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# AVOIDING BURIAL OF CROP RESIDUES FOR SUSTAINABLE AGRICULTURE

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## ABSTRACT

*Modern input-intensive farming has led to increased crop residues, often burned by farmers with adverse environmental effects. Crop residue management improves soil health, water movement, and nutrient incorporation, enhancing productivity and yield. India's agricultural sector generates substantial crop residues, often burnt after harvest, causing nutrient losses and degrading soil properties. This leads to environmental issues like greenhouse gas emissions and air pollution. Using machinery-based residue management practices, such as zero till drills and happy seeders, can mitigate negative impacts, promote microbial activity, and improve soil and environmental health.*

## INTRODUCTION

Modern input-intensive farming techniques resulted in linear growth in crop residual production. These agricultural wastes are frequently burned often by farmers, which has adverse impacts on the environment. (Blanco-Canqui &Lal, R.2009). A well-known and widely accepted method for managing different soil physical, chemical, and biological functions is crop residue management. Crop residues have an impact on soil water movement, runoff, and infiltration as well as the number of nutrients that are incorporated into the soil for crop production. Conservation-based management of crop residue by maintaining soil organic matter levels, agriculture can increase soil productivity and crop yield. Increased OM at the soil surface and improved nitrogen cycling and retention are two important benefits of surface-residue management. Increased microbial activity and biomass at the soil's surface serve as a storage area for nutrients essential for crop production and improve long-term stability to allow for more absorption. Changes also exist in the soil's chemical and physical properties in addition to the altered nutrient distribution throughout the soil profile. A practical strategy to decrease agriculture's environmental impact is only through higher crop residues management and decreased soil carbon sequestration. The agricultural sector in India generates a large volume of crop residues (Pandit *et al.*, 2020). The distribution and availability of the residues are highly spatiotemporal due to the diversity in the cropping practices and agroclimatic conditions across the country. According to Hiloidhariet *et al.* (2014), the gross crop residue in India was 686.2 Mt, out of which 234.5 Mt (34.2 %) surplus residues were available for use. Annual

output of 110 Mt of wheat, 122 Mt of rice, 71 Mt of maize, 26 Mt of millets, 141 Mt of sugarcane, 8 Mt of fibre crops (jutemesta, cotton), and 28 Mt of pulses results in 500-550 Mt of agricultural residue, both on and off the farm. Surplus residues are burnt after the harvesting by the farmers in the fields. The surplus residue is expressed as 'total residue – used for cattle animal, looking as fuel, organic fertilizer'.

**Table:1. Crop-wise gross and surplus residue potential in India**

| Crop group | Gross residue (Mt) | Surplus residue (Mt) |
|---|---|---|
| **Cereal** | 367.7 | 90.1 |
| **Oilseed** | 48.8 | 13.7 |
| **Pulse** | 17.9 | 4.83 |
| **Sugarcane** | 110.6 | 55.7 |
| **Horticulture (Banana, Coconut, Arecanut)** | 61.4 | 22.5 |
| **Others (Cotton and jute)** | 79.8 | 47.3 |
| **Total (Mt)** | 686.2 | 234.5 |

(Source: Hiloidhari et al. 2014)

## ❖ Production of crop residues:

Crop residues generate per year by Punjab (51 Mt), Maharashtra (60 Mt), and Uttar Pradesh (60 Mt) produce the most crop residues (46 Mt). Cereals provide the most residues (352 Mt) among various crops, followed by fibres (66 Mt), oilseeds (29 Mt), pulses (13 Mt), and sugarcane (12 Mt). 70% of the agricultural wastes seem to be from cereal crops (rice, wheat, maize, and millets), with rice contributing for 34% of the total. The top and leaves of sugarcane produce 12 Mt of agricultural residues in India or 2% of all crop residues. (NPMCR.2014).

## ❖ Losses during the burning of crop residue:

### Nutrient loss:

In addition to organic carbon, it is predicted that burning one tonne of rice straw results in losses of 5.5 kg of nitrogen, 2.3 kg of phosphorus, 25 kg of potassium, and 1.2 kg of sulphur. Crop residues from various crops often contain N is made up of 80% nitrogen, 25% phosphorus, 50% sulphur, and 20% potassium (K). The amount of N, P, K, and S lost as a result of completely burning the rice straw were 100, 20.1, 19,8, and 80.2%, respectively. Thus, there would be losses from the burning wheat straw of

100, 22.2, 21.8, and 75.0%. The loss of each nutrient was less due to partial burning of the agricultural residues as compared to complete burning.

