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DISCUSSION PAPER

STUBBLE BURNING: THE NEED FOR A BEHAVIOURAL LENS

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ABSTRACT

The open incineration of paddy crop residue, or stubble burning, in the north Indian states of Punjab and Haryana has become a recurring issue every winter. As pollution caused by stubble burning contributes to the Delhi Smog, the two events are almost always hyphenated in the public discourse, highlighting the former as primarily a public health issue rather than a farmers' issue. The policy solutions have broadly taken the form of a ban on the practice, incentivising farmers to adopt new crop residue management systems, or fining them. This year, the challenges presented by the COVID-19 pandemic and farmers' protests over the recent Farm Laws have amplified the impact of stubble burning and complicated the policy response.

This paper looks at stubble burning in the context of the COVID-19 pandemic. It analyses the implementation of key policy measures undertaken over the years to address it, from a behavioural perspective of the farmer. It also assesses the scope for greater private sector engagement in abating stubble burning and suggests some policy actions towards the end.

CONTEXT: STUBBLE BURNING AMIDST THE PANDEMIC

Stubble burning has been a common way of managing crop residue in North India. However, over the last decade, owing to its linkage with Delhi's winter smog and increased media spotlight, the practice has invited various policy measures from State and Central governments. On the back of these policies, since 2016, Punjab, Haryana and Uttar Pradesh have witnessed a decrease in stubble burning events during the months of October and November (figure 1 below).

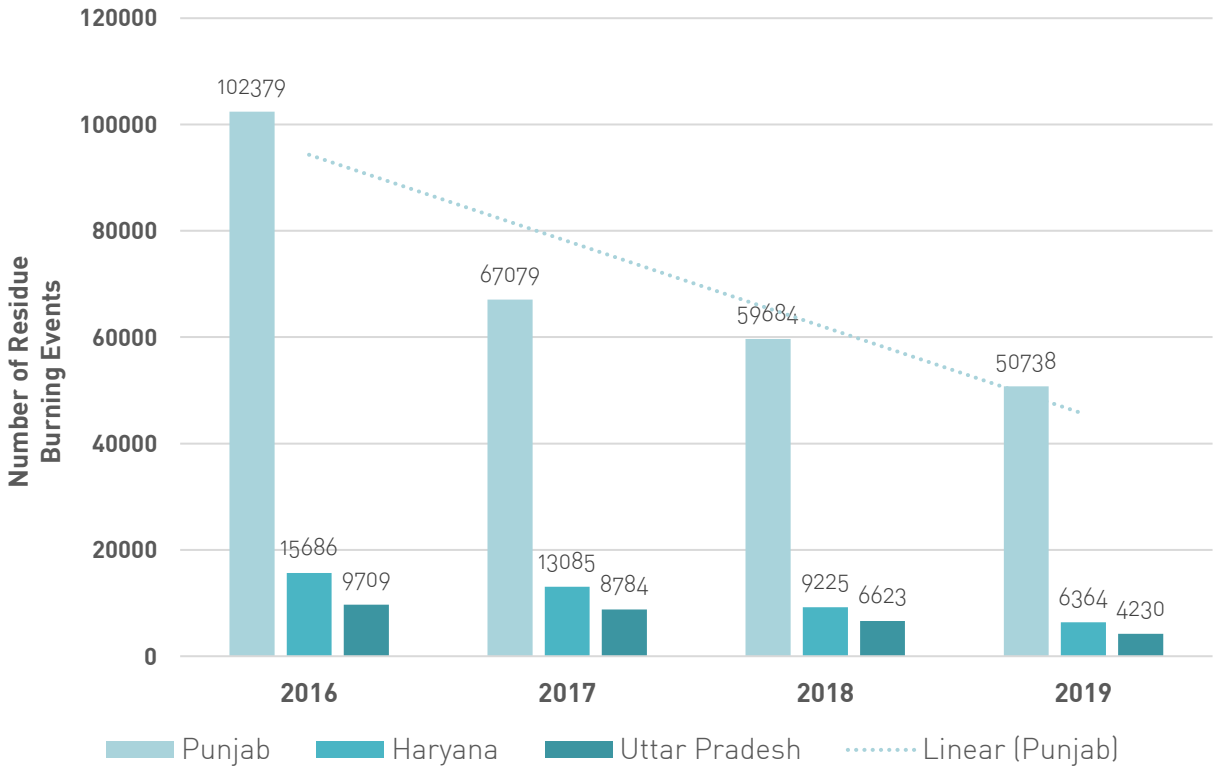

Figure 1: Crop Residue Burning: 1 October to 30 November (2016 - 2019)
Source: CREAMS laboratory, ICAR 2019

Still, in 2018-19, Punjab and Haryana generated 28.10 million tons of paddy straw out of which 40.21% was burnt in the fields (Ministry of Agriculture and Farmers Welfare 2019: 56). While the number of burning events overall has gone down substantially, Punjab has seen a significant increase in such events in 2020. Figure 2 below shows that between 1 October and 28 October 2020, Punjab recorded 21,335 burning events, much higher than the number of burning events in 2018 and 2019 during the same time. This year, the discontent over the new Farm Laws has also become a key factor in the increase in burning events as farmer union leaders across Punjab have been reluctant to cooperate with the government (Jagga 2020).

