Usage of Agriculture Residue in Rural Sectors of Haryana

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Abstract

India is the second largest agriculture-based country in the world, it generates 500 million tons of agriculture waste every year. Burning of crop residue is observed majorly in the Indo Gangetic Plain comprising states of Punjab, Haryana and Uttar Pradesh. In Haryana, every year 9.06 million tons of crop residue are burnt which deteriorates the air quality. The pollutants released from burning have hazardous health effects on humans and also cause ecosystem imbalance. The aim of the study is 'Usage of Agriculture Residue in Rural Sectors of Haryana'. The study was conducted in rural sectors of Sonipat and Jhajjar districts, respectively. The majority of crop residue in Sonipat and Jhajjar was utilized as animal feeding, except for mustard residue which cannot be consumed by livestock. The second most utilization of crop residue was sale to brick kilns where the residues were burned, except for bajra residue which was purchased by dairy farms. The emission load was estimated for the residues burned in brick kilns. This ground investigation suggests that the government should develop appropriate residue control strategies that would work well with current agricultural methods without jeopardizing the system's productivity or environmental sustainability.

Introduction

In the overall economy of India, agriculture holds a major contribution. The northwestern states of India, comprising states namely Punjab, Haryana, and Uttar Pradesh, together form a densely populated agricultural zone. A wide range of crops like wheat, maize, rice, sugarcane, pulses, cotton, jute and millets are cultivated across the country and the left-over crop material which includes roots, stalk, leaves after harvesting is called crop residue. The crop residue can be used in many ways like animal feeding, fuel for cooking and organic manure and the remaining is the surplus residue. Annually, India generates 234 million tonnes of surplus crop residue of the total crop residue generated annually, that is 500-550 million tonnes (Mt). The utilization of residue depends on productivity, crop intensity & the crops cultivated in the country. The highest quantity of residue was identified in Uttar Pradesh (60 Mt), followed by Punjab (51 Mt) and Maharashtra (46 Mt).

Scope of the Study

The agricultural hub of India is mainly situated in north-western region (also called as Indo-Gangetic Plain) including states of Punjab and Haryana. The agricultural practices in these states are categorized by two growing seasons: first is chiefly winter wheat crop, harvested in the months of April-May, and the second is mainly a summer rice crop, harvested in the months of October- November. Mechanical harvesters are being mainly used during harvesting of crops for the last 30 years. But due to this harvesting method, it leaves extra crop residue than traditional means and most of the farmers burn these residues to prepare the grounds for the upcoming growing season. Approximately 23 million tons of rice residue are burnt annually in the Indo-Gangetic Region. Burning crop residue not only pollutes the environment by releasing soot particles, sulfur dioxide, carbon dioxide, nitrogen dioxide, polycyclic aromatic hydrocarbons and carbon monoxide; it also results in loss of essential plant nutrients. Haryana has appeared to be an imperative state for Rice & Wheat production in India. Table 1 shows the emission of pollutants from crop residue burning in Haryana during the year of 2008-2009.

Table1: Pollutants emitted from crop residue burning in Haryana during the year of 2008- 2009

Name of the pollutant released	Emission (in metric tons per year)
CO2	**13,907.71**
CO	844.56

NOx	22.95
Sox	3.67
VOC	144.13
Particulate matter	35.80

Source: Sanjay et al., 2021

The reason behind crop burning practices in Haryana should be known; the scope of the study is to know the reason why agriculture residue burning is being practiced in Haryana and if not, then what are the other ways to utilize crop residue. The study was conducted in Sonipat and Jhajjar districts of Haryana through ground level information with the help of questionnaire surveys.

Methodology

The case study focusses on the usage of agriculture residues in the rural sectors of districts of Sonipat and Jhajjar in the state of Haryana. The study was conducted through ground level information with the help of questionnaire surveys. The survey was completed by visiting ten randomly selected villages with agriculture practices from each district. From each village 16 houses were surveyed. So, the total comes out to be 20 villages and 320 houses. The study period was from Mid of January to March, 2021.

