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Crop Residue Burning: Its Impact and Management

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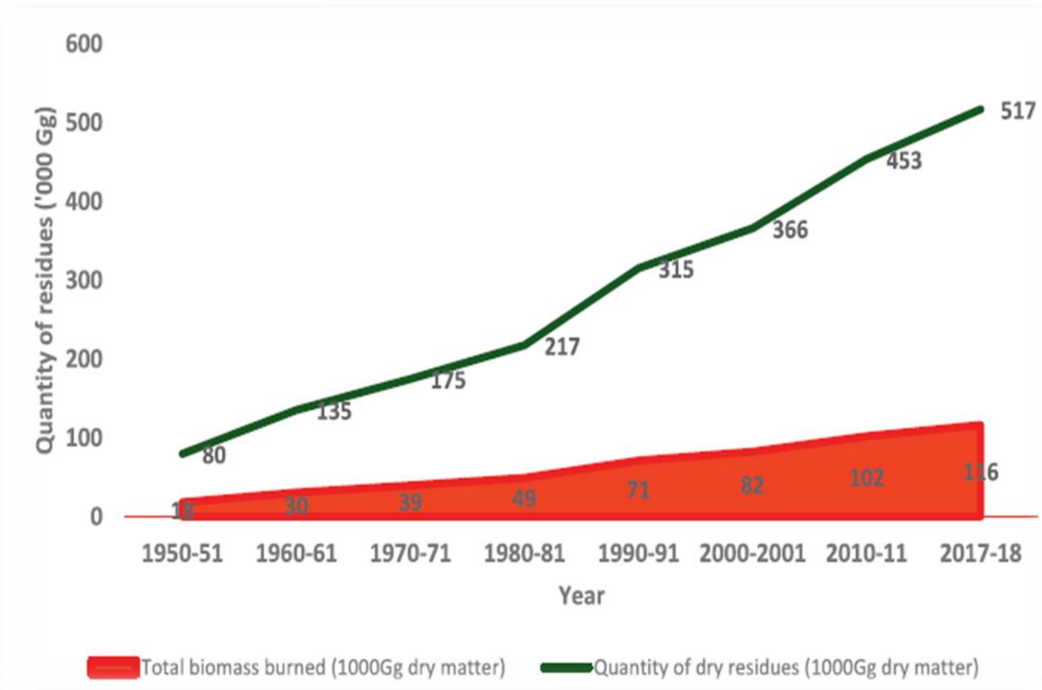
Introduction

India being the second largest agro-based economy with year-round crop cultivation, generates a large amount of agricultural waste, including crop residues. A huge amount of land is used for farming and a wide range of crops are cultivated in its different agro-ecological regions. Crop residue burning has developed into a significant environmental issue that affects human health and contributes to global warming. The global economic expansion is greatly influenced by the agricultural sector. The world's food output has greatly increased as a result of the rising food demand in developing nations. Consequently, agro-based industries are lucrative ventures in both developed and developing nations. Agro-product production is increased by the diversity of agricultural practices, which has resulted in an overall rise in waste production and environmental damage. According to the Indian Ministry of New and Renewable Energy (MNRE), India generates on an average 500 million tons of crop residue per year. However, there is still a surplus of 140 Mt out of which 92 Mt is burned each year (NPMCR, 2019). Agricultural residues are the biomass that remains in the field after the economic grain components have been harvested. During harvest times, a lot of agricultural wastes are produced each year, including sugarcane leaves and tops, woody stalks, and cereal straws. But a significant amount of the crop wastes are not used and are instead abandoned in the fields. It is quite difficult to dispose of such a vast number of crop waste. The crop wastes are burned in situ to quickly and cheaply clear the field and allow tillage practices to move forward unhindered by leftover crop material. Farmers choose burning because it is a quick and simple approach to deal with the massive amounts of crop residues and get the field ready for the following crop well in advance. Agricultural residues burning may emit significant quantity of air pollutants like CO_2, N_2O, CH_4, emission of air pollutants such as CO, NH_3, NOx, SO_2, volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) and particulate matter like elemental carbon at a rate far different from that observed in savanna/forest fire due to different chemical composition of the crop residues and burning conditions (Zhang *et al*., 2011, Mittal *et al*., 2009).



