International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; SP6: 69-72

Jitendra Ojha
Faculty of Agricultural Sciences & Allied Industries, Rama University Kanpur, Uttar Pradesh, India

Deepankar Tiwari
Faculty of Agricultural Sciences & Allied Industries, Rama University Kanpur, Uttar Pradesh, India

Correspondence
Jitendra Ojha
Faculty of Agricultural Sciences & Allied Industries, Rama University Kanpur, Uttar Pradesh, India

(Special Issue -6)
3rd National Conference
On
PROMOTING & REINVIGORATING AGRI-HORTI, TECHNOLOGICAL INNOVATIONS
[PRAGATI-2019]
(14-15 December, 2019)

Stubble burning: An issue that touches field in rural area and lungs in urban

Jitendra Ojha and Deepankar Tiwari

Abstract
Burning of farm waste causes severe pollution of land and water on local as well as regional scales. It is estimated that burning of paddy straw results in nutrient losses viz., 3.85 million tonnes of organic carbon, 59,000 t of nitrogen, 20,000 t of phosphorus and 34,000 t of potassium. This also adversely affects the nutrient budget in the soil. It results in the emission of smoke which if added to the gases present in the air like methane, nitrogen oxide and ammonia, can cause severe atmospheric pollution. These gaseous emissions can result in health risk, aggravating asthma, chronic bronchitis and decreased lung function. Burning of crop residue also contributes indirectly to the increased ozone pollution. The chapter puts forth literature on various aspects of residue generated on the field, chemical composition of the residue, volume of pollution caused by residue burning, adverse impact of burning on human and animal health and various ways of crop stubble management.

Keywords: Crop stubble burning, chemical composition of residue, health impact of stubble burning**,** stubble burning and soil fertility and crop stubble management

Introduction
Production and consumption activities generate pollution and waste, and atmospheric environment can absorb pollution/waste up to a limit. Agriculture is one of the important production activities and crop residue burning generates a significant amount of air pollution. Atmospheric environment can absorb this pollution in a particular geographic region given its assimilative capacity. If the burning activities remain confined within the assimilative capacity, the pollution does not create harmful effects. Therefore, in the initial stages when the production and burning activities are limited, pollution caused through these activities is not considered a problem. However, due to technological advancements in the agricultural sector,

Objectives of the Study
The study focuses on environmental policy issues associated with rice residue burning. The main objectives of the study are:
1. Assess the broader significance of agriculture-based pollution in Punjab and describe existing and proposed policies.
2. Evaluate the cost of pollution caused by agricultural waste burning to the society at large and suggest a range of potential alternate uses of rice/wheat stubble.
3. Review the relative significance of policies and technologies in changing residue management practices in Punjab. Assessment undertaken in addressing above objectives was completed though there view of existing secondary data, reports and publications and through interviews and discussions with concerned policy makers and analysts.

Material & Methods
For the assessment of economic valuation of pollution on human health, a primary household survey of 150 households was carried out in three villages in the Patiala district. The details of methodology are provided in each of the chapters. The review of the technology context associated with historical reductions in burning as a residue management practice in India has been undertaken through the review of reports and publications relating to technological change in this area, and of its adoption by Indian farmers. Review of the policy context was done through analyses of historical legislative changes and government programmes and incentives, available published and unpublished relevant documents, and through interviews and discussions with Punjab government officials.

Chemical component in stubbles
Crop residue is not a waste but rather a useful natural resource. About 25 % of nitrogen (N) and phosphorus (P), 50 % of sulphur (S) and 75 % of potassium (K) uptake by cereal crops are retained in crop residues, making them valuable nutrient sources. Sidhu *et al*. (2007) estimated the quantity of nutrients available in rice. According to his study, the paddy straw has 39 kg/ha N, 6 kg/ha P, 140 kg/ha K and 11 kg/ha S. When transformed into monetary values it becomes Rs.424 ha^{-1} of N, Rs. 96 ha^{-1} of P and Rs. 231 ha^{-1} of S, i.e., a sum equal to Rs.751 ha^{-1}

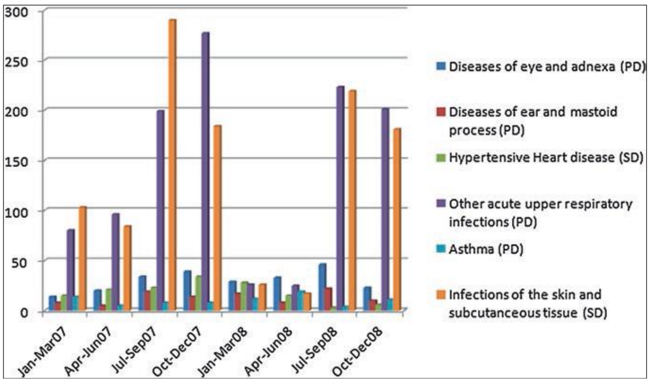
Table 1: Nutrient content of paddy straw and amounts removed with one tone of straw residue

