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## Winter air pollution and hazy urban cities due to crop residue burning: Its alternative and future aspects

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### Abstract

Crop residue burning is the major rising problem in degrading soil health as well as in terms of creating air pollution across the Indo-Gangetic plains. Punjab and Haryana are the major cereal producing states in North India, hence left over with huge amount of stubble. Most of the farmer consider burning rice residue the most convenient way to save time, labour and timely sowing of next season crop. Huge amount of stubble burning during festive season (Oct-Nov), mostly in North India, results in haziness and foggy appearance around the surrounding. Burning fire cracker and crop stubble at the same time, deteriorate the air quality and creates pollution in the environment. The depleting ambient air quality causes various health issues like eye irritation, lung infection etc. Replacing stubble burning with other efficient alternative would be the best way to improve the air restrict such illegal practice of burning, some beneficial policies should be introduced that would labour effective and time saving.

**Keywords:** Climate change, stubble burning, air quality index, air pollutions, happy seeder, residue recycling, zero tillage, mulching, bio energy production

### Introduction

India is second largest producer of rice and wheat utilizing about 9.6 million hectare of land per year (Sharma *et al.*, 2010) [18], hence produce largest amount of crop residue. In Indo-Gangetic Plain (IGP) of India, Rice-wheat rotation is the most prominent farming practice. Around 12 million hectares out of the IGP's total area of approximately 66 million hectares is under rice-wheat cropping system (Sharma *et al.*, 2010) [18]. In India, Punjab and Haryana are largest producing states of wheat and rice, contributing about 41% of annual food grain production (Abdurrahman, Chaki & Saini *et al.*, 2020) [1].

India once reaped the benefits of green revolution, has now suffering with numerous negative consequences of the same and came to huge environmental and human health risk. With the aim of increasing food grain production, use of chemicals became very familiar among farmers without concerning about the quality of the produce. Using chemical fertilizer, synthetic herbicides is harming the soil health, causing environmental pollution. India is already suffering with various respiratory ailments in COVID-19 war. On the other hand, the increasing rate of respiratory impairment due to air pollution as a result of intensive stubble burning in North India, the environment and global health obligation must not to be forgotten. Thus, keeping future aspects in mind, the most serious issue that is arising nowadays is air pollution.

Stubble burning is the common practice of fire setting to the leftover after the economic crop has been harvested. On a global scale, stubble burning accounts for roughly a quarter of all biomass burning (including forest fires) (Yadav and Devi., 2019; Zhang *et al.*, 2016) [21, 22]. It accounts for over 60% of total biomass emissions in Asian countries (Zhang *et al.*, 2015) [23]. As per the study conducted by Gupta and Sahai 2004, approximately 1.5 times of the yield out of total crop yield is left in the field untilled, hence the farmers left with the burning option to dispose crop residue in order to sow next crop. Burning around 63mt of agricultural stubble releases 3.4 mt of CO, 0.1 mt of NOx, 91 mt of CO<sub>2</sub>, 0.6 mt of CH<sub>4</sub>, and 1.2 mt of particulate matter into the environment (Abdurrahman, Chaki & Saini, 2020) [1]. According to the World Health Organization's Air Quality Guidelines, the annual mean concentration for PM10 should not exceed 20 g/m<sup>3</sup>, after which the risk of cardiac health impacts increases. (World Health Organization, 2005). It has become a significant component of changing climate as it contributes in increasing green house gases and aerosols in the atmosphere. (Nicewinger *et al.*, 2018) [13].

Along with changing climate, stubble burning is also contributing to air pollution, global warming, and soil nutrient depletion (Abdurrahman, Chaki & Saini, 2020) <sup>[1]</sup>. Rice stubble burning worsens the ambient air quality, which has an influence on human health and the environment. (Chawla and Sandhu, 2020) <sup>[7]</sup>. The Air Quality Measure (AQI) can be defined as a daily air quality index that is used to report on pollution levels, ranging from 0 to 500. The national air quality standard for the pollutant is set at 100, by the EPA (Environmental Protection Authority) to protect public health in India. AQI levels below 100 are considered good and unhealthy when its value exceeds 100. Recently, many cities were experiencing extreme air quality levels, resulting foggy layer induced by burning activities and low temperature.

