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Paddy Straw Management; Introduction to Different Ways

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SUMMARY

Paddy straw management is an addressing concern nowadays throughout Punjab and other major rice growing states. As India is the second largest rice producing country in the world which augments this concern. There is a need of an hour to develop both effective and economical paddy stubble management strategies. However, several management strategies have been developed which varies in their effectiveness and adaptability.

INTRODUCTION

More than half of the world's population eats rice (*Oryza sativa*), making it a key crop for ensuring food security and generating income. India is a significant producer and exporter of rice. When cereal crops are harvested, agricultural waste or crop residue is thought to make up around half of the final product, which is straw. After harvesting, it is a non-edible substance that is frequently left on the field. Paddy straw has historically been thought of as a useful by-product of rice farming since it can be utilised in a variety of ways, such as construction material and cattle feed. However, there is a tremendous output of rice straw as a result of the growth in rice yield and area under cultivation. Additionally, automation reduced animal dependence and hence the need for feed. The burning of biomass on the paddy field is therefore considered the most efficient method of getting rid of the waste.

It is crucial to note that open field burning is a frequently used technique across the world, however the extent of its use varies. For instance, according to Gadde et al., (2009), only around 25 percent of rice straw is likely burned in India, compared to about 50 percent in Thailand, while the whole residue is burned in the Philippines.

A record 315.7 million tonnes of food grains were produced in India in 2021-2022, which was a big step toward the country being self-sufficient and food security. (Unknown, 2021a) Paddy is grown on roughly 45 million hectares in India (Anonymous, 2021a) out of which was3.59 million hectares in Punjab. Crop leftovers are shown to be rising with the growth in crop output (including cereal and other crops). In India, it is believed that the rising tendency of crop wastes is a significant problem for farm management. Punjab (51 Mt), Maharashtra (46 Mt), and Uttar Pradesh (60 Mt) are the three states with the biggest agricultural residue production (Anonymous, 2013a).

What is Paddy Straw?

Rice straw is **produced as a by-product of rice production at harvest**. Rice straw is removed with the rice grains during harvest and it ends up being piled or spread out in the field depending if it was harvested manually or using machines. Ratio of straw to paddy ranges from 0.7-1.4 depending on the variety and growth.

Straw is the only organic material available in significant quantities to most rice farmers. About 40 percent of the nitrogen (N), 30 to 35 percent of the phosphorus (P), 80 to 85 percent of the potassium (K), and 40 to 50 percent of the sulphur (S) taken up by rice remains in vegetative plant parts at crop maturity. (A. Dobermann et al.,)

Why there is a need to manage Paddy Straw?

With the right management, adding rice straw to paddy soil may preserve and improve soil fertility. However, improper management of the inclusion of straw can lead to a decline in production effectiveness and an increase in greenhouse gas emissions.

Different ways of managing Paddy Straw

Hence crop residue can be utilized by using different methods which are discussed in detail as below:

1.Physical Method
2.Chemical & Biological method

Physical Method

Farmers use this method a lot because it doesn't require any machinery to manage the residue and a typical farmer can do everything himself. To reduce particle size, crop residues can be ground, soaked, pelleted, or chopped in a variety of ways.

In-situ management

Rice straw can be managed successfully in –situ by allowing sufficient time (10-20days) between its incorporation and sowing of wheat crop to avoid N deficiency due to N immobilization (Yadvinder et al., 2005). The net supply of N from crop residue to subsequent crop depends upon the decomposition period prior to planting the next crop, residue quality and soil environmental conditions. However, the practice of in-situ rice straw incorporation as an alternative to burning has been adopted by only a few farmers because of high incorporating costs and energy; as well as time intensive.

Fig: In-situ Crop Residue Management in INDIA (Source: Dr. KK Singh)

Crop residue as Mulch

As incorporation of crop residue requires much time for field preparation, the quick and easy option is to collect the residue and use it as mulch in succeeding crop. The potential benefits of no-till can be fully realized only when it is practiced continuously and soil surface should remain covered at least 30% of previous crop residue. Rice residue management in no-till systems provides multiple benefits, including soil moisture conservation, suppression of weeds, improvement in soil quality (Singh et al., 2005) The suppression of weeds with straw mulch might help to reduce herbicide requirements.

Use for energy generation

In many nations, the use of agricultural waste as a source of biomass energy is becoming more widespread. In nations like India and China where agriculture is the primary industry, agricultural leftovers might be a substantial source of biomass energy. Successful research and development on the use of agricultural leftovers, especially rice straw, as a possible feedstock for biomass energy has been demonstrated in various regions of the world. Utilizing rice straw and rice husk for electricity has both environmental and financial advantages, which rice-producing nations like China, India, and Indonesia can profit from. Rice residue cogeneration systems can generate heat and power that can be used to meet local energy needs.

