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# STUBBLE BURNING IN NORTH INDIA: DEFOGGING THE FACTS

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DISCUSSION PAPER

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## | ABSTRACT

Crop stubble burning in Northern India, though a common practice among farmers across the country, has made headlines in recent years owing to its association with Delhi's winter pollution levels. Notwithstanding the media and political narratives on the issue, currently available data shows that stubble burning is not a major contributor to Delhi's foul air, being only an episodic factor that coincides with the onset of winters. The practice of stubble burning itself is a symptom of poorly conceived agricultural and environmental policies, particularly in the states of Punjab and Haryana, that necessitate a reappraisal. This paper attempts to delink the increasingly hyphenated issues of Delhi's Air Pollution and Stubble Burning in Punjab and Haryana. It delves further into the policy issues behind the entrenchment of stubble burning as a way of dealing with agricultural waste. Finally, the paper provides a brief analysis of government responses to discourage farmers from burning crop stubble and ends with possible near-term measures that could be taken up.

## | CONTEXT

Crop Stubble Burning, or the burning of residual stalks of crops after harvesting, is a common practice across India (Table 1 below). Some major agrarian states like Punjab, Haryana, Uttar Pradesh, Maharashtra and Karnataka account for the bulk of crop residue generation as well as its burning in the country (Ministry of Agriculture 2014: 8). Paddy, wheat and sugarcane are the major foodgrains of India, and thus, constitute most of the annual crop residue.

Table 1: Crop Residue Generated and Burned in Major Agrarian States across India in Million Tonne (MT) (Ministry of Agriculture 2014: 8)

State	Residue Generated	Residue Burned
Andhra Pradesh	43.89	2.73
Assam	11.43	0.73
Bihar	25.29	3.19
Chhattisgarh	11.25	0.83
Gujarat	28.73	3.81
Haryana	27.83	9.08
Karnataka	33.94	5.66
Madhya Pradesh	33.18	1.91
Maharashtra	46.45	7.42
Odisha	20.07	1.34
Punjab	50.75	19.65
Rajasthan	29.32	1.78
Tamil Nadu	19.93	4.08
Uttar Pradesh	59.97	21.92
West Bengal	35.93	4.96

Punjab and Haryana, particularly, witness the burning of paddy straw by farmers during the months of October and November as part of preparation of fields for winter crops like wheat and potato. In 2018-19 alone, Haryana and Punjab produced 79.3 lakh MT and 201.7 lakh MT of paddy straw respectively (Ministry of Agriculture and Farmers Welfare 2019: 5-6). Of that, farmers in Haryana burned 13.4 lakh MT while those in Punjab burned 99.6 lakh MT of paddy straw (ibid.) Stubble Burning has been known to have adverse effects on soil health and water retention capability of soil. For instance, burning 1 tonne of paddy straw can result in a loss of around 5.5 kg Nitrogen, 2.3 kg Phosphorus, 25 kg Potassium, and 1.2 kg Sulphur (other than organic carbon) content from the soil apart from loss of beneficial micro-organisms that are essential to maintain soil fertility (ibid.: 4). Over the last few years, stubble burning has become a major talking point in the national media on account of it being connected with Delhi's winter air pollution levels.

## | IS STUBBLE BURNING RESPONSIBLE FOR DELHI'S TOXIC SMOG?

Media reports tend to identify stubble burning in Punjab and Haryana as a major contributor to Delhi's air pollution at the onset of winter every year (The Economic Times 2019; Mukherjee 2019; Bera & Choudhary 2018). However, there is a need to decouple the two issues as currently available data do not offer conclusive proof of the same.

According to a 2016 study conducted by researchers from IIT-Kanpur, vehicles contributed to more than half of Delhi's air pollution (Sharma & Dikshit, 2016: vii-x). The primary sources of PM<sub>2.5</sub><sup>1</sup> concentration in the air were road dust (38%) and vehicular pollution (20%), as per the study. A 2018 study by TERI-ARAI found that the key sources of Delhi's PM<sub>2.5</sub><sup>2</sup> pollution in winter were industry (30%), transport (28%) and dust (17%) while agricultural burning contributed only 4% (see Table 2) (TERI-ARAI 2018:13). The TERI-ARAI study also concluded that during winters, 70% of the sources of Delhi's pollution were located within Delhi and NCR (national capital region) meaning only 30% of the city's pollution could be attributed to regions outside Delhi-NCR (ibid.:18).