	N	P	K	S	Si
Content in straw, percent dry matter	0.5–0.8	0.16–0.27	1.4–2.0	0.05–0.10	4–7
Removal with 1 t straw, kg/ha	5–8	1.6–2.7	14–20	0.5–1.0	40–70

Causes of Stubble Burning
- Farmers need to prepare their field for the next sowing season in order to do so they have to remove the stubble as early as possible & they find burning as quickest method
- Stubble burning is cheap method because it requires less laboures
- Green revolution intensified our cropping system which gives us less time for preparing the field
- There is a myth among the farmer that the ash containing the biomass of the stubbles will increase the fertility of soil.
- It costs around 1500-3000rs for clearing of stubble of an acre, so farmers can't employ this much input for only removal of stubbles, this becomes a reason of burning stubbles rather than clearing
- Increased use of combines which are helpful in easy and efficient harvest leaves stubbles behind whose management becomes hectic.
- The machine "happy seeder" which is made for management of straw can be affordable for large farmers only and majority of farmers lie under marginal and small category.
- The subsidies which are granted by the govt. are not enough for management of straw.

Myths Associated with stubble burning
Stubble burning is a new form of jhum cultivation where slash and burn system was prevalent. In this system cultivators used to clear the forest usually by burning them and they had a believe that the biomass which gets added in soil increases the fertility of soil. In the same way it is believed by the present day soilmens that the biomass which gets added by burning stubbles in the form of ash contains a lot nutrient which a mere myth. In longer run it is not profitable at all not only for the soil health but also for the crop production.

Result & Discussion
Effects on human health
Epidemiological studies show that the contamination of air quality increases adverse health impacts (Ostro *et al*. 1995). Air pollution contributes to the respiratory diseases like eye irritation, bronchitis, emphysema, asthma etc., which not only increases individuals' diseases mitigation expense but also affect their productivity at work. Most of the studies valuing health impacts of air pollution remain confined to urban areas as air pollution is considered mainly the problem of urban areas in developing countries. Though health consequences from burning of agricultural residue are not fully understood, relative short exposure may be more of a nuisance rather than a real health hazard, many of the components of agricultural smoke cause health problem under certain conditions (Long *et al*. 1998).



Effects of Stubble burning on Environment
Open field burning of crop stubble results in the emission of many harmful gases in the atmosphere, like carbon monoxide, N2O, NO2, SO2, CH4 along with particulate matter and hydrocarbons. These trace gases have adverse implications not only on the atmosphere but also on human and animal health (Gupta and Sahai 2005; Lal 2006; Agarwal *et al*. 2006 [1]; Canadian Lung Association 2007). These also result in the loss of plant nutrients and thus adversely affect soil properties. It has been estimated that for the year 2000, the emission of CH4, CO, N2O and NO2 was 110, 2306, 2 and 84 Gg respectively, from the field-burning of rice and wheat straw (Mandal *et al*. 2004).
A study conducted by the National Remote Sensing Agency in Punjab reported that wheat crop residue burning contributed about 113 Gg (Giga gram = 10 billion gram) of CO, 8.6 Gg of NO2, 1.33 Gg of CH4, 13 Gg of PM10 and 12 Gg of PM2.5 during May 2005 and paddy straw/stubble burning was estimated to contribute 261 Gg of CO, 19.8 Gg of NO2, 3 Gh of CH4, 30 Gg of PM10 and 28.3 Gg of PM2.5 during October 2005 (Badarinath and Chand Kiran 2006) [2].

Pollutants	Crop waste burning (Emission factor Gg Year^{-1})				
	Cereals	Sugarcane	Other	Total Waste	Total Buring
Biomass Burned Tg year−	67–189	32–70	17–30	116–289	148–350
Biomass Burned Tg year−	67–189	32–70	17–30	116–289	148–350
BC	55–292	19-49	12-31	86-372	102-409
OC	134–770	48–122	39–79	211–970	399–1,529
OM	287–1,250	97–247	60–143	444–1,639	663–2,303
CO2	102–353	48–131	25–55	175–539	224–638
NOX	168–845	80–313	42–132	289–1,290	393–1,540
CH4	181–762	86–283	45–119	313–1,164	420–1,486
NH3	87–367	41–136	22–57	151–560	189–661

Source: Venkataraman *et al*. (2006)

Effect on soil

1. Heat from burning straw penetrates into soil upto 1cm.
2. Repeated burning in fields permanently diminishes bacterial population by 50%.
3. Wheat and paddy stubbles leaves about 10 inch layer which makes it difficult to plough it back.

