting research and innovative measures to handle crop waste without burning. The National policy for management of crop residue (NPMCR) recently formulated by the Central Government, has laid out policies and regulations to be undertaken by the local agencies to curb crop burning and initiatives towards sustainable management practices.

However, there is little evidence in the published literature to support the effective control of the situation, most likely due to the lack of education, awareness programs, and stakeholder engagement in the implementation of the policies and initiatives. Continued air pollution especially in the months of November and December suggest that above policies have not fully prevented crop burning. There is a need to understand that why farmers choose the alternative of burning of agricultural residue and there is an urgent need for policy makers to arrive at suitable mitigation policies which would reduce agricultural residue burning in the region which is very essential for the protection of overall environment.

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