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<sup>1</sup> Extremely tiny or fine particulate matter which is thirty times smaller than the width of one strand of human hair. Higher particulate matter concentration in the air creates a visible layer of smoke.

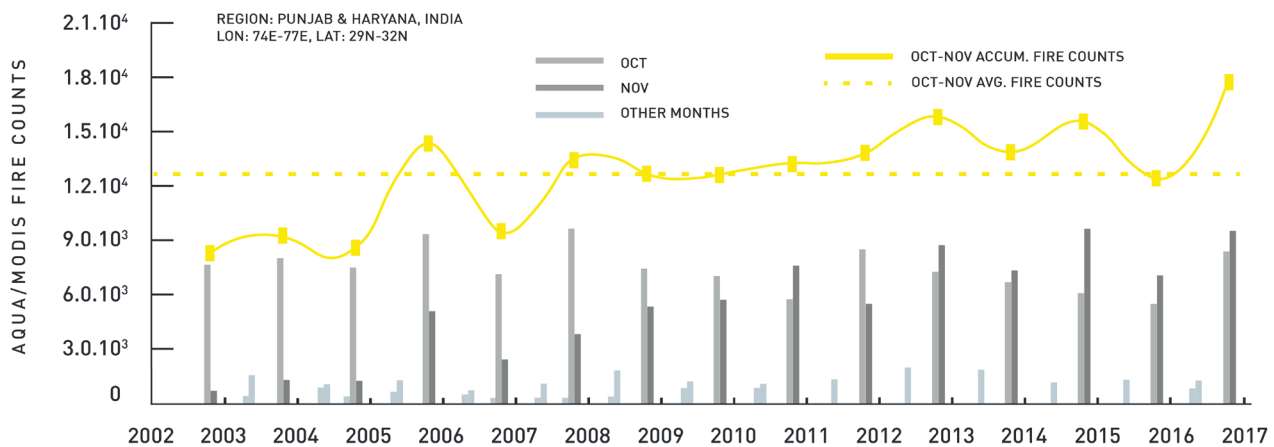
Table 2: Average sectoral contributions in PM2.5 and PM10 concentrations in Delhi during winters and summers (TERI-ARAI 2018: E13)

Sectors	PM2.5		PM10	
	Winters	Summers	Winters	Summers
Residential	10%	8%	9%	8%
Agricultural Burning	4%	7%	4%	7%
Industry	30%	22%	27%	22%
Dust (Soil, Road Construction)	17%	38%	25%	42%
Transport	28%	17%	24%	15%
Others	11%	8%	10%	7%

Compared to the TERI-ARAI and IIT-Kanpur studies, a 2018 study utilised 15-year trends of stubble burning using satellite data and ground measurements of PM<sub>2.5</sub> concentration in Delhi to conclude that agricultural fires in Punjab and Haryana strongly affect PM<sub>2.5</sub> levels in the capital (Jethva et al 2018: 1756). The 15-year trend of stubble burning, as per the study, showed that the number of fires have steadily increased between 2002 and 2017 (Figure 1 below) leading to an increase in PM<sub>2.5</sub> levels (50 µg/m<sup>3</sup> to 300 µg/m<sup>3</sup>) between early October and early November on days when stubble burning peaks. The trend also shows that the fire counts in October have steadily decreased while those in November have increased over the same time period (we will discuss this crucial finding in the next section). The study, however, doesn't provide a breakdown of different sources of PM<sub>2.5</sub> unlike the TERI-ARAI and IIT-Kanpur studies. Its conclusions, though, can be understood by taking into account the climatic conditions of North India during October-November.

Winters in Delhi are characterised by dry winds of significantly lower speeds that flow from the North-West to the South-East. These slow moving cold winds from the north carry with them smoke generated in Punjab and Haryana, and meet the warm air in Delhi that traps the particulate matter over the city. In contrast, on days when the wind speed is high, one can observe a visibly clear sky during the same time period.

FIGURE 1: NUMBER OF FIRES ACROSS HARYANA AND PUNJAB DURING 2002-2017 (JETHVA ET AL 2018: 1770)



It is clear from the above discussion that stubble burning is not a major contributor to Delhi's pollution but only an episodic constituent of it during winters. Although, climatic conditions lead to an influx of PM<sub>2.5</sub> to Delhi from the burning fields of Punjab and Haryana creating a visible layer of thick smog. Now that we have decoupled the two issues, let's understand why farmers in Punjab and Haryana choose to burn stubble, how this issue is a symptom of agricultural policies that have incentivised unsustainable on-farm practices for farmers, and why it is important to address it not through knee-jerk measures, but a long-term shift in the way agriculture is practiced in the two states.

