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Crop Residue Management

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Introduction

Crop residue, in general, are parts of plants left in the field after crops have been harvested and threshed or left after pastures are grazed. These materials have at times been regarded as waste materials that require disposal but it has become increasingly realized that they are important natural resources and not wastes. Crop residue, traditionally considered as “trash” or agricultural waste, is increasingly being viewed as a valuable resource. If the current trend continues, crop residue will be a “co- product” of grain production where both the grain and the residue have significant value. The emergence of crop residue as a valuable resource has evolved to the point where there are competing uses for it.

The recycling of crop residues has the advantage of converting the surplus farm waste into useful product for meeting nutrient requirement of crops. Maintenance of highly productive cropping requires effective protection of soils against erosion, conservation of relatively high amounts of soil organic matter, provision of optimum conditions for soil biota, and to prevent undesirable environmental effects of high-level fertilizer applications, the highest possible rate of recycling of plant nutrients. Appropriate field management of crop residues can help to achieve all of these goals.

The primary agricultural residue in Europe is provided by wheat production (i.e., wheat straw), followed by residues from maize (maize stalks, cobs) and barley (barley straw). Maize residues are primarily produced in Eastern Asia (which includes China), sugar cane residues are largely produced in South Asia (which includes India), and oil palm residues are mostly produced in South-Eastern (which includes, among others, Indonesia and Malaysia). In comparison with other continents, Africa is shown to produce agricultural residues at a much lower level compared to the other regions, which is primarily related to the lower output of agricultural crops in this continent.

Generation of crop residues in India

The Ministry of New and Renewable Energy (MNRE, 2009), Govt. of India has estimated that about 500 Mt of crop residues are generated every year. There is a wide variability in the generation of crop residues and their use across different regions of the country depending on the crops grown, cropping intensity and productivity of these crops. The cereal crops (rice, wheat, maize, millets) contribute 70% while rice crop alone contributes 34% to the crop residues. Wheat ranks second with 22% of the crop residues whereas fibre crops contribute 13% to the crop residues generated from all crops. Generation of crop residues of cereals is also highest in Uttar Pradesh (53 Mt), followed by Punjab (44 Mt) and West Bengal (33 Mt). Maharashtra contributes maximum to the generation of residues of pulses (3 Mt) while residues from fibre crops are dominant in Andhra Pradesh (14 Mt). Gujarat and Rajasthan generate about 6 Mt each of residues from oilseed crops.

Utilization and on-farm burning of crop residues in India

The utilization of crop residues varies across different states of the country. Traditionally crop residues have numerous competing uses such as animal feed, fodder, fuel, roof thatching, packaging and composting. The residues of cereal crops are mainly used as cattle feed. Rice straw and husk are used as domestic fuel or in boilers for parboiling rice. In states like Punjab and Haryana, where crop residues of rice are not used as cattle feed, a large amount is burnt on-farm. Estimated total amount of crop residues surplus in India is 141 Mt. Cereals and fibre crops contribute 58% and 23%, respectively and remaining 19% is from sugarcane, pulses, oilseeds and other crops.

State-wise generation and remaining surplus of crop residues in India

Source: Pathak *et al.*, 2010

State	Crop residue generation (MN 2009)	Crop residuessu (MNRE, 2009	Crop residuesbu (based on IPC coefficients)	Crop residues bu (Pathak etal. 201
Mt yr-1				
Andhra Pradesh	43.89	6.96	6.46	2.73
Arunachal Pradesh	0.40	0.07	0.06	0.04
Assam	11.43	2.34	1.42	0.73
Bihar	25.29	5.08	3.77	3.19