(Source: Venkatraman *et al*., 2021)

Fig 1: **TREND OF CROP RESIDUE BURNING**

Why Farmers Are Burning Crop Residues?

First reason is lack of crop residue management strategies and lack of awareness among the farmers. Farmers have been burning large quantities of crop residues, particularly in areas with high yield potential due to its interference with tillage and seeding operations for the next crop. They will have to invest to water the fields to decompose the stubble. Many farmers cannot afford extra money to rent a tractor and plough stubble into the earth where they can decompose. Waiting period of 1 to 2 months for stubble to decompose is another factor. Harvesting crops with the help of machines makes stubbles unusable for use as fodder. On the other hand, turn around period of one to two months for stubble decomposition does not facilitate timely planting. Burning of crop residue clears the land quickly and it is a very easy procedure to be followed. However, because of increased mechanization, particularly the use of combine harvesters, declining numbers of livestock's, long period required for composting and unavailability of alternative economically viable solutions, farmers are compelled to burn the residues. For harvesting rice and wheat crops, combine harvesters are widely utilized in central and eastern Uttar Pradesh, Uttarakhand, Bihar, Rajasthan, Madhya Pradesh, and in the southern regions as well. The lack of labor, high harvesting season salaries, simplicity of harvesting and threshing, and weather uncertainty are the main factors contributing to the rapid development in the use of combine harvester. About 80% of the leftovers from combine harvesting are left in the field as loose straw, where they are eventually burned on farms.

Fate of Crop Residues:

Traditionally crop residues have numerous competing uses such as animal feed, roof thatching, packaging fodder, fuel and composting. The residues of cereal crops are mainly used as cattle feed. Rice husk and straw are used as boiler fuel or as fuel for heating homes. Crop residues are either used by farmers directly or sold to middlemen or landless people who then sell them to industry. The residual waste is either burned on-site or left unused. The estimated surplus of crop wastes in India ranges from 91 to 141 Mt. The contribution of cereals and fibre crops is 58% and 23%, respectively, with the remaining 19% coming from other crops like sugarcane, pulses, and oilseeds (MNRE, 2009). Domestic fuel is made from coconut shells, rapeseed and mustard stalks, pigeon pea, jute, mesta, and sunflower. In the majority of the country, sugarcane tops are either burned on-farm to grow a ratoon crop or utilised as feed for dairy cows. Cotton, chilli, pulse, and oilseed crop leftovers are primarily used as fuel for domestic purposes. Groundnut leftovers are used as fuel in lime and brick kilns.

Adverse Effect of On-Farm Burning of Crop Residues:

Crop residue burning releases smoke and soot particles that are harmful to both human and animal health. Additionally, it causes the loss of plant nutrients like N, P, K, and S as well as the production of greenhouse gases like carbon dioxide, methane, and nitrous oxide, which contribute to global warming. Burning crop wastes is a waste of important resources that could be used to generate energy, feed, and carbon for rural homes and small businesses. Crop residue burning produces heat that raises soil temperature and kills active beneficial microbial populations, although the effect is only temporary because the bacteria quickly recover. However, frequent field burning permanently reduces the microbial population. The overall impact of all these pollutants on the environment and human health is disastrous. Numerous scientific studies have connected this exposure to pollution to a number of issues, primarily affecting the heart and lungs. Such contaminants are also connected to early death in patients with heart or lung illness. Methane (CH_4), carbon monoxide (CO), nitrous oxide (N_2O), oxides of nitrogen (NO_X), sulphur (SO_X), and other trace gases that are chemically and radioactively significant are among the hydrocarbons and other trace gases that are significantly released into the atmosphere as a result of burning agricultural waste. Additionally, it releases a significant amount of particles made up of a diverse range of organic and inorganic substances. One ton of rice straw on burning releases about 3 kg particulate matter, 60 kg CO, 1460 kg CO_2, 199 kg ash and 2 kg SO_2 (Gadi, 2003). Numerous contaminants that are present in high concentrations in biomass smoke are known or suspected carcinogens and could pose a serious threat by contributing to a number of lung and airborne ailments. Many crop wastes, particularly those in the form of straw, are excellent feed for dairy animals. These are wasted after being burned. When the severe lack of animal feed is taken into account, this loss becomes more serious.