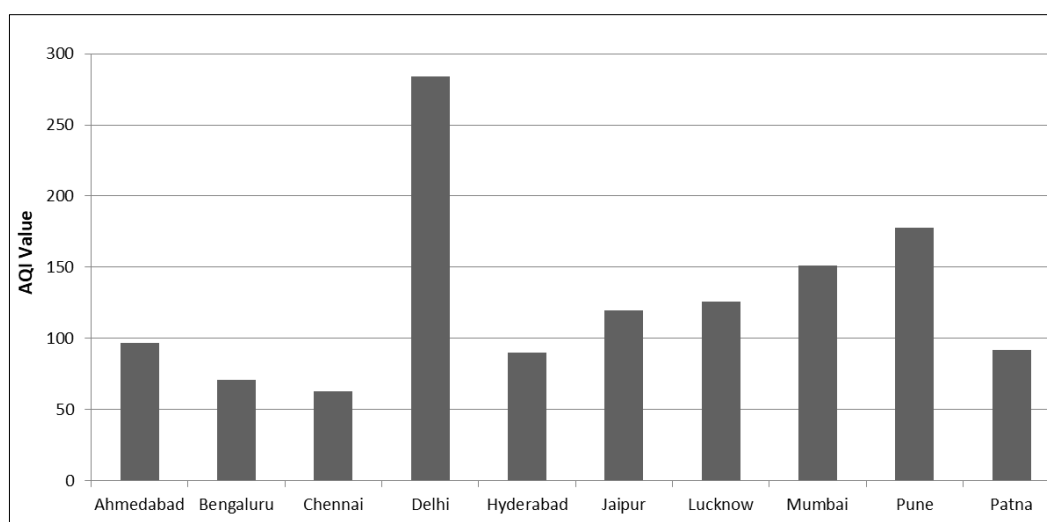
Burning crop residue is a crime under Section 188 of the Indian Penal Code (IPC) and the Air and Pollution Control Act (APCA) of 1981, but least implementation of these government acts has been witnessed across the country. More than 50 per cent of the total sown under paddy was get burnt, despite of several restriction (Creams 2020). Crop residues, instead of burning, could be utilized in alternative ways, including use as cattle feed, compost with manure, rural roofing, bioenergy &, beverage production, packaging materials, wood, paper, and bioethanol, etc. This review article aims to present the current status of stubble-burning practices for disposal of crop residues in India and discuss several alternative methods for better utilization of crop residues.

### Statistics and Problems with stubble burning

Stubble burning is one of the world's leading sources of air pollution, emitting particulate and gaseous pollutants that have serious consequences for human health and the environment (Sharma *et al.*, 2010) <sup>[18]</sup>. The major cause of stubble burning is the less availability of time in between the harvesting of rice and sowing of wheat crop. Based on the report by NPMCR (2019) <sup>[14]</sup> crop residue produced is highest in the state of Uttar Pradesh (60 Mt) followed by Punjab (51 Mt) and Maharashtra (46 Mt) with a grand total of 500 Mt per year out of which 92 Mt is burned. Approximately 84 Mt (23.86%) of the stubble is burned each year on the field after harvest (Abdurrahman, Chaki & Saini, 2020) <sup>[1]</sup>. Haryana and Punjab, two of India's most important agricultural states,

contribute 48 percent of the total residue burning (Gadde *et al.*, 2009) <sup>[8]</sup>. In Punjab, rice is sown in May-June (Kharif season) and harvested from October till mid-November every year (Chawla and Sandhu 2020) <sup>[7]</sup>. After harvesting rice crop, majority of farmers practices burning in order to clean their field. Badrinath *et al.* (2006) <sup>[3]</sup> reported 70-80 mt of rice straw is been disposed of by burning. As a result, it frequently accumulates in the atmosphere and results in foggy appearance. According to the Indian Agricultural Research Institute (IARI), about 63.6 percent of the rice stubble generated each year in India is set to fire (IARI, 2012). Rice stubble burning in comparison to wheat is a concerned problem in rising pollutants level in the atmosphere as it generally takes place during winter months and inversion condition is most prominent during those months (Chawla and Sandhu 2020) <sup>[7]</sup>. In several studies it was demonstrated that rice stubble burning release a substantial quantity of pollutants (RSPM, NOx, and SO<sub>2</sub>) in the environment in a short period of time (Gadde *et al.*, 2009; Mittal *et al.*, 2009; Singh *et al.*, 2015) <sup>[8, 11, 17]</sup>. It releases carbon dioxide, carbon monoxide, nitrogen oxides, sulfur oxides, and methane as well as particulate matters (PM 10 and PM 2.5) (Abdurrahman *et al.*, 2020) <sup>[1]</sup>.

