

Stubble Burning- A wicked problem and issues to be addressed

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1. INTRODUCTION

Stubble burning is rapidly becoming a major contentious issue of agriculture and environment in India. This practice is rampant in the northwestern states of Punjab, Haryana and observed in the western Uttar Pradesh. The entire region is known for most intensive rice-wheat cultivation in the country. The State of Haryana being adjacent to the National Capital Delhi, always attract



attention whenever the issue is discussed. Haryana occupies only 1.5% of the land area but contributes 15% of India's agriculture produce. 86% of the State's geographical area is arable, of which 96% area is cultivated and 76% of the cultivated area is under assured irrigation. Paddy (*monsoon or kharif season*) and wheat (*winter or rabi season*) are the two main crops, both of which have witnessed a quantum jump in production during the *Green Revolution* initiated in 1960s. During the period 1966-67 to 2011-12, the area under paddy cultivation has increased 6.5 times to 1.235 million ha, while the area under wheat has increased nearly 4-fold to 2.531 million ha¹ (Yadav, 2017).

The *Green Revolution* saved India from perpetual hunger and external dependency for food grains. But also, it brought in quite a few unanticipated collateral damages. The obvious and the most important one is over-exploitation of groundwater resources, as irrigation is now predominantly dependent on groundwater sources. The over-exploitation is manifested by fast declining groundwater levels, dwindling well yields and rapidly drying up aquifers, all of them pointing to serious concerns on water security of the State. As the groundwater level declines, energy consumption to lift groundwater increases proportionally, thereby carbon footprint expands over the region.

The acutely stressed groundwater resources of the region were initially highlighted by a landmark publication by Rodell et.al. in *The Nature* (2009)², using Gravity Recovery and Climate Experiment Satellite (GRACE) data. Similarly, GRACE based data has indicated the extremely stressed groundwater situation in Punjab province of Pakistan, representing contiguous Indus basin aquifers³ (Iqbal et al 2016).

¹ Yadav A. (2017) Rice and Wheat Cultivation in Haryana: A Spatial Temporal Analysis. International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; v 5 Issue XII. <https://www.ijraset.com/files/serve.php?FID=12559>

² Rodell, M., Velicogna, I., Famiglietti, J.S. (2009) Satellite-based estimates of groundwater depletion in India. *Nature* 460, 999–1002, <http://dx.doi.org/10.1038/nature08238>

³ Iqbal N, Hossain F, Lee H, Akhter G (2016) Satellite Gravimetric Estimation of Groundwater Storage Variations Over Indus Basin in Pakistan. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*. 9 (8) doi [10.1109/JSTARS.2016.2574378](https://doi.org/10.1109/JSTARS.2016.2574378)

Groundwater extraction is energy dependent also (*either electricity or diesel*). The staggering 20.5 million of wells operational for irrigation in the country⁴(Saha, D et.al., 2017) resulted an emission of ~ 45.3 MMT of carbon into atmosphere, which accounts for 6% of total carbon emissions from India⁵ (Rajana et.al. 2020). Declining groundwater needs more energy to extract, which is corroborated from the fact the carbon emission from tube wells has doubled between 2000 and 2013⁴. Haryana has contributed to 2.95 MMT of carbon emission into atmosphere from its irrigation wells in 2013.

The other concern that stems from water-intensive agriculture in this region is deteriorating groundwater quality, resulting from overdose of fertilizers, pesticides, insecticides and rodenticides and increase in soil and groundwater salinity due to rising water levels in certain canal command areas^{6,7} (Kumar et.al.2007, Singh et al 2011).