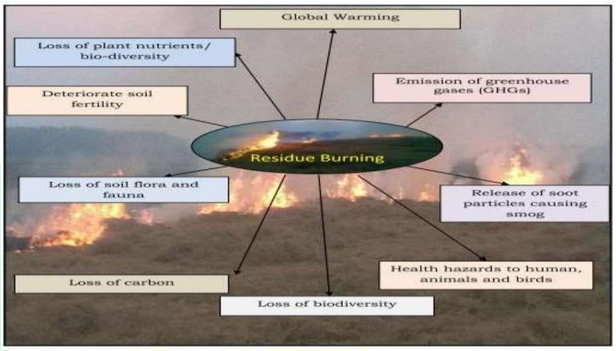
Chhattisgarh	11.25	2.12	1.84	0.83
Goa	0.57	0.14	0.08	0.04
Gujarat	28.73	8.9	9.64	3.81
Haryana	27.83	11.22	6.06	9.06
Himachal Pradesh	2.85	1.03	0.20	0.41
Jammu and Kashmir	1.59	0.28	0.35	0.89
Jharkhand	3.61	0.89	1.11	1.10
Karnataka	33.94	8.98	3.05	5.66
Kerala	9.74	5.07	0.40	0.22
Madhya Pradesh	33.18	10.22	3.74	1.91
Maharashtra	46.45	14.67	7.82	7.41
Manipur	0.90	0.11	0.14	0.07
Meghalaya	0.51	0.09	0.10	0.05
Mizoram	0.06	0.01	0.02	0.01
Nagaland	0.49	0.09	0.11	0.08
Odisha	20.07	3.68	2.61	1.34
Punjab	50.75	24.83	9.84	19.62
Rajasthan	29.32	8.52	3.84	1.78
Sikkim	0.15	0.02	0.01	0.01
Tamil Nadu	19.93	7.05	3.62	4.08
Tripura	0.04	0.02	0.22	0.11
Uttarakhand	2.86	0.63	0.58	0.78
Uttar Pradesh	59.97	13.53	13.34	21.92
West Bengal	35.93	4.29	10.82	4.96
India	501.76	140.84	91.25	92.81

Management of Crop Residues

1. **Crop residue burning:** Burning of residues in the field has been the traditional method followed by farmers. Recently, with the advent of mechanized harvesting, farmers have been burning in situ large quantities of crop residues left in the field since it interferes with tillage and succeeding operations for the subsequent crop, causing loss of nutrients and SOM.

Reasons for burning of residues in-situ:

- Scarcity of labour for manual harvesting.
- Use of combine harvester with the growth of farm mechanization.
- Timeliness in operation and clearing of field:
- Control of weeds/pests and short-term availability of nutrients.



Consequences of crop residue burning

Rice straw burning in the field has an adverse effect on soil and environment (Table 4). This practice causes large losses up to 80% N, 25% P and 21% K and 4–60% of S. It also kills soil borne deleterious pests and pathogens. One of the advantages of burning is that it clears the land quickly of residues before the next crop is established, thus facilitating seed germination and establishment. (Sidhu and Beri, 2008).

The stubble burning leads to wastage of valuable resources which could be used as a source of carbon, bio-active compounds, feed and energy for rural households and small industries. Heat generated from the burning of crop residues elevates soil temperature and consequently active beneficial microbial population with their diversity is reduced significantly, impacting adversely on the nutrient transformation in the soil. As a result, the succeeding crops suffer from nutrient deficiencies. Although the effect is temporary and the microbial population is recovered within a certain period, but repeated burnings may exhibit permanent effect on the population of soil microorganisms making the soil unfertile due to reduction in organic matter content accompanied with significant reduction in nutrient mineralization in the soil

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Emissions from open burning of rice straw and other crop residues in India.

Name of gases/Polluta	Rice straw		Other crop residues	
	EF (g/kg dm)	India (Gg)	EF (g/kg dm)	India (Gg)
CO_2	1,515	127,260	1,460	16,253
CH_4	2.70	227	1.20	13
N_2O	0.07	5.88	0.07 1	1
CO	92.00	7,728	34.70	386
NMHC	7.00	588	4.00	45
NO_x	3.38	588	3.10	35
SO_2	0.40	34	2.00	22
Total particulatematter (TPM)	13.00	1092	13.00	145
Fine particulatematter (PM 2.5)	3.90	328	12.95	144

Source: Chaudhary *et al*., 2016.

2. **Baling and removing the straw:** Removing the crop residues from the field is an alternative for management that would reduce burning of residues and utilize them for other purposes. Under baling/collection, baler is used to make compact bales of paddy stubble. Two machines are required to enable this- raker for heaping straw into rows and baler for compacting the straw into bales. Raker makes single linear heaps of straw and baler compacts it into rectangular or cylindrical bales depending of type of baler used. Once straw is baled at the field, custom built trolleys are used for transporting these bales directly to end users or conversion plants for further processing rice straw into useful products or fuels (ex-situ management). This practice is also producing lesser quantity of residue during harvesting. Removal/bailing practice comprised of utilizing as:
   - Livestock feed.
   - Compost making:.

- Biochar production.
- Bio-oil production.
- Biogas production.

