STUBBLE BURNING IN AGRICULTURE: CURRENT SCENARIO AND SUSTAINABLE SOLUTIONS

APARNA JAISWAL[1]*, ARADHANA KUMARI[1], VINITA PARTE[1], S K RAI[2]

[1]College of Agriculture, Ganjbasoda, Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur, Madhya Pradesh;
[2]College of Agriculture, Balaghat, Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur, Madhya Pradesh

*Corresponding Author, E-mail: rituparnika@gmail.com

Stubble burning, an easy method of discarding crop residues from the fields, adopted mostly by farmers of the rice-wheat growing belt of India, often posing challenges to environment and human health. Burning of paddy stubbles in the field has become a common practice in the Indo-Gangetic plains during the months of October and November to grow subsequent wheat crop. Air pollution in the Indian National Capital Region due to stubble burning in Punjab and Haryana region reported every year during the early months of winter season. Prolonged exposure to air pollution from stubble burning can cause or worsen conditions like asthma, bronchitis, and other respiratory diseases. Studies of Verma et al (2019) revealed an exponential rise in residue burning in Madhya Pradesh (Figure 1). Interestingly, agricultural residue fires were reported to be high after the harvest of winter wheat crop (*Rabi* season) than that of *Kharif* harvesting season.

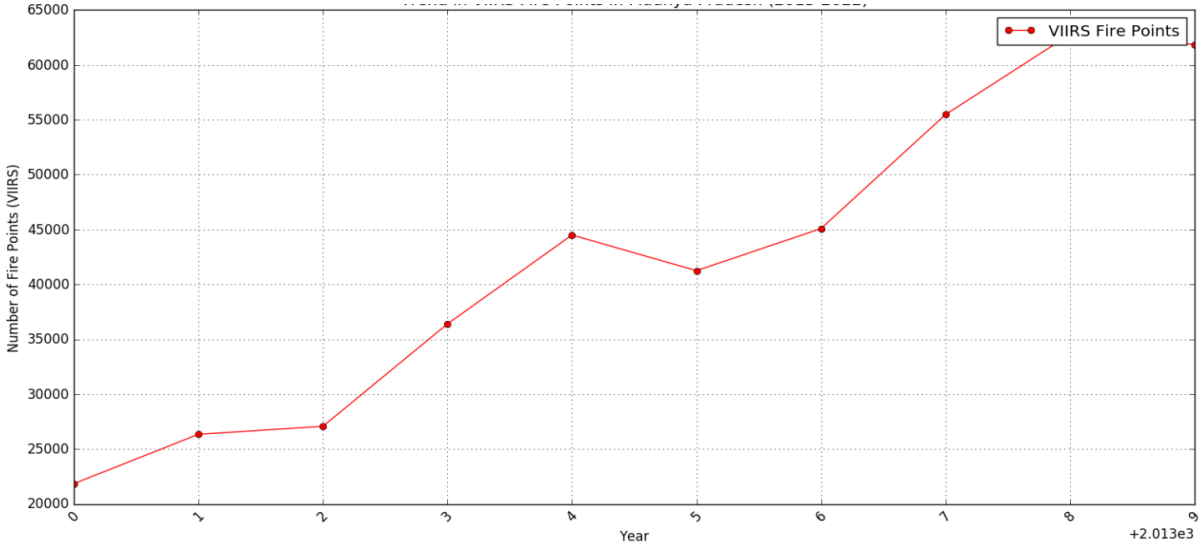

Figure 1. Incidents of stubble burning in Madhya Pradesh during 2013-2022 (Source: https://india.mongabay.com)

According to satellite-based study conducted by Verma et al (2019), India's greenhouse gas emissions from crop residue burning also increased 75 per cent over the past decade with Madhya Pradesh accounting for the second-largest area under farm fires after Punjab. The study carried out by the Indian Institute of Science Education and Research, Bhopal, covering 602 districts of all the Indian states except the Northeast region generated the first nationwide, district-level estimates of agricultural area burned and emissions from the fires. The study revealed that despite the efforts of Indian Government to prevent agriculture residue burning, by launching programmes and policies since 2014, crop residue burning is an extensive practice in India (Deshpande et al, 2023). The study shown an increase in the total agricultural area burned in the country from 3 million hectares (in 2011) to 4.5 million hectares (in 2020) with 21% increase in the states along the Indo-Gangetic plains. In other states, even though there was 37% decrease in burnt area during 2011-15, then increased by 245%. This caused an exponential growth in India's GHG emissions from about 19,340 billion grams per year to more than 33,800 billion grams per year in a span of 10 years.