In the recent past, stubble burning has become the most controversial issue related to agriculture. Though presently restricted to Punjab and Haryana and to some extent in Western Uttar Pradesh only, is spreading gradually in the other parts of India. The stubble burning in Punjab and Haryana, has been cited as a major cause of massive air pollution in Delhi, the capital of India and adjoining urban agglomeration. In late September to October each year, farmers mainly from these two states burn more than 30 MMT of crop waste⁸ (Thakur 2017). The generally stated reason is that it is a low-cost means of straw disposal, which helps reduce the turnaround time between harvesting of *kharif* paddy and sowing winter crop⁹ (Ashok S. 2017). Though crop burning is observed for both the main cropping seasons, the most severe one is during post *kharif* harvesting which corresponds to the period of October-November every year. The smoke from the burning of residues produces a toxic cloud of particulate matter and gases, which is unable to disperse and envelope over the region because of the climatic conditions prevailing during the time in north-west India and creates ¹⁰(NASA 2017). Paddy stubble burning contributes 25-30% of poor air quality in Delhi¹¹. The economic cost of exposure to air pollution from stubble burning in North Western India is pegged at nearly 2 lakh crore INR annually, as per the studies taken up by IFPRI and partner institutes¹².

The National Green Tribunal, the watchdog of environment in India, took the crop burning and related pollution issues with utmost seriousness and even imposed a stiff fine on the Administration of National Capital Territory of Delhi for failing to file an action plan to tackle the air pollution, by providing incentives

⁴ Saha D, Marwaha S, Mukherjee A (2017) Groundwater Resources and Sustainable Management Issues in India- In **Clean and Sustainable Groundwater in India**, , Editors: Dipankar Saha, S Marawaha & A Mukherjee, **Springer**, ISBN 978-981-10-4551-6, https://doi.org/10.1007/978-981-10-4552-3_1

⁵ Rajana A, Ghosh K, Shah A (2020) Carbon footprint of India's groundwater irrigation. Carbon Management <https://doi.org/10.1080/17583004.2020.1750265>

⁶ Kumar, M., Kumari, K., Ramanathan, A. (2007) A comparative evaluation of groundwater suitability for irrigation and drinking purposes in two intensively cultivated districts of Punjab, India. *Environ Geol* **53**, 553–574. <https://doi.org/10.1007/s00254-007-0672-3>.

⁷ Singh k, Hundal, H.S., Singh D (2011) Geochemistry and assessment of hydrogeochemical processes in groundwater in the southern part of Bathinda district of Punjab, northwest India. *Environ Earth Sci*, **64**, 1823–1833

⁸ Thakur J. (2017) **Brace for air pollution in Delhi as crop burning starts in neighbouring states**: Agricultural stubble running into millions of tonnes is burnt by farmers in northern India every October. An estimated 35 million tonnes are set afire in Punjab and Haryana alone. *Hindustan Times*, Sep 28, 2017

⁹ Sowmiya A (2017) **Agricultural pollution: The fields are still burning**, *The Indian Express*, October 19, 2017. Retrieved 9 November 2017

¹⁰ NASA (2017) **Stubble Burning in Northern India**, Earth Observatory. Retrieved 9 November 2017.

¹¹ Govt of India (2019) Report of the Committee on Review of the Scheme "promotion of agricultural mechanisation for in-situ management of crop residue in states of Punjab, Haryana, Uttar Pradesh and NCT of Delhi" Government of India, Ministry of Agriculture and Farmers Welfare, Govt of India

¹² Times of India (2019a)

http://timesofindia.indiatimes.com/articleshow/68263069.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cpst

and infrastructural assistance to farmers¹³. The Supreme Court of India also lashed out at Punjab, Haryana, and Uttar Pradesh States on November 6th, 2019, for not taking enough measures to curb stubble burning¹⁴. The Court has also asked the States to monetarily reward farmers who refrained from stubble burning. The Punjab and Haryana Govts have adopted a slew of measures including an incentive of INR 2500/acre for small and marginal farmers for not burning crop residues¹⁵ (Business Standard, 2019). In 2018 a Central Sector Scheme is launched on “Promotion of agriculture mechanization for insitu management of crop residue in the States of Punjab, Haryana, Uttar Pradesh and NCT Delhi” where 50% to 80% on the cost of machinery is provided to the farmers. There are claims that such measures helped in reducing fire counts considerably. Recently Govt of Haryana has launched a Scheme, where INR 7000/acre would be given to the farmers for adopting alternate less water intensive crops in *kharif* season in preference to paddy¹⁶. The scheme has been initiated in 19 blocks of the state where the depth of groundwater levels has exceeded 40 m bgl

Besides creating air pollution, the stubble burning impacts soil nutrition and in turn crop yields also. Burning one ton of paddy straw accounts loss of 5.5 kg of nitrogen, 2.3 kg of phosphorus, and 25 kg of potassium, 0.5 kg of sulphur and organic carbon⁵. The heat generated kills the microorganism and burrowing creatures like snails, which as such are also affected because of overdose of fertilizers and pesticides already¹⁷. (Sharma P.K., Mishra B, 2001). The burning of crop residues adversely affects the soil temperature, which in turn affects germination and growth.