3. **Surface retention and mulching:**

Mulching is a conservational and climate smart agricultural practice where crop residues are retained onto the surface as a cover/mulch by chopping/shredding it to smaller pieces and spreading it evenly on the ground**.** Surface retention of residue in soil can be managed by the technology of happy seeder and zero tillage. It was also observed that with the practice of surface retention of residues enhances the soil NO3 by 46%, N uptake by 29%, and yield by 37% than burning. The soil physical properties viz. soil moisture, temperature; aggregate formations are also affected by residue management practices. Surface retention is also act as mulch and mulching play important role in suppression of weeds.

There are numerous benefits of rice crop residue retention as mulch in cropland. On-site residue retention improves soil physical, e g., structure, infiltration rate, plant available water capacity, chemical, e.g., nutrient cycling, cation exchange capacity, soil reaction and biological, e.g., SOC sequestration, microbial biomass C and species diversity of soil biota.

4. **Residue incorporation:** Crop residue incorporation involves mixing or blending crop residue with 0-15cm top soil layer. Soil incorporation or mixing is similar to mulching as far as the first stage is concerned which is chopping/cutting the rice straw and evenly spreading it in the field. The key line of differentiation here is that straw is not retained as the top layer. In-situ incorporation of residue increases the soil nutrientas N, P, K and SOM.

Conclusion

Crop residues are not the agricultural waste but it is most valuable for the managing system as well as for human welfare. As crop residues have multiple functions in the soil, affecting directly and indirectly diverse ecosystem services, investments in research to better understand the impact associated with residue management are essential to define strategies for the industrial use of this raw material. The main advantage of Crop Residue Management includes fuel and labour savings as well as long-term benefits to soil structure and fertility. Overall, incorporation of crop residues appears to be a better management option. In the long-term, incorporation of crop residues increased the productivity of the crops and it also improve the physical, chemical and biological properties of the soil. It is assumed that India will become the most populous country by 2050 in the world. It will be a major challenge to ensure food security for all as well as to keep the environment safe and pollution-free. Therefore, Crop Residue Management should gain pivotal importance in delivering a better ecosystem while offering a better livelihood to the increasing population. Farming with good soil and crop management practices provides a proper direction to meet the future challenges of food, water and energy requirement, to mitigate degradation of natural resources and to prevent the climate change.

References

Aynehband A, Gorooei A. and Moezzi A A. 2017. Vermicompost: An Eco-friendly Technology for Crop Residue Management in Organic Agriculture. Energy Procedia 141:667-671.

Chaudhary M, Prasad M, Srinivasan K K and Singh S Kr. 2016. Crop residue management for nutrient cycling and improving soil productivity. ICAR- Indian Grassland and Fodder Research Institute, Jhansi- 284003.

FAO. 2015. Conservation agriculture. http://www.fao.org/ag/ca/1a.html. Accessed on 16 December 2020.

Karwariya S, Singh R P, Prasad A R, Kumar D A. 2014. Extraction of Crop Residue Burnt Field and its Impact on Soil Fertility (Case study of Central Madhya Pradesh, India). *International Journal of Scientific Research in Agricultural Sciences* 1(8): 156-164.

Lohan S K, Jat H S, Yadav A K, Sidhu H S, Jat M L, Choudhary M, Peter J K, Sharma P C. 2018. Burning issues of paddy residue management in north-west states of India. Renewable and Sustainable Energy Reviews 81:693–706.

Mandal K G, Misra A K, Hati K M, Bandyopadhyay K K, Ghosh P K and Mohanty M. 2004. Rice residue- management options and effects on soil properties and crop productivity. Food, Agriculture & Environment 2 (1): 224-231.

MNRE (Ministry of New and Renewable Energy Resources).2009. Govt. of India, New Delhi.

Murphy J, Braun, R, Weiland P, Wellinger A. 2011. Biogas from Crop Digestion. IEA Bioenergy.

Pathak H, Bhatia A, Jain N and Aggarwal P K. 2010. Greenhouse gas emission and mitigation in Indian agriculture – A review, In ING Bulletins on Regional Assessment of Reactive Nitrogen, Bulletin No. 19: 34.

Shyam C, Kaur S. 2016.Crop residue management- a sustainable way to control weeds in rice. *Indian Journal of Ecology* 43 (1): 83-87.

Sidhu B S, Beri V. 2008. Rice residue management: farmer's perspective. *Indian Journal of Air Pollution* 8:61–67.