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Importance of Crop Residue Management in Agriculture

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SUMMARY

Meaning of crop residue management "residue", with its cannot rotation of something left over that nobody wants, gives a false impression of the value of the straw, stubbles and other vegetative parts of crops that remain after harvest, since many farmers burn them or otherwise dispose them. Importance, factors affecting decomposition of crop residues, advantages and socioeconomic of crop residues.

INTRODUCTION

India being an agriculture-dominant country produces more than 500 million tons of crop residues annually. These residues are used as animal feed, for thatching of homes, and as a source of domestic and industrial fuel. A large portion of unused crop residues are burnt in the fields primarily to clear the left-over straw and stubbles after the harvest. Non availability of labour, high cost of residue removal from the field and increasing use of combines in harvesting the crops are main reasons behind burning of crop residues in the fields. Burning of crop residues causes environmental pollution, is hazardous to human health, produces greenhouse gases causing global warming and results in loss of plant nutrients like N, P, K and S. Therefore, appropriate management of crop residues assumes a great significance. Plant, animal including human residues, green plant materials and municipal wastes serves as effective source of plant nutrients and humus in soil. Soil organic matter (SOM) plays an important role in maintaining proper rhizosphere for better growth of the plants. In intensive agriculture, soil often gets sick due to continuous use chemical fertilizers. Organic manures are used to increase efficiency of fertilizers. Conservation agriculture, with the following three core inter-linked principles, is a viable option for sustainable agriculture and is an effective solution to check land degradation (Kassam, 2011).

Why crop residue?

To maintain acceptable environment free from excessive pollution on ground and air
To conserve ever scarce and costlier raw material and energy cycle (in situ)

Crop Residues Potentials:

A Large amount of rice residue is annually produced in the rice growing countries. Moreover, the adoption of mechanized farming has resulted in leaving a sizeable amount of rice straw in the field after harvesting the grain. There is enormous potential for recycling these residues in the crop production systems. Total amount of crop residue produced in India is estimated at 350 × 106 Kg/yr,of which wheat residue constitutes about 30% and that of rice about 40%.Another estimate shows that 120 × 106 kg/yr rice residue, out of 180 × 106 kg/yr (assuming that 1/3rd of the residue is used as feed for animals and other purposes) can be returned to the soil to enhanance soil quality; it will contribute to soil 2.604 million tons of N+P2O5+K20,considering the nutrient contents in rice straw as 0.61%N, 0.18%P2O5 and 1.38% K2O. It is worth mentioning here that large uncertainties as well as variability exist in the estimates of generation, utilization and on-farm burning of crop residues. Pathak *et al*. (2004) had estimated that annually 523 Mt crop residues were generated in India, out of which 127 Mt was surplus.

Crop	Residue Yield(t)	Nutrient (%)			Nutrient potential (000) t		
		N	P2O5	K20	Total	Utilizable	Fertilizer Equivalent
Rice	1,10,495	0.61	0.18	1.38	2398	799	399
Wheat	82631	0.48	0.16	1.18	1504	501	250
Sorghum	12535	0.52	0.23	1.34	262	87	43
Maize	11974	0.52	0.18	1.35	252	84	42
Pearl millet	6967	0.45	0.16	1.14	121	40	20
Barley	2475	0.52	0.18	1.30	51	17	08
Finger millet	5351	1.00	0.20	1.00	118	39	19
Sugarcane	22736	0.40	0.40	1.28	423	23	211
Potato	7867	0.52	0.21	1.06	141	141	70
G.nut pods	10598	1.60	0.23	1.37	339	339	169
Total	273629	-	-	-	5609	2470	1231

Factors affecting decomposition of crop residues:

1. Quantity added
2. Size of the residue
3. Method of application

I. Incorporation
II. Surface application

Advantages of residue management

1. Physical properties of soil

Soil structure

Addition of organic matter to the soil favors the formation of aggregates, increase structural stability due to straw addition and better distribution of aggregate size following reduced soil disturbance due to crop residues.

Bulk density and porosity

Incorporation of straw with FYM reduces bulk density and increase the porosity of the soils.

Hydraulic conductivity:

Crop residue increases the hydraulic conductivity by modifying soil structure microspores and aggregate stability.

Soil temperature:

Mulching with plant residues raised the minimum soil temperature in winter the reduction in upward heat flux from soil and decreased soil temperature during summer due to shading effect.

Soil moisture: Reduces the rate of evaporation due to increase in amount of residues on the soil surface.

2. Chemical properties of soil

- Organic carbon: increases with continuous addition of organic matter.
- Soil pH: increases soil pH significantly.
- By decarboxylation of inorganic anions, ligand exchange and addition of basic cations.
- Cation exchange capacity (C.E.C): Soil organic matter acts as reservoir for essential plant nutrients prevents leaching of elements required for growth. Addition of residues increases C.E.C.