2. WHY STUBBLE BURNING?

Crop burning is observed both post *kharif* and *rabi* harvesting, though post *kharif* is practiced widely. Various reasons are being coined for stubble burning, most commonly discussed one is that the manual harvesting of the crops is replaced by fast and less labor-intensive mechanized methods like using *combined harvester*. In manual harvesting, crop is cut from its base while, *combined harvesters* leave stubble of about 10- 14 inches, the removal of which is a labor-intensive work. Till a few years ago, migrant laborers were available aplenty and manual harvesting was common particularly for paddy. Increased mechanization has dampened the demand of laborers and in turn migrant laborers shifted to other options and are not available as before. So, the farmers adopt mechanized farming and burn the crop residue. As the awareness against the stubble burning is increasing, new technologies have come in rescue. Attachments can be fixed to *combine harvesters* that shred the stubble left by the machine into smaller pieces which can either be mixed up with soil or can be collected for cattle feed separately. Another methodology is *happy seeder* which drill seeds without removing the leftover *kharif* paddy stubbles. The farmers are reluctant to use these technologies, citing additional cost in farming¹⁸ (Anand 2016).

¹³ NGT (2018) "[Crop burning: NGT slaps Rs 2 lakh as costs on Delhi govt for not filing action plan](#)". *Hindustan Times*. 2018-04-03. Retrieved 2018-06-26.

¹⁴ OutlookIndia.com (2019) <https://www.outlookindia.com/website/story/india-news-this-cant-happen-in-a-civilised-country-supreme-court-pulls-up-centre-delhi-govt-over-pollution/341672>

¹⁵ Business Standard (2019) https://www.business-standard.com/article/economy-policy/punjab-haryana-announce-rs-2-500-acre-incentive-to-stop-stubble-burning-119111500057_1.html

¹⁶ Sarkariyojana.com (2020) Haryana Mara Pani Meri Virasat Scheme- Rs. 7000/ Acre Incentive to Farmers to Switch from Paddy. <http://sarkariyojana.com/haryana-mera-pani-virasat-scheme/>

¹⁷ Sharma P.K., Mishra B (2001) Effect of Burning Rice and Wheat Crop Residues: Loss of N, P, K and S from Soil and Changes in the Nutrient Availability. *Journal of the Indian Society of Soil Science*. 49, Issue:3,425-429. ISSN: 0019-638X

¹⁸ Anand G. (2016) "[Farmers' Unchecked Crop Burning Fuels India's Air Pollution](#)", *The New York Times*, Nov. 2, 2016. Retrieved 9 November 2017

The other argument also coined is implementation of *The Haryana Preservation of Subsoil Water Act, 2009*¹⁹ (Govt of Haryana 2009). As per this Act the farmers are forbidden from sowing *kharif* paddy before May 10 and transplanting before June 10. The earlier practice was to start for nursery by 25th April and transplanting initiated by 28th May. By 10th June, the most severe phase of evapotranspiration is over and mostly coincides with the arrival of monsoon. Thus, this Act aims to reduce huge pre-monsoon pumping of wells which is considered to be the main reason for extensive groundwater over-exploitation in Haryana. As per the estimation made by CGWB,

$$\text{Stage of Groundwater Development} = (\text{Gross Groundwater Draft})/(\text{Net Groundwater Availability}) \times 100$$

in the state has increased from 109% in 2004 to 137% in 2017²⁰ (Saha et al 2019). Now the late transplanting also delays the harvesting for *kharif* paddy (end-October) resulting in a very narrow window to prepare their fields for the following *rabi* crop (wheat). Such a situation compels the farmers for mechanized farming and burning stubbles as a quick-fix solution.

