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Crop Residue Management – A Review

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Crop residues are the plant parts that are left in the field after harvesting. These residues are usually burnt to clear the field as a field preparation for the next crop. Burning residues is the cheapest and common method adapted by farmers. Burning of residues affects the soil health as well as pollute the environment. Due to burning of residue, microbes are killed and making soil unfertile. Besides macro and micro nutrients which are easily volatilized due to burning of residue in the soil. So, different scientific communities are in great concern for the management of agriculture crop residue. To manage this issue, it is necessary to adapt diversified management practices and inclusion of mechanization as a part in managing increases the scope of usage of crop residues as a future prospect. Crop residue management improves both soil and environmental Quality.

Introduction

Agriculture is the backbone and soul of Indian Economy. Large quantities of agricultural wastes are generated in our country. This paves way for the copious scope and concept of crop residue management arrived from the major cropping system of India *i.e.* rice – wheat which is the burning problem. Crop residues are the plant parts that are left unaccounted for economic purpose in the field after harvesting. Agro based industries also produces large amount of residues. Some of them were used as animal feed, fuel for cooking, industrial fuel and manure production. However, a large portion of crop residues is left and utilized in the field. According to National Policy for Management of Crop Residues (NPCMR), annually India generates about 500 Mt of crop residues.

Highest crop residue generation is in Uttar Pradesh (60 Mt), followed by Punjab (51 Mt) and Maharashtra (46 Mt). Among the crops, cereals generate maximum amount of crop residue (352 Mt), followed by fibres (66 Mt), Oil seeds (29 Mt), Pulses (13 Mt) and sugarcane (12 Mt). So, it is necessary to convert the agricultural residues into reusable one. This review focuses on management of crop residues by different methods.

Crop residue burning

The major source for air pollution, global climate change, soil health deterioration and soil erosion is observed due to burning of agricultural crop residue. Carbonaceous aerosols which are produced during the burning of crop residue play an important role for both climate change and air pollution (Jethva *et al.*, 2018).

Burning of agricultural residues, resulted in emission of 70, 7 and 0.66 % of C in the form of Co_2, Co and CH_4 in rice straw respectively, while 20 and 2.1% is emitted in the form of NOx and N_2O respectively, and 17% of S emitted in the form of S0x upon burning (Carlson *et al*., 1992).

Burning of crop residues lead to enormous loss of plant nutrients particularly organic carbon. Nearly 80-90% Nitrogen (N), 25% phosphorus (P),20% Potassium (K), 50% sulphur(S) and entire amount of organic carbon was found to be lost in the form of gaseous and particulate matter.

The National Green Tribunal (NGT) established under the National green tribunal act of 2010laid down objectives to states for reducing crop residues burning by recycling initiatives and awareness among the people. The NGT banned crop residue burning in Rajasthan, Uttar Pradesh, Haryana and Punjab by imposing fines in the range of INR 2500 to 1500 on farmers who burnt crop residues (Jithendra *et al.*, 2017).

Crop residue management

The crop residues can be used in efficient and utilizable manner. Cereal residues are used as cattle feed. Ground but and rice residue are used as domestic fuel. Crop residues can also be used in the following novel ways:

Livestock feed

Traditionally, crop residues are used as livestock feed. In recent days, the number of livestock and usage of crop residues starts declining rapidly. Rice straw contains high amount of silica content in leaves than on stem made it less preferable by cattle as feed. To overcome this, the crop should be cut close to the ground (Na *et al.*, 2014).

In dairy farm industry feed account for major operating costs transporting of crop residues directly from field reduces the problem by farmers to some extent increasing efficiency of feed from residue increase farm profitability and reduce environmental pollution (Kaur *et al.*, 2019).

Energy generation

The consumption of energy in India augmented by 7.9% in 2018 and it is expected to be 18% by 2035. By 2015 India might be the second largest contributor in energy demand (Ministry of statistics and program implementation, 2019).

Biofuel

Increase in growth population results in need of food and energy. So, it is necessary to increase the food grain production and energy. At present 80% of the worlds energy source is dependent on fossil fuels (Barros *et al.*, 2018).

The process of converting loose agricultural residues into solid biofuels called as briquetting technology. it is easier to handle, transport, store and uses biofuels (Werther *et al.*, 2000). A dark Brown viscous liquid called as bio oil. Is produced from crop residues by the process of fat pyrolysis, where in the temperature of residue is raised to 400 to 500 degrees Celsius (Pathak *et al.*, 2012)

Composting

A mass of well rotten organic manure stated as compost. Composting is the process of decomposition by microorganisms under controlled condition. Compost helps in maintaining soil fertility and enhancing sustainable productivity, higher yield, resistant to drought, disease are some of the beneficial effects of compost (Lei *et al.,* 2010).

Crop residues acts as source of many nutrients such as N, P, K and S and forms primary source of organic matter. The recycling of the crop residues by compositing is one of the best management practices for managing excess crop residue (Tesfay *et al.,* 2011).

Biomethanation

Biomethanation is the process of converting organic material into biogas under anaerobic conditions. A high quality of biogas is extracted and manure produced is recycled into soil. Per ton of dry rice straw have the potential yield of 300m3 biogas with 55-60%methane.The resultant byproduct slurry can be used as organic manure to the soil (Surendrapratak *et al.,* 2012).

