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Crops residue management for sustainable crop production and environmental health

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Crop residues burning is an important source of environmental pollution and therefore, a great cause of concerns for the scientists, researchers, policy planners, social activists and the governments. The rising level of crop residue surplus on account of higher crop biomass production, poses a great challenge before us for its effective and efficient management. The suitable strategies needs to be devised for its on-farm utilization, which *inter alia* includes proper incorporation and decomposition in-situ so as to supply organic matter for improving the soil physico-chemical and biological properties. The increase in soil fertility by organic sources helps in reducing the environmental pollution, caused due to heavy use of chemical fertilizers. The crop residue management not only reduces the environmental hazards caused due to its burning but also saves a huge amount of money sent by the farmers on fertilizers and other chemical amendments. In totality crop residues management ensures the overall benefits for the society at large besides its favourable effects on environmental and agricultural health and food production.

Introduction: Agricultural dependent economy like ours produces plenty of crop residues *i.e.*, over 500 million tons (MT) every year (MNRE, 2009). Cereal crops such as rice, wheat, maize and millets contribute 352 MT crop residues (70%) of the total crop residue. While, among the cropping systems, rice-wheat system accounts for nearly one-fourth of the total crop residue produced in India. It was reported that surplus crop residue of about 141 MT is either burnt or remain unutilized which is detrimental to soils, crops, human being and overall environmental health. The practice of rice and wheat stubble burning as a method of field cleaning for the next season crop sowing have adverse impact on environment and also threatens the socio-economic as well as agricultural activities. The straw from rice and wheat is used in limited quantity in the field because 82% of the rice straw and 17% wheat straw is burnt in the fields and the rest is removed for other purposes (Beri *et al.*, 2003). The rice straw burning causes deterioration in local air quality which in turn affects the health of local community. The environmental consequences of field burning of crop residues are not seen only in terms of air pollution but also in terms of decreasing rate of organic matter content of the soil, which is an important constituent of soil fertility and crop productivity. Crop residue should not be considered as waste but should be treated as tremendous natural resources available with the farmers at their own field because it acts as a storehouse of soil fertility improvements besides its role in improving the soil physico-chemical and biological properties. However, the stubble burning at farm level not only causes injurious effects to human and environmental health but also adversely affects the population of several agriculturally beneficial micro-organisms by perishing their lives. The straw burning diminishes the soil fertility on account of losing almost all nutrients found in the straw *i.e.*, more than 80% nitrogen, 25% phosphorus, 20-21% potassium, 4-60% sulphur, which in turn reduced crop production (Mandal *et al.*, 2004).

Crop residues, in general, are parts of the plants left in the field after crops have been harvested and thrashed. These left over materials have been regarded as a waste at certain times and places but it also acts as a great natural resource of the farmers. Its retention from agricultural point of view is pivotal in sustaining soil fertility in light of scarcity of alternative sources of organic amendments, which in turn, save the cost on purchase of fertilizers and other chemical amendments. Besides, it has dynamic role to play in securing the environmental as well as soil health by reducing soil erosion, soil moisture retention and nutrient recycling. It improves the soil and environmental quality because it acts as a source of organic matter and carbon storage. The quantities of nutrients that can be returned annually to the soils through crop residues of common cultivated crops are considerable, therefore, requires great efforts for their proper disposal and utilization. Now a

day's crop residue burning is becoming a serious issue all across the country and its management is receiving a great deal of attention from various quarters such as researchers, farmers, environmental and social activists, policy planners and the governments for sustainable crop production and environmental health.

Benefits of crop residue management :

Enriching the soil health and quality :

Generally, the incorporation of crop residues increases soil porosity especially the large pores of soil and reduce soil bulk density, regardless of tillage operations. It is clear that residue retention has a positive effect on long-term soil quality but it is not suitable for all agro ecosystems in terms of its effects on crop production. Soil type, crop rotation and weather conditions have a great bearing on the effect of crop residue management for crop production. Residue mineralization leads to more nutrients availability for the crop plants besides, it also supplied organic matter to the soil, which modify the soil structure and thereby development of root system.