3. Potential Strategies and approaches

In the earlier days, paddy straw was considered to be the main fodder for the cattle. Now with the massive quantity of straw generated in Haryana, the supply is in huge excess of the demand from cattle and buffaloes. The farmers are increasingly reluctant now to feed paddy straw to their cattle and buffaloes, as they hold the view that this might result in reduced quantity and quality of milk production, owing to the generous use of fertilisers and pesticides in crop cultivation. For feeding livestock, farmers turn to high quality cattle feed and generous use of green fodder together with small quantity of wheat straw.



Figure 1: Sowing of wheat by Happy Seeder, post Kharif harvesting by combined harvester

The farmers are also reluctant to invest further to cut the leftover stubble, as this will involve additional expenditure (INR 2,000/acre or more), over and above the amount incurred for mechanized farming.

The farmers need lot of awareness generation and training to adopt new technologies. Various organizations are working alongside State Government in this direction, in an attempt to both increase grain productivity and reduce economic and labour inputs required by the farmers. To get out of this problem, which has engulfed the State of Haryana and is soon spreading to the other regions of the country, we must adopt well thought-out strategies, depending upon the cropping practice and calendar, land holding of the farmers, pattern of water use and climatic conditions of the area. Some of the strategies are outlined below.

¹⁹ Govt of Haryana (2009) Haryana Preservation of Subsoil water Act 2009. <https://www.legalcrystal.com/act/134916/the-haryana-preservation-of-subsoil-water-act-2009-complete-act>

²⁰ Saha, D., Marwaha, S., Dwivedi, S.N. (2019) In: Singh, A., Saha, D., Tyagi, A.C. (Eds.), National Aquifer Mapping and Management Plan- A Step towards Water Security in India- in Water Governance: Challenges and Prospects. http://doi.org/10.1007/978-981-13-2700-1_3

i.) Reduce area under paddy and pursue crop diversification

The farmers in Haryana were never traditional rice cultivators. They initiated rice cultivation, largely in response to the national policy to make our country self-sufficient in food grains. As a result, there is a huge surge in area under rice cultivation during. The Working Group on *Productivity Enhancement of Crops in Haryana* recommended in 2013 to replace water guzzling paddy by less water intensive maize, gaur, pulses and oil seeds. However various such attempts did not really take off because of the difference in net farm returns and market risks. Both rice and wheat give assured return because of Minimum Support Price and backed by procurement by the Govt. Though the Govt is taking steps like, incentivizing INR 7,000/ acre for shifting from paddy to less water intensive crops, they are restricted to areas with deep groundwater levels. Moreover, a rice farmer earns ~INR57,000/ha whereas maize in a maize-wheat combination would set them back by about INR15,000-17,000/ha. An estimate by some experts suggests that a compensation of ₹12,000 per hectare for such an initiative would be more acceptable, keeping the power savings in mind.

ii) Expanding basmati cultivation during *kharif*

Basmati harvesting is done manually, thus hardly any crop residue or stubble is left thus, completely obviating the need for burning of residues. Govt of India (2019) data says that only 7-10% of the area under basmati is burnt. The farmers also feel that the straw from basmati rice serves as better quality fodder. In 2018-19, out of 1.445 million ha under paddy cultivation, 0.795 million ha was under basmati. The State Govt may further promote organic basmati, which has a growing demand from national and international markets. Flood irrigation for basmati cultivation is an issue but recent experiments with drip irrigation are showing encouraging results.

iii) A relook into the Haryana Preservation of Subsoil Water Act, 2009

Is it possible to relax the Act and allow plantation of paddy before June 10, so that the gap between *kharif* harvesting and sowing of *rabi* widens? However, a strong argument exists in favour of the Act, as the legislation is conceived to reduce huge pre-monsoon groundwater pumping. The CGWB resource assessment data reveals that the Stage of Groundwater Development of the State has increased from 109% to 135% between 2005 and 2013, but between 2013 and 2017 it has increased by a smaller margin of only 2%. A more detailed assessment of the groundwater saved on account of implementation of the Act is required to be done. The elephant in the room, however, is the free/subsidized power for pumping, which is contributing to over-exploitation. Some experts suggest that the power subsidy amount can be provided to the farmers as DBT (direct benefit transfer), while they can be asked to bear the actual costs of energy charges. Lot of awareness to be created among farmers to clear confusion and built confidence in this matter.

