Vol. 4 Issue- 5, January 2024 (e-ISSN: 2582-8223)

JUST AGRICULTURE
multidisciplinary e-Newsletter

A Revolutionary Approach to Ending Stubble Burning in India

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ARTICLE ID: 02

Addressing Stubble Burning for Sustainability

A major challenge facing India is the provision of food grains for a growing population while maintaining the natural resource base. In addition to being a significant source of energy, food grains have a key role to play in food and nutritional security as well. However, harvesting a variety of crops creates a lot of residues, both on and off the farm. There is approximately 500 Mt of crop residues generated each year according to the Ministry of New and Renewable Energy. As a result of human labour shortages, high costs of removing residue from the fields, and mechanized harvesting of crops, the problem of 'on-farm' burning or stubble burning has become increasingly prevalent in recent years, contributing to severe air pollution in Northern India.

It is therefore important to find innovative solutions that can curb the menace of stubble burning in order to promote sustainable, healthy, pollution-free farming practices in order to curb the menace of stubble burning in agriculture.

Stubble Burning

A stubble burn refers to the act of setting on fire straw that has been left over after the harvest of grains, such as paddy, wheat, etc. There is a practice in India called stubble burning (parali) which is used to remove Paddy crop residues from fields in preparation for sowing wheat, which is done around the end of September and the beginning of November. Punjab, Haryana, and Uttar Pradesh are the primary states where this practice is prevalent during this time of year.

Effects of Stubble Burning

Environmental Degradation:

Stubble burning poses a substantial threat to air quality in India, particularly during November in north Indian states. The research conducted by Kaskaoutis et al. (2014)

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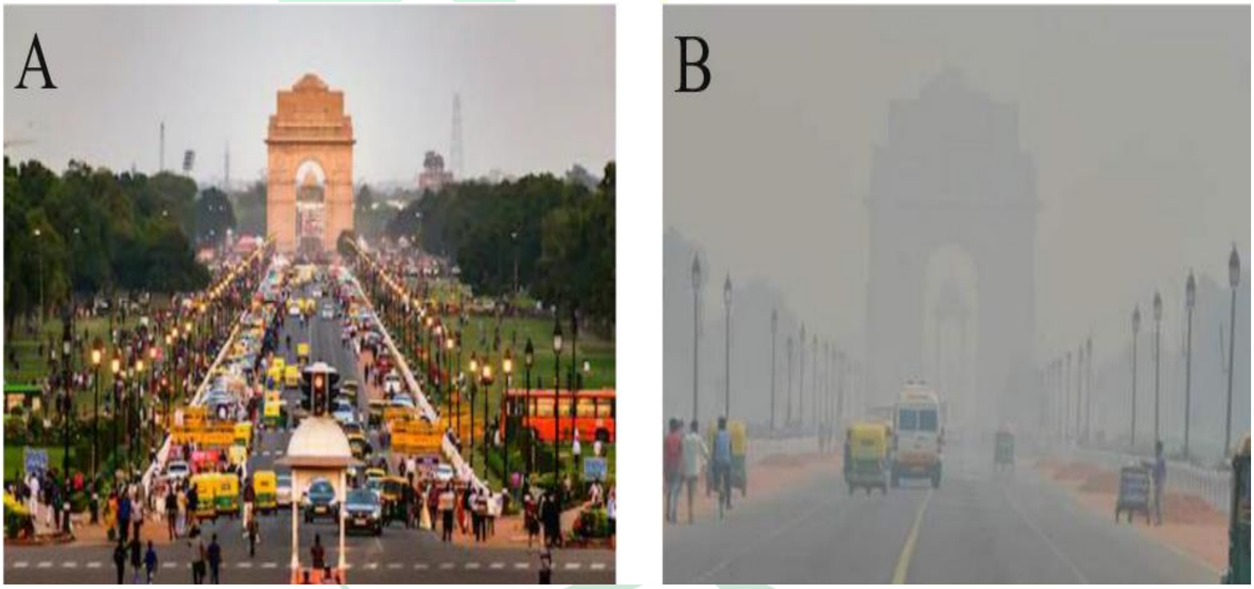
emphasizes the significant impact of agricultural burning on air quality, attributing it to the release of aerosols and gaseous pollutants. The concentration of PM2.5 and PM10, known for their adverse effects on health, increases notably during stubble burning periods. An analysis conducted by the World Bank in 2001 revealed that biomass burning contributes substantially to the concentration of PM2.5 in major Indian cities, reaching up to 70%. During the burning of rice stubble and wheat stubble in 2011, Delhi experienced a substantial increase in PM2.5 levels of 78% and 43%, respectively. While burning episodes were taking place in Delhi in 2015, Singh (2015) observed a notable 300 mg/m^3 increase in the hourly concentration of PM10. As a result of stubble burning, PM10 and PM2.5 concentrations rose by 86.7% and 53.2% respectively in Mandi-Gobindgarh city.