Researchers working on issues associated with residue burning stress that many farmers in states like Madhya Pradesh are largely unaware of policies that discourage crop residue burning and alternative crop residue management options. While farmers opt for stubble burning to clear farm fields quickly for the next crop cycle, its consequences are far-reaching and contribute to countless problems. In this regard it is important to understand why farmers adopt field fires avoiding the government-imposed regulations and restrictions. Based on the available literature it is observed that these detrimental practices are often result of a combination of economic, logistical, and traditional factors. Some of them are explained below.

Time Constraints: Being a quick and efficient method of clearing crop residue from the farm fields, stubble burning helps farmers to save enough time for land preparation for the succeeding crop after the harvesting the first crop particularly when the time gap between two crop seasons is too short due to long crop duration of the two crops like that of rice-wheat system.

Cost-Effective: In regions where farmers have limited access to on-farm resources and low-cost technologies that facilitate removal of crop residue or their recycling, farmers normally prefer the most cost-effective solution available i.e., field burning. In fact, burning of stubbles require relatively low investment compared to manual clearing or using machinery for residue removal.

Labor Shortage: Shortage of agricultural labor during peak crop seasons is a common phenomenon in Indian villages. Involvement of family labour in farming is also declining largely due to the migration of unemployed rural youth from villages to other regions in search of better living opportunities. This situation drives farmers to choose burning as a quick and less labor-intensive method for clearing fields especially when the labor-intensive alternatives are costly for them.

Traditional Practices: In some areas, stubble burning is a deeply ingrained traditional practice passed down through generations. Here, farmers may be resistant to shift from the practice due to cultural or historical reasons that view field burning as a customary and efficient way of crop residue management.

Limited Access to Technology: Lack of access to modern agricultural machinery for residue management can also lead farmers to rely on traditional methods like burning. In regions where technology adoption is slow, farmers may not have the means to implement more sustainable alternatives.

Weather Conditions: Weather conditions, such as unseasonal rains or unexpected delays, can disrupt regular farming practices. In such situations, farmers may resort to burning as a quick solution to avoid further complications in their planting schedules.

Limited Awareness: Farming communities of rural India mostly do not have clear awareness about the environmental and human health hazards associated with stubble burning due to many reasons. Also, their limited access to information sources and agricultural technology providers keeps them uninformed about sustainable agricultural practices, and continue with the practices like agriculture residue fires as a convenient waste disposal method.

Addressing the issue of stubble burning requires a holistic approach that considers the socio-economic context of farmers, promotes awareness, and provides viable alternatives that align with both environmental sustainability and economic feasibility.

PROBLEMS ASSOCIATED WITH STUBBLE BURNING

Impact on Air Quality: It is one of the most significant impacts of stubble burning due to the release of pollutants into the air. The combustion of crop residues releases particulate matter, carbon monoxide, and volatile organic compounds, contributing to degraded air quality and that in turn cause serious health implications in both rural and urban populations.

Contribution to Climate Change: Stubble burning releases significant amounts of GHGs to the atmosphere and that further contribute to global warming and climate change. Mohammad et al. (2020) reported that 63 mt of burning residue produce 90 mt of carbon dioxide, 3.3 mt of carbon monoxide, and 0.7 mt of methane.

Impact on Soil Health and Biodiversity: Burning crop residues leads to the loss of organic matter from soil and affects fertility, water retention capacity, and overall health of agricultural soils. Additionally, intense heat from stubble burning affects the biodiversity, by eliminating many native plant species, destroying the natural habitat of small animals, earthworm population, and beneficial soil macrofauna and microflora. This in turn, disrupts the ecosystem sustainability and affects agriculture and agri-based food chains.

Waste of Resources: Burning of stubbles represents a wasted resource since they can potentially be utilized for soil covering as mulch, soil incorporation to add soil organic matter, bioenergy production, recycled to bales which have other alternative uses, and composting.