Way forward

Agricultural waste includes paddy and wheat straw, cotton sticks, bagasse and animal waste. Keeping in view the increasing problems associated with crop stubble burning several initiatives for its proper management have been taken up. Various departments and institutions are promoting alternative uses of straw instead of burning. These include:

Use of Rice Residue as Fodder

The rice residue as fodder for animals is not a very popular practice among farmersin Punjab. This is mainly because of the high silica content in the rice residue. It is believed that almost 40 % of the wheat straw produced in the state is used as dry fodder for animals.

Use of Crop Residue in Bio Thermal Power Plants

Another use of rice residue that is being encouraged by various institutions and departments is the use of rice residue for generation of electricity. A 10 MW biomass based power plant at village Jalkheri, Fatehgarh Sahib with paddy straw as fuel was set up in the year 1992.

Use of Crop Residue for Mushroom Cultivation

Paddy straw can be used for the cultivation of Agaricus *bisporus*, Volvariella *Volvacea* and Pleurotus *spp*. One kg of paddy straw yields 300, 120–150 and 600 gof these mushrooms, respectively. At present, about 20,000 metric tonnes of strawis being used for cultivation of mushrooms in the state. Paddy Straw Mushrooms (Volvariella *volvacea*) also known as grass mushrooms are so named for their cultivation on paddy straw used in South Asia. PaddyStraw is high temperature mushroom grown largely in tropical and subtropical regions of Asia, e.g. China, Taiwan, Thailand, Indonesia, India, and Madagascar. In Indonesia and Malaysia, mushroom growers just leave thoroughly moistened paddy straw under trees and wait for harvest.

Use of Rice Residue in Paper Production

The paddy straw is also being used in conjunction with wheat straw in 40:60 ratios for paper production. The sludge can be subjected to bio-methanization for energy production. The technology is already operational in some paper mills.

Use of Rice Residue for Making Bio Gas

The PSFC has been coordinating a project for processing of farm residue into biogas based on the technology developed by Sardar Patel Renewable Energy Research Institute (SPRERI). A power plant of 1 MW is proposed to be set up at Ladhowal on pilot basis on land provided by PAU. The new technology will generate300 m3 of biogas from 1 t of paddy straw.

Production of Bio-oil from Straw and Other Agricultural Wastes

Bio-oil is a high density liquid obtained from biomass through rapid pyrolysis technology. It has a heating value of approximately 55 % as compared to diesel. It can be stored, pumped and transported like petroleum based product and can be combusted directly in boilers, gas turbines and slow and medium speed diesels or heat and power applications, including transportation. Further, bio-oil is free from SO2 emissions and produces low NO2. Certain Canadian companies (like Dyna Motive Canada Inc.) have patented technologies to produce bio-oil from biomass including agricultural waste. Though their major experience is with bagasse, wheat straw and rice hulls, feasibility of this technology with paddy straw needs to be assessed.

Efforts made for curbing the problem

1. Environment legislations
2. The legislation on pollution in India in general and Punjab
3. In particular. It presents provisions of various laws to control pollution like
4. Water Act 1974, Air Prevention and Control of Pollution Act 1981, Environment
5. Protection Act 1986, National Environment Tribunal Act 1995, Noise Pollution
6. Rules 2000, Bio-diversity Act 2000 and so on. The chapter also discusses various
7. Functions and activities of Central Pollution Control Board, Punjab Pollution
8. Control Board, Punjab State Council for Science and Technology, Punjab Energy
9. Development Agency and Bio Diversity Board to control various types of Pollution.

Monitoring and Recording the Levels of Pollutionin Punjab

At present as per the National Ambient Air Quality Monitoring program, three major pollutants are being monitored; these are the Suspended Particulate Matter (SPM) Respirable Suspended Particulate Matter (RSPM), Nitrogen Oxides(NO2) and Sulphur Dioxide (SO2). Other pollutants like Carbon Monoxide (CO), Ozone (O3), Lead (Pb) and Greenhouse gases like CO2, CH4 etc. are monitored depending on the availability of data. To assess the cumulative and overall impact of the three pollutants (SO2, NO2 and SPM) on air quality and also to assess the non-cumulative noncompliance of the standards, an Air Quality Index has been formulated. This index is measured as the sum of the ratios of the three major pollutant concentrations to their respective air quality standards.

Agriculture Councils

With the realization of the harmful effects of wheat and paddy monoculture on the ecology and environment, the Punjab government has been encouraging the diversification in agriculture, away from the rice-wheat cropping pattern towards other remunerative and less water intensive crops since the past few years. Basmati paddy, hyola, sunflower, pulses and vegetables are being promoted as alternative to paddy and wheat monoculture.

