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ENHANCING ENVIRONMENTAL SUSTAINABILITY OF RICE-WHEAT CROPPING SYSTEM THROUGH POST-HARVEST RESIDUE MANAGEMENT

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Abstract: *Rice-wheat is a major cropping system in Indo-Gangetic plain sand most crucial for maintaining food security to meet the feeding demand of increasing population. However, sustainability of this cropping system is at risk due to the deterioration of natural resources. Management of crop residues must be required for viability of rice wheat systems. Due to high yields of this rice wheat system results into producing maximum crop residue. Crop residues are parts of the plants left in the field after harvesting crops. They are important natural resources and not wastes. Residue management is getting more attention because of its diverse and positive effects on soil physical, chemical and biological properties which maintain ecological balance of the crop production system. They are currently burn especially in case of rice residues leading to degradation soil health, nutrient and organic matter losses, air pollution affecting health and deteriorate environment. Best promising in-situ rice straw management is to use it as mulch reduces weed incidence and direct drilling of wheat with Happy Seeder help out to avoid straw burning in obtaining sustainable productivity. There are several other options for crop residue management includes uses as input in industry to produce energy and as biochar which use as soil amendment to enhance soil fertility. Energy generation through crop residue is one of the major spotlight areas of renewable energy programs in India which depends on agricultural sector.*

Crop residue acts as an input for their industrial utilization for making rakes and balers after removal from the field. Several practices for crop residue are removal, incorporation and surface retention. Removal of crop residues is necessary to feed livestock and maintain mixed farming. Benefits of Residue incorporation results more microbial activity helps in improvements in soil properties and sustaining crop productivity.

Keywords*: Crop Residue, Energy, Food Security, Happy Seeder, Mulch, Productivity, Rice- wheat system*

Introduction: Rice-wheat rotation is the major production system in India that spread about 13.5 million hectares in the Indo-Gangetic Plains out of which 10 million hectares area of this system present in India. Major state of India such as Haryana, Punjab, Uttar Pradesh, Madhya Pradesh and Bihar dominate rice-wheat system which contributes 42% of total food grain production [1].Therefore, rice-wheat system is the keystone of food security in India to feed the increasing population. This cropping system resulted into production of maximum crop residues i.e. 285 million tonnes of gross crop residues and 71.9 million tonnes surplus crop residues. The gross potential of crop residues in India is estimated around 686 million tonnes and the surplus crop biomass is nearly 234.5 million tonnes. Cereals only contributed about 367.7 million tonnes of gross residues and surplus potential is around 90.1million tonnes. Rice produces 154.0 million tonnes as gross crop residues and 43.5 million tonnes as surplus crop residue [2]. Now a day, Increasing constraints of labour and time have led to adoption of mechanized farming in the highly intensive RW cropping system. Approximately 91% of total rice area is mechanically harvested. Traditionally, wheat and paddy straws have been removed from the fields for use as cattle feed but paddy straw is considered poor feed for animals due to its high silica content[3].Due to high yields of this rice wheat system results into producing more crop

residue. Rice residues are normally burnt before sowing of wheat crop because many tillage operations are required for their incorporation and required much time for sufficiently decomposition of rice straw in field. Therefore, incorporation of rice residue delays wheat sowing for obtaining high yield. Burning is the easiest and cheapest way to remove large loads of crop residues produced by farmers in the country. It resulted into air pollution, human and animal health problem as well as loss of nutrients present in it. Hence, proper management of paddy straw residue is a need of the hour which provided beneficial effects in future. Thus, for maintaining the sustainability of this cropping system, crop residue management is the viable option which have positive effects on soil physical, chemical and biological properties which maintain ecological balance of the crop production system. Efforts should be needed to improving soil health through efficient utilization crop residue with the application of principle of conservation agriculture.

Rice Straw Burning-A Problem: After rice crop harvesting, farmers burnt rice residue because it is fast, easy and economical way for rice straw disposal. Secondly, shortage of time for land preparation for next wheat crop sowing leads to burning of residue. Burning of rice straw has various detrimental and harmful effects like nutrient losses, deprive soil organic matter, adversely affect the beneficial soil micro flora and fauna, air pollution, road accidents and health hazards.

Why Crop Residue Management is Needed: Crop residue is the remaining plant material or left over biomass, after harvesting or processing of economic components of planted crops, it includes leaves, stalks and roots. Due to lacking of traditionally crop residues competing uses such as animal feed, fodder, fuel, roof thatching, packaging and composting. Increased mechanization, particularly use of combine harvester in the indo gangetic plains produce large amount of crop residue which should be properly manage.