(iii) Technological innovation

Technological solutions involving direct seeding by machines like *Happy Seeder* is the most talked about, but it does indeed have limitations also. The effectiveness of this technique depends upon the moisture level (not too moist, not too dry) of the soil at the time of seeding. The agronomic practices will need to change

particularly with regard to application of fertilizer and irrigation and more innovations are needed in this field. Another issue is requirement of such a huge no of machines for only during the 10-15-day window in a whole year. The Central Sector Scheme on promotion of agriculture mechanization for insitu management of crop residue launched in 2018, where provisions for providing subsidy to the individual farmers of cooperative society exists is a welcome move.

(iv) Finding other uses of crop residues

Though utilization of paddy straw in power generation is supported by the Govt with some incentives, we need to initiate new researches for its potential alternate use, such as for manure production, or mixing with soil itself or in paper or cardboard and packing industries etc. If the farmers manage to get suitable price for the straw they produce, this will serve as an incentive to use the shredder for collecting the crop residues.

4. STUBBLE BURNING –A VILLAGE VIEW

A survey was conducted in a village called Pindarsi in Thaneashwar block, Kurukshetra district to understand the issue. The village has 106 agriculture dependent families, of which 95 families with a land holding of 4-6 acres, whereas 6 families hold more than 30 acres. The village has transformed itself from rainfed cultivation (mainly wheat and gram) to groundwater based robust agriculture (paddy and wheat). The groundwater-based irrigation was initiated by dug-cum-bore well during 1970-75, where dug wells were 5-8m deep and bore wells at the base with another 7-10 m. The first bore well was drilled in the village in 1975, which was 25 m deep. As the water level started declining with increasing groundwater pumping in the area, deeper bore wells were sunk, with the capacity of submersible pump increased simultaneously. Recently constructed bore wells are often 100-120m deep, and water levels are encountered in 35-40m bgl range. The pumps are of 15-30 HP capacity and are placed at 40-50m below ground. To curb extraction of groundwater, during 2008 the Haryana Govt has restricted electricity supply for irrigation use for 8 hrs. in a day. Canal-based irrigation was also initiated in 1970-72, which now caters about 60% of the cultivated area though bore wells are rampant in the command areas also. However, the canals benefit mostly the large landed plots, as they are conveniently located in low-lying areas and get the benefit of gravity flow.

Table 1: The changing groundwater scenario of the village over the decades between 1970 and 2020

	1970-80	1980-90	1990-2000	2000-2010	2010-2020
Number of wells	5-6 (Dug well)	30-35 (dug cum bore well)	35-40 (dug cum bore well)	100 (bore well Average depth 70 m)	100-110 (borewell Average Depth- 120 m)
Pump capacity	Manual	3HP electric	5-7.5 HP Electric	Few pumps of 15 HP	15-25 HP
Water level (bgl)	8m	10-15m	15-20m	25-30m	35-40m

The paddy cultivation started during 1972-1975, once the farmers realized the abundant and round the year availability of groundwater and its easy exploitation with subsidized power. After 1990, all the farmers in the village fully switched over to paddy (which also included basmati variety) during *kharif*. Presently *Figure 2: Wasteful pumping observed in Pindarsi Village during field visit*

60% of *kharif* cultivation is under non-basmati rice, while 20% is under basmati and remaining area under Jowar/Bajra. The *rabi* crop is predominantly wheat. Stubble burning in the village started in 1998-1999 and it was a post *kharif* phenomenon. It was not exactly stubble burning, the manually harvested hay/husk was burnt to reduce the work. Mechanised harvesting started during 2002-2004 with the arrival of combined harvesters and by 2008 the use of mechanised harvesting became a routine practice. Stubble burning as a standard practice started with the arrival of combine harvesters and is now mainly prevalent for paddy (*kharif*) but also practiced for wheat (*rabi*) crop. Many places the land remain idle for one or two months for post *rabi* stubble burning. However, basmati rice grown in *kharif* is harvested manually (80% of total) and hardly any stubble burning is reported.