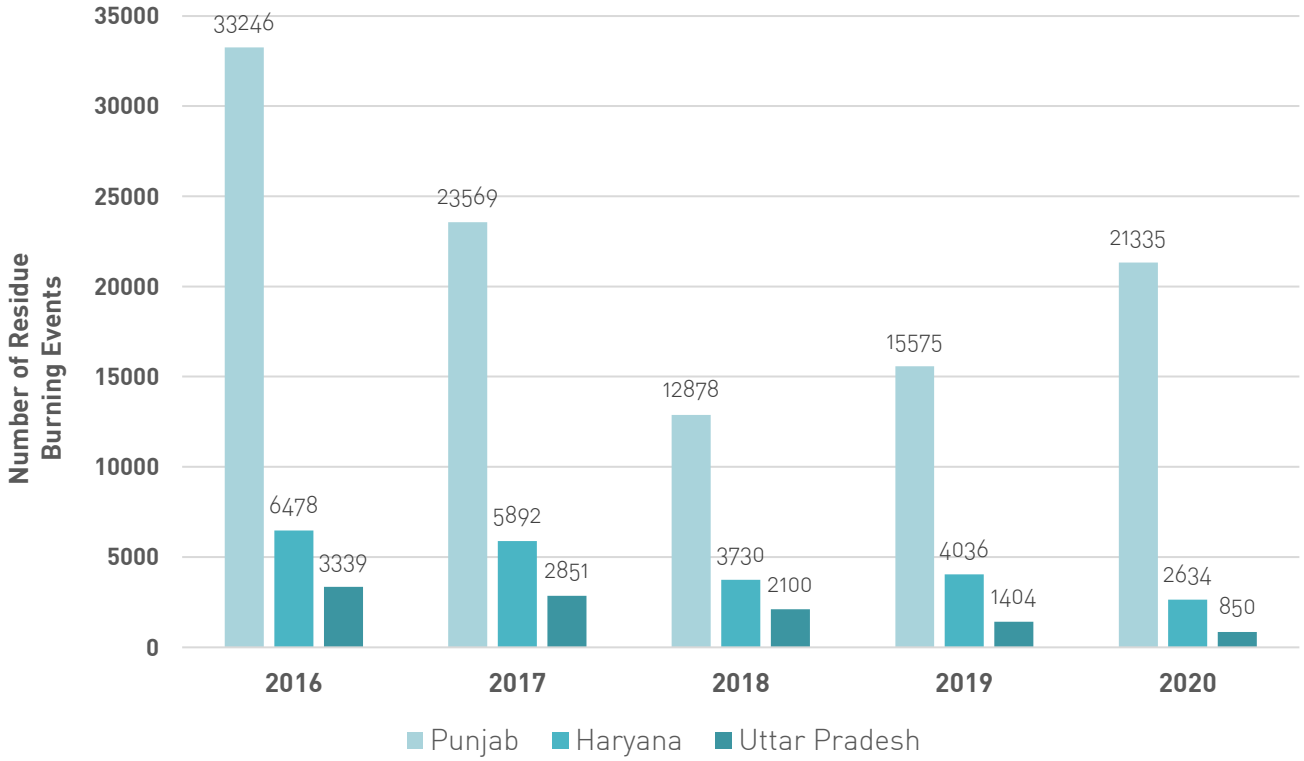

Figure 2: Crop Residue Burning: 1 October to 28 October (2016 - 2020)
Source: CREAMS laboratory, ICAR 2019

As noted by several studies, stubble burning reduces Nitrogen, Sulphur and Organic Carbon content in the soil in the long run apart from killing the beneficial microbial population. It also releases about 627 kilotonnes (Kt) of PM10 and 4677 Kt of carbon monoxide into the atmosphere annually in India (TERI 2020: 2), while contributing to 15-35% of ambient PM2.5 concentrations (Pandey et al. 2020: 3).

The PM2.5 particulate emission increases the risk of lung cancer and other respiratory illnesses. These health impacts cost rural Punjab more than INR 7.6 crore annually, while air pollution due to residue burning costs India USD 30 billion every year (Pandey et al. 2020: 10). Pollution-linked pulmonary conditions, caused or aggravated by stubble burning, can increase the risk of contracting the ongoing COVID-19 disease and make its treatment difficult. With the shift of healthcare resources towards COVID-19, an increase in respiratory infections will add to the burden of the healthcare infrastructure (Pandey et al. 2020: 3).

While stubble burning has always been a public health issue, it holds grave consequences under the

current circumstances. Yet, despite it being a crime under the Indian Penal Code and the Air and Pollution Control Act of 1981, for many farmers, it has become a behavioural imperative. The practice does have certain immediate benefits. The residual ash left behind lowers soil acidity, quickly controls weeds and insects and augments the immediate availability of nutrients such as Potassium and Phosphorous. But beyond such benefits, it is supported by prevalent agricultural policies and practices.

UNSUSTAINABLE AGRICULTURAL PRACTICES: A BEHAVIOURAL PERSPECTIVE

Punjab and Haryana are not naturally conducive for paddy due to the absence of black soil which is suited for its cultivation. Despite that, they together account for 15% of the country's rice production (Open Government Data Platform India). This level of production has been achieved due to the availability of high-yielding varieties of seeds, fertiliser subsidy, free electricity, and farm mechanisation since the Green Revolution (Murgai 1999). Above all, the power subsidy regime in the states enables the pumping of huge volumes of groundwater at zero-cost that compensates for the absence of black soil.

Consequently, in Punjab, groundwater extraction has increased from 149% of naturally available recharge in 2013 to 165% in 2018, indicating an unfolding water crisis in the state (Central Ground Water Board 2018). This, along with the guaranteed procurement of paddy under the Minimum Support Price regime, provides a robust structural support that makes paddy a reliable and profitable crop for farmers to grow (Ministry of Agriculture and Farmers Welfare 2019: 45).

