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RICE STRAW MANAGEMENT FOR SUSTAINABLE AGRICULTURE-A REVIEW

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Abstract

The present study is aimed to review the rice residue management in rice- wheat cropping system. Wheat residue is somewhat easy to be managed as it can be fed to the animals but rice residue contains high amount of silica i.e. why not appropriate for the animals' feed. For its disposal, it may be incorporated in the soil, but leads to immobilisation of nitrogen because of wider C: N ratio, so farmers prefer to burn rice straw instead of using it in another way. Burning of rice straw, which is common practice in N-W India cause multiple types of problems like degradation of soil structure and fertility, green house gases emission, global warming, environmental pollution, health problems of human beings and animals, wasteful utilization of energy and reduced crop production. Innovative strategies are being adopted to convert rice residue into some usable form or decomposing it in the field itself by some means, however pace is very slow and not up-to the mark. There is a dearth of appropriate methods, machinery, resources and will power to follow the cleaner and environmentally friendly technologies. A lot of efforts are still needed in this direction.

***Keywords*:** Carbon, Environment, Production, Rice and Wheat

Essentiality of Proper Rice Residue Management

Left over parts or remains of crop after harvesting of economical parts of plant is known as crop residue. Rice–wheat cropping system (RWCS), the world's largest agricultural production system in India, now struggling for sustainability and yield reduction due to declining water availability, soil quality deterioration and atmospheric pollution (Bhatt *et al.*, 2016). Productivity of R-W cropping system can be a serious issue and productivity needs to be improved, as population of India is expected to reach 135 crores by 2025. Traditional method of rice establishment by transplanting and burning of rice straw after harvesting followed by wheat sowing should be altered in light of stopping removal of precious soil nutrients and reducing the environmental pollution for saving the mankind from ill-effects of these. Dobermann and Witt, 2000 reported that nitrogen, phosphorous, potash, sulphur, magnesium, calcium and silicon present in rice straw. Nutrients concentration in wheat and rice residue are as : 0.611% N, 0.064% P and 1.17% K and 0.70% N, 0.09% P and 1.48 % K respectively. Retention of crop residue improved soil pore spaces, roughness and hydraulic conductivity, thereby increased the interception of rain water by the soil (Radford *et al.*, 1995 and Shinners *et al.*, 1994).

In the present scenario, on farm residue management is the prime concern for rice-wheat cropping system. The amount of crop residues produced in 2001 was estimated to be approximately 4 x 10^9 Mg in a year over the world i.e. almost 9% higher produced than the year 1991(Lal, 2005). Punjab produces about 22 million tonnes of rice residue which is 65% of total rice residue production in North-western states. After harvesting, which is usually done mechanically and residue left behind in the field, it is very difficult for the farmers to dispose off or utilize it within a very small time frame of ten to twenty days (Lohan *et al.*, 2018).

Concentration of CO_2 in the atmosphere increased up-to 38% from pre-industrial period to 2008 and still increasing. Practices of fossil fuel combustion, cutting of forests, biomass burning, crop cultivation, urbanization etc. lead to CO_2 emission enhancement. Soil C sequestration is an effective tool to lower atmospheric carbon and increasing its percentage in soil and crop residue retention or incorporation plays a very significant role. Carbon sequestration by residue retention is one of important land use and soil management technique.

Crop residue burning released green house gases and black carbon which caused global warming (NAAS, 2017). By burning of one megagram of rice residue, 13 kg of particulate matter and 1460 kg of CO_2 released. North western states of India burnt 23 million mega grams of crop residues in a year and due to widespread crop burning, Delhi became the most polluted in the World during 2016 November month (www.theguardian.com/World/India).