Stubble burning generally practiced in winters, when there is less dispersion of pollutants due to low temperature. This condition does not allow the emitted smoke from burning to disperse properly and results in reduced dilution and accumulation within the environment, further mixing up with fog and forms smog. Thus, results in the emission of a large amount of pollutants, especially on the festive season along with the emissions from firecrackers during October-November in India. Due to crop residue burning, the air quality is deteriorating day by day with the high rate creating a terrible haze in most of the northern cities of India. During this time, most of the north Indian cities, particularly those in the National Capital Region (NCR), face significant pollution, with air quality index frequently reaching severe levels (AQI). Also, reported by that these cities have been experiencing extreme fog and haze induced by different anthropogenic activities, as well as lower temperatures in the winter, particularly during October-December month each year. (Abdurrahman *et al.*, 2020) <sup>[1]</sup>.



Source: Central pollution Control Board (CPCB), 2020

Graph 1: Air Quality Index (AQI) values of major cities in India observed on 30<sup>th</sup> Dec 2021

Also, research done on meteorological variables on air pollution indicated that the air quality of both indoor and outdoor air was worsened throughout the winter Rizwan Nongkynrih, & Gupta, 2013<sup>[15]</sup>. This poses a serious threat to the human health causing health problems, including death in extreme situations. The consequences of this air pollution include skin and eye irritation, respiratory problems (dry cough, wheezing, breathlessness, chest discomfort, asthma), and hypertension (Rizwan, Nongkynrih, & Gupta 2013)<sup>[15]</sup>. Studies indicated significant adverse effect on human pulmonary functions due to decreased air quality as a result of rice stubble burning (Awasthi *et al.*, 2010)<sup>[2]</sup>. In addition to this, it also reduces the visibility, stated by Chawla and Sandhu, 2020<sup>[7]</sup>. The influence of biomass burning on Particulate Matter 2.5 in Delhi varies from day to day (peaking at 58%) since it is largely dependent on the air mass transit pathway, which is regulated by meteorological parameters from source to destination region. Beig G. *et al.*, 2020<sup>[5]</sup>. In 2017, approximately 12.5% of the total deaths occurred due to the cause of air pollution, recently reported by Chakrabarti *et al.*, 2019<sup>[6]</sup>.

Recently in November 2021, the air quality index has been observed (377) to be worst since last six years. The corresponding figure (Shown in Table 1) for last year was 327, while the air in November 2019 was also cleaner with an average AQI of 312. In 2018, the AQI for November was 334, while November 2017 recorded an AQI of 360. The AQI for November 2016 was 374, only marginally lower than this year's figure. The average for 29 days of November 2015 was 358. Data for November 30, 2015 was not accessible.

**Table 1:** Values showing increasing trend of AQI levels in Delhi from past 5 year

Year	2015	2016	2017	2018	2019	2020	2021
AQI values	358	364	360	334	312	327	377

**Source:** Central pollution Control Board (CPCB), 2021

With increasing air pollution, the Delhi Government has decided to complete lockdown and ordered to ban transportation, construction, school and offices remained close in order to reduce vehicle on roads and reduce the pollutants level from the air.

Despite of taking care of the short term benefits of burning, farmers are less concerned about the long term negative effects on soil quality and health risks. Due to occurrence of such unstoppable practices of stubble burning, air quality is deteriorating day by day and would be a alarming for future generation. Instead of framing strict rules against crop residue burning, farmers should be offered with the easiest and profitable source of residue consumption. As a result, it is imperative that comprehensive measures be implemented to combat this threat from its source.

## Interventions to prevent stubble burning

### Awareness among farmers

The government should spread awareness about advantages and disadvantages of each option. Awareness could be created by conducting capacity building and training programmes on ill effects of residue burning, their effective management and utilization by agricultural institutions/organizations. Establishment of custom hiring centres (CHC) and providing machinery at subsidised rates in order to help farmers in managing crop residue. Creating awareness about new

technology would help in removing socio-economic barrier among the people. In addition to this, participation of the community is crucial in order to reduce the pollution level as the governmental efforts alone are not enough.