The farmers of Punjab and Haryana practice double-cropping of rice and wheat or potato in a year. However, after the imposition of the Preservation of Subsoil Water Act in 2009[1] and the consequent delay in transplanting of paddy, the time window between the harvesting of paddy and sowing of the rabi crop is short, giving farmers only two to three weeks to manage the colossal amount of crop residue. Since the farmers have limited time and monetary resources, they burn the stubble as it is inexpensive and time-effective. In a survey of 625 farmers in Punjab, 41% stated the short time window between harvesting paddy and sowing wheat as the reason for burning and 48% believed that burning is faster and economical for them (Pandey et al. 2020: 5).

While the Central and State governments have attempted to address the issue through provision of subsidised crop residue management systems, monetary incentives, fines, and awareness programmes, the persistent occurrence of stubble burning highlights the shortcomings of these policies. However, owing to their habit and generational thinking around stubble burning, it is entirely possible that the farmers might continue the practice even when viable options are made available.

To nudge a change in this context, cost- and time-effective alternatives need to exist that can enable farmers to manage the crop residue efficiently and sow the rabi crop on time. Stubble burning in Punjab and Haryana, thus, must be viewed from a behavioural lens where farmers' decisions and government measures are guided by what's most profitable for them in the short run and sustainable in the long run.

[1] According to the Act, farmers were forbidden from sowing paddy before May 10, and transplanting it before June 10. This Act aimed at delaying the sowing of paddy into a time frame when the monsoon rainfall could be utilised for the crop instead of groundwater. This was implemented keeping in view the falling groundwater table in Punjab and Haryana.

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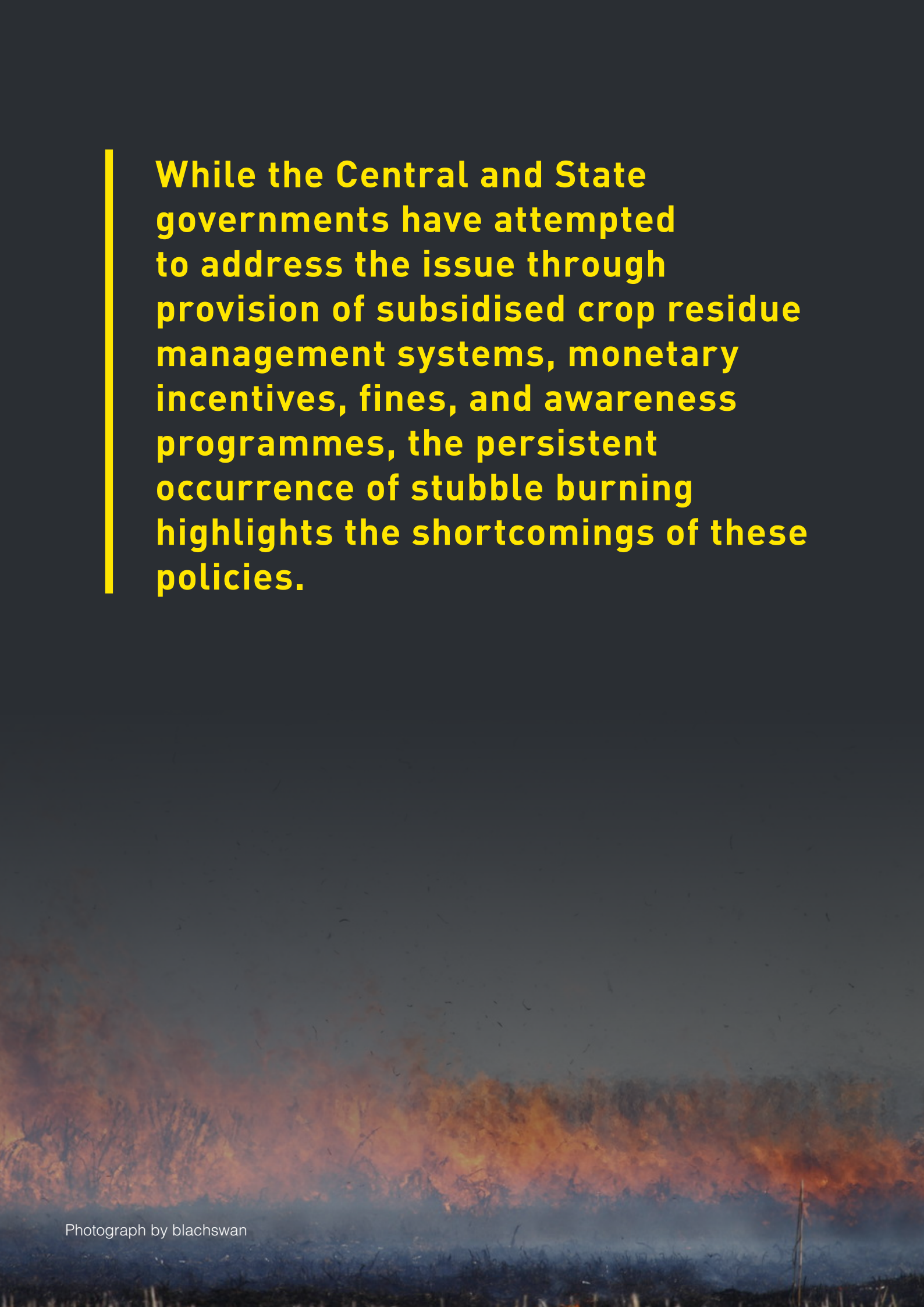

Photograph by blachswan

POLICY MEASURES AND IMPLEMENTATIONAL BOTTLENECKS

The Central and State Governments have undertaken several interventions to deal with stubble burning. The following is a timeline of primary policy interventions undertaken since 2013.