Regulatory and Legal Consequences: In India, Central and State Governments has implemented strict regulations and penalties to discourage the stubble burning practice realizing its detrimental effects. Hence, farmers who continue with stubble burning practice may face legal consequences, adding another layer of disadvantage to this unsustainable method.

WAYS FOR RECYCLING CROP RESIDUES

Soil Covering and Soil Incorporation: Using crop residue as a mulching material or soil incorporation of residue results improved moisture retention capacity of soil, add organic matter to soil, improves soil structure, soil fertility, encourages beneficial microbial population and overall soil health. Besides, mulching suppresses weeds growth and regulate soil temperature.

Composting: Composting crop residues by mixing them with other organic materials like manure, kitchen scraps, or green waste produces low-cost nutrient-rich organic manure for crops.

Mushroom Cultivation: Certain crop residues can be used as substrates for mushroom cultivation. Here, mushrooms provide additional income to farmers but, use of waste mushroom substrates for composting enhances their additional income.

Bioenergy Production: Converting crop residues into biomass fuel through processes like anaerobic digestion or combustion not only provide a sustainable energy source but also reduce the need for fossil fuels.

Livestock Feed: Use of crop residues as a livestock feed depends upon the crop type and treatment. Some crop residues particularly that of cereals have much value as a feed material. Hence, farmers can make use of these residues for additional income generation.

Biodegradable Packaging Material: Use of residues for making packaging materials is a potential venture. Biodegradable items have an increasing market as they will reduce our reliance on non-biodegradable material and pollution due to non-biodegradable materials.

Raw Material of Paper and Pulp: Further, exploring ways to use crop residues for the production of paper and pulp contribute to sustainable forestry practices by reducing the demand for wood-based raw materials.

Textile Industry: Exploring the possibility of using crop residues in the textile industry. Innovations in sustainable fashion and textile production may find ways to incorporate these residues into fabric production.

EFFECTIVE WAYS TO STOP THE BURNING OF STUBBLES

To stop stubble burning practice, a comprehensive and collaborative approach need to be developed, involving farmers, policymakers, and the society. Some effective ways to address and mitigate stubble burning are:

Promotion of Alternative Practices for Stubble Management: Encouraging and educating farmers about alternative practices such as mulching, ploughing residues back into the soil or using them for compost. This can be done by organizing community awareness campaigns, training programmes, farmers' seminars etc. Empowering farmers with the knowledge and skills to implement sustainable practices on their farms and educating them about the long-term benefits of sustainable agricultural practices to the environment as well as their well-being, can potentially reduce the rate of stubble burning to a greater extent.

Incentives: Providing financial incentives or subsidies to farmers who adopt sustainable crop residue management practices can offset the perceived economic disadvantages of alternatives to burning. Technological and financial support to initiatives that make use of crop residues for various purposes, such as biomass energy production, animal fodder, or industrial applications, motivate more people to come up with small business ideas utilizing agricultural waste.

Access to Technology: Improving access to various machineries designed for crop residue management practices like mulching, ploughing, and incorporating crop residues back into the soil, making these methods more accessible and feasible for farmers.

CONCLUSION

The disadvantages of stubble burning are multifaceted, impacting air and soil quality, and biodiversity, and contributing to climate change. It is the need of an hour to create a comprehensive and sustainable approach to curb stubble burning, protecting both the environment and the livelihoods of farmers. Farmers, policymakers, and communities should collaborate to find alternative, sustainable methods for managing crop residues. In-situ management, using Zero Till Planter and Drill machines are also promising in order to reduce residue burning. By adopting innovative agricultural practices, we can mitigate the negative consequences of stubble burning and work towards a more environmentally friendly and sustainable future.

REFERENCES

Deshpande, M.V., Kumar, N., Pillai, D., Krishna, V.V, Jain, M. 2023. Greenhouse gas emissions from agricultural residue burning have increased by 75 % since 2011 across India. *Science of The Total Environment,* 904:166944.

Muhammad, I., Abdurrahman, Sukalpaa, C., Saini G. 2020. Stubble burning: Effects on health & environment, regulations and management practices, *Environmental Advances*, 2:100011.

Verma, S., Dar, J.A., Malasiya, D., Khare, P.K., Dayanandan, S., Khan, M.L. 2019. A MODIS-based spatiotemporal assessment of agricultural residue burning in Madhya Pradesh, India. *Ecological Indicators*, 105:496-504.

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