Use for Biogas production

In India, 23% of rice straw residue produced remains as surplus or un-used. Punjab, Haryana and UP are three major rice producing states in India. Part of this surplus produce can be used at farmer’s fields for biogas production. Punjab Agricultural University, Ludhiana has designed a batch type biogas plant in which crop residue can be used as feed along with cow dung. This plant can run for 3-4 months eliminating cumbersome operation of daily addition of cow dung. Mussoline et al., (2013) reviewed that operating conditions of a biogas plant such as pH (6.5-8.0), temperature (35-40º C) and nutrients C: N ratio of 25-35 can yield methane from 92-280l/Kg of volatile solids. These scientists used untreated rice straw in combination with piggery wastewater in a farm-scale biogas system to generate electricity. It has been recommended an overall straw (dry wt.) to wastewater ratio (wet wt.) of 1 to 1.4 to improve gas production and decrease the acclimation period.

Straw as Biochar

Biochar which is like charcoal is produced through burning organic materials like rice straw with no or extremely low levels of oxygen. However, biochar is recommended to improve soil productivity, straw burnt in the open is exposed to plenty of oxygen therefore the combination of the carbon from the biomass and oxygen in the air releases carbon dioxide into the atmosphere. The absence of oxygen during the burning phase means that the carbon in the biomass largely remains intact. The creation of biochar rather than ash therefore reduces the amount of greenhouse gases released into the atmosphere. Another advantage of biochar is its large surface area and pore volume. Biochar also has the capacity to adsorb pollutants like pesticides before they enter local water sources. Biochar can stimulate native soil microbial activity, provide favourable habitat for microbes, and encourage mycorrhizal fungal colonisation for improved plant water and nutrient supply (Warnock et al., 2007) and may promote rhizobia for N_2 fixation in leguminous plants.

Chemical & Biological Methods

Both chemical and biological methods are used to decompose the rice straw which can further be used for many purposes. Chemicals used to improve the utilization of rice straw may be alkaline, acidic or oxidative agents. Alkali agents have been most widely investigated and practically accepted for application on farms as these alkali agents can be absorbed into the cell wall and make the structural fibres swollen. These processes enable the rumen microorganisms to attack more easily the structural carbohydrates, enhancing degradability and palatability of the rice straw. The most commonly used alkaline agents are sodium hydroxide (NaoH), ammonia (NH3) and urea. The biological model of straw management is the use of fungi and/or their enzymes to improve nutritional value by selective delignification.

Compost

Rice straw is the only organic material available in significant quantities at most rice farms. About 40% (N), 30-35% of (P), 80-85% of (K) and 40-50% of (S) taken up by rice remains in vegetative plant parts at crop maturity. Straw is also an important source of micronutrients such as zinc (Zn) and silicon (Si). So, rice straw can be converted into compost to use it as fertilizer to improve nutrient content in soil. This compost along with chemical fertilizers can help to sustain or even increase the agronomic yield.

Ethanol production

Rice straw is an attractive lignocellulosic material for bioethanol production. It has high cellulose and hemicelluloses, which can be readily hydrolysed into fermentable sugars. Bioethanol produced from rice straw can be used as transportation fuel. The choice of suitable pre-treatment methods is to increase the efficiency of enzymatic scarification and thereby making the whole process economically viable. With the introduction of genetically modified yeast, synthetic hydrolysing enzymes, other sophisticated technologies and their efficient combination, the process of bioethanol production from rice straw can be a feasible technology.

Rice straw as feed

Rice straw in developing countries is used as a main feed for ruminants. The Nutritional value of rice straw can be enhanced with physical, chemical and biological treatments. Chemical treatment of straw with alkalis such as ammonia and sodium hydroxide, has been commonly used for improving both apparent digestibility, bacterial colonization on cellulose and voluntary intake of straws (Vadiveloo, 2000). In addition to the above-mentioned uses of paddy straw, it is also used in some other operations though in small quantities. It may be used as mushroom growth medium, packaging material, animal bedding, handicrafts, paper making, erosion control mulching and building material etc

CONCLUSION

Some suggestions in this regard include encouraging the use of happy seeds, increasing the usage of paddy straw, improving the palatability of paddy straw for cattle, discouraging the burning of straw through public education and the enforcement of laws, and providing farmers with training.

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