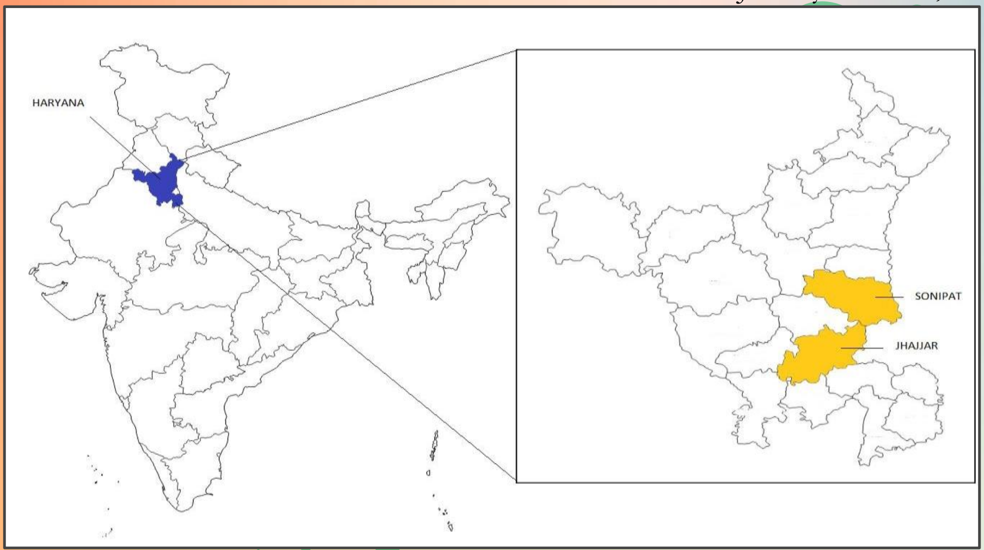

Figure 1: Representation of study area

Results and Discussion

Of the 160 samples collected in Sonipat, 102 were farmers while 58 were of different professions; like businessman, labor and servicemen. Likewise, in Jhajjar, of 160 samples collected, 104 were farmers and 56 were of different professions. From each district, data of agriculture residue was collated as discussed below. The details comprise of production of crop, waste generated by crop and utilization of waste as animal feeding, sale to industry, dumping, sharing of waste. In the category of sale to industry, the residue is sold to nearby brick kilns except for bajra residues, that were sold to dairy farms, while in dumping the residue is composted on the agriculture field for the nourishment of the soil and in sharing of waste, the residue is shared among their neighbors or other villagers who are in need of the crop residue. Bajra residue is also sold, but not to brick kilns. The villagers sell the residue to local vendors and from them, the dairy farms purchase the residues.

For each crop; its production, waste generation and utilization of waste, average value of 10 villages was taken and multiplied with total area of the crop (data obtained by collecting it from Department of Agriculture of Sonipat and Jhajjar, respectively, shown in table 2.) of respective district to obtain the total crop residue for each crop of the district. In order to do that the quantity of each aspect that is production, waste generation and use of waste that was calculated as Quintal/Acre, it was converted into Kg/Hectare and then the quantity was converted into tonnes, and finally multiplied with area of the crop used for cultivation in respective district to obtain the values as shown in table 3 and 4.

Table 2: Agriculture data of land area under crop of Sonipat and Jhajjar

	Area (in hectares)	
Crop	**Sonipat***	**Jhajjar****
Rice	116000	50900
Bajra	6700	38900
Wheat	146000	107000
Mustard	3000	32000

*Source: Department of Agriculture, Sonipat
**Source: Department of Agriculture, Jhajjar

Table 3: Agricultural details of overall district of Sonipat

Crop	Area (in hectares)	Production (in tons)	Waste (in tons)	Utilization of Waste (in tons)			
				Animal feeding	Sale to Industry	Dumping	Sharing
Rice	116000	492679.93	483077.43	304072.49	83776.80	74670.19	22186.08
Bajra	6700	17521.80	24729.20	23694.45	-	1031.99	-
Wheat	146000	720536.43	726994.28	496820.91	145391.64	67753.23	22367.94
Mustard	3000	4077.23	3891.90	-	2223.95	1630.89	-

Table 4: Agricultural details of overall district of Jhajjar

Crop	Area (in hectares)	Production (in tonnes)	Waste (in tonnes)	Utilization of Waste (in tonnes)			
				Animal feeding	Sale to Industry	Dumping	Sharing
Rice	50900	190771.76	205433.21	140454.46	59381.86	-	5596.90
Bajra	38900	81235.03	102821.38	92748.85	2557.23	-	7515.29
Wheat	107000	414437	427384	304836	99304	7597	15647
Mustard	32000	60734	47553	-	17109	12022	18415

Although most of the residue was consumed for animal feeding, some of the residue was also sold to brick kilns where it is burned and emit pollutants which have health hazards like cancer, respiratory problems, and ecosystem imbalance. To quantify the pollutants, emission load of respective district was calculated. For that, the emission factors were obtained by reviewing various research papers and then the emission factor was multiplied with the amount of agriculture residue that was sold to brick kilns. Since bajra residues were sold to dairy farm (as per our survey), it was not considered in calculations. The emission load is tabulated below in table 5.

Table 5: Emission load of crop residue of Sonipat and Jhajjar

	Emission load of crops (metric tonnes/year)					
	Rice		Wheat		Mustard	
Pollutants	**Sonipat**	**Jhajjar**	**Sonipat**	**Jhajjar**	**Sonipat**	**Jhajjar**
PM10	646.51	458.25	591.74	404.17	14.01	107.79
PM 2.5	548.49	388.77	369.29	252.23	10.45	80.41
CO	4080.85	2892.55	13467.63	9198.53	164.13	1262.64
SO2	94.08	66.69	123.58	84.41	2.29	17.62