2013 - 2014: Crop Diversification Program (CDP) under Rashtriya Krishi Vikas Yojana (RKVY)
To shift the production of paddy to alternate crops like cereals, pulses, vegetables, fruits to serve the twin aims of reducing groundwater depletion caused due to excessive water usage in paddy irrigation and meeting the increasing demands for these alternate crops.
2014: National Policy for Management of Crop Residue (NPMCR)
To control the burning of crop residue to prevent environmental degradation through in-situ management and promote utilisation of residue for power generation, packing material, paper/board/panel industry, and composting.
2015: Ban on Agricultural Stubble Burning
Banned by the National Green Tribunal in Punjab, Haryana, Rajasthan, and Uttar Pradesh in 2015 under Section 188 of the IPC and the Air and Pollution Control Act of 1981. A fine of INR 2,500 to INR 15,000 is imposed on farmers practising stubble burning (Chakravartty 2015).
2018 – 2020: Central Sector Scheme on 'Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi'
To prevent environmental degradation due to crop residue burning through managing crop residue by incorporation in the soil and collection for further utilisation, and creation of awareness among stakeholders through Information, Education, Communication (IEC) strategies.
Biomass-based Power Generation
The Government of India (GoI) has directed the National Thermal Power Corporation (NTPC) to utilise crop residue pellets for 10% blending for power generation, which has helped farmers gain monetary return of approximately INR 5500 per ton of crop residue (Bhuvaneshwari et al. 2019: 7).
2019: MoU between Punjab Government and CSIR- NEERI
The Punjab Government signed a memorandum with CSIR-National Environment Engineering Research Institution (NEERI) for a five-year collaboration in effective monitoring of Environmental Protection Action Plans prepared for clean rivers, clean air, and waste management.
2019-20: Compensation Offered to Farmers for Not Burning Paddy Stubble
Punjab government announced an INR 2,500 per acre compensation to small and marginal farmers who own up to 5 acres of land, cultivate non-basmati rice and had not burnt paddy in any part of the field (Krar 2019).

A common string that passes through the policy measures undertaken by the Centre and State governments is that the farmers are held solely responsible for the management of stubble generated on their land. This notion is rooted in the 'polluter pays' principle that holds polluters (farmers) accountable for the pollution (stubble burning) from their economic activity. However, it is crucial to recognise that in most cases, farmers burn crop residue because they must. There exist certain gaps in government policies and their implementation that still makes burning paddy stubble the best alternative for farmers to manage the crop residue.

Shortage of Crop Residue Management (CRM) Machines

Although farmers are expected to use CRM machines for managing stubble, non-availability of these machines has been a crucial issue. In 2018-19, the number of machines delivered in Punjab stood at 28,609 (Ministry of Agriculture and Farmers Welfare 2019). The following year, this number fell to 14,625, even when the total number of machines sanctioned by the government was 22,872. This indicates that the farmers did not receive the required machinery (Nirmal 2019).

On examining the data on machines delivered and sanctioned in 2019-20, we can observe a discrepancy between the two, with the number of machines supplied consistently falling behind the number of machines authorised. Figure 3 shows that the availability of machines is a crucial factor behind stubble burning.

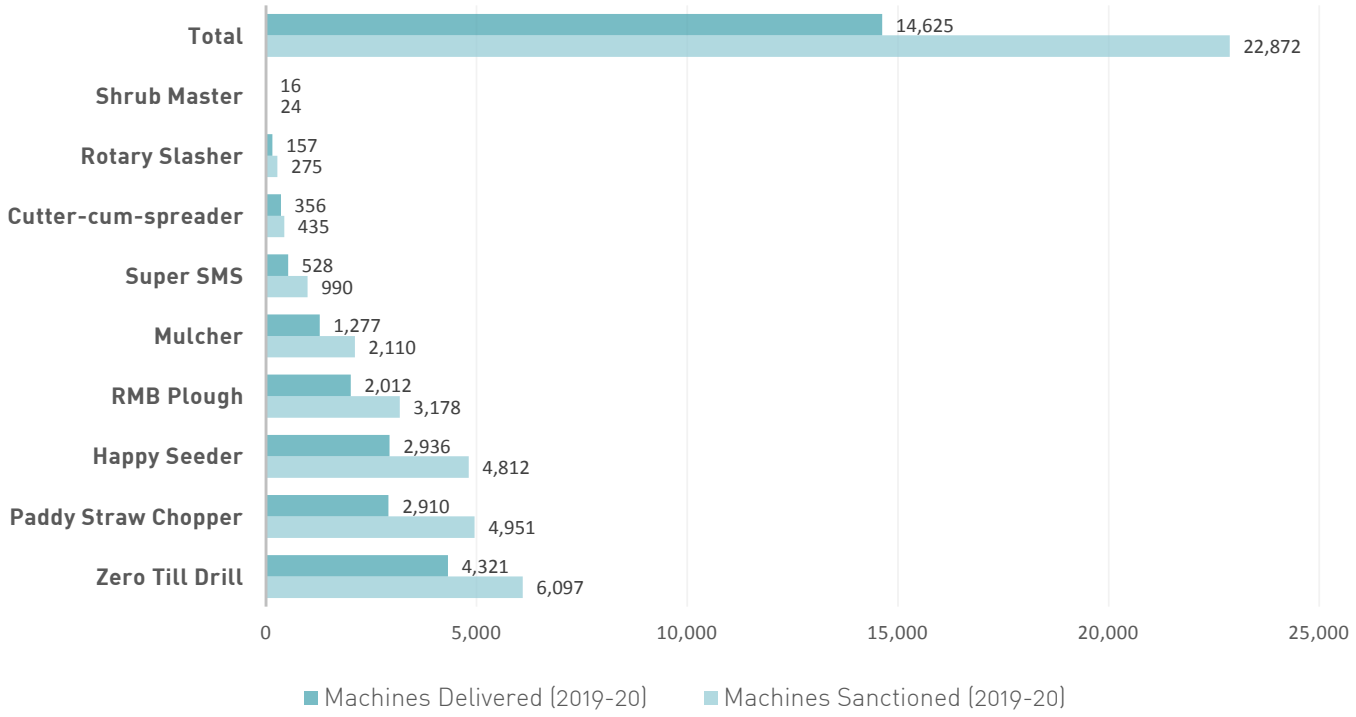

Figure 3: Machines Sanctioned and Delivered in Punjab (2019-20
Source: Nirmal 2019

A Happy Seeder machine is currently the most viable alternative to stubble burning as it removes the stubble while sowing wheat, without the need for manual labour. It sows six to eight acres a day. Hence, in the 25-day time window, the 12,694 machines delivered between 2018 and 2020 (9758 in 2018-19 and 2936 in 2019-20), can sow 20 lakh hectares to 25 lakh acres in a day (Nirmal 2019).