## THE POLICY FAILURES BEHIND STUBBLE BURNING

Farmers in Punjab and Haryana have been setting fire to paddy straw since at least the late 1980s (Chaba and Sinha 2019). As mentioned in the previous section, during the last 15 years, there has been a noticeable shift in the timing of agricultural fires in Punjab and Haryana. The number of fires recorded in November has increased significantly while fires in October have seen a declining trend. Simultaneously, the time window available between the harvesting of paddy crop and the sowing of the next crop (20 September to 15 November, depending upon the varieties of paddy) has become shorter (2-3 weeks).

### 1. The Preservation of Groundwater Act

The key reason behind this trend is the stringent Preservation of Subsoil Water Act (PSWA) enacted in 2009, almost simultaneously, in the two states. The Act was enacted to counter the high rate of groundwater depletion in the two states<sup>1</sup>. Because much of Punjab's groundwater was being consumed to irrigate water-intensive crops like paddy, the act banned the sowing of paddy before mid-May, effectively ending the practice of double cropping of paddy by farmers during April-October (Punjab Government Gazette 2009). As a result, farmers in Punjab are not allowed to plant the pre-monsoon paddy crop during April-June and can only grow paddy around mid-June in most districts. Consequently, while they were able to harvest paddy by early October before the Act came into place, they are now only able to harvest it between late October and mid-November. This leaves them a shorter time window to harvest as well as prepare the field for the next crop, which is why they choose burning the stubble instead of other, more eco-friendly options.

### 2. The Push towards Double Cropping

Notably, the practice of double cropping itself became common after the state governments, as part of a conscious push towards increasing foodgrain production, encouraged farmers to move away from coarse cereals and introduced a new variety of rice in the mid-1990s that matured in just 60 days as against other varieties that took longer (Sood 2015). Farmers therefore started planting two crops of paddy every year before winter. As this required massive water and electricity consumption, the states also instituted a power subsidy regime that charged flat tariffs based on tubewell pump power and not the actual power usage (Gandhi 2018: 131). This subsidy regime is still in function, and has encouraged farmers to pump groundwater out without worrying about the power units consumed, over time leading to decreased groundwater levels, and thus, setting the stage for the PSWA.

### 3. The Minimum Support Price (MSP) Regime

The subsidy regime, however, has also been supplemented by a progressively high MSP on paddy (see Table 3). Though taken as an immediate response to improve farmers' incomes across India by successive governments, high rates of MSP, particularly on water and nutrient-intensive crops like paddy have encouraged farmers to keep sowing this crop year on year. Especially in the case of a fall in market prices, the MSP rate of procurement by the government becomes the only way for most marginal and small farmers to, at the least, recover their input costs. Ultimately though, the MSP regime keeps the farmers engaged in a cropping system that has led to decreasing soil health, depleting groundwater and falling profits as a result.

<sup>1</sup> As per latest data, Punjab and Haryana have the highest groundwater development stress (annual groundwater extraction divided by average annual groundwater recharge) among Indian states at 149% and 135% respectively meaning they are pumping out groundwater at a rate much faster than the annual recharge rate (Bisht 2019).



Table 3: Punjab MSP rates for Paddy (2006-07 to 2016-17)

Crop Year	MSP on Paddy (INR)		
	Common	Super Fine	Total
2006 - 07	580 + 40*	610 + 40*	1270
2007 - 08	645+100*	675+100*	1520
2008 - 09	850 + 50	880 + 50*	1830
2009 - 10	950 + 50	980 + 50*	2030
2010 - 11	1000	1030	2030
2011 - 12	1080	1110	2190
2012 - 13	1250	1280	2530
2013 - 14	1310	1345	2655
2014 - 15	1360	1400	2760
2015 - 16	1410	1450	2860
2016 - 17	1470	1510	2980

Source: Department of Agriculture and Farmer Welfare, Government of Punjab; \*Bonus from Government of India

Thus, misuse of water was incentivised by government policies that focused solely on increasing food grain production without taking into account its long-term consequences. One such consequence has been the practice of stubble burning that, because of climatic factors, creates a visible public health issue for Delhi every year.

## | COUNTER MEASURES

The government's response to the practice of stubble burning has ranged from a blanket ban with steep fines to subsidies on alternative technology for management of crop residue.