Management Strategies for Crop Residues:

The previous 50 years have seen a substantial improvement in Indian agriculture. In India, there are numerous methods for managing crop waste. In USA, on-farm burning is restricted in various states. For example, in California farmers require a permit for crop residues burning, which can be carried out only on 'burndays' determined by the local authorities in consultation with the California Air Resource Board. Land deterioration can be stopped through conservation agriculture, which is a practical option for sustainable agriculture. Recent estimates have shown that conservation agriculture-based resource conserving technologies (RCTs), such as raised bed planting, crop diversification, unpuddled mechanical transplantation of rice, zero/reduced tillage, direct drilling of seeds, and direct seeding of rice, are being applied. These advancements in residue management save burning of straw, increase soil organic C, improve input efficiency, and perhaps lower GHG emissions (Pathak et al. 2011). However, various variations of zero-till seed-cum-fertilizer drill/planters have been created, including the happy Seeder, turbo Seeder, and rotary-disc drill, permitting direct drilling of seeds even in the presence of surface wastes. These machines are highly helpful for controlling weeds, monitoring soil temperature, managing crop leftovers, and saving moisture and nutrients. Ploughing is the main method for fully or partially incorporating crop leftovers into the soil. Power tillers can include the above-ground section that has been chopped into little pieces. It increases soil organic matter and soil N, P and K content as

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compare to other management option. Surface retention and mulching in which leaves straw residues from a previous crop on the soil surface without any form of incorporation. It protects the fertile surface soil against wind and water erosion. To reduce crop residue burning there are some alternate uses of crop residue burning like livestock feeding, compost making, energy source, bio fuel and bio-oil production, biochar production, increase diversification of important bio agents, gasification and managing crop residues with conservation agriculture developing crop varieties having high root biomass.

Diversified use of crop residue as fuel for power plants, production of cellulosic ethanol, use of crop residue, rice straw in paper/board/panel and packing material industry. Collection of crop residue for feed, brick making, etc. and extending subsidy for transport of crop residue to fodder in deficient areas. Capacity building and awareness generation can be done by organizing training of farmers for creating awareness about effects of crop residue burning, adoption of conservation agriculture practices and resource conservation technology through all ongoing State/Centre Sector Schemes. Besides this, creation of awareness about various measures to prevent crop residue burning through mass media, print media, etc. just before the harvesting seasons. Demonstrations of crop residue management technology on a large scale by the State Department of Agriculture and other Government Institutions can be encouraged.

Conclusion

The management of agricultural waste sustainably has grown to be a significant concern, particularly for emerging nations like India with rising populations, production rates, and economic growth. Crop residues are one type of agricultural waste that has presented unique issues because of its enormous volume and lack of management tools. The soil resource base must be robust and healthy for agriculture to be sustainable and to ensure the nation's food security in both the short- and long-term perspectives. Crop leftovers play a key role in conservation agriculture, which is an efficient response to the aforementioned problems and maintains a solid foundation of natural resources. To reduce the amount of crop residue burning through various programs, the Indian government has made numerous interventions. The following technologies can be used to extract energy from crop residues: pyrolysis, direct combustion, gasification, carbonization, ethanol synthesis, liquefaction, and bricking. It will assist meet energy demand and enhance the nation's economic situation in addition to lowering air pollution and addressing climate change. Incorporation, surface retention and mulching, baling and removing the straw, no tillage, feeding, and other methods can also be used to harvest energy from agricultural leftovers. In contrast, incorporation outperforms other techniques in terms of crop productivity and soil fertility.

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