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Possible Reasons and Farmers Awareness Towards Crop Residue Burning: an Overview and a Case Study from Mirzapur Village of Kurukshetra District, India

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Abstract

The research was carried out to identify the factors responsible for crop residue burning (CRB) and to check the awareness level among farmers regarding residual burning and it impacts on environment. For the study, self-structured questionnaire and face-to-face interview methods were adopted to generate data from 50 respondents (farmers) of the Mirzapur village in the Kurukshetra district of Haryana. Questionnaire comprises of information about the factors behind practice of crop residual burning, and its impacts on environment, soil quality, and human health. During the study period, most of the respondents (96%) in the study area practiced agricultural crop residue burning after crop harvesting. The main reason behind this practice was to prepare their land for the next crop in short time and to remove pest, weeds etc. Additional factors observed behind residual burning were non-availability of man power for manual harvesting of stubble, high cost of residues removal, and low market rates of residues. About 90% of the respondents were well aware regarding air pollution caused by residual burning however, they were unaware about specific air pollution related health problems and green house gases emissions. The farmers were also unaware about the negative impacts of residue burning on soil quality. The research concluded that the farmers had low awareness regarding CRB and its related impacts. There is a need to create awareness among farmers through *gram panchayats* (village societies), community based organizations, NGO's and institutions like *Krishi Vigyan Kendras*. The use of new technologies like happy seed harvester along with composting are also recommended to deal with the problem. The state government should formulate more effective polices after due consultation with the farmers and augmenting the capacities of farmers to manage the waste more competently rather than burning alone.

Introduction

India being an agriculture-dominant country generates about 500-550 million tons of crop residues every year (IARI, 2012). 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. Farmers use crop residues either themselves or sell it to landless households or intermediaries, who further sell them to industries (Pathak *et al*., 2011) however, a large portion of unused crop residues, were burnt in the fields. The practice of burning is not a new idea but started many generations ago with the burning of grasslands. Burning is an inexpensive, labour efficient means of removing unwanted crop residues prior to tillage or seedbed preparation. The crop residues are subjected to open burning on account of high labour wages and anxiety of the farmers to get the crop produce collected and marketed at the earliest. The system is basically a man-made and perception of traditional culture that has evolved over the years and is based mainly on strong socio-cultural traditional beliefs, confounded by the economic status of the people. The two states namely Punjab and Haryana alone contribute 48 % of the 13915 Gg (Giga gram=10 billion gram) rice straw surplus produced in India and are subject to open field burning (Gadde *et al.,* 2009).

Burning of crop residues leads to 1) release of soot particles and smoke causing human health problems; 2) emission of greenhouse gases (GHGs) such as carbon dioxide, methane and nitrous oxide causing global warming; 3) loss of plant nutrients such as nitrogen (N), phosphorous (P), potassium (K) and sulphur (S); 4) adverse impacts on soil properties and 5) wastage of valuable carbon (C) and energy rich residues. Biomass burning is one of the significant global sources of atmospheric aerosols and trace gas emissions, which have a major impact on climate and human health (Pandey *et al.,* 2005; Kharol and Badarinath, 2006).

The rice and wheat system (RWS) is one of the widely practiced cropping systems in northern India. About 90–95% of the rice area is used under intensive rice wheat system in Haryana and Punjab (Gadde *et al.,* 2009). Widespread adoption of green revolution technologies and high yielding variety of seeds increased both, crop as well as crop residues. In the last few decades intensive mechanization of agriculture has been occurring and combine harvesting is one such input, particularly in the RWS where relatively short period of time is available between rice harvesting and wheat plantation and any delay in planting adversely affects the wheat crop. This coupled with combine harvesting compels the farmers to burn the residue to get rid of stubble left out after the harvest. Wheat and rice crop residues are burnt during the months of April–May and October–November each year, respectively in the state of Haryana leading to impacts on different environmental components. Therefore, the present research was carried out to identify the factors responsible for crop residue burning and to check the awareness level among farmers regarding residual burning and it impacts on environment.

Material and methods

Study area

Haryana produces 24.7 metric ton/year (Mt/year) of cereal crop residues in India and is at fifth position after Uttar Pradesh, Punjab, West Bengal, and Andhra Pradesh (Jain *et al.,* 2014). Kurukshetra district of Haryana covers 3.46% area of the state (CGWB, 2007). Mirzapur village is situated in the Thanesar block of Kurukshetra district of the Haryana State (Figure 1). Kurukshetra lies between latitude 29°53' to 30°15' N and longitude 76°26' to 77°04' E in the North Eastern part of Haryana State. The village is situated on National Highway-1 (NH1) about 4.4 km far from the main City of Kurukshetra and about 87 km distance from the state capital Chandigarh, covering an area of 1530 sq.km. From transect walk and personnel observation from 2 years it came to notice that the village farmers practiced crop residue burning twice in a year and also the village is easily approachable, making it suitable site for the study. The population of the village was about 5490, having 1046 houses and a literacy rate of 74.93 % (Population Census, 2011).