But even these number of Happy Seeders are not enough as Punjab has 56.83 lakh acres of land where stubble is burnt every year. Hence, 12,694 machines can sow only one-third to two-fifths of the total area. Punjab would need on an average 35,000 Happy Seeder machines to cover this entire area. There have also been reports stating delays on the government's behalf in placing orders to empanelled manufacturers (Gupta 2019: 18).

Along with the Happy Seeder, the Super Straw Management System (Super SMS) attachment is used with the tractor to spread the residue evenly as mulch. But the number of Super SMS machines is also short of demand which makes it challenging to manage the straw chopped by the Happy Seeders (Nirmal 2019).

Unaffordable Equipment and Labour

CRM machines are expensive, and despite the subsidy from the government, most farmers are unable to afford them. A Happy Seeder machine costs about INR 1.3 lakh. Even after 50% subsidy, a farmer must pay about INR 65,000, which could be a massive financial burden, especially for smallholders.

Loans to cover the cost of buying or renting the machine, which costs INR 4,000 per acre, surpasses the budget constraints of small and marginal farmers (Kumar 2019). Although the Central Sector Scheme (CSS) also provides 80% subsidy to farmer co-operative societies to rent the necessary machinery, most of them still do not have enough funds to purchase machinery (Pandey et al. 2020: 15).

The usability of Happy Seeder machines is also contingent on the availability of big tractors with 65 Horsepower (HP) capacity, as only high capacity tractors can pull the Happy Seeder machine effectively. In Punjab, majority of the tractors have 30 HP to 40 HP capacity. Additionally, the basic cost for a 65 HP tractor is INR 96,000, which is too expensive for a small farmer (Kumar 2019). Farmers also find it uneconomical to invest their money into purchasing the CRM machines as they are used only once a year for about 20 days, thus leading to additional maintenance costs.

Another holdup is the shortage of labour. In Punjab, 80% of paddy is harvested using combine harvesters, which leave larger rice residue behind, as against manual harvesting, which leaves shorter stems behind and thus generates a lower amount of stubble. Between 2004-05 and 2011-12, the workforce in agriculture shrunk by 30.57 million labour, chiefly due to the MNREGA scheme. Increasingly, the workers from Bihar and Uttar Pradesh find jobs within their states and do not migrate as much as they did earlier. Due to this supply shortage, labour cost for sowing paddy has increased from INR 1,500 per acre to INR 2,000-2,500 per acre from 2017 to 2018 (Gupta 2019: 5).

Interviews with farmers conducted by the Council on Energy, Environment and Water (CEEW) revealed that due to their financial condition, farmers prefer to burn the stubble and pay the fines levied on them rather than purchase the unaffordable machines and expensive labour.

Inefficient Rental Markets

Under the CSS, Farm Machinery Banks or Custom Hiring Centres can be established for providing machinery and equipment hiring services to farmers. However, the rental market remains inefficient. In 2018, the Muktsar district in Punjab ordered 96 Happy Seeder machines, out of which only 41 were delivered (Pandey et al. 2020: 18).

Media reports indicate that in some villages, only two machines are available for 1000 farmers (Kumar 2019). A farmer from Ambala, Haryana put in an application for a Happy Seeder machine in 2019 and was asked to form a co-operative of 15 farmers. Even after doing so, his application for a machine continued to get rejected until he gave up.

