International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

An Analysis of the Impact of Stubble Burning and Firecrackers on the Environment and Human Well-Being

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Abstract

Pollution, the contamination of the environment with harmful materials, affects human health, quality of life, and ecosystem functions. Recently, stubble burning and firecracker usage have drawn attention for their environmental impact, particularly in India's National Capital Region (NCR): Delhi, where toxic air creates public health emergencies in winter due to inversion, moisture, and poor wind dispersion. Fireworks also cause short-term air quality deterioration by releasing hazardous chemicals and organic pollutants. Ground-level displays have immediate health effects, unlike high-altitude releases, which dilute pollutants. The bursting of firecrackers is seen as a symbolic expression of joy in Indian Culture. Using both primary data, from farmers as well as the people of Delhi and Chandigarh (two Union Territories of India, one being the capital city and the other being a comparatively cleaner and greener city) and secondary data and information, collected from government and credible portals, an analysis has been done on the impact of stubble burning and firecrackers along with the reasons for these taking place from the surveys carried out online. This analytical research aims to bring forward the potential reasons for people continuing to burst firecrackers and farmers burning stubble, despite knowing the detrimental impacts on environment and health of others, as well as assessing the impact on the health of residents of Delhi and Chandigarh.

Keywords: POLLUTION, STUBBLE BURNING, FIRECRACKERS

Introduction

Stubble burning, the practice of burning residual crop straw, severely degrades air quality, increases greenhouse gas emissions, and contributes to climate change. However, it remains a cost-effective method for clearing fields, controlling weeds, and managing pests and pathogens. Air quality in North India, measured by the AQI (Air Quality Index) on a scale of 0-500, often exceeds safe limits during burning episodes. There is a very short window of 10-20 days between the harvesting of paddy and sowing of wheat, at the end of the Kharif season. Delay in sowing would risk compromising on the yield of the wheat crop, while planting the paddy crop earlier would entail suboptimal utilisation of monsoon rains and consequently greater reliance on scarce groundwater. Therefore, the farmer cannot lengthen this time window and has to speedily dispose of the leftover residue by the combined harvesters before sowing the wheat crop. Burning has been the traditional go-to option for farmers in North India (especially in Punjab); it is easy and costless, unlike alternative means of disposal.

Firecrackers, on the other hand, are burnt in joy and a method of expression. Different societies of the world attach a strong cultural significance to the use of fireworks. They have been used as decorative elements, symbolic representations during religious ceremonies, weddings, national festivals, opening and closing of major sports events throughout the world etc. They are part of collective celebrations that bring positivity and cheer in society. Many historians believe that fireworks were first developed in ancient China to ward off evil spirits. The first natural 'firecrackers' were bamboo stalks that when thrown in a fire, would explode with a bang because of the overheating of the hollow air pockets in the bamboo. The Skanda Purana mentions that during Diwali people held Ulkas (firebrands) in their hands to light the path for their departed ancestors.

Objectives

1. To assess the impact of stubble burning and bursting of firecrackers on the environment with focus on Delhi and Chandigarh and health of its residents.
2. To understand reasons and compulsions of farmers behind burning of stubble.
3. To find and suggest ways/strategies to minimize the negative impact of stubble burning and bursting of firecrackers.

Methodology

The research project was carried by:

1. Obtaining information and secondary data from various digital and print resources.
2. Obtaining primary data through online surveys on people's perspective (residents of Delhi and of Chandigarh) on this issue.
3. Obtaining primary data through online surveys on farmers' perspective on this issue.
4. Our data source was the CPCB(Central Pollution Control Board) that puts out data for various locations across India.
5. While CPCB has several monitors in Delhi, we selected the four locations that provided us with the most consistent dataset. We thus have data for four locations in Delhi-- Dwarka, Sector 8 in South West Delhi, Jahangir Puri in North West Delhi, ITO in Central Delhi, and 4) Anand Vihar in East Delhi and two locations in Chandigarh-- Sector 22 in Central Chandigarh and Sector 53 in South West Chandigarh.
6. The data thus obtained was statistically analysed.

Observations, Data Collection and Analysis

1. On the basis of various literary sources/survey of secondary data:

1.1 Stubble Burning

- Stubble burning is a significant source of carbon dioxide (CO_2), VOCs (Volatile Organic Compounds), nitrogen oxides (NO_x) and hydrocarbons (HC) accounting for about 10% of the total emissions in the world [1]
- It is estimated that about 352 Mt (Metric Tonne) of stubble is generated each year in India out of which 22% and 34% are contributed by wheat and rice stubble respectively. About 84 Mt (23.86%) of the stubble is burnt on-field each year immediately after harvest. [2]
- According to Bhuvan, a geo-portal of ISRO(Indian Space Research Organisation), 85.5% and 83.6% of the total area of Punjab and Haryana is used as croplands. In Punjab, more than 90% of the farmers

burn their stubble in the field. [3]

- The disastrous haze observed over India during the winter season has been linked to stubble burning as it coincides with the burning periods (October-November). During this time, most Indian cities, especially within the NCR experience air pollution often reaching the severe levels of the AQI. In November 2023, Delhi recorded a peak AQI of 403.
- The GOI (Government of India) offers a 50-80% subsidy for the promotion of agricultural mechanization for in-situ management of crop residue in the states of Punjab, Haryana, UP and NCT of Delhi [4]

Satellite image taken on Oct. 25 and 26, 2023 shows the extent of farm fires in Punjab and Haryana against the claim of reduced fires this year: NASA (Source- Times Now, Oct 27, 2023)

1.1.1 Impacts of Stubble Burning

- Impact on air quality-Burning of stubble contribute towards the emission of greenhouse gases (CO_2, N_2O, CH_4), air pollutants (CO, NH_3, NOx, SO_2, NMHC, volatile organic compounds), particulates matter and smoke thereby posing a serious threat to air quality. It is estimated that burning of 63 Mt of crop residue emitted 4.86 Mt of CO2 equivalents of GHGs 3.4 Mt of CO and 0.14 Mt of NOx.
- Impact on Soil Fertility and agriculture productivity-Stubble burning burns the essential nutrients inside the soil [2], raises the soil temperature to about 42 °C, thus displacing or killing the important microorganisms in the soil at a depth of about 2.5 cm [5, 6, 7]. It results in death of various living creatures, loss of organic matter in the soil, deterioration of soil structure, destruction of useful microorganisms. [8]
- Impact on Health and wellbeing- Burning of crop residues can cause coughing, eye irritation, headache, nausea, skin irritation, and respiratory allergies, blurred vision, bronchial infection, dizziness, asthma, and fatigue are other minor side effects. [9]

1.2 Firecrackers

- It is reported increased emission and accumulation of PM_{10}, SO_2, NO_2, O_3 and trace metals like Fe, Zn, Cu, Cd, Pb, Ni in air due to fireworks during Diwali festival.[10]
- It has also been observed that there has been a significant increase in atmospheric pollutants, particularly PM_{10} and $PM_{2.5}$ in Delhi during Diwali period attributing this to the use of fireworks. An overall increase of nearly 25% in $PM_{2.5}$ concentration level every year during the Diwali festival in New Delhi was reported. [11, 12]
- There has been an observation stating that short term degradation in air quality due to extensive burning of fire-crackers during Diwali festival for the years 2011–2016 over an urban Indian region.