On-site, residues retention improved soil physical, chemical, and biological properties and increased crop production (Hejazi *et al.*, 2010). Crop residues incorporation increase SOM, soil N, P and K (Mandal *et al.*, 2004). Mulches are effective against soil erosion and off-site. The crop residue incorporation caused improved soil conditions by enhancing soil water retention and nutrient availability lead to higher plant height and grain yield compared to control (Mbah and Nneji, 2011). Mbah and Nkpaji (2009) observed higher maize yield by residue incorporation. Mulch farming through residues retention improves quality of water and air. Residue retention@ 30% in the zero tillage direct seeded rice followed by zero tillage chickpea/lentil/safflower cropping system proved as better alternative for getting higher yield in rice fallow area of Eastern Indo-Gangetic plains (Rakesh *et al.*, 2018). Through residue incorporation, world food production can be increased upto 40Mt/year due to addition of soil organic carbon @ 1 tonne C/ha/year (Bijay, 2009). Huang *et al.*, 2012 observed increased crop yield due to improved soil condition by stubble incorporation in China, similar results were also recorded by Prasad *et al.*, 1999.Wei *et al.*, 2015 observed high content of nutrients and improved crop yield by retention of wheat residue

Ways and Means for Crop Residue Management

Rice residues can be managed by strategies suggested by Yadwinder and Sidhu, 2014 viz. use of crop residue for manure, energy production, ethanol production, biogas formation, biochar production etc.

Common Practice of Residue Burning

Farmers prefer burning of rice residue lacking cost, time and economically better alternative in the fields where combines are used for harvesting (Yadwinder *et al*., 2014). Estimates indicate that up to 80% of rice residues are burnt by farmers in Punjab. Burning of the rice residues leads to reduction in soil fertility, atmospheric pollution, increasing smog, decreasing visibility, health issues, killing useful insects and destroying beneficial microbes etc. Nutrients are lost, which are present in rice residue by burning and the loss is around 90% (N and S) and 15-20% (P and K) and it is reported by NAAS, 2017 that million tonnes of carbon loss and tonnes of nitrogen wasted annually due to burning. Bhatt *et al*., 2015 emphasized that crop residue burning causing loss of nutrients and emission of green house gases, consequently increasing cost of cultivation and declining the soil and environment quality parameters.

Residue Retention/Residue Incorporation

Salih *et al*., 2012 observed high soil fertility and crop productivity in treatments with residue retention as compared to residue removal. Most reliable system for dry land wheat production was full residues incorporation into the soil along with application of 70 kg nitrogen in a hectare (Sadeghi and Bahrani, 2009). After harvesting of rice and almost ten days before sowing wheat, rice residue had meagre negative effect on N availability if decomposed under aerobic conditions. Singh *et al*. 2004 reported that straw of rice have water-soluble form of K, released in the soil when straw incorporated. Soil organic carbon pool enlarged by the incorporation of residue and also availability of nutrients in the soil. Sidhu *et al*., 1995 and Beri *et al*., 1992 conducted separate experiments on residue management and concluded that soils with crop residue incorporation had more number of bacteria and fungi as compared to the fields with residue removal or burning. Kong, 2014 reported beneficial effects of maize residue retention on the following wheat crop productivity and soil fertility in maize-wheat cropping system. Singh *et al*., 2010 found residue incorporation with different doses of nitrogen increased nutrient uptake, soil fertility and higher yield of crops at Patna. Wheat grain yield improved by rice residue incorporation before sowing of wheat along with *Trichoderma* and FYM in Raipur, India (Chandra, 2018).

For rice residue incorporation extra efforts in the form of more tillage operations, use of implements like chopper, additional application of water and urea has to be done by the farmers, so farmers are reluctant to use paddy straw, instead burning of residue is easier and simpler operation to do to save the time for sowing next crop, resources and labour cost (NAAS, 2017).

Residue Removal: Residue removal has both direct and indirect adverse effects and important among these are lesser addition of carbon in the form of biomass, decline in nutrients availability in soil due to improper cycling , reducing soil fertility due to decrease in flora and fauna of soil and lesser microbial activity therefore. Indirect impacts are increasing risks of soil runoff, erosion and compaction of soil ultimately leading to lesser growth and yield of crops.

Conclusion

Although there are various ways for residue management but residue burning is common among all. There are a lot of disadvantages connected with this practice in terms of monetary, environmental and resource conservation etc. Researchers are still searching for the long term residue management strategies for the society and environmental benefits.

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