Biochar production

An important role of biochar is long term Sequestring of carbon in the soil and plays pivotal role mitigation of greenhouse gases. Biochar is produced from crop residue biomass by heating in the absence of oxygen (Surendrapratak *et al.,* 2012).

Nearly 38-49% of carbon footprints from rice cultivation are found to be reduced through biochar production. Pyrolysis temperature, heating rate and type of feedstock are the factors determine quality of Biochar (Mohammed *et al.,* 2016).

Gasification

Gasification is a thermo chemical process in which gas is produced by partial Combustion of residues. Producer gas from gasification process contains large amount of impurities which acts as a major drawback in biomass gasification process. Biofilters are used as filter to clean the impurities.one ton of Biomass yields 300kWh of Electricity (Pathak *et al.,* 2012).

Bedding material

Crop residues are used as bedding material in animal shed. Each kilogram of straw absorbs about 2 to 3 kg of urine and is highly enriched with N.

Mulching

Covering the surface of the soil with croppl residues reduces the evaporation rate and maintains soil temperature for proper growth of the plant. Mulches in turn suppress the growth of weed throughout the main crop season (Mirsky *et al.,* 2013). Crop resiudes as mulches found to be useful in many ways such as improves soil health by increasing microbial population in soil, conserves soil water and reduces weed germination which improves crop yields and saves amount of irrigation water (Singh *et al.,* 2010).

Organic mulches in the soil suppress wee through immmobilization of available N and residues have the ability of winter hardiness (Clark *et al.,* 2017). Residues are easily and cheaply available source in farm. While using it as mulch it is found to be economical. Other than soil and water conservation, mulches increase the yield to an extent of more than 50%. These organic matters are beneficial for the growth of earthworms and soil microbial population (Prem Ranjan *et al.,* 2017).

Residue retention

Retention of residues in the field will promotes the organic matter present in the soil and improves the physical properties of the soil (Hiel *et al.,* 2018).

Appropriate tillage practices and reduced form tillage reduces physical disturbance of the soil and accumulation of more soil organic matter through microbial population by enhancing retention of residue (Lal and Kimble *et al.,* 1997).

Mushroom cultivation

Maize stalks are suitable for cultivation of oyster mushroom. Maize residues with or without rice bran supplement also proves to be more suitable for oyster mushroom cultivation. Maize husk and stalk found to be suitable in terms of increased number of fruiting bodies and fresh weight if mushroom (Abena *et al.,* 2015).

The crop residues used in mushroom cultivation converts inedible residues into edible with high amino acid and protein content (HariKrishna *et al.,* 2013).

Conservation agriculture

The basic principles of conservation agriculture are zero tillage (no tillage), crop residue management and crop rotation. Direct sowing of seed to avoid tillage operations is done with happy seeder or zero-till-seed-cum-fertilizer drill. Reduced tillage provides a better way of reducing degradation of soil organic matter and ultimately improving water retention capacity (Pare *et al.*, 2014).

At least 30% of the crop residues should be covered with the soil surface to improve physical, chemical and biological properties of the soil as soil conservation measure to reduce loss of soil through erosion. (Unger and Mccalla, 1980). The nature of physical modification of soil varies with respect to depth, intensity and frequency (Reiosky *et al*, 2015).

Mechanization in crop residue management

The decrease in farm workers and labours paves way for the farmers in need of adapting mechanization in managing crop residues. To overcome land surplus and labour scarcity problem, mechanization found to be of great potential.

Happy seeder

Happy seeder is a technology of direct drilling of seed crop without removing or burning previous crop residue. It is a tractor mounted machine that cuts and lifts straw and sows succeeding crop into bare soil. The lifted straws are sown over the area as mulch.

Benefits of happy seeder

It saves fertilizers upto 10%
Yield increases to 5%
It saves labour of about 30hrs/ha
Wates saves to 12 cm/ha
High power use efficiency and saves Electricity of 168kWh/ha
Prevents choking of machine under heavy straw load (Mooventhan *et al.,* 2018)

Baler

Balers are classified into different types based on various shapes and sizes as round, rectangular, square and industrial used. Balers compress the residues into compact baler with bailing pressure. Round type of baler is the commonly used type and square type is the least used whereas rectangular type of baler is used in large scale feedlot production. The beneficial effects of baler are easier to handle, transport and store. It can be used as biofuel and animal feeding.

Hayrake

Hay raking is done when straw moisture is less than 35-45%. Hay rake is similar to baler that cuts straw into windrows and made into bale using baler.

In conclusion the crop residual burning have been a major threat to global climate change and air pollution. Crop residue burning releases higher amount of toxic and poisonous substances. It releases many carbonaceous materials gases like So_2, No_2 and many greenhouse gases. So it is of necessary to manage the residues in a sustainable manner. Instead of burning residues, they can be used in reusable and effective manner in many diversified ways such as biofuel, cattle feed, and mushroom cultivation. sTo ensure effective residue management, amount of residues grown out yearly should be continuously monitored to stop further impact of crop residue burning.

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