This study has also reported increased concentrations of trace gases and further PM_{10} and $PM_{2.5}$ concentrations were found to be 4 to 5 times higher than their prescribed safer limits. [13]

- An improvement in air quality was reported after the imposition of a ban on firecrackers in different parts of the world. [17] It has been reported that the low AQI post ban on firecrackers in N. China during spring festival along with decrease in PM $_{2.5}$ and PM_{10}. The positive effect of a ban on fireworks on air quality over the states of Indo-Gangetic Plains airshed was also reported. [18]

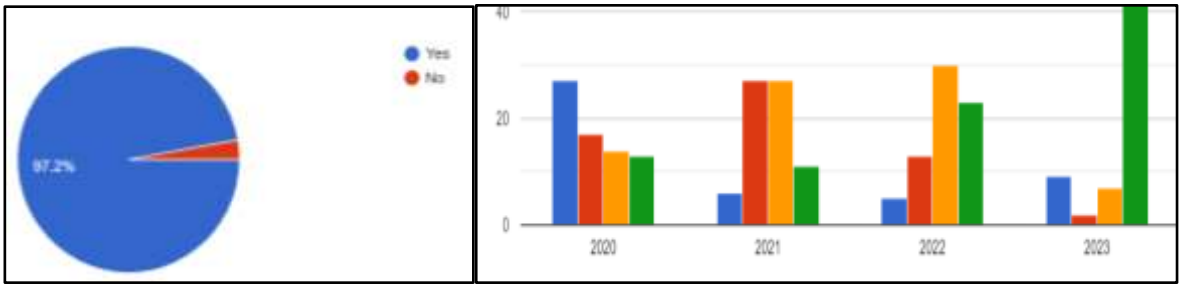
1.2.1 Impact of Firecrackers

- Each year there are several reports on firework-related injuries. [14]
- The burning of fireworks releases a large amount of air pollutants, particularly sulphur dioxide (SO_2), carbon dioxide (CO_2), carbon monoxide (CO), and PM (Particulate Matter) along with several metal salts, for example Al, Mn, and Cd. There is increasing recognition of the detrimental effect of urban air pollution on human health both in the long-term and in the short term. Adults exposed to high levels of ambient air pollution have shown increased prevalence of chronic cough, phlegm, and breathlessness and are therefore at an increased risk of developing respiratory symptoms, asthma, COPD (Chronic Obstructive Pulmonary Disease), allergic rhinitis, lower respiratory tract infections, and lung cancers. [15]
- Fireworks can produce noise peaks of about 160dB(A) which have the potential to cause a rupture of the tympanic membrane. Noise from fireworks is considered impulsive noise and the effect on human hearing are particularly more aggressive than other types of noise, since a single exposure can, instantaneously, damage hearing. [16]

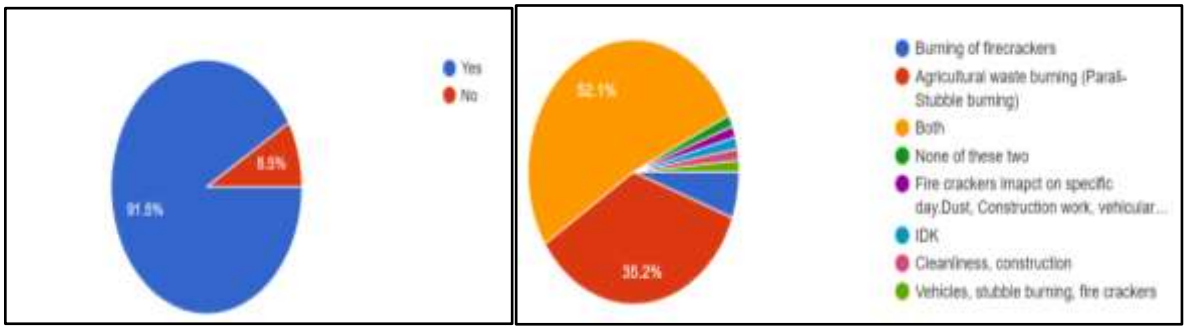
2. On the basis of primary data collected through surveys and questionnaires

Perspective of People of Delhi

1. 97.2% people agree on deterioration of air quality in recent years and have witnessed a rise in pollution level this year as compared to previous three years.

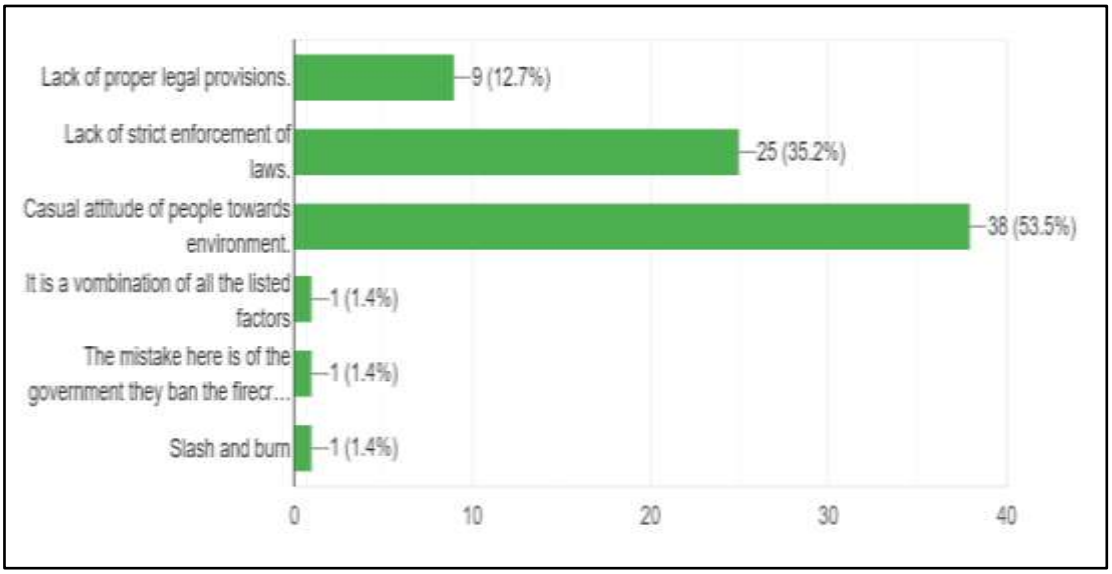


2. Majority of stakeholders are concerned about rising levels of pollution in Delhi and believe that both fireworks and stubble burning are an important contributing factor.