The pollution levels in Delhi before and during stubble burning periods are depicted in Figures (A) and (B).

Despite not being the primary pollution source, stubble burning significantly contributes to air pollution in India. Industrial and vehicular emissions also play pivotal roles, but stubble burning intensifies the problem during November, aggravating air quality indices. In 2019, Delhi, Ghaziabad, and Greater Noida recorded "severe" AQI values, prompting government interventions such as school closures and warnings against outdoor activities. The urgency to address stubble burning becomes evident as it exacerbates an already critical air quality situation in northern regions, necessitating comprehensive measures to mitigate its environmental impact.

Impact on Soil Properties:

Stubble burning not only harms air quality but also degrades soil productivity. Heat from burning residues elevates soil temperature up to 42°C, harming microorganisms at 2.5 cm depth. This leads to a loss of essential nutrients: 0.445 Mt NPK for rice stubble, 0.144 Mt for wheat, and 0.84 Mt for sugarcane waste annually (Jain et al., 2014). Replenishing soil fertility incurs additional costs for fertilizer or compost.

Impacts on Human Health:

Health risks associated with air pollution are especially high for vulnerable groups like children, pregnant women, the elderly, and people with health issues. There are lots of health issues associated with exposure, from skin and eye irritation to severe neurological, cardiovascular, and respiratory problems. As a result of chronic exposure, lung diseases such as asthma, COPD, bronchitis, and lung cancer may develop. Especially for children, fine particulate matter (PM2.5) penetrates the lungs and bloodstream, contributing to pulmonary dysfunction. PM2.5 pollution alone accounts for a substantial percentage of deaths in certain regions, causing respiratory issues, asthma, coronary diseases, tuberculosis, stroke, lung cancer, cardiac arrest, and acute respiratory infections. Farmers exposed to stubble smoke often experience eye and lung irritation, incurring significant medical expenses.

Mortality rates:

There has been a gradual increase in the number of deaths caused by air pollution in recent years. High levels of PM2.5 pollution affect 50% of India's population, surpassing WHO limits. With 49% lacking access to adequate healthcare, South Asian countries face a high incidence of premature deaths due to prolonged exposure. Respiratory disorders and cardiovascular mortality result from toxic inhalation. In India, over 600,000 dies prematurely annually due to air pollution, reducing Delhi's life expectancy by 6.4 years. Meeting WHO standards could extend life by 9 years. In Pakistan, air pollution causes 135,000 annual deaths. In 2017, India saw 1.24 million deaths, with 51% under 70 years attributed to air pollution. Trauma deaths increase by 2.3% with a 100 $\mu g/m^3$ rise in particulate matter.

Insufficient Stubble Management Infrastructure:

There are alarming statistics confirming the lack of appropriate stubble management infrastructure: farmers burnt almost 15.4 million metric tons of stubble (out of 19.7 MMT) in open fields due to an absence of proper infrastructure (Punjab government 2017). This practice, while environmentally detrimental, is preferred by farmers for its cost-effectiveness and expediency, enabling them to clear the land swiftly for the upcoming cropping season. However, the repercussions are far-reaching. The immense volume of stubble burnt not only releases a substantial amount of pollutants into the air but also contributes to soil degradation and reduced agricultural yields. As a result of the current reliance on quick, but unsustainable, practices for stubble management, there is a pressing need for enhanced infrastructure. In order to discourage farmers from burning, infrastructure improvements are needed in order to provide viable alternatives that balance efficiency with ecological sustainability and long-term agricultural viability.

Negative Effects of Subsidies for Agriculture:

Agriculture subsidies have historically been designed to enhance crop yields and productivity, but they have unintentionally contributed to detrimental environmental effects. One prominent issue is stubble burning exacerbation. Due to the increasing availability of subsidized inputs, certain farming practices have become heavily dependent on those that generate residues conducive to stubble burning.

Alternatives to Stubble Burning

Bio Enzyme-PUSA:

To address India's severe stump-burning problem, the Indian Agriculture Research Institute (IARI) has developed a bio enzyme called "Pusa decomposer."

In recent years, the Pusa decomposer has emerged as a sustainable and eco-friendly decomposer. Specifically, it facilitates the decomposition of crop residues, such as rice straw, without causing excessive pollution. Stubble is rapidly decomposed by spraying this bio enzyme on it and mixing it with water. Stubble will begin decomposing in 20-25 days after being sprayed with this enzyme, converting it into manure, which further improves soil health.

In recent years, a growing number of farmers have switched to bio enzymes, which have been shown to positively impact agricultural sustainability and mitigate environmental challenges.