### In-situ management

Promoting in-situ management practices such as incorporation in soil, mulching, baling/binding for use as domestic/industrial fuel and fodder could actually prevent environmental degradation and loss of soil mineral nutrients caused by crop residue burning. The primary methods to manage the residue is mulching by cutting and on-field distribution, baling and removal from the field, incorporation by tilling into the field, and on-field burning (Shyamsundar *et al.* 2019)<sup>[19]</sup>.

### Direct seeding by happy seeder

One of the best modern mechanized technology introduced is Happy seeder. It is a tractor-mounted machine that cuts and lifts rice straw, sows wheat into the soil and mulches rice residue in one single operation (NAAS, 2017; Sidhu *et al.*, 2015)<sup>[12, 16]</sup>. This is considered to be the best conservation tillage technologies to reduce burning. Shyamsundar *et al.* (2019)<sup>[19]</sup> reported present new evidence that happy seeder reduces stubble burning and could boost farmer income. Mechanized harvesting technologies leave behind large quantities of residue in the crop field for open burning. Happy seeder has the potential to eradicate the burning practice of rice residue as it has the efficiency to sow wheat seeds directly into the soil. It not only performs efficiently but also leads to significant savings in wheat production cost in the research area in south-eastern Punjab (Keil 2021)<sup>[10]</sup>.

### Crop Diversification

Diversified use of crop residue for various purpose could help in reducing total residue burning counts. It includes utilization of crop dry matter in biochar production, charcoal gasification, power generation, as industrial raw material for production of bio-ethanol. The residue material could be modified as a packing material in paper/board/panel industry, in compost making for mushroom cultivation etc. PUSA Bio decomposer is a viable solution for crop residue management. It is developed by the scientist at IARI, which turns crop residue to manure in 15-20 days by accelerating the decomposition process- a fungi based liquid solution.

### Implementation taken by government-suitable law, beneficial policies and schemes

To control the occurred environmental losses, strict rules, easily accessible supporting policies and schemes should be introduced by the government in our country. To reduce air pollution level, The Punjab and Haryana High Court has, directed the respective governments to take all steps possible and started penalizing farmers indulging in stubble burning. However, despite of imposing heavy fines, stubble burning is continued on increasing. Farmers should be offered grabby alternatives for not burning their stubble so that they could stop burning practice and could adopt other decomposing practices. Provision to punishment has also been introduced that is sending jail to the person who is burning residue for upto five years or charged penalty with fine upto Rs.1crore or with both. In 2019, the Indian Supreme Court authorised a few of northern states to pay farmers who don't burn their

stubble 2,400 rupees per acre. The programme was well-liked, but it was underfunded, and it quickly ran out of funds (BBC 2020) [4]. Least burning (least burning area i.e. 48.7% in Patiala and 40% Ludhiana) in 2018 was observed in comparison to past four years due to strict policies, awareness among farmers, proper disposal of stubble, or tilling back in soil with the help of subsidies machinery like happy seeder (Chawla and Sandhu 2020) [7]. Frequent checking of Pollution under Control Certificates to ensure that vehicles are emitting gases within permissible norms and banning crackers could also help. Moreover, developing and creating job opportunities for the migrants in their peripheral and thus preventing further congestion of the already-choked cities of India.

### Conclusion

Crop residue burning, the onset of winter and intensive firecrackers burning on festive season have turned many cities into a gas chamber. All the pollutants from stubble burning moves out and largely affect the urban cities, mostly Delhi NCR region in North India, depleting environment air quality. The situation has now getting worse and causing human health problems. In order to improve air quality, the stubble burning has to be replaced by environmental friendly practices, without forgetting the feasibility criteria for farmers. Such alternatives may include efficient utilization of residue by incorporating crop residue to boost soil fertility, adopting in-situ management practices and crop diversification. Conducting capacity building programmes and establishing custom hiring centres (CHC) would help farmers to know about mechanized technology for better utilization of straw. The farmers should be encouraged for using machineries such as happy seeder and Bio decomposer for proper removal of stubble in a short period of time and should be available at subsidized rate. The most promising approach is using stubble for bio-energy production, which not only help in improving environmental quality through crop residue management but also generate additional value to the economy of agricultural sector. Strict punishment or heavy penalty fee should be charged by the government on burning crop residue. This review article offers a solid understanding about the negative impacts of crop residue burning on environment and best eco-friendly alternatives to mitigate its impact. Despite of implementing numerous sustainable technologies, the upcoming hazardous situation due to air pollution induced by stubble burning, could not be overcome without the cooperation of general public and farming society of our country.

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