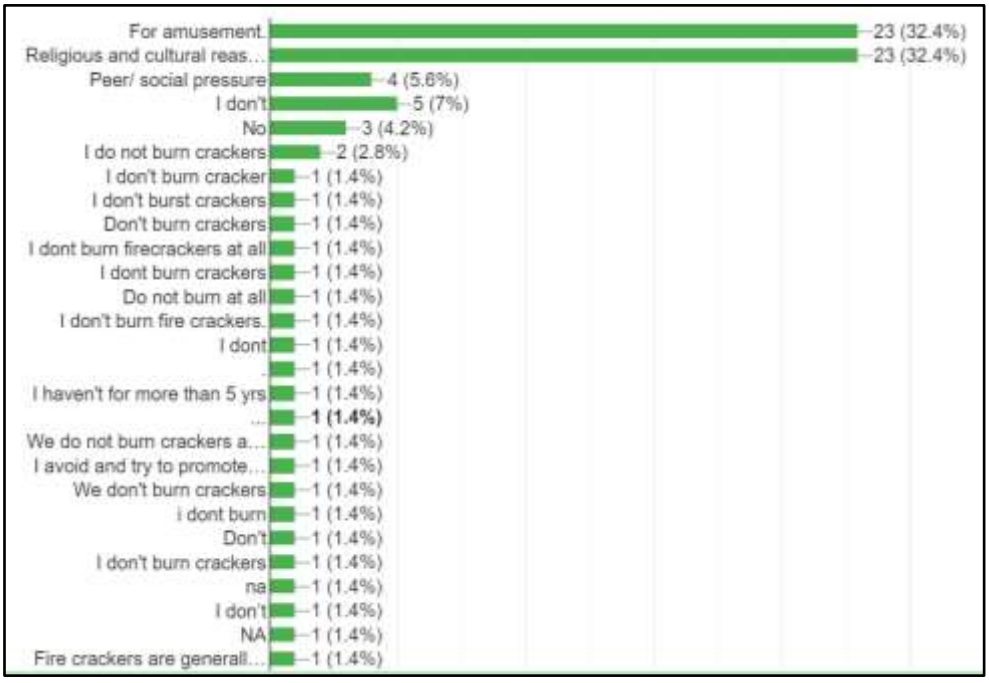


3. Air Pollution in Delhi is significantly affecting health and other aspects of daily life.

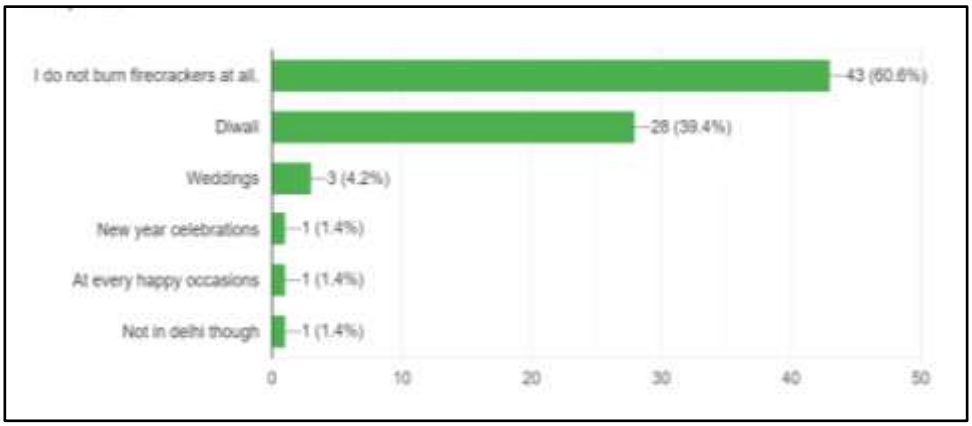
4. Casual approach of people and lack of strict enforcement of regulations are important factors for the prevailing situation.



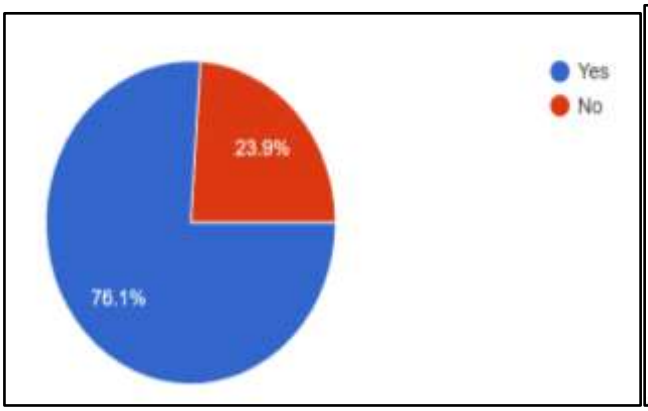
5. Firecrackers are burned mainly because of religious and cultural significance and for amusement.

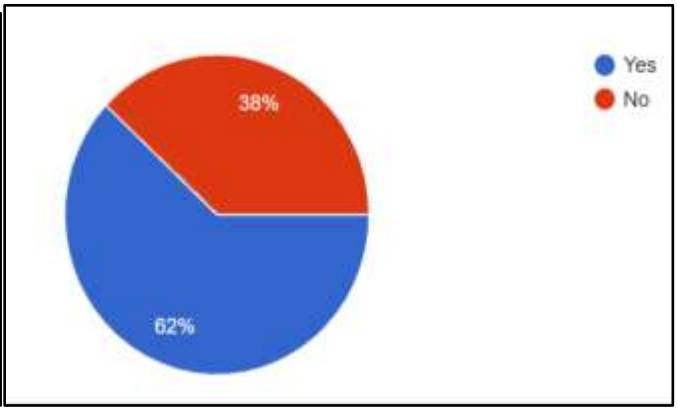


6. Nearly 61 % people do not burn the firecrackers at all while a select few burst firecrackers only during Diwali. Currently there is no bar/ restriction on the quantity of firecrackers an individual can purchase, possess or use.

