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Impacts of Burning Crop Residues and Its in-situ Management

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Abstract
India is a major producer of cereals, pulses, oilseeds, and other agricultural products. Currently, the majority of farmers in North India follow rice-wheat cropping system which yields a large amount of uneconomical yield (Straw). With increased crop production, crop residues increase, and farmers are eventually forced to burn the residues due to a variety of factors. In India, the total amount of crop residues generated is 516 million tonnes on average, and the crop burned is 116 million tonnes in 2017-2018. The problem of on-farm burning of crop residues is increasing due to many reasons. The crop residues can be used for multiple beneficial uses and hence, residue burning causes wastage of resource potential and results in environmental pollution. Residue burning can decrease the soil fertility, degrade the air quality, imparts health issues, emits greenhouse gases, results in an imbalance of radiation and reduce the soil organic matter and even productivity of soil. The major constraints such as time, resources, finances and farm mechanization are responsible for crop residue burning. Alternative uses such as composting, residue incorporation, mulching etc. are a few effective techniques that can help to minimize the negative impacts arising from residue burning.

Keywords: Crop residue, incorporation, sustainability, rice, wheat

Introduction
Agriculture has a major impact on the Indian economy as a whole (Maitra et al., 2021; Praharaj et al., 2021). A wide variety of plant species are cultivated in large tracts of land in India, which has diverse ecological and agricultural regions. After harvest, the vast majority of crop residues are left in the field. After harvesting the economic parts of the crop, therest of the crop parts, including the stems, leaves, seed pods and roots, are known as crop residue. Itis estimated that India produces about 500 Mt of plant residues annually (MNRE, 2009) with significant regional diversity. Unequal distribution and use of crop residues depend on cultivated crops, planting potential andproduction nationwide (Bhuvaneshwari et al. 2019). The highest amount of crop residues are generated in UttarPradesh (60 Mt) as it has the highest agricultural land in India (Badarinath and Chandkiran, 2008). Climate change is an important environmental issue that has captured the world's attention in recent past years. Global climate change commonly referred to as global warming, is a serious environmental issue affecting human life and planet earth. The continued increase in CO_2 concentration in the atmosphere is believed to be accelerated by human activities such as the burning of fossil fuels, deforestation and crop residue burning. It is estimated that India produces 371 million tons (mt) of crop residue with wheat and rice alone i.e. 27-36% and 51-57%, respectively (Hayashi *et al.*, 2014). The practice of burning of crop residues has been quite rampant in India. As the harvesting of crops is done, a significant leftover part of the crop plant still

remains in the field. Thus, the management of crop residue remains a major activity in the post-harvest preparation of the field for the next crop cycle and burning of the crop residue is a common method of the same.

Why burning: The major reason behind the practice of burning is the physiology of treating the residue, as the name indicates, waste. Different studies suggested that a huge volume of rice and wheat crop residue is being produced in the agricultural practice, which is the major contributor to the total stubble load of India. These studies also point out that around two third to three fourth of the residue is being burnt in the case of paddy, mainly because of less available economical alternate options to the farmers. After the harvesting of rice, there is very less time for land preparation before the sowing of wheat. Thus, farmers choose to burn the residue to ensure timely sowing of the next crop (fig.1). It has also been pointed out by the farmers that sowing of wheat in leftover stubble results in less germination of crop. There is a possibility of reduced crop yield in case of rice residue is incorporated into the soil without giving sufficient time before sowingthe wheat crop, because of immobilization of inorganic nitrogen and its adverse effect due to nitrogen deficiency(Sharma and Prasad 2008; Thuy *et al.*, 2008).As per estimates, 80% of the paddy harvest is harvested by using a combined harvester and in most cases, the remaining stubbles are burnt in open fields. In other words it can be said that the burning is preferred by farmers over other alternates available to them.

Figure 1:Farmer burning the residue to ensure timely sowing of next crop

Impact of Burning: Open field burning of crop stubble results in the emission of many harmful gases in the atmosphere, like CO, CO_2, N_2O, SO_2, and CH_4 along with particulate matter and hydrocarbons (fig 2). These gases have adverse implications not only on the atmosphere but also on human and animal health. These air pollutants have toxicological properties and are potential carcinogens. Furthermore, the release of carbon dioxide in the atmosphere due to crop stubble burning results greenhouse effects. The smoke fumes contain particulates of partially combusted materials as soot, which become airborne and are transported downwind, especially during winters when inversion set in.

The burning of crop stubble in open fields has an adverse impact on the fertility of the soil, eroding the number of nutrients present in the soil. Burning also kills soil microorganisms, flora and fauna due to high temperature. Burning and removal of one-ton residue from the field resulted in the loss of 400 kg of organic carbon (5.5 kg N, 2.3 kg P, 25

kg K and 1.2 kg S). Thus even the occasional burning has serious implications on the carbon component of the soil.

Figure 2: Open field burning of crop stubble and emission of many harmful gases in the atmosphere

In-situ Management: About 25% of nitrogen (N) and phosphorus (P), 50% of sulphur (S) and 75% of potassium (K) uptake by cereal crops are retained in crop residues, making them valuable nutrient sources and not a waste. However less than 1% of the farmers incorporate crop stubble because of more tillage operations required in case of incorporation than burning of stubbles. Though the crop stubble has various alternate uses, but the best alternative available to the burning of the rice residue is in-situ incorporation. But the in-situ incorporation is less preferred by the farmers as the stubble takes time to decompose in the soil that may adversely affect the wheat productivity because of less time available for wheat sowing after harvesting of paddy. Contrary to the practice, the incorporation of rice stubble into the soil has favorable impacts on the soil's physical, chemical and biological properties such as pH, organic carbon, water holding capacity and bulk density of the soil. Furthermore, the losses suffered by the soil and the farm ecology due to burning are avoided when the incorporation is performed.

There are various options of machinery which are available to the farmers that can be used for the process of in-situ incorporation of stubble, for example:

- Sowing of wheat with Happy Seeder without tillage operations
- Cutting the residue in soil with the help of Chopper/Mulcher and incorporation of residue in soil with Rotavator and Reversible Mould Board Plough.

In a few studies, it was found that wheat yield lowered in thefirst 1-3 years when the rice stubble was incorporated in the soil 30 days prior to sowing of the wheat crop, mainly because of the immobilization of soil nitrogen in the presence of crop residues with wide C/N ratioSharma and (Prasad 2008; Thuy *et al.*, 2008). However, in the subsequent years rice stubble incorporation did not affect wheat crop yield, but had a positive impact on the soil health of the field.

Conclusion

Crop residues can be used as feed for livestock, and raw materials for industry and fuel. Management problems of crop residues remain diverse in different regions like in some regions crop residues is burns due to a lack of proper education farmers and however, in other places everyone are aware of the adverse effects of paddy straw burning at the farm

level but they are constrained by the lack of acceptable speciesof machinery, economically viable and alternatives for disposal of paddy residues. Government should promote and provide need-based support on alternative options to stop residue burning instead of strict law enforcement to minimize its implications on soil, human and animal health.

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