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"CROP RESIDUES MANAGEMENT WITH CONSERVATION AGRICULTURE: ITS POTENTIAL AND CONSTRAINTS"

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INTRODUCTION

India is an agrarian economy. A vast majority of land is used for farming and a wide range of crops are cultivated in its different agro-ecological regions. It is estimated that approximately 500-550 Mt of crop residues are produced per year in the country. Crop residues are a tremendous natural resource-not a waste. Residue management is receiving a great deal of attention because of its diverse effects on soil physical, chemical, and biological properties. The quantities of nutrients that can be returned annually to soils as residues of common cultivated crops are considerable, requiring worthwhile consideration. Biological nitrogen fixation (BNF) by leguminous crops and the recycling of fixed N when leguminous crop residues are returned to the soil can be a significant source of N to the soil organic N pool as well as for subsequent plant uptake. Thus, there is a need to determine sink sizes and turnover rates of different quality residues and to increase the efficiency of nutrient cycling from residues through different soil sinks, and eventually to growing plants, with minimum loss from the system.

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 (Table 1). 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 generation of crop residues is highest in Uttar Pradesh (60 Mt) followed by Punjab (51 Mt) and Maharashtra (46 Mt). Among different crops, cereals generate maximum residues

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(352 Mt), followed by fibres (66 Mt), oilseeds (29 Mt), pulses (13 Mt) and sugarcane (12 Mt) (Fig. 1).

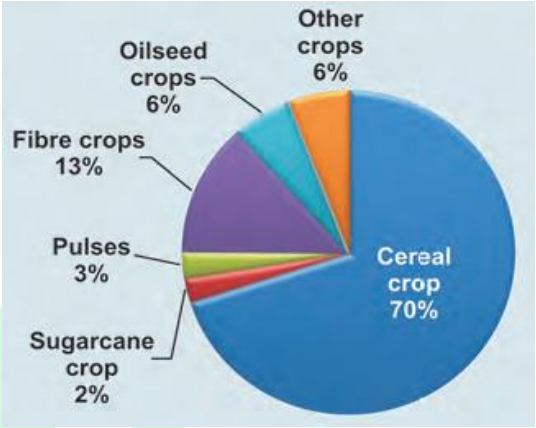

Fig. 1. Residue generation by different crops in India (calculated from MNRE, 2009)

UTILIZATION AND ON-FARM BURNING OF CROP RESIDUES IN INDIA:

Estimated total amount of crop residues surplus in India is 91-141 Mt. Cereals and fibre crops contribute 58% and 23%, respectively (Fig. 2) and remaining 19% is from sugarcane, pulses, oilseeds and other crops. Out of 82 Mt surplus residues from the cereal crops, 44 Mt is from rice followed by 24.5 Mt from wheat, which is mostly burnt on-farm (Table 1). In case of fibre crops (33 Mt of surplus residue) approximately 80% of the residues are from cotton and are subjected to on-farm burning.

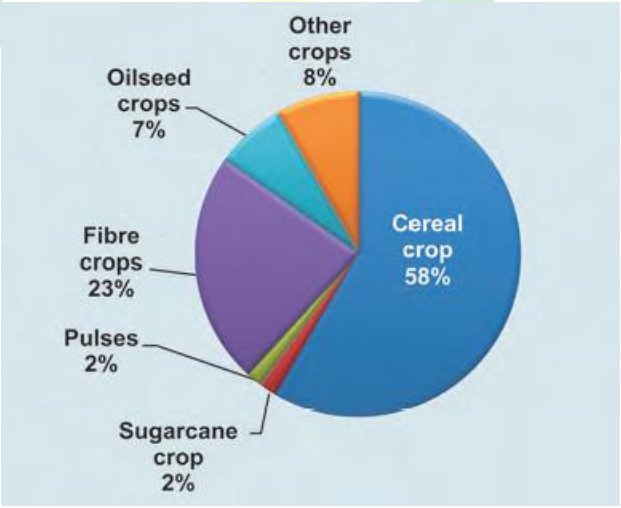

Fig. 2. The share of unutilized residues in total residues generated by different crops in India (calculated from MNRE, 2009)

Table 1: State-wise generation and remaining surplus of crop residues in India

	Crop residues	Crop residues surplus	Crop residues burnt	Crop residues burnt

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State	generation (MNRE, 2009)	(MNRE, 2009)	(based on IPCC coefficients)	(Pathak *et al.* 2010)
	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**

ADVERSE CONSEQUENCES OF ON-FARM BURNING OF CROP RESIDUES:

Burning of crop residues leads to release of soot particles and smoke causing human and animal health problems. It also leads to emission of greenhouse gases namely carbon dioxide, methane and nitrous oxide, causing global warming and loss of plant nutrients like N, P, K and S. The burning of crop residues is wastage of valuable resources which could be a source of carbon, bio-active compounds, feed and energy for rural households and small industries.

REASONS BEHIND ON-FARM BURNING OF CROP RESIDUES:

Farmers and policy makers are well-aware of the adverse consequences of on-farm burning of crop residues. However, because of increased mechanization, particularly the use of combine harvesters, declining numbers of livestocks, long period required for composting

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and unavailability of alternative economically viable solutions, farmers are compelled to burn the residues.

COMPETING USES OF CROP RESIDUES:

The crop residues can be gainfully utilized for livestock feed, composting, power generation, biofuel production and mushroom cultivation besides several other uses like thatching, mat-making and toy making.

Livestock feed:

In India, the crop residues are traditionally utilized as animal feed as such or by supplementing with some additives. Crop residues are low-density fibrous materials, low in nitrogen, soluble carbohydrates, minerals and vitamins with varying amounts of lignin which acts as a physical barrier and impedes the process of microbial breakdown.

Compost making:

The crop residues have been traditionally used for preparing compost. For this, crop residues are used as animal bedding and are then heaped in dung pits. In the animal shed each kilogram of straw absorbs about 2-3 kg of urine, which enriches it with N.

Energy source:

In recent years, there has been an increase in the usage of crop residues for energy generation and as substitute for fossil fuels. In comparison with other renewable energy sources such as solar and wind, biomass source is storable, inexpensive, energy-efficient and environment-friendly.

Bio-fuel and bio-oil production:

Conversion of ligno-cellulosic biomass into alcohol is of immense importance as ethanol can either be blended with gasoline as a fuel extender and octane-enhancing agent or used as a neat fuel in internal combustion engines.

Bio-methanation:

The process of bio-methanation utilizes crop residues in a non-destructive way to extract high quality fuel gas and produce manure to be recycled in soil.

Gasification:

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Gasification is a thermo-chemical process in which gas is formed due to partial combustion of crop residues. The main problem in biomass gasification for power generation is the purification of gas for removal of impurities.

Biochar production:

Biochar is a high carbon material produced through slow pyrolysis (heating in the absence of oxygen) of biomass. It is a fine-grained charcoal and can potentially play a major role in the long-term storage of carbon in soil, i.e., C sequestration and GHG mitigation.

CONCLUSIONS:

India has the challenging task of ensuring food security for the 'most' populous country by 2050 with one of the largest malnourished population. Besides, farming in future has to be multi-functional and ecologically sustainable so that it can deliver ecosystem goods and services as well as livelihoods to producers and society. Hence farming should effectively address local, national and international challenges of food, water and energy insecurity; issues related to climate change; and degradation of natural resources. For ensuring the country's food security both in the short- and long-term perspectives and making agriculture sustainable, the soil resource base must be strong and healthy.

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