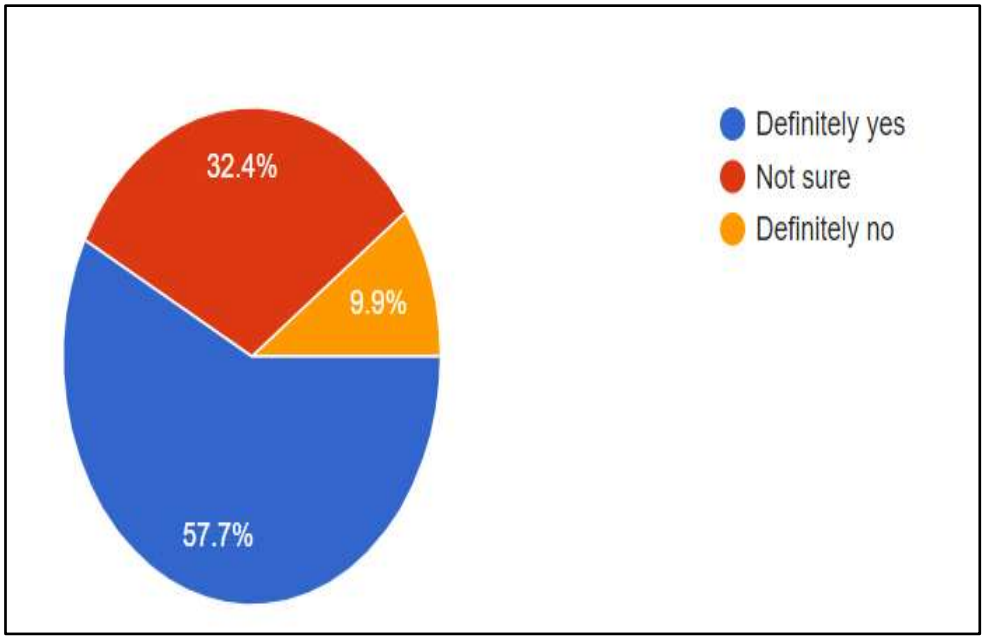


7. Around 76% people hold firecrackers as an important source of noise pollution and 62 % consider it as a culprit for waste generation and source of land pollution. People have also witnessed accidents due to firecrackers.

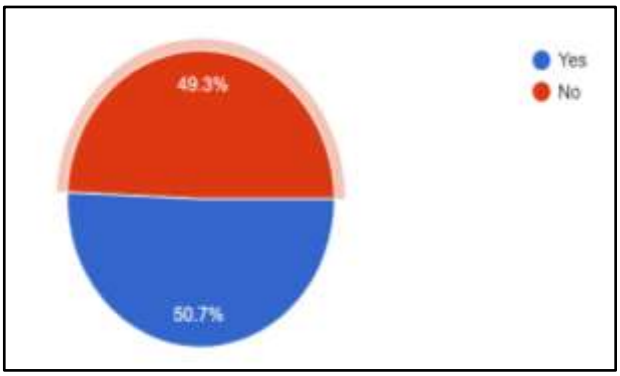




8. Nearly 58 % believe green crackers to be an alternative to traditional firecrackers and majority of them may opt for green crackers if their costs are made comparable.

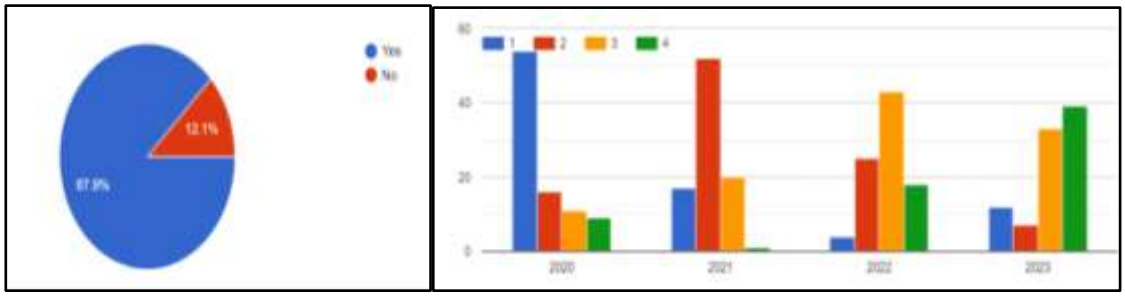


9. Nearly half the people surveyed (50.7 %) recommend a complete ban on the use of firecrackers.

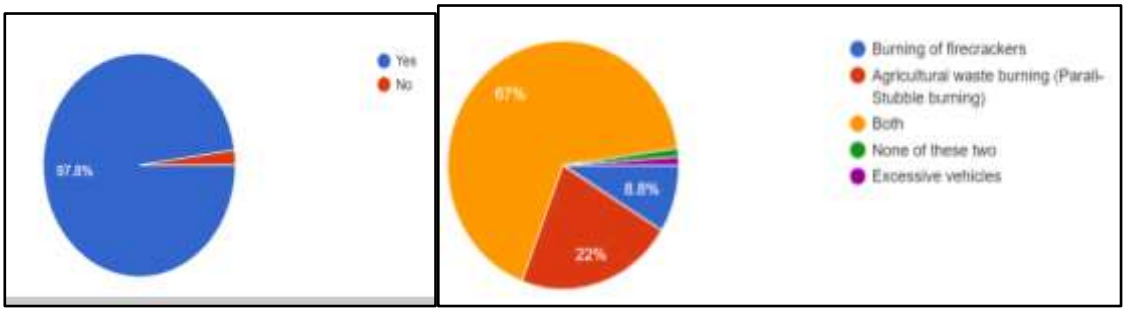


Perspective of People of Tricity, Chandigarh.

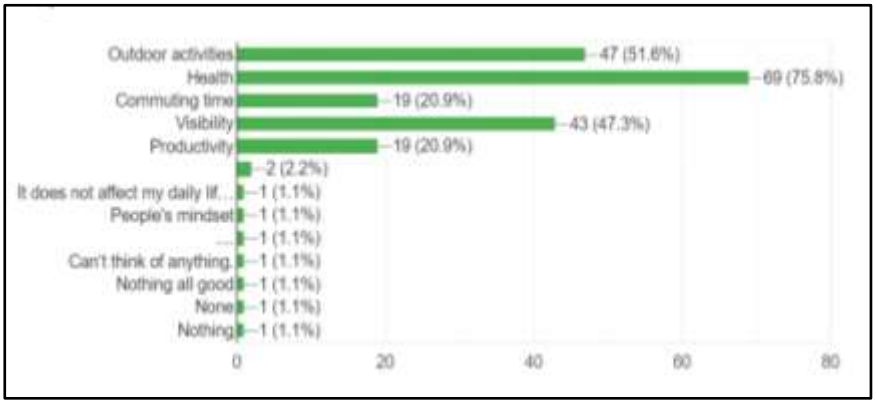
1.Nearly 88% of surveyed people observe a deterioration in the air quality of Chandigarh.



