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Crop residue management: A way to reduce environmental pollution

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ABSTRACT

Crop residue management (CRM), a cultural technique that maintains more residues from the preceding crop and involves fewer and/or less intensive tillage operations, is intended to assist safeguard soil and water resources and offer extra environmental advantages. While preserving or improving crop yields, CRM is typically cost-effective in meeting conservation standards and lowering fuel, machinery, and labor expenses. India is an agrarian economy. In different agro-ecological areas, a wide variety of crops are grown on a large percentage of the country's territory. With the production of 112.18 million tons (Mt) of wheat, 120.0 Mt of rice, 35.91 Mt of maize, 17.52 Mt of millets, 399.25 Mt of sugarcane, 8.1 Mt of fiber crops (Jute, Mesta, Cotton), 28.0 Mt of pulses, and 41.15 MMT of oilseeds crops in the 2020-21 crop year ({Directorate of Economics & Statistics, MOA, DAC, New Delhi (final estimate-2020-21), it is only natural that a significant amount of crop residues are produced both. The entire country produces 500-550 Mt of crop leftovers annually, according to estimates. The simplest and most widely used technique adopted by farmers is burning wastes. Burning leftovers degrades soil quality and pollutes the environment. Remainder burning kills bacteria and renders soil infertile. In addition, macro and micronutrients are easily volatilized as a result of soil residue burning. Therefore, the management of agricultural crop residue is of major significance to several scientific communities. It is required to use a wide range of management techniques to address this problem, and including mechanization into the solution expands the potential applications for agricultural leftovers in the future. Crop residue management enhances the quality of the soil and the ecosystem. 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. Crop residue burning is a waste of precious resources that could be used to produce carbon, bioactive chemicals, feed, and energy for rural households and small businesses.

KEYWORDS

Crop Residue, Plant Nutrient, Burning, Global Warming, Green House Gases, Environmental Pollution, Soil Fertility

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India sustains around 17.6% of the world's population but just 2.4% of its geographical area and 4.2% of its water resources, demonstrating the fact that our natural resources are under a lot of stress. One of our key challenges is the requirement to provide food grains for a growing population while maintaining the natural resource base (Bawatharani *et al.*, 2015).

Because they are a significant source of energy, food grains are essential for a secure supply of food and nourishment. Food grains would thus continue to be the primary pillar of food security, and of all the crops produced, rice, wheat, and pulses continue to make up the staple diet of the majority of rural residents.

As per available estimates (Directorate of Economics & Statistics, MOA, DAC, New Delhi, final estimate, 2020-21). India produced about production of 112.18 million tons (MT) of wheat, 120.0 MT of rice, 35.91 MT of maize, 17.52 MT of millets, 399.25 MT of sugarcane, 8.1 MT of fiber crops (Jute, Mesta, Cotton), 28.0 MT of pulses and 41.15 MT of oilseeds crops in the 2020-21 crop year. Rice, wheat and sugarcane are three crops that are most vulnerable to crop waste burning.

Farmers favour these crops because they offer a larger financial return than other crops do. The surrounding rice-wheat-dominant regions of western Uttar Pradesh and Haryana, where enormous amounts of rice and wheat crop leftovers are produced but their disposal is a challenge due to a lack of dairy and draught animals are also known for growing rice, sugarcane and wheat. Therefore, agricultural residue management stands a decent chance of succeeding in this crucial strategic area.

Fig 1. Crop residues after the harvest and Plowing

Many agricultural harvesting processes produce a significant amount of residues, both on and off the farm. Around 500 MT of crop leftovers are produced annually, according to the Ministry of New and Renewable Energy's estimate. Punjab (51 MT), Uttar Pradesh (60 MT) and Maharashtra (51 MT) produce the most crop leftovers (46 MT). Cereals provide the most residues of any crop (352 MT), followed by fibres (66 MT), oilseeds (29 MT), pulses (13 MT) and sugarcane (36 MT) (12 MT). Cereal crops (rice, wheat, maize and millets) account for 70% of the crop leftovers, with rice making up 34% of this total. 12 MT or 2% of India's crop residues is produced from top and leaf residues from sugarcane (MoA&FW 2018). Crop residues are typically utilized as animal bedding, feed for livestock, mulch for the soil, fuel for domestic and industrial usage, mushroom cultivation, bio-gas production, bio-manure or compost and thatching for rural dwellings. Nonetheless, a significant amount of crop waste is burned "on-farm" mostly to prepare the ground for planting the following crop. Due to a lack of labourers, the high cost of removing agricultural leftover from the field and robotic crop harvesting, the issue of "on-farm" burning of crop residues has gotten worse in recent years.