Figure 1 Map showing location of the study area (Mirzapur village)

Survey work

For the study, questionnaire survey (Annex-I), face to face interview methods and data from secondary sources were adopted. The questionnaire was first prepared in English and then translated to Hindi (native language) and then back to English to verify

the consistency and content of the questionnaire. As per information obtained from the Head of the village, known as "*Sarpanch*" in native language, there are about 100 households engaged in farming out of which 50 % are alternatively selected for data collection. The questionnaire comprises of information about the farmer knowledge and practice towards CRB, factors behind practice of CRB, and its impacts on soil quality, human health and environment. The face to face interview provides information regarding farmer's set of mind for crop residue burning and their awareness level for the same. The purpose of the study was clearly explained to the study participants and their verbal consent was obtained. Confidentiality of the collected data was strictly maintained throughout the study period.

Results and discussion

Social demographic characteristics

Fifty farmers were selected for the study. The response rate was 94% and the reason for not responding were their absence during the survey. All the study participants were males, as in Indian agriculture system mainly male members are involved in field farming and females are assisted in the related work. About 40 % of the farmers were in the age group of 49–58 years, while 30 % were 39–48 years, 15 % were 29–38 years and 5 % were of 18–28 years and rest 10 % were above 60 years. Regarding educational status, 14 % can read and write only, 50 % attended primary, 18 % had middle and high school qualification, 02 % were graduate and post graduate and the rest 16 % were totally illiterate. All the study respondents were married and 62% of them have a family size of 5 members while 36% has 6–10 members in their family. Approximately 12 % of the farmers were having their annual income < 1 lac (*in Indian Rupees*), 38% between 1–3 lacs, 30% between 4–5 lacs, and the rest 20% >5 lacs (Table 1).

Agricultural crop residue burning practice

Most of the respondents (96%) practice agriculture crop residue burning after every crop harvest. In Haryana especially wheat straw is mainly used as cattle feed than rice straw due to high silica content, therefore the residue burning is comparatively practised more after rice harvesting. However, the rice straw is commonly used for cattle shed roof making, for cattle bed during winter season and for making animal dung cakes houses. The burning was mostly practiced during evening hours however, the farmers do not know the reason behind it. A few of them shared that the spread of fire is more visible during evening time and can be managed if goes beyond control. Only 10 % farmers knew that CRB practice is banned in Haryana and nobody knows about any kind of punishment or fine imposed on defaulters, which can be one of the reasons behind residue burning. However, the Haryana State Pollution Control Board has filed cases against 32 farmers in the special environment courts at Kurukshetra and Faridabad and approved nine cases during 2015-16 (The Times of India, 2015). Further, lack of awareness among farmers, CRB burning at large scale in a short period, less manpower to vigil/control and effective implementation of rules regarding CRB could be the possible reasons behind environmentally unacceptable practice (Table 2).

Table 1 Social demographic characteristics of the respondents of the study area.

Characteristics	Percentage
Age of farmers in years	
18-28	05%
29-38	15%
39-48	30%
49-58	40%
> 60	10 %
Education qualification	
Total Literacy rate	70%
Illiterate	16 %
Read and write only	14%
Primary	50%
Middle /high school	18%
Graduate / Post graduate	02%
Marital status	
Married	100%
Family size	
Small (up to 5 members)	62%
Medium (6–10 members)	36%
Large (> 10 members)	02%
Annual income in rupees	
< 1 lacs	12%
1–3 lacs	38%
4–5 lacs	30%
> 5 lacs	20%

Factors responsible for crop residual burning

A large portion of the residues burnt mainly to clear the field for sowing of the succeeding crop. Crop residues management problem is increasing in recent years due to manual labour shortage, high cost of removing the crop residues by conventional methods and use of combines for crop harvesting. The other additional factors behind intentional burning of crop residues are pest and pasture management and soil fertility enhancement. Residues burning provides a rapid way of controlling weeds, insects and diseases, both by removing them directly or by altering their natural habitat (Pathak *et al.,* 2011). Many places in India for example in northwest the time gap between rice harvesting and wheat sowing is only 15–20 days. In this short duration, farmers prefer to burn the rice straw on-farm instead of harvesting it for fodder or any other use. Further, huge transportation cost also promotes farmers to opt the CRB (Pathak *et al.,* 2011). Similar findings were reported in Suquian region of the Jiangsu province of China where the farmers were so tired in the sowing month that they are unwilling to spend the valued time on call-back crop residue (Yang *et al.,* 2008). The respondent's interview revealed that those who have cattle will not practice CRB as they need fodder for them.