Role in water conservation : Crop residue acts as mulch, which reduces erosion and runoff losses and increases the permeability of soil thus helps in conserving soil moisture. In the drier parts of country, crop residues can serve as good mulch material to moderate the soil temperature, better penetration and conservation of rain water for growing crops with better yields.

Crop residue as a potential source of energy as well as amendments : Crop residues could be used as an alternative fuel and a potential source of energy production. Besides, its energy potential it can also be used as a source of soil amendment, biomass feedstock for livestock and an alternate to chemical fertilizers. Such beneficial effects could have lost under field burning practice of crop residues.

Enriching the environmental health and quality : Crop residue retention offers several environmental and ecological benefits for the soil-water-plant system, including improved soil structural quality. Crop residues management with its potential ability to offset the fossil fuel demands and consequent reduction in carbon-di-oxide emission due to proper in-situ incorporation of residue improves the environmental quality, would have otherwise severely affected under field crop residue burning practice.

Improving the socio-economic health of the society:

Benefits to the farming community : Crop residues affect the crop production significantly when used in association with other agricultural practices such as crop rotation and zero tillage. If the residue is used for fertility enhancement purposes than it reduces the huge cost on fertilizers and other amendments, which ultimately save the farmers money. As a source of energy it can save upon the expenses incurred on fuels to run the agricultural equipments. Biomass can provide added income to farmers without compromising the production of main food and even non-food crops (UNEP, 2009).

Benefits to the rural areas : The use of biomass *i.e.*, crop residues as raw materials for bio energy production should be encouraged for a secure energy supply and reduction in fossil fuel CO_2 emissions, which in turn revitalization of rural areas (Cherubini and Ulgiati, 2010).

Benefits to the society as a whole : Proper crop residue management practices improve the environmental, human and animal health. Environment related hazards created due to faulty agricultural practices *viz.*, crop residue burning on the field could be reduced by adopting suitable strategies for residue management, which in turn leads to healthy life as well as saving of large expenses of the society on health related issues raised from environmental illness.

Adverse effects of crop residue :

– Sometime residue retention can induce plant diseases by harbouring pests and pathogens and thus endangering crop yields.

– Residues on the soil surface might be problematic for good seed-to-soil contact and also acts as obstacle to seedlings emergence.

– The burning of crop residue is associated with the impoverishment of soil organic matter and consequent reduction in soil fertility.

– Crop residues burning adversely affects the crop yield, environmental quality and human as well as animal health.

Strategies for crop residue management :

– Develop awareness among the farmers about the ill consequences of crop stubble burning on environmental health and agricultural production.

– Use of crop residues as far as possible as a raw material for power generation and potential new source for environmental protection and rural development.

– Popularisation and adoption of climate-smart agriculture.

– Application of reusable agricultural by-products in soil and nutrient management.

– Development of harvesting machineries which leaves no or minimal crop residues of crops like paddy towards a more sustainable and holistic agriculture ecosystem.

Fig. 1 : Crop residue burning in field

Fig. 2 : Crop residue management at field

– Call on farmers towards zero straw burning as a part of sustainable crop production by advancing the timely farm operations with other means than burning crop residues.

– Management of rice crop stubbles for improving the quality of environment and socio-economic condition of the paddy farmers through improved *in-situ* decomposition and management of crop residues.

– Use of crop residues as compost and animal feed.

– Use of straw as a renewable source of energy to replace fossil fuels.

– Carbon sequestration in soil is a key solution to limit burning crop residues in the open field.

Conclusion : In most of the cases, crop residues either burnt or left unutilized for various reasons ranging from quick field clearing to fertility improvement without considering the ill effects. If the residue utilized wisely for enrichment of soil fertility will reduce the cost on purchase of fertilizers and other chemical amendments. It reduces erosion and runoff losses considerably and increases the permeability of soil thus conserves soil moisture, moderate the microclimate of the soil. Proper management of crop residues offsets the ill effects of residue burning and hence, ensures better ecological health and environment for crop production. Therefore, optimum utilization and efficient management of crop residues is the need of the day for the betterment of society, agriculture productivity and environmental health.

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