According to estimates, crop residue burning is most common in four states: Haryana, Punjab, Uttar Pradesh and West Bengal (MNRE, 2018).

Negative Effects of Burning Crop Residue

Loss of Nutrients

According to estimates, burning one tonne of rice straw results in the loss of 1.2 kg sulphur, 5.5 kg sulphur, 2.3 kg phosphorus, 25 kg potassium and 2.3 kg sulphate in addition to organic carbon. Crop leftovers from various crops typically comprise 80% nitrogen (N), 25% phosphorus (P), 50% sulphur (S), and 20% potassium (K).

Impact on Soil Properties

The heat from burning wastes, killing beneficial soil organisms, raises the temperature of the soil. Regular residue burning destroys the entire microbial community and lowers the amount of N and C in the top 0-15 cm of the soil profile, which is crucial for the development of crop roots.

Fig 2. Crop Residues Management

Emission of Greenhouse and Other Gases

Burning crop residues has the potential to release Green House Gases (GHGs) as well as other trace gases and aerosols that are significant in terms of chemistry and radiation, such as CH_4, CO_2, N_2O, NOX, and other hydrocarbons. According to estimates, when rice straw is burned, the carbon (C) present releases CO_2 (70% of the carbon), CO_2 (7%) and CH_4 (0.66%), while the nitrogen (N) releases N_2O at a rate of 2.09%. Moreover, burning crop residue generates a significant number of particles made up of a wide range of organic and inorganic substances.

Many chemicals detected in high concentrations in biomass smoke are recognized or suspected carcinogens and may cause a number of lung and air borne illnesses (Jitendra *et al.*, 2017).

Impact on Air

When stubble is burned, the exposed environment's air quality is dangerous. Because burning agricultural waste produces gaseous and aerosol pollutants, it has a significant influence on air quality. The health of people exposed is considered to be most affected by PM 2.5 and PM 10.

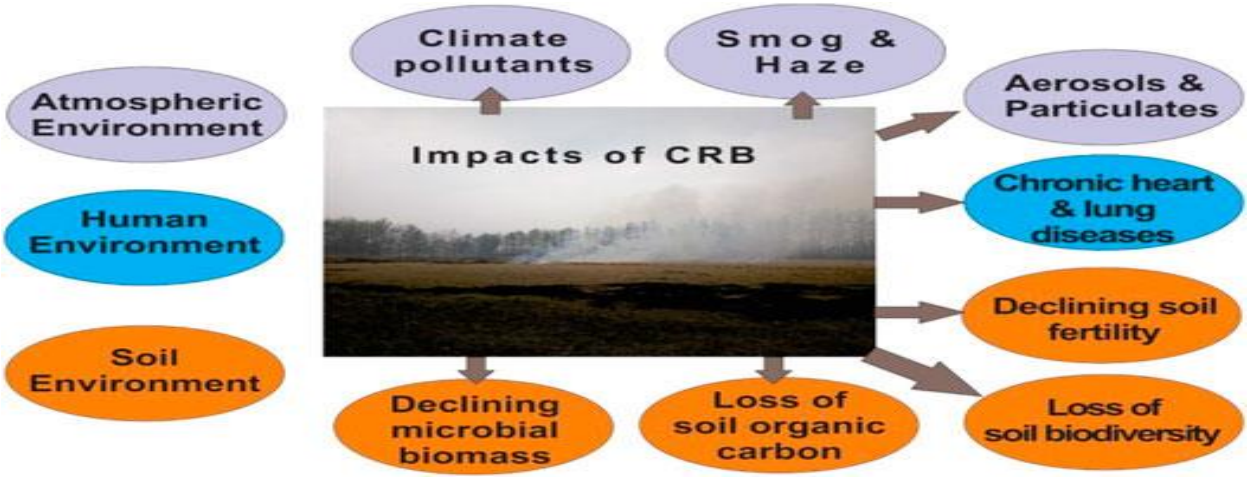

Fig 3. Impacts of CRB

Impact on Agricultural Productivity

Crop stubble burning has an effect on the agricultural industry. There is compelling evidence that air pollution affects food production.