**Table:2 Loss of nutrients due to burning of Crop residue.**

| Crop Residues | N Loss | P Loss | K Loss | Total |
|---|---|---|---|---|
| | Mt/year | | | |
| **Rice** | 0.236 | 0.009 | 0.2 | 0.45 |
| **Wheat** | 0.079 | 0.004 | 0.061 | 0.14 |
| **Sugarcane** | 0.079 | 0.001 | 0.033 | 0.84 |
| **Total** | **0.394** | **0.014** | **0.295** | **1.43** |

[Source: Jain *et al.* (2014)]

## ❖ Impact on soil properties:

### Physical properties:

Burning agricultural waste reduces the soil's organic matter content, which affects the physical health of the soil. Maintaining crop residues is crucial for protecting soil aggregates from the impact of incoming raindrops. Poor organic matter content causes the breakdown of soil aggregates and the destruction of soil structure. The physical protection against wind and water is provided by agricultural residue remaining on the soil's surface. Burning crop wastes exposes the soil, making it vulnerable to wind and water erosion. The direct exposure of bare soil to sun radiation causes an increase in soil temperature, which is unfavourable for plants and other soil organisms. In addition, the soil is losing moisture, which increases the risk of crop failure in regions with a lack of water.

### Chemical properties:

Burning of crop residues leads to loss of organic matter from the soil which can potentially deteriorate soil productivity and soil health due to decrease organic matter content. The amount of N and C in the top 0–15 cm of the soil profile decreases as a result of the decreasing organic matter content, which also causes the pH of the soil to rise towards alkalinity. Reduced cation exchange capacity, an essential indicator of soil fertility, is a result of decreased levels of organic matter. Agricultural residue is a significant and economical source of organic carbon and nutritional components. however, when they are burned off, they are lost.

It is estimated that when one tonne of paddy straw is burnt, it accounts for the loss of approximate 5.5 kg nitrogen, 2.3 kg phosphorus, 25 kg potash, 1.2 kg sulphur, all secondary nutrients, 50 to 70 percent of

various essential micronutrients, as well as organic carbon (Anonymous 2014). But, if the crop residue is retained or applied to the soil, it enriches the soil with organic matter and nutrients, especially organic nitrogen and carbon.

**Biological properties:**

Burning crop residue may destroy pests and diseases associated with the stubble and straw of earlier crops while also increasing mineralization, which results in an increase in nutrients available for the plants (Thakur et al. 2019). However, the heat produced by burning crop residues raises the soil's temperature and kills beneficial soil organisms. 1 cm of soil is heated by burning paddy straw, increasing the soil's temperature to 33.8 to 42.2°C. This kills the fungal and bacterial populations critical for fertile soil. Burning wheat straw may destroy 50% of the bacterial population up to 2.5 cm soil depth (Hesammi *et al*. 2014).

## IMPACT ON ENVIRONMENT

Burning crop residues cause several environmental issues. Burning crop residue primarily has adverse impacts on the environment, including the emission of greenhouse gases (GHGs) that contribute to global warming, increased levels of particulate matter (PM) and smog that create health risks, decreased in the biodiversity of agricultural lands, and decrease soil fertility (Lohan. S. K. 2018).

Burning crop residue increases the number of air pollutants such as $CO_2$, CO, $NH_3$, $NO_2$, $SO_2$, non-methane hydrocarbon (NMHC), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and particulate matter (PM) by a large amount. (Mittal, S. K.2009). As a result, the residue burning in India's northwest contributes to around 20% of the country's total emissions from burning agricultural waste, including organic and inorganic.

## IMPACT ON MICROORGANISMS

There is a greater diversity of microorganisms, especially those which live in the soil (Maron *et al.* 2011). an increase in density in the soil's uppermost layers. As a result, the degradation of soil organic matter, including crop residues, maintains soil structures while decreasing crop residue, which substantially impacts the biogeochemical cycling of nutrients. Via the mineralization-immobilization of soil organic matter, soil microbes are essential in mediating changes in the soil TOC (Breulmann *et al*. 2014). A significant proportion of components, such as carbon, nitrogen, and sulphur, vaporise during burning and are subsequently lost from plant residues as a result of volatilization (Raison 1979).