In a 2013 directive to the states of Punjab, Haryana and UP, the National Green Tribunal asked for a ban on stubble burning. Following the directive, state governments started imposing fines on farmers caught burning residue. In fact, the Punjab Pollution Control Board (PPCB) collected over 3 lakh rupees till mid-October 2018 out of a total of almost 9 lakh rupees officially levied as fines on stubble burning farmers (Koshy & Vasudeva 2018). Many farmers, mostly marginal and small, are not able to pay these fines immediately leading to them collecting over time.

Beyond such disincentives, the governments have also made farm straw management equipment available at subsidized rates to individual farmers (offering a 50% discount) and farmer self-help groups (80% discount) in order to promote in-situ management of crop residue. However, these machines have not been adopted by a majority of farmers as one machine, even after a 50% discount, costs INR 50000-100000 (Ministry of Agriculture and Farmers Welfare 2019: 13) which is a high cost given the state of farmer incomes in the country. Moreover, these machines sit idle for 10-11 months a year piling up additional maintenance costs.

In 2018-19, the central government sanctioned INR 1151.8 crore under its scheme for promoting mechanisation for in-situ management of crop residue (ibid.: 8). A total of 28,609 machines were provided to farmers in Punjab alone under the scheme (see Table 4).

Table 4: Straw Management Equipment distributed in Punjab and Haryana in 2018-19  
(Ministry of Agriculture and Farmers Welfare 2019: 16)

Name of the Machine/Equipment	Number of Machines		
	Punjab	Haryana	Total
SMS	3634	909	4543
Happy Seeder	9758	2376	12134
Reversible M.B. Plough	3034	1159	4193
Shrub Master/ CuttterCum Spreader	86	216	302
Straw Chopper/ Shredder/ Mulcher	4486	1581	6067
Rotary Slasher	484	265	749
Zero Till Drill	3437	2527	5964
Rotavator	3690	1714	5404
TOTAL	28609	10747	39356

The trends in burning events detected during 2016-18 show a marked decrease that could be attributed to government efforts on the issue. Table 5 shows the observed number of crop burning events in 2016, 2017 and 2018 in the states of Punjab and Haryana. As shown in the table Punjab has had a decrease of 41.69% in the number of stubble burning events in 2018 compared to 2016 while Haryana has seen a decrease of 41.15% during the same period.

Table 5: Number of Stubble Burning Events Observed in Haryana and Punjab (Ministry of Agriculture and Farmers Welfare 2019: 33-34)

State	2016	2017	2018
Punjab	102379	67079	59695
Haryana	15686	13085	9232

## PROSPECTS FOR SUSTAINABLE MANAGEMENT OF CROP RESIDUE

Paddy straw burning is more common among farmers who use combine harvesters as compared to those who manually harvest the crop. This is because combine harvesters leave a longer standing stubble (25-30 cm height) in the field that cannot be readily mixed into soil through ploughing (ibid.: 4).

Additionally, combine harvesters are mostly utilised by farmers who grow non-basmati rice, while basmati rice is mostly harvested manually (ibid.: 5). The residue from basmati is also used as animal fodder while that from non-basmati is not, owing to a higher silica content in the latter. This difference in harvesting practices based on paddy variety is crucial for any policy measure that aims to discourage farmers from burning stubble. For instance, in 2018, out of a total of 14.45 lakh hectares of land under paddy cultivation, Haryana used 7.95 lakh hectares for basmati and 6.49 lakh hectares for non-basmati varieties. Compared to that, Punjab had a reported area of 31.03 lakh hectares under paddy cultivation, out of which around 5.11 lakh hectares were under basmati and 25.92 lakh hectares was under non-basmati cultivation (ibid.: 5-6).

Clearly, farmers in Punjab have a higher share of non-basmati residue, and thus require more attention through policy interventions. In the near-term, interventions can promote cropping of basmati paddy in Punjab through appropriate pricing mechanisms to encourage farmers to grow basmati. At this point, many farmers in Punjab do not choose to grow basmati due to price fluctuations in the export market (ibid.: 36). This issue can be tackled by stimulating domestic basmati demand.

Crop diversification, as a long-term measure, seems to be an appropriate response to move farmers away from unsustainable on-farm practices like stubble burning. Water-intensive paddy should be gradually phased out in states like Punjab and Haryana that are facing the issue of groundwater overuse. Emphasis should be on promoting coarse cereals and high value crops like vegetables and fruits that are comparatively less resource-intensive and bring higher returns for farmers.

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