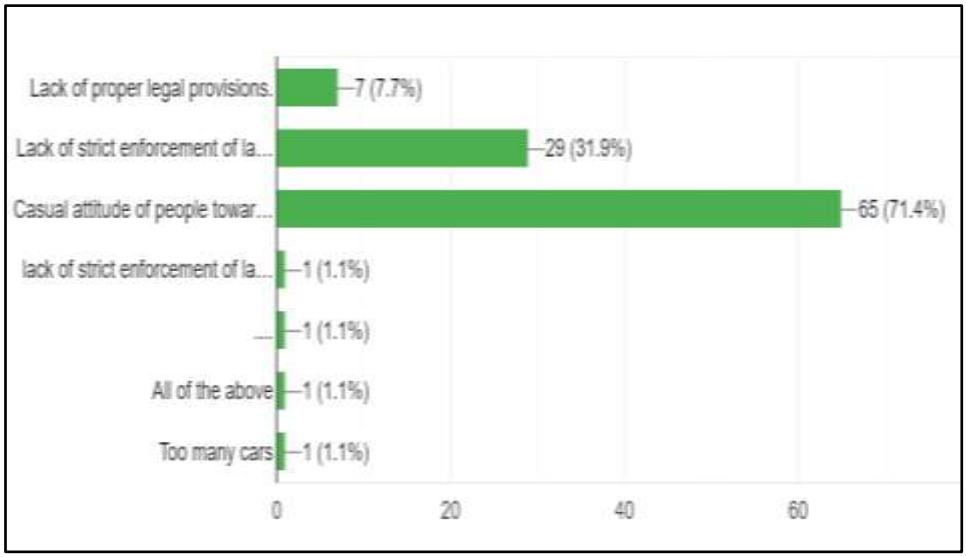
2.Around 98% find strong correlation between AQI and stubble burning.



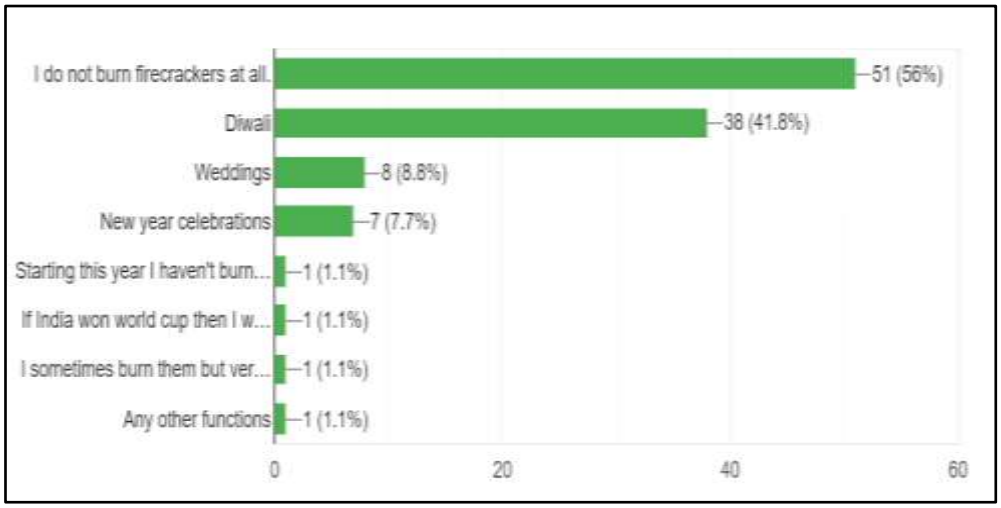
3.The pollution in Chandigarh is affecting various aspects of daily life. health, outdoor activities, visibility, commuting time and productivity.

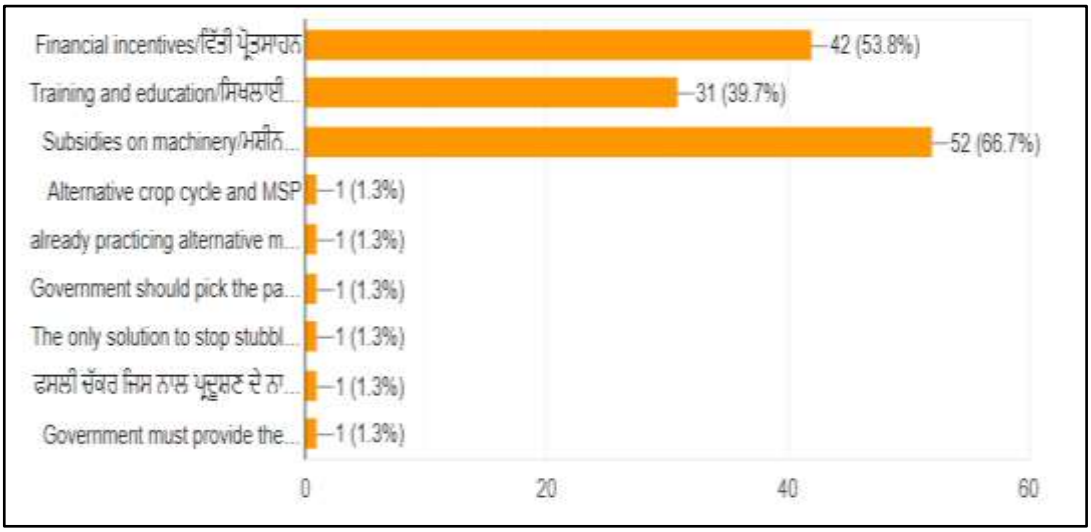


4.Casual approach of the public towards the environment and lack of strict enforcement of laws are major factors responsible for deterioration of air quality in Chandigarh.