Table 2 Awareness level among respondents regarding crop residue burning

Sr. No	PARTICULARS	RESPONDENTS	
		Yes (%)	No (%)
1.	Did you practice agricultural crop residues burning (CRB)?	96%	4%
2.	Do CRB creates air pollution?	90%	10%
3.	Do CRB burning can cause asthma problems?	14%	86%
4.	Any respiratory problem due to CRB?	02%	98%
5.	Did you observe any visibility problem related to CRB?	72%	28%
6.	Do you know any fatal accident due to CRB?	4%	96%
7.	Do you think CRB can decrease soil organic matter / microbial biomass?	2%	98%
8.	Do you know CRB can increase green house gases emission?	–	100%
9.	Did you have any benefits after CRB?	97%	3%
10.	Do you know soil fertility decreased by CRB?	96%	4%
11.	Do you know CRB practice is ban in Haryana?	90%	10%
12.	Did Panchyat give any punishment to anybody regarding crop residue burning?	–	100%

Impact on ambient air

About 90% of respondents were well aware regarding air pollution caused by residue burning. However, none of them were aware regarding green house gases emission. About 72% of the respondents reported about visibility problem after residue burning. It is estimated that India annually emits 144719 Mg of total particulate matter from open field burning of rice straw (Gadde *et al.,* 2009). The heavy smog and haze in the National Capital Delhi during winter in 2014 was also blamed due to the burning of crop residues and vehicular emissions. The satellite images by US National Aeronautics and Space Administration (NASA) revealed huge amounts of crop residues burning in Punjab, Haryana and Uttar Pradesh responsible for smog and hazy weather in northern India, especially over Delhi and the National Capital Region. The north and northwesterly winds blows from these states towards Delhi and the NCR bring huge amounts of soot from emissions of crop burning (Vashishtha, 2014).

Impact on soil quality

The awareness level regarding impact of CRB on soil quality was quite low in the study area as only 2% of the respondent agreed that CRB decreases the soil organic matter. Burning of crop residues leads to loss of plant nutrients like N, P, K and S and is

wastage of valuable resources which could be a source of carbon, bio-active compounds, and other soil nutrients. Heat generated from the burning of crop residues elevates soil temperature causing death of active beneficial microbial population. Residue burning affects soil as nutrient loss by volatilization, ash convection, runoff, wind and soil erosion and leaching of fire-released nutrients (Schoch and Binkley, 1986). Sateesh *et al.,* (2014) investigated an average deterioration of 17.32 % Carbon, 12.69 % Nitrogen and 16.23 % Potassium in wheat fields after burning residues in different villages of Madhya Pradesh. Burning has a differential impact on soil fertility, it increases the short-term availability of some nutrients and reduces soil acidity, but ultimately leads to loss of other nutrients (like N and S) and organic matter (Richard 2001).

Impact on health

According to the study only 02 % farmers knew that residual burning may be responsible for respiratory problem, about 14 % farmers quote "Asthma" as particular disease and 4 % of the respondents informed about visibility problem and had witnessed the fatal accidents because of burning. According to the IARI (2012) report burning of crop residues leads to release of smoke, greenhouse gases namely carbon dioxide, methane and nitrous oxide causing global warming and large amount of particulates which cause adverse impacts on human health. The resulting smoke from crop residue burning may become a health hazard as it may causes multiple and lasting effects particularly on children's lung function (Awasthi et al., 2010) and may results in respiratory and eye problems (Grace *et al.,* 2003). High incidence of asthma symptoms, lower lung function and/or more respiratory hospitalizations were reported among populations exposed to outdoor smoke from rice straw burning in Butte County, California, USA (Jacobs *et al.,* 1997) and Niigata, Japan (Torigoe *et al.,* 2000).

Policy/Government Initiative regarding crop residue burning

Time to time, the authorities in the Haryana state has warned farmers and even pointed out that proceedings will be initiated against them for violating the ban on burning stubble. Haryana's agriculture department is promoting the use of various techniques like happy-seeder, turbo-seeder, shredder, bailing machine and zero-seed-cum-fertilizer drill to facilitate in-situ management of crop residues by providing subsidy to farmers for the purchase of machines. During harvesting time, the state government discourage farmers from crop residue burning through newspapers. Haryana's environment department has issued a notification under the Air (Prevention & Control of Pollution) Act of 1981 that bans the burning of agriculture waste in open fields. The government also issued advisory to the farmers not to burn wheat stubble as it leads to manifold increase in the air pollution level during the harvesting season. The pollution control board officials have been asked to keep a strict vigil and file cases against the defaulting farmers. In recent years, the board has filed cases against 32 farmers in the special environment courts at Kurukshetra and Faridabad. The Punjab government recently announced a financial grant of Rs.1 crore ($157,000) and Rs.100,000 for each district and village rid of the malaise and reward the districts and villages which curbed the practice of straw burning (The Times of India, 2015). Being having similar

agricultural practices and climatic conditions with Neighbouring state Punjab, the same policy of rewarding the particular village bodies can be adopted in Haryana also.