Management Options for Rice Crop Residue

1. **Off-farm Utilization of Rice Straw:** Removing of rice straw after harvesting can use as fodder and animal hay bedding, paper/ board making, packing material, mushroom cultivation, fuel in brick kilns, raw material for ethanol production and power from paddy straw-baling.

1.1. Rice Straw Use as Fodder: Large amount of rice straw which is a by-product of the rice crop can use as source of feed to ruminant livestock. Polysaccharides, lignin and silica content are high in rice straw and its intake reduces the degradability activity by micro-organisms present in animals. So, to make these rice straw digestible through using chemical treatments, such as NaOH and NH_3 to improve the nutritive value of rice straw [4].Another way is to use of fungi or enzyme treatments which are cost effective and environmental-friendly method for enhancing the nutritive value of rice straw to feed cattle's.

1.2. Rice Straw Use as Paper Making: Commercial uses of rice straw for many industrial purposes includes paper making and dissolving grade pulps involves different process like cutting and screening of the rice straw, acidic pre treatment, alkaline extraction, soda pulping and bleaching. Silica content is removed for its introduction into the pulping system for either bleaching paper-making or dissolving-grade pulps.

1.3. Rice straw use as packing material: Rice straw is used extensively as a packing materialcan replace the use of plastic material which takes hundreds of years to decompose and adversely affect human health and threatens the environment. Using of rice straw as package material which is bio degradable easily can also help in maintaining of agro-ecosystem. In addition to this, rice straw use as input for mushroom cultivation. Rakes and baler can also be made from rice crop residue.

1.4. Rice Straw Use as Input for Power Generation: Rice straw-based power generation is gaining importance as rice crop residues has potential to generate electricity because of their large availability. Rice straw based power plants not only solve the problem of removing rice residue from fields without burning which effect soil health but also reduce green house gas emissions that add to climate change, acidification and other environmental hazard problems.

2. **On-farm Utilization of Rice Straw:** In situ management of Rice crop residue includes straw incorporation and surface retention act as mulch give several advantages. On farm uses of rice straw not only helps in

increasing yield of next crop but also enhance soil fertility.

2.1 Rice Straw Incorporation: Rice residues are important natural resources and recycling of these residues through their incorporation in to soil helps in improves the soil physical, chemical and biological properties. Incorporation of rice straw is time costly and time taking process but in long run it helps in improving soil fertility. Organic materials such as crop residues give sustainable and ecologically sound alternatives for meeting the nutrient requirements of crops. In addition to their role as the primary source of carbon and management of crop residues properly have a significant impact on soil physical properties. It is eco-friendly approach which helps in providing food supplement to soil micro organisms and add nutrients after decomposition in soil which can fulfils the nutritional demand of next crops and minimize the application rate of fertilizers. Increasing concern for the environment and to sustain soil productivity through proper crop residue management. Enhancing soil productivity through using resource conservation technology of in situ incorporation of rice straw id better option.

Rice Straw Use as Mulch: The retention of rice residues as a surface mulch is helping in moisture conservation and enhance yield in addition to reduce air pollution. Soil evaporation is a non-productive loss of water which can reduce by application of rice straw as mulch. Mulching increase soil water content thus helps in meeting the need of water for crop growth and yield attributes. Sowing of wheat in zero tilled field having rice residue is possible only with the use of machinery equipped with modern technology i.e. turbo seeder and happy seeder increase wheat crop yield by decreasing erosion, increasing soil water holding capacity, availability of nutrients and improving soil structure. Rice straw mulching will be beneficial in increasing yield, soil organic carbon and water use efficiency in wheat [5]. It suppresses maximum soil temperature, elevate minimum temperature during early season. In addition, mulching reduce weed growth which interfere with crop for nutrient, water, space and light. Surface application of rice residues @ 6 and 7 tonnes ha^{-1} significantly reduce the growth and development of P. minor and recorded higher weed control efficiency [6].

Conclusion: Best possible *in-situ* rice straw management option is its use as mulch and direct drilling of wheat with happy seeder. Rice straw as a mulch successfully reduces weed seedling emergence, weed biomass and increases weed control efficacy. It increases water use efficiency through reducing of evaporation. Post harvest residue management option includes animal food, input for electricity generation, rakes, baler, paper and packing material. If these crop residue are manage accurately not only enhance soil productivity but also increase yield of next crop specially wheat crop. Environmental problems like air pollution minimize through best crop residue management.

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