AGRI MAGAZINE
(International E-Magazine for Agricultural Articles)
Volume: 02, Issue: 07 (July, 2025)
Available online at http://www.agrimagazine.in

Stubble Burning in Agriculture

*Dibyajyoti Das
M. Sc. Scholar, Department of Agricultural Meteorology, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha-751003, India
*Corresponding Author's email: dibyajyotidas179@gmail.com

Stubble burning, the practice of intentionally setting fire to crop residues left after harvesting grains like rice and wheat, is a widespread agricultural method, particularly in regions like northern India, China, and parts of North America. While it offers a quick and cost-effective way to clear fields for the next planting season, its environmental and health consequences have made it a pressing global concern. This article explores the reasons behind stubble burning, its detrimental effects, and sustainable alternatives to mitigate its impact.

Causes of Stubble Burning

Stubble burning is driven by a combination of practical, economic, and systemic factors:

1. Time Constraints: In regions like Punjab and Haryana, India, farmers face tight schedules between harvesting rice (in October-November) and sowing wheat (by mid-November). Mechanized harvesting, using combine harvesters, leaves behind significant crop residue, which farmers burn to quickly prepare fields. Manual residue removal is time-consuming and labor-intensive, making burning an attractive option.

2. Economic Factors: The cost of alternative residue management methods, such as purchasing or renting machines like the Happy Seeder, can be prohibitive for small and marginal farmers. For instance, a Happy Seeder requires a tractor, with combined costs up to $15,000, which many farmers cannot afford. Additionally, rice straw, particularly non-basmati varieties, has high silica content, making it unsuitable as animal fodder without processing, further limiting its utility.

3. Lack of Awareness and Infrastructure: Many farmers are unaware of viable alternatives or lack access to residue management infrastructure. In northern India, despite government subsidies for crop residue management machines, their availability and affordability remain challenges. Traditional practices and a lack of awareness about the environmental impact of burning also perpetuate the practice.

4. Policy-Induced Pressures: In India, policies like the Punjab Preservation of Subsoil Water Act (2009) delay paddy sowing to conserve groundwater, compressing the time available for field preparation. This leaves farmers with little choice but to burn stubble to meet sowing deadlines.

Environmental and Health Impacts

Stubble burning has severe consequences for the environment, human health, and agriculture:

1. Air Pollution: Burning crop residue releases significant pollutants, including particulate matter (PM2.5 and PM10), carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), and sulfur oxides (SOx). In India, stubble burning contributes to 14-35% of Delhi's PM2.5 levels during October-November, exacerbating smog and reducing air quality to hazardous levels. A 2017-2018 estimate suggests India's stubble burning emits 176.1 million tons of CO_2, 10 million tons of CO, and 0.453 million tons of PM2.5 annually.

2. Health Risks: The pollutants from stubble burning are linked to respiratory illnesses like asthma, bronchitis, and chronic obstructive pulmonary disease (COPD). Prolonged exposure increases risks of lung cancer and eye disorders, such as cataracts. In rural Punjab, health treatment costs for ailments linked to stubble burning are estimated at Rs 7.6 crore annually. Children and the elderly are particularly vulnerable.

3. Soil Degradation: Burning destroys beneficial soil microflora and fauna, disrupts the carbon-nitrogen balance, and reduces organic matter. It results in the loss of nutrients like nitrogen (up to 90%), phosphorus, potassium, and sulfur, increasing fertilizer costs for farmers.

4. Climate Change: Stubble burning contributes to greenhouse gas emissions, accelerating global warming. It also affects regional climate patterns, with smoke contributing to haze and reducing visibility, particularly in northern India during winter.

Sustainable Alternatives

To address stubble burning, governments, researchers, and organizations have proposed several sustainable solutions:

1. Technological Interventions:

Happy Seeder: This tractor-mounted machine cuts and lifts straw, sows seeds, and deposits residue as mulch, reducing the need for burning. Despite its effectiveness, high costs and limited availability hinder adoption.

PUSA Bio-Decomposer: Developed by the Indian Agricultural Research Institute, this enzyme decomposes stubble into manure in 20-25 days, improving soil fertility and reducing emissions. Its use is expanding, with Haryana applying it on 121,000 hectares in 2021.

Crop Residue Management Machines: Tools like rotavators, zero-till seed drills, and balers help incorporate or collect residue. Subsidies for these machines have been provided in states like Punjab and Haryana, with over 200,000 machines distributed since 2018.

2. Alternative Uses for Crop Residue:

Bioenergy: Residue can be converted into biomass briquettes, bioethanol, or used in power plants, offering economic benefits. For example, Punjab has initiated bio-ethanol plant projects, though delays and community protests have posed challenges, consequences and solutions.

Compost and Fodder: Stubble can be processed into compost, cattle feed, or used for mushroom cultivation, paper production, and packaging materials. The Gauthan model in Chhattisgarh collects residue for organic fertilizer production, creating jobs and reducing burning.

Rice Bio-Parks: Proposed by agricultural scientist M.S. Swaminathan, these facilities convert stubble into products like cardboard and animal feed, promoting a circular economy.

3. Crop Diversification: Shifting from water-intensive crops like paddy to maize, millets, fruits, or vegetables reduces residue and conserves water. In 2022, Punjab announced minimum support prices (MSP) for maize, bajra, sunflower, and moong to encourage diversification.

4. Policy and Awareness:

Subsidies and Incentives: Governments should expand subsidies for residue management machines and incentivize non-burning practices. Haryana offers Rs 1,000 per acre for farmers avoiding burning.

Awareness Campaigns: Educating farmers about the environmental and economic costs of burning is crucial. In Ambala, Haryana, an IAS officer reduced stubble burning by 80% through awareness and alternative methods.

Stricter Enforcement: Despite bans under India's Air and Pollution Control Act (1981) and fines by the National Green Tribunal, enforcement remains weak. Proactive measures, like Punjab's Crop Residue Management Loan Scheme, aim to support farmers in adopting alternatives.

Challenges and the Way Forward

While alternatives exist, their adoption faces hurdles. High costs of machinery, limited infrastructure, and farmer skepticism due to time constraints or low MSP for alternative crops discourage change. For instance, shorter-duration paddy varieties like PUSA-1509 produce less residue but lack MSP support, making them less attractive. Additionally, only 44% of rural Indian households believe stubble burning contributes to pollution, highlighting the need for awareness.

To address stubble burning effectively, a multi-pronged approach is necessary:

Scale Up Infrastructure: Increase access to affordable residue management machines and bio-decomposers.

Policy Reforms: Review policies like MSP and water conservation acts to balance environmental and agricultural goals.

Public-Private Partnerships: Encourage industries to convert residue into viable products, creating economic incentives for farmers.

Farmer Education: Expand awareness campaigns to shift mindsets and promote sustainable practices.

Conclusion

Stubble burning remains a complex challenge rooted in agricultural, economic, and policy dynamics. Its environmental and health impacts, particularly in northern India, underscore the urgency for sustainable solutions. By combining technological innovations, alternative residue uses, and robust policy support, governments and communities can transform crop residue from a pollution source into a valuable resource, fostering a greener and healthier agricultural future.

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