NO2	60.32	42.75	63.97	43.69	0.71	5.47
EC	28.82	20.43	61.06	41.71	1.27	9.75
OC	168.06	119.12	42.16	28.8	4.67	35.93

Emission load of rice and wheat in Sonipat is higher than Jhajjar. The pollutants, namely PM10, PM2.5, SO2, NO2 and CO released from wheat and rice residue burning were approximately 59% more than the pollutants from wheat and rice in Jhajjar. The emission load is more due to more production which results in more generation of waste which is sold to brick kilns where it is burnt. The residue of mustard was identified to be sold to brick kilns and hence emission load was estimated. The pollutants like CO, SO_2, NO_2, PM10 and PM2.5 released from burning of crop residue in brick kilns have a negative influence on the environment as well as the health of human beings. Decrease in lung function, irritation in the nose, throat and eyes and early mortality are the consequences of release of SO_2. During our survey findings, some villagers of both Jhajjar and Sonipat district reported health disabilities like headache and eye irritation; the reason may be emissions from brick kilns. Elder people and infants with pre respiratory disorders are at the major risk. Due to poor kiln structure, the amount of CO emission is elevated which may affect the central nervous system and result in symptoms like choking of breath, headache, exertion and nausea. In plants, SO_2 causes browning of leaves, decrease in chlorophyll content (both chlorophyll a and b) and finally necrosis. So_x and NO_x together are largely cause for the decline in lichen population. NO_2 may also reduce the photosynthetic activity of plants. Plant growth and production may also be altered by the suspended particulate matter (SPM) by accumulation on the plant surface which may increase the infection of plants to pathogens and pests and decrease in the rate of photosynthesis.

The ambient air quality data of respective district was collected from the website of Central Control Room for Air quality Management (CAQM). From April, 2020 to March, 2021, air quality data was collected on an hourly basis and average was estimated for each month of the total duration. The parameters collated were PM10, PM2.5, SO_2, NO_2 and CO accordingly.

Table 6: Air quality data of PM 10 and PM 2.5 of Sonipat and Jhajjar

		Pollutants (in μg/m³)			
Year	**Month**	**PM10**		**PM2.5**	
		Sonipat	**Jhajjar**	**Sonipat**	**Jhajjar**
2020	April	121.61	90.54	30.65	44.99
2020	May	171.36	106.2	39.85	46.3
2020	June	164.77	104.42	41.75	48.26
2020	July	99.07	60.73	29.48	28.64
2020	August	79.89	44.53	20.32	25.38
2020	September	129.12	101.08	23.21	52.6
2020	October	241.35	217.05	57.29	125.46
2020	November	301.31	242.09	118.01	175.82
2020	December	241.73	198.57	92.45	138.87
2021	January	204.79	177.72	80.22	130.92
2021	February	193.86	208.92	63.76	124.49
2021	March	240.01	193.38	45.94	94.26

Table 7: Air quality data of SO_2 and NO_2 of Sonipat and Jhajjar

		Pollutants	
Year	**Month**	**SO_2**	**NO_2**

		Sonipat	Jhajjar	Sonipat	Jhajjar
2020	April	27.99	11.74	53.48	19.13
2020	May	27.49	7.91	53.99	24.38
2020	June	31.23	6.55	57.06	35.12
2020	July	34.6	3.69	24.86	17.8
2020	August	19.15	3.36	14.99	29.87
2020	September	37.47	3.4	15	28.84
2020	October	24.36	13.19	15.01	49.94
2020	November	16.36	11.5	93.16	54.51
2020	December	15.48	7.16	45.18	86.4
2021	January	8.64	5.76	31.25	49.63
2021	February	8.36	23.71	28.59	36.99
2021	March	17.34	23.6	29.1	27.22

Table 8: Air quality data of CO in Sonipat and Jhajjar

	Pollutants (in mg/m³)	
Month	**CO**	
	Sonipat	**Jhajjar**
April	0.91	0.52
May	0.76	0.7
June	0.49	0.78
July	0.35	0.74
August	0.33	0.57
September	0.49	0.56
October	0.79	1.14
November	1.04	1.83
December	0.86	2.65
January	0.87	1.84
February	0.82	1.42
March	0.63	0.94

If we compare table 6,7 and 8, we find that during the harvesting period of Kharif crop (October-November) and Rabi crop (April- May), there is a gradual increase in the average concentration of the pollutants, the reason maybe increases in burning activities in brick kilns during that period. It can be said that brick kiln emissions are contributing to degraded air quality in respective districts.

Conclusion

The farmers were bound to sell their residue to the brick kilns due to socioeconomic reasons. Without income they cannot lead their life. The economic status of farmers needs to be uplifted, lack of knowledge and income is the major problem behind crop burning. Educating farmers about the ill effects of air pollution and also about different crop managements that are possible. Different uses of crop residue can be done like mushroom production, packing material, construction materials, roof thatching and handicrafts, all these are ex situ conservation of crop residue. Since farmers don't have time for in situ conservation of crop residue because they have to prepare land for next growing season. For that, the government can make a separate market for crop residue on public private partnership where farmers can sell their residue and get a handsome amount in return to elevate their economic status. From the market the industries may buy the residue for paper making, mushroom cultivation, bioethanol and biogas production. This will reduce the residue being sold to brick kilns and reduce the emission of pollutants enhancing the air quality. Apart from that, the government can set up composting & biogas plants at village level for discrete and commercial uses. To run such plants, locals can be hired which will generate employment and provide them employment. This will improve the livelihood of the villagers and educate them about the utilization of agriculture residues.

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