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The villagers conceded that before the enactment of the *Haryana Subsoil Water Preservation Act 2009*, huge groundwater pumping was done for *kharif* paddy as the nursery used to start around 25th April and transplantation by 20th May. The monsoon arrival in the area is around 15th - 20th June every year. Often huge wasteful pumping is observed in the village, as many farmers have a tendency to keep the pump switched on throughout the day, keeping in view the limited hours during which the electricity was available. Post enactment, the paddy nursery would start around 15th May and the transplantation by 15th June, which by and large coincides with the onset of monsoon in the area.

The villagers articulated a number of direct and indirect causes for stubble burning and these include financial, behavioral, labor and environment related issues:

- i. The number of cattle at the farm level has reduced (also because the cattle have become high yielders of milk), so also there is consequently less demand for fodder (*bhusa*). Besides, the farmers felt that the pesticides and fertilizers used in farming made the fodder unhealthy for cattle, resulting in reduced production of milk and sickness. The farmers are thus inclined to burn the crop residues, rather than using the same as fodder.
- ii. Even after arrival of combined harvester (during 2001-02, till 2008), 50% of the *kharif* crop was machine harvested and the remaining 50 % manually. In case of *rabi* crops, 80% of wheat was harvested manually until about 2000 or so. Manual harvesting leaves only about 1.5-2 inch of stubble, which is suitable for plough and incidents of residue burning were less common.
- iii. Post 2007-2008, stubble burning was rampant mainly for *kharif* and also for *rabi* crops as combined harvesters were beginning to be used widely.
- iv. If the farmers don't burn the stubble, cut with the shredder fitted with the combined harvester and allow it to mix with soil, it would cost around Rs 4000-5000/acre for *kharif* harvesting.
- v. Previously all the family members were involved in farm related work and manual harvesting was more prevalent. With better economic conditions, the farmers shifted to engagement of migrant laborers. Now the migrant labourers are in shortage. Introduction of mechanised farming on a large scale triggered higher number of incidents of crop burning. Sometimes, the farmers resort to burning of

stubble after the rabi harvesting in order to see make their fields clean with an uninterrupted view. They also believe that burning would kill all the pests and weed seeds. This reason they site for post *rabi* harvesting burning.

- vi. Very occasionally, the fire in stubble/matured paddy or wheat field can also be caused by short circuit in electric lines. The last of such a major incident happed in this village in 2006, when 30-35 acres of standing wheat crop got burnt.
- vii. Some progressive farmers are adopting *Happy Seeders* (which can be attached to a tractor), but the general observation is that it would be popular with more subsidy and incentive to farmers.
- viii. Generally, the farmers are reluctant for crop diversification during kharif season, unless there is good procurement price and assured procurement.

5. Way Forward

The way out needs multipronged strategies and actions involving all stakeholders at different levels. It is obvious that there are multiple and wide-ranging issues connected with stubble burning in the northwestern India, particularly in Haryana. It is not proper to put the blame solely on the implementation of *The Haryana Preservation of Subsoil Water Act, 2009* in the State. In fact, the Act has impacted positively on the severely stressed groundwater resources of the State. There should be a detailed evaluation on incremental improvement in groundwater resources, while at the same time it is important to fine-tune the Act vis-à-vis agronomic practices, if required. There are other social, economic and behavioral issues, which force the farmers towards stubble burning. The technological innovations available to get rid of the stubble left behind by the mechanized farming, is required to be adopted by the farmers which will require awareness generation, training and provision of subsidy to farmers. Agro-climate based crop diversification issues will need to be evaluated and supported by proper MSP and assured procurement. Understanding the issues with clarity warrants two pronged approach - State level analyses- based on secondary data and in- depth village level data collection and farmer-based study in selected villages, including where the present study made, Pindarsi village, in Kurukshetra district.

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