Pollutants may affect agricultural productivity directly or indirectly. Injuries to the leaves, grains, or the absorption of heavy metals are examples of direct effects on plants. For instance, nitrogen oxide can damage plant tissue and cause discoloration.

Acid rain, which can have detrimental effects on plants, soil, and even induce plant death, may be brought on by SO_2. Chlorosis may develop in plants exposed to particle pollution for long time (Ghosh *et al*., 2019).

Impact on Human Health

Many studies have discovered a connection between air pollution and the chance of developing a number of health issues, notably in kids, pregnant women, the elderly, and people who already have medical illnesses. The negative effects of exposure to air pollution range from serious neurological, cardiovascular, and respiratory illnesses to eye and skin irritation. Long-term health impacts from exposure to high levels of air pollution include asthma, Chronic Obstructive Pulmonary Disease (COPD), bronchitis, loss of lung function, emphysema, cancer and other lung problems. Most farmers who are exposed to stubble smoke have reported experiencing eye and lung irritation and have incurred significant medical expenses. Compared to larger particles, PM 2.5 has a stronger effect on people (Ghosh *et al.*, 2019).

Impact on the Economic Development

A nation's economic growth is negatively impacted by air pollution in addition to its detrimental effects on human health and the environment. Since a country's economic and technological development determines how effectively it controls air pollution, increasing pollution has a number of negative economic effects. The number of tourists visiting Delhi has decreased by 25% to 30% recently because of city's elevated air pollution levels (Kumar *et al*., 2015).

Strategy for Reduce Crop Burning

- The promotion of technology for the best use and in-situ management of crop residue in order to prevent the loss of priceless soil nutrients and minerals and to promote overall soil health.
- Encouragement of a variety of uses for crop residue, including power generation, use as a source of industrial raw materials for the manufacturing of bio-ethanol, use as a container for fruits and vegetables and glassware, use in the production of paper, board panels and mushroom culture.
- Building the skills of various stakeholders, such as farmers and extension agents, is a key component of agricultural development programmes.
- Field-level demonstrations on crop residue management are also organized as part of all programmes and schemes.
- Advancement of adaptive research for crop residue management and the creation of tools for the efficient use of such residues.
- Creating and implementing the required laws, regulations, executive orders, and other policy measures to control agricultural residue burning.
- It is necessary to review crop rotation in the IGP region by enticing farmers away from the rice-wheat cropping system and towards alternate cropping cycles.
- To lessen soil compaction and preserve soil fertility, conservative agricultural practices must be encouraged nationwide for rice, wheat, maize, and sugarcane, such as reduced lignin (20%) crops.
- After harvest, crop residues with a lignin concentration of 20 to 30 percent should be left on the cropland and treated with in situ crop residue management machinery (Tandon, 1996).
- It is necessary to design crop-harvesting equipment that keeps 30 to 40% of crop wastes in the field while bailing the remainder.
- The support and promotion of using rice straw and crop leftovers as paper, board, packaging material.
- For proper management of straw, combine harvesters should be modified to collect finely chopped crop residues by using twin cutter bar types of combine harvesters for harvesting the top portion of the crop for grain recovery and a lower cutter bar for harvesting straw at a suitable height and windrowing.

Conclusion

Open field burning is a quick and inexpensive practice, however it is not long-term viable. In addition, it is possible that residue burning caused to climate change and global warming. As a result, we must motivate farmers to stop residue burning in order to protect the environment, human health, economic well-being and healthy soil. Therefore, it is necessary to educate farmers about the negative effects of crop residue burning through awareness campaigns and other means.

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