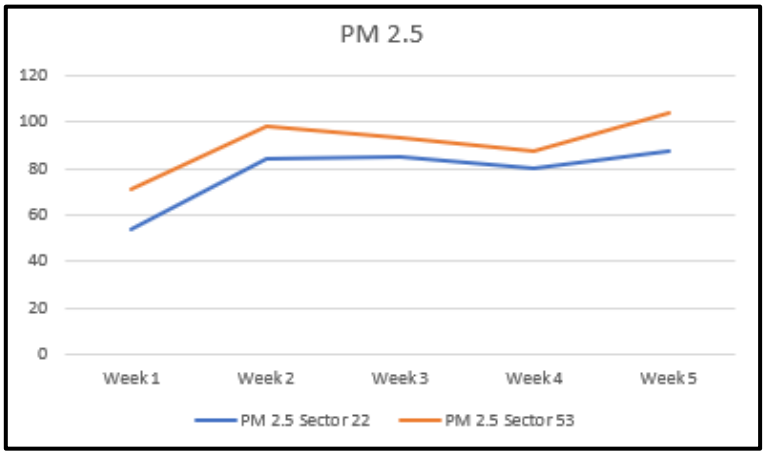
5. While 56% of the people do not burn firecrackers at all, nearly 42 % do it only during Diwali.

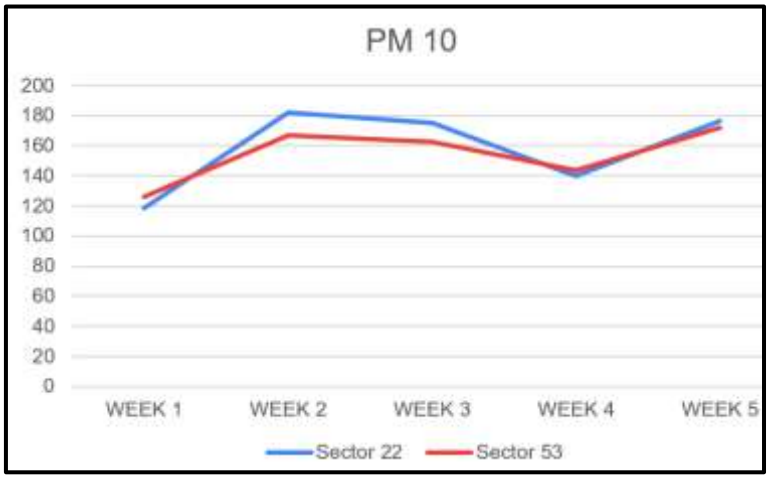


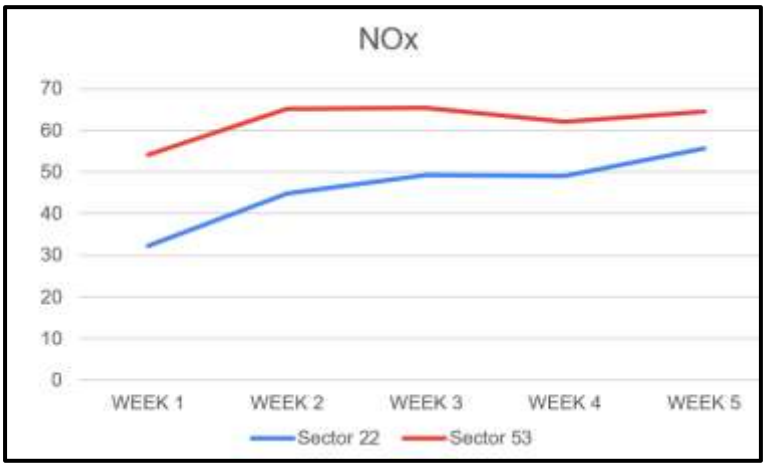


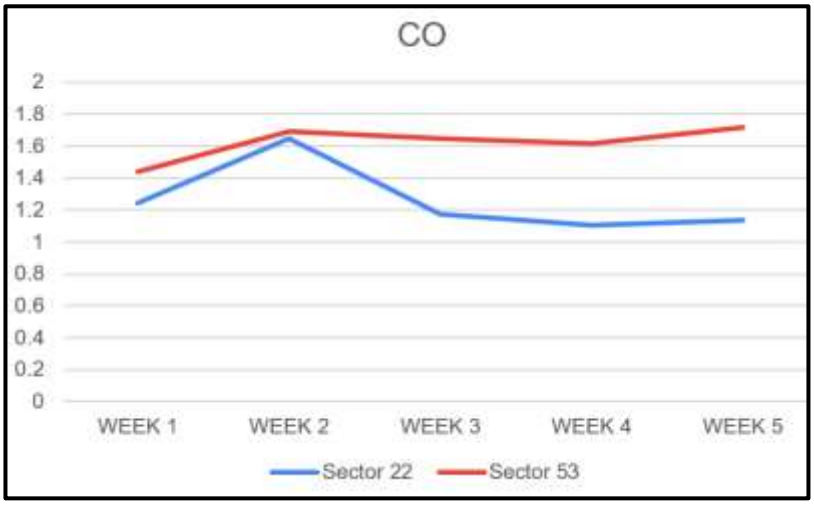
From the data gathered from the official website of CPCB, following trends during Diwali and winter can be observed. (Diwali on 12th November 2023)

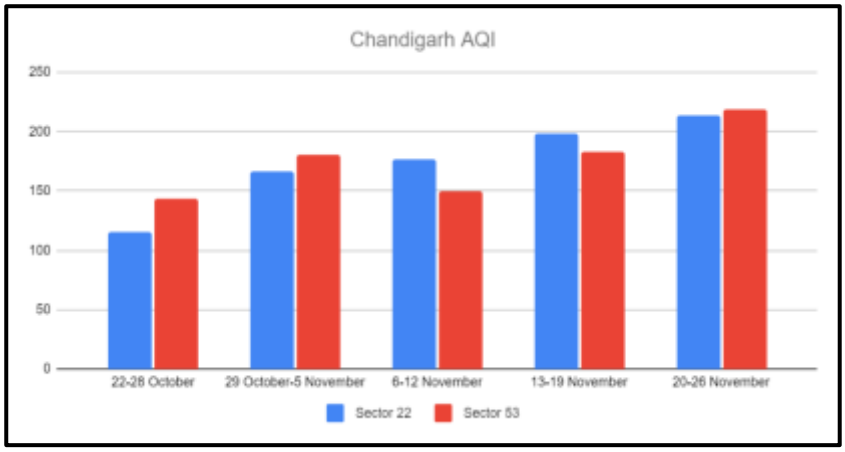
Graphs for 2 selected locations in Chandigarh:

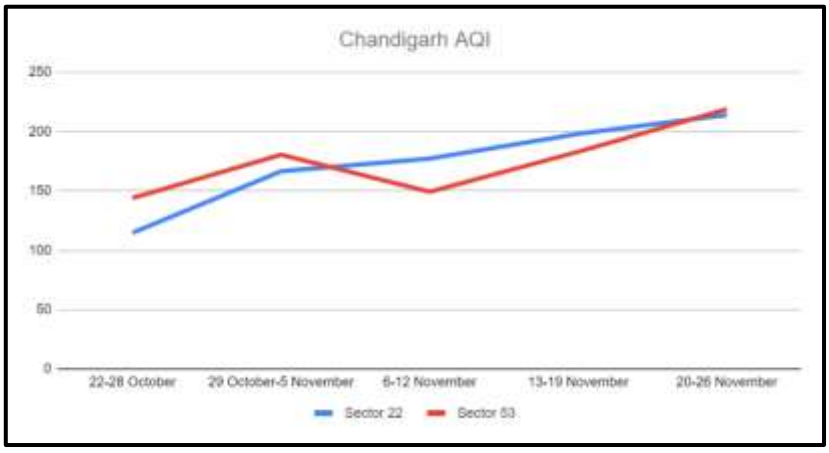








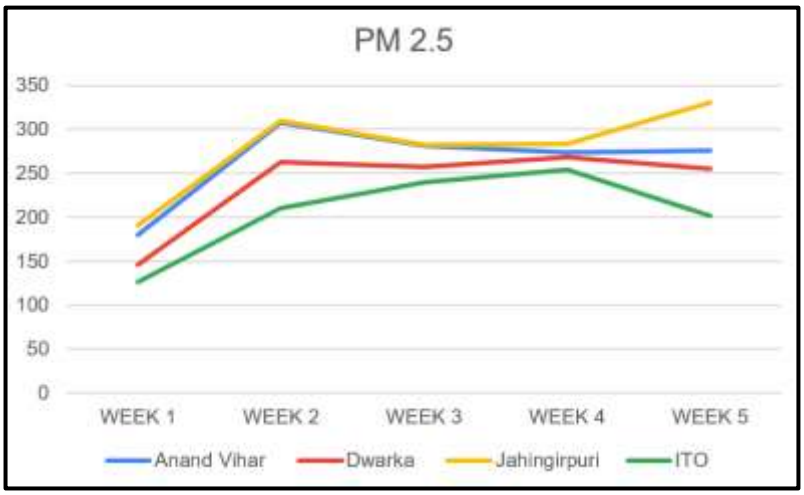


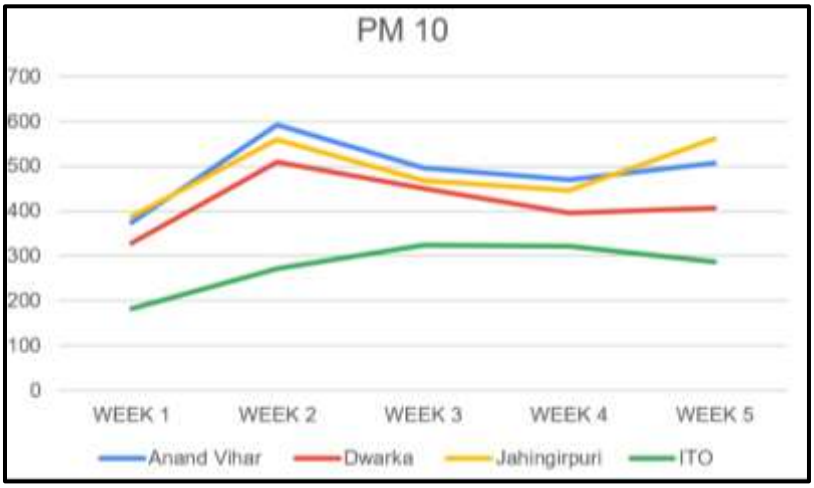


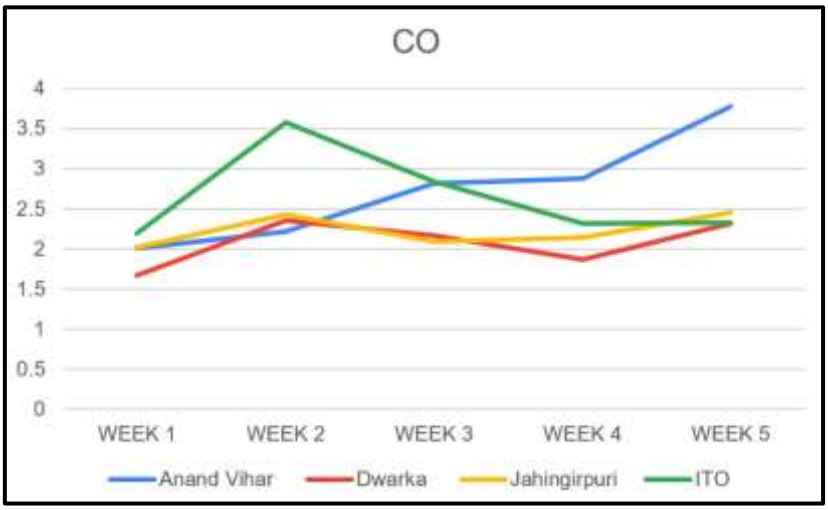
Week 1: 22 Oct-29 Oct. 2023 Week 2: 29 Oct.- 5 Nov. 2023

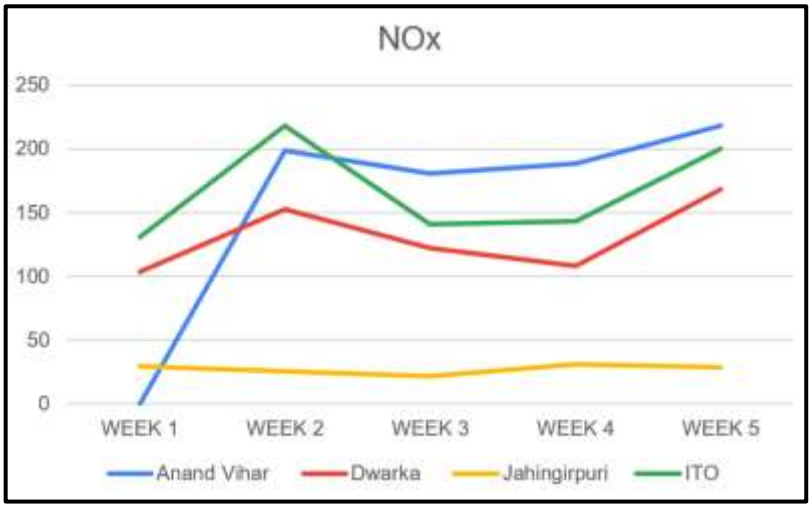
Week 3: 5 Nov- 12 Nov., 2023 Week 4: 19 Nov.- 26 Nov. 2023