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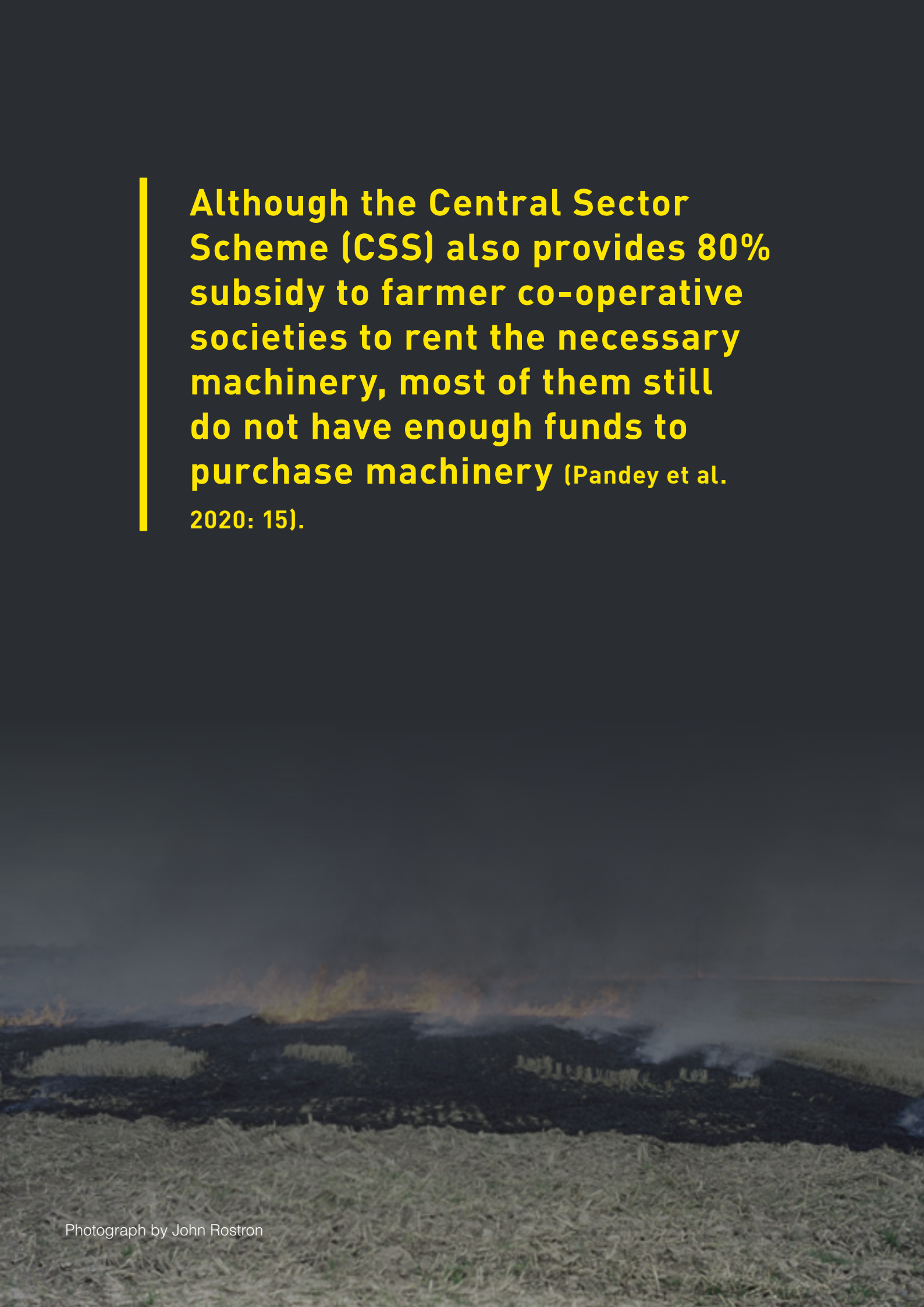

Photograph by John Rostron

The rental cost is also not standardised as some farmer's co-operatives charged INR 500 per acre while others charged INR 1,500 per acre. This has created uncertainties amongst farmers as they are not aware of the accurate pricing of the machinery and equipment (Gupta 2019: 19).

Inadequate Market for Paddy Residue Management

Punjab generated 20.17 million metric tonnes (MT) of crop residue in 2018-19. Paddy residue is valuable biomass that can be utilised in power plants, composting, biofuel, mushroom cultivation, utensils, cardboard/paper making, as fodder, and mulch.

Punjab utilised only about 50% of the paddy straw generated during 2018-19. Sixty-three per cent of the paddy straw – 6.41 million tons – was managed through different available straw management systems, including machinery and equipment (Figure 4 below). Note that this number also includes 2.89 MT straw which was partially burnt or taken out of fields. Punjab's seven biomass-based projects could utilise only 1% of the straw generated (Ministry of Agriculture and Farmers Welfare 2019: 52).

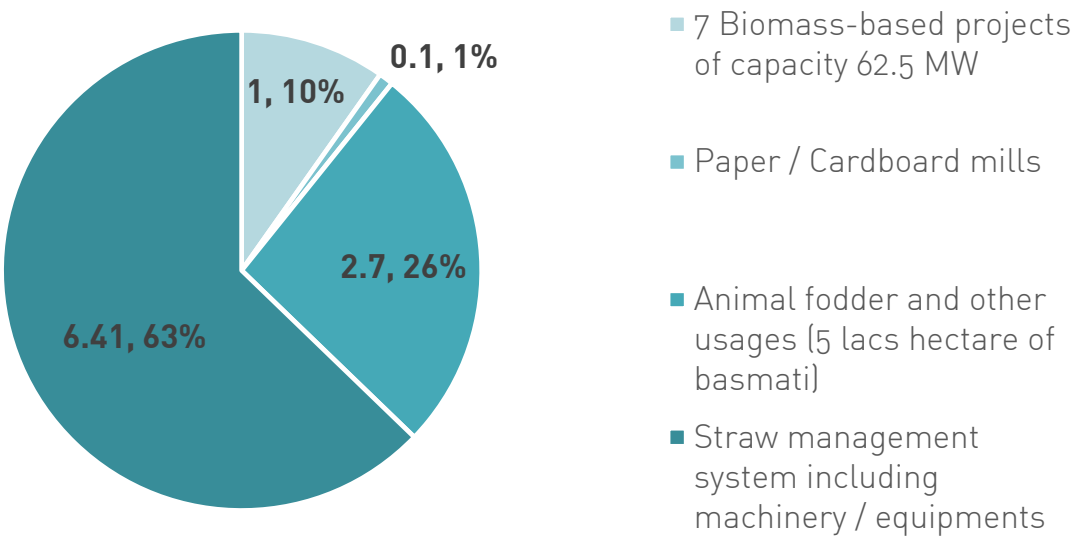

Figure 4: Amount of crop residue used (million tons per year)
Source: Ministry of Agriculture and Farmers Welfare 2019

The markets for an alternative use for paddy straw are either absent or small, supply chains are inefficient, and the technology available is not advanced enough to use the total amount of crop residue that is generated (Sarma 2018). Baling paddy straw, a method to compress loose paddy straw into square bales for easy transportation, is a potential paddy straw management system. But it costs the farmer INR 1,100-1,400 per acre to get the bales made and transported to a storage area or a paper and cardboard mill (Gupta 2019: 19).