Happy Seeder Machine for planting in standing paddy stubbles

This technology, developed by PAU, has already been adopted by the government of Punjab and is being popularized by Department of Agriculture. Wheat was successfully sown in 200 acres area using Happy Seeder during 2007–2008producing 5–10 % more yield (with 50–60 % less operational costs) compared to conventionally sown wheat. Financial analysis by PAU indicated that this machine is more profitable than other conventional alternatives like full stubble incorporation through direct drilling or rotary seeding.

Tractor Operated Paddy Straw Chopper

For incorporation of paddy straw into soil, the University has also developed a Tractor Operated straw Chopping-cum spreading machine. The Machine, in a single operation, harvests the left over paddy stubble after combining, chops it into pieces and spreads it on to the field. The chopped and spread stubble then can easily be incorporated in the soil after light irrigation by using a rotavator or disc harrow.

Promotion of Zero Tillage

The department of Agriculture, Government of Punjab is promoting "Zero Tillage Technique" since 2001–2002 in areas of state where wheat is sown after harvesting of rice. Zero till system refers to planting crops with minimum of soil disturbance. The other novel approach with much promise is the use of "Happy Seeder", which combines stubble mulching and seed drilling functions into one machine. The emphasis is on conserving moisture and residue management. Apart from benefits like proper mulching of paddy residue instead of burning, timely sowing, reducing run off and soil erosion, lesser deep percolation and improving soil health by incorporating plant nutrients, the zero tillage increases farmer's profit by Rs. 2,200–3,000/- per hectare by saving 80 % of diesel as wheat is sown in one pass only.

Conclusion

Crop residue fires in India are enhancing concentration of toxic gases like benzene and toluene, the risk of cancer would be even higher for farmers and villagers closest to the field, the study shows, adding that mitigating crop fires could these risks. Blaming only the farmers may not solve the problem of air pollution and there is a need to find sustainable technological solutions. It is important to diagnose and address the fundamental problems that force the farmers to burn the stubble on field and not utilize it for any productive purpose.

References

1. Agarwal S, Trivedi RC, Sengupta B. Air pollution due to burning of residues. In Proceeding of the Workshop on Air Pollution Problems Due to Burning of Agricultural Residues, held at PAU, Ludhiana Organized by the Indian Association for Air Pollution Control in collaboration with the Punjab State Pollution Control Board. New Delhi: Patiala and the Central Pollution Control. Agarwal, S., Trivedi, R. C., & Sengupta, B. (2008). Air pollution due to burning of agricultural residue. Indian Journal of Air Pollution Control. 2006; 8(1):51-59.
2. AIT-EEC. Evaluation and selection of Ligno-Cellulose wastes which can be converted into substitute fuels. Project report submitted to EEC, Belgium. Badarinath, K. V. S., & Chand Kiran, T. R. (2006). Agriculture crop residue burning in theindo-Gangetic Plains—A study using IRSP6 WiFS satellite data. Current Science. 1983; 91(8):1085-1089.
3. Badarinath KVS, Kumar Kharol S, Sharma Anu R. Long range transport of aerosols from agriculture crop residue burning in indo-Gangetic Plains. A study using LIDAR, ground measurements and satellite data. Journal of Atmospheric and Solar-Terrestrial Physics. 2008; 59(3):219-236.
4. Badve VC. Feeding systems and problems in the Indo-Ganges plain: Case study. In A. Speedy & R. Sansoucy (Eds.), Feeding dairy cows in the tropics. Proceedings of the FAO Expert Consultation Held in Bangkok, Thailand, 1991.
5. Beri V, Sidhu BS, Bahl GS, Bhat AK. Nitrogen and phosphorus transformation as affected by crop residue management practices and their influence on crop yield. Soil Useand Management. 1995; 11:51-54.
6. Beri V, Sidhu BS, Bhat GS, Singh BP. Nutrient balance and soil properties as affected by management of crop residues. In M. S. Bajwa, *et al*. (Eds.), Nutrient management for sustained productivity (vol. II, pp. 133–135). Proceedings of International Symposium. Ludhiana, India: Department of Soil, Punjab Agricultural University, 1992.
7. Bhattacharya SC, Shrestha RM. Bio-coal technology and economics. Bangkok, Thailand: RERIC, 1990.
8. Bhattacharya SC, Pham HL, Shrestha RM, Vu QV. CO2 emissions due to fossil and traditional fuels, residues and wastes in Asia. In AIT Workshop on Global Warming, Issues in Asia, September 8–10, 1993. Bangkok, Thailand: AIT, 1993.