3. Biological properties of soil

It provides energy for growth and microbial activities and substrates for microbial biomass. Provide suitable environment for biological N fixation. Enzymes microbial biomass, dehydrogenase and alkaline phosphates activities increase in sandy loam soil. Microbial population: increase microbial biomass and enhances availability of nutrients in soil as well as the microbial biomass act as a sink and source of plant.

4. Other advantages:

Root development

Crop needs good soil tilth to develop their roots. This requirement can only be met if the top soil is properly managed, including erosion control where necessary, and if root penetration in the sub soil is enhanced.

Water availability

Water availability of the various means of increasing the availability of water to plants, the most efficient are those that promote its infiltration and storage in the soil profile and slow down its evaporation. Here, porosity and water absorption are the keys. Crop residues can help to improve these two parameters.

Nutrients store

The main reason for advocating the return of crop residues to the soil is that this provides the soil with the nutrients needed for the growth of subsequent crops. Interactive effects of organic matter: It is difficult to separate the various effects of returning crop residues to the soil. A good soil tilth combined with proper provision of water and nutrients promotes good yields. If any one of these components is missing, the whole system may be disrupted. For this reason it is better, at least to try to improve the whole system than to focus too narrowly on individual components. Component research should be undertaken only when it is certain that the component in question constitutes a critical constraint.

The socioeconomic context

Returning crop residue to the soil is not a common practice for most farmers who prefer to use them for other purposes like, livestock feed, fuel and building materials, burn or remove them from fields. The rationale for this behavior lies in the fact that residues are an obstacle to tillage operations and that, in certain cases, they could sustain pest, whose populations build up to levels that threaten the next season′s harvest.

Soil resilience

Soil degradation occurs slowly, due to resilience of the soil. It is reassuring because a well managed soil may not suffer much from short term stresses such as, flooding or severe drought. It can be concerning because prolonged stress takes time to show its effects, such that crop yields may remain relatively high as stress levels build. As a result, farmer may realize the problems they face too late.

Detrimental effect

- It may help in proliferation of pathogens
- Excessive organic residues may hinder tillage and planting operations
- It may influence through phytotoxins
- It may be detrimental due to allelochemicals

Residue management options:

Rice residue management is important in rice-wheat cropping system as machines are increasingly used for harvest. Several management options are available to farmer for the management of rice residues like, burning, incorporation, surface retention and mulching and baling and removing the straw.

Residue burning:

Traditionally, rice and wheat straw are removed from the field for use as cattle feed and for other purposes in south Asia. Recently with the advent of mechanized harvesting, farmers have been burning in-situ large quantities of crop residues left in the field as crop residues interfere with tillage and seeding operations for the subsequent crop, causing loss of nutrients and soil organic matter. Many farmers chop-off the rice stubbles with a stubble shaver, dry them and burn completely to facilitate timely planting of wheat leading to all kinds of environmental pollution. Thus one option is burning despite the large losses (up to 80%) of N, 25% of P, 21% of K and 4-60% of S. These practices also cause significant air pollution and kills beneficial soil insects and microorganisms. However, burning also kills soil borne deleterious pests and pathogens.

Residue incorporations

Crop residues may be incorporated partially or completely into the soil depending upon methods of cultivation. Ploughing is the most efficient residue incorporation method. Incorporation of rice residues before wheat planting compared to incorporation of wheat straw before rice planting is difficult due to low temperatures and the short interval between rice harvest and wheat planting.

Surface retention and mulching:

Direct drilling in surface mulched residues is a practice that leaves straw residues from a previous crop on the soil surface without any form of incorporations. Surface retention of residues helps in protecting the fertile surface soil against wind and water erosion. The large volume of residues remaining on the surface often lead to machinery failures, thus affecting sowing of seeds of the following crop. Farmer usually follows this method where no tillage or conservation tillage practices are prevalent.

Baling and removal of straw:

Surplus straw from agriculture may be used for a number of useful purposes such as livestock feed, fuel, building materials, livestock bedding, composting for mushroom cultivation, bedding / mulching for vegetables such as, cucumber, melons etc., and for orchards and other crops.

Zero or no tillage:

Addition of rice straw at 10 t/ha at 4-5 weeks before transplanting of rice is equivalent to basal application of 40 kg of N/ha through urea. To use this residue it would necessitate the adoption of conservation tillage system in soils and eco regions wherever the technique can be adopted. In this approach soil quality is enhanced.

CONCLUSION

Crop residue management through conservation agriculture can improve soil productivity and crop production by maintaining SOM levels. ... Greater microbial biomass and activity near the soil surface acts as a reservoir for nutrients needed in crop production and increases structural stability for increased infiltration. Conservation agriculture, with crop residues as an integral component, is an effective solution to the aforesaid challenges and ensures a strong natural resource base. The conservation agriculture sets principles towards sustainable production systems and these principles need to be translated into practices as per site-specific requirements. The best way to go about is to start working with a group of selected farmers from varying situations, use their knowledge and experiences and assess what and how much can be achieved and what is needed more to make conservation agriculture a success.

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