## BENEFITS OF CROP RESIDUE MANAGEMENT

- **On the soil**:

  Conserving soil organic matter (SOM) levels through crop residue management can increase soil productivity and crop production. Enhanced nitrogen cycling and retention and higher OM at the soil surface are two important benefits of surface-residue management. Increased microbial activity and biomass at the soil's surface provide a reservoir for nutrients essential for crop production and improve soil structural stability to allow for more penetration**.** One of these responsibilities is protecting the soil from wind and water erosion. The risk of soil erosion increases when crop waste is removed because it exposes the soil surface to erosive forces. Although most people are focused on water erosion, wind erosion may be just as harmful. This is particularly true in areas that face rolling hills and strong winds frequent, both of which contribute to soil erosion**.**

- **On the environment:**

  Retaining crop residues has various ecological and environmental advantages for the soil, water, and plant system, including improved soil structural quality. Crop residue management, with its potential to reduce the need for fossil fuels and the carbon dioxide emissions that result from improper in-situ incorporation of residue, improves the environmental quality, that would've been negatively affected by the field crop residue burning practice.

- **On microorganism:**

  Soil microbial communities play an important role in the soil ecosystem process and the biogeochemical cycle of fundamental elements, such as nitrogen and carbon. Agricultural residue returning can increase the amount of organic matter in soil and provide suitable habitat for the growth and proliferation of microorganisms. fatty acid analysis was used to evaluate the community structure of cultivable bacteria and fungi, and two substrate utilisation assays were used to define the overall soil microbial community structure. When compared to black polyethene mulch, hairy vetch cover

cropping did not substantially increase crop yield, but had a significant effect on the structure of the microbial community. When compared to inorganic fertilizer, crop productivity under the black polyethene mulch was significantly increased by the highest levels of compost and manure, but there was no visible impact on the structure of the soil microbial community.

## ❖ PRACTICES OF CROP RESIDUE MANAGEMENT BY MACHINERY:

### Machinery used to retain crop residue on the soil surface:

i. **Zero till drill:** it is the tractor-drawn sowing machine with the invented 'T' type. Furrow openers are fitted.

**Advantages:** Capable of direct sowing the crop without tillage Simple design, operation and maintenance.

**Limitations:** Unsuitable due to clogging of furrow openers in open crop residue.

ii. **Happy seeder:** it is a PTO-driven machine with attached flails/blades for cutting stubble at the front and a hoe sowing system.

**Advantages:** capable and doing buried and exposed ruins direct sowing in the field.

**Limitation:** ineffective in cutting damp residue.


iii. **Mulcher:** it is a tractor PTO-driven machine, which chops crop residue into small pieces.

**Advantages:** Incorporation of crop residues cut by mulcher into the soil by simple machines like disc harrow.

**Limitations:** Additional field handling and timing for sowing

iv. **Rotary disc drill:** it is a tractor-driven machine. It is fitted with a soil razor disc at the front and a sowing system at the rear.

**Advantages:** Effective on dry and moist residues able to cut

- Capable of sowing even after the residues have been mixed in the soil.

**Limitation:** Commercial and non-availability.

## ❖ SUITABLE MACHINERY FOR INCORPORATION OF CROP RESIDUE INTO THE SOIL:

i. **Rotavator:** This tractor is the main PTO-driven tillage equipment fitted with L or C-type blades.

**Advantages:** Suitable for soil application of compacted residues or loose residues (4-5 tonnes per hectare)

**Limitations:** Additional field for sowing operational requirement from long-term use subsurface hardening

ii. **Super seeder:** It is an active type sowing machine with 'LJF' type blades at the front and a seed sowing system at the rear.

**Advantages:** Direct sowing of the crop in case of compacted and loose residues.

**Limitations**: High fuel consumption and high horsepower and wear of blades.


iii. **Mouldboard Plough:** It is the main implement for the primary ploughing of the soil.

**Advantages:** Capable of burying the residues more deeply in the soil.

• Useful in burying the weed seeds present in the upper surface to a depth.

**Disadvantages:** excess of energy and time need for additional field operations for seedbed preparation and sowing.


## CONCLUSION

The agricultural sector generates a large volume of crop residues along with there will be more burning of crop residues which will be directly impacting on soil nutrients, soil properties, environment, as well as microbial activity. Burning of crop residue leads to the loss of valuable nutrients contained in it. Soil health deteriorates and harmful air pollutants are released so there is a great challenge to agriculturists to manage crop residues effectively and efficiently for enhancing the sequestration of carbon and

maintaining the sustainability of production. As a result, for the welfare of society, agricultural production, and environmental safety, effective management and optimum utilisation of crop residue are now required. And practising the management of crop residue by the machinery to enhance the soil fertility status by improving/ maintaining soil chemical and nutritional properties.

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