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DATA STORYTELLING: WHAT ARE THE ALTERNATIVES TO CROP RESIDUE BURNING IN INDIA?

Earth provides enough to satisfy every man's need, but not for every man's greed.
—Mahatma Gandhi

On the morning of November 10, 2021, Chandrakant Pradhan was traveling by car from his residence to the Confederation of Indian Industries (CII) office on Lodhi Road, New Delhi. There was poor visibility throughout his journey. In November 2021, capital city New Delhi consistently recorded an air quality index (AQI) greater than 450. Most air quality monitoring stations categorized the air pollution levels as severe. These poor weather conditions also resulted in multiple health issues, such as red eyes, headaches, cough, itchy skin, and itchy throat, for people living in and around New Delhi. One of the reasons for such environmental conditions during winter was the burning of crop residues by farmers in the states surrounding Delhi, such as Haryana, Punjab, and Uttar Pradesh.

Since 2018, Pradhan had been working with farmers in villages of Punjab and Haryana to adopt environmentally sustainable straw management practices as part of CII's Crop Residue Management (CRM) initiative. CII's goal was to eliminate the traditional practice of openly burning crop residues in villages. To monitor the ground-level activity in these villages, his team had been actively working with farmers to build awareness and collect impact data through surveys. Traveling through Delhi traffic, Pradhan wondered how he could demonstrate the results of the CRM initiative at the upcoming meeting with the funding agencies. Through these meetings, he wanted to raise stakeholders' awareness about the availability of alternative CRM methods, and the tools necessary for adopting these methods by farmers in various districts and villages of Punjab and Haryana. Several thoughts popped up in his mind as he crisscrossed through the Delhi traffic. How could he effectively present the data collected through farmers' surveys? How can the collected data be examined? What valuable insights could he gain from the data that could be shared during the stakeholder meeting? Was there enough evidence to determine whether this initiative would be effective in reducing pollution over time?

Pradhan intended to present insights based on the survey data analysis to various stakeholders, especially to corporates who could help scale up the CRM intervention through their corporate social responsibility (CSR) funds and to the policy makers who could help develop the necessary regulations and create markets for crop residue. Funding agencies could assess CRM's effectiveness by comparing data from 2019 with the 2020 data. The survey also provided the ground reality and constraints faced by farmers, which allowed the development of holistic policies. In essence, stubble burning was a behavioral issue that required financial support and a long-term policy framework. CII could be an enabler by providing the necessary ecosystem to ensure success once the farmer was committed to no burning. To convince all stakeholders to participate in an initiative aimed at solving Delhi's problem of pollution during winter, Pradhan realized that he had to dive deep into data storytelling.

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PRACTICE OF CROP RESIDUE BURNING

The unpredictable weather conditions around the world have made climate change one of the hottest topics of discussion. Global leaders have discussed and set steep goals for reducing carbon footprints and greenhouse gas emissions. In the Delhi National Capital Region (NCR) of India, there was a similar concern every year between October and December when air pollution peaked. As Delhi was a landlocked city, the burning of crop residue by farmers in the surrounding areas of Punjab, Haryana, and Uttar Pradesh contributed to high levels of air pollution. In October, farmers in these agriculture-intensive states cleared their fields by burning the leftover stubble from the paddy harvest to prepare the fields for the wheat harvest. However, October to December were winter months with low wind speeds. Low wind speed and smoke from burning crop residues, therefore, exacerbated air pollution not just in these three states but also in neighboring Delhi NCR. In addition, burning of crop residue reduced microbial activity in the fields, increased irrigation requirements, and negatively affected soil health.

The practice of burning crop residue dated to India's Green Revolution in the 1960s. The revolution was aimed to make India self-sufficient in food grains. Hence, the cultivation practice of rotating the two primary crops (rice and wheat) was encouraged through minimum support prices (MSP). Farmers adopted this initiative because they were assured an income and received government aid. Mechanized harvesting practices were introduced in 1980 to help farmers overcome labor shortages and increase yields. The use of equipment such as combine-harvester was effective in terms of cost and time but left behind large amounts of crop residue in the field.[1]

Punjab, Haryana, and Uttar Pradesh were known as "India's food basket".[2] According to the World Bank statistics,[i] 60.4% of India's overall land area was used for agriculture. Punjab and Haryana covered 84% of their geographical area with agriculture, primarily wheat and paddy. Yield-focused two-crop cultivation for so many years had raised concerns about the probable exhaustion of natural resources and the sustainability of this system.[3]

Burning of crop straw accounted for 36% of national capital air pollution, according to System of Air Quality and Weather Forecasting and Research (SAFAR).[4] Paddy residue cannot be used as animal feed because of the high silica content in it. For rice crops, 80% of farmers burnt crop residues compared with 25% for wheat [Singh *et al.*, 2021]. Farmers in the region had been forced to delay rice sowing until the monsoon season because paddy was a water-intensive crop. Monsoons had a cascading impact on rice harvesting time, which extended till the end of October, leaving only 15 to 20 days between rice harvest and wheat sowing. To conserve the groundwater level, even the government had imposed a law prohibiting farmers from sowing the paddy early, resulting in a shorter period for clearing the fields for wheat crop. Farmers, thus, found burning straw to be a quick, cost-effective way to prepare their fields.