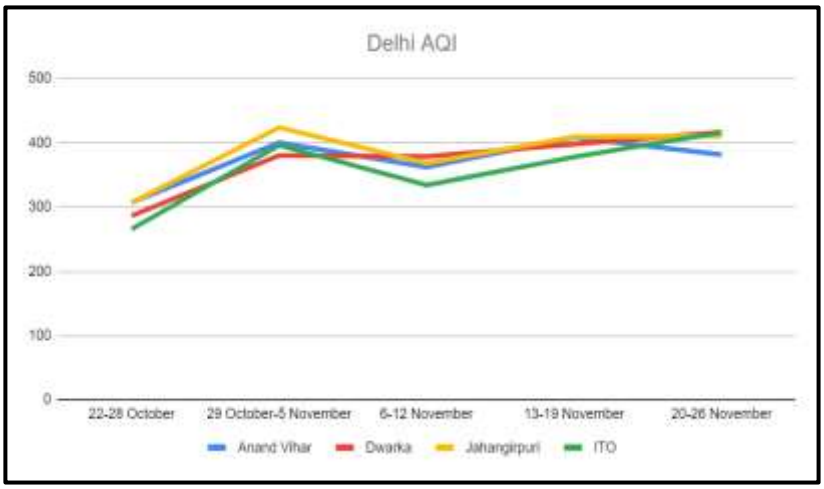
Graphs for 4 selected locations in Delhi

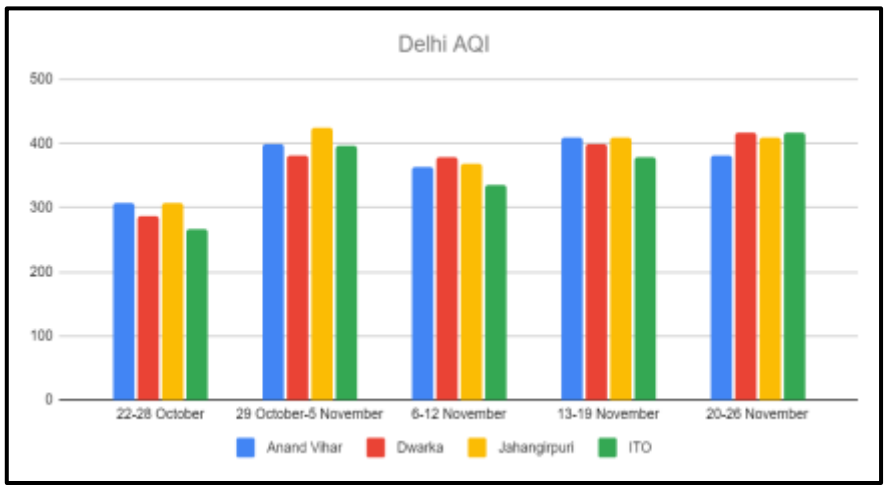












Week 1: 22 Oct-29 Oct. 2023 Week 2: 29 Oct.- 5 Nov. 2023

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Interpretation and Results

Stubble Burning

- Punjab and Haryana have a significant portion of their land used for crop cultivation, with a high percentage of farmers engaging in stubble burning.
- Short window period between harvesting paddy and sowing wheat, quickest disposal method, economic and practical constraints as alternatives to burning are often labour-intensive, expensive, or impractical, are important reasons for farmers opting for stubble burning.
- Stubble burning releases substantial quantities of various harmful pollutants, deteriorating air quality, contributing to haze, and damaging soil fertility by destroying essential microorganisms and nutrients. Exposure to these pollutants can cause respiratory and other health issues, including coughing, eye irritation, and asthma.
- The economic cost of stubble burning is substantial, estimated at Rs 2 L Cr annually.
- Residents of Delhi and Chandigarh have noticed worsening environmental quality over recent years, attributing it to stubble burning and firecrackers. factors.
- The GOI offers subsidies for agricultural mechanisation to manage crop residue and has legally classified crop residue burning as an offense.
- Many farmers do not burn stubble, and many Delhi and Chandigarh residents do not use firecrackers. Those who burn stubble burning have certain compulsions, while most firecracker users cite cultural and religious reasons.
- Pollution from stubble burning and firecrackers affects the health, outdoor activities, visibility, commuting time and productivity of Delhi and Chandigarh residents.

Bursting of Firecrackers:

- Firecrackers significantly increase atmospheric pollutants (PM_{10}, SO_2, NO_2, O_3). Studies show short-term spike in air pollution during Diwali, with PM levels often exceeding safe limits.
- Fireworks are deeply rooted in tradition, especially in India during Diwali, and hold longstanding cultural significance.
- Firecrackers contribute to air, soil, and water pollution by releasing toxic chemicals and debris that harm ecosystems.
- Exposure to firecracker pollutants can cause respiratory distress, skin irritation, and acute injuries.
- The noise from firecrackers can lead to temporary or permanent hearing damage.
- While the economic costs of firecracker pollution are high, the firecracker industry is a significant economic activity, particularly in regions like Sivakasi.
- The Supreme Court of India and the NGT(National Green Tribunal) have imposed restrictions on firecrackers, including a ban on non-green crackers and those with high emissions.

Conclusion

Both stubble burning and firecrackers harm the environment and public health. Stubble burning causes seasonal pollution spikes, particularly in agricultural regions, while firecrackers lead to severe short-term pollution during festive periods. Public awareness of these impacts is high, with many supporting measures to reduce pollution. Effective strategies for managing stubble burning include both in-situ and ex-situ management practices. Farmers need compensation to stop burning stubble and efforts must be

made to bring changes in the mindset and social behaviour of the farming community.

Fear of penalties alone will not effectively address the problem. To reduce stubble burning, we need effective enforcement of existing regulations, financial incentives, education and training and increased subsidies for alternative practices. Promoting green crackers and enforcing stricter bans on traditional firecrackers can help mitigate their environmental impact. Increase in financial incentives for farmers to adopt alternative residue management practices, enhance awareness programs about health and environmental impacts, and strict enforcement of burning bans are crucial for addressing stubble burning. Similarly, promoting the use of green crackers, raising public awareness of their environmental impact, and consistently enforcing bans during festive periods can be significant to address issue of firecrackers.

These findings underline the necessity for a multifaceted approach, combining regulatory measures and public awareness, to address the environmental and health challenges posed by stubble burning and firecrackers.

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