Thus, in the absence of adequate market and supply chains, farmers do not find it economical to invest the time and resources to collect the paddy straw, because even if they do so, there is no guarantee that the stubble will be bought or even taken away from their fields.

Lack of Awareness and Trust

Studies indicate a lack of awareness among farmers regarding the implications of stubble burning and other options to manage crop residue. A study conducted in Mirzapur village of Kurukshetra district in Haryana revealed that farmers have a low level of awareness about specific health impacts of air pollution caused due to crop burning and its effects on soil quality (Grover 2015: 82).

Another study comprising 50 farmers in Jind district of Haryana found that farmers are highly aware of the environmental and health impacts of stubble burning and even feel the need to stop the practice. However, they have poor awareness of alternative options to burning stubble (Dhall 2020: 10).

Misinformation regarding a fall in wheat yield when Happy Seeder machines are used for sowing wheat also exist. But farmers and experts have clarified that during the early years, using Happy Seeders will not increase or decrease the wheat yield significantly, and the proper technique must be followed to reap a good wheat harvest. After 2 to 3 years, wheat yield starts to rise by 8-10% (Goyal 2019).

There have been cases where farmers collected the crop residue for the government officials to pick them up, but no official visited. This led to losses for the farmer in terms of the total cost incurred to extract the crop residue and a lack of trust in government assurances. Some farmers ultimately burnt the crop residue as it was blocking large areas of their fields (Dhall et al. 2020: 12). There are also reports from Punjab where farmers who refrained from burning stubble have not received their INR 2500 per acre compensation from the government (Singh 2020).

Dhall et al. (2020) also found that less than 50% of the farmer respondents were engaged in agricultural programmes undertaken by the government, and most farmers were using the internet to explore agriculture-related programmes. This could indicate that farmers do not find government-led programmes relevant or they do not trust these sources.

PRIVATE SECTOR ENGAGEMENT: LEARNING OUTCOMES

From the previous section, we can conclude that the policy responses and their impact on stubble burning remain limited due to the gaps in adequate monetary support to farmers, availability of CRM machines, awareness programmes, and utilising the stubble for alternate purposes. In this context, the private sector carries immense potential in enabling the farmers to adopt sustainable practices to stubble burning, which can be economical for them, both in the short- and long-term.

As part of their Corporate Social Responsibility (CSR) initiatives, private companies can offer their expertise to the government and the farmers by creating a market for crop residue, building supply chains, and investing in alternate uses of crop residue to broaden its demand. To this end, a US $1 million Paddy Straw Challenge Fund has been set up by the Punjab State Farmers' and Farm Workers' Commission to invite worldwide applications for products that can ensure in-situ incorporation of paddy straw within 20 days of harvesting paddy, without negatively impacting the soil. Private sector engagement has already picked up pace in this area, out of which some best practices are discussed below.

The Confederation of Indian Industry (CII) undertook a Crop Residue Management (CRM) Programme in 2019, covering rice-intensive geographies of Punjab and Haryana to build a successful model for behaviour change among farmers. In 2018, 64% of the paddy straw generated was being burnt, which reduced to 24% after field interventions in 2019-20. Within one year, the adoption of better CRM practices rose by 84%, which also improved yields. Ex-situ solutions like baling cost about INR 4350 per acre, which is 48% more than the cost of burning, demanding better solutions to make it affordable to the farmers. This intervention by CII emphasises the role of actionable and affordable alternatives to inspire change in farmers' behaviour (Sharma et al. 2020: 2). The following table lists out some other key private ventures providing farmer-friendly alternatives to stubble burning.

Table 1: Key Private Sector Initiatives on Stubble Burning

A2P (Agri2Power) Energy Solution	They purchase the residue from farmers and process it into pellets or biofuels that can be used in food processing, pharmaceutical, and dyeing industries like Pepsi and Hindustan Unilever.
RY Energies	They procure crop residue from the farmers to convert it to biomass resources that are then utilised to generate electricity in power plants.
Farm2Energy	They are educating farmers to refrain from burning the residue, collecting paddy straw bales and using them to produce biogas, biochar and bio pellets that are then sold to industries.
Bio-lutions	They are converting agricultural waste to biodegradable packaging.
Kriya Labs	They are converting paddy straw into rice pulp and then into biodegradable cutlery.
Punjab Biomass Power Ltd (PBPL)	This is a 12 MW rice-straw power plant that uses 1,20,000 tonnes of stubble collected from about 15,000 farmers as input. They pay INR 900 per tonne for non-basmati rice straw and INR 1,500 per tonne for basmati rice straw, which is a good subsidiary income for farmers (Sood 2015).

While these initiatives are meaningful alternatives, they cannot address stubble burning in its entirety because of their localised nature. There is, thus, a need to consolidate private sector efforts and expand these initiatives along with structured government interventions.

POLICY RECOMMENDATIONS

While looking at stubble burning as a behavioural problem, we find that farmers are compelled to burn the crop residue because of the lack of CRM machines, expensive technology, high capital investments, lack of awareness, and limited markets for crop residue. Policy interventions, thus, should also be aimed at helping farmers gradually shed the generational practise of stubble burning through a multi-pronged framework that benefits them not only now, but also in the long run.

1. Improve Awareness among Farmers

Farmers usually take the total yield as the only indicator for evaluating the value gained from, say, using a Happy Seeder machine. The maximum a farmer can profit by switching to Happy Seeders is INR 22,254 per hectare and in the worst case lose INR 4012 per hectare. On average, the Happy Seeder is 10% more profitable than the most profitable burning options (Shyamsundar et al. 2019: 536).