ABOUT CII – CROP RESIDUE MANAGEMENT INITIATIVE

The CII had partnered with NITI Aayog to bring diverse stakeholders to a common platform and design action plans for tackling air pollution in Delhi NCR by reducing the Crop Residue Burning (CRB) in Punjab and Haryana. CII's CRM initiative aimed at promoting the adoption of alternative environmentally sustainable CRM practices by farmers in these two states. These practices could be broadly classified into in situ or in field and ex situ or ex field. CII's objective was to induce behavioral changes among farmers through mass awareness campaigns, machinery deployment, technical training, and participatory management. In 2018, the CII Foundation implemented a pilot project on 16,000 acres of farmland across 19 villages in Punjab's Patiala and Ludhiana districts. More than 80% of the farmers adopted the sustainable CRM practices, and 75% of the farmland in the adopted area managed to avoid stubble burning. By 2021, the project was expanded to 226 villages in ten districts in Punjab and Haryana, covering 199,867 acres of farmland and supporting 40,040 farmers. The CRM intervention resulted in 89% of farm area turning either completely free of stubble burning, or a significant reduction in the extent of burning through partial burning. CII

[i] World bank statistics - https://data.worldbank.org/indicator/AG.LND.AGRI.ZS?end=2015&locations=IN&start=2001&view=chart Last accessed on May 3, 2023

worked toward expanding the program to other parts of these two states, and perhaps even to other states in the country over the next few years, based on availability of funding and regulatory support.

SUSTAINABLE CROP RESIDUE MANAGEMENT PRACTICES

In situ management methods such as straw incorporation and mulching supported the soil's capacity to retain water, nutrients, organic matter, and micro-organisms. These in situ methods, however, required access to tools such as super seeders, rotavators, and mulchers. Furthermore, some of these methods would be unsuitable for certain types of subsoil conditions. In these cases, ex situ methods such as collection and baling of leftover straw were more appropriate. Rice-growing countries such as China, Australia, and East Asian countries had banned straw burning and their farmers were encouraged to use baling, composting, and mulching instead.

TELLING THE STORY USING DATA

As Stephen Few, author and data visualization expert, stated, "Numbers have an important story to tell. They rely on you to give them a clear and convincing voice." In addition to providing access to the necessary tools (machinery and equipment) for rent, the team at CII had adopted various other mechanisms to change farmers' behavior, such as awareness building, technical training for efficient use of these tools, and handholding the farmers during the next crop season after paddy had been harvested. These projects were assessed through a detailed farmer survey to understand the level of farmer acceptance of various sustainable CRM practices, use of tools, the cost and time taken for alternative methods, and the impact of these sustainable alternatives on the next crop. The challenge for Pradhan was to gain complete and in-depth understanding of the survey data, extract valuable and actionable insights from it, and effectively explain these data to various stakeholders, especially to corporates willing to fund the CRM initiative. How can Pradhan explore these data, and what aspects of data should he focus on? How to present data such that it provides context and helps in highlighting key points to the audience? The success and progress of initiatives like CII's CRM are critical to saving the planet for future generations; therefore, Pradhan has an uphill task ahead of him. Can the existing toolkit for Data Visualization and Storytelling help him convince the donors?

DATA DESCRIPTION

The data available for analysis were collated from the sample surveys conducted with farmers after the CRM interventions in 2019 and 2020 in the two states of Punjab and Haryana respectively. Note that while there might have been some commonality in the sample of farmers who participated in these two surveys, there was no common identifier that would help identify the farmers who participated in both these surveys.

The data description was as follows:

- Farmer details such as
  - State, District, Village, Adoption year, Agriculture land in acres
- CRM practices adopted by farmers
- Tools used by farmers for various CRM practices
- Feedback on the benefits or challenges faced because of the adoption of CRM

Description and details of the data are provided in **Exhibit 1**.

Exhibit 1

Data Structure

Brief description of the data:

Name	Description
State	Farmer's State
District	Farmer's District
Adoption year	Adoption year (2019, 2020)
Land	Land area in acres
Method	Adopted CRM practice (complete burning, partial burning, straw incorporation, mulching, collection)
Tool	Tools (such as Mulcher, Super Seeder, Rotavator, etc.) used for application of various CRM methods during 2020.
Feedback	Feedback from farmers on the benefits/challenges of adopting CRM. Feedback was collected based on three criteria: 1. Weed infestation 2. Water consumption 3. Fertilizer consumption Feedback was collected using a three-point scale (-1, 0, +1). For example, for water consumption, value of -1 implied that the water consumption had decreased, value of 0 indicated that there had been no change in water consumption, and value of +1 indicated that the water consumption had increased.

Source: Prepared by authors based on the data provided by the CII

ENDNOTES

(All internet sources were accessed on May 2, 2022)

[1] Bhuvaneshwari, S., Hettiarachchi H, and Meegoda J N (2019), "Crop residue burning in India: Policy challenges and potential solutions." *International Journal of Environmental Research and Public Health,* 16(5), 832-851

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[3] Ladha, J K., Pathak H, Padre A T, Dawe D and Gupta R K, (2003), "Productivity trends in intensive rice–wheat cropping systems in Asia." *Improving the Productivity and Sustainability of Rice-Wheat Systems: Issues and Impacts,* 65, 45-76

[4] Singh G, Gupta M K, Chaurasiya S, Sharma V S and Pimenov D Y (2021), "Rice Straw Burning: A Review on its Global Prevalence and the Sustainable Alternatives for its Effective Mitigation", *Environmental Science and Pollution Research*, 25, 321125–321155