Conclusion and recommendations

As per the study most of the farmers in the study area were practising crop residue burning after crop harvesting. The reasons behind this practice were land preparation for the next crop, to remove pest and weeds, less time gap between two successive crops, non–availability of man power for manual harvesting of stubble, high cost of residues removal, and low market rates of residues. Regarding the awareness level farmers had knowledge about the environmental impact of residue burning like air pollution but unaware about green house gases emission. The study reported that most of the respondents were facing the problems during these months but unaware about the particular health problems like respiratory, and eye irritation related to residual burning. Only 2% of the respondent were of the opinion that it decreases the soil organic matter but were unaware that burning crop residues leads to loss of plant nutrients like N, P, K and S.

The crop residues can be collected and managed properly and can be used for conservation agriculture. Conservation agriculture offers a good promise in using these residues for improving soil health, increasing productivity, reducing pollution and enhancing sustainability and resilience of agriculture. The resource conserving technologies involving no- or minimum-tillage, direct seeding, bed planting and crop diversification with innovations in residue management are possible alternatives to the conventional energy and input intensive agriculture. Returning of crop residues into the soil using cropping devices and harrowing and baling straw for livestock use can be some of the alternatives to burning. Excess straw can be sold for industrial use such as straw particle board, and for ethanol production.

CRB is not an environmentally acceptable form of agricultural residue management. However, if there are no options especially in case of pest and disease affected crops residues, the farmers can take precautions to curb the environmental and human health impacts. Farmers should never practise crop residues burning at night as damp conditions produce more harmful smoke emissions and calmer conditions may cause smoke retention or poor dispersal. There must be adequate fireguard and water supply provision to control fire hazards. The burning should not be across an entire field as a large field, stubble or windrow burn produces more smoke, whereas piled or baled straw will burn hotter and faster and produce fewer pollutants.

There are numerous options which can be practiced such as composting, generation of energy, production of biofuel and recycling in soil to manage the residues in a productive manner. There is a need to create awareness among the farming communities about the importance of crop residues in conservation agriculture for sustainability and resilience of Indian agriculture. Community based organizations, NGO's and institutions like "*Krishi Vigyan Kendras"* must play more active role in creating awareness among farmers to control CRB. The state government should

formulate more effective polices after due consultation with the farmers and augmenting the capacities of farmers to manage the waste more competently rather than burning alone.

Authors' contributions: *Dr. Hardeep Rai Sharma (Assistant Professor), corresponding author, designed the research and the manuscript; Ms. Dipti Grover (Assistant Professor), helped in designing the research and manuscript writing, supervised the data collection and Ms. Pardeep Kaur (M. Sc. student) generated and interpretated the data.*

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Annexure I

Questionnaire for the assessment of awareness, practice and related factors of Mirzapur village farmers towards crop residue burning

Village Profile

Village…… Tehsil…….. District…….

Location with respect to National Highway/state Highway/ Road…….

Agricultural Office…….. (since years)

Agricultural schools…….. (since years)

Visited Households Profile

Contact Details

1. Name of the head of the family …….
2. Age……
3. Marital Status……
4. Type of family-: (a) Nuclear…….. (b) Joint……
5. Size of Family

   Small (upto 5 members)

   Medium (6–10 members)

   Large (> 10 members)

6. Religion…….
7. Monthly Income……..
8. Cropping pattern…….
9. Agricultural Machines owned by the family
10. Cattle information

    (a) Number…… (b) Type…….

11. Water Source……

Family Education

Education level	Husband	Wife	Children
Illiterate			
Can read only			
Can write only			
Primary			
Middle			
High School			
Graduate			
Post graduate			

QUESTIONS REGARDING CROP RESIDUE BURNING (CRB)

1. Did you burn crop residue?
2. At what time you burned the crop residues?

3. Do you know CRB can cause/generates?

- Air pollution: yes/ no
- Asthma problem: yes/no
- Respiratory problems: yes/ no
- Visibility problem : yes/no
- Next crop output: increase/decrease
- Accidents on roads: yes/ no
- Reduce soil fertility: yes/ no
- Texture of the soil: stony/ same /dry
- Decreased soil organic matter/ microbial biomass: yes/ no
- Increased Green House Gas Emission: yes /no

4. Why you prefer residue burning?

5. What are the benefits of crop burning?

6. What will you do after burning the crop?

7. From where you get the information regarding CRB issues?

TV ( ) Radio ( ) Panchyat ( ) Other ( )

8. Do you know CRB is ban in our country?

9. Did village Panchyat gave punishment to any one for crop residual burning?