Thus, awareness programmes must explain the amount the input costs, fertilisers, and water that CRM machines and in-situ treatment save in the short-term, along with the positive impact on soil fertility in the medium- to long-term, which reduces agrochemical costs. NGOs and universities can play a crucial role in communication, social nudging through trusted networks, and demonstration and training for farmers (Shyamsundar et al. 2019: 538).

Additionally, to nudge the farmers to shift away from paddy production, it is also crucial to increase the procurement of pulses, oilseeds, and coarse cereals on MSP. A proper agricultural marketing infrastructure for these crops can prove useful to incentivise the farmers to adopt crop diversification.

2. Ensure Affordability and Availability of CRM machines

Raising awareness is futile if not teamed with CRM systems that are available and affordable. As mentioned earlier, despite subsidies, CRM machines remain unaffordable or unavailable to farmers. To bridge this gap, amplified manufacturing and better financial incentives are required.

A farmer will adopt cleaner measures only when they can afford the machines required, and if the machines or residue management services are available on time. The rental markets for the machines must be regulated to avoid any artificially inflated prices and differential pricing.

Innovation by the private sector in developing alternative usage of paddy straw and more crop residue intensive technologies, which are inexpensive and can be made readily available, is required through government and private-sector investment.

3. Scale Incorporation of Crop Residue into the Soil

Crop residue is a natural resource that contributes to soil fertility, irrigation efficiency, and erosion control if ploughed directly into the soil or after composting. Research studies show that soil treated with crop residues hold about five to ten times more aerobic bacteria and up to eleven times more fungi than the soil from which residues were either burnt or removed (Lohan et al. 2018: 701). Conservation agriculture is a sustainable way to retain and manage the adequate amount of crop residue.

The report of the Committee constituted to look into crop residue burning in Northern India has recommended paddy straw incorporation into the soil as more environmentally sustainable than ex-situ management. The latter is more expensive and takes useful biomass away from the soil. However, ex-situ management could be economically viable if bio-fertilisers produced from the crop residues can be brought back to the field.

In 2018, out of the 28.10 million tonnes of paddy straw that Haryana and Punjab together produced, 59.79% was managed through incorporation in the soil and other measures (Ministry of Agriculture and Farmers Welfare 2019: 56). There is a need to promote higher incorporation of residue into the soil as a short-run measure. This will require both better availability of machines and more Information, Education, Communication (IEC) activities.

Ongoing innovations in the Happy Seeder and new mulcher machines are a step in the right direction to make available CRM systems that are more affordable and acceptable within the farmer's community. The new bio-decomposer capsules developed by the Indian Agricultural Research Institute, when scaled to Punjab and Haryana, can be highly effective in incorporating stubble into the soil through converting it into nutritious manure (The Print 2020).

Another measure could be the provision of subsidies or cash transfers by the government to encourage in-situ management of crop residues, similar to the subsidies on mineral fertilisers or amendments (Lohan et al. 2018: 703).

4. Strengthen Linkages for Ex-situ Management of Crop Residue

Ex-situ management of crop residue holds great potential in managing the stubble and also ensuring income for the farmers. Crop residue can be utilised in power plants, producing biofuels, handicrafts, fodder, mulch, and mushroom cultivation.

Since ex-situ management is expensive and markets for crop residue are scanty, the local governments, municipalities, and farmers' associations must come together to launch community programmes to facilitate the collection of crop residue and transportation to where it is needed. The government must come together with the private sector to create markets and supply chains to establish adequate systems for linking farmers who can supply crop residues to the private sector with a demand for it.

Creation of inter-state linkages between farmers will help even out the demand and supply of paddy straw. This could be an ensured source of income for the farmers.

5. Incentivise Crop Diversification

Cost-effective technology can address stubble burning in the near-term, but in medium- to long-term, scaling crop diversification is an important policy intervention. Crop diversification improves the diversity of food production, thereby improving nutritional security and ecosystem services for pest and disease control. It also improves the resilience of the ecosystem to climate variability and extreme events. It can be implemented through crop rotation, polycultures, increased structural diversity or agroforestry (Pandey et al. 2020: 18).

Despite efforts by both the Punjab and Haryana governments, diversification of the cropping pattern has not been successful. Professor H.S. Shergill of Panjab University has suggested that this is because "diversified agriculture is incompatible with commercial farming" that is taking place in these states. The current paddy-wheat rotation is ideal for sustaining current levels of farmers' incomes. He also stated that a shift away from paddy can only be gradual and over a long period of time.

A long-term strategy is needed to cause a slow transition to alternative crops like maize and make them as economically attractive as paddy is today. An MSP scheme for maize and adequate monetary support to farmers to compensate them for the variable yield of maize is necessary. The farmers must be ensured guaranteed public procurement at a reasonable price. Efficient and affordable machinery to cultivate alternate crops must also be in place, along with scaling of awareness programmes (Ministry of Agriculture and Farmers Welfare 2019: 45).

6. Promote Short-Duration Rice Varieties

Early-maturing varieties of rice provide farmers with enough time for harvesting the paddy crop, clearing out the stubble and preparing the fields for the next crop. The Punjab Agricultural University (PAU) has developed PR 126 and PR 127 varieties that mature early, consume less water, have less heavy stubble and have a higher yield.

The farmer's decision on the rice variety is often influenced by the willingness of the rice mills in the area to

procure their paddy for milling and delivery to the Food Corporation of India (FCI). There have been reports of rice mills taking out advertisements to discourage farmer from planting the PR 126 variety as they would not procure it (Ministry of Agriculture and Farmers Welfare 2019). This political network of rice millers can be very influential. Hence, it is also crucial to look at the factors that deter them from procuring this variety and try to fix their problems, to allow the farmers to switch to these short-duration rice varieties.

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