Palletization:

Rice straw can be dried and compressed into pellets, which can then be mixed with coal as a fuel for thermal power plants and industries. In addition to conserving coal, it can also minimize carbon dioxide emissions in the atmosphere.

Figure: Paddy straw-based pellets

Paddy straw-based pellets can play a vital role in the domain of energy production in India by replacing or merging with the need for fossil fuel in an ecologically sustainable approach. Globally, there is an annual production of 731 metric tons (Mt) of paddy residues, with India alone generating approximately 171 metric tons (Mt) of these residues. It's extremely imperative to utilize the paddy residues to facilitate its wastage in the form of farm fires which is a major problem in the Northern India.

Happy Seeder:

Using happy seeder technology is the best way to manage residues and direct seed wheat in paddy fields. A tractor-mounted machine called the Happy Seeder is an alternative to burning the stubble, cutting and lifting rice straw, sowing wheat into the bare soil, and covering the sown area with the straw as a mulch to conserve moisture and reduce water consumption.

Figure: A Happy seeder operated for stubble management

Chhattisgarh Innovative Model:

The Chhattisgarh government has initiated a pioneering project known as the Chhattisgarh Innovative Model, which centers around the establishment of gauthans. Gauthans are designated five-acre parcels owned by individual villages where unused crop residues, or stubble (parali), are gathered through voluntary contributions termed parali daan (people's donations). These collected agricultural residues are then transformed into organic fertilizer by combining them with cow dung and natural enzymes. This innovative approach not only addresses the issue of stubble disposal but also promotes sustainable agricultural practices by converting agricultural waste into a valuable resource for enhancing soil fertility.

Biofuel Production:

Agricultural stubble in India, generating 1570 PJ annually, is effectively utilized for energy through combustion, gasification, or methanation. The Ministry of New and Renewable Energy (MNRE) has established 500 biomass-fueled power plants, contributing 11.5% to total renewable energy generation (8700.8 MW capacity). For example, the Jalkheri plant in Fatehgarh Sahib District, operating since 1992, uses crop stubble at 350 rupees/ton, providing additional income to farmers and reducing emissions. Another 7.5 MW plant in Gulabewella, Punjab, established in 2002 by Malwa Power Pvt Ltd., utilizes mustard and cotton stalks, rice husk, and sawdust, supplying 465.1 GWh to the grid from 2005 to 2015. The by-products (bottom ash and fly ash) from these processes find economic value in cement and brick manufacturing or road construction.

Additional Alternative Uses:

Scientists propose alternative uses for agricultural stubble to mitigate the harmful effects of burning. These include utilizing stubble for alcohol refineries, mushroom farming fodder, and boiler fuel for gasification. Other approaches involve producing bio-lubricants, nano-silica for solar cells and cosmetics, and exploring applications in pulp and paper manufacturing. Agricultural stubble also proves beneficial in the building sector, enhancing concrete properties and improving thermal characteristics of fired bricks. These sustainable practices aim to reduce stubble burning and promote eco-friendly alternatives.

Forward Strategy

- **Stubble Management Initiative:** In order to regulate post-harvest management at the grassroots level, schemes similar to the MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) should be introduced for harvesting and composting stubble. Efforts should be made to encourage farmers to dispose of stubble properly, encourage composting, and discourage the burning of stubble.

- **Incentivizing Stubble Reuse and Recycling:** Introduce incentives for farmers engaged in the efficient reuse and recycling of stubble. This approach aligns with sustainable agricultural practices and contributes to environmental conservation.
- **Deployment of New Crop Varieties:** The selection of varieties with short durations such as Pusa Basmati-1509 and PR-126 can be an effective strategy. The rapid maturity of these plants makes them a viable alternative to traditional crops while simultaneously improving soil health.
- **Enhancing Farmer Awareness:** A comprehensive education is essential to changing farmers' behavior. Stubble burning should be emphasized in awareness programs in order to protect human health and soil fertility. The promotion of environmentally friendly technologies is essential as part of these initiatives.

References

Abdurrahman, M. I., Chaki, S., & Saini, G. 2020. Stubble burning: Effects on health & environment, regulations and management practices. Environ. Adv. 2, 100011.

Jain, N., Bhatia, A., Pathak, H., 2014. Emission of air pollutants from crop residue burning in India. Aerosol Air Qual. Res. 14 (1), 422–430

Kaskaoutis, D.G., Kumar, S., Sharma, D., Singh, R.P., Kharol, S.K., Sharma, M., Singh, A.K., Singh, S., Singh, Atinderpal, Singh, D., 2014. Effects of crop residue burning on aerosol properties, plume characteristics, and long-range transport over Northern India: effects of crop residue burning. J. Geophy. Res-Atmos. 119 (9), 5424–5444.

Singh R.P., 2015. Impacts of stubble burning on ambient air quality of a critically polluted area–Mandi